RESOLUTION NO. 412

A RESOLUTION OF THE WOODINVILLE CITY COUNCIL ADOPTING THE COMPREHENSIVE STORMWATER MANAGEMENT PLAN DATED DECEMBER 2010.

WHEREAS, the effective and efficient management of stormwater is a high priority of the City to preserve the quality, economic base, and livability of the community; and

WHEREAS, the effective management of stormwater can prevent flooding that can cause significant damage to private property, public infrastructure and facilities, and cause severe disruption and economic impacts; and

WHEREAS, the City of Woodinville owns and operates a stormwater utility that conveys surface water flows through pipes, ditches, ponds, vaults, and detention facilities to receiving waters of Little Bear Creek and the Sammamish River; and

WHEREAS, the City of Woodinville recognizes the need to plan for effective and efficient stormwater management of surface water flows; and

WHEREAS, the City of Woodinville recognizes the need to operate its stormwater utility in a cost effective manner meeting the needs of the City and its citizens; and

WHEREAS, the City completed its Comprehensive Stormwater Management Plan in December 2010 and presented it to the City Council in February 2011; and

WHEREAS, the SEPA Determination of Non-significance was issued for the Comprehensive Stormwater Management Plan on June 13, 2011; and

WHEREAS, the City Council after consideration deems the proposed plan to be in the public interest and its adoption necessary for the promotion of the public health, safety and welfare;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF WOODINVILLE, WASHINGTON, HEREBY RESOLVES AS FOLLOWS:

Section 1. Comprehensive Stormwater Management Plan Adopted. The Comprehensive Stormwater Management Plan, dated December 2010, a copy of which is attached hereto, is hereby adopted and approved as the Woodinville Comprehensive Stormwater Management Plan.

RESOLVED this 6th day of March, 2012.

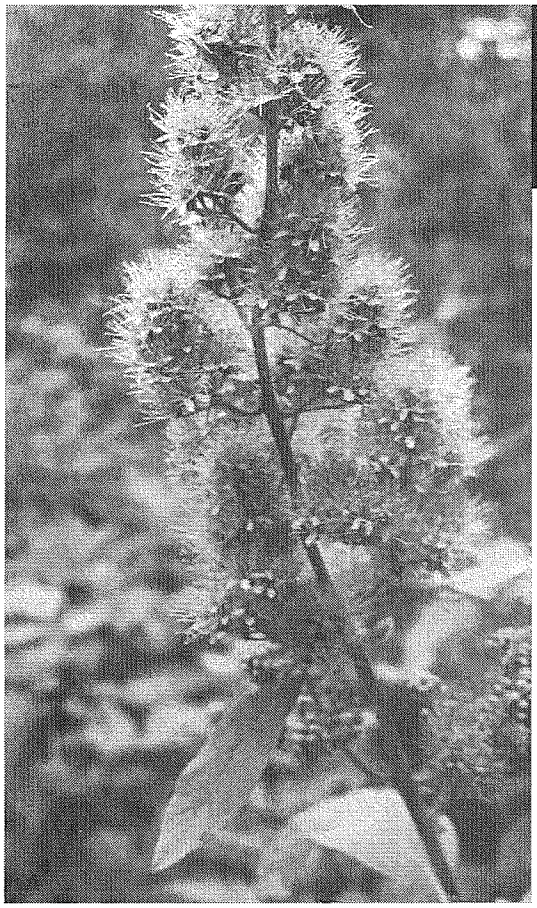
Bernard W. Talmas

BERNARD W. TALMAS, MAYOR

ATTEST/AUTHENTICATED:

Jennifer Kuhn

JENNIFER KUHN, CITY CLERK/CMC



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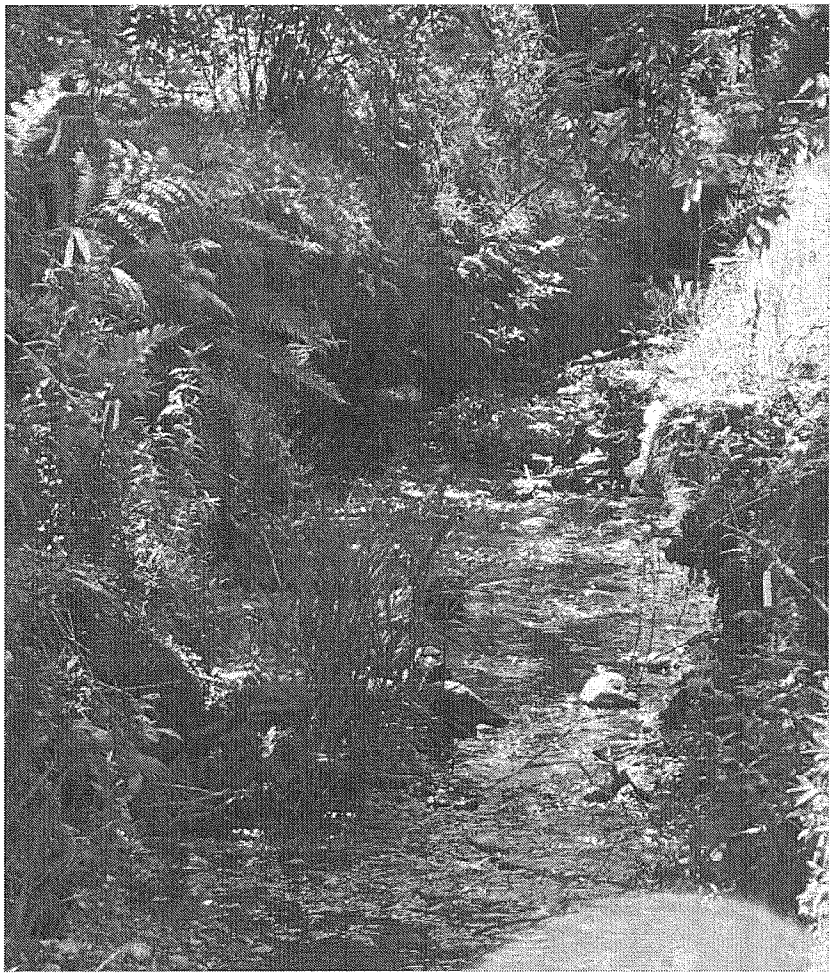
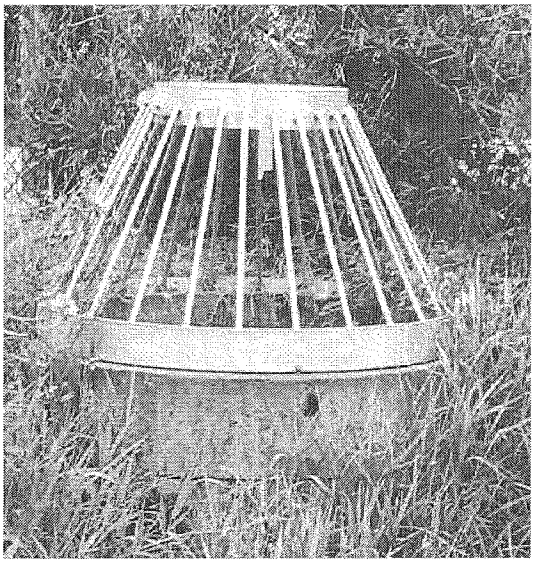
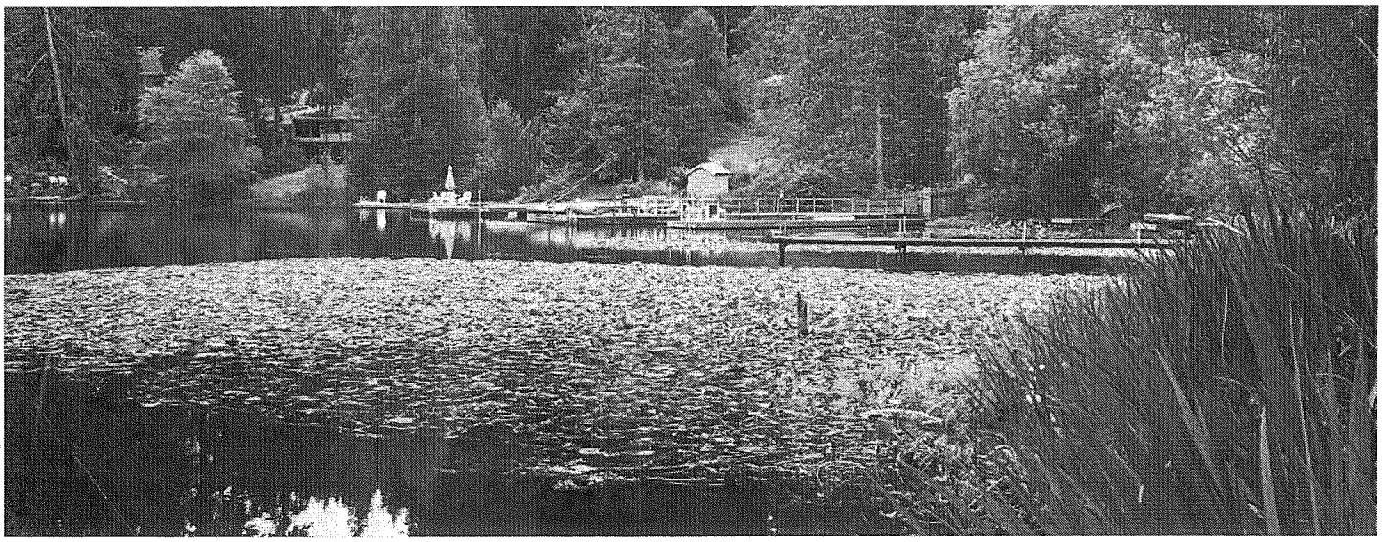




CITY OF WOODINVILLE FINAL

Comprehensive Stormwater Management Plan



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City of Woodinville
Comprehensive Stormwater Management Plan

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Woodinville Comprehensive Stormwater Management Plan

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Abbreviations and Acronyms

2005 ECOLOGY MANUAL	2005 Department of Ecology Stormwater Management manual for Western Washington
ACTION AGENDA	Puget Sound Partnership Action Agenda
BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe
CIP	Capital Improvement Projects
CITY	City of Woodinville
CSWM	Comprehensive Stormwater Management
CWA	Clean Water Act
ECOLOGY	Washington State Department of Ecology
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FPS	feet per second
GIS	Geographic Information System
GMA	Growth Management Act
HSG	Hydrologic Soil Group
IDDE	Illicit Discharge Detection and Elimination
KCSWDM	King County Surface Water Design Manual
KCSWM	King County Surface Water Management
LF	Linear Feet
LID	Low Impact Development
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resource Conservation Service
NTCHS	National Technical Committee for Hydric Soils
PARTNERSHIP	Puget Sound Partnership
PHASE II PERMIT	2007 National Pollution Discharge Elimination System Phase II Municipal Stormwater Permit
R	Residential (Zoning)
SBUH	Santa Barbara Urban Hydrograph
SEPA	State Environmental Policy Act
SCS	Soil Conservation Service
SR	State Route
SWM	Stormwater Management
SWPPP	Stormwater Pollution Prevention Plan
Tc	Time of Concentration

TMDL	Total Maximum Daily Load
UGA	Urban Growth Area
UIC	Underground Injection Control
UTILITY	Surface Water Utility
WMC	Woodinville Municipal Code
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation

Executive Summary

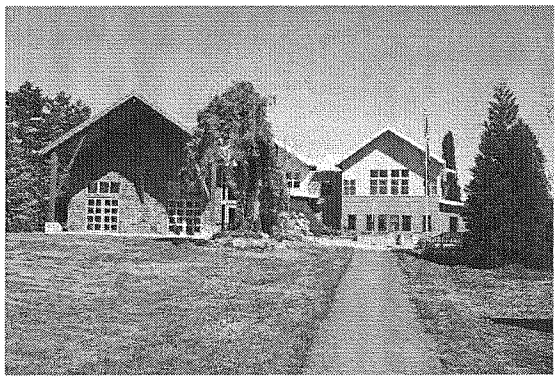
Background

Incorporated in 1993, the City of Woodinville (City) is a young, growing city faced with the challenges of balancing continuing economic development with environmental protection, and host of local, state and federal regulations. The City's existing stormwater management program is currently providing public education, maintaining its drainage system, approving new development/redevelopment, controlling pollution sources, monitoring water quality, protecting salmon habitat, constructing capital improvement projects (CIPs), and complying with various regulatory requirements, including the federal Clean Water Act (CWA) through the City's 2007 National Pollution Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit (Phase II Permit). Figure ES-1 shows a vicinity map of the City.

The intent of this Comprehensive Stormwater Management (CSWM) Plan is to create a vision for the City to ensure its stormwater infrastructure and program planning occurs in a manner that is consistent with the expectations and priorities of the City, its citizens and the Washington State Department of Ecology (Ecology).

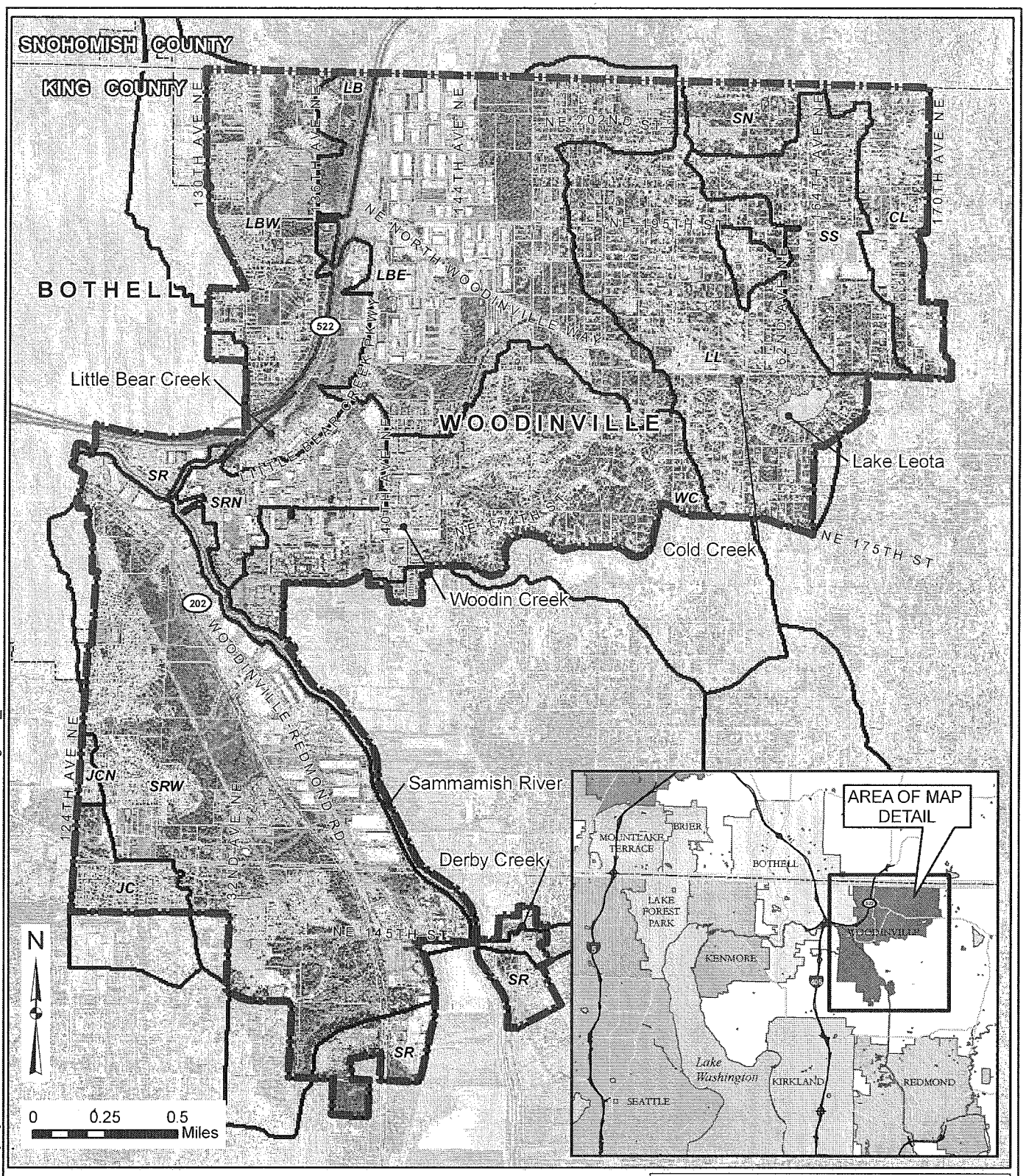
Purpose of the Study

In May 2009, the City initiated the development of its first CSWM Plan, building upon an earlier internal draft plan developed by City staff. The intent of this plan was to update the list, priorities, and costs of the City's stormwater management (SWM) capital projects, document the status of the City's current SWM Program and compare it to regulatory requirements, estimate future capital and regulatory compliance (regulatory gap analysis) requirements, and review staffing and revenue levels to ensure adequate resources for implementation.



City of Woodinville City Hall

The City's SWM Program is built upon the Phase II Permit as issued by Ecology in 2007; it gives the City five years (2007-2011) to comply. Thus, the Phase II Permit requires the City to update and expand its SWM Program by the end of 2011. In addition, the City needs to be in compliance with a number of other local, regional and state requirements including the Puget Sound Partnership Action Agenda (Action Agenda) for cleaning up Puget Sound, the State's Underground



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LEGEND

- City Limits
- County Boundary
- Parcel Boundary
- SR Subbasin Boundary
- Lake
- Streams
- Highway

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville (city limits,hydrology,parcel boundaries,streets), King County GIS (county boundary) and Aerial from Aerials express 2005.
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE ES-1

VICINITY MAP

otak

OCTOBER 2010

Injection Control (UIC) Rule that governs stormwater infiltration, the Endangered Species Act (ESA), and the regional Watershed Resource Inventory Area (WRIA) habitat enhancement plan for the Lake Washington Watershed. These regulations will be integrated with the City's CIP needs and basin planning priorities as the CSWM Plan is developed.

Approach

The approach used in developing this CSWM Plan is to document and evaluate drainage problems, address local capital needs, list activities and resources required for Phase II Permit compliance, and operate within the annual revenues of the City's SWM Fund, as shown in Figure ES-2.

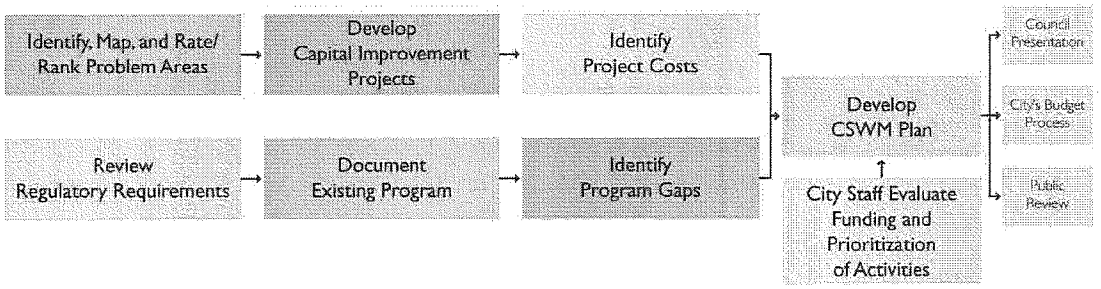


Figure ES-2 – CSWM Planning Process

SWM Plan Adoption Process

The SWM Plan Adoption Process will happen in phases with some overlap between the phases:

- Phase I: State Environmental Policy Act (SEPA) Process
- Phase II: Public Review Process
- Phase III: City Council and Planning Commission Review and Approval Process

The City will conduct Phase I: SEPA Process while beginning the public review process. Phase I will consist of drafting the Non-Project SEPA Checklist, filing the Checklist with the City, and a 30 day comment period. After the 30 day comment period, the City will issue a "Determination of Non-Significance" on the SEPA Checklist with an additional 15 day comment period.

Phase II: Public review process will be done in conjunction with Phase I: SEPA Process. Phase II will include posting the Draft SWM Plan on the City's website, and making it available at City Hall on compact disk (no charge) or hard copies available for purchase. The City will also conduct an Open House or Public Meeting to conduct discussions with the public and receive public comments on the Draft SWM Plan.

Phase III: City Council and Planning Commission Review and Approval Process will include a Public Hearing and Study Session with the City Council, along with a Public Hearing with the Planning Commission. The City Council will issue a decision on the adoption of the SWM Plan.

1.0 Introduction

This CSWM Plan consists of the following Sections:

- Executive Summary
- Section 1: Introduction
- Section 2: Characterization of the Study Area
- Section 3: City's Stormwater Management Plan
- Section 4: SWM Facilities and Maintenance
- Section 5: SWM Capital Needs
  - 5.1: City-Wide Hydraulic Analysis
  - 5.2: Problem Ranking and CIP Development
  - 5.3: Capital Improvement Implementation Plan
- Section 6: Regulatory Compliance
- Section 7: SWM Program Summary and Implementation

Also included in the CSWM Plan are several technical appendices that provide details on the Phase II Permit, the CIP development process, maintenance standards, and the City's Water Quality Monitoring Program.

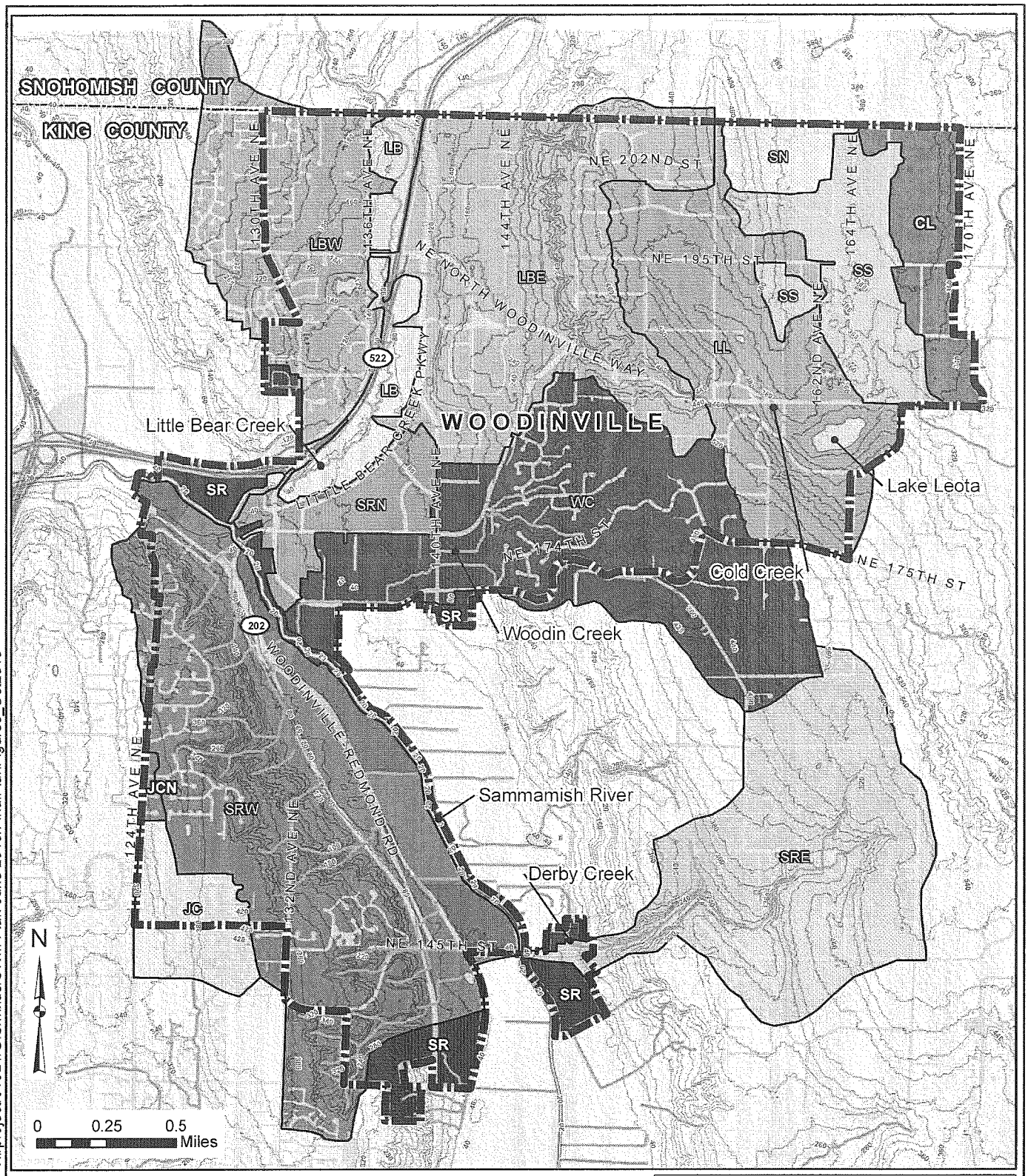
2.0 Characterization of the Study Area

Section 2 provides a general description of the major watersheds and drainage basins in the City based on topography, soils, hydrologic conditions, natural drainage features, and major stormwater facilities. Appendix A provides drainage basin maps within the City.

For the purpose of this study, the City's drainage area was divided into major watersheds and adjacent drainage areas, as shown in Figure ES-3. As the study progressed, these watersheds were further defined into major drainage basins. The study area has been characterized by drainage basin boundaries, hydrologic characteristics (including climate, soils, topography, sensitive areas, steep slopes and floodplains), drainage basins and streams, and existing zoning and future impervious percent area.

3.0 Overview of City's SWM Program

Section 3 provides an overview of the Purpose and Mission of the City's SWM Program, together with a summary of current organization, staffing, utility rates and annual revenues, activities and services.



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LEGEND

- City Limits
- County Boundary
- Highway
- Streams
- 20 ft Contour

Basin Boundary

- Cottage Lake (CL)
- Juanita Creek (JC)
- Juanita Creek North (JCN)
- Little Bear (LB)
- Little Bear East (LBE)
- Little Bear West (LBW)
- Lake Leota (LL)
- School North (SN)
- School South (SS)
- Sammamish River (SR)
- Sammamish River East (SRE)
- Sammamish River North (SRN)
- Sammamish River West (SRW)
- Woodin Creek (WC)

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE ES-3

DRAINAGE BASINS

CITY OF WOODINVILLE

OCTOBER 2010

The City's SWM Program is primarily funded through utility fees, with the revenue being collected and distributed annually from the City's Surface Water Management Fund. To date, utility fees, along with periodic grants and a small amount of investment income, have been used to cover the annual costs of the various SWM Program activities and capital projects. Initial utility rates were established in 1993 and have been increased once by 2.5% in 2006. Current single family residential rates are $87.15/parcel/year ($7.26/month). Parcels other than single family are charged a rate based on percent impervious area and acreage. In 2010, total SWM Fund revenues are projected to be $915K. Since 2008, the City has also received a total of $275,000 in grant funding from Ecology for Phase II Permit implementation.

The City's SWM Program includes a number of activities and services that are organized into the following services and activities:

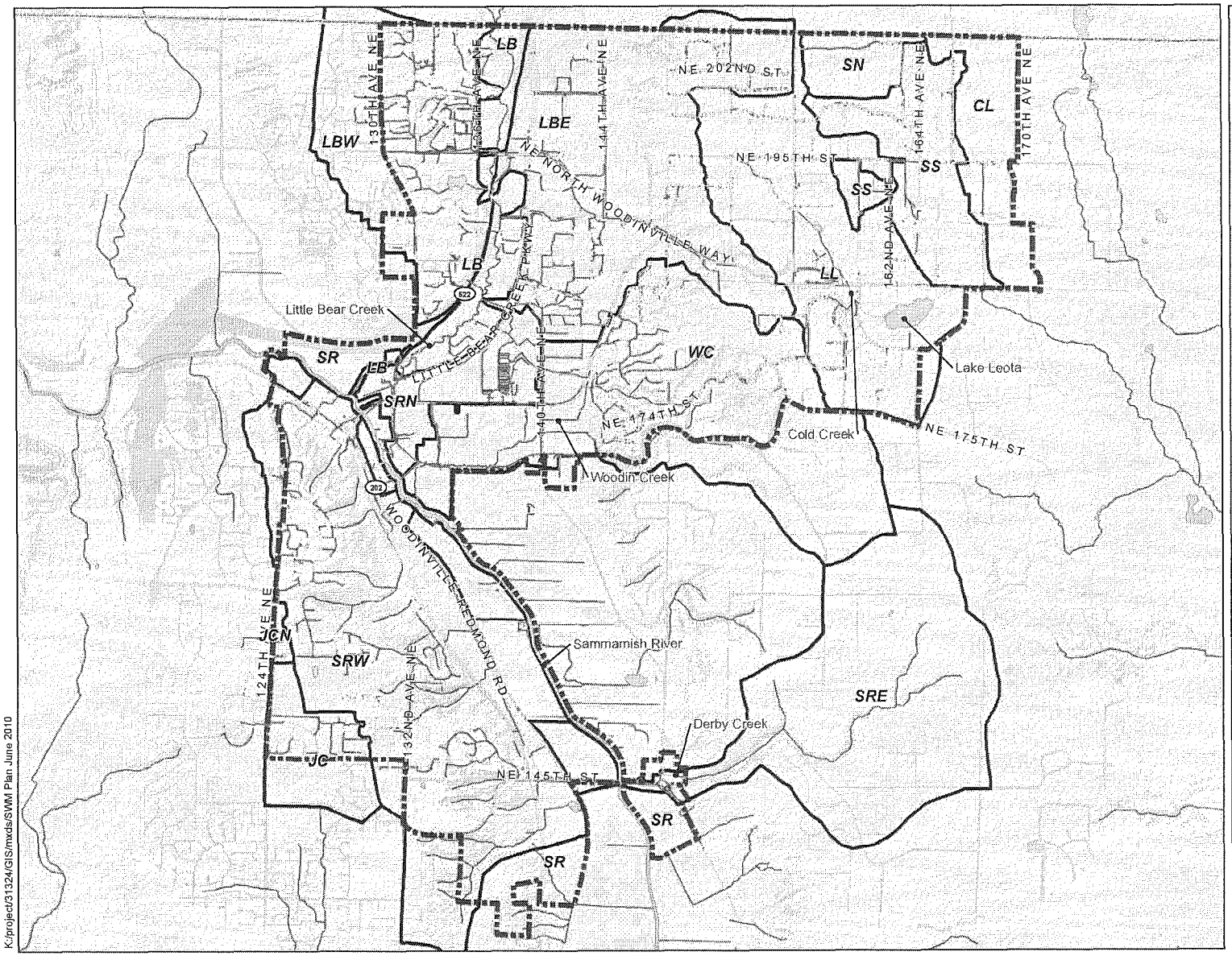
- *Capital Improvement Program*
- *Stormwater System Maintenance*
  - Complaint Response
  - Catch Basin Cleaning
  - Minor Surface Water Improvements
- *Phase II Permit Compliance, which includes:*
  - Public Education and Outreach
  - Public Involvement and Participation
  - Illicit Discharge Detection and Elimination
  - Controlling Runoff from New Development, Redevelopment and Construction Sites
  - Pollution Prevention and Operations and Maintenance for Municipal Operations
- *Other regulatory compliance activities associated with ESA, WRIA, and the Action Agenda*
- *Water Quality Monitoring*
- *Program Management and Administration*

4.0 SWM Facilities and Maintenance

Section 4 provides a summary of the City's stormwater inventory, including the existing status of the City's Geographic Information system (GIS)-based mapping, and the additional activities needed to ensure the City is in compliance with the regulatory obligations of Phase II Permit. (Inventory and mapping of the City's drainage facilities are required under Permit requirement #3, to create and operate an Illicit Discharge Detection and Elimination (IDDE) Program.)

The City's stormwater system mapping and inventory as shown in Figure ES-4 currently includes the following (February 16, 2010 data):

- 3,260 catch basins/manholes
- 20 pond/tanks
- 37.6 miles of open ditches/swales
- 60 miles of streets
- 1,958 outfalls/major culverts
- 12 public vaults
- 53.1 miles of pipes



Legend

- Woodinville City Limits
- County Boundary
- City of Woodinville Stormwater Pipes Dated: 02/16/10
- Stormwater Open Channel
- Stream
- 5ft Contour (King Co. LIDAR)
- Waterbody
- Basin Boundary

N

0 1,000 2,000 4,000 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries,storm system mapping), from the City of Woodinville (city limits, hydrology parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010.

STORMWATER MANAGEMENT PLAN

FIGURE ES-4

DRAINAGE SYSTEM MAP

CITY OF WOODINVILLE

OCTOBER 2010

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Stormwater facilities require regular inspection, cleaning, and repair to ensure that they are functioning as intended in order to provide the required flow control, treatment, detention, and conveyance. The City's Operations and Maintenance Program aims to protect public health and safety, maintain drainage system integrity and function, reduce infrastructure repair and life cycle costs, enhance water quality, and achieve regulatory compliance.

Section 4 summarizes the City's SWM Operations and Maintenance activities, including staffing and organization and activities. This section continues with an assessment of how well the City is meeting its minimum Phase II Permit requirements, and provides conclusions and recommendations to ensure future compliance.

Maintenance Activities

The maintenance staff performs most of the maintenance activities required to support the City's Operations and Maintenance Program. However, the City does contract out a few services such as annual public and private facility inspections, vactor services, and major repair work. King County performs the facility inspections and generates work orders for the public facilities that are sent to the City. The County also mails out maintenance correction lists for the private facilities that are maintained by private property owners and provides follow up education and inspection services.

The City's maintenance staff provides the following surface water maintenance activities:

- Street and drainage system cleaning
- Drainage conveyance system repair and construction
- Open channel and ditch maintenance
- Public retention/detention facility maintenance
- Citizen service request response
- Emergency response
- Miscellaneous service programs

Organization and Staffing

Since January 2003, the City's Public Works maintenance staff has consisted of a supervisor, a lead worker, and a three-person crew, supported by seasonal staff during the summer. Collectively, the maintenance staff share the responsibility of maintaining the streets, stormwater infrastructure, publicly owned parking lots, repairs of all fleet vehicles and equipment, and responding to citizen inquiries and complaints. The City's parks and public buildings are maintained by other crews.

5.0 SWM Capital Needs

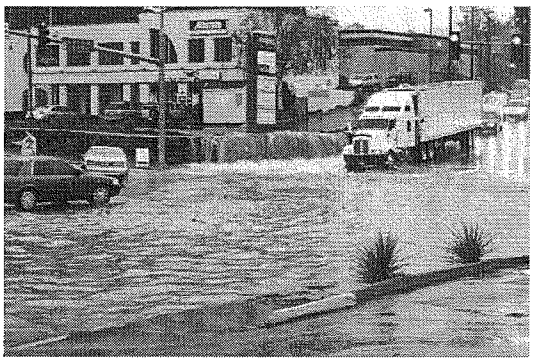
Section 5 describes the Capital Improvement Project development methodologies, including information sources, stormwater hydrologic and hydraulic modeling and results, rating and

ranking criteria for drainage concerns. It concludes with the presentation of an updated Capital Improvement Program for the City with project descriptions, costs and implementation priorities.

City-Wide Hydraulic Analysis

The City requested that an initial 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 onsite.

The city-wide hydraulic analysis shows that approximately 75% of the analyzed pipes have sufficient capacity for the 24-hour, 25-year rainfall event (3.1 inches) and 63% of the City's pipes have enough capacity for the 24-hour, 100-year rainfall event (3.7 inches). 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 through 11 in Appendix B show the areas where existing pipes are under capacity.



Flooding at 131st Avenue NE near the Railroad Trestle

The hydrologic and hydraulic modeling methodology, supporting calculations, and detailed modeling results are included in the Citywide Hydraulic Analysis Technical Memorandum in Appendix B.

Problem Identification and Ranking: Development of CIPs

The planning process used to develop the City's CIP Plan consisted of the following four steps as shown in Figure ES-5:

- 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.

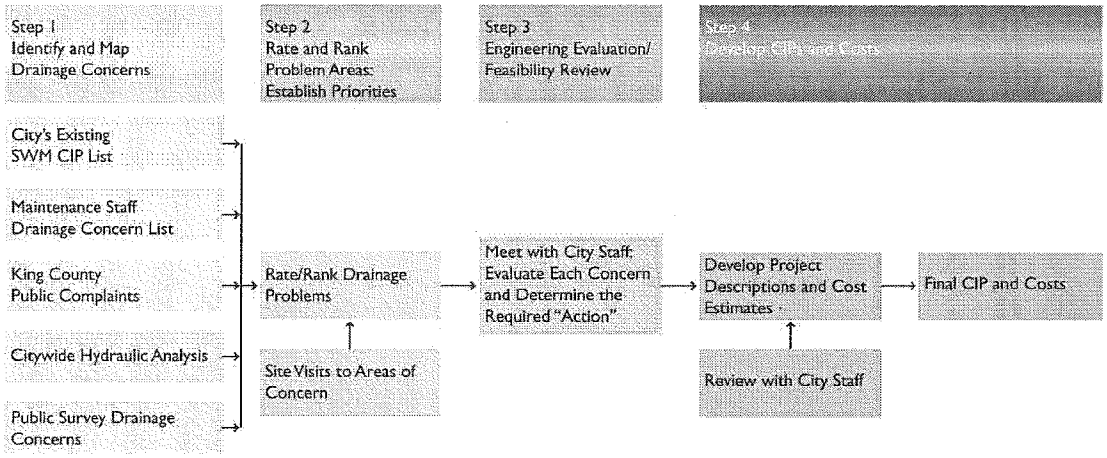


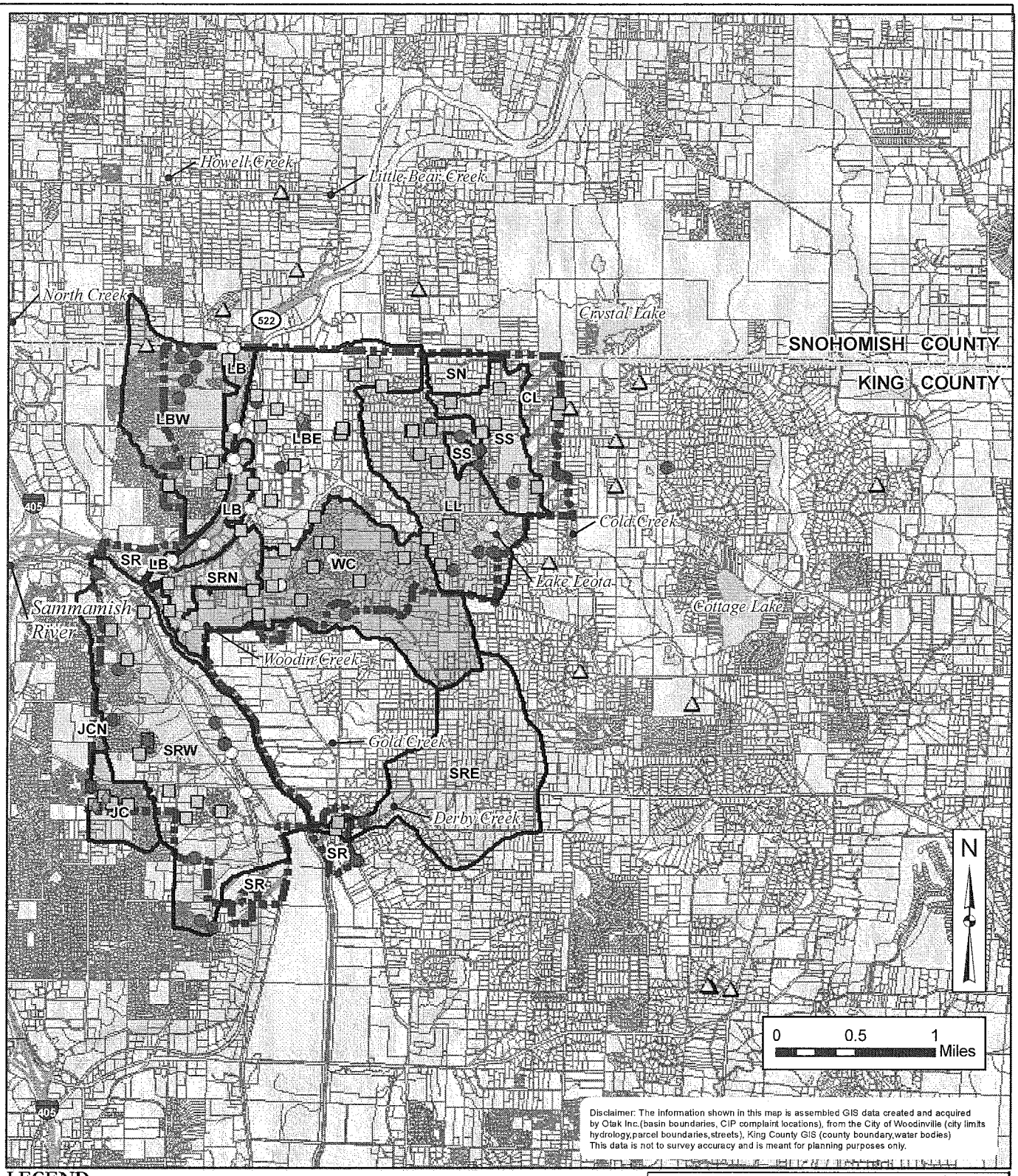
Figure ES-5 – CIP Development Process

Step 1—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 above in Figure ES-5. 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. 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 as shown in Figure ES-6. (See Appendix C for the listing and ranking of identified drainage problem areas.)

Step 2—After compiling these 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. Each drainage problem was given a score of 0 to 5 for each criterion with a total possible weighted score of 115. The top scoring drainage concerns were visited in the field to visually inspect the nature of the problem and its severity, estimate its cause and develop an initial assessment of the type of problem and type of solution that may be needed and considered in Step 3.

Step 3—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.

Step 4—In the final step of the CIP development, the top 24 priority drainage concerns were further developed into CIP projects. Many of the reported concerns were related to similar issues or problem areas in a manner such that the resulting ten recommended CIP projects addressed the top 24 ranked drainage problems/concerns.



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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 ES-6

DRAINAGE COMPLAINTS LOCATION MAP

CITY OF WOODINVILLE

OCTOBER 2010

Ten projects were developed to a preliminary engineering level of design to address each of the problem areas and to estimate costs. Project sketches and planning level quantity/cost estimates were developed using available GIS data, existing as-builts, and information documented during the field visits. The descriptions, sketches and preliminary cost opinions are presented in Appendix D.

Resulting Capital Improvement Program

The updated Capital Improvement Program includes drainage problem and project descriptions, planning level cost estimates, and implementation priorities for each of the ten new CIP projects identified in the CIP development planning process. These new projects were prioritized based on the categories of flood hazard, community considerations and environmental impacts. The total cost of the ten new CIP projects is $6.4M as shown in Table ES-1. Figure ES-7 shows CIP project locations.

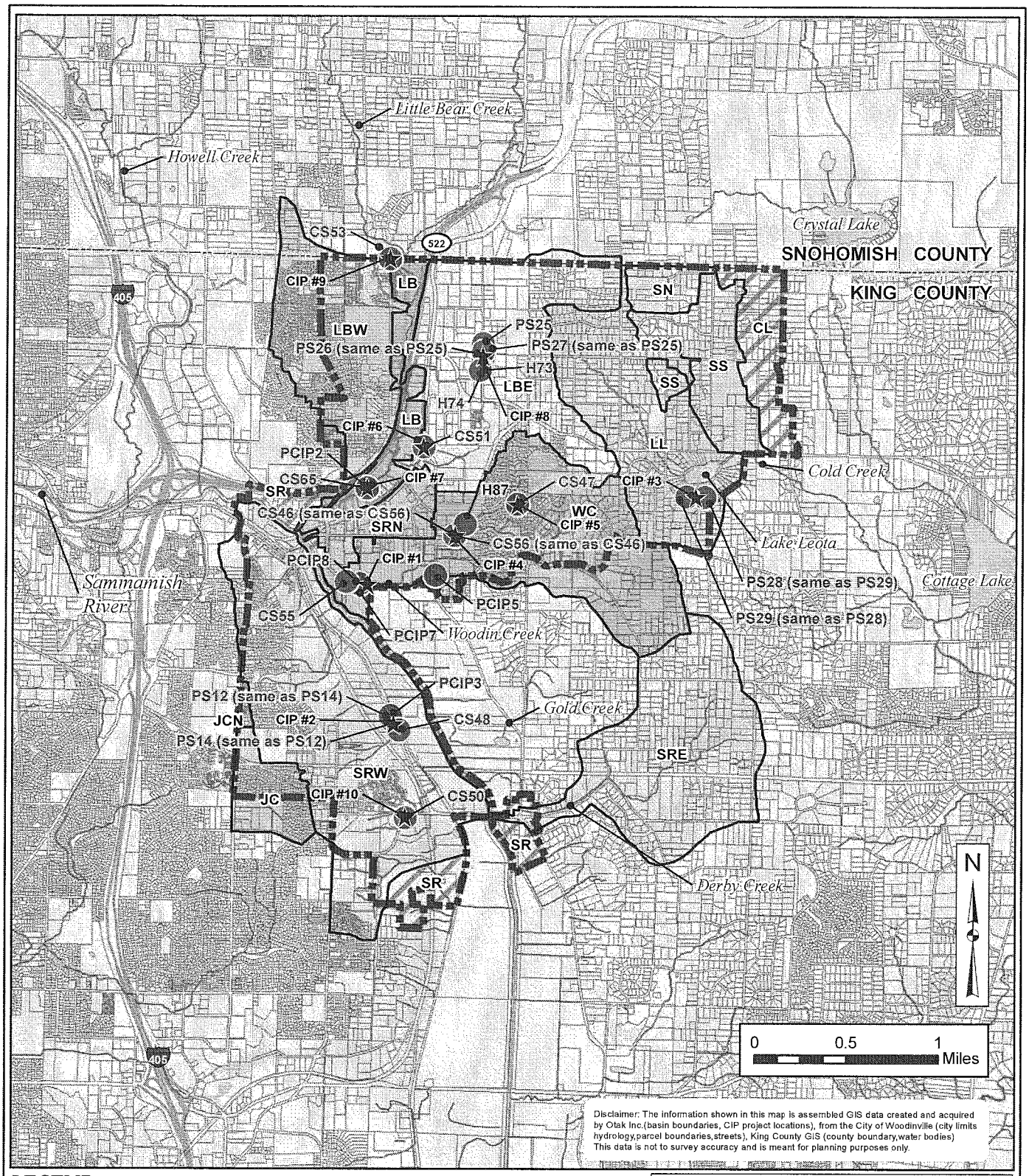
Table ES-1
Summary of CIP Projects

Problem Areas	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 PL NE CIP	$40,000
6	Cottonwood Trees at 14300 NE Wood-Duvall Road CIP	$57,000
7	Little Bear Creek Culvert at 134th Ave NE CIP	$1,619,155
8	144th Ave NE CIP	$153,000
9	136th Ave NE and NE 205th Street CIP	$153,000
10	137th PL NE CIP	$48,000
	Total	**$6,432,155**

(1) Based on 2010 dollars and planning level cost estimates. See Appendix D for cost estimate backup.

6.0 Regulatory Compliance

Section 6 outlines the City's regulatory requirements and other stormwater-related obligations, including the UIC Rule, the Action Agenda, ESA, and WRIA activities and improvements. The set of regulatory requirement that guide the development and implementation of the City's SWM Program are those associated with the Phase II Permit as summarized below.



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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 ES-7

CIP PROJECT LOCATION MAP

CITY OF WOODINVILLE

OCTOBER 2010

NPDES Phase II Municipal Stormwater Permit

The City of Woodinville has been identified by Ecology as a National Pollutant Discharge Elimination System Phase II community. As such, the City needs to comply with the requirements of its *National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Discharges from Small Municipal Separate Storm Sewers in Western Washington.*

The Phase II Permit applies to cities with populations less than 100,000 located within, or partially within an urbanized area, and that are operating a municipal separate storm sewer system which discharges to a water of Washington State. The Phase II Permit outlines stormwater program activities and implementation milestones that the City must follow over a five-year timeframe, beginning February 16, 2007, in order to comply with federal law. All Phase II communities are expected to develop a stormwater program that includes the required activities, implement those activities within the required timeframes over the term of the Phase II Permit (i.e. 2008–2011), and submit annual reports to Ecology to document progress toward complete program implementation.

The major program elements required by the Phase II Permit together with the associated Phase II Permit conditions are listed below, with a copy of the Permit presented in Appendix E:

- Public Education and Outreach (Special Condition S5.C.1)
- Public Involvement and Participation (Special Condition S5.C.2)
- Illicit Discharge Detection and Elimination (Special Condition S5.C.3)
- Controlling Runoff from New Development, Redevelopment, and Construction Sites (Special Condition S5.C.4)
- Pollution Prevention and Operation and Maintenance for Municipal Operations (Special Condition S5.C.5)
- Total Maximum Daily Load Requirements (Special Condition S7)
- Monitoring (Special Condition S8)
- Reporting (Special Condition S9)

Figure ES-8 shows the Phase II Permit requirements and milestones.

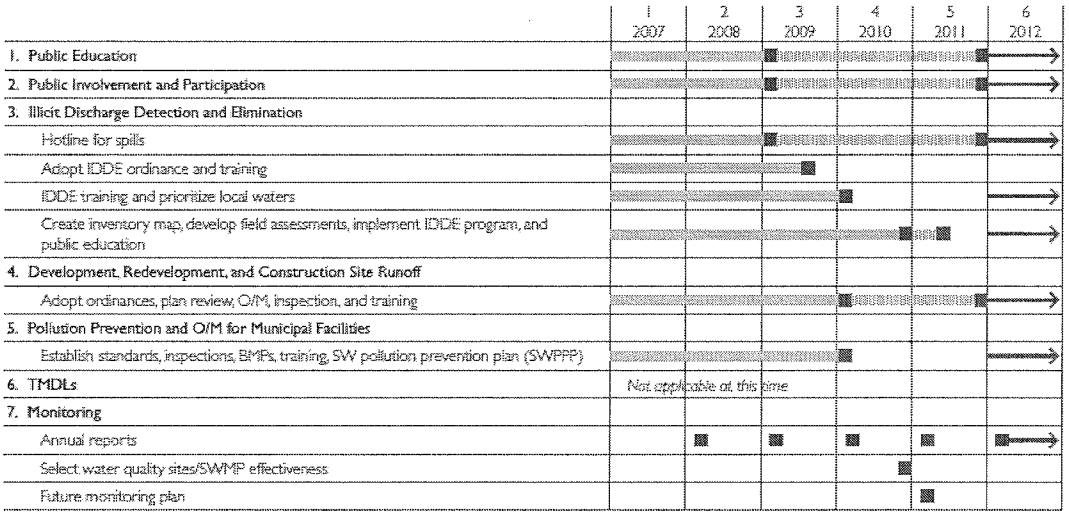


Figure ES-8 – Phase II Permit Requirements and Milestones

7.0 SWM Program Summary and Implementation

The City's future SWM Program needs to maintain regulatory compliance, fulfill its other stormwater-related obligations and address local SWM Program priorities. The City's future SWM Program also needs to include the recommended maintenance and capital activities presented in Sections 4 and 5, respectively. By integrating, prioritizing and funding the proposed activities for regulatory compliance with the proposed capital projects, the City's updated CSWM Plan will be effectively implemented.

Regulatory Compliance

NPDES Phase II Municipal Stormwater Permit

Documentation of the City's compliance activities is organized in accordance with the five components enumerated below. Current and past compliance activities are summarized in its 2007, 2008, and 2009 Annual Reports, which are posted on the City website and are available for review at City Hall. For each of the five regulatory compliance elements, planned future compliance activities are outlined in the City's 2009 Stormwater Management Program and summarized in Section 6 together with future requirements for Total Maximum Daily Loads (TMDLs), Monitoring, and Reporting.

Permit Compliance Activities

1. Public Education and Outreach

The City will continue the development and implementation of its public education and outreach program by refining education activities based on survey results. The emphasis of

the City's educational activities will be proper vehicle washing, conducting a follow up survey to measure program effectiveness, continuing to offer rain barrels and compost bins at the Spring Garden Fair, and recordkeeping of activities for the purposes of annual reporting.

2. Public Involvement and Participation

The City plans to continue its ongoing public involvement and participation strategies, including creating opportunities for public involvement and community feedback, and posting and responding to comments on the CSWM Plan.

Culvert Outfall

3. Illicit Discharge Detection and Elimination

The City intends to build upon existing IDDE activities by updating its code to modify allowable and conditional discharges, developing procedures, conducting field assessments of high priority receiving waters, tracing and removing sources as identified in the field, continuing to update the stormwater system map, conducting staff training, providing public education, and developing activity tracking procedures.

4. Controlling Runoff from New Development, Redevelopment and Construction Sites

The City will need to continue and update its ongoing development review/inspection program that includes consistent application of development standards, conducting permitting processes, ensuring long-term operations and maintenance of facilities, providing construction inspection/enforcement, as well as staff training, recordkeeping and reporting. The City will need to update its code to adopt either the 2005 Ecology Stormwater Management Manual for Western Washington (2005 Ecology Manual) or the 2009 King County Surface Water Design Manual (KCSWDM) and its associated maintenance standards, and low impact development (LID) requirements.

5. Pollution Prevention and Operations and Maintenance for Municipal Operations

The City will continue to emphasize maintenance of its infrastructure by building upon and expanding its prior accomplishments including facility and catch basin inspections and facility maintenance in accordance with the updated maintenance standards required in the Phase II Permit. Other areas that the City will focus on for 2010 include reducing stormwater impacts from municipal operations, developing and implementing a Stormwater Pollution Prevention Plan (SWPPP) for its maintenance facility, and enhancing staff training, recordkeeping and cost tracking.

6. Preparing for Future Monitoring

Under the existing Phase II Permit, the City is required to prepare for future stormwater outfall and program effectiveness monitoring. It is likely in the next permit term (beginning in 2012), that the City will be required to implement a new outfall monitoring program. (These monitoring requirements will likely be similar to those already in place for NPDES Phase I permittees with the exception of Best Management Practices (BMPs) effectiveness monitoring.) It is anticipated that this monitoring program will involve an increase in the City's investment in staff time and resources for equipment purchase, installation, sample collection and lab analyses, data analysis, recordkeeping, and annual reporting.

7. Annual Reporting and Status of LID

Under the City's existing Phase II Permit, annual reports must be submitted by March 31st each year for compliance activities occurring in the previous calendar year.

Pursuant to the Permit Modification issued June 17, 2009, no later than March 31, 2011, the City will also need to conduct an evaluation and submit a summary of identified barriers to the use of LID and measures to address barriers. This report is to include currently available LID practices that can be reasonably implemented within the Permit term, and a list of potential or planned non-structural SWM actions and/or LID techniques that the City will undertake to prevent stormwater impacts, with schedules, goals and metrics to identify, promote, and measure LID use.

Compliance with Phase II Permit Requirements for SWM Maintenance

The City's existing Operations and Maintenance Program addresses many of the requirements of the Permit and is close to meeting its Phase II Permit compliance goals. In some cases, small changes are necessary to update existing standards or activities. In a few areas, there are new activities that the City will need to perform to fully address the requirements and targeted due dates required for compliance with the Phase II Permit.

Specific areas needing attention for regulatory compliance include:

- Adopting and implementing updated maintenance standards consistent with the 2005 Ecology Manual.
- Developing and implementing a nutrient and integrated pest management plan and facilities maintenance manual.
- Developing and implementing on-going staff training program.
- Developing and implementing a SWPPP for the City's maintenance facility.
- Developing and implementing a private facility maintenance enforcement program.

Water Quality Monitoring

The City's SWM Program also includes an ambient Water Quality Monitoring Program that has been in place since 2000. This is a discretionary activity that supports the City's efforts to gain a better understanding of current conditions and to track changes in its natural drainage systems. The City's existing Water Quality Monitoring Program is presented in Appendix F.

Low Impact Development and Sustainability

In July 2007, the City was actively working on updating and completing their sustainability study with involvement from the Citizen Advisory Panel. The City gathered information on implementing LID standards, by looking at LID examples from other municipalities throughout the Pacific Northwest. The City is strongly interested in, and actively pursing, the creation of sustainable land-use standards and LID drainage design standards. These are likely to be implemented in the near future by updating their zoning codes and design standards.

Little Bear Creek near the 134th Street Culvert

Capital Improvement Plan

The City's recommended capital projects have an estimated cost of $6.4M. The top ranked project addressed the flooding on Woodin Creek with a cost estimate of $2.6M. The nine other capital projects total $3.8M, with an average cost of about $643K. Priorities for funding and construction will be determined by the City Council.

Conclusion

This updated Comprehensive Stormwater Management Plan for the City of Woodinville provides an assessment of existing drainage conditions within the City, lists activities needed for regulatory compliance and presents an updated, prioritized list of capital projects and costs for future funding and implementation.

Areas within the City's SWM Program that need enhancement have been identified, including activities to achieve regulatory compliance by the end of 2011. An updated CIP plan presents prioritized CIP projects and associated costs for future funding and implementation. Sections 1 through 7 that follow present the detailed analysis and recommendations of the updated Comprehensive Stormwater Management Plan, with its associated technical appendices.

Section 1—Introduction

Background

The purpose of this study is to define the existing stormwater system, define regulatory gaps, document deficiencies in the stormwater system and outline actions needed in the future for both regulatory compliance and capital improvements. This study also identifies the total cost to implement the Comprehensive Stormwater Management Program.

Incorporated in 1993, the City of Woodinville is a young, growing city faced with the challenges of meeting a host of local, state and federal demands on its resources. In the area of stormwater management, the City is currently providing education, maintaining its drainage system, reviewing new development for compliance with stormwater design standards, controlling pollution sources, monitoring water quality, protecting salmon habitat, constructing Capital Improvement Program projects, and complying with requirements of the federal Clean Water Act for managing its municipal stormwater system discharges. Figure 1-1 shows the vicinity of the City of Woodinville.

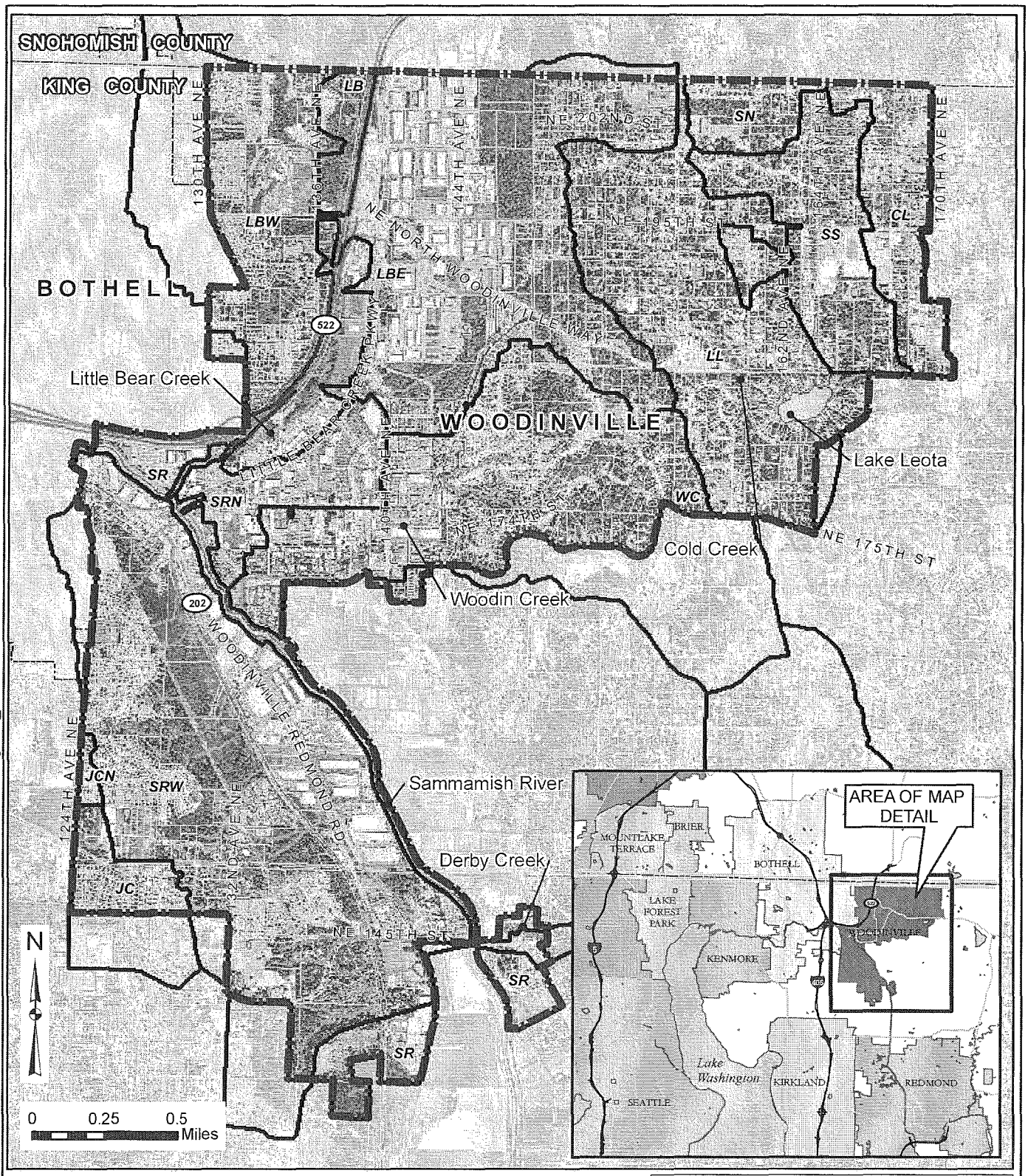
To manage its stormwater, the City needs to address local facility needs, reduce flooding, enhance water quality, protect habitat areas and comply with various regulatory requirements. The primary requirements guiding much of this CSWM Plan update include those associated with the Phase II Permit, and the Puget Sound Partnership Action Agenda.

This CSWM Plan is consistent with the 2007 National Pollution Discharge Elimination System Phase II Municipal Stormwater Permit and addresses the other regulatory obligations of the City, while also addressing the City's capital facilities planning needs and other local SWM priorities and initiatives.

Overview of the Stormwater Management Planning Process

In May 2009, the City embarked on the creation of its first CSWM Plan. The intent of the project is to update the list, priorities, and costs of the City's stormwater capital projects, review and document the status of the City's current Stormwater Management Program, compare it to regulatory requirements, estimate future capital and regulatory compliance requirements and review staffing and revenue levels to ensure adequate resources for implementation.

The City intends to use this study to continue to plan, develop, fund and implement its CSWM Program in order to meet existing and future stormwater-related requirements, reduce localized flooding, and address its other local and regional drainage obligations.



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LEGEND

- City Limits
- County Boundary
- Parcel Boundary
- SR Subbasin Boundary
- Lake
- Streams
- Highway

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville (city limits hydrology,parcel boundaries,streets), King County GIS (county boundary) and Aerial from Aerials express 2005.
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 1-1

VICINITY MAP

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The following analysis of the City's SWM Program was conducted in a series of steps that resulted in achieving the following objectives:

- Documentation of the City's existing SWM program
- Listing of the City's various regulatory requirements and SWM obligations
- Reviewing and analyzing the City's existing SWM Program in comparison to regulatory requirements and activities needed for compliance
- Inventory and mapping of major SWM facilities
- Locating and assessing existing flooding problems
- Identifying capital and maintenance needs
- Forming an updated SWM capital facilities plan
- Developing a CSWM Plan that establishes needed SWM activities and priorities

The flow chart in Figure 1-2 below shows the overall SWM planning process.

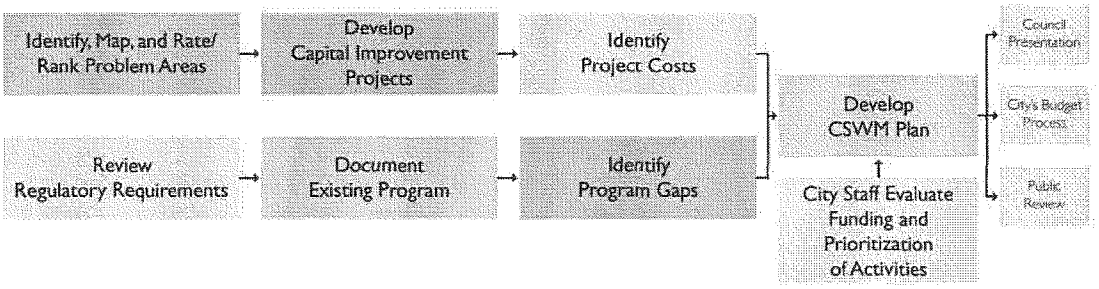


Figure 1-2 – SWM Planning Process

In general, the development of SWM CIP projects and costs occurred concurrently with documentation and review of regulatory requirements and local SWM initiatives, with the results being integrated into the City's CSWM Plan.

Plan Overview and Organization

This plan begins with an Executive Summary and then presents each phase of the SWM planning process in Sections 1 through 7 as described below.

Section 1—Introduction: Lists study objectives, provides an overview of the CSWM planning process and outlines the format and content of the CSWM Plan.

Section 2—Characterization of the Study Area: A characterization of the City's natural drainage systems is presented in a series of maps and brief technical summaries that describe the study area in terms of watershed and basin boundaries, hydrologic characteristics, physical features and environmental characteristics.

Section 3—City's Stormwater Management Plan: Documents the existing City's SWM Program and CIP Plan, describes its purpose and mission, and summarizes the current SWM Program in terms of activities, services, equipment, staffing, organization and revenue.

Section 4—SWM Facilities and Maintenance: Provides an overview of the City's SWM Operations and Maintenance Program including staffing and organization, system inventory/mapping, equipment, activities, staff training and recordkeeping. This Section concludes with an assessment of how well the City is meeting the minimum Phase II Permit requirements for maintenance, and provides conclusions and recommendations to ensure future compliance.

Section 5—SWM Capital Needs: Presents CIP Project development methodologies including information sources, stormwater hydrologic and hydraulic modeling results, and rating and ranking criteria. This Section concludes with the presentation of a recommended Capital Improvement Program that includes project descriptions, costs and implementation priorities.

Section 6—Regulatory Compliance: Describes the City's existing SWM Program in comparison to the Phase II Permit and defines the City's other drainage-related regulations and obligations. It gives the City credit for its existing SWM Program activities and lists actions needed to achieve regulatory compliance.

Section 7—SWM Program Summary and Implementation: Integrates the results of the CIP development process with the results of the regulatory compliance analyses to form the City's updated Comprehensive Stormwater Management Plan. SWM activities and projects are listed and prioritized for future funding and implementation.

Data Sources

As part of this SWM planning process, a variety of information has been collected, reviewed and analyzed. Sources of information included interviews with City staff, the City's 2009/2010 budget (organizational charts, expenditures, revenues and capital facilities), the City's Water Quality Monitoring Reports, the Washington State Department of Ecology website for Total Maximum Daily Load status, City's 2002 Environmental Species Act Habitat Assessment, the July 2005 Water Resource Inventory Area #8 Chinook Salmon Conservation Plan, the City's Phase II Permit and other stormwater-related local, state and federal regulations and obligations, the City's 2008 and 2009 Phase II Permit Annual Reports to Ecology together with the accompanying stormwater management documents, the Puget Sound Partnership Action Agenda, the City's stormwater system mapping and inventory, input on potential capital improvement needs (from public survey responses, reported public concerns, maintenance lists and modeling results), the City's website, 2009 Comprehensive Plan and the Woodinville Municipal Code (WMC).

Section 2—Characterization of the Study Area

Service Area

Drainages within the City

The existing stormwater management service area of the City is approximately 5.6 square miles as defined by the City limits and is located entirely within King County. It is composed of major contributing watershed areas and adjacent drainages that have been divided into eleven subbasins. Major drainage basins include the Sammamish River, Little Bear Creek, Woodin Creek, School Creek and Lake Leota basins (See Appendix A for basin maps). The City also includes small portions of the Bear Creek, Cottage Lake, Derby Creek, and Juanita Creek drainage basins. Watershed and basin areas are shown in Figure 2-1.

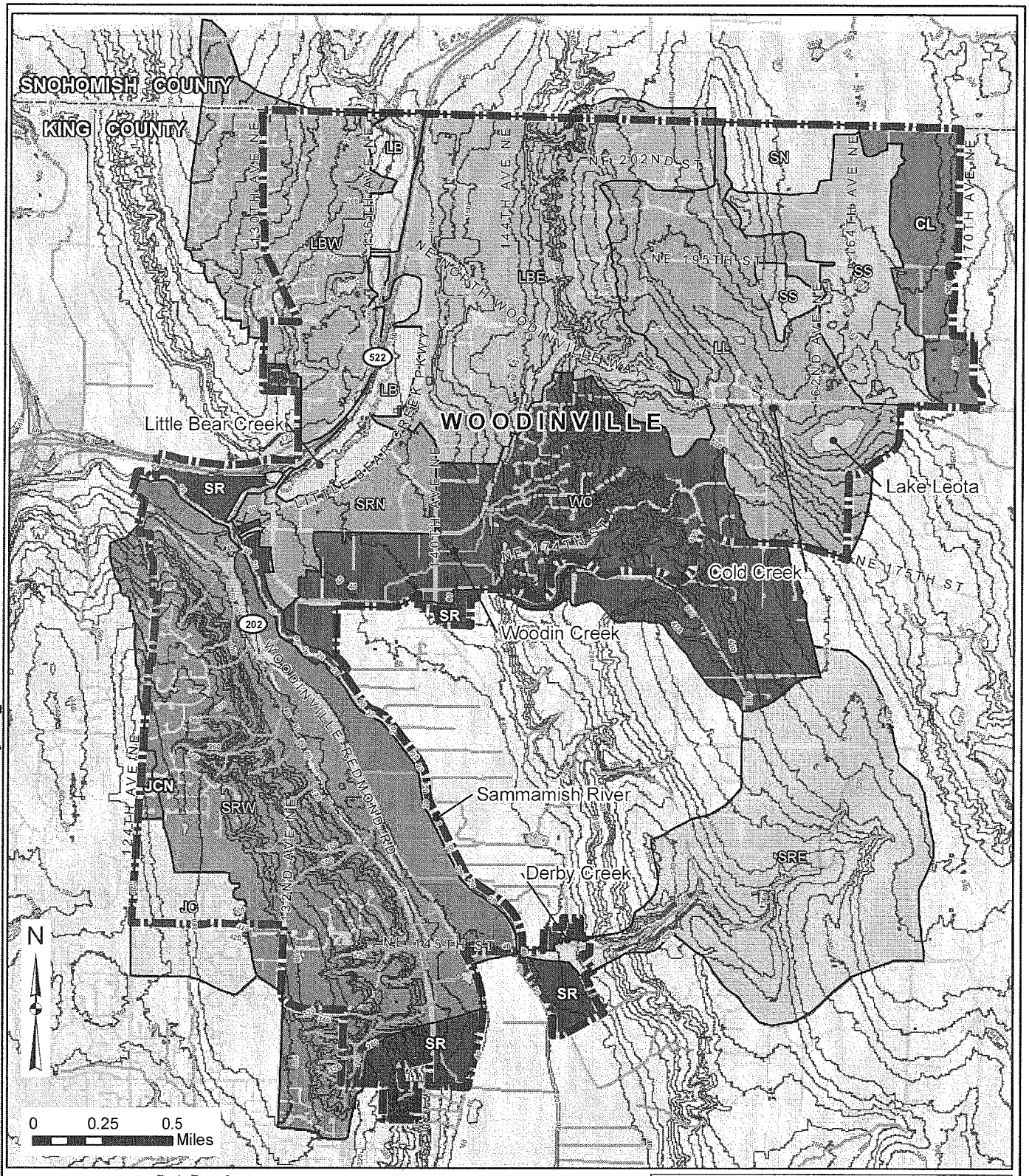
Major watersheds are provided in Table 2-1 which lists the total drainage basin areas that contribute runoff within the City.

Table 2-1
Drainage Basin Areas Within City Limits

Drainage Basin ID	Area (Acres)	Area (%)
Cottage Lake	139	3.8%
Juanita Creek Basin	69	1.9%
Lake Leota Basin	463	12.8%
Little Bear Creek Basin	1,026	28.3%
Sammamish River Basin	1,184	32.6%
School Creek Basin	283	7.9%
Woodin Creek Basin	460	12.7%
Total	3,624	100%

Adjacent and Downstream Drainages

The area to the north of the City limits, that includes portions of the Little Bear Creek and School Creek, is maintained by Snohomish County. The area west of the City limits includes the downstream reaches of the Sammamish River and Juanita Creek drainages, and is maintained by King County and the City of Bothell. The areas to the east and south of the City limits including portions of Woodin Creek, Derby Creek, Lake Leota, School Creek and Sammamish River basins are maintained by King County.



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LEGEND

- City Limits
- County Boundary
- Highway
- Streams
- 20 ft Contour

Basin Boundary

- Cottage Lake (CL)
- Juanita Creek (JC)
- Juanita Creek North (JCN)
- Little Bear (LB)
- Little Bear East (LBE)
- Little Bear West (LBW)
- Lake Leota (LL)
- School North (SN)
- School South (SS)
- Sammamish River (SR)
- Sammamish River East (SRE)
- Sammamish River North (SRN)
- Sammamish River West (SRW)
- Woodin Creek (WC)

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 2-1

MAJOR WATERSHEDS AND DRAINAGE BASINS

CITY OF WOODINVILLE

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Hydrologic Characteristics

The hydrologic characteristics of the City are determined by climate, soils, land cover, vegetation and slopes. Topography defines the drainage basins and has an effect on the direction and velocity of surface water flow and drainage paths. Streams, lakes, wetlands, steep slopes and floodplains manage and direct natural runoff flows through detention, treatment, and infiltration. As development occurs, these natural drainages are modified, often changing the performance and function of these natural drainage facilities and redirecting flows from one basin or watershed into another.

Climate

The City is part of the Puget Sound geographic region, which experiences a marine climate characteristic of the West Coast region. Average annual precipitation in this area is approximately 49 inches. The average temperature in the coldest months of the year, December and January, is 33° F and in the warmest month of the year, August, is 76° F. The rainy season begins in October and continues through March, often extending into April-June. The rainfall is usually of light or moderate intensity and snowfall is normally light, and of short duration.

The precipitation data for the City as found in the 2009 King County Surface Water Design Manual are:

- 2-year, 24-hour: 1.8 inches
- 10-year, 24-hour: 2.6 inches
- 25-year, 24-hour: 3.1 inches
- 100-year, 24-hour: 3.7 inches

The City has experienced two large storm events in the last few years. On October 20, 2003, over five inches of rain fell within a single 24-hour period. This storm exceeded the 100-year storm event for the area, which is four inches of rain within a 24-hour period, and resulted in widespread flooding and related damage.

The second large event occurred December 1-3, 2007. This storm event was the result of three storms that hit the Puget Sound area within a three day period. On December 1, 2007, snow fell throughout western Washington. Then, on December 2, the snowfall changed to rain, and the following day, December 3, there was near record rainfall throughout western Washington. The rain gage closest to Woodinville recorded 3.43 inches for December 3 and a total of 4.89 inches for the period of December 1-4. The December 1-3, 2007 runoff/flood event produced more precipitation than the average 25-year, 24-hour storm event, which is defined by the KCSWDM, as ranging from 3.0 to 3.2 inches in the Woodinville vicinity, with 100-year, 24-hour precipitation value ranging from 3.7 to 3.8 inches.

Soils

The following soils information has been taken from the Natural Resource Conservation Service (NRCS) Soil Survey. This NRCS Soil Survey was downloaded directly from the NRCS website in GIS format. Figure 2-2 shows the soils coverage of the City.

The glacial history of the area has played an important role in the development of surface soils, and subsequently, regional and local stream characteristics. Glacially derived sediments and older geologic parent materials dictate not only the soil type, but also soil characteristics such as porosity and permeability, and subsequently erosion sensitivity and slope stability.

The major types of material deposited by the glacier within the Woodinville area are till, outwash, and some material mixed with volcanic ash. Outwash soils are typically sandy and gravelly, and have a lesser potential for runoff due to their permeable characteristics. Till soils typically have a higher runoff potential. Soils of this type allow for the use of infiltration facilities and pervious pavement that can support local groundwater recharge.

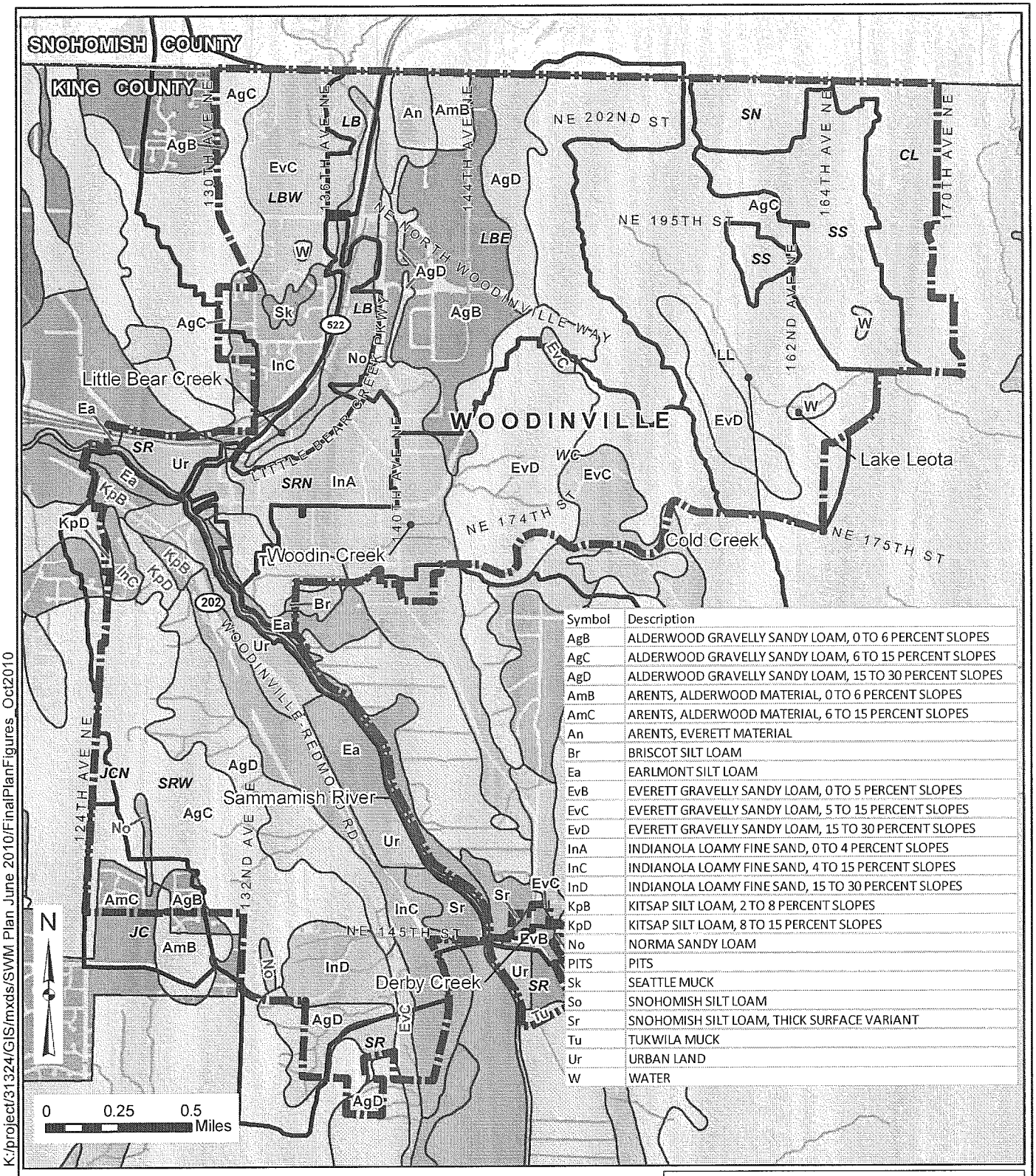
The thirteen different soil types within the City are classified by NRCS as Alderwood, Arents-Alderwood, Arents-Everett, Briscot, Earlmont, Everett, Indianola, Kitsap, Norma, Seattle, Snohomish, Tukwila and Urban. The hydrologic soil groups (HSGs) were identified using the 2005 Ecology Manual. The HSG is defined as a soil characteristics system defined by the U.S. Soil Conservation Service in which a soil may be categorized into one of the four soils groups (A, B,C, or D) based upon infiltration rate and other properties.

HSG Type A: Low runoff potential. Soils having high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

HSG Type B: Moderately low runoff potential. Soils having moderate infiltration rates when thoroughly wetted, and consisting chiefly of moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

HSG Type C: Moderately high runoff potential. Soils having slow infiltration rates when thoroughly wetted, and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. These soils have a slow rate of water transmission.

HSG Type D: High runoff potential. Soils having very slow infiltration rates when thoroughly wetted, and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan, till, or clay layer at or near the surface, soils with a compacted subgrade at or near the surface, and shallow soils or nearly impervious material. These soils have a very slow rate of water transmission.



Symbol	Description
AgB	ALDERWOOD GRAVELLY SANDY LOAM, 0 TO 6 PERCENT SLOPES
AgC	ALDERWOOD GRAVELLY SANDY LOAM, 6 TO 15 PERCENT SLOPES
AgD	ALDERWOOD GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES
AmB	ARENTS, ALDERWOOD MATERIAL, 0 TO 6 PERCENT SLOPES
AmC	ARENTS, ALDERWOOD MATERIAL, 6 TO 15 PERCENT SLOPES
An	ARENTS, EVERETT MATERIAL
Br	BRISCOT SILT LOAM
Ea	EARLMONT SILT LOAM
EvB	EVERETT GRAVELLY SANDY LOAM, 0 TO 5 PERCENT SLOPES
EvC	EVERETT GRAVELLY SANDY LOAM, 5 TO 15 PERCENT SLOPES
EvD	EVERETT GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES
InA	INDIANOLA LOAMY FINE SAND, 0 TO 4 PERCENT SLOPES
InC	INDIANOLA LOAMY FINE SAND, 4 TO 15 PERCENT SLOPES
InD	INDIANOLA LOAMY FINE SAND, 15 TO 30 PERCENT SLOPES
KpB	KITSAP SILT LOAM, 2 TO 8 PERCENT SLOPES
KpD	KITSAP SILT LOAM, 8 TO 15 PERCENT SLOPES
No	NORMA SANDY LOAM
PITS	PITS
Sk	SEATTLE MUCK
So	SNOHOMISH SILT LOAM
Sr	SNOHOMISH SILT LOAM, THICK SURFACE VARIANT
Tu	TUKWILA MUCK
Ur	URBAN LAND
W	WATER

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LEGEND

City Limits
County Boundary
Basin Boundary
Highway
Streams

Soil Type as Classified by NRCS

AgB, AgC, AgD, AmB, AmC, An, Br, Ea, EvB, EvC, EvD, InA, InC, InD, KpB, KpD, No, PITS, Sk, So, Sr, Tu, Ur, W

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies), NRCS soils data
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 2-2

DRAINAGE BASINS WITH SOILS
(AS CLASSIFIED BY NRCS)

CITY OF WOODINVILLE

OCTOBER 2010

Table 2-2 provides the soil types and associated HSGs located throughout the City.

Table 2-2 Soil Types and Areas				
Soil Name	Soil Abbreviation	Hydrologic Soil Group[1]	Area (acres)	Area (%) In City
Alderwood	Ag	C	1,945	53.6%
Arents-Alderwood	Am	B	45	1.2%
Arents-Everett	An	B	23	0.6%
Briscot	Br	D	1	<0.1%
Earlmont	Ea	C	75	2.1%
Everett	Ev	A	540	14.9%
Indianola	In	A	579	16%
Kitsap	Kp	C	41	1.1%
Norma	No	D	100	2.8%
Seattle	Sk	D	10	0.3%
Snohomish	Sr	D	26	0.7%
Tukwila	Tu	D	53	1.5%
Urban	Ur	D	152	4.2%
Water	W	N/A	34	0.9%
Total			**3,624**	**100%**

1. Hydrologic soil group based on the 2005 Ecology Manual.

As shown above in Table 2-2, the soils mapped within the City have been categorized by the NRCS into HSGs A-D. HSGs are useful for determining a general description of a region's soil characteristics. HSG type A soil generally has the lowest runoff potential and type D soil has the highest runoff potential. The characteristics of these soil types and the percentages of each within the City are listed in Table 2-3.

Table 2-3 Citywide Hydrologic Soil Groups			
HSG	Area Acres/ Percentage	Soils	Characteristics
A	1092 — 30.4%	• Everett gravelly sandy loam (EvB, EvC, EvD) • Indianola (InA, InC, InD) *Sand, Loamy sand or sandy loam types of soil*	Low runoff potential and high infiltration rates even when thoroughly wetted. Consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
B	67 — 2.0%	• Arnets, Alderwood (Am) • Arnets, Everett (An) *Silt Loam or Loam*	Moderate infiltration rate when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse texture.

Table 2-3 Citywide Hydrologic Soil Groups			
HSG	Area Acres/ Percentage	Soils	Characteristics
C	2,060 — 57.0%	• Alderwood gravelly sandy loam (AgB, AgC, AgD) • Kitsap silt loam (KpB, KpC, KpD) *Sandy Clay Loam*	Low infiltration rate when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
D	341 — 9.2%	• Briscot (Br) • Seattle muck (Sk) • Snohomish (Sn) • Tukwila (Tu) • Urban land (Ur) *Clay Loam, Silty Clay Loam, Sandy Clay or Clay*	Highest runoff potential. Very low infiltration rate when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shall soils over nearly impervious material.
Total	3,596 — 100%		

According to this system of soil classification and characterization, depending on location, about 30% of the City has soils that support infiltration and 59% of the City has soils that would accept little infiltration.

Erosion Hazard Rating Hydric Rating (Source NRCS)

According to NRCS:

> *"the ratings in this interpretation indicate the hazard of soil loss from unsurfaced roads and trails. The ratings are based on soil erosion factor K, slope, and content of rock fragments.*
>
> *The ratings are both verbal and numerical. The hazard is described as "slight," "moderate," or "severe." A rating of "slight" indicates that little or no erosion is likely; "moderate" indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and "severe" indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.*
>
> *Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00)."*[1]

See Table 2-4 for erosion hazard hydric rating for each soil type.

[1] NRCS.Web Soil Survey. < http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx> Accessed August 18, 2010. 9:05 a.m.

Table 2-4 Select Soil Properties				
Soil Abbreviation	Erosion Hazard Rating	Hydric Rating	Drainage Class	Suitability for Roads
AgB	Slight	Partially Hydric	Moderately well drained	Well suited
AgC	Moderate	Partially Hydric	Moderately well drained	Moderately suited
AgD	Severe	Not Hydric	Moderately well drained	Moderately suited
AmB	Slight	Not Hydric	Moderately well drained	Moderately suited
AmC	Moderate	Not Hydric	Moderately well drained	Moderately suited
An	Slight	No Hydric	Somewhat excessively drained	Well suited
Br	Slight	Partially Hydric	Somewhat poorly drained	Moderately suited
Ea	Slight	Partially Hydric	Somewhat poorly drained	Poorly suited
EvB	Slight	Not Hydric	Somewhat excessively drained	Well suited
EvC	Moderate	Not Hydric	Somewhat excessively drained	Well suited
EvD	Severe	Not Hydric	Somewhat excessively drained	Moderately suited
InA	Slight	Partially Hydric	Somewhat excessively drained	Well suited
InC	Moderate	Not Hydric	Somewhat excessively drained	Moderately suited
InD	Severe	No Hydric	Somewhat excessively drained	Moderately suited
KpB	Moderate	Partially Hydric	Moderately well drained	Moderately suited
KpD	Severe	Partially Hydric	Moderately well drained	Moderately suited
No	Slight	Partially Hydric	Poorly drained	Poorly suited
Pits	Not Rated	No Hydric	Not Rated	Not Rated
Sk	Slight	All Hydric	Very poorly drained	Poorly suited
Sr	Slight	Partially Hydric	Somewhat poorly drained	Poorly suited
Tu	Slight	All Hydric	Very poorly drained	Poorly suited
Ur	Not Rated	Not Hydric	Not Rated	Not Rated
W	Not Rated	Not Hydric	Not Rated	Not Rated

Hydric Rating (Source NRCS)

According to the NRCS

> *"This rating indicates the proportion of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is designated as "all hydric," "partially hydric," "not hydric," or "unknown hydric," depending on the rating of its respective components.*
>
> *Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.*
>
> *The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993)."*[2]

See Table 2-4 for hydric rating for each soil type.

Drainage Class (Source NRCS)

According to NRCS

> *"drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual".*[3]

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[2] NRCS.Web Soil Survey. < http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx> Accessed August 18, 2010. 8:50 a.m.

[3] NRCS.Web Soil Survey. < http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx> Accessed August 18, 2010. 9:00 a.m.

The ratings in this interpretation indicate the suitability for using the natural surface of the soil for roads. The ratings are based on slope, rock fragments on the surface, plasticity index, content of sand, the Unified classification of the soil, depth to a water table, ponding, flooding, and the hazard of soil slippage."

See Table 2-4 for drainage class rating for each soil type.

Suitability for Roads (Natural Surface) (Source NRCS)

According to NRCS

"the ratings are both verbal and numerical. The soils are described as "well suited," "moderately suited," or "poorly suited" to this use. "Well suited" indicates that the soil has features that are favorable for the specified kind of roads and has no limitations. Good performance can be expected, and little or no maintenance is needed. "Moderately suited" indicates that the soil has features that are moderately favorable for the specified kind of roads. One or more soil properties are less than desirable, and fair performance can be expected. Some maintenance is needed. "Poorly suited" indicates that the soil has one or more properties that are unfavorable for the specified kind of roads. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00)."[4]

See Table 2-4 for suitability for roads rating for each soil type.

Topography

The City lies within the Sammamish River Valley. Topographic features characterizing this area are direct products of the advance and retreat of glacial ice during the Frasier Glaciation period, between 10,000 to 13,000 years ago. A melt water stream flowing off the Vashon glacier formed the Sammamish River Valley. With the retreat of the glacier, the size of the river decreased and small channels formed and began draining the Sammamish River Valley slopes and floodplains. Over time, precipitation and runoff draining from upland surfaces further eroded and deeply incised the drainage channels that currently dissect the valley.

Elevations within the City range from approximately 30 feet in the Wilmot Park and downtown area near the Sammamish River to 560 feet in the Laurel Hills neighborhood, southwest of Lake Leota and are shown in the topographic overlay of Figure 2-1.

Along the Sammamish River corridor, the area is flat with relatively low gradients. To the west, the landscape includes steep grades which gradually flatten out to the west in the

[4] NRCS.Web Soil Survey. < http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx> Accessed August 18, 2010. 9:15 a.m.

Kingsgate neighborhood on the east side of 124th Avenue NE. In the most southwest corner of the City, south of the Tolt pipeline easement, the land surface slopes to the southwest, draining to the west into the Juanita Creek basin.

To the east, the grades increase more gradually. At approximately 156th Avenue NE, the land surface begins to slope to the east. This is the boundary line between the Bear Creek basin and the Sammamish River basin drainages.

Localized steep slopes have been identified in the City's Comprehensive Plan and are located in various areas throughout the City, including the hillside west of the Sammamish River and east of 144th Avenue NE, as shown in the Critical Areas map presented in Figure 2-3.

Treatment Swale near Woodinville-Duvall

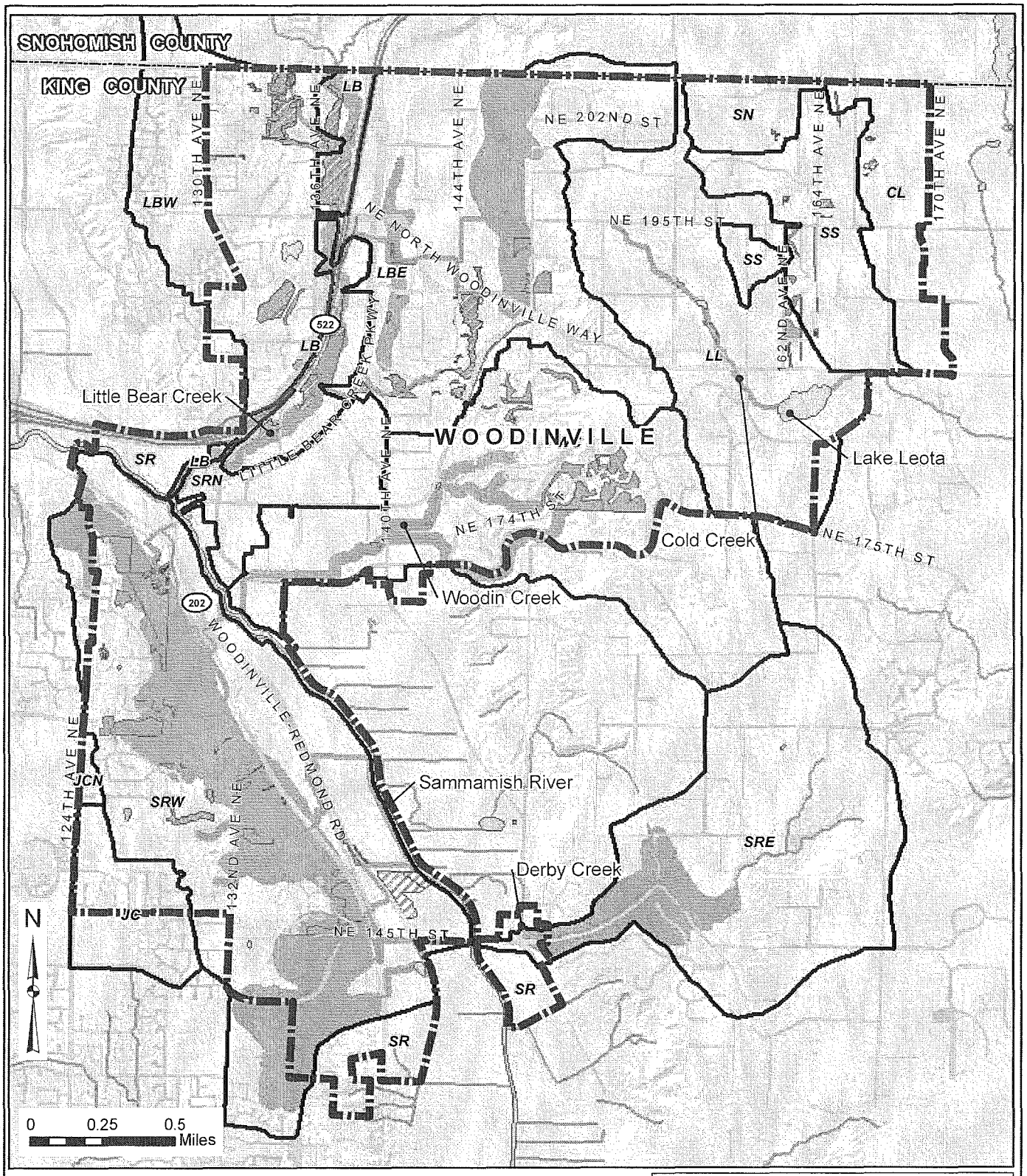
Sensitive Areas

Sensitive areas such as steep slopes, wetlands, and streams exist throughout the City. They are regulated by WMC Chapter 21.24 Critical Areas. The City's Critical Area Ordinance (No. 375) was adopted in 2004 and is in accordance with the Growth Management Act. Protection of the sensitive areas is important to prevent harm to the public from flooding, erosion, landslides, or steep slope failures. It is also important for protecting and preserving natural function and habitat areas. These sensitive areas are also critical for the survival of fish and wildlife. Wetlands and streams within the City provide habitat to a variety of fish and wildlife. As development occurs, these areas must be properly protected during and after construction through proper BMPs and stormwater facility design, construction and maintenance, as shown in Figure 2-3. See Appendix G for the wetland locations and total areas throughout the City.

Steep Slopes

Steep slopes are regulated by City Code, WMC Chapter 21.24, sections 290 through 310. This section describes the development and permit requirements near steep slopes. Slopes that equal or exceed 40% are considered hazards and a minimum buffer of 50 feet is required. Steep slopes cover approximately 28.6 acres within the City. These areas include the following:

- West side of State Route (SR)-202 that parallels the Sammamish River
- Woodinville Duvall Road from Woodinville Snohomish Road to 156th Avenue NE
- West side of SR-522 that parallels Little Bear Creek



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LEGEND

- City Limits
- County Boundary
- Subbasin Boundary
- Lake
- Streams
- Highway

Sensitive and Critical Areas

- Native Growth Protection Easement (NGPE)
- Wetland
- Critical Area

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries), from the City of Woodinville (city limits,hydrology,parcel boundaries,streets, sensitive and critical areas), King County GIS (county boundary,water bodies) This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 2-3

SENSITIVE AND CRITICAL AREAS

CITY OF WOODINVILLE

otak

OCTOBER 2010

Wetlands

Wetlands are classified and regulated by the City's Critical Area Ordinance. The wetland regulations are defined in WMC Chapter 21.24, sections 320 through 360. Any modification to wetlands requires mitigation. Wetlands and riparian corridors perform valuable functions within the ecosystem. Clearing of vegetation, grading, filling, draining, and other activities associated with land development impact the ability of the riparian zone to provide drainage, stabilize stream banks, provide wildlife habitat, and filter pollutants from the water.

There are approximately 68 acres of wetlands in the City, as shown in Figure 2-3. The majority of the wetlands are linked to the riparian corridors of streams and tributaries, and associated floodplains. Some of the significant wetland areas within the City include the following:

- Lake Leota
- Pond north of NE 190th Place
- Pond south of NE 190th Place
- City Rotary Park property north of NE 195th Street
- Undeveloped City Park property east of 134th Avenue NE
- East of Greenbriar development at Woodinville Duvall Road/144th Avenue NE
- Southeast of the Tolt Pipeline Right of Way crossing of SR-202

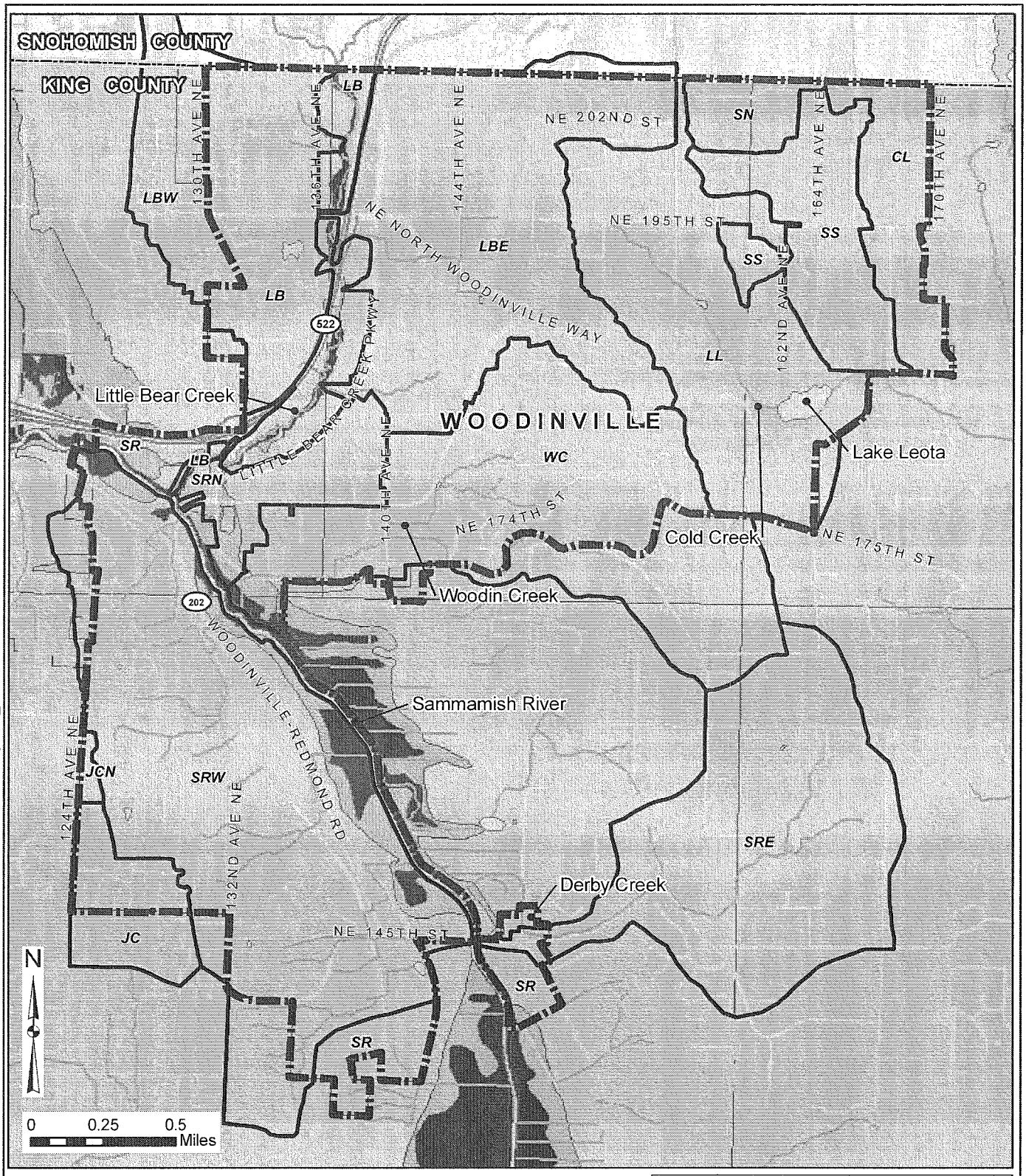
See Appendix H for a copy of the City's habitat assessment reports for Woodin Creek and Little Bear Creek.

Floodplains

Note: Federal Emergency Management Agency (FEMA) is conducting updated flood boundary mapping for the City of Woodinville. These maps have not been finalized as of November 2010. The information in this section is based on the FEMA mapping completed in 1999.

A Flood Insurance Study has been conducted by FEMA for the King County area that includes the City of Woodinville. In this study, FEMA investigated the existence and severity of flood hazards. A flood boundary map was published in November 1999 as shown in Figure 2-4. The 100-year flood is the base flood for purposes of floodplain management measures and the purchase of residential flood insurance. A 100-year flood area is strategically defined as those lands, which are subject to a one percent or greater chance of flooding in any one year. The 500-year flood is a larger flood that is used to indicate additional areas of flood risk in the community, and has a 0.5% of occurring in any one year.

Based on this study, the 100-year floodplain has been delineated by FEMA along the Sammamish River and Little Bear Creek by FEMA. According to FEMA's 1999 mapping, the majority of the floodplain area is within the City limits.



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LEGEND

- City Limits
- County Boundary
- Basin Boundary
- Lake
- Stream
- Highway

FEMA Flood Zone Designations

- Zone A – Areas with a 1% chance of flooding (inside the 100-year floodplain) and a 26% chance of flooding over the life of a 30-year mortgage.
- Zone X – Areas outside the 1% annual chance of flooding (also known as the 100-year flood plain).
- Zone X500 – Inside the 500-year flood plain

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies), FEMA Flood Data:1999 City of Woodinville FEMA mapping (note: 2010 mapping has not been approved at the time this map was created).
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 2-4

FEMA FLOODWAY MAP

CITY OF WOODINVILLE

otak

OCTOBER 2010

Drainage Basins and Streams

The City of Woodinville lies within the Lake Washington watershed, with the majority of its stormwater runoff discharging to the Sammamish River. A small portion of the southwest area of the City discharges to Juanita Creek, and the northeast area of the City discharges to Bear Creek.

Woodin Creek, Derby Creek, and Little Bear Creek are all tributaries of the Sammamish River. Lake Leota and School Creek are basins of the Bear Creek Watershed. For the purposes of this study, the City's major watersheds and associated adjacent drainages were divided into fourteen basins. Figure 2-1 shows the major watersheds drainage basin boundaries.

Table 2-5 shows the area of each drainage basin within the City. The area shown is that portion of the City within the Sammamish River watershed that discharges directly into the river.

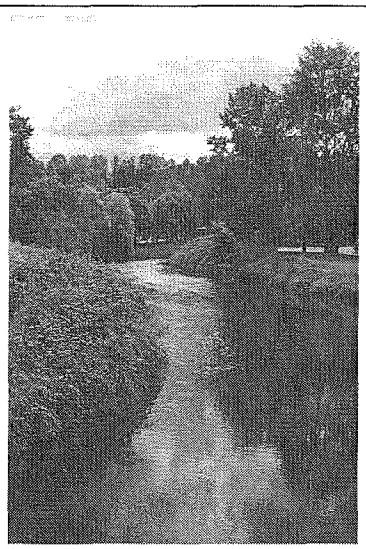
Table 2-5
Watershed Areas within the City of Woodinville

Watershed	Basins	Area (acres)
Sammamish River	1. Sammamish River East 2. Sammamish River West 3. Sammamish River North 4. Sammamish River	1,184
Little Bear Creek	1. Little Bear Creek, 2. Little Bear Creek East 3. Little Bear Creek West	1,026
Woodin Creek	1. Woodin Creek	460
Lake Leota (To Bear Creek)	1. Lake Leota	463
Juanita Creek	1. Juanita Creek 2. Juanita Creek North	69
School Creek	1. School Creek North 2. School Creek South	283
Cottage Lake	1. Cottage Lake	139
Total	**14**	**3,624**

A brief overview of each of the major watershed areas within the City follows.

Sammamish River

The Sammamish River Watershed is approximately 170 square miles and is located in both King County and Snohomish County. The river is approximately 13.5 miles long. The upper reach of the Sammamish River extends from the Lake Sammamish weir in Marymoor Park downstream through the valley to the City of Woodinville. The lower reach of the Sammamish River extends from Woodinville to its discharge point into Lake Washington. About 25% of the City's land area drains directly to the river, while 50% of the City first drains into Woodin and Little Bear Creeks and then into the Sammamish River. The remaining 25% drains to the east to Bear Creek and to the west to Juanita Creek.



Sammamish River as it flows through Woodinville

According to King County[5], the following salmonid species are currently known to inhabit the Sammamish River system: chinook, coho, sockeye, kokanee, steelhead, and coastal cutthroat. Two salmon-bearing streams are located in the upper reach of the Sammamish River: Bear Creek and Little Bear Creek, both of which drain areas located within the City of Woodinville.

In 2004, the Sammamish River was listed on the Ecology 303(d) list for violation of fecal coliform and water temperature standards in certain locations during the summer months. The river also, on occasion, violates of the State's dissolved oxygen standards in some locations during the summer months. There is no State mandated TMDL formally established for the Sammamish River at this time.

Bank erosion has been occurring in many of the unnamed tributaries of the Sammamish River including the hillside west of SR-202 as a result of poor soils, steep slope conditions, and increased flows from development within the area. Removal of sediment from the SR-202 drainage ditch system has been identified as an annual maintenance task for City crews. The City has received a Hydraulic Project Approval permit from the Washington Department of Fish and Wildlife to remove up to 50 cubic yards a year from this location.

The City's Habitat Action Plan has identified the Sammamish River as a critical migratory corridor for anadromous salmon in the Sammamish Watershed. It is the primary link between Lake Washington and Lake Sammamish, connecting major tributaries and upland habitats with each other and interior lakes, as well as a hatchery upstream of Lake

[5] Stream and River Water Quality Monitoring: Sammamish River Site 0450. King County. Accessed August 16, 2010 at 9:30am. <http://green.kingcounty.gov/WLR/Waterres/StreamsData/WaterShedInfo.aspx?Locator=0450>

Sammamish. The goal of the City's Habitat Action Plan is to preserve and enhance the Sammamish River corridor by employing the following strategies:

- Restoring riparian areas to enhance habitat.
- Creating and enhancing pools in the river channel.
- Exploring engineered solutions to cool the river to reduce thermal stress.
- Protecting all major tributaries to the river as habitat and sources of cool water for the river.
- Identifying and purchasing critical parcels with natural functions.
- Closely monitoring project and continually applying adaptive management.

Little Bear Creek

The Little Bear Creek Watershed, tributary to the Sammamish River, is approximately 14.5 square miles and is approximately 7.7 miles long. The watershed is located in the City and Snohomish County. Approximately 25-35% of the City drains into Little Bear Creek. Chinook, coho, sockeye, steelhead, and cutthroat trout are currently known to inhabit Little Bear Creek. In addition, the creek has been recognized as one of the most productive remaining salmon spawning streams within the Lake Washington watershed.

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

In 2004, Little Bear Creek was listed on the Ecology 303(d) list for violation of dissolved oxygen standards; however, there is no State mandated TMDL for Little Bear Creek at this time. The City samples the creek once a month on the upstream side of the SR-202 crossing for fecal coliform. See Appendix F for more information on Water Quality sampling in the City.

In 2002, the City conducted a habitat assessment of the Little Bear Creek corridor within the City limits. The project goals were to document existing fish and wildlife, habitat conditions, fish and wildlife utilization, and identify potential restoration opportunities along Little Bear Creek within the City limits. Because ESA considerations are an important facet of current stream related surveys, the focus was on collecting data that would assist in the determination of limiting factors as they relate to ESA listed salmonids.

This habitat assessment included some of the following selected recommendations:

- Obtain, preserve, and enhance land along Little Bear Creek to minimize further habitat degradation from continued development; acquire undeveloped parcels.
- Initiate a program to reestablish conifers within the riparian zone.

- Restore hardened rip/rap banks along Little Bear Creek; including creation of pool habitat, and addition of large woody debris.
- Retrofit potential pollution-generating sites.
- Reforest upland areas dominated by non-native species.
- Create off-channel habitat by day-lighting culverted tributaries.
- Investigate the feasibility of purchasing key riparian habitat areas.
- Maintain regular street sweeping, storm drainage system cleaning, and add sediment traps where feasible to reduce the amount of sediment entering the creek.

A complete basin plan has not been prepared for Little Bear Creek Basin. However, Snohomish County is currently preparing a restoration and monitoring project plan for the basin. The study will focus on small farm plans, streamside restoration and fish passage barriers. The Snohomish County Ambient Water Quality Monitoring Summary Report 1992-1995 (Snohomish County, 1996) which was conducted to monitor water quality throughout Snohomish County is part of the county's Ambient Water Quality Monitoring Program. The program was designed to establish baseline conditions for Snohomish County surface waters, to identify problem areas for non-point pollutants, and to correlate non-point pollution with land use. The Surface Water Management Department uses the results of the program to determine which educational programs and BMPs will most effectively reduce non-point pollution to surface waters.

In 2002, the Sammamish River Action Plan identified the Little Bear Creek watershed as rapidly urbanizing with residential development and hobby farms located in the upper watershed. Most of the Little Bear Creek watershed within Snohomish County is medium density rural residential. The SR-9 and SR-522 corridors support light and heavy industry. Little Bear Creek, like North and Swamp Creeks, flows into Lake Washington. In 1995, Ecology assessed Little Bear Creek as not supporting the designated uses of primary and secondary contact recreation because of pollutants. The major pollutant identified by Ecology was a bacterium. Sources of bacteria include runoff from pastureland, animal holding, and failing septic systems. Runoff from roads and the industrial areas in the lower watershed also contributes petroleum products, metals, and sediment to the creek. According to King County[6], Little Bear Creek watershed has historically supported a variety of fish species, including coho salmon, sea-run cutthroat trout, steelhead, chinook salmon, sockeye and kokanee salmon, resident cutthroat trout, rainbow trout, sculpins, lampreys, and stickleback. However, the abundance of fish such as coho salmon has noticeably decreased in recent years, and is consistent with other watersheds in the Sammamish River and Lake Washington Basin.

In 2006, Snohomish County's Council amended Ordinance No. 06-115, requiring the use of Low Impact Development techniques as a condition of new development in the southwest portion of the urban growth area expansion in the Little Bear Creek Watershed. The

[6] http://green.kingcounty.gov/WLR/Waterres/StreamsData/WaterShedInfo.aspx?Locator=0478

ordinance also adoption a new section of the Snohomish County Code 30.63.025 summarized below:

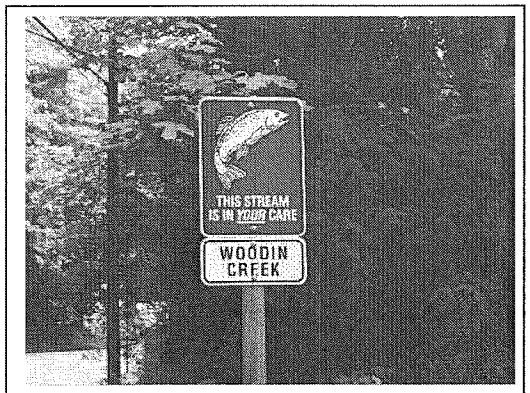
I. This action essentially adopts the LID Technical Guidance Manual for Puget Sound and provides a framework for site assessment and project design and gives specifications for individual projects.

II. The manual also explains how individuals can obtain credits to help them reduce the size of their stormwater facilities by using LID techniques. The manual presents findings from national and international research and monitoring to help professionals make informed decisions when using LID techniques.

III. The Final Environmental Information Statement (EIS) for Snohomish County's 10 year update recommends the use of LID as a mitigation measure for new development on properties that would have been added to the Southwest Urban Growth Area—this is consistent with where the City of Woodinville would want to go if we annexed the area known as "Grace" into the City in the future.

Woodin Creek

The Woodin Creek Watershed is approximately one square mile in area. It is approximately 1.6 miles long and is a tributary to the Sammamish River. The watershed is located in the City and King County. About 10-15% of the City land area drains to Woodin Creek. Juvenile coho and cutthroat have been seen in Woodin Creek. However, Woodin Creek has not been identified for significant usage by salmonid.



Stewardship Sign for Woodin Creek

Woodin Creek has been significantly altered by development at its headwater. The Creek has been piped through Woodinville Plaza, straightened through Canterbury Square, and straightened and relocated during the construction of NE 171st Street. Native growth protection easements have been established in some areas within the basin for its tributaries. Streets in the upper basin have shown signs of settling and these areas have seen groundwater seepage overland.

Sediment deposition in Woodin Creek has caused flooding on NE 171st Street and on private property. Sediment deposition has also occurred in the stormwater facilities at Woodinville Duvall Road/NE 178th Street where Woodin Creek tributaries flow through these facilities.

In 2004, the City completed the habitat assessment of the Woodin Creek corridor within the City limits. This assessment made the following selected recommendations:

- Identify stormwater facilities, determine adequacy of treatment provided, and if necessary, retrofit.
- Explore the opportunities to restore functionality to the stream corridor.
- Continue the spawner surveys and water quality monitoring.
- Assess, and correct fish passage barriers.
- Initiate a program to reestablish conifers.
- Evaluate possibility of connecting off-channel ponds and habitat.
- Evaluate alternatives to improve sediment transport.
- Evaluate maintenance activities in Woodin Creek Park; enhance and improve the buffer area.
- Provide enforcement and/or education related to maintaining native growth protection areas in the upper basin.

Woodin Creek is also part of the City's ongoing water quality monitoring program as discussed in Appendix F.

Roadway cross culvert on Woodin Creek

Lake Leota

The Lake Leota Watershed is approximately 0.7 square miles in area and is located entirely within the City. According to King County, the lake is approximately 10 acres in surface area with a maximum depth of approximately 24 feet and a mean depth of 12 feet. Lake Leota is a part of the Bear Creek drainage basin, and has not been identified for significant usage by salmonid species.

The residents of Lake Leota have participated in the King County Lake Stewardship Program since 1998. This program involves data collection by volunteer lake monitors. The data collected is compiled into a report by King County Department of Natural Resources. This report provides citizens, scientists, lake managers, and other interested individuals with current information on King County lake water quality and physical conditions. This monitoring information helps guide lake protection and stewardship activities. The water quality data suggests that thermal stratification is stable through summer, and sediments release phosphorus to deep water, under low oxygen conditions.

Juanita Creek

The Juanita Creek Watershed is approximately 6.4 square miles. The creek is approximately 3 miles long and it is tributary to the Sammamish River and is approximately 1 mile west of the City limits. The watershed is located in Woodinville, Kirkland, and King County. The

following salmonid species are currently known to inhabit Juanita Creek: coho, sockeye, kokanee, and cutthroat trout.

Derby Creek

The Derby Creek Watershed is approximately 0.4 square miles. The creek is approximately 1.5 miles long and tributary to the Sammamish River. The majority of the watershed is located in King County, within less than 5 percent within the City. Derby Creek has not been identified for significant usage by salmonid.

School Creek

The majority of the School Creek watershed is located in Snohomish and King Counties. The small area of this watershed that lies within the City is in the most southwest portion of the watershed, with most of its surface water draining into the Bear Creek watershed. Bear Creek is a productive salmonid stream and has been TMDL listed for fecal coliforms, temperature and dissolved oxygen.

Zoning and Impervious Areas

The City's Comprehensive Plan was adopted by Ordinance No. 157 in June 1996. The Comprehensive Plan regulates land use and zoning to provide for the orderly development of property in the City from 1996 to 2016. The Comprehensive Plan has been amended over the past years and was updated in 2003 (to comply with the GMA) and again in 2009.

The City has developed and regularly updates its Comprehensive Plan for land use. The Comprehensive Plan, with its land use and zoning requirements, regulates the maximum impervious surface allowed on a site. WMC Chapter 21.12, section 21.12.030 describes the allowable maximum impervious surface percentages for residential areas which range from a maximum impervious surface for single family of 20% for the Residential (R)-1 zone to 75% coverage for the R-8 zone. The maximum impervious surface percentages for multi-family range from 85% for the R-12 zone to 90% for the R-48 zone.

As the densities increase, the amount of impervious surfaces increase, which increases the amount of surface water runoff. The required water quality and flow control facilities also increase in number, size, and in type as the impervious surfaces increase. These facilities are needed to properly manage the surface water runoff from development and redevelopment.

Low Impact Development techniques such as pervious hard surfaces aid in decreasing the amount of impervious surfaces and allow for infiltration, and have been promoted by the City. The City has been using the KCSWDM to size and design new stormwater facilities within the City.

Existing Zoning

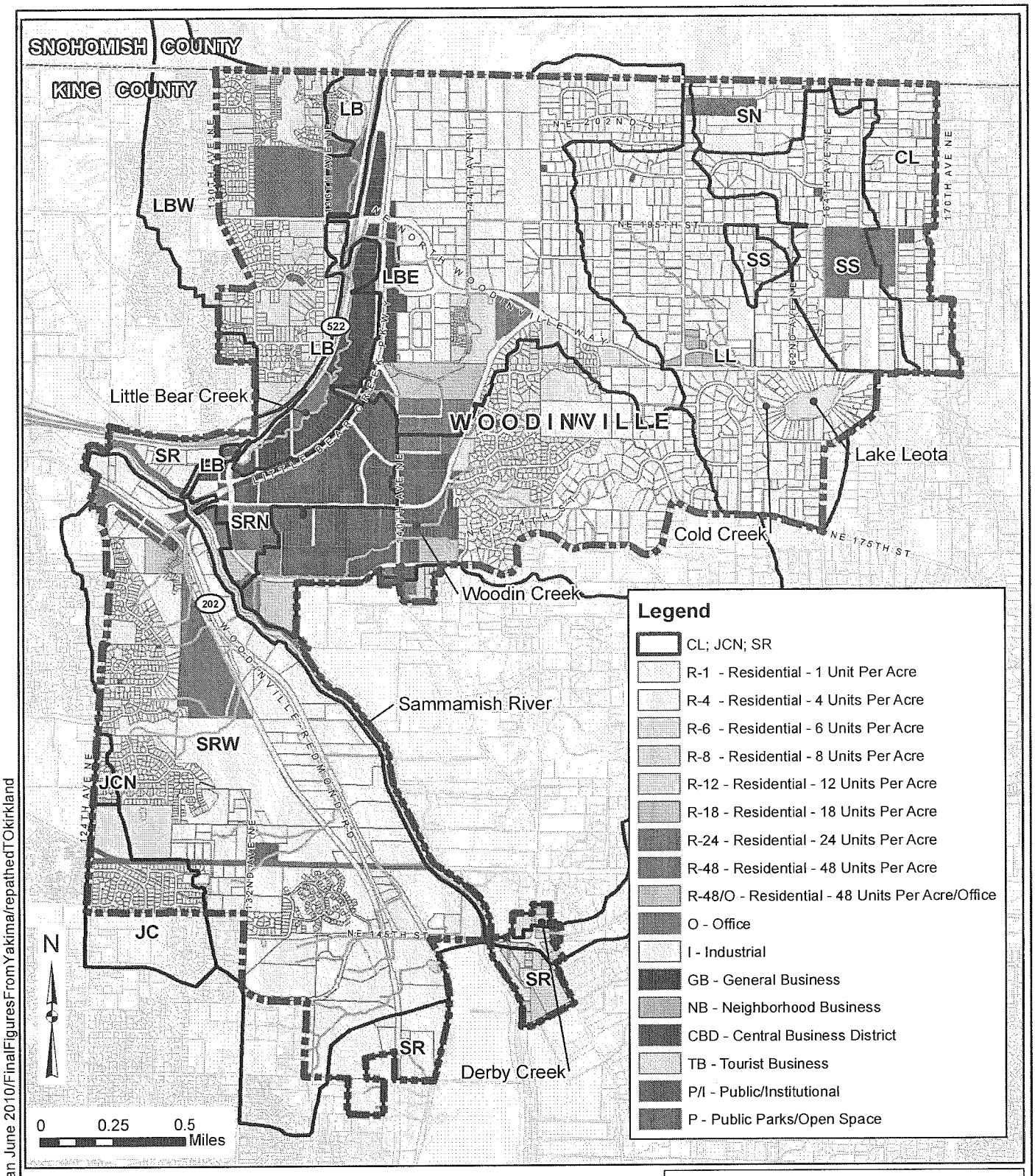
Figure 2-5 shows the City's existing zoning map last updated in April 2010, as presented in the City's Comprehensive Plan. The existing zoning areas within the City are summarized in Table 2-6.

Table 2-6
Existing Zoning

Basin	Zone	Total Area of the Zone (acres)	Percent in the Basin
Cottage Lake	P/I - Public/Institutional	11..2	8.1%
	R-1 - Residential - 1 Unit Per Acre	116.3	83.7%
	No Zone Identified	11.5	8.3%
Juanita Creek North	R-6 - Residential - 6 Units Per Acre	6.3	66.8%
	No Zone Identified	3.1	33.2%
Juanita Creek Basin	P - Public Parks/Open Space	4.5	7.7%
	R-4 - Residential - 4 Units Per Acre	0.9	1.5%
	R-6 - Residential - 6 Units Per Acre	41.9	70.4%
	No Zone Identified	12.2	20.5%
Lake Leota Basin	NB - Neighborhood Business	7.3	1.6%
	P/I - Public/Institutional	1.4	0.29%
	R-1 - Residential - 1 Unit Per Acre	389.9	84.4%
	No Zone Identified	63.6	13.8%
Little Bear Creek Basin	CBD - Central Business District	2.4	1.8%
	GB - General Business	55.4	40%
	I - Industrial	1.8	1.32%
	P - Public Parks/Open Space	21.95	15.8%
	R-6 - Residential - 6 Units Per Acre	25	18%
	No Zone Identified	32.1	23.1%
Little Bear Creek East Basin	CBD - Central Business District	4.0	0.7%
	GB - General Business	30.7	5.7%
	I - Industrial	189.3	34.9%
	NB - Neighborhood Business	0.1	0.02%
	O - Office	12.9	2.4%
	P/I - Public/Institutional	0.4	0.07%
	R-1 - Residential - 1 Unit Per Acre	214	39.6%

Table 2-6 Existing Zoning			
Basin	Zone	Total Area of the Zone (acres)	Percent in the Basin
Little Bear Creek East Basin (Cont'd.)	R-24 - Residential - 24 Units Per Acre	13.2	2.5%
	R-48/O - Residential - 48 Units Per Acre/Office	23.4	4.3%
	R-6 - Residential - 6 Units Per Acre	22.2	4.1%
	R-8 - Residential - 8 Units Per Acre	21.7	4%
	No Zone Identified	9.1	1.7%
Sammamish River Basin	CBD - Central Business District	0.15	<0.1%
	I - Industrial	79.4	40.2%
	O - Office	2.9	1.5%
	P - Public Parks/Open Space	13.6	6.9%
	P/I - Public/Institutional	0.4	0.2%
	R-12 - Residential - 12 Units Per Acre	4.2	2.1%
	R-18 - Residential - 18 Units Per Acre	0.1	<0.1%
	R-4 - Residential - 4 Units Per Acre	0.01	0.04%
	R-6 - Residential - 6 Units Per Acre	31.1	3.1%
	R-8 - Residential - 8 Units Per Acre	5.5	2.8%
	TB - Tourist Business	27.0	13.6%
	No Zone Identified	27.1	13.7%
Sammamish River Basin East	P/I - Public/Institutional	1.0	9.8%
	TB - Tourist Business	5.6	34.9%
	No Zone Identified	66.6	55.4%
Sammamish River Basin West	CBD - Central Business District	7.8	0.9%
	I - Industrial	263.4	30.9%
	P - Public Parks/Open Space	51.9	6.1%
	P/I - Public/Institutional	4.4	0.5%
	R-18 - Residential - 18 Units Per Acre	8.4	1%
	R-24 - Residential - 24 Units Per Acre	3.2	0.4%
	R-4 - Residential - 4 Units Per Acre	339.3	39.7%
	R-6 - Residential - 6 Units Per Acre	98.9	11.6%
	No Zone Identified	76.6	8.9%

Table 2-6 Existing Zoning			
Basin	Zone	Total Area of the Zone (acres)	Percent in the Basin
Sammamish River Basin North	CBD - Central Business District	66.6	54.4%
	GB - General Business	4.6	3.7%
	I - Industrial	3.9	3.2%
	P - Public Parks/Open Space	2.4	2%
	P/I - Public/Institutional	17.7	14.5%
	R-18 - Residential - 18 Units Per Acre	5.4	4.4%
	R-48 - Residential - 48 Units Per Acre	0.03	0.02%
	No Zone Identified	21.8	17.8%
School Creek Basin North	P/I - Public/Institutional	9.2	14.8%
	R-1 - Residential - 1 Unit Per Acre	49.7	79.9%
	No Zone Identified	3.3	5.3%
School Creek Basin South	P/I - Public/Institutional	24.1	10.9%
	R-1 - Residential - 1 Unit Per Acre	174.1	79.1%
	No Zone Identified	21.8	9.9%
Woodin Creek Basin	CBD - Central Business District	98.0	21.3%
	O - Office	2.5	0.6%
	P - Public Parks/Open Space	5.5	1.2%
	P/I - Public/Institutional	2.5	0.5%
	R-1 - Residential - 1 Unit Per Acre	138.8	30.2%
	R-12 - Residential - 12 Units Per Acre	3.6	0.8%
	R-18 - Residential - 18 Units Per Acre	18.7	4.1%
	R-24 - Residential - 24 Units Per Acre	6	1.3%
	R-4 - Residential - 4 Units Per Acre	5.5	1.21%
	R-48 - Residential - 48 Units Per Acre	4.8	1.0%
	R-6 - Residential - 6 Units Per Acre	112.7	24.5%
	No Zone Identified	60.9	13.3%



LEGEND

- City Limits
- County Boundary
- Subbasin Boundary
- Parcel Boundary
- Lake
- Streams

Disclaimer: The information shown in this map is assembled GIS data created and acquiredby Otak Inc.(basin boundaries), from the City of Woodinville (existing zoning,city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary, water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 2.5

EXISTING ZONING

CITY OF WOODINVILLE

otak

JUNE 2010

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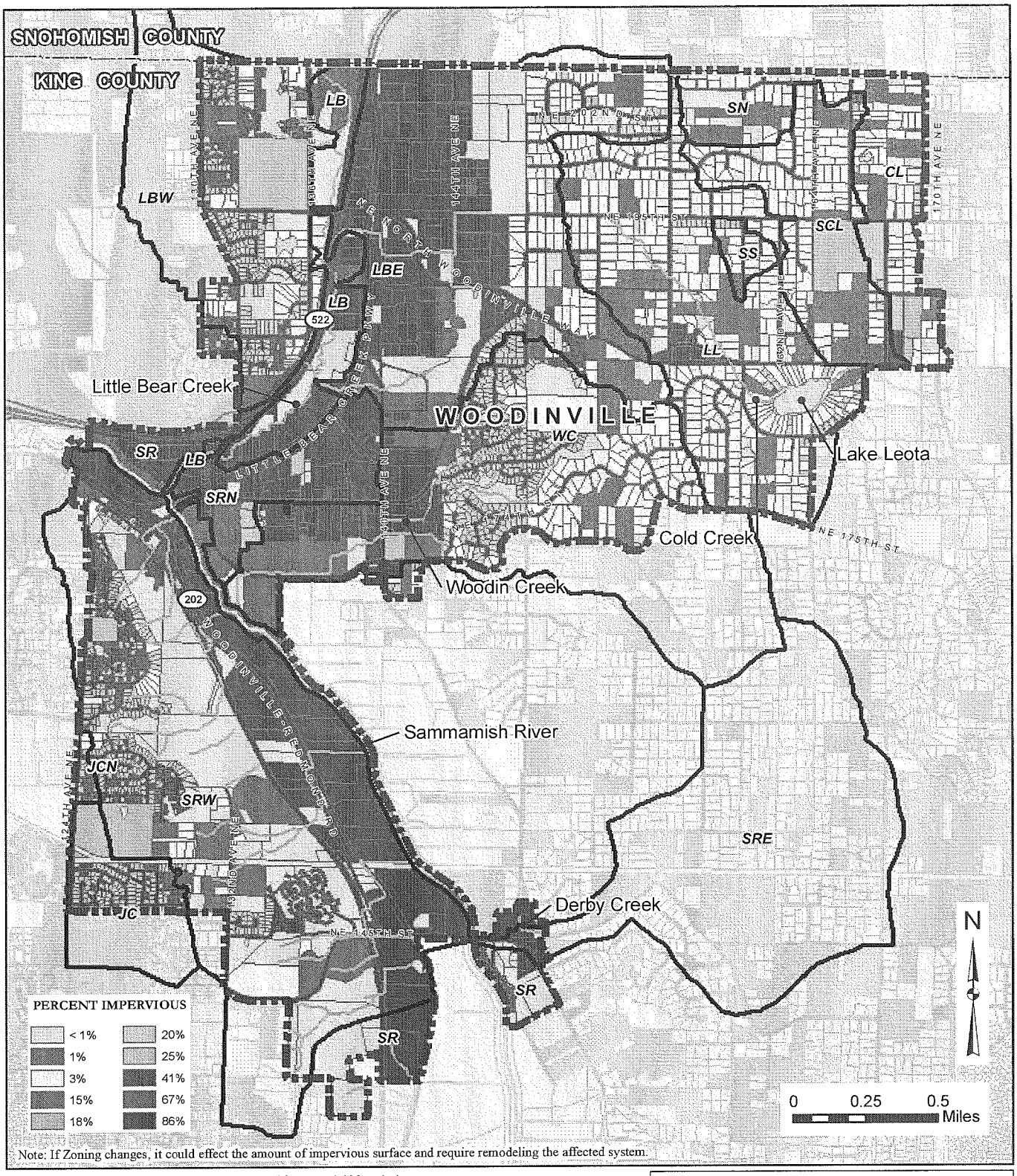
Future Impervious Percent Area

In the future, changes in impervious percent area will occur, as development continues according to the City's Comprehensive Plan. Increases in both residential and commercial development and densities within the City limits are anticipated as shown in Figure 2-6. The zoning in Snohomish County in Little Bear Creek (dated January 2009) is provided in Figure 2-7, including the total area for each zone within the watershed in Snohomish County.

The hydrologic effects of future development have been analyzed and are discussed along with the hydrologic modeling results in Section 5.1.



Note: If Zoning changes, it could effect the amount of impervious surface and require remodeling the affected system.

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LEGEND

- City Limits
- County Boundary
- SR Subbasin Boundary
- Parcel Boundary
- Lake
- Streams

Basin Name and Abbreviation

Cottage Lake (CL)	School North (SN)
Juanita Creek (JC)	School South (SS)
Juanita Creek (JC)	Sammamish River (SR)
Little Bear (LB)	Sammamish River East (SRE)
Little Bear East (LBE)	Sammamish River North (SRN)
Little Bear West (LBW)	Sammamish River West (SRW)
Lake Leota (LL)	Woodin Creek (WC)

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries, future land use impervious area), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies).
This data is not to survey accuracy and is meant for planning purposes only.

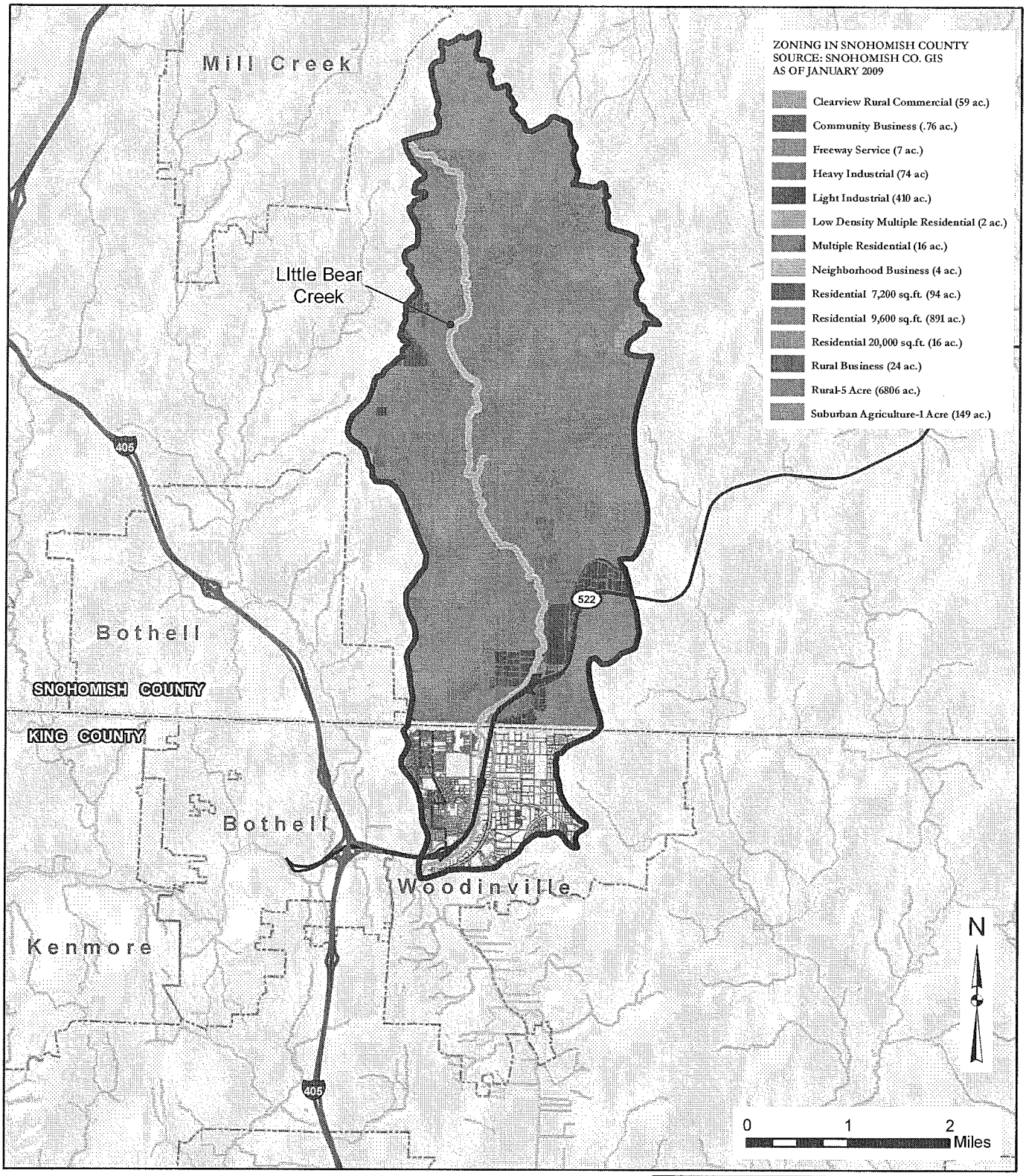
STORMWATER MANAGEMENT PLAN

FIGURE 2.6

FUTURE IMPERVIOUS PERCENT AREA

CITY OF WOODINVILLE

OCTOBER 2010



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LEGEND

- City Limits
- County Boundary
- Little Bear Creek Subbasin
- Parcel Boundary
- Lake
- Streams

LITTLE BEAR CREEK WATERSHED

CITY	ACREAGE	PERCENT IN WATERSHED
Woodinville	1076 ac.	11%
Bothell	140 ac.	1%
Unincorporated Snohomish County	8588 ac.	88%
Total Acreage	9804 ac.	

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(Little Bear Ck watershed boundary within the city), from Snohomish Co.(streets,streams,2009 zoning, city limits, Little Bear Ck watershed in Sno Co), King County GIS (county boundary, water bodies,city limits).
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 2.7

ZONING IN LITTLE BEAR CREEK SUBBASIN

CITY OF WOODINVILLE

OCTOBER 2010

otak

Section 3—City's Stormwater Management Plan

Section 3: City's Stormwater Management Program

Introduction

Section 3 provides an overview of the Purpose and Mission of the City's Stormwater Management Program together with a summary of current organization and staffing, utility rates and annual revenues, existing capital projects list, and annual SWM activities and services. Regulatory requirements and other surface water obligations are compiled, including those associated with the City's Phase II Permit, the Underground Injection Control Rule, the Puget Sound Partnership Action Agenda, and WRIA #8 Chinook Salmon Conservation Plan and the City's ESA Habitat Assessment Report. The City's Maintenance Program and the CSWM capital needs are described in additional detail in Sections 4 and 5, respectively.

Purpose and Mission

The City's Stormwater Management Program is dedicated to addressing public safety, protecting properties and structures, supporting continued economic development, and protecting and preserving the natural environment and its functions. The City's Stormwater Management Plan addresses economic development:

- By providing clarity during the planning process regarding the City of Woodinville's stormwater standards, and the developer or business contributions towards stormwater infrastructure.
- By providing clear and straightforward recommendations as to the priority investments over the next 20 years, six years and two years regarding the City's capital investment program.

The goals of the City's SWM Program are to:

- Promote public safety by minimizing uncontrolled stormwater runoff.
- Provide for the comprehensive, integrated management and administration of the City's stormwater facilities and operations.
- Achieve compliance with the various SWM-related regulatory requirements, specifically the Phase II Permit.
- Actively maintain the design capacity of the City's drainage infrastructure.
- Develop an annual program to design and construct capital projects to reduce flooding, enhance conveyance capacity and protect habitat.

To this end, the City's SWM Program routinely conducts numerous activities and services, ranging from program administration to complaint response, and includes education and outreach, development review, water quality monitoring, habitat enhancement, facility maintenance and capital improvement design and construction.

Organization and Staffing

The City of Woodinville is organized into five major departments, including the Public Works Department. The City's SWM Program is included within the Public Works Department, which is responsible for the City's stormwater management operations, capital improvements and regulatory compliance. In the Public Works Department, the Director and the Assistant Director provide management and administration of the City's SWM Program, providing activities and operations with support from the Construction Inspector, Engineering Technician, the Maintenance Manager and the Maintenance Technicians.

Utility Rates and Revenues

The Surface Water Utility (Utility) was formed in 1993 by Ordinance No. 26 and is currently administered by the Public Works Department. The Utility was established to pay for stormwater management activities, including but not limited to basin planning, stormwater system operations, maintenance, construction of facilities, regulatory compliance and water quality.

The initial stormwater management fees established in 1993 were equivalent to those established by King County in 1992 and included a flat fee service charge for single family residential parcels, with the fee based on percent of impervious area. Businesses and other larger parcels of land pay more based on the amount of impervious area.

In January of 2002, the Council adopted Ordinance No. 313 which allowed stormwater management fees to be amended by resolution of the City Council. Resolution No. 311 established a one-time increase of 2.5% that went into effect in January of 2006, raising fees to levels shown in Table 3-1. These rates have continued to be in effect to today. According to the City's 2010 Budget, total SWM Fund revenues are projected to be $915,000.

Table 3-1
Woodinville Stormwater Management Fees

Rate Category	Percent Impervious Surface	Annual Service Charge
1. Residential: Single-family home	NA	$87.15/parcel
2. Very Light	≤ 10%	$87.15/parcel
3. Light	More than 10%, ≤ 20%	$203.36/acre
4. Moderate	More than 20%, ≤ 45%	$421.25/acre
5. Moderate Heavy	More than 45%, ≤ 65%	$813.43/acre
6. Heavy	More than 65%, ≤ 85%	$1,031.31/acre
7. Very Heavy	More than 85%, ≤ 100%	$1,350.89/acre

Impervious area calculations are computed and utility rates are assigned by City staff. Any appeals of SWM utility fees by property owners are processed by City staff in accordance

with WMC 13.03 – Storm and Surface Water Utility. Utility fees are then billed and collected through an interlocal agreement with King County. The County includes the City's annual SWM utility fees on its annual property tax statement; fees are collected by the County and distributed to the City. The City pays the County a small service charge and customer service fee of $1.54 per SWM utility account billed plus an annual charge of 1% of projected annual service charge revenue to be collected. In 2010, the City utility accounts numbered 3,831 and the County billing fee amounted to $5,959. Utility revenues received by the City are placed in the Surface Water Management Fund and are used to support SWM program activities such as public education, stormwater system maintenance, regulatory compliance, administration and capital projects. For capital projects, the Surface Water Management Fund transfers funds to the Surface Water Capital Project Fund.

For 2011 and 2012, the City anticipates that $880K and $810K, respectively, of SWM Fund revenue will be needed to support SWM Program operations activities. Any remaining SWM Fund revenue will be allocated to support of capital projects.

The City does offer discounts to property owners when their parcels are served by one or more retention/detention facilities that meet City code provisions and are maintained at the expense of the property owner. Non-residential parcels are charged at the rate of one lower rate category than it is classified by its percentage of impervious area, with the exception of non-residential parcels in the light category which are charged the equivalent of the residential rate/acre/year. Qualifying residential parcels and parcels in the very light rate category are charged half the residential flat rate. Discounts range from a high of 57% rate reduction to a minimum of 21% rate reduction. According to the City, there are 80 properties that qualify for discounts at this point in time.

Flooding during December 2007 storm event

Grants are an additional source of income for the City's SWM Program. In 2008, the City received a $50,000 grant from Ecology to implement the Phase II Permit. In 2009, the City received another $75,000 grant from Ecology for additional implementation of Phase II Permit activities. Both of the grants went towards funding the development of this SWM Plan to help guide the City in identifying additional activities to achieve compliance. In 2010, the City received an additional $100,000 from Ecology for additional implementation of Phase II Permit activities. The activities of implementation for this grant have not yet been determined.

The City's SWM Program is primarily funded through utility fees. To date, utility fees, along with periodic grants and a small amount of investment income, have been used to cover the annual costs of the various SWM Program activities and capital projects.

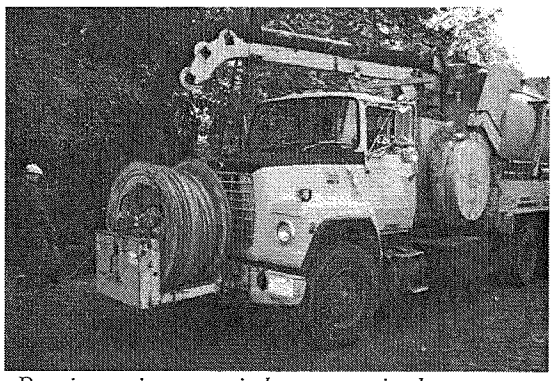
Activities and Services

The City's SWM Program includes six major of activities and services that are organized as listed below:

1. *Capital Improvement Program*
2. *Stormwater System Maintenance*
   - Complaint Response
   - Catch Basin Cleaning Program
   - Minor Stormwater Improvements
3. *Phase II Permit compliance, which includes:*
   - Public Education and Outreach
   - Public Involvement and Participation
   - Illicit Discharge Detection and Elimination, and facility inventory/mapping
   - Development Review: Controlling Runoff from New Development, Redevelopment and Construction Sites
   - Pollution Prevention and Operations and Maintenance for Municipal Operations
4. *Compliance with other local, regional and state regulatory requirements including: Endangered Species Act/Water Resource Inventory Area activities*
5. *Water Quality Monitoring*
6. *Program Management and Administration*

Capital Improvement Program

The City has historically developed, funded and administered its SWM CIP Program, with CIPs being identified, designed and constructed on an as-needed basis, using local funding provided by the City's SWM Utility Fund.



Routine maintenance is key to sustained stormwater facility performance.

Stormwater System Maintenance

The City's SWM Program includes an annual stormwater facilities maintenance program. This program includes maintaining the proper function of SWM facilities through cleaning, mowing, inspection and repair/replacement activities. In addition, street sweeping is annually

conducted to help reduce particulate and pollutant loading to the conveyance system and local receiving waters. Much of the City's stormwater system maintenance activities are driven by the requirements of the Phase II Permit for inspection with maintenance of facilities being provided according to prescribed frequencies and maintenance standards. The City's stormwater maintenance and operations program is discussed in greater detail in Section 4, along with any potential impacts to the City's maintenance program associated with annexation of the City's urban growth area (UGA). The Phase II Permit required maintenance standards are presented in Appendix I.

Complaint Response

The City's SWM Program is responsible for receiving and responding to public complaints. Drainage concerns are documented and responded to using maintenance referrals or Customer Service Request Forms, as submitted by citizens. Depending on the nature and magnitude of the problem, City staff either addresses it internally or brings in assistance from outside agencies or contractors. Response to water quality complaints and spill reports will become part of the City's emerging Illicit Discharge Detection and Elimination program that is required by the Phase II Permit.

Catch Basin Cleaning

The City annually cleans catch basins and other conveyance facilities in order to maintain flow capacities and to decrease the threat of flooding. Currently, the City is inspecting and cleaning catch basins on a rotating schedule such that all catch basins are inspected and cleaned at least once every five years in accordance with the City's maintenance standards and the Phase II Permit.

Minor Surface Water Improvements

City crews also actively investigate and address minor stormwater issues such as localized flooding or erosion problems, and repairs. Most of these repairs are made in the field and are routinely conducted by the maintenance crew. In the last three years, the City has completed four minor surface water improvements including catch basin repairs and replacements in the Wallington neighborhood, replacing a cross culvert at NE 162nd Street, two berming projects at Lake Leota and other catch basin repair and replacements performed on an as-needed basis.

Status of City's Compliance with Regulatory Requirements

The City has been implementing the requirements of its Phase II Permit over the past several years. Documentation of the City's compliance activities is organized in accordance with the five regulatory compliance elements and components and is summarized in its 2007, 2008, and 2009 Annual Reports, which are posted on the City website and are available for review at City Hall.

As part of this CSWM planning process, the City evaluated its SWM Program for compliance with regulatory obligations in the Fall of 2009. The results of this regulatory gap analysis are summarized in Table 6-1, located at the end of Section 6. This analysis focuses on the Phase II Permit but also includes the City's other stormwater-related obligations. Regulatory requirements have been listed, along with milestone dates, current activities, and future activities needed for compliance, together with due dates. As outlined in this Section, the City's existing SWM Program already includes many of the required legal authorities, policies, and programmatic activities needed for compliance. Some of these activities will need to be enhanced or expanded for full compliance in the future. Table 6-1 and Section 7 provide more information on both existing activities and the new activities the City will need to implement to come into full compliance. A brief description of existing activities organized by the five regulatory compliance elements is presented below.

Public Education and Outreach

The City has developed a brochure titled "Simple Ways You Can Help Save Our Salmon", which describes stream/runoff friendly alternatives to pesticides, fertilizers, and household cleaning products. Car wash kits are also available to fund raising groups. Articles about stormwater are published in the City's newsletter and posted on the City's website. A video on stormwater issues, including proper vehicle washing, has been sponsored by the City and shown on the local television station. The City has implemented additional passive educational tools such as interpretative signage around habitat areas and catch basin stenciling. The City also organizes volunteer planting events as part of the Sammamish Releaf project and holds an annual Earth Day event. At the City's annual Spring Garden Fair, rain barrels and compost bins are offered at a subsidized rate. In 2009, the City participated in a community survey to determine current stormwater understanding within the City. The survey revealed that proper vehicle washing is the highest priority topic for the City's education programming to focus on.

The City will follow as a similar route as Snohomish County who has adopted Low Impact Development Standards (Amended Ordinance No. 06-115) specific to the Little Bear Creek Watershed. The City's LID standards should be similar to the LID Technical Guidance Manual for Puget Sound which contains detailed guidance on how best to design, construct and maintain LID practices.

Public Involvement and Participation

In 2008, 2009 and 2010, the City posted its Annual Reports to Ecology and SWM Program documents on its website. In 2009, as part of this CSWM planning effort, the City conducted a stormwater survey to request information about known stormwater problems. In 2010, the City's draft Stormwater Management Comprehensive Plan has been made available for public review and comment prior to adoption.

Illicit Discharge Detection and Elimination

In January 1993, the City created and established citywide Water Quality Standards by the adoption of City Ordinance No. 24, codified in the WMC Chapter 14.06. These standards make it unlawful for any person to discharge any contaminants into receiving water bodies, including surface waters, ground water, or Puget Sound. In 2003, the City reinforced its commitment to protecting water quality by adopting City Ordinance No. 350, codified in WMC Chapter 1.07 (see Appendix J), that established the discharge of contaminants into surface water, stormwater or ground water as a civil violation. In 2009, the City established a "Hazardous Spill" hotline and posted it on the City website. City has also recently updated its stormwater system mapping and responds to reported drainage and water quality problems. WMC Chapter 1.07 will need to be updated to meet NPDES Phase II Permit requirements.

Controlling Runoff from New Development, Redevelopment, and Construction Sites

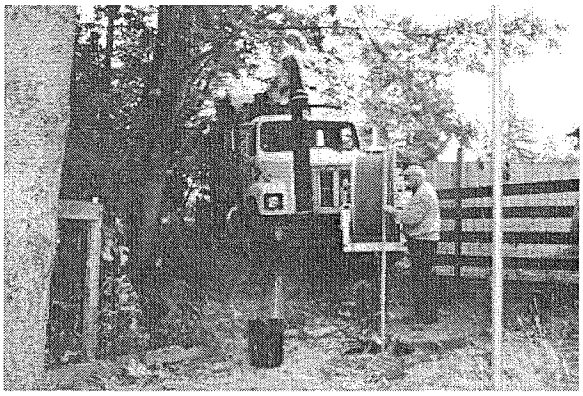
The City's oversight of development is codified in WMC 14.09 – Surface Water Runoff Policy, which establishes surface water runoff policy, adopts the KCSWDM, requires inspection and maintenance of stormwater facilities, and includes enforcement authority. WMC 1.03, 1.06 and 1.07 set forth a progressive set of penalties and enforcement procedures as required by the Phase II Permit. In 2008, the City adopted by rule the 2005 KCSWDM, outlining stormwater requirements for new developments and redevelopments. The City anticipates adopting the 2009 KCSWDM by October 1, 2010. The City conducts a permit review process that includes plan review, site inspections and enforcement to ensure that all required BMPs are installed as designed and proper erosion and sediment control methods are being used.

Existing City inspectors have been certified by Washington State Department of Transportation (WSDOT) in erosion and sediment control methods. If necessary, the Code Enforcement Officer can also provide assistance with enforcement. The City contracts with the King County Water and Land Resources Division to provide stormwater facility inspections for all private systems to verify that the facilities are properly maintained and functioning.

Pollution Prevention and Operation and Maintenance for Municipal Operations

City maintenance crews perform maintenance and spot checks of problem areas as needed. Currently, the City contracts with a private vendor to perform catch basin, pipe, and culvert inspections and cleaning. The City also conducts regular street sweeping with a high efficiency street sweeper purchased in 2003. The City contracts with King County to perform annual facility inspections.

In April 2002, the Regional Road Maintenance ESA Guidelines were adopted by the City via Resolution No. 222. These guidelines describe the recommended BMPs for completing road maintenance tasks with the least amount of environmental impacts. Following these guidelines protects the City from "take" liability under the ESA 4(d) rule and satisfies the Phase II Permit requirements for roadway maintenance practices that reduce stormwater impacts. The City's maintenance staff have attended Regional Road Maintenance ESA Guidelines training. See Section 6 for a more detailed information on current compliance activities, a compliance assessment of Phase II Permit requirements, and recommendations for future compliance activities.



City Maintenance Activities

Review of City SWM Maintenance Program

Findings from this regulatory review indicate that the City's Operations and Maintenance Program has made good progress in meeting the Phase II Permit requirements. Areas that need attention include updating maintenance standards, developing and implementing a nutrient and integrated pest management plan, as well as creating a facilities maintenance plan to reduce pollutant discharge from public lands, continuing staff training, developing and implementing a Stormwater Pollution Prevention Plan for the City's maintenance facility, and enforcing private facility maintenance.

Maintenance activities that will be continued on an annual basis include:

- **Complaint Response**—This activity will continue. Water quality complaints and spill reports will be investigated as part of the City's emerging IDDE program.
- **Catch Basin Cleaning**—This activity will continue on a schedule that allows all catch basins within the City to be inspected every five years and cleaned as necessary in accordance with the City's maintenance standards.
- **Minor Stormwater Facility Repairs/Improvement**—Inspection and repair of the City's drainage system occurs on an ongoing basis. This activity will continue according to future SWM Fund maintenance forecasts.

Other Regulatory Requirements/Stormwater-Related Obligations: Endangered Species Act and Water Resource Inventory Area Improvements

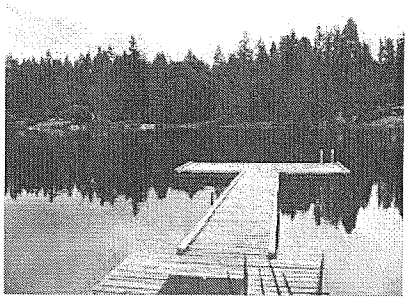
The City is part of WRIA #8 in the Lake Washington Watershed. In July 2005 the City participated in the development of the Chinook Salmon Conservation Plan, which it ratified on July 11, 2005. Over a number of years, the City has undertaken a variety of actions to

protect and restore habitat consistent with this Plan. The activities completed to date cover a broad range that include interjurisdictional coordination and collaboration; habitat restoration and enhancement; updates to policies, programs and regulations; and water quality monitoring.

In April 2002, the Regional Road Maintenance ESA Program Guidelines were adopted through Resolution No. 222. These guidelines describe the recommended BMs to complete road maintenance tasks with the least amount of environmental impacts. Maintenance staff have been attending trainings to better understand these maintenance guidelines.

The City annually sets aside operating budget funds for projects that involve stream and riparian area plantings and maintenance. Often, the work is performed by community volunteers. These are generally habitat-related projects that provide additional benefits such as erosion control and aesthetics. Some of the volunteer projects have included partnerships with King County, Washington State, Northshore School District, and Woodinville Water District. The City also seeks volunteer groups, such as Boy Scout and Girl Scout troops to stencil "Dump no waste - drains to stream" along the side of stormwater catch basins. This program educates both the volunteers and the general public.

In addition, the City participates in the King County Salmon Watchers Program and performs annual fish counts along with visits to known fish habitat areas. Specific sites and guidelines are established for volunteers to perform counts consistently and accurately. This information provides a basis for producing a long range history which is used to determine the wellness and function of habitat and surface water control systems for flow and water quality.


A local dock at Lake Leota

Water Quality Monitoring

Since 2000, the City has had an ongoing Water Quality Monitoring Program that includes monthly grab samples at Little Bear Creek, Woodin Creek and Derby Creek. Temperature monitors have also been placed at each of these three creeks and have been collecting hourly temperature data since 2003. Samples are analyzed for seven parameters including fecal coliform, Nitrate/Nitrite, Total Phosphorous, Total Suspended Solids, Lead, Zinc, and Copper. Fecal Coliform measurements for all three creeks exceed the established standard, however, on the average, all other parameters are within their respective limits. For more information about the City's Water Quality Monitoring Program, see Appendix F.

Program Management and Administration

Management and administration responsibilities include activities needed to support the development and implementation of the SWM Program. Typical activities include policy and procedure development, budgeting, contract administration, staff supervision and direction, performance tracking and reporting (including Phase II Permit compliance tracking and reporting), program evaluation, communications, customer service, internal and agency coordination, and utility administration.

Section 4—SWM Facilities and Maintenance

Introduction

System operations and maintenance are integral components of a successful surface water management program. Roadway and non-roadway areas contribute runoff to the City's stormwater system and require BMPs to reduce the impacts of contaminated runoff and particulates to stormwater facilities and receiving waters.

Surface water and stormwater facilities require regular inspection, cleaning, and repair to ensure that they are functioning as intended in order to provide the required flow control, treatment, detention, and conveyance. An effective Operations and Maintenance program aims to protect public health and safety, maintain drainage system integrity and function, reduce infrastructure repair and life cycle costs, enhance water quality, and achieve regulatory compliance.

Under the City's Phase II Permit, the City of Woodinville is required to conduct and record operation and maintenance activities within specific timeframes, according to specific standards, including facility inventory/mapping, inspection, cleaning, maintenance, and repair. This Section outlines the City's existing operations and maintenance program activities, compares them to the minimum permit requirements, and evaluates regulatory compliance status. Where needed, options that the City can consider to achieve regulatory compliance are presented for consideration. The Section concludes with a discussion of management issues and provides suggestions for future compliance activities and SWM Program implementation.

Background

Prior to the incorporation of the City in 1993, the King County Surface Water Management Division managed surface water within the Woodinville area and provided facility maintenance. Upon incorporation, the City assumed the management of routine stormwater facilities through the adoption of its own Surface Water Utility. Since that time, the City has entered into interlocal agreements with King County for continued support. Today, through these annual agreements, King County continues to administer the various stormwater management fees and provides inspection and maintenance services as directed by the City. In the spring of 1999, the City began the development of an in-house stormwater management maintenance and operations program, which included the hiring of a maintenance supervisor. In January 2001, the City hired two maintenance workers and began purchasing equipment to develop the City's Stormwater Maintenance Program. Since that time, the City has been progressively assuming more of the City's routine maintenance functions, and continuing to reduce the role of King County.

Staffing and Organization

Since January of 2003, the City's Public Works maintenance staff has consisted of a supervisor, a lead worker, and a three-person crew, supported by seasonal staff during the summer. Collectively, the maintenance staff share the responsibility of maintaining the streets, stormwater infrastructure, publicly owned parking lots, repair of all fleet vehicles and equipment, and responding to citizen inquiries and complaints. The City's parks and public buildings are maintained by other crews.

Stormwater Facilities Map and Database

A comprehensive drainage system network map is an essential element of the City's Stormwater Management Program. Facility mapping gives the City an understanding of the stormwater system and provides the basis for scheduling maintenance activities and evaluating infrastructure needs.

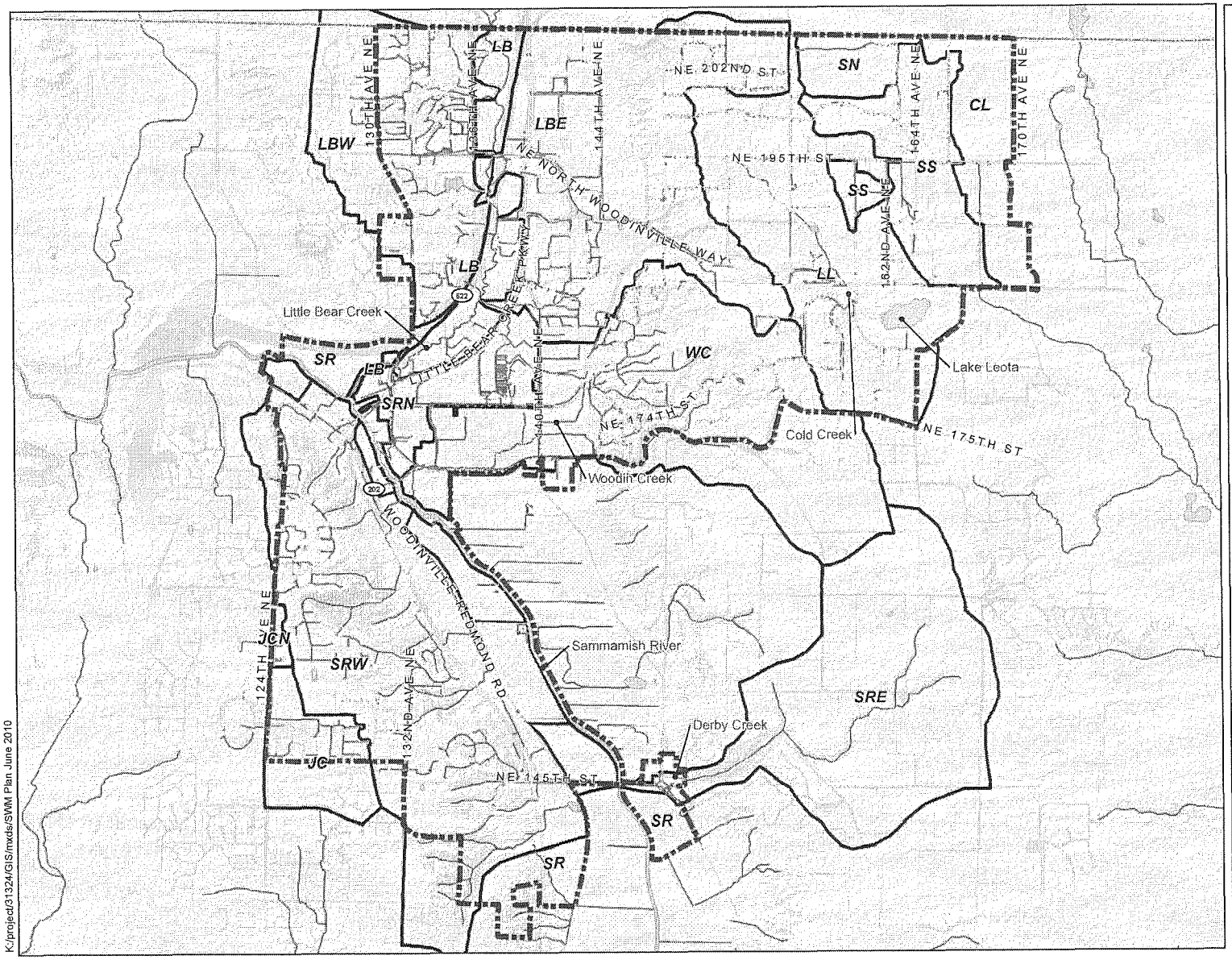
As part of the Phase II Permit, the City is required to complete a municipal storm system map that addresses the following items:

- Location of municipal storm system outfalls and receiving waters and structural stormwater BMPs owned, operated, or maintained by the Permittee.
- For all storm sewer outfalls with a 24-inch nominal diameter or larger, map the tributary conveyances, associated drainage areas, and land use.
- Map all connections to the municipal separate storm sewer authorized by the City.
- Geographic areas served by the City's municipal separate storm sewer system that do not discharge stormwater to surface waters.
- Comply with Ecology's approved mapping standard, preferably in a GIS format.

As part of this study, the City's GIS database of drainage facility mapping was both expanded and updated, building upon the City's previously-established drainage network map. The base-mapping includes streets, parcel boundaries, contours, pipes, ditches, culverts, manholes/catch basins, drainage basin and watershed boundaries, as well as other features. A database was developed to accompany the GIS mapping that included parameters such as material type and size, pipe orientation, pipe size, pipe length, and pipe diameter.

Stormwater System Inventory

The City's surface water infrastructure includes catch basins, pipe networks with manholes, detention basins and stormwater tanks, roadside ditches and swales, treatment facilities, outfalls, and culverts. Mapping of the system has recently been updated; the current mapped inventory is summarized in Table 4-1 and displayed graphically in Figure 4-1.



Legend

- Woodinville City Limits
- County Boundary
- City of Woodinville Stormwater Pipes Dated: 02/16/10
- Stormwater Open Channel
- Stream
- 5ft Contour (King Co. LIDAR)
- Waterbody
- Basin Boundary

N

0 1,000 2,000 4,000 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries,storm system mapping), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010.

STORMWATER MANAGEMENT PLAN

FIGURE 4-1

DRAINAGE SYSTEM MAP

CITY OF WOODINVILLE

OCTOBER 2010

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

Table 4-1 Existing Inventory Summary		
Inventory Item	Quantity	Unit
Catch Basins/Manholes	3,260	Each
Outfalls/Major Culverts	1,958	Each
Roadside Ditches/Swales	37.6	Miles
Total Length of 12" Pipe	39.3	Miles
Total Length of 18" Pipe	5.7	Miles
Total Length of 24" Pipe	4.1	Miles
Total Length of Greater Than 24" Pipe	4.0	Miles
Total Length of Pipes	53.1	Miles
Stormwater Ponds/Tanks	20	Each
Streets	60	Miles
Vaults	12	Each

Facility inventory data as of February 16, 2010. Please note that the City may be able to use Low Impact Development 'green' techniques to manage runoff where site topography and geologic conditions are suitable.

The City's current drainage network base map and database complies with the Phase II Permit requirements and is a good base upon which to build an ongoing stormwater system map program. Mapping will continue to be updated and refined as new information is obtained, including outfall determinations, tributary areas and structural stormwater BMPs.

The City's existing stormwater GIS database was used in this study as the basis for developing city-wide hydraulics analysis. It was also used for determining pipe size, material type, flow direction, and system connectivity, as well as the basis for developing and graphically displaying the needed SWM capital projects. The stormwater GIS database was significantly updated during the city-wide hydraulic analysis, working in concert with the City's GIS staff. The City is committed to developing a complete and updated GIS-based mapping of its drainage systems and will continue to update the GIS database as new development and re-development occurs to allow for complete and accurate future hydraulic analysis.

Recommendation for Continued Development of Stormwater Facilities Map

The City's existing drainage network map will require updates as new development and redevelopment occurs. Staff, engineers and contractors working on new development and capital improvement projects should submit as-builts and other pertinent drainage

information, for making the base map complete and keeping the base drainage network database up-to-date. The City should schedule updates twice a year to the drainage base mapping to incorporate as-built data and any additional surveyed information collected by City staff.

Equipment

Equipment from the City's shared maintenance equipment pool that is used for surface water infrastructure maintenance includes:

- 5-yard dump truck
- F-450 flatbed truck
- Backhoe/trailer
- Mower
- Street sweeper
- Pick-up trucks

Vactor truck used to clean out stormwater conveyance system.

Cleaning of manholes, catch basins, and pipes requires the services of a vactor or jet rodder truck. The City currently contracts these services to outside vendors on an annual basis, including emergency response.

In forecasting maintenance equipment needs, the City will need to take into account the additional equipment needs associated with alternative pavement surfacing methods. If, for example, the City were to allow the use of porous pavement in public streets or parking lots, the additional need for vactor equipment or services would need to be determined.

Maintenance Facility

The City is currently using a vacated school building as their temporary maintenance facility, located just next to City Hall. All vehicles are parked in the former school parking lot, and equipment is stored in the upper level storage area. The site has been retrofitted with catch basin filter inserts and bio-swales to provide water quality treatment of stormwater. A SWPPP will be developed for his site and submitted to Ecology later this year in order to comply with the City's Phase II Permit.

Maintenance Activities

The maintenance staff performs most of the maintenance activities required to support the City's Operations and Maintenance Program. However, the City does contract out a few services such as annual public and private facility inspections, vactor services, and major repair work. King County performs the facility inspections and generates work orders for the

public facilities that are sent to the City. The County also mails out maintenance correction lists for the private facilities that are maintained by private property owners and provides follow up education and inspection services.

The City's maintenance staff provides the following surface water maintenance activities:

- Street and drainage system cleaning
- Drainage conveyance system repair and construction
- Open channel and ditch maintenance
- Public retention/detention facility maintenance
- Emergency response and miscellaneous service programs

Each of these activities are described below. Please note that with alternative stormwater practices, comes the possibility of more complex maintenance activities and additional equipment needs for the City of Woodinville.

Street and Drainage System Cleaning

The purpose of the street cleaning program is to remove silt, sand, leaves, and miscellaneous debris from the road surfaces before it enters the public drainage system, which may reduce the capacity of the conveyance system and/or cause water pollution. Street sweeping is an effective method of pollution prevention that removes pollutants from the street system so they are not transported through the conveyance system to receiving waters where they can negatively impact water quality. In 2009 City crews logged 625 hours in street sweeping. In 2010, the City expects to log 700 hours of sweeping activity. Sweeping is performed by City staff on a seasonal schedule as follows:

- Tourist District and downtown core – once per week April through September
- Tourist District and downtown core – every other week October through March
- Major and minor arterials – every other week
- Residential streets – once every four months
- City wide leaf pick up – every day in October, November and December

The drainage system (manholes, catch basins, pipes, vaults) is cleaned with a vactor or jet rodder truck; currently, these services are contracted to an outside vendor. In 2009, the City cleaned 800 catch basins at a cost of $30,000. In 2010, the City plans to clean two vaults and clean 810 catch basins and has budgeted $60,000 for these activities. During cleaning activities the City frequently finds other problems such as brick and grout failures that need attention. This occurred approximately 12 times in 2009. In rare cases (2 in 2009) catch basins and pipes have been found fully clogged with debris. Based on statistics for 2009 and the first half of 2010, the City estimates an annual waste collection/disposal burden of 200 tons of material from catch basin cleaning activities.

Drainage Conveyance System Repair and Construction

City maintenance staff also performs minor construction and repair as needed, for existing catch basins, manholes, and pipes to ensure the proper function of the public storm and surface water system. Major repairs that cannot be performed with existing City equipment are contracted to outside vendors and/or King County. In general, a stormwater system will last between 50 and 100 years depending on the site conditions and the materials used in construction.

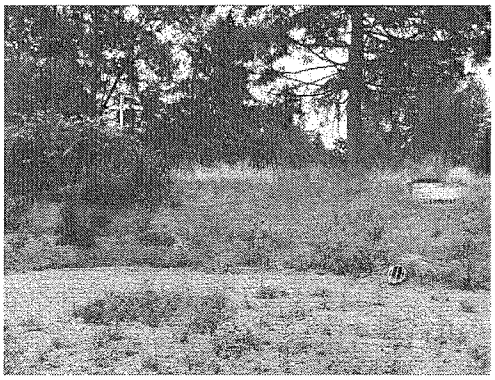
Open Channel and Ditch Maintenance

The City's open channel and ditch maintenance program is responsible for cleaning and stabilizing the public open channel and ditch systems, maintaining adequate system conveyance capacity, managing vegetation, minimizing channel/ditch erosion, improving water quality, and ensuring the proper operation of the public storm and surface water system.

Public Retention/Detention Facility Maintenance

The retention/detention facility maintenance program maintains public drainage facilities so they operate as designed and preserve a clean, landscaped appearance. Maintenance of retention/detention facilities includes:

- Removal of sediment from the bottom of ponds, storage vaults, inlets, and other structures
- Access road repair
- Vegetation control (mowing and major landscaping)
- Garbage and debris removal
- Fence & sign repair
- Overall aesthetic appearance



Local stormwater facility maintained by City maintenance crews.

Emergency Response and Miscellaneous Service Programs

The emergency response program provides quick response to emergency situations during storm events and other non-storm related emergencies. Typical emergency situations include:

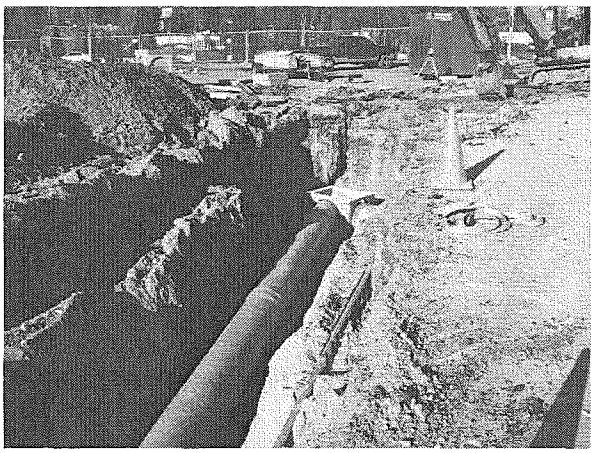
- Flooding
- Landslides
- Fallen Trees
- Spills

As part of Phase II Permit requirements, the City is in the process of developing an IDDE program. The City has already taken steps to establish and post a spill reporting hotline on its website.

Maintenance and engineering staff respond as a team to emergencies and citizen service requests as they occur. The City has created and routinely uses a Citizen Request for Service form to receive and follow up on public complaints. In addition, the City contracts with King County and private companies for additional support as needed.

Staff Training

Maintenance staff have attended training on the Regional Road Maintenance ESA Program Guidelines and associated BMPs, and additional training on water quality, BMPs, illicit discharges, and inspection/enforcement is being provided by the City's senior Public Works staff.



Construction of Stormwater Facilities

Recordkeeping

Although the City currently does not have a separate SWM tracking and recording system for its various maintenance and Phase II Permit activities, the City tracks their activities throughout the year and maintains records of all inspections performed by King County and other vendors. Starting in 2009, the City started tracking and recording stormwater maintenance activities using the Task Tracker application.

City's Compliance with Minimum Phase II Permit Requirements for Operations and Maintenance Programs

The City's existing operations and maintenance program addresses many of the requirements of the Permit and is close to meeting its Phase II Permit compliance goals. In some cases, small changes are necessary to update existing standards or activities. In a few areas, there are new activities that the City will need to perform to fully address the requirements meet the due dates required for compliance.

Minimum NPDES Permit Requirements

Table 4-2 (presented at the end of this Section) outlines the minimum maintenance performance measures required by the Phase II Permit and their associated due dates, as listed in Special Condition S.5.C.5 *Pollution Prevention and Operations and Maintenance for Municipal Operations.* Private facility inspection is also required by the Phase II Permit, as listed in Special Condition S.5.C.4 *Controlling Runoff from New Development, Redevelopment and Construction Sites.*

Inspection frequencies are stipulated in the Phase II Permit. In terms of required inspections, compliance is achieved by accomplishing at least 95% of all scheduled inspections specified in S.5.C.b-d, and at least 80% of all scheduled inspections specified in S.5.C.4.c.iii., during the five year term of the Phase II Permit.

The Phase II Permit further stipulates that the maintenance standards in Chapter 4, Volume V of the 2005 Ecology Manual must be applied. When an inspection identifies exceedance of a maintenance standard, the Phase II Permit stipulates the timelines within which maintenance must be performed. The Maintenance Standards from the 2005 Ecology Manual are included in Appendix F for reference.

Regulatory Compliance Assessment and Findings

A regulatory compliance assessment, conducted as part of this surface water comprehensive plan update, was performed to evaluate the City's current stormwater management program. The City's existing SWM Program activities were compared against the Phase II Permit requirements. Where gaps were identified, actions were proposed to meet regulatory compliance needs. Table 4-2 (located at the end of this Section) presents the findings of this regulatory compliance assessment and presents actions, where needed, for the City to achieve regulatory compliance.

In summary, the findings from the assessment indicate that the City needs to continue its existing activities and to take the following additional steps to fully comply with Phase II Permit requirements:

- Adopt either the 2005 Ecology Manual or the 2009 KCSWDM and the associated maintenance standards.
- Develop and implement a nutrient and integrated pest management plan.
- Develop and implement a facilities maintenance plan.
- Develop and implement an ongoing staff training program and maintain records of staff trainings.
- Develop and implement a stormwater pollution prevention plan for City maintenance and materials storage facilities.
- Implement a private facility maintenance enforcement process.

Conclusions

During the Operations and Maintenance Program evaluation of the City's Stormwater Maintenance Program, four issues arose that relate to SWM Program implementation:

- Compliance with ESA.
- The need for a new, permanent maintenance facility.
- The development and attainment of new maintenance standards.
- Potential impacts of annexation on the City's Operations and Maintenance Program.

Each of these issues and their relationship to the City's emerging SWM Program is documented below.

ESA Compliance

In April of 2002, the City adopted the Regional Road Maintenance ESA guidelines, which follow a recommended set of BMPs for conducting road maintenance activities. Following these guidelines protects the City from assuming liability under Section 7 of the ESA 4(d) rule. An added benefit of following these guidelines is that it also helps the City meet its requirements under the Phase II Permit for reducing stormwater impacts of roadway maintenance.

Permanent Maintenance Facility

The City is evaluating locations and funding options to construct a permanent maintenance facility. A permanent facility would allow the City to purchase additional equipment, take over many of the maintenance tasks that are currently contracted out to others and be more responsive. If the City elects to purchase a vactor truck in the future, alternative sites for decant disposal would need to be evaluated. Alternatively, vactor services can continue to be provided on contract by other jurisdictions or by emergency response providers, as is the City's current practice.

Maintenance Standards

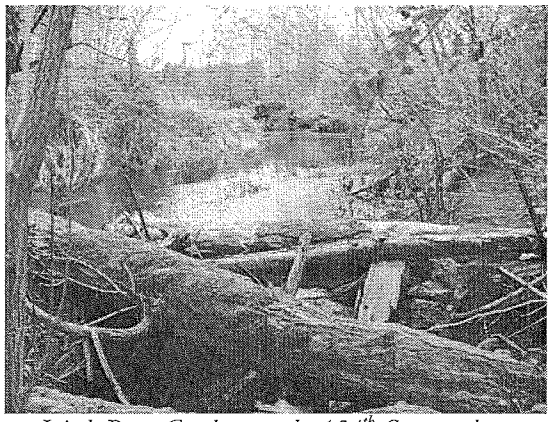
The maintenance standards in the 2005 Ecology Manual as shown in Appendix F are the minimum standards required by the Phase II Permit and focus on stormwater treatment and flow control facilities. The KCSWDM includes the same maintenance standards as the Ecology 2005 Manual; however, it also includes the following six additional maintenance standards that go beyond the Phase II Permit requirements:

- Conveyance pipes and ditches
- Fencing
- Gate/bollards/access barriers
- Grounds (landscaping)
- Access roads
- Stormwater wetlands

While these additional maintenance standards could be useful in guiding maintenance activities that the City already performs, at issue is whether or not the City wants to take on a greater regulatory commitment than is required by the Phase II Permit.

Potential Impacts of Annexation on the City's Operation and Maintenance Program

The City's UGA extends from the northern City limits into Snohomish County along the SR-522 corridor and covers an area of approximately 0.5 square miles. In December 2002, Snohomish County prepared The Little Bear Creek Drainage Needs Report which included the City's UGA as part of the SR-522 study area. The study area includes a mixture of residential, commercial and industrial development and is traversed by the Burlington Northern Santa Fe (BNSF) Railroad as well as SR-522. Stormwater runoff in the SR-522 study area is collected mostly in open channels and ditches. The study area is also served by drainage infrastructure associated with SR-522, the BNSF Railroad and industrial development. The report identified four CIP projects to correct erosion and flooding within the City's UGA. According to a status report issued in May of 2007 these four projects have been addressed since the initial 2002 report was issued. However, three additional projects within in or adjacent to the City's UGA have been identified since the initial 2002 report was issued. The culvert replacement project at 61st Avenue SE and 231st Street SE (LB-LB-12) was completed in 2009. The two remaining maintenance projects involved clearing culvert obstructions and regrading/dredging ditches to improve conveyance at 61st Avenue SE and 231st Street SE (LB-LB-31) and 58th Avenue SE and 238th Street SE (LB-LB-32). Status of the remaining two maintenance projects was not available from the County at this time. Available data from Snohomish County appears to indicate that most existing problems with erosion and flooding have been addressed and the development of future problems minimized by the adoption and application of updated drainage standards. No additional CIP for the City's UGA is anticipated at this time.



Little Bear Creek near the 134th Street culvert

Recommendations

Overall, the City has taken many of the steps necessary to comprehensively address the maintenance requirements of its municipal stormwater management program and those of the Phase II Permit. However, in order to fully comply with Phase II Permit requirements, there are a number of areas where the City should make improvements to its existing SWM Maintenance Program, as presented in Table 4-2. These maintenance activities are listed below with suggestions for future compliance.

Maintenance Standards

Update and perform maintenance as needed in accordance with Phase II Permit timelines.

Annual Inspection and Maintenance of Facilities

Perform maintenance in accordance with updated standards and Phase II Permit timelines. Achieve at least 95% of scheduled inspections by the end of the Phase II Permit term.

Spot Checks of Facilities after Large Storm Events

Continue to inspect problem catch basins and stormwater facilities; maintain and repair as needed in accordance with updated standards and Phase II Permit timelines.

Catch Basin Inspection

Complete inspections of entire inventory and clean/repair as needed in accordance with updated standards and Phase II Permit timelines.

Roadway Maintenance

Continue to follow the Regional Road Maintenance ESA Program Guidelines to reduce stormwater impacts from road maintenance activities.

Non-Roadway Maintenance

Develop and implement a nutrient and integrated pest management plan as well as a facilities maintenance plan to reduce pollutant discharge from public lands, as required by the Phase II Permit.

Staff Training

Continue to send staff to stormwater maintenance training sessions such as the Regional Road Maintenance ESA Program training. Continue to conduct ongoing training at staff meetings to address changes in procedures or requirements. Maintain records of staff trainings.

SWPPP for Maintenance Yard

Develop and implement a SWPPP for the City's maintenance and materials storage facilities.

Private Facility Maintenance Enforcement

Continue annual inspections and correction notices. Follow up with enforcement actions to ensure maintenance is conducted as needed.

Maintain Records

Continue to maintain records of maintenance activities. Include records of enforcement actions for private facility maintenance. Record results in Annual report to Ecology.

Table 4-2
Minimum Maintenance Permit Requirements & Compliance Assessment

Permit Reference	Minimum Performance Measure	Due Date	Compliance Assessment	Action Required		Action Required
				Yes	No	
S5.C.5.a	Establish Maintenance Standards consistent with Chapter 4, Volume V of 2005 Ecology Manual	2/16/2010	WMC 14.09 adopts the King County Surface Water Design Manual, which includes maintenance standards. The City is currently operating under the 2005 KCSWDM and needs to update its maintenance standards for consistency with 2005 Ecology Manual.	✓		To meet the minimum Permit requirements, the City could adopt Chapter 4, Volume V of the 2005 Ecology Manual. Alternatively, the City could adopt the 2009 KCSWDM, which includes additional maintenance standards that go beyond the minimum requirements of the Permit. See Appendix F for the Maintenance Standards in the Ecology 2005 Manual.
S5.C.5.a.ii	When an inspection identifies an exceedence of the maintenance standard, maintenance shall be performed within: • 1 year for typical maintenance of facilities • 6 months for catch basins • 2 years for maintenance that requires capital construction of <$25K	Goes into effect following adoption of maintenance standards in 2010	The City's existing program uses the maintenance standards from the 2005 KCSWDM to guide its maintenance activities. The City will need to comply with this requirement using the updated maintenance standards starting in 2010.	✓		Adopt updated maintenance standards from 2005 Ecology Manual or the 2009 KCWSDM.

Table 4-2 Minimum Maintenance Permit Requirements & Compliance Assessment						
Permit Reference	Minimum Performance Measure	Due Date	Compliance Assessment	Action Required		Action Required
				Yes	No	
S5.C.5.b	Annual inspections of municipal stormwater treatment and flow control facilities and maintenance in accordance with adopted maintenance standards.	Annually, starting 2/15/10	The City is already conducting annual inspections of public stormwater facilities. The City will need to maintain its facilities in accordance with updated maintenance standards. Inspection frequencies may be reduced based on maintenance records of double the proposed inspection frequency, or written statements may be substituted documenting a specific less frequent inspection schedule based on actual inspection and maintenance experience and certified in accordance with general condition G19 of the Phase II Permit.		✓	
S5.C.5.c	Spot checks of potentially damaged treatment and flow control facilities after 10-year storm events. If warranted, inspect all facilities that may be affected. Conduct repairs or take maintenance action in accordance with adopted maintenance standards.	After 2/15/10	The City's existing program conducts spot checks of known problem areas before and after major storm events.		✓	

Table 4-2
Minimum Maintenance Permit Requirements & Compliance Assessment

Permit Reference	Minimum Performance Measure	Due Date	Compliance Assessment	Action Required		Action Required
				Yes	No	
S5.C.5.d	Inspect all municipal catch basins and inlets at least once before the end of the permit term. Clean in accordance with adopted maintenance standards. Dispose of decant water in accordance with Appendix 6 of the Phase II Permit.	Permit End (180 days prior to permit expiration or 8/19/11)	The City's existing program includes catch basin inspection and cleaning. The City has created a rotating schedule for inspection and cleaning to ensure that all catch basins are inspected at least once every 5 years and cleaned in accordance with the updated maintenance standard. The City's contractor is disposing of decant water at a decant facility which complies with Phase II Permit requirements.		✓	
S5.C.5.e	Compliance with inspection requirements of S.C.5.b-d.	Permit End (180 days prior to permit expiration or 8/19/11)	The City's existing program is conducting inspections and will need to demonstrate an annual rate of achievement of at least 95% of scheduled inspections in order to meet this requirement.		✓	

Table 4-2 Minimum Maintenance Permit Requirements & Compliance Assessment						
Permit Reference	Minimum Performance Measure	Due Date	Compliance Assessment	Action Required		Action Required
				Yes	No	
S.5.C.5.f	Establish and implement practices to reduce stormwater impacts associated with runoff from municipal streets, parking lots and roads and road maintenance activities. The following activities must be addressed: • Pipe/culvert cleaning • Ditches/roadside vegetation • Street cleaning • Road repair/utility installation • Snow/ice control • Pavement striping • Dust control	2/15/2010	In April of 2002, the City adopted the Regional Road Maintenance ESA Program Guidelines, which include BMPs for conducting road maintenance activities. Following these guidelines will keep the City in compliance with this requirement, as well as protect the City from take liability under the ESA 4(d) rule.		✓	

Table 4-2
Minimum Maintenance Permit Requirements & Compliance Assessment

Permit Reference	Minimum Performance Measure	Due Date	Compliance Assessment	Action Required		Action Required
				Yes	No	
S.5.C.5.g	Establish and implement policies and procedures to reduce pollutants in discharges from public lands including parks, open space, road ROW, maintenance yards and stormwater facilities. At a minimum, the policies and procedures shall address: • Nutrient and integrated pest management plans • Sediment and erosion control • Landscape maintenance and vegetation disposal • Trash management • Building exterior cleaning and maintenance	2/15/2010	The City will need to comply with this requirement starting in 2010.		✓	The City should develop and implement a nutrient and integrated pest management plan as well as a facilities maintenance plan to address compliance with this requirement.

Table 4-2 Minimum Maintenance Permit Requirements & Compliance Assessment						
Permit Reference	Minimum Performance Measure	Due Date	Compliance Assessment	Action Required		Action Required
				Yes	No	
S.5.C.5.h	Develop and implement an on-going training program for construction, operations and maintenance personnel on: • Phase II Permit requirements • O&M standards • Inspection procedures • BMP selection • Reducing water quality impacts in daily activities • Reporting water quality concerns and illicit discharges. • Provide follow up training to address changes in procedures or requirements. • Maintain records of training.	2/15/2010	The City will need to comply with this requirement starting in 2010.	✓		The City should continue to send staff to stormwater related O&M trainings annually, conduct ongoing training for O&M staff during staff meetings, and maintain records of training. The Regional Road Maintenance ESA Program trainings would satisfy the training needs for the road maintenance activities
S.5.C.5.i	Develop and implement a SWPPP for all municipal heavy equipment maintenance or storage yard and material storage facilities. Implement nonstructural BMPs immediately following SWPPP development.	2/15/2010	The City will need to comply with this requirement starting in 2010.	✓		The City should develop and implement a SWPPP for its maintenance and materials storage facilities.

Table 4-2
Minimum Maintenance Permit Requirements & Compliance Assessment

Permit Reference	Minimum Performance Measure	Due Date	Compliance Assessment	Action Required		Action Required
				Yes	No	
S.5.C.5.j	Maintain records of inspections, maintenance and repair activities in accordance with Special Condition S9 Reporting Requirements.	2/15/2010	The City's existing program is maintaining records of maintenance activities and will continue to do so.		✓	
S.5.C.4.c.iii	Annual inspections of private stormwater treatment and flow control facilities and enforcement of maintenance in accordance with adopted maintenance standards.	2/16/2010	WMC 14.09 requires maintenance of private drainage facilities. The City's existing program includes private facility inspections conducted under contract by King County. Notices of deficiencies are sent to property owners; however, there is currently no follow up activity to ensure maintenance is conducted.	✓		The City should implement a maintenance enforcement activity to ensure that private facility maintenance is occurring as required by code.
S.5.C.4.e	Maintain records of inspections and enforcement actions related to private facility maintenance.	2/16/2010	The City's existing program is maintaining records of private facility maintenance inspections and correction notices.		✓	

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.

Section 5.2: Problem Ranking and CIP Development

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.

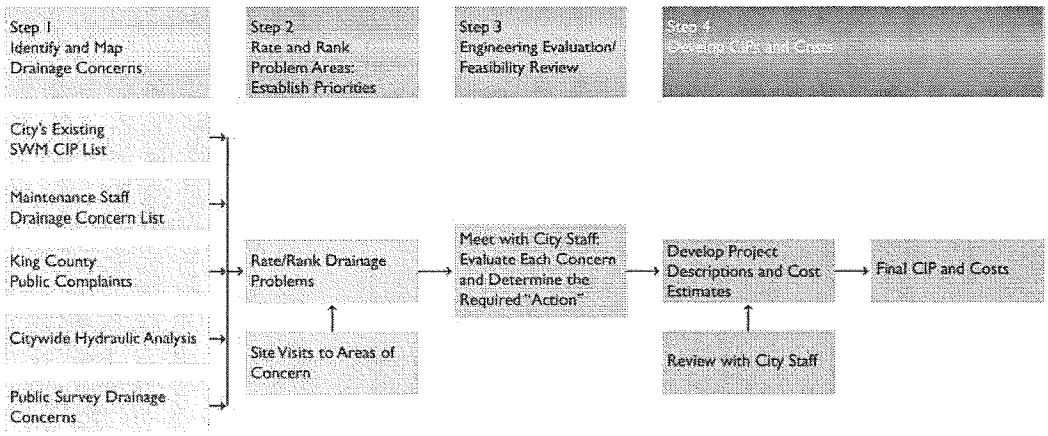


Figure 5.2-1 CIP Development Process Flow Chart

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

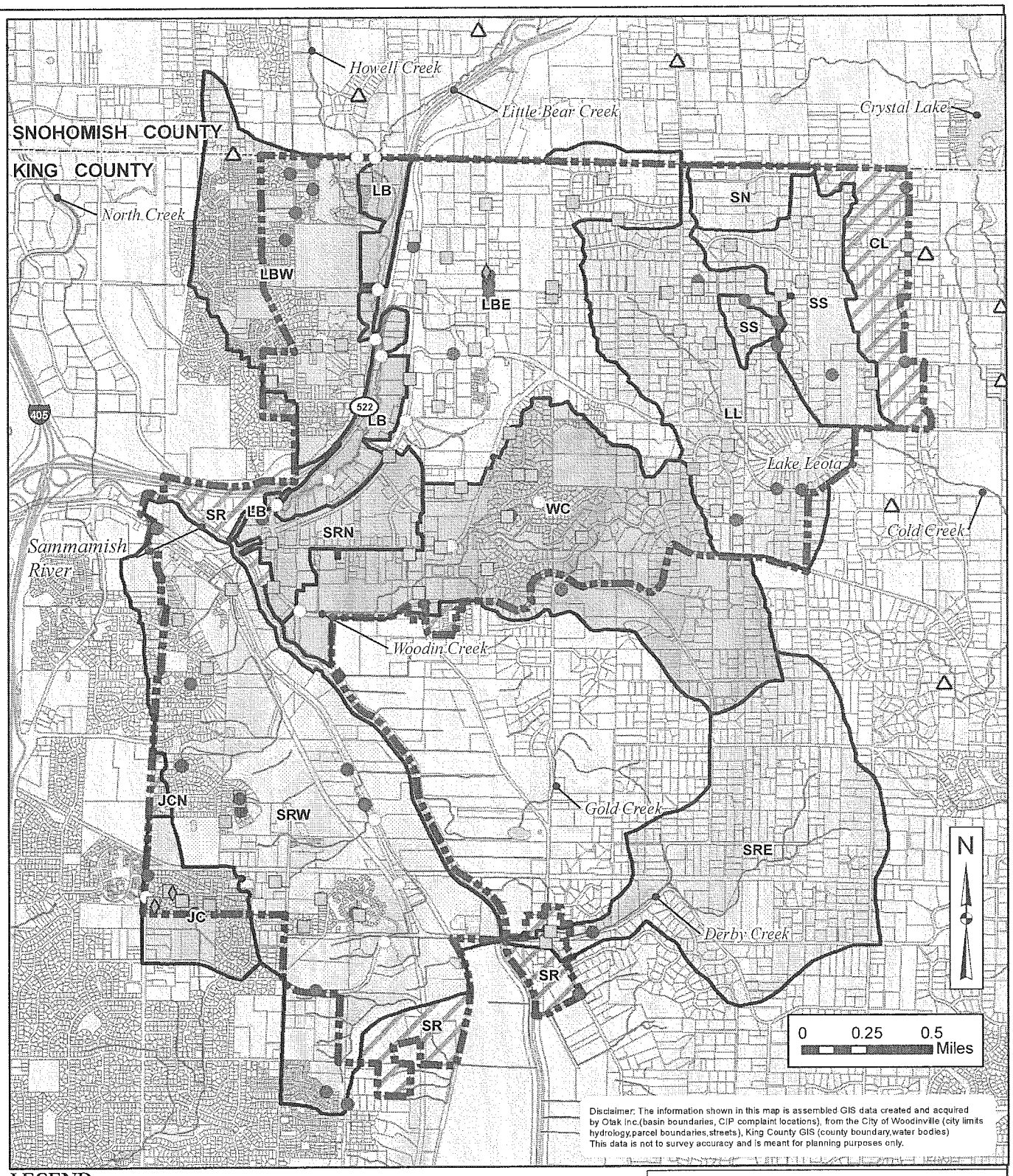
Rating/Ranking Approach and Methodology

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

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- *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

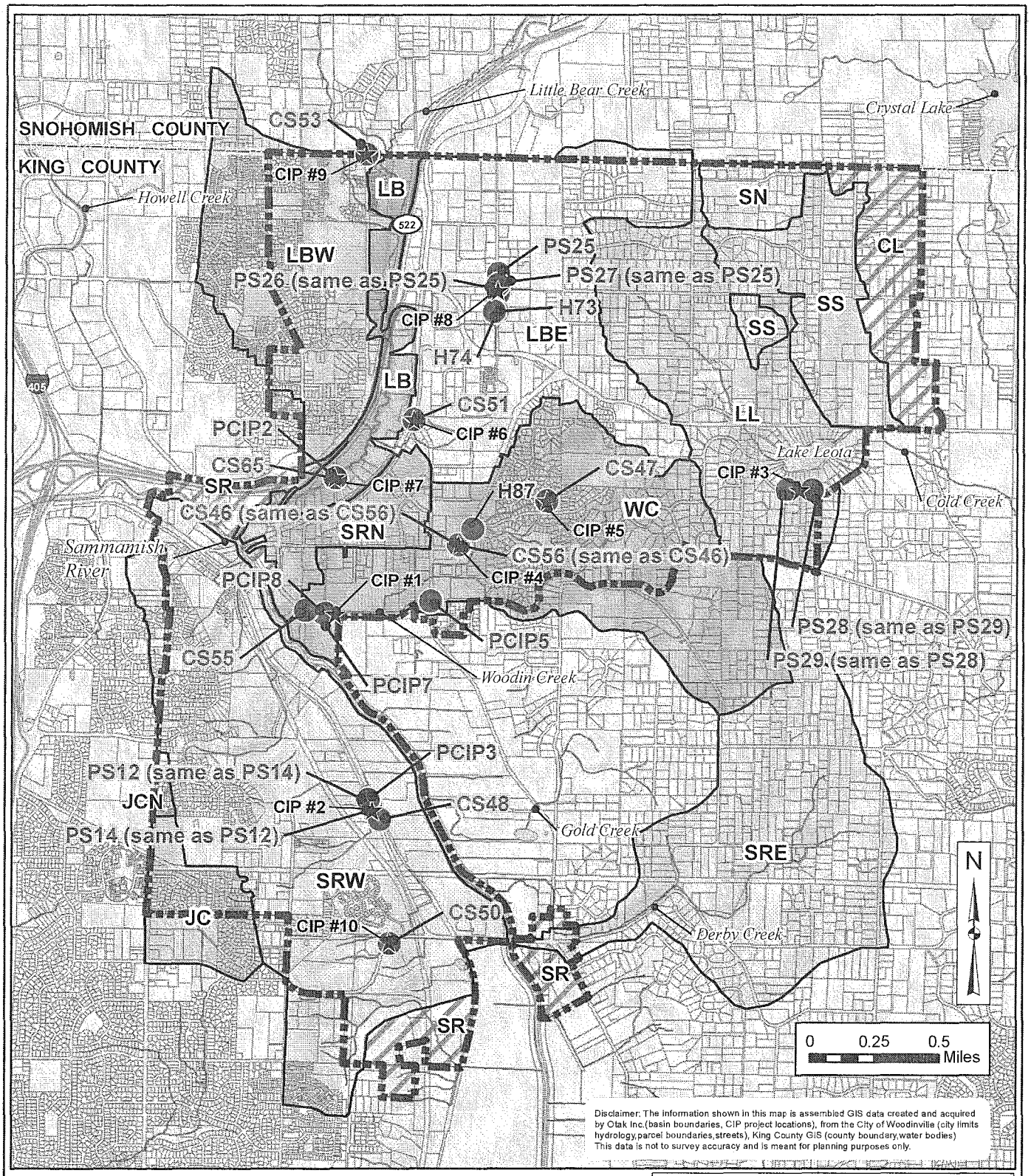
In the final phase of CIP development, the top 24 ranked drainage problems, with scores of 85 or higher, were assessed, a possible solution was proposed and the scope and cost estimate were created. Many of the reported problems were related to each other, resulting in a total of ten new stormwater CIP 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.



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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.

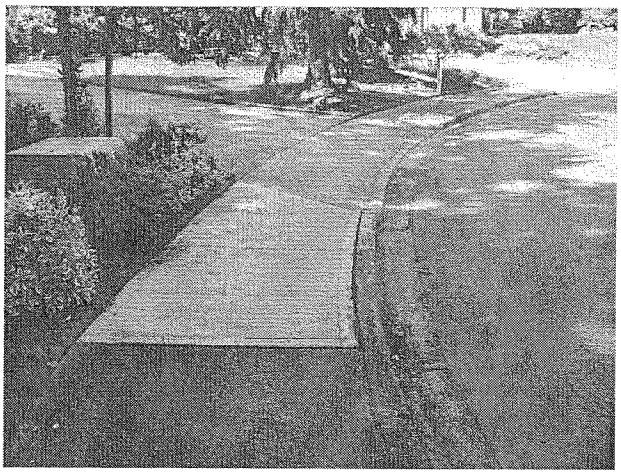
Project Cost: **$102,000**

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.

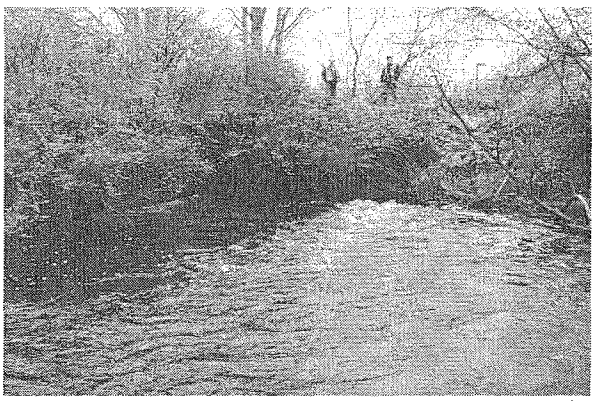
Project Cost: **$57,000**

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.

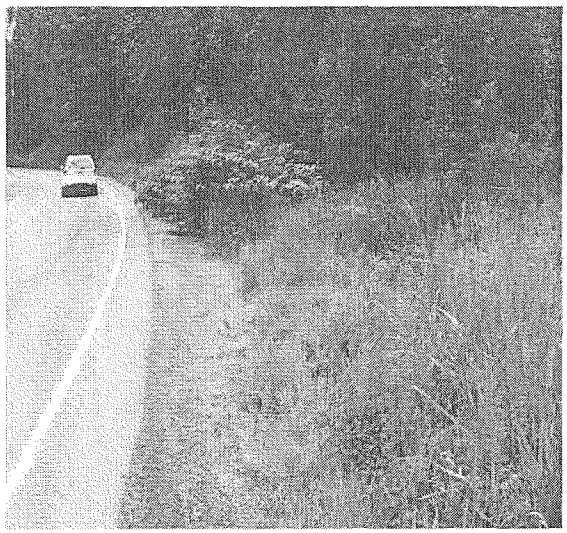
***Project* Cost: $153,000**

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

Section 6—Regulatory Compliance

Stormwater Regulatory Requirements

The City's stormwater-related regulatory requirements include compliance with the following:

- NPDES Phase II Permit
- Underground Injection Control Rule
- Endangered Species Act and Water Resources Inventory Area Planning
- Puget Sound Action Agenda
- Low Impact Development and Sustainability

The following analysis compares the City's SWM Program with each of the above regulatory requirements. Actions and activities, along with schedule for compliance have been documented for implementation.

NPDES Phase II Municipal Stormwater Permit

The City of Woodinville has been identified by Ecology as a NPDES Phase II community. As such, the City needs to comply with the requirements of its Phase II Permit. See Appendix E for the Phase II Permit.

The Phase II Permit outlines stormwater program activities and implementation milestones that the City must follow beginning February 16, 2007, in order to comply with federal law. All Phase II communities are expected to develop a stormwater program that includes the required activities, implement those activities within the required timeframes over the permit term (i.e. 2007–2011), and submit annual reports to Ecology to document progress toward complete program implementation.

Permit Coverage

The Phase II Permit applies to cities with populations less than 100,000 located within, or partially within an urbanized area, and that are operating a municipal separate storm sewer system which discharges to a water of Washington State. As a Phase II community, the requirements of the Phase II Permit apply throughout the entire incorporated area of the City.

Permit Timeline

The Phase II Permit was issued by Ecology on January 17, 2007, became effective on February 16, 2007, and was modified on June 17, 2009. The permit modification included minor changes to correct inconsistencies, improve flexibility, reduce costs and advance LID techniques. The permit covers a five-year period that expires on February 15, 2012. While the actual years of the permit run from February 16 of each year to February 15 of the following year, the reporting requirements cover a calendar year from January 1 to

December 31. The City's permit will be reviewed and renewed for a second five-year period, starting in 2012. The timeline and milestone requirements for the City's 2007-2011 Phase II Permit are outlined in Figure 6-1.

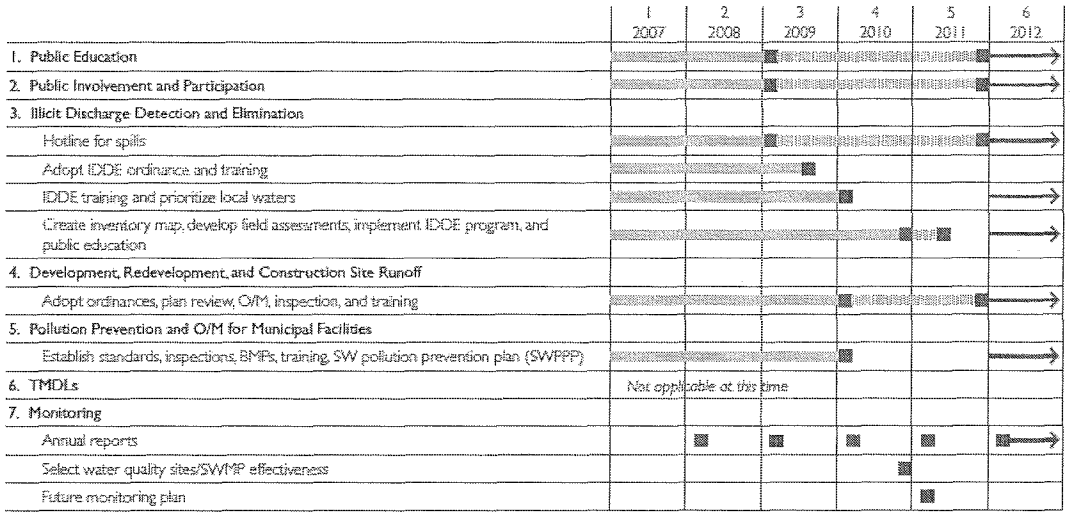


Figure 6-1 Phase II Permit Requirements and Milestones

Permit Requirements

The major program elements required by the Phase II Permit together with the associated permit conditions are listed below.

- Public Education and Outreach (Special Condition S5.C.1)
- Public Involvement and Participation (Special Condition S5.C.2)
- Illicit Discharge Detection and Elimination (Special Condition(S5.C.3)
- Controlling Runoff from New Development, Redevelopment, and Construction Sites (Special Condition S5.C.4)
- Pollution Prevention and Operation and Maintenance for Municipal Operations (Special Condition S5.C.5)
- Total Maximum Daily Load Requirements (Special Condition S7)
- Monitoring (Special Condition S8)
- Reporting (Special Condition S9)

The requirements and due dates associated with Special Conditions S5.C.1 through S5.C.2 are covered in detail in the City's annual SWM Program document that is prepared to accompany the City's Annual Report to Ecology, which is available at City Hall and is also posted on the City's website for reference. Requirements of Special Conditions S5, and S7-S9, are summarized below, along with the results of the detailed regulatory gap analysis. A summary of outstanding NPDES compliance items through the remainder of the permit

cycle is included at the end of this Section as Table 6-6. The regulatory gap analysis is presented in a matrix format and is included at the end of this Section as Table 6-7.

Public Education and Outreach (S5.C.1)

Phase II Permit Requirement:

One of the primary requirements of the Phase II Permit is to implement an educational outreach program designed to achieve measurable improvements in the target audiences' understanding of the problem of stormwater impacts and what they can do to solve them. The goal of the program is to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts. Target audiences include residents, businesses, industries, elected officials and municipal employees. In addition, the City is required to measure the understanding and adoption of the targeted behaviors among at least one target audience in at least one subject area.

Status of City's Activities

The following activities are planned by the City to support implementation of its public education and outreach program. The City will refine stormwater education activities based on the community survey results and emphasize educational activities related to proper vehicle washing. Towards the end of the Phase II Permit cycle, the City will conduct a follow-up survey to determine the effectiveness of outreach activities relating to proper vehicle washing. The City will track and record all education and outreach activities for the purpose of annual reporting.

To comply with this Phase II Permit requirement, the City must conduct a public survey to measure the effectiveness of this public education program. Based on the results of this survey, the City may choose to pursue additional target audiences based on the results of the community survey. Some examples of topics aimed at additional target audiences include:

- Short presentations during stream planting projects (Sammamish Releaf) about the effects of stormwater on the environment.
- Presentations to neighborhood groups about local stormwater and environmental issues, proper maintenance of local drainage facilities, and proper household use and disposal of pesticides and fertilizers.
- Educate businesses to prevent discharge of pollutants from their properties through site visits, mailings, and existing documents such as the King County Stormwater Pollution Prevention Manual, as well as proper maintenance of their on-site drainage facilities.
- Hold training seminars for the development community on proper stormwater infrastructure design and the use of LID techniques and encourage local developers to attend similar trainings conducted by local agencies (i.e., King County).

Table 6-1 outlines the implementation plan needed to achieve the goals and objectives of the Public Education and Outreach Program and meet the compliance deadlines in the Phase II Permit.

Table 6-1 Public Education and Outreach		
Purpose: Develop an education program to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts		
Applicability: Target audiences as identified. May include general public, businesses, landscapers and property managers, engineers, contractors, developers, review staff and land use planners.		
Task ID	Task Description	Schedule Notes
ED&O-1	Refine stormwater education activities based on survey results. Prioritize target audiences. Develop new brochures, adjust website content, etc.	**Target date for revised education program is mid-2010.**
ED&O -2	Conduct follow up community survey to determine effectiveness of revised education program.	**Target date for completion of survey is in 2011.**
ED&O -3	Update Stormwater Quality website.	**Update on a quarterly basis.**
ED&O -4	Continue to offer rain barrels and compost bins at Spring Garden Fair at subsidized rate.	**Annually**

ED&O = Education and Outreach

Public Involvement and Participation (S5.C.2)

Phase II Permit Requirement:

The Phase II Permit stresses the need for the City to provide on-going opportunities for citizens to review and participate in development of the SWM Program. This condition also requires the City to post the Annual Report and SWM Program document on the City's website to encourage and allow for receipt of public comment.

Status of City's Activities

The following activities are planned by the City to support development and implementation of its public involvement and participation program. The City will host annual public meetings/workshops related to its SWM Program and encourage citizen input. The City will also post the draft Stormwater Management Comprehensive Plan on the City's website and encourage public comment. And finally, the City will post the draft and final Stormwater Management Comprehensive Plan and future Annual Reports on the City's website; and track and record all public involvement and participation activities for the purpose of annual reporting.

Table 6-2 outlines the implementation plan to achieve the goals and objectives of the Public Involvement Program and meet the compliance deadlines in the Phase II Permit.

Table 6-2 Public Involvement		
Purpose: Create opportunities for the public to participate in the decision making processes involved in the development, implementation and update of the CSWM Plan.		
Applicability: Applies to general public, advisory council and watershed committees.		
Task ID	Task Description	Schedule Notes
PI-1	Conduct a public meeting to solicit input and comments on the CSWMP. Conduct SEPA process, publish notice, and present CSWMP to Council for adoption.	**Target is to conduct this activity during the summer of 2010.**
PI-2	Post CSWM Plan and Annual Report on the City's website.	**Due date of March 31, 2009.** Status: SWMP and Annual Report will be posted as completed each year.

PI = Public Involvement

Illicit Discharge Detection and Elimination (S5.C.3)

Phase II Permit Requirement:

Most cities, like Woodinville, need to develop and implement a plan to detect and eliminate illicit discharges to the storm sewer system. This includes adopting an ordinance prohibiting non-stormwater discharges to the City's stormwater system, developing a map of the stormwater infrastructure system, conducting field investigations, removing any identified sources, informing the community about hazards associated with illegal discharges and improper disposal of waste, providing opportunities for the public to report illicit discharges and spills that may pose water quality concerns, and conducting staff training.

Status of City's Activities

The City will continue working towards developing an IDDE program by 2011. Tasks include:

- Completing the mapping of the City's stormwater system.
- Revising WMC 14.06 Water Quality Standards to update the allowable and conditional discharges for consistency with the Phase II Permit.
- Reviewing WMC 1.07.030 - Violations and updating as needed to maintain consistency with updated WMC 14.06 – Water Quality Standards.
- Prioritize receiving waters.
- Establish procedures.
- Train staff.
- Conduct field assessment activities to identify and remove illicit connections to the stormwater system.
- Train field staff to identify and report illicit discharges.
- Develop and distribute IDDE-related educational materials to businesses and the residential community.
- Track and record all IDDE activities for the purpose of annual reporting.

Table 6-3 outlines the implementation plan needed to achieve the goals and objectives of the IDDE Program and to meet the compliance deadlines in the Phase II Permit. Particular attention will be paid to those tasks that need to be accomplished in 2010.

Table 6-3 Illicit Discharge Detection and Elimination		
Purpose: Detect and remove illicit connections, illicit discharges, and improper disposals (including spills) into the MS4.		
Applicability: Applies to the City's municipal separate storm sewer system.		
Task ID	Task Description	Schedule Notes
IDDE-1	Continue updating storm system map with private systems, new developments, and corrections from field verifications.	**Due date of February 15, 2011.** Status: Under development.
IDDE-2	Update existing ordinance to modify allowable and add conditional discharges.	**Due date of August 15, 2009.** Status: Completed November 2010.
IDDE-3	Document the City's IDDE Program, including procedures for inspection, identification, and enforcement.	**Due date of August 15, 2011.** Status: Under development.
IDDE-4	Conduct training for staff responsible for responding to IDDE complaints.	**Due date of August 15, 2009.** Status: Training initiated; complete in 2010.
IDDE-6	Conduct training for all municipal field staff on identification and reporting of illicit discharges.	**Due date of February 15, 2010.** Status: Training initiated; complete in 2010.
IDDE-7	Identify and prioritize receiving waters for field assessment.	**Due date of February 16, 2010.** Status: Complete by end of 2010.
IDDE-8	Begin field inspections to locate potential illicit discharges. Document and keep records of inspections.	**Due date of February 15, 2010.** Status: Some inspections have begun. Formal program to start following IDDE-3, IDDE-4 and IDDE-5.
IDDE-9	Develop and distribute IDDE related educational materials.	**Due date of August 19, 2011.** Status: Under development.
IDDE-10	Document and keep records of all public complaint reports, field inspections, follow-up activities, and enforcement actions.	**Due with Annual Report.** Status: Under implementation.

IDDE = Illicit Discharge Detection and Elimination

The City of Woodinville is currently addressing wineries and winery waste through an information and outreach program. According to the Ecology website "Area wineries now understand that their liquid winery wastes must be disposed of via the sanitary sewer, their solid wastes must be composted, land applied, or used to feed stock, and that no wastes from any part of the winemaking process should be discharged to the City's storm drain

system.[1]" Since June 2009 at least another 10-15 businesses have determined to locate tasting facilities here.

Controlling Runoff from New Development, Redevelopment, and Construction Sites (S5.C.4)

Phase II Permit Requirement:

Drainage from new development and redevelopment are addressed in this requirement. To comply with this requirement, the City will need to:

- *Develop, implement, and enforce a program to reduce pollutants in stormwater runoff from new development, redevelopment, and construction sites disturbing one acre or more.*
- *Adopt an ordinance requiring the minimum technical requirements of the 2005 Ecology Manual, legal authority for inspection of private facilities, provisions to allow for LID techniques, requirements for inspection and maintenance of facilities, and enforcement procedures.*
- *Review construction documents and conduct routine inspections during construction.*
- *Inspect established stormwater BMPs on an annual basis.*
- *Establish maintenance standards consistent with the 2005 Ecology Manual.*
- *Train City staff in permit review, site inspection, and program enforcement.*

Status of City's Activities

The City needs to adopt either the 2005 Ecology Manual or the 2009 KCSWDM, both of which include maintenance standards and require follow up maintenance enforcement actions for private facilities. Staff may need follow-up training as the new manual and maintenance standards are adopted. Most of this training can be provided in-house or through programs offered by Environmental Protection Agency, King County, or other agencies. Finally, the City will need to track and record all runoff control activities for the purpose of annual reporting and permit compliance.

Table 6-4 outlines the implementation plan to achieve the goals and objectives of the program to control runoff from new development, redevelopment, and construction sites and meet the compliance deadlines in the Phase II Permit.

[1] June 2009

Table 6-4 Controlling Runoff From New Development, Redevelopment, and Construction Sites		
Purpose: Establish a program to reduce pollutants in stormwater runoff from new development projects, redevelopment projects, and construction sites. Apply the minimum technical requirements of Appendix 1 of the Phase II Permit (or equivalent).		
Applicability: All new development, redevelopment, and construction sites that disturb one acre or greater and smaller projects that are part of a larger development plan.		
Task ID	Task Description	Schedule Notes
CTRL-1	Adopt either the 2009 KCSWDM or the 2005 Ecology Manual and update City Codes as needed.	**Due date of February 16, 2010.** Status: Completed. Adopted the 2009 KCSWDM
CTRL-2	Continue to conduct plan review and site inspections for new development and redevelopment projects.	**Due date: Ongoing.** Status: Program in place.
CTRL-3	Adopt updated maintenance standards.	**Due date of February 16, 2010.** Status: Will occur concurrently with CTRL-1.
CTRL-4	Continue to implement City's existing tracking system to electronically document maintenance inspections and correlate work to NPDES requirements.	**Due date: Ongoing.** Status: Records are maintained as required by NPDES permit. Electronic tracking system is in place.
CTRL-5	Continue to provide NOI for Construction Activity to developers during pre-application meeting.	**Due date: Ongoing.** Status: Program in place.
CTRL-6	Conduct official training for staff on stormwater design requirements, erosion control, and Ecology construction permit.	**Due date of February 16, 2010.** Status: Complete by the end of 2010 following CTRL-1 and CTRL-3.

CTRL = Controlling Runoff from New Development, Redevelopment and Construction Sites

Pollution Prevention and Operation and Maintenance for Municipal Operations (S5.C.5)

Phase II Permit Requirement:

Ongoing maintenance is a key element of a successful SWM Program. To meet this requirement, the City must develop and implement a program to prevent or reduce pollutant runoff from municipal operations. The program must include annual facility inspections, spot checks of permanent treatment and flow control facilities other than catch basins, catch basin inspections, practices to reduce stormwater impacts from roadway runoff, and practices to reduce pollutant discharges from non-roadway municipal property; train municipal staff on standards, BMP selection, and how to reduce water quality impacts in daily activities; and develop and implement a SWPPP for all heavy equipment maintenance or storage yards and materials storage facilities.

Status of City's Activities

Table 6-5 outlines the implementation plan to achieve the goals and objectives of the Operations and Maintenance Program and meet the compliance deadlines in the Phase II

Permit, in accordance with G20 Letters of Notification submitted to Ecology in April 2010 and September 2010.

Table 6-5 Pollution Prevention and Operations and Maintenance		
Purpose: Develop an O&M program to prevent or reduce pollutant runoff from municipal operations.		
Applicability: All stormwater treatment and flow control facilities, catch basins, streets and roadways, and non-roadway public properties managed by the City.		
Task ID	Task Description	Schedule Notes
O&M-1	Continue to conduct annual inspections of water quality and flow control facilities.	**Due date of February 15, 2010.** Status: Program in place through contract with King County.
O&M-2	Continue to perform spot checks of water quality and flow control facilities after major storm events.	**Due date: After Major Storms.** Status: Program in place.
O&M-3	Continue to implement a schedule for rotating catch basin inspection and maintenance.	Due date of August 19, 2011. Status: Program in place.
O&M-4	Conduct roadway maintenance (street sweeping, vegetation removal, ditch cleaning, and infrastructure repair).	Due date of February 15, 2010. Status: Program in Place.
O&M-5	Develop a facilities maintenance manual that addresses stormwater issues and includes an Integrated Pest Management Plan to restrict pesticide and fertilizer use near fish habitat areas.	**Due date of February 15, 2010.** Status: Complete by the end of 2010.
O&M-6	Identify training needs, schedule and conduct ongoing training program on stormwater management.	**Due date of February 15, 2010.** Status: Complete by end of 2010 following O&M-5 and CTRL-3.
O&M-7	Evaluate facilities and develop a SWPPP as needed.	**Due date of February 15, 2010.** Status: Document Completed. Need to implement
O&M-8	Maintain records of inspections and maintenance repairs.	Due date with Annual Report Status: See CTRL-4.

O&M = Operations and Maintenance

Total Maximum Daily Loads (S7)

Phase II Permit Requirement:

Under the TMDL requirements, affected permittees must comply with specific requirements that are stipulated in Appendix 2 of the Permit. For applicable TMDLs not listed in Appendix 2, compliance with the Phase II Permit constitutes compliance with these TMDLs.

Status of City's Activities

TMDLs have been developed for Little Bear Creek (for fecal coliform) and Bear Evans Creek Watershed (for fecal coliform, temperature and dissolved oxygen); however no

additional requirements have been identified for inclusion in the City's Phase II Permit at this time.

Monitoring (S8)

Phase II Permit Requirement:

Under the monitoring requirements, the City will need to prepare for implementation of a comprehensive long-term monitoring program that includes stormwater outfall and SWM Program effectiveness monitoring. For the stormwater monitoring preparations, the City will need to select two outfalls and document the reasons for site selection, possible constraints, a description of the drainage basin and any water quality concerns in the receiving waters. For the program effectiveness monitoring, the City will need to design an approach to assess the effectiveness of a targeted action or focused suite of actions and whether the SWM Program is achieving a targeted environmental outcome. The City must identify the actions and outcomes to be evaluated, select sites and develop monitoring plans no later than December 31, 2010.

Status of City's Activities

Under the existing Phase II Permit, the City is required to prepare for future stormwater outfall and program effectiveness monitoring.

Annual Reporting & Reporting on LID Barriers (S9)

Phase II Permit Requirement:

Under the Reporting requirements, annual reports must be submitted by March 31st each year for compliance activities occurring in the previous calendar year. Annual reporting submittals must include a copy of the City's current Stormwater Management Program document and the Annual Report Form for Cities, Towns and Counties, as provided by Ecology.

Pursuant to the Phase II Permit modification issued June 17, 2009, no later than March 31, 2011, the City will also need to submit a summary of identified barriers to the use of LID and measures to address barriers together with a report that describes currently available LID practices that can be reasonably implemented within the Permit term, potential or planned non-structural actions and LID techniques to prevent stormwater impacts with schedules to require broader scale implementation in the future, and goals and metrics to identify, promote, and measure LID use.

Wilmot Park - City of Woodinville

Additional permit conditions, such as Special Conditions S1 through S4 and General Conditions G1 through G20, apply to the City of Woodinville, though they do not result in specific program activities. These additional conditions cover topics such as who is covered by the Phase II Permit, what discharges are authorized under the permit, and describes the legal guidelines for transferring, revoking, and appealing the permit.

Status of City's Activities

Annual reports must be submitted by March 31st for compliance activities occurring in the previous calendar year.

Underground Injection Control Rule

UIC Control Rule:

With the passage of the Safe Drinking Water Act by Congress in 1974, the EPA created the Underground Injection Control Program as one of the key programs for protecting drinking water sources. In 1984, Ecology received the authority from EPA to regulate UIC wells and adopted the UIC rule, Chapter 173-218 WAC. UIC wells do not include wells that draw water from underground aquifers such as potable water wells. In contrast, a UIC well is a human-made hole that is used to put water or other fluids into the ground. In Washington, most of these wells are used to dispose of septic wastes and stormwater runoff. In January 2006, Ecology adopted revisions to the UIC program rule which went into effect on February 3, 2006. The rule applies to both new and existing UIC wells. Even though UIC wells are used for stormwater management, there is no overlap between the UIC rule and Phase II Permit requirements. Under Special Condition S2.A.1, the Phase II Permit clearly states that, "Discharges to ground waters of the state through facilities regulated under the UIC program, Chapter 173-218 WAC, are not covered under this permit."

As it relates to stormwater management, the rule regulates Class V UIC wells which must be registered and rule authorized (meet the nonendangerment standard) or receive a State Waste Discharge Permit issued by Ecology to operate. The rule also requires annual updates to Ecology on well status changes and sets specific criteria for well decommissioning and associated notifications.

Status of City's Activities

The activities required for compliance with the UIC Rule depend on the number and type of underground injection control facilities (such as dry wells or underground infiltration galleries) that the City uses for stormwater management. With less than 10 city-operated infiltration facilities, the City's UIC requirements are fairly minor.

The City will determine which infiltration facilities are categorized as UICs, requiring registration with the State. Long term activities may include retrofitting existing injection control facilities to provide additional water quality treatment.

Endangered Species Act and Water Resources Inventory Area Planning

ESA Requirements:

In 1999, the federal government listed the Puget Sound Chinook salmon and bull trout as threatened in the Puget Sound Region. Local governments have responded to these listings by putting in place policies and practices to protect and restore these fish populations and their habitat. In the Puget Sound region, a coalition

of local governments has created a Regional Forum system for coordinating these protection and restoration efforts on a watershed basis. The Regional Forum is organized by watershed (WRIA), consistent with the watershed identification system used by Ecology and other state resource agencies. In addition to these current listings, steelhead trout were listed as threatened in May 2007 and as of October 2008 are now protected under the same regulations as threatened Pacific salmonids.

The Watershed Planning Act (RCW 90.82) provides local governments a framework and resources for developing local solutions to watershed issues on a watershed basis. These WRIA or watershed plans are required to address water quantity with optional elements of water quality and habitat.

In order to integrate salmon recovery planning into watershed planning, twelve State agencies signed a Memorandum of Understanding for the coordinated implementation of the Watershed Planning Act and the Salmon Recovery Planning Act. The Memorandum clarifies over a 10-year planning horizon roles and responsibilities, annual reporting requirements, fosters cooperative working relationships between state agencies, local governments and tribal governments, and, where possible, simplifies implementation procedures. The Regional Forum uses WRIA watershed planning as a tool to integrate water resource planning issues, including salmon protection and recovery.

Status of City's Activities

The City of Woodinville is included in WRIA 8, the Cedar, Lake Washington, Sammamish watershed. The July 2005 WRIA 8 Chinook Salmon Conservation Plan was approved in May 2008 and ratified by the 27 participating jurisdictions by September 2005, including the City of Woodinville. Actions within the Plan have been developed in three broad categories: land use, planning, and infrastructure; site-specific habitat protection and restoration projects; and public outreach and education. The Plan is currently under implementation in accordance with a three-year work plan that covers 2008-2010.

The City of Woodinville ratified the Plan in Resolution No. 307 adopted July 11, 2005. In the Resolution, the City gave its approval and support to plan goals to:

- Continue work on a collaborative basis to further plan implementation.
- Use the plan as a guide and source for local action and site specific projects.
- Use an adaptive management approach.
- Use the start list to guide priorities.
- Work together to seek funding opportunities.

In addition to the Resolution ratifying the July 2005 WRIA 8 Chinook Salmon Conservation Plan, the City has solidified its commitment to preserving, enhancing and protecting fish and wildlife habitat through its 2009 Comprehensive Plan land use goals and policies and plans to continue its support of ongoing activities, as outlined in Section 3. As part of the City's 2002 ESA Habitat Assessment, several other activities were identified for future implementation, as described below.

The Regional Road Maintenance ESA Program Guidelines are based on the King County 4(d) program template. To fully comply with the Section 4(d) ESA limits and receive protections under this clause, the City must complete the Part 3 application and receive approval for the associated road maintenance package from WSDOT and the Federal Services. Since Woodinville's maintenance program is based directly on the Services-Approved King County program, it is assumed that the City would also qualify for coverage.

In addition, the City needs to maintain a high level of water quality and habitat protection during construction activities. Many of the City's capital projects focus on habitat restoration, and as such, take place in areas that ESA-listed species extensively utilize. Projects such as fish passage culvert replacements and channel modifications have the potential to create temporary impacts that may harm aquatic life. The City needs to outline policies, monitoring protocols, and construction inspection guidelines to ensure appropriate erosion control, water quality BMPs, and mitigation requirements are implemented during construction, and also identify personnel to oversee proper implementation of habitat protection measures on active construction sites.

The City recognizes the potential for water quality impacts associated with chemical plant and insect controls. Although the Parks, Recreation, and Open Space goals and policies contained within the City's Comprehensive Plan address ESA compliance, they do not address chemical use for noxious and invasive weed control or mosquito control. The issue of herbicides and pesticides has been identified as a potential liability for ESA compliance and the City must adopt an Integrated Pest Management Plan (consistent with Phase II Permit requirements) that provides direction on how, when and which chemicals may be used during facility and parks maintenance operations.

Puget Sound Action Agenda

Puget Sound Action Agenda Requirements:

In April, 2007, the Washington State Legislature passed legislation abolishing the Puget Sound Action Team and creating a new Puget Sound Partnership (Partnership) to coordinate and lead the effort to restore and protect Puget Sound. The Partnership consists of a Leadership Council, Executive Director, Ecosystem Coordination Board, and a Puget Sound Science Panel. The Partnership's charge is to define a strategic action agenda that prioritizes necessary actions based on science and includes clear, measurable goals for the recovery of Puget Sound by 2020. Adopted December 1, 2008, the Puget Sound Action Agenda replaces the prior Puget Sound Water Quality Management Plan. The Action Agenda sets state policy, is a strategy for cleaning up, restoring and protecting Puget Sound, and includes five strategic priorities and associated long-term and short-term actions to achieve progress. The five strategic priorities include:

A. *Protect intact ecosystem processes, structures, and functions*
B. *Restore ecosystem processes, structures, and functions*
C. *Reduce the sources of water pollution*
D. *Work effectively and efficiently together on a priority basis*
E. *Build an implementation, monitoring, and accountability management system*

Although the Partnership has no regulatory authority to enforce implementation of the Action Agenda, it is authorized to develop funding criteria that prohibits funding projects and activities that are in conflict with it. However, to encourage accountability, the Partnership is authorized to designate entities which consistently achieve outstanding progress in implementing the Action Agenda as "Puget Sound Partners". Further, the Partnership is also authorized to create funding preference for these "Puget Sound Partners" for funds allocated to the Puget Sound basin. While the Partnership is accountable for achieving the Action Agenda, the legislature intended that all governmental entities within Puget Sound exercise their existing legal authorities to implement applicable provisions. Should the Partnership determine that an entity is substantially out of compliance with the Action Agenda, it may recommend to the governor that the entity be ineligible for state financial assistance until the substantial noncompliance is remedied.

Under Priority C of the Action Agenda, Reduce the sources of water pollution, subpriority C.2.2 focuses on managing stormwater runoff in urban and urbanizing areas to reduce stormwater-related impacts, and calls for implementing NPDES municipal stormwater permits, incorporating LID requirements for development and redevelopment into all stormwater codes, and retrofitting existing stormwater facilities for compliance with current standards. However, detailed implementation planning has not yet been completed and due dates for these objectives have not yet been established.

Implementing Phase II Permit covers many of the Action Agenda stormwater objectives. The City has been implementing its Phase II Permit for close to three years with an additional two years of implementation remaining under the current permit cycle. In addition, the Phase II Permit Modification issued in June 2009 advances LID as earlier described.

In January 2010, the Partnership published its first biennial "State of the Sound Report" that documents the current status of the ecosystem, as well as status of implementation and funding. The Partnership's major focus since publishing the Action Agenda in December 2008 has been to evaluate ecosystem status and develop a performance management system to manage recovery efforts. Implementation of the Action Agenda is just getting underway. The Partnership's near term work is to align the state's 2011-1012 biennium budget to the Action Agenda.

In 2010, the Partnership plans to work aggressively toward:

- *Finalizing ecosystem indicators*
- *Prioritize threats to the ecosystem*
- *Establish outcome measures with implementing agencies*
- *Set quantitative targets and benchmarks for the reduction of priority threats and identify potential revisions to the 2008 Action Agenda*
- *Establish criteria to determine consistency of action with the Action Agenda*

Status of City's Activities

Until this work is complete, there is no new direction regarding stormwater management priorities. Currently, the City is addressing the Action Agenda priority for managing stormwater runoff in urban areas to reduce stormwater impacts by implementing its NPDES

Phase II Permit requirements and encouraging LID for new development and redevelopment.

Low Impact Development and Sustainability

LID Requirements:

Using LID techniques for surface water management on new developments and capital improvement projects is a way to improve water quality in a manner that more closely emulates flow characteristics from natural forested conditions. Recreating these natural functions in LID designed projects does a better job of protecting the environment when compared with traditional engineering drainage designs. LID has been emerging over the past several years as a new way of managing stormwater runoff. The goal of LID is twofold: a) capture pollutants in stormwater prior to discharging to a lake or stream (usually through settling and filtration); and b) reduce peak flows that are caused by converting land from forest to buildings, streets and parking lots (via detention/ storage and or infiltration in an LID facility). An increase in peak flows cause erosion of stream channels and destruction of aquatic habitat.

There is a high degree of interest on the subject, particularly in the Puget Sound. Ecology has devoted a section to the subject in the 2005 Ecology Manual, and the Puget Sound Action Team published the "Low Impact Development Technical Guidance Manual for the Puget Sound" in 2005, which is frequently used as a technical resource by engineers and planners.

Status of City's Activities

The issue of stormwater management and protecting the environment is of particular interest to the City of Woodinville because it is located in two salmon bearing watersheds, Little Bear Creek and Bear Creek/Cottage Lake Creek. The City of Woodinville published a draft sustainable development study in February 2007, with emphasis on the R-1 zone that covers approximately 1,100 acres at the northeasterly end of the City. The study is entitled "Draft R-1 Sustainable Development Review." The study was issued after a moratorium was established to limit development in the R-1 zone, to be enforced until the results of the study were made complete and a decision could be made. The study examined several key factors, environmental, neighborhood character, transportation, and capital facilities and services. Under environmental, sustainability was a key component, with the use of LID. The study presented the benefits, options, and land-use requirements of LID, and recommended implementing LID in the zoning codes and drainage design standards.

In July 2007, the City was actively working on updating their sustainability study with involvement from the Citizen Advisory Panel. The City gathered information on implementing LID standards, looking at examples of what other municipalities have done to implement LID based facility designs.

The City is strongly interested in, and actively pursuing, the creation of sustainable land-use standards and LID drainage design standards. These are likely to be implemented in the near future by updating the zoning codes and design standards.

Potential Future NPDES Phase II Permit Requirements

The Department of Ecology has not published the next Phase II Permit scheduled to begin in 2012. However, there are three areas that there are anticipated additional activities that may be required for the City of Woodinville: monitoring, TMDLs and LID.

Monitoring

It is likely that in the next permit term (beginning in 2012), the City will be required to implement monitoring programs. These monitoring requirements are similar to those already in place for NPDES Phase I permittees with the exception of BMP effectiveness monitoring. It is anticipated that the monitoring programs will involve additional investment by the City in staff time and resources for equipment purchase, and installation, sample collection, lab analysis, data analysis, recordkeeping, and annual reporting.

Total Maximum Daily Loads

TMDLs have been developed for Little Bear Creek (for fecal coliform) and Bear Evans Creek (fecal coliform, temperature and dissolved oxygen); however they are not current requirements under the Phase II Permit. Should a TMDL be approved by EPA or a Detailed Implementation Plan be approved by Ecology during the Phase II Permit cycle that applies to the City, additional requirements may be established by Ecology through future Phase II Permit modifications. This may require such activities are monthly water quality monitoring on both creeks along with annual reporting of the monitoring results.

Low Impact Development

In February 2009, the Pollution Control Hearing Board ruled that Ecology begin to prepare all Phase II permittees, including the City of Woodinville, for future implementation of LID. Ecology has been convening a stakeholder advisory process to provide input on those requirements. No specific requirements on LID for the next permit cycle have been identified at this time.

Summary of NPDES Compliance Items

A summary of outstanding NPDES compliance items through the remainder of the permit cycle is presented in Table 6-6. The regulatory gap analysis is presented in a matrix format as Table 6-7.

Table 6-6 Outstanding NPDES Compliance Items for the Remainder of the Permit Cycle As of September 2010	
Item	Due
Public Education and Outreach	
Develop system to document education and outreach activities	2/15/09
Conduct follow up survey to measure effectiveness of education efforts related to proper vehicle washing	12/31/11
Public Involvement and Participation	
Host annual public meetings or workshops related to the City's Stormwater Program	Annually
Post 2010 Annual Report and SWMP on website	3/31/11
Post 2011 Annual Report and SWMP on website	3/31/12
Illicit Discharge Detection and Elimination	
Update ordinance	8/15/09
Prioritize receiving waters for field assessments	2/15/10
Develop procedures for field assessments, and characterizing, tracing and removing sources	Prior to field assessments
Train staff to conduct field assessments and follow up activities and develop system to track trainings	Summer 2010
Conduct dry weather field assessments of 3 high priority receiving waters	Summer 2010
Characterize, trace and remove sources as needed	Summer 2010
Develop system to document number and types of spills identified, inspections made and outcome of enforcement actions (Does the City's CRS system satisfy this requirement?)	Prior to field assessments
Complete mapping of structural stormwater BMPs	2/15/11
Conduct dry weather field assessment of at least one high priority receiving water	Summer 2011
Develop and distribute IDDE related education materials and track feedback	8/19/11
Runoff Control for New Development, Redevelopment and Construction Sites	
Adopt ordinance that includes minimum technical requirements equivalent to the 2005 Ecology Manual and provisions to allow LID techniques	2/16/10
Adopt maintenance standards for facilities consistent with the 2005 Ecology Manual	2/16/10
Develop permit tracking system capable of documenting all inspections, enforcement activities, maintenance activities, and construction sites	2/16/10
Train staff in new ordinance requirements and develop system to track trainings	2/16/10
Non-Roadway Property Maintenance	
Develop Nutrient Management and Integrated Pest Management Plan	2/15/10
Train Staff on Nutrient Management and Integrated Pest Management Plan	After Plan is developed
Implement Nutrient Management and Integrated Pest Management Plan	After Staff Training
Develop Facilities Maintenance Plan	2/15/10

Table 6-6 Outstanding NPDES Compliance Items for the Remainder of the Permit Cycle As of September 2010	
Item	Due
Train Staff on Facilities Maintenance Plan	After Plan is developed
Implement Facilities Maintenance Plan	After Staff Training
Develop and implement a SWPPP for City equipment maintenance and storage facilities	2/15/10
Conduct quarterly SWPPP inspections and repairs as necessary for heavy equipment maintenance or storage yards and materials storage facilities	Quarterly after SWPPP is developed
TMDLs	
Coordinate with Ecology on the development/implementation of the Little Bear Creek Fecal Coliform TMDL and the Bear-Evans Watershed Fecal Coliform/Temperature/Dissolved Oxygen TMDL detailed implementation plans	TBD – As determined by Ecology
Monitoring	
Prepare for future stormwater outfall monitoring; select two outfalls and document site selection	12/31/10
Prepare for future program effectiveness monitoring; identify 1 questions to be studied, select monitoring sites and develop monitoring plans	12/31/10
Describe status of preparation for future monitoring and include in annual report	3/31/11
Describe status of preparation for future monitoring and include in annual report	3/31/12
Reporting	
Develop 2010 Annual Report and SWMP and submit to Ecology	3/31/11
Develop 2011 Annual Report and SWMP and submit to Ecology	3/31/12

Table 6-7
CITY OF WOODINVILLE
Surface Water Management Program Analysis

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
SWMP Element #1 - Public Education and Outreach								
S5.C.1.a	1.1 Outreach to Two Target Audiences	Begin implementing or participating in an education and outreach program. Prioritize target audiences and subject areas: -General Public about stormwater basics; -Businesses about chemical use/storage and illicit discharges; -Homeowners/Landscapers/Property Managers about yard care, fertilizers, carpet cleaning, auto maintenance, LID and pond maintenance; -Development Community about flow control, stormwater treatment, LID, and erosion control.	Begin By Year 2 (2/15/2009)	Car wash kits are available to fund raising groups.	Car wash kits are available to fund raising groups.	In Place	Ongoing	
				Brochure addressing stormwater basics is available at the City information counter.	Brochure addressing stormwater basics is available at the City information counter.	In Place	Ongoing	
				Articles in City newsletter and on website.	Articles in City newsletter and on website.	In Place	Quarterly	
				Conduct volunteer planting as part of the Sammamish Releaf project.	Conduct volunteer planting as part of the Sammamish Releaf project.	In Place	Annually	
				Host a booth and distribute information at annual Earth Day events.	Host a booth and distribute information at annual Earth Day events.	In Place	Annually	
				Offer rain barrels and compost bins at Spring Garden Fair at subsidized rates.	Offer rain barrels and compost bins at Spring Garden Fair at subsidized rates.	In Place	Annually	
				Stormwater website	Stormwater website	In Place	Update Quarterly	Recommended Activity.
					Based on the survey results (Element 1.2) emphasize education related to proper vehicle washing.	In Place	Ongoing	The City is already providing some education focused on proper vehicle washing and may want to increase its emphasis with additional educational tools. Refer to Ecology Stormwater Education and Outreach resources for additional guidance.
S5.C.1.b	1.2 Measure Results of the Educational Activities	Begin participating in an effort to measure understanding and adoption of the targeted behaviors for at least one targeted audience in at least one subject area.	Begin By Year 2 (2/15/2009)	Completed community survey in 2009 to determine current stormwater understanding in the community.		Complete	Once	Community survey in 2009 provides a baseline from which the City can measure understanding and behavior changes through follow up surveys.
					Conduct follow up survey to determine effectiveness of education related to proper vehicle washing.	12/31/2011	Once	
S5.C.1.c	1.3 Maintain Records	Track and maintain records of public education and outreach activities.	Required to Begin By Year 2 (2/15/2009)		Develop spreadsheet or database system to document all education and outreach activities (numbers of brochures distributed, car wash kits handed out, website visits, etc.)	ASAP (2010)	Ongoing	Demonstrates extent of program and facilitates annual reporting to Ecology. Need to start as soon as possible as due date for beginning this activity has passed.
SWMP Element #2 - Public Involvement and Participation								
S5.C.2.a	2.1 Input to SWMP	Create on-going opportunities for public to participate in decision-making processes involving the development, implementation and update of the SWMP.	Year 1 (2/15/2008)	Conducted a citywide survey in 2009 to identify stormwater problems.				The City can get credit for public involvement through watershed committees, stewardship programs, environmental activities or other similar activities (i.e. Sammamish Re-leaf in Element 1.1).
				Planning a public meeting in 2010 and SEPA review as part of this comprehensive stormwater management plan update.	Host annual public meetings or workshops related to stormwater program.	Summer 2010	Annually	
S5.C.2.b	2.2 Availability of Stormwater Program Documents	Make the SWMP and the Annual Report available to the public by posting on the City Website.	March 31 Each Year	Posted the 2007 and 2008 Annual Reports and SWMPs on City's website.				
					Post 2009 Annual Report and SWMP on City's website.	3/31/2010	Annually	
					Post 2010 Annual Report and SWMP on City's website.	3/31/2011	Annually	
					Post 2011 Annual Report and SWMP on City's website.	3/31/2012	Annually	
SWMP Element #3 - Illicit Discharge Detection and Elimination								
S5.C.3.a	3.1 Storm Sewer System Map	Develop a municipal storm sewer system map of: -All storm sewer outfalls (including tributary areas and land use); -Receiving waters; -Structural stormwater facilities; -Connection points authorized during permit term; -Areas not draining to surface water.	Year 4 (2/15/2011)	Mapping is being reviewed and updated as part of the comprehensive stormwater management plan update.	Finish mapping update.	2/15/2011	Once	
					Update maps with as-built information from new developments and capital projects.	After initial map is complete	Annually	

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
S5.C.3.b	**3.2 Illicit Discharge Ordinance**	Develop and implement an ordinance prohibiting non-stormwater discharge to the MS4. The ordinance should cover: -Potable water flushing; -Lawn and landscape irrigation runoff; -Swimming pool discharges; -Street and sidewalk wash water; -Other non-stormwater discharge. Include enforcement procedures in the ordinance and develop an enforcement strategy.	Year 2.5 (8/15/2009)	Current WMC 14.06 - Water Quality has been in place since 1993 when the City adopted King County Code 8.12 through Ordinance No. 24. In 2003, the City reinforced its commitment to protecting water quality by adopting City Ordinance No. 350, codified in WMC Chapter 1.07, by establishing discharge of contaminants into surface water, stormwater or ground water as a civil violation.	Revise WMC 14.06 to update allowable discharges and conditional discharges. Review WMC 1.07.030 and update as needed to maintain consistency with updated WMC 14.06.	ASAP (2010)	Once	City has missed the due date for this requirement and has submitted a G20 notification to Ecology.
S5.C.3 & S5.C.3.c	**3.3 Detection and Elimination Program**	Develop and implement program to detect and address non-stormwater discharges, including spills and illicit connections.	Permit End (8/19/2011)	Respond to complaints and observed problems and assist the Fire Department with spill clean-up.	Respond to complaints and observed problems and assist the Fire Department with spill clean-up.	In Place	Ongoing	
		Develop procedures for: -Locating priority areas based on land use, previous complaints, and storage practices; -Field assessment during dry weather of outfalls in 3 priority receiving waters; Once a problem is reported or identified: -Characterizing nature and potential threat of illicit discharges; -Tracing the source of illicit discharge; -Notifying property owners; -Removing the source and conducting follow-up inspections.	Variable In time to meet milestone dates for each activity		Identify and prioritize receiving waters for field assessment.	5/1/2010	Once	Procedures need to be developed prior to the first round of field assessments during Summer 2010. Center for Watershed Protection (CWP) has a guidance manual for developing a successful IDDE program. Screening for illicit connections shall be conducted using *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*, Center for Watershed Protection, October 2004 or another methodology of comparable effectiveness.
					Develop procedures for field assessment activities.	5/1/2010	Once	
					Develop procedures for characterizing, tracing and removing sources.	5/1/2010	Once	
		Field Assessments of 3 high priority receiving waters	Year 4 (2/15/2011)		Follow established procedure and conduct field assessments of 3 high priority receiving waters during dry weather.	Summer 2010	Once	Assessments must occur in dry weather prior to 2/15/2011 permit deadline.
		Field Assessments of at least one high priority receiving water	Annually After Year 5 (2/15/2012)		Follow established procedure and conduct field assessment of 1 high priority receiving water during dry weather.	Summer 2011	Once	Assessments must occur in dry weather prior to 2/15/2012 permit deadline.
		Characterization, source tracing and removal	As needed		Characterize, trace, and remove sources of illicit discharges following established procedures.	As needed	As needed	
S5.C.3.d	**3.4 Public Education and Spill Reporting**	Inform public employees, businesses, and general public of hazards associated with illegal discharges.	Permit End (8/19/2011)		Develop and distribute IDDE related educational materials.	Permit End (8/19/2011)	Once	Can be incorporated into overall education program (Element 1.1)
		Publicize a hotline for public reporting of spills and illicit discharges.	Year 2 (2/15/2009)	Spill reporting hotline has been established. City documents and routes complaint calls as received.	Document and route complaint calls as received.	In Place	Ongoing	
		Keep records of calls and follow-up actions taken.	Year 2 (2/15/2009)	City's CSR software tracks customer complaints and City follow-up activity.	City's CSR software tracks customer complaints and City follow-up activity.	In Place	Ongoing	
S5.C.3.e	**3.5 Program Evaluation and Tracking**	Track number and type of illicit discharges, including spills, identified and inspections made.	Permit End (8/19/2011)		Set-up system to track numbers and types of spills identified, inspections made, and outcome of enforcement actions.	5/1/2010	Ongoing	Recommended due date to have program in place prior to Summer 2010 inspections.
		Track feedback from public education efforts.	Permit End (8/19/2011)		Track feedback on IDDE related educational activities.	Permit End (8/19/2011)	Ongoing	Likely to be minimal.
S5.C.3.f	**3.6 Staff Training**	Train responsible staff on illicit discharge identification, investigation, clean-up, and reporting.	Year 2.5 (8/15/2009)		Conduct training for engineering staff responding to IDDE complaints.	Training initiated; complete in 2010	Once with follow-up as needed	City has missed the due date for this requirement and has submitted a G20 notification to Ecology.
		Ongoing training for all municipal field staff on identification and reporting.	Year 3 (2/15/2010)		Conduct training for all maintenance staff on identifying illicit discharges and proper reporting procedures.	Training initiated; complete in 2010	Once with follow-up as needed	
		Document and maintain records of training.	Year 2.5 (8/15/2009)		Develop and implement a tracking system to document staff training.	ASAP (2010)	Ongoing	City has missed the due date for this requirement and has submitted a G20 notification to Ecology.

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
SWMP Element #4 - Controlling Runoff from New Development, Redevelopment, and Construction Sites								
S5.C.4.a	**4.1 Stormwater Runoff Control Ordinance**	Adopt an ordinance to address runoff from new development, redevelopment, and construction site projects disturbing 1 or more acre. The ordinance should include: -Minimum technical requirements equivalent to the 2005 Ecology Manual; -Legal authority for inspection of private facilities; -Provisions to allow LID techniques.	Year 3 (2/16/2010)	WMC 14.09 establishes the surface water runoff policy, adopts the KCSWDM, requires inspection and maintenance of stormwater facilities and includes enforcement authority. WMC 1.03, 1.06 and 1.07 set forth penalties and enforcement procedures. On 2/11/08, The City adopted by rule the 2005 KCSWDM.	Adopt an ordinance to update WMC 14.09 and adopt the 2009 KCSWDM.	ASAP (2010)	Once	City has missed the due date for this requirement and has submitted a G30 notification to Ecology. The 2009 KCSWDM has been deemed equivalent to the 2005 Ecology Manual through permit modification issued 6/17/2009. Note: 2009 KCSWDM requires LID type flow control BMPs to attenuate stormwater runoff volumes on site.
S5.C.4.b	**4.2 Site Plan Review and Inspection**	Develop a permitting process with plan review, inspection, and enforcement for public and private projects that disturb 1 acre of land or greater. -Review all stormwater site plans; -Inspect high risk sites prior to clearing and construction; -Inspect all sites during and after construction; Verify all sites have a maintenance plan in place and maintenance responsibility has been assigned; -Implement an enforcement strategy. Compliance = 80% of scheduled inspections.	Year 3 (2/16/2010)	Community Development receives all applications and forwards plans to appropriate department for review.	Community Development receives all applications and forwards plans to appropriate department for review.	In Place	For each proposed project	
				Civil plans examiner reviews all site plans for both temporary and permanent stormwater control.	Civil plans examiner reviews all site plans for both temporary and permanent stormwater control, verifies maintenance plan is in place and maintenance responsibility has been assigned.	In Place	For each proposed project	
				Civil site inspector performs construction inspections approximately two times per week on active sites.	Civil site inspector performs construction inspections approximately two times per week on active sites.	In Place	2 X/week	Listed frequency based on current City practice. Permit requires one inspection during and one inspection following construction.
S5.C.4.c	**4.3 Long Term Operation and Maintenance**	Adopt an ordinance requiring inspection and maintenance of stormwater facilities and establishing enforcement procedures.	Year 3 (2/16/2010)	WMC 14.09 requires inspection and maintenance of private stormwater facilities and includes enforcement authority. WMC 1.03, 1.06 and 1.07 set forth penalties and enforcement procedures. Inspection and maintenance of public facilities is included in Element 5.	Complete.	In Place	N/A	
		Adopt maintenance standards for facilities consistent with the 2005 Ecology Manual.	Year 3 (2/16/2010)	WMC 14.09 adopts the KCSWDM, which includes maintenance standards.	Update maintenance standards with the City's upcoming adoption of the 2009 KCSWDM.	ASAP (2010)	Once	City has missed the due date for this requirement and has submitted a G30 notification to Ecology.
		Inspect treatment and flow control facilities annually.	Year 3 (2/16/2010)	Contract with King County to annually inspect private stormwater facilities, identify needed repairs and send maintenance requests to facility owners.	Contract with King County to annually inspect private stormwater facilities, identify needed repairs and send maintenance requests to facility owners.	In Place	Annually	
				Begin follow up maintenance enforcement actions with property owners starting in 2009.	Continue follow up maintenance enforcement actions with property owners.	In Place	As needed	
		For new residential developments that are part of a larger common plan of development, inspect new water quality and flow control facilities every 6 months during building construction.	Year 3 (2/16/2010)		Inspect new water quality and flow control facilities every 6 months during building construction.	In Place	Ongoing	
S5.C.4.d	**4.4. Permit Tracking and Inspection Records**	Keep records of all inspections, enforcement actions, maintenance activities, and construction sites.	Year 3 (2/16/2010)	Maintain records of work performed and inspection records from King County.	Develop a permit tracking system to electronically document all inspections, enforcement activities, maintenance activities and construction sites and correlate work to NPDES requirements.	ASAP (2010)	Ongoing	This tracking system relates to development projects; separate from the O&M tracking system described in Element 5.9.
S5.C.4.e	**4.5 NOI for Construction Activity**	Make copies of the "Notice of Intent for Construction Activity" and/or "Notice of Intent for Industrial Activity" available to developers.	Immediately (2/16/2007)	The NOI is discussed in pre-application meetings and Ecology contact information is given to applicants. The NOI is also available at the Development Services counter.	The NOI is discussed in pre-application meetings and Ecology contact information is given to applicants. The NOI is also available at the Development Services counter.	In Place	For each proposed project	

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
S5.C.4.f	4.6 Staff Training	Conduct training for staff in permitting, plan review, construction site inspection, and enforcement concerning the Stormwater Runoff Control program (Element 4.1); Maintain records of training.	Year 3 (2/16/2010)	Staff attend training as available.	Identify and attend specific training related to stormwater design and erosion control in the 2009 KCSWDM and the Ecology construction permit.	Following adoption of new manual (2010)	Once	Most training can be conducted in-house or through seminars offered by EPA, King County, and other agencies.
				Two staff will attend CESCL training in 2009.	CESCL training for staff involved in construction site inspections.	As needed	Once for all inspection staff	
					Conduct follow up staff training as needed to address changes in procedures, techniques or staffing.	After initial training	As needed	
					Maintain records of training.	ASAP (2010)	Ongoing	Use tracking system developed in Element 3.6.
SWMP Element #5 - Pollution Prevention and Operation and Maintenance for Municipal Operations								
S5.C.5.a	**5.1 Adopt Maintenance Standards**	Adopt maintenance standards consistent with the 2005 Ecology Manual;	Year 3 (2/16/2010)	Covered under Element 4.3.	Covered under Element 4.3.			
S5.C.5.b	**5.2 Annual Inspections of Water Quality and Flow Control Facilities**	Conduct annual inspections of stormwater treatment and flow control facilities; Perform necessary maintenance actions. Compliance = 95% of scheduled inspections.	Annually Starting in Year 3 (2/15/2010)	Contract with King County to perform annual inspections of public facilities. The County sends the City work orders for maintenance.	Perform annual inspections of public facilities and identify maintenance needs.	In Place	Annually	
				Maintenance crews perform maintenance as needed.	Perform maintenance as identified through inspections: Mowing	In accordance with maintenance standard	3 x /year	Likely frequency. Actual maintenance dependent on condition at inspection.
					Perform maintenance as identified through inspections: Sediment Removal	In accordance with maintenance standard	Once every 5 years	Likely frequency. Actual maintenance dependent on condition at inspection.
					Perform maintenance as identified through inspections: Miscellaneous repairs (flow control structures, fences, etc)	In accordance with maintenance standard	Once every 3 years	Likely frequency. Actual maintenance dependent on condition at inspection.
S5.C.5.c	**5.3 Spot Checks after Storm Events**	Spot check stormwater treatment and flow control facilities after major storm events (>10-year recurrence interval); Conduct repairs as necessary.	After major storm events Starting in Year 3 (2/15/2010)	City conducts spot checks before and after storm events of known problem areas and looks for new problem areas.	Continue inspections of problem areas before and after storm events; maintain or repair as necessary.	In Place	2 x/year	Likely frequency. Actual maintenance dependent on condition at inspection.
S5.C.5.d	**5.4 Catch Basin Inspection**	Inspect all catch basins and inlets at least once during the permit term; Clean catch basins as necessary; Dispose of decant water appropriately.	Permit End (8/19/2011)	City has created a rotating schedule for catch basin inspection and cleaning, starting in 2009.	Continue rotating catch basin inspection and cleaning so that all catch basins are inspected at least once every five years and cleaned in accordance with the City's maintenance standards.	In Place	Update as needed	
				Use a private contractor for catch basin inspection and cleaning on a budgetary basis.	Inspect and clean catch basins in accordance with the City's maintenance standard by the end of the Permit term.	Permit End (8/19/2011)	In accordance with schedule	Actual maintenance dependent on condition at inspection.
					Annual catch basin inspection and cleaning following initial activities.	Future	In accordance with schedule	Actual maintenance dependent on condition at inspection.
				Private contractor disposes of decant water at appropriate decant facility.	Dispose of decant water at appropriate decant facility.	In Place	Ongoing	
S5.C.5.f	**5.5 Road Maintenance**	Implement practices to reduce stormwater impacts from street, parking lot, and highway runoff. Address the following activities: -Pipe and culvert cleaning; -Ditch and roadside vegetation management; -Street cleaning; -Street repair, resurfacing, and striping; -Snow and ice control; -Utility installation; -Dust control.	Year 3 (2/15/2010)	Adopted the ESA Regional Road Maintenance Guidelines in April 2002.	See 10.3.c for additional implementation activities.	See 10.3.c	See 10.3.c	
				Operate street sweeper daily October - January up to 800 hours; increased sweeping for fall leaf pickup and following snow/ice events.	Operate street sweeper daily October - January up to 800 hours; increased sweeping for fall leaf pickup and following snow/ice events.	In Place	800 hours/year	
				Continue use of private contractor for vactor services to clean pipes/culverts.	Clean pipes/culverts in accordance with City's adopted maintenance standard.	In Place	Once every 5 years	Likely frequency. Actual maintenance dependent on condition at inspection.
				Mow roadside ditches as needed for vegetation management.	Mow roadside ditches.	In Place	3 x / year	Likely frequency. Actual maintenance dependent on condition at inspection.
					Minor ditch repair as part of ongoing road maintenance (may include hand ditching, blading, and reseeding).		Once every 3 years	Likely frequency. Actual maintenance dependent on condition at inspection.

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
S5.C.5.g	5.6 Non-Roadway Property Maintenance	Implement practices to reduce stormwater impacts from city-owned non-roadway property runoff (parks, open space, right-of-way, and maintenance yards). Address the following: -Application of fertilizer, pesticides, and herbicides; -Sediment and Erosion control; -Landscape maintenance and vegetation disposal; -Trash management; -Building exterior cleaning and maintenance.	Year 3 (2/15/2010)	Working to develop and implement an Integrated Pest Management Plan (See Element 10.3.a).	See 10.3.a for additional implementation activities.	ASAP (2010)	See 10.3.a	City has missed the due date for this requirement and has submitted a G20 notification to Ecology. The Parks Department is responsible for parks maintenance.
					Develop a facilities maintenance manual that includes practices to reduce impacts to stormwater.	ASAP (2010)	Once	City has missed the due date for this requirement and has submitted a G20 notification to Ecology. Facilities Department is responsible for building maintenance and landscaping.
					Implement facilities maintenance practices.	After manual is developed	Ongoing	Facilities Department is responsible for building maintenance and landscaping.
S5.C.5.h	5.7 Staff Training	Implement ongoing training activities for construction, maintenance, and operations personnel. Include training on: -O&M standards; -inspection procedures; -selecting appropriate BMPs; -Reducing water quality impact in daily activities; -Reporting of water quality concerns and illicit discharges. Maintain records of training.	Year 3 (2/15/2010)	City staff have attended training on ESA Regional Road Maintenance Guidelines.	Send two staff per year to stormwater related O&M training (i.e. ESA Road Maintenance training or similar).	In place	2 people/year	Recommended training schedule.
					Conduct ongoing training for O&M staff during staff meetings or other regularly scheduled department gatherings.	ASAP (2010)	Bi-monthly	Refresher sessions in staff meetings.
					Maintain records of training.	ASAP (2010)	Ongoing	Use tracking system developed in Element 3.6
S5.C.5.i	5.8 SWPPP for Maintenance Yards	Develop and implement Stormwater Pollution Prevention Plans for all equipment maintenance and storage yards not covered under the Industrial Stormwater General Permit. Include an implementation schedule for structural BMPs and conduct occasional visual inspection of discharge from the site.	Year 3 (2/15/2010)		Evaluate City maintenance storage facilities.	Complete	Once	SWPPP is required.
					Develop SWPPP for heavy equipment maintenance or storage yards and material storage facilities.	ASAP (2010)	Once	City has missed the due date for this requirement and has submitted a G20 notification to Ecology.
					Quarterly inspections and repairs as necessary to implement SWPPPs for heavy equipment maintenance or storage yards and material storage facilities.	ASAP (2010)	Quarterly	
S5.C.5.j	5.9 Record Keeping	Maintain records of inspection and/or repair activities.	Ongoing	Starting in 2009, began tracking and recording stormwater maintenance activities with an application called Task Tracker.	Continue tracking and recording maintenance activities with the Task Tracker application.	In Place	Ongoing	
SWMP Element #6 - Program Implementation								
S5.A.1	6.1 SWMP Implementation	Develop and implement a SWMP that covers the geographic area subject to the permit. Included with Elements 1 through 5.	Permit End (8/19/2011)	Developing SWMP that complies with Permit requirements as part of this comprehensive stormwater management plan update.	Implement, manage and coordinate SWMP activities as described in this comprehensive stormwater management plan update.	See Elements #1-5	See Elements #1-5	Conducting activities in Elements #1-5 meets this requirement.
S5.A.2	6.2 SWMP Documentation	Prepare written documentation of the SWMP and issue annual updates with the Annual Report to Ecology.	March 31 Each Year	City has developed and submitted its 2007 and 2008 SWMPs to Ecology.	Complete.	Complete	N/A	
					Develop and submit 2009 SWMP to Ecology	ASAP (2010)	Once	
					Develop and submit 2010 SWMP to Ecology	3/31/2011	Once	
					Develop and submit 2011 SWMP to Ecology	3/31/2012	Once	
S5.A.3	6.3 Program Tracking	Track the cost or estimated cost of development and implementation of the SWMP; provide this information to Ecology upon request.	Annually starting in 2009	Use SWM Fund budget to estimate development and implementation costs of the SWMP if information is requested by Ecology.	Use SWM Fund budget to estimate development and implementation costs of the SWMP if information is requested by Ecology.	In Place	As requested by Ecology	
		Track the number of inspections, enforcement actions, and public education activities. Include this information in the Annual Report.	As stipulated by Permit	Tracking of inspections, enforcement actions and public education activities are covered in Elements #1-5.	Tracking of inspections, enforcement actions and public education activities are covered in Elements #1-5.	See Elements #1-5	See Elements #1-5	
S5.B	6.4 MEP and AKART	Design the SWMP to reduce discharge of pollutants to the Maximum Extent Practicable (MEP), meet State AKART requirements, and protect water quality.	N/A	WMC focuses on MEP and AKART standards for reducing pollutants.	No specific activities.	Complete	N/A	Conducting activities in Elements #1-5 meets this requirement.

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
SWMP Element #7 - Total Maximum Daily Load Allocations								
S7.A	**7.1 Permit Recognized TMDLs**	Applicable TMDLs are listed in Appendix 2 of the NPDES Permit. None apply to the City of Woodinville at this time.	N/A	No TMDLs apply in this category.	No TMDLs apply in this category.	N/A	N/A	
S7.B	**7.2 TMDLs not Listed in Permit**	Compliance with TMDLs not listed in Appendix 2 of the Permit is achieved by meeting the requirements of the Permit; Keep records and report activities relevant to applicable TMDLs.	N/A	Participate in monitoring efforts for the Little Bear Creek Fecal Coliform TMDL.	Participate in monitoring efforts for the Little Bear Creek Fecal Coliform TMDL.	In Place	See 8.1	The TMDL was approved by EPA on 7/1/05.
				Coordinate with Ecology on the development of the Detailed Implementation Plan for the Little Bear Creek Fecal Coliform TMDL.	Coordinate with Ecology on the development of the Detailed Implementation Plan for the Little Bear Creek Fecal Coliform/Temperature/Dissolved Oxygen TMDL.	TBD	As determined by Ecology	The Detailed Implementation Plan for Little Bear Creek Fecal Coliform TMDL is on hold indefinitely.
S7.C	**7.3 TMDLs Approved during the Permit Cycle**	Comply with future TMDL requirements issued through permit modifications.	N/A	Coordinate with Ecology on the development of the Detailed Implementation Plan for the Bear-Evans Watershed Fecal Coliform/Temperature/Dissolved Oxygen TMDL.	Coordinate with Ecology on the development of the Detailed Implementation Plan for the Bear-Evans Watershed Fecal Coliform/Temperature/Dissolved Oxygen TMDL.	TBD	As determined by Ecology	The Detailed Implementation Plan for the Bear-Evans Watershed Fecal Coliform/Temperature/ Dissolved Oxygen TMDL is expected to be completed by June 2010. City has no formal obligation to comply with TMDL requirements until they are included in the NPDES permit.
SWMP Element #8 - Monitoring								
S8.B	**8.1 Existing Monitoring**	Describe any stormwater monitoring or studies and type of information gathered in annual report; Assess the appropriateness of the BMPs in the SWMP and note any proposed changes.	March 31 Each Year	Collect and report water quality data to Snohomish County for Little Bear Creek, Woodin Creek, and Derby Creek. City contributes funding for King County to monitor Lake Leota.	Collect and report water quality data to Snohomish County for Little Bear Creek, Woodin Creek, and Derby Creek. City contributes funding for King County to monitor Lake Leota.	In place	Monthly	
S8.C.1.a	**8.2 Stormwater Monitoring**	Prepare for future monitoring by selecting 2 outfalls for flow-weighted composite sampling (must meet Ecology requirements). Document site selection, possible constraints, basin description, and water quality concerns in receiving waters.	12/31/2010		Identify two sites for future monitoring. Conduct site visits to verify suitability for permanent installation of sampling equipment. Verify sites are appropriately mapped in outfall database (Element 3.1)	12/31/2010	Once	
S8.C.1.b	**8.3 SWMP Effectiveness Monitoring**	Prepare for future monitoring by identifying 2 questions be studied and selecting monitoring sites. Develop a monitoring plan based on Ecology requirements.	12/31/2010		Identify two questions to be studied and suitable sites for collecting relevant data.	12/31/2010	Once	Consider partnering with other WRIA 8 communities to develop a collaborative monitoring study.
					Develop a monitoring plan for each site.	12/31/2010	Once	
S8.C.2	**8.4 Annual Reporting**	Describe the status of identifying monitoring sites, questions, and developing monitoring plan.	Starting with 2010 Annual Report (3/31/2011)		Include status report on steps taken to prepare for future monitoring with the 2010 Annual Report.	3/31/2011	Once	
					Include status report on steps taken to prepare for future monitoring with the 2011 Annual Report.	3/31/2012	Once	
SWMP Element #9 - Reporting								
S9.A&B	**9.1 Annual Reports**	Submit annual reports each year on the previous year's NPDES Phase II activities. Report includes current SWMP, Annual Report Form (Appendix 3 of Phase II Permit), and applicable supporting documentation.	March 31 Each Year	Developed and submitted the 2007 and 2008 Annual Reports to Ecology.				Complete the annual permit reporting forms supplied by DOE and assemble supporting documentation (use information tracked under Element 9.2).
					Develop and submit 2009 Annual Report to Ecology.	ASAP (2010)	Once	
					Develop and submit 2010 Annual Report to Ecology.	3/31/2011	Once	
					Develop and submit 2011 Annual Report to Ecology.	3/31/2012	Once	
S9.C.2	**9.2 Ongoing Tracking**	To support annual report submittal, maintain records of activities completed and implementation status of each element in Elements 1 through 5. Track progress toward meeting minimum performance measures and plans for meeting future permit deadlines	Ongoing	Tracking some compliance activities as documented in Elements 1-5.	-Track SWM related activities completed by all City departments and correlate activities to NPDES permit requirements. -Document staff hours and expenses to complete activities. -Track progress toward meeting milestones outlined in the permit. -Identify activities that are behind schedule and revise implementation schedule as needed to maintain realistic goals.	March 31 Each Year	Quarterly	
S9.C	**9.3 Maintaining Records**	Maintain records of SWMP and permit activities for five years.	Ongoing	Maintain records of SWMP activities.	Maintain records of annual SWMP activities and archive the records as submitted to Ecology.	In Place	Ongoing	Maintain records in City files for at least five years.
S9.D	**9.4 Public Access**	Make all records of SWMP and permit activities available to the public at reasonable times during business hours.	Ongoing	Make records of SWMP activities available to the public.	Make records of SWMP activities available to the public.	In Place	Ongoing	

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
SWMP Element #10 - Additional Regulations								
	10.1 Underground Injection Control Rule	Comply with Washington State's UIC Rule, as outlined in WAC 173-218. The updated rule went into effect February 3, 2006, and incorporates federal UIC guidelines. Compliance includes registration and assessment of City owned and operated wells, with retrofitting or abandonment as needed, constructed prior to the effective date. Wells constructed after the effective date require registration prior to use and must comply with the nonendangerment standard.	Registration by 2/02/2009 Assessment by 2/02/2011		Complete and submit Ecology registration forms for existing wells constructed prior to 2/02/2006.	ASAP (2010)	Once	The City has missed the deadline for this requirement. Deadline of 2/2/2009 is for 50 wells or less. The City currently owns and operates less than 10 infiltration facilities.
					Assess existing wells constructed prior to 2/02/2006 to evaluate threats to groundwater.	2/2/2011	Once	
					Develop schedule and retrofit existing wells constructed prior to 2/02/2006 identified as a high threat to ground water. Take immediate action to correct the use of wells determined to be an imminent public health hazard.	Immediate if health hazard	Once per well	
					Comply with the non-endangerment standard and register wells constructed after 2/02/2006.	Prior to Use	Once per well	
					Provide updates on changes in status of registered wells.	After 2/2/2009	Annually	
					Notify Ecology of well decommissions.	Within 1 year	Once per well	
					Notify Ecology of well decommissions when the well poses an imminent public health hazard.	Immediately	As needed	
	10.2 Puget Sound Action Agenda	The Puget Sound Partnership's December 2008 Action Agenda identified 5 strategic priorities for restoring and protecting Puget Sound. Priority C.2.2 calls for implementing NPDES municipal stormwater permits, incorporating LID requirements for development and redevelopment into all stormwater codes, and retrofitting existing stormwater facilities for compliance with current standards.	Not Yet Specified	Implementing NPDES municipal stormwater permit (See Elements 1-9) covers many of the Puget Sound Action Agenda objectives.	Implementing NPDES municipal stormwater permit (See Elements 1-9) covers many of the Puget Sound Action Agenda objectives.	Not Yet Specified	Ongoing	Implementation planning is currently underway.
					Incorporate LID requirements for development and redevelopment into City stormwater code.		Once	
					Retrofit existing stormwater facilities for compliance with current standards.		As specified in future guidance document	
	10.3 Endangered Species Act General	Continue compliance with ESA guidelines through individual project review and/or implementation of basin plan activities.	N/A	Comply with ESA guidelines through Individual project reviews.	Comply with ESA guidelines through Individual project reviews.	In Place	Ongoing	
				Annual Sammamish Re-leaf volunteer project.	Continue Sammamish Re-leaf projects and pursue habitat and restoration activities.	N/A	Annually	
					Pursue CIP projects focused on habitat protection and fish passage improvements (see Element 13).	Per approved 6-Yr SWM CIP	Annually	
					Monitor changes and new developments in ESA regulations.	N/A	Ongoing	
	10.3.a Endangered Species Act IPM Plan	Adopt an Integrated Pest Management (IPM) Plan to guide maintenance activities in parks and open space areas. The plan should outline appropriate use of chemicals (fertilizers, pesticides, etc) to reduce impacts to fish habitat.	N/A		Develop IPM Plan.	ASAP (2010)	Once	Recommended due date.
					Implement IPM Plan during landscape and vegetation management activities.	Starting in 2010	Ongoing	Recommended due date; consistent with required due date for Element 5.6 for IPM Plan.
	10.3.b Endangered Species Act Construction Methods	Review existing construction methods for public projects and outline sequencing guidelines to protect fish habitat, consistent with the erosion and sediment control guidelines of the KCSWDM. Train staff on appropriate methods.	N/A		Outline sequencing guidelines for public projects.	2010	Once	Recommended due date.
					Require ESC Plans for both public and private projects that include a sequencing schedule.	Starting in 2010	Ongoing	New activity identified as part of the ESA program analysis.
					Conduct short training with City maintenance staff to ensure understanding of how erosion control and sequencing affect fish habitat.	2010	Annually	Recommended due date.
	10.3.c Endangered Species Act 4(d) Coverage	Apply for 4(d) coverage through WSDOT and the services as part of full adoption of the ESA Road Maintenance Manual.	N/A	City has adopted 4(d) rule ESA Road Maintenance Manual to guide maintenance activities.	Complete and submit application to appropriate agencies.	6/30/2010	Once	Application is the last step in full adoption of the manual and 4(d) rule protection for maintenance activities. Recommended due date.
					Track responses and approval.	9/30/2010	Once	Recommended due date.
	10.4 WRIA 8	Continue involvement with WRIA 8 activities.	N/A	Participates in WRIA 8 activities.	Continue involvement with WRIA activities.	In Place	Ongoing	
			N/A		Look for opportunities to partner with other WRIA agencies to meet program goals (i.e. monitoring program, ESA, etc).	N/A	As available	

Requirements				Existing SWM Program	Future SWM Program			
Permit Ref	Stormwater Program Element	Activities/BMPs Needed for Regulatory Compliance	Permit Milestone Date	Current Activities	Required Activities, Due Dates and Frequencies	Due Date	Frequency	Comments
SWMP Element #11 - Local Stormwater Activities								
	11.1 Professional Consulting Services	Implement miscellaneous contracts as determined by City Staff to support the SWM Program (includes professional services for SWM program planning, private vactoring, TVing of storm drain lines, etc).	N/A	Identify and administer consulting contracts to support the surface water program.	Identify and administer consulting contracts to support the surface water program.	In Place	Annually	
	11.2 Redmond/ Bear Creek Groundwater Program	Participate in groundwater evaluation program to maintain adequate drinking water source to local communities.	N/A	Participate in groundwater evaluation program.	Participate in groundwater evaluation program.	In Place	Ongoing	
SWMP Element #12 - Program Overhead								
	12.1 Vehicle Use	SWM Fund pays the City's Equipment Rental Fund for annual vehicle use. Equipment Rental Fund then purchases and maintained vehicles.	N/A	Ongoing program cost.	Continue to allocate budget for vehicle use.	Annually	As part of annual budget process	
	12.2 General Fund Payment	Payment to General Fund for overhead services	N/A	Ongoing program cost.	Continue to allocate budget for General Fund Payment.	Annually	As part of annual budget process	
	12.3 General SWM Program Overhead	Includes budgets for Communication, Travel, Advertising, Rentals & Leases, Repairs & Maintenance, and Miscellaneous	N/A	Ongoing program cost.	Continue to allocate budget for SWM Program Overhead.	Annually	As part of annual budget process	
	12.4 Supplies	Includes office supplies as well as safety gear, software, signage, small tools, and miscellaneous maintenance and planting supplies.	N/A	Ongoing program cost.	Continue to allocate budget for Supplies.	Annually	As part of annual budget process	
SWMP Element #13 - Capital Projects								
	13.1 Surface Water Reserve Projects	City's SWM budget pays into the surface Water Capital Projects Budget to fund CIP projects. The fund pays for both construction and engineering costs.	Ongoing	Approved expenditures in the 2009 Budget include: - Sammamish River Outfall - Comprehensive SWM Plan Update	Transfer funds from Surface Water Management fund to the Surface Water Reserve fund to support implementation of the 6-Yr SWM CIP being developed as part of this comprehensive stormwater plan update.	Annually	As part of annual budget process	
SWMP Element #14 - Maintenance Yard and Equipment								
	14.1 Capital Outlay (Equipment)	Budget for SWM contribution to equipment purchases.	N/A	The 2009/2010 Budget includes purchase of a video camera in 2009 for pipe inspections.	Allocate budget for needed equipment purchases.	Annually	As part of annual budget process	
	14.2 Maintenance Yard Construction	Construct a new maintenance yard for storing equipment and resources needed for operations of city-owned infrastructure.	N/A	The 2009/2010 Budget allocates resources in 2009 and 2010 towards the Public Works Maintenance Yard.	Transfer funds from the Surface Water Management Fund to the Surface Water Reserve Fund to support construction of the Public Works Maintenance Yard.	As Needed	As part of annual budget process	

Notes:

- Activities are based on the *Western Washington Phase II Municipal Stormwater Permit*, issued January 17, 2007 and modified June 17, 2009.
- The permit effective dates are February 16, 2007 through February 15, 2012 and permit years run from February to February.
- "Permit End" means 180 days prior to the expiration date of the permit (8/19/2011)
- "2005 Ecology Manual" refers to the Washington State Department of Ecology's 2005 *Stormwater Management Manual for Western Washington.*
- Monitoring requirements vary based on City or County population. Guidelines listed here are for small cities (population between 10,000 and 25,000).
- Activities in Program Elements 11-14 are not required by the NPDES Phase II permit, but are the management, planning, administrative and capital project activities needed to run a successful program.

Due in 2010
Due in 2011
Due in 2012

Section 7—SWM Program Summary and Implementation

Section 7: SWM Program Summary and Implementation

The City's future SWM Program needs to maintain regulatory compliance, fulfill its other stormwater-related obligations and address local SWM Program priorities. The City's future SWM Program also needs to include the recommended maintenance and capital activities, as presented in Sections 4 and 5, respectively. By integrating, prioritizing and funding the proposed activities for regulatory compliance with the proposed capital projects, the City's updated CSWM Plan will be effectively implemented.

Regulatory Compliance

NPDES Phase II Municipal Stormwater Permit

Documentation of the City's compliance activities is organized in accordance with the five components enumerated below. Current and past compliance activities are summarized in its 2007, 2008, and 2009 Annual Reports, which are posted on the City website and are available for review at City Hall. For each of the five regulatory compliance elements, planned future compliance activities are outlined in the City's 2009 Stormwater Management Program and summarized in Section 6 together with future requirements for TMDLs, Monitoring, and Reporting.

Phase II Permit Compliance Activities

1. Public Education and Outreach

The City will continue the development and implementation of its public education and outreach program by refining education activities based on survey results. The emphasis of the City's educational activities will be proper vehicle washing, conducting a follow up survey to measure program effectiveness, continuing to offer rain barrels and compost bins at the Spring Garden Fair, and record keeping of activities for the purposes of annual reporting.

2. Public Involvement and Participation

The City plans to continue its ongoing public involvement and participation strategies, including creating opportunities for public involvement and community feedback, and posting and responding to comments on this CSWM Plan.

3. Illicit Discharge Detection and Elimination

The City intends to build upon existing IDDE activities by developing procedures, conducting field assessments of high priority receiving waters, tracing and removing sources as identified in the field, continuing to update the stormwater system map, conducting staff training, providing public education, and developing activity tracking procedures.

4. Controlling Runoff from New Development, Redevelopment and Construction Sites

The City will need to continue and update its ongoing development review/inspection program that includes consistent application of development standards, conducting permitting processes, ensuring long-term operations and maintenance of facilities, providing

construction inspection/enforcement, as well as staff training, recordkeeping and reporting. The City updated its code to adopt the 2009 KCSWDM and its associated maintenance standards, and LID requirements; however, the City is considering adopting the 2004 Ecology Manual.

5. Pollution Prevention and Operations and Maintenance for Municipal Operations

The City will continue to emphasize maintenance of its infrastructure by building upon and expanding its prior accomplishments including facility and catch basin inspections and facility maintenance in accordance with the updated maintenance standards required in the Phase II Permit. Other areas that the City will focus on for 2010 include reducing stormwater impacts from municipal operations, developing and implementing a SWPPP for its maintenance facility, and enhancing staff training, recordkeeping and cost tracking.

Roadside ditch on NE180th Street to be converted to a "raingarden" for water quality treatment as part of the "Lake Leota and NE 180th Street CIP."

6. Preparing for Future Monitoring

Under the existing Phase II Permit the City is required to prepare for future stormwater outfall and program effectiveness monitoring. It is likely in the next permit term (beginning in 2012), that the City will be required to implement a new outfall monitoring program. (These monitoring requirements will likely be similar to those already in place for NPDES Phase I permittees with the exception of BMP effectiveness monitoring.) It is anticipated that this monitoring program will involve an increase in the City's investment in staff time and resources for equipment purchase, installation, sample collection, lab analyses, data analysis, recordkeeping, and annual reporting.

7. Annual Reporting and Status of LID

Under the City's existing Phase II Permit, annual reports must be submitted by March 31st each year for compliance activities occurring in the previous calendar year.

Pursuant to the Phase II Permit Modification issued June 17, 2009, no later than March 31, 2011, the City will also need to conduct an evaluation and submit a summary of identified barriers to the use of LID and measures to address barriers. This report is to include currently available LID practices that can be reasonably implemented within the Permit term, and a list of potential or planned non-structural SWM actions and/or LID techniques that the City will undertake to prevent stormwater impacts, with schedules, goals and metrics to identify, promote, and measure LID use.

Compliance with Phase II Permit Requirements for SWM Maintenance

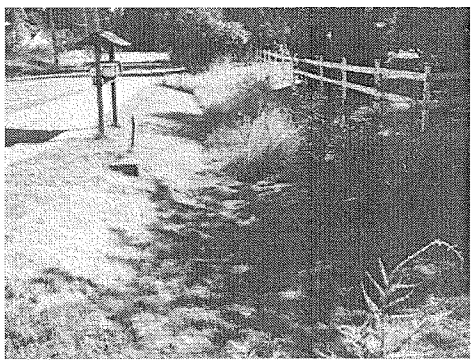
The City's existing operations and maintenance program addresses many of the requirements of the Permit and is close to meeting its Phase II Permit compliance goals. In some cases, small changes are necessary to update existing standards or activities. In a few areas, there are new activities that the City will need to perform to fully address the requirements and targeted due dates required for compliance with the Phase II Permit.

Specific areas needing attention for regulatory compliance include:

- Adopting and implementing updated maintenance standards consistent with the 2005 Ecology Manual.
- Developing and implementing a nutrient and integrated pest management plan and facilities maintenance manual.
- Developing and implementing on-going staff training program.
- Developing and implementing a SWPPP for the City's maintenance facility.
- Developing and implementing a private facility maintenance enforcement program.

Water Quality Monitoring

The City's SWM Program also includes an ambient Water Quality Monitoring Program that has been in place since 2000. This is a discretionary activity that supports the City's efforts to gain a better understanding of current conditions and to track changes in its natural drainage systems. The City's existing Water Quality Monitoring Program is presented in Appendix F.



The City is responsible for maintaining roadside ditches.

Low Impact Development and Sustainability

In July 2007, the City was actively working on updating and completing their sustainability study with involvement from the Citizen Advisory Panel. The City gathered information on implementing LID standards, by looking at LID examples from other municipalities throughout the Pacific Northwest. The City is strongly interested in, and actively pursing, the creation of sustainable land-use standards and LID drainage design standards. These are likely to be implemented in the near future by updating their zoning codes and design standards.

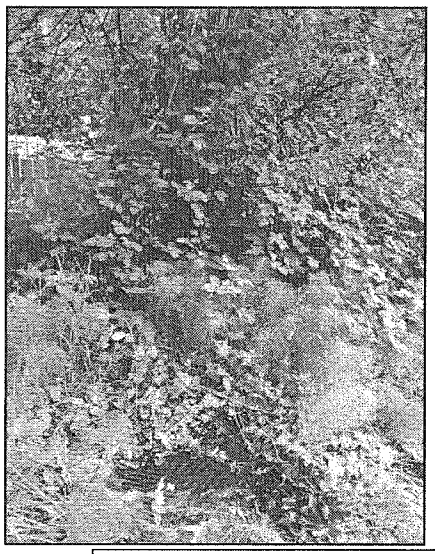
Capital Improvement Plan

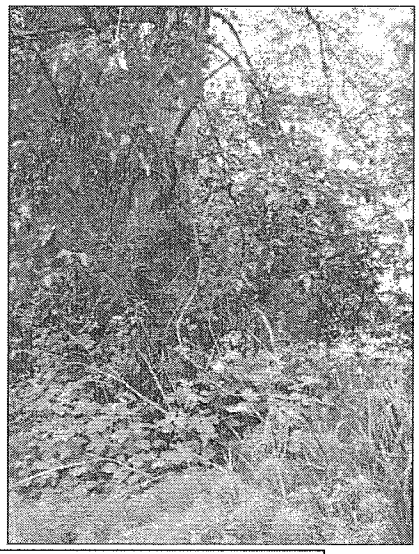
The City's recommended capital projects have an estimated cost of $6.4M. The top ranked project addressed the flooding on Woodin Creek with a cost estimate of $2.6M. The nine other capital projects total $3.8M, with an average cost of about $643K. Priorities for funding and construction will be determined by the City Council.

Conclusion

This updated Comprehensive Stormwater Management Plan for the City of Woodinville provides an assessment of existing drainage conditions within the City, lists activities needed for regulatory compliance and presents and updated prioritized list of capital projects and costs for future funding and implementation.

Areas within the City's SWM Program that need enhancement have been identified, including activities to achieve regulatory compliance by the end of 2011. An updated CIP plan presents prioritized CIP projects and associated costs for future funding and implementation.





"Cottonwood Trees at 14300 NE Wood-Duvall Road CIP" addresses these two large cottonwood trees whose root systems are intruding on a nearby Type 2 catch basin and conveyance pipe.

Average Climate Temperatures
http://www.weather.com/weather/wxclimatology/monthly/98072

Bear Creek
http://green.kingcounty.gov/wlr/waterres/streamsdata/WaterShedInfo.aspx?Locator=0484

Juanita Creek Watershed
http://www.ci.kirkland.wa.us/depart/Public_Works/Storm__Surface_Water/Juanita_Creek_Watershed.htm

King County Lake Leota Stewardship Program
http://your.kingcounty.gov/dnrp/wlr/water-resources/small-lakes/data/LakePage.aspx?SiteID=23

King County Water and Land Resources Division: Sammamish River Site 0450
http://green.kingcounty.gov/WLR/Waterres/StreamsData/WaterShedInfo.aspx?Locator=0450

King County Water and Land Resources Division: Little Bear Creek Site 0478
http://green.kingcounty.gov/WLR/Waterres/StreamsData/WaterShedInfo.aspx?Locator=0478

Woodinville Municipal Code
http://www.mrsc.org/wa/woodinville/index_dtSearch.html

NPDES Phase II Stormwater Permit
http://www.ecy.wa.gov/programs/wq/stormwater/municipal/phaseIIww/wwphiipermit.html

Vladimir Novotny and Harvey Olem. *Water Quality Prevention, Identification, and Management of Diffuse Pollution,* Van Nostrand Reinhold: New York, 1994, p. 109.

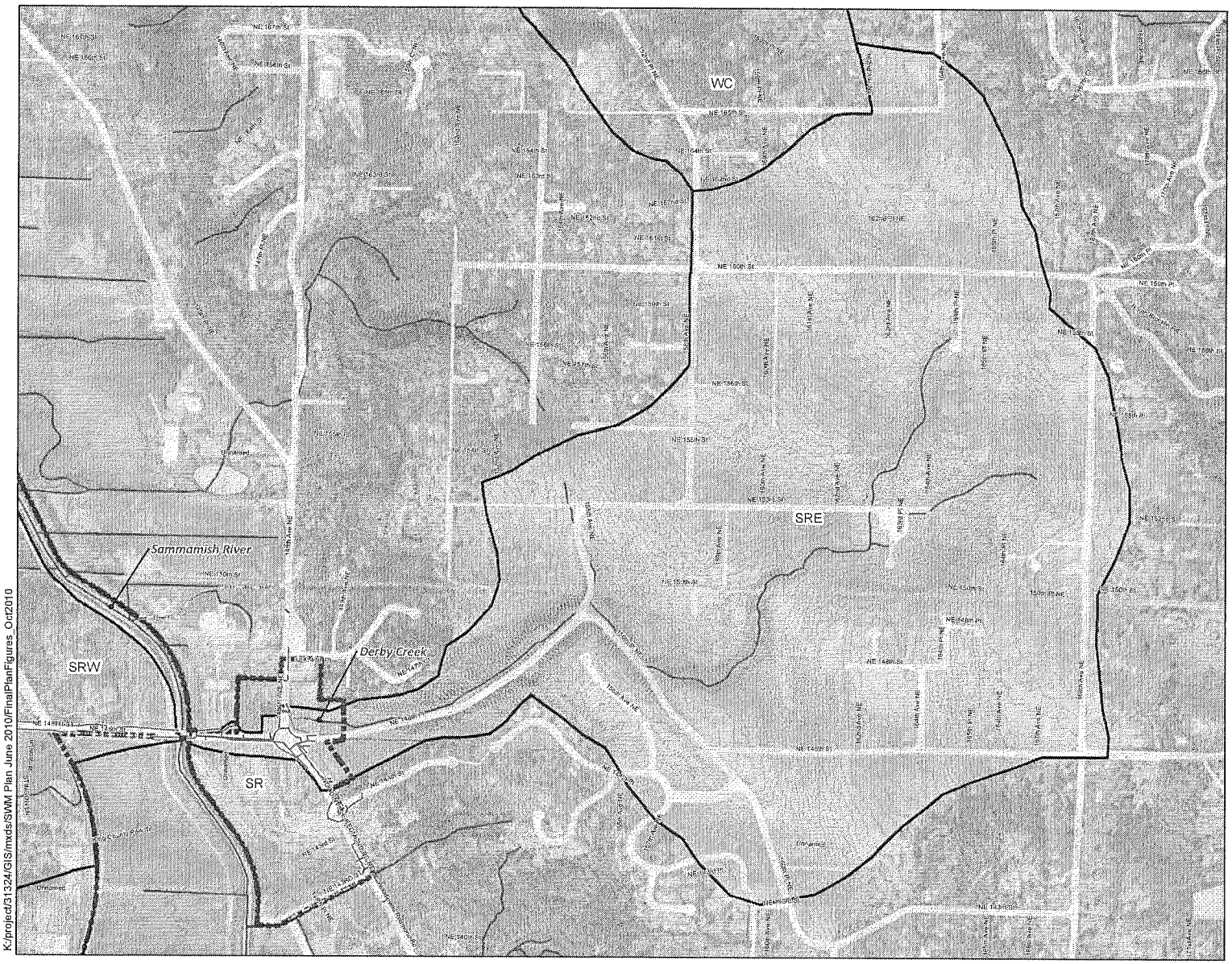
Stormwater Management Manual for Western Washington. Department of Ecology. 2005.

Portland Bureau of Environmental Service. Santa Barbara Urban Hydrograph Method. http://www.portlandonline.com/bes/index.cfm?a=55823&c=35122 Access August 30th, 2010 at 2:25pm.

Snohomish County, Public Works Department, Surface Water Management Division: Little Bear Creek Drainage Needs Report, December 2002.

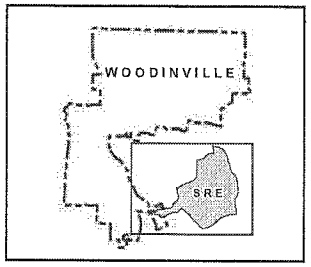
Snohomish County, Public Works Department, Surface Water Management Division: Implementation of DNR/MDP Flooding Projects Status Report, May 2007.

Appendix A
Drainage Basin Maps



Legend

- Woodinville City Limits
- County Boundary
- Sammamish River East (SRE)
- Waterbody
- Subbasin Boundary
- City of Woodinville Stormwater Pipes Dated: 02/16/10
- Stormwater Open Channel
- Stream
- 5 ft Contour (King Co. LIDAR)



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0 400 800 1,600 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc. (basin boundaries, storm system mapping), from the City of Woodinville (city limits, hydrology, parcel boundaries, streets), King County GIS (county boundary, water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial imagery from 2005.

STORMWATER MANAGEMENT PLAN

FIGURE A-1.1

SAMMAMISH RIVER EAST BASIN

CITY OF WOODINVILLE

OCTOBER 2010

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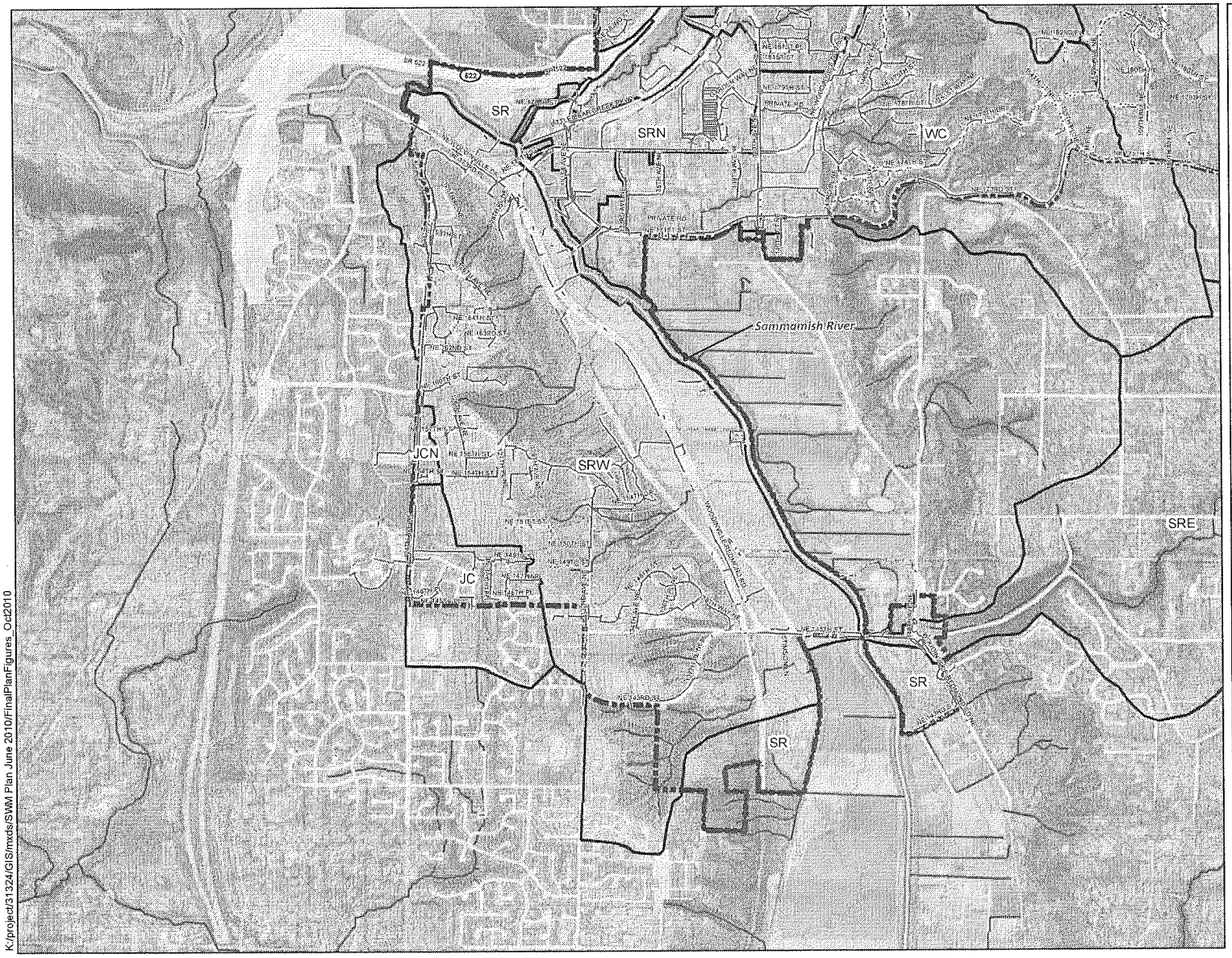
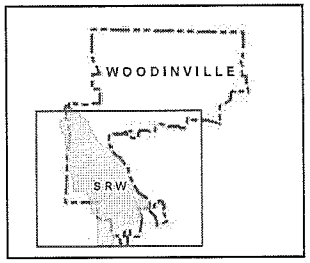


Legend

- Woodinville City Limits
- County Boundary
- Sammamish River West Basin (SRW)
- Waterbody
- Subbasin Boundary
- City of Woodinville Stormwater Pipes Dated: 02/16/10
- Stormwater Open Channel
- Stream
- 5 ft Contour (King Co LIDAR)



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Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries,storm system mapping), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
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City of Woodinville data received Feb. 16, 2010. Aerial Imagery from 2005.

STORMWATER MANAGEMENT PLAN

FIGURE A-1.2

SAMMAMISH RIVER WEST BASIN

CITY OF WOODINVILLE

otak

OCTOBER 2010

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Little Bear Creek
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LB
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SRN
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NE 200TH PL
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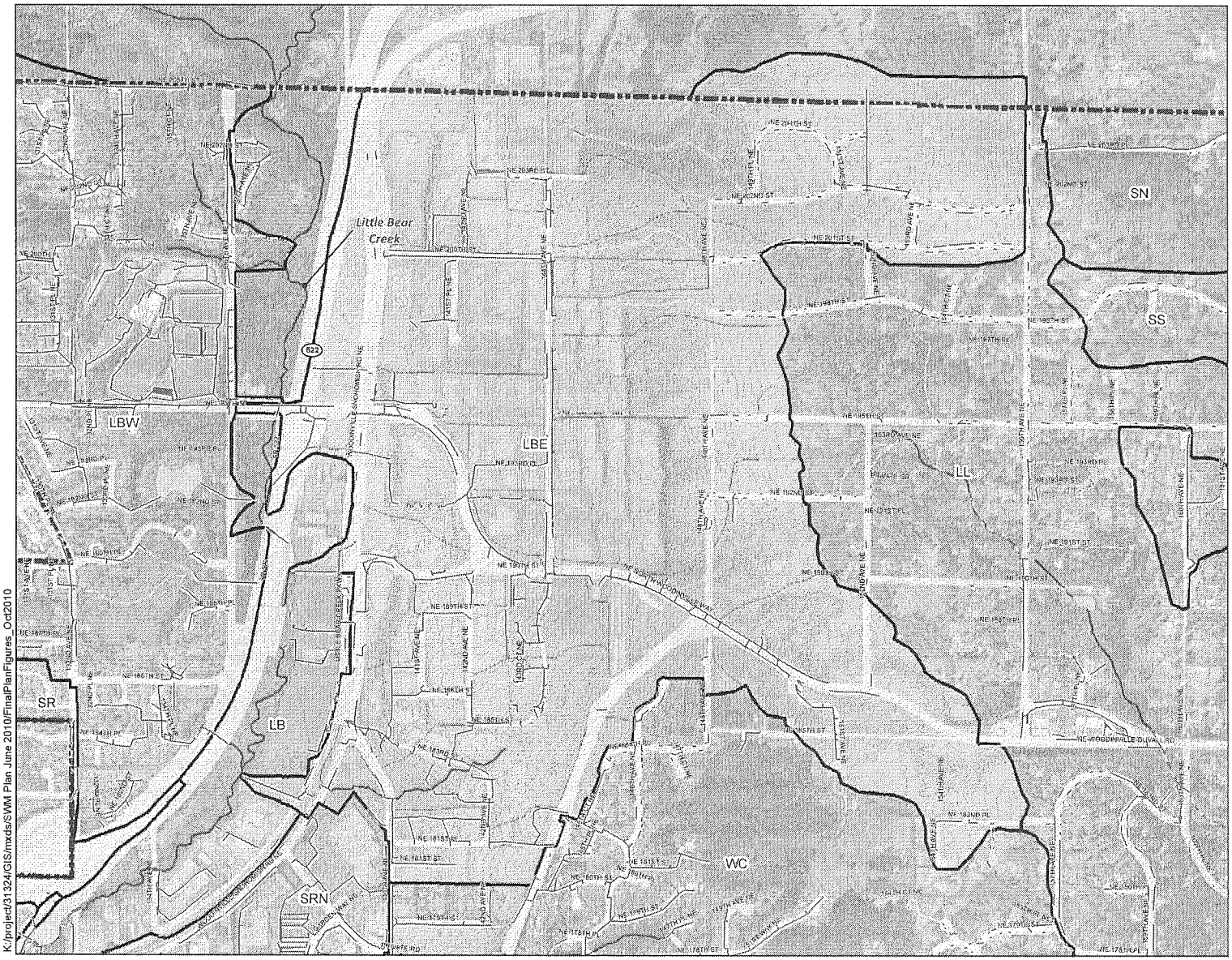
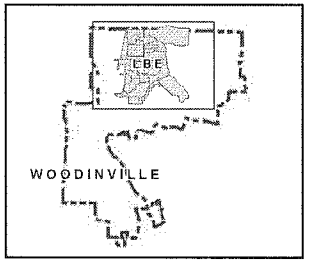


Legend

- Woodinville City Limits
- County Boundary
- Little Bear East (LBE)
- Waterbody
- Subbasin Boundary
- City of Woodinville Stormwater Pipes Dated: 02/16/10
- Stormwater Open Channel
- Stream
- 5 ft Contour (King Co. LIDAR)



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0 400 800 1,600 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries,storm system mapping), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
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City of Woodinville data received Feb. 16, 2010. Aerial Imagery from 2005.

STORMWATER MANAGEMENT PLAN

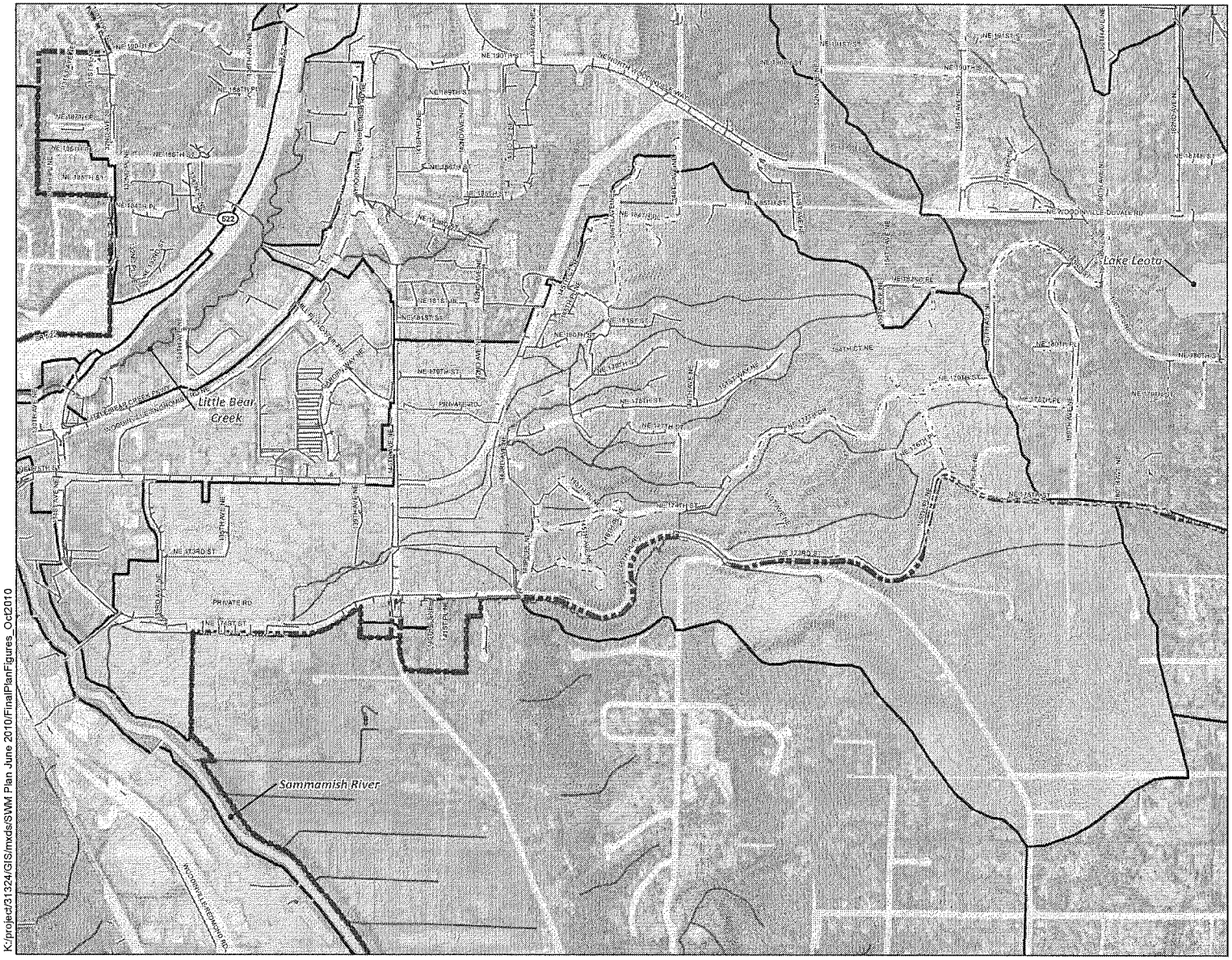
FIGURE A-1.4

LITTLE BEAR EAST BASIN

CITY OF WOODINVILLE

OCTOBER 2010

K:/project/31324/GIS/mxds/SWM Plan June 2010/FinalPlanFigures_Oct2010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Sammamish River
Lake Leota
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NE 175TH ST
NE 173RD ST
NE 170TH ST
NE 168TH ST
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NE 163RD ST
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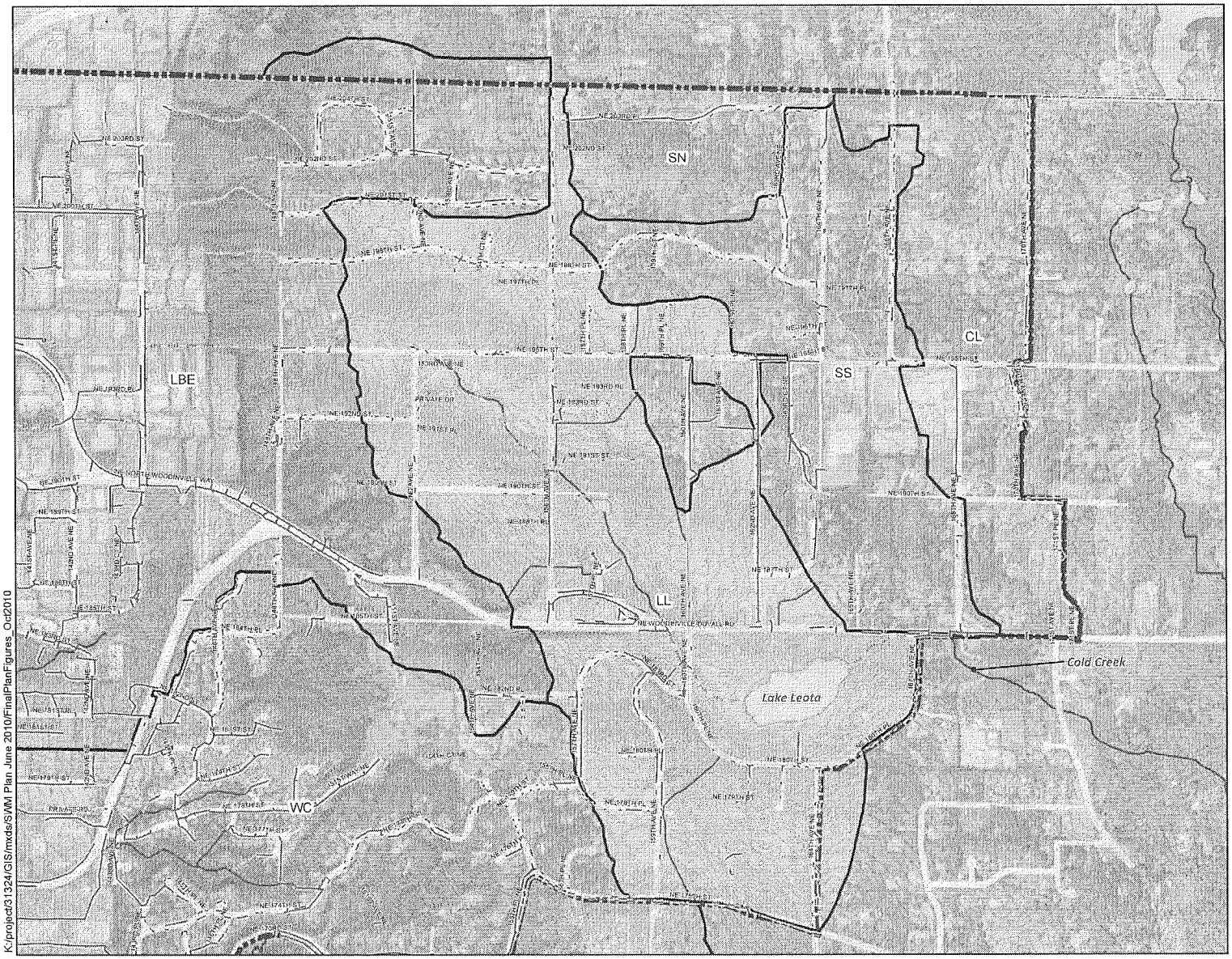
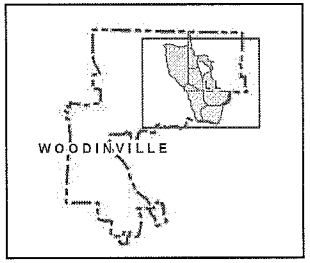


K:/project/31324/GIS/mxds/SWM Plan June 2010/FinalPlanFigures_Oct2010

Legend

- Woodinville City Limits
- County Boundary
- Lake Leota Basin (LL)
- Waterbody
- Subbasin Boundary
- City of Woodinville Stormwater Pipes Dated: 02/16/10
- Stormwater Open Channel
- Stream
- 5 ft Contour (King Co. LIDAR)



N

0 400 800 1,600 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc. (basin boundaries,storm system mapping), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR).
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City of Woodinville data received Feb. 16, 2010. Aerial imagery from 2005.

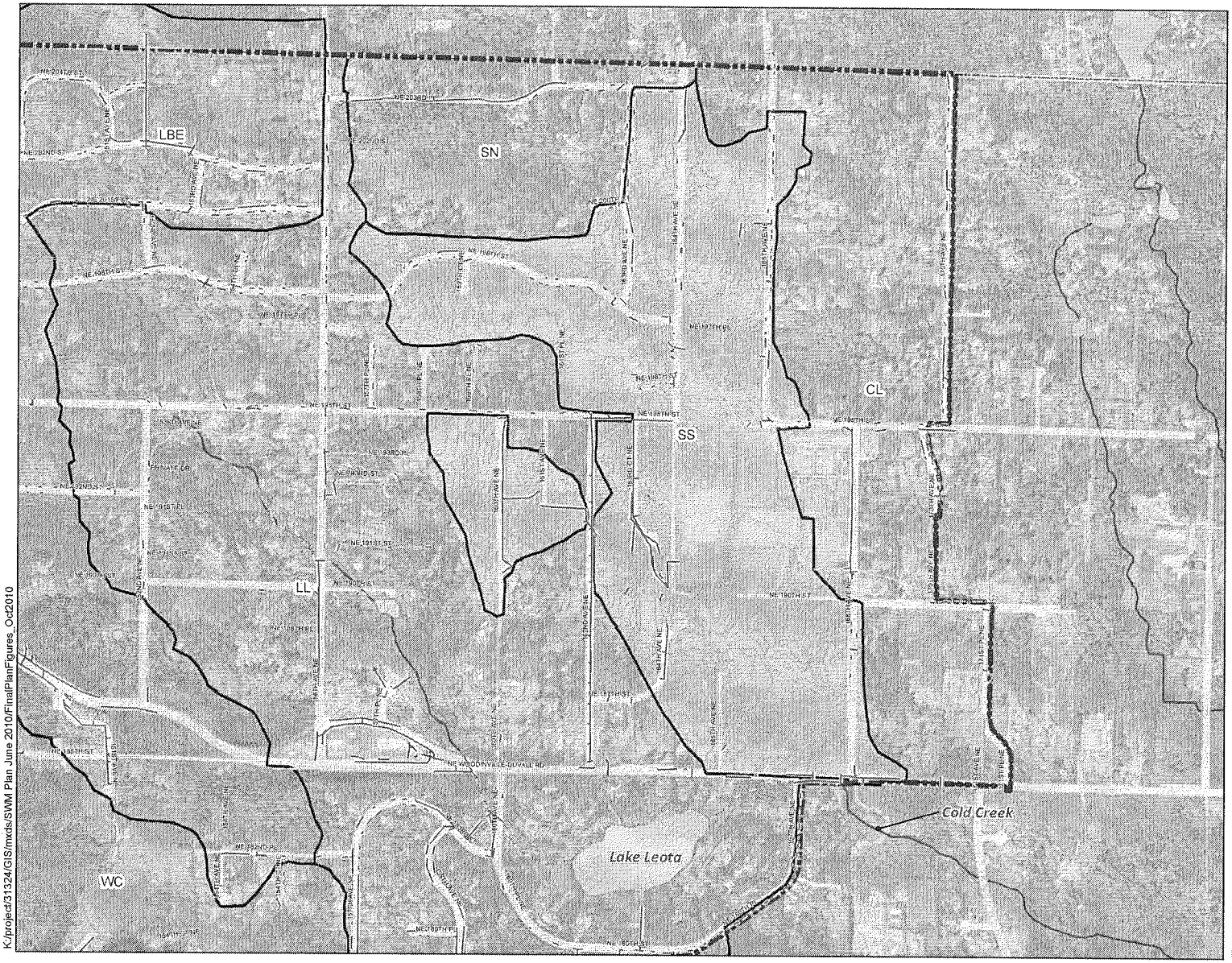
STORMWATER MANAGEMENT PLAN

FIGURE A-1.6

LAKE LEOTA BASIN

CITY OF WOODINVILLE

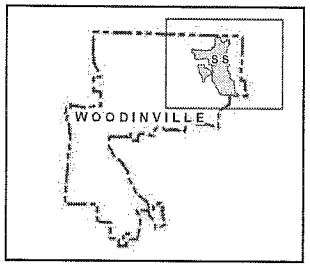
OCTOBER 2010



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

Legend

- Woodinville City Limits
- County Boundary
- School Basin South (SS)
- Waterbody
- Subbasin Boundary
- City of Woodinville Stormwater Pipes Dated: 02/16/10
- Stormwater Open Channel
- Stream
- 5 ft Contour (King Co. LIDAR)



N

0 300 600 1,200 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc. (basin boundaries,storm system mapping), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
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City of Woodinville data received Feb. 16, 2010. Aerial imagery from 2005.

STORMWATER MANAGEMENT PLAN

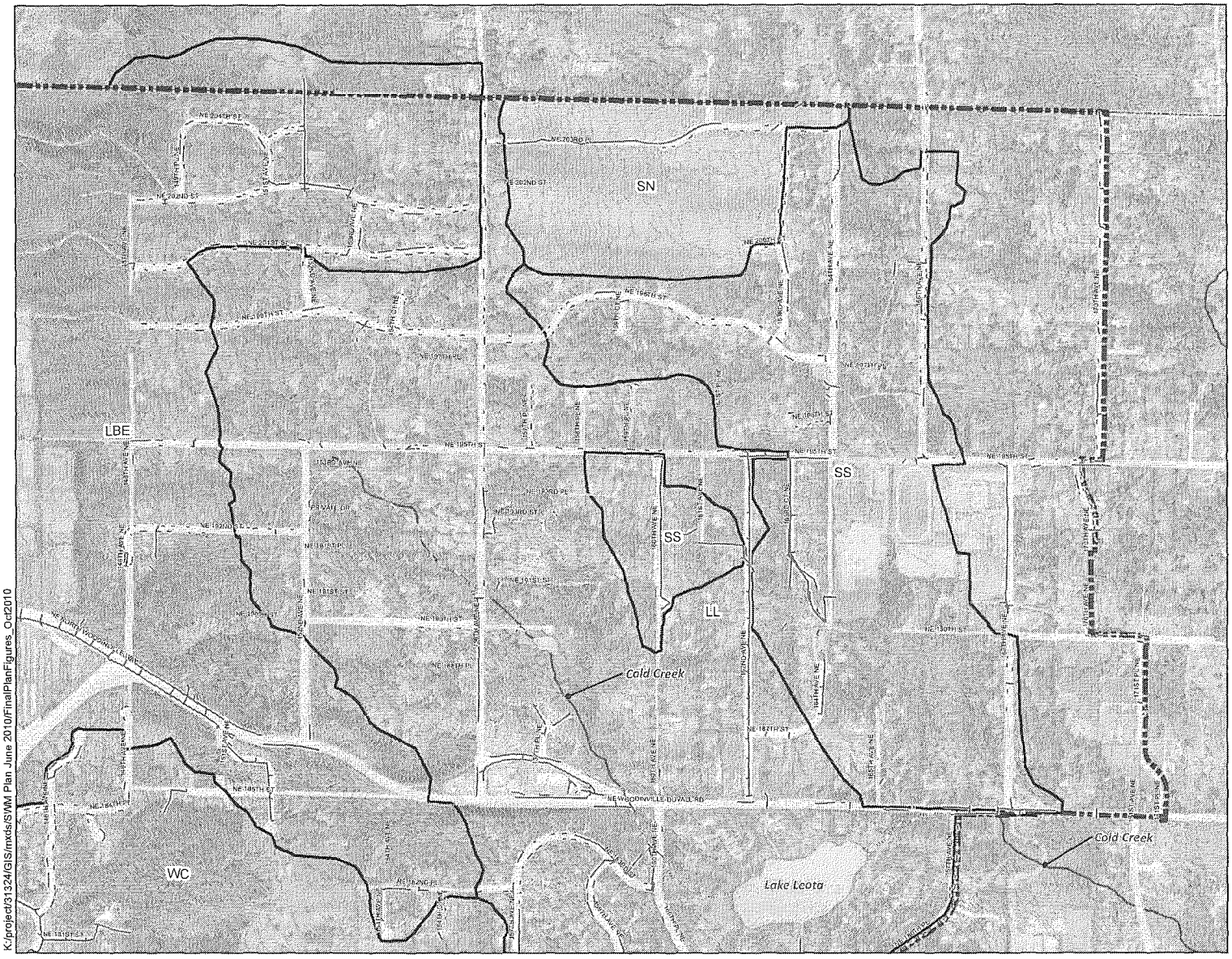
FIGURE A-1.7

SCHOOL BASIN SOUTH

CITY OF WOODINVILLE

otak

OCTOBER 2010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Cold Creek
Cold Creek
Lake Leota
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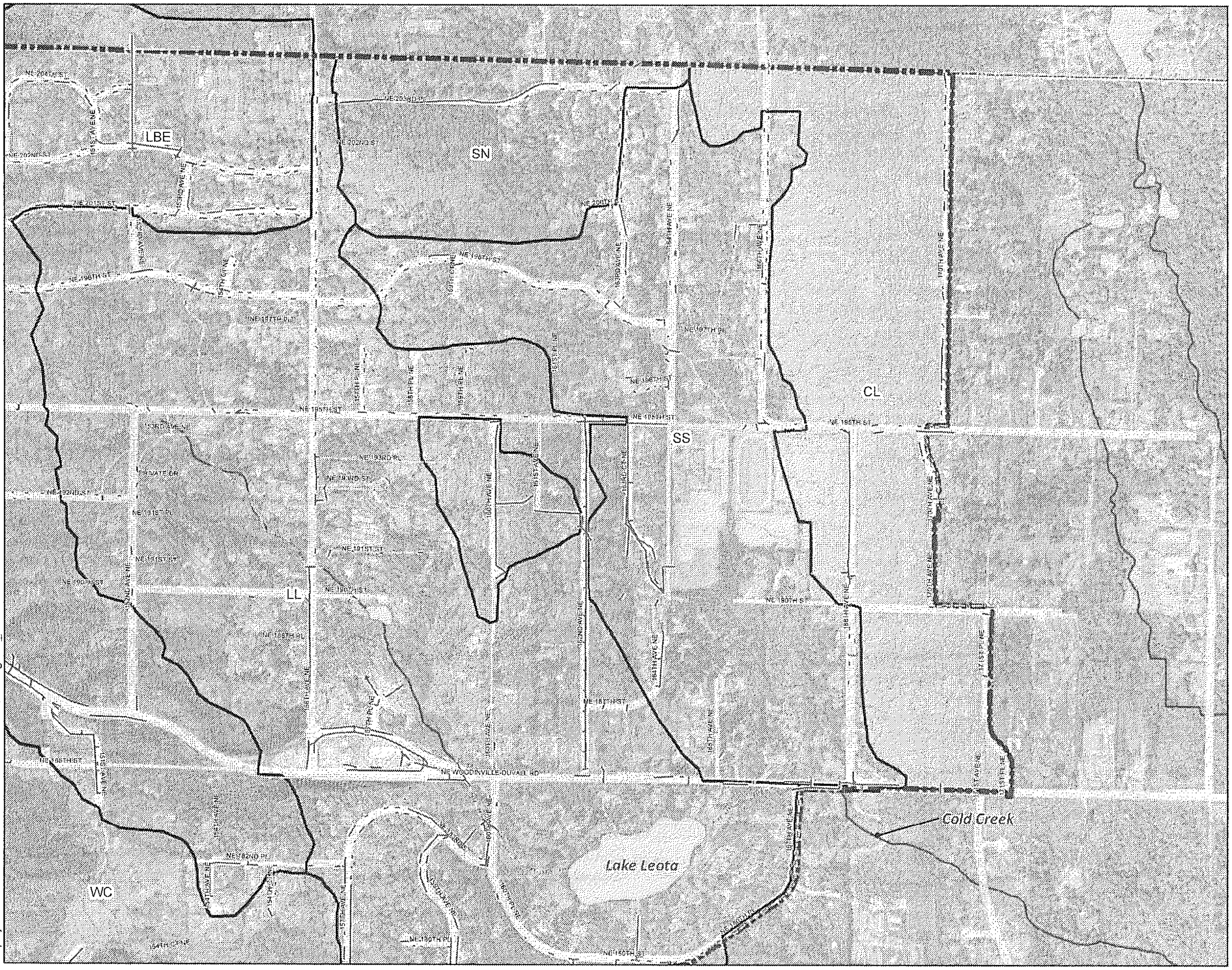


Legend

Woodinville City Limits

County Boundary

Cottage Lake Basin

Waterbody

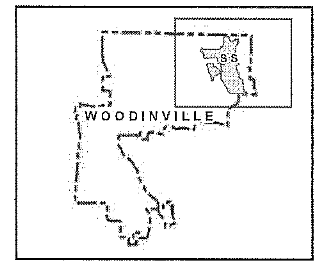
Subbasin Boundary

City of Woodinville Stormwater Pipes Dated: 02/16/10

Stormwater Open Channel

Stream

5 ft Contour (King Co. LIDAR)



N

0 300 600 1,200 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries,storm system mapping), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial Imagery from 2005.

STORMWATER MANAGEMENT PLAN

FIGURE A-1.10

COTTAGE LAKE BASIN

CITY OF WOODINVILLE

OCTOBER 2010

Appendix B

Technical Memorandum

City-wide Hydraulic Analysis

Otak, Inc.

June 9, 2010

Technical Memorandum

10230 NE Points Drive
Suite 400
Kirkland, WA 9803
Phone (425) 822-4446
Fax (425) 827-9577

To:	Tom Hansen, City of Woodinville Clint Moyer, City of Woodinville
From:	Jessica Christofferson, EIT Greg Laird, PE
Copies:	File
Date:	June 9, 2010
Subject:	City-wide Hydraulic Analysis
Project No.:	31324

Introduction

This memo describes the city-wide hydraulic analysis completed as one element of the Stormwater Comprehensive Plan project for the City of Woodinville (City). The purpose of the analysis is to better identify portions of the City's storm drainage conveyances that may not have adequate capacity to accommodate potential development within Woodinville.

The City inventoried approximately 4,700 stormwater pipes as part of a geographic information system (GIS) database. This GIS database of stormwater pipes was used for pipe size, type, and system connectivity. The stormwater database was significantly updated during the time of the city-wide hydraulic analysis. The City will continue to update the GIS database as new development and re-development occurs and additional survey information is acquired.

The city-wide hydraulic analysis focused on the larger pipes located lower in the various drainage basins. This analysis did not include an evaluation of existing culverts or ditches. The capacity of the culverts that convey Little Bear Creek were analyzed in a technical memorandum by Otak, Inc. (Otak) dated July 11, 2008 (see Appendix A).

Hydrologic and hydraulic methodology is described in the following sections. All supporting calculations for this analysis are included in Appendix B.

Hydrology

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 King County 2009 Surface Water Design Manual, 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. 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 the Department of Ecology and Washington State Department of Transportation by MGS Engineering Consultants and Oregon Climate Service in January 2006. Table 1 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 1
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, School, and Daniels Creek Basins. Based on the areas of interest to this city-wide hydraulic analysis, Otak split three of these basins (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 by Otak and City staff. The basin boundaries may change if new information about the underground storm drainage system is acquired.

Curve Number

The major components that determine a curve number are the land use and cover, the underlying soil and its hydrologic condition, and antecedent moisture condition. Composite curve numbers were estimated for each subbasin according to a combination of land cover and hydrologic soil group.

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 (TAZ) 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 (ROW)

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. Figures 1 and 2 present the assigned existing and future land uses.

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

Figure 3 shows the areas considered as new development between 1990 and 1998 and new development after 1998.

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.

Land Cover Conversions

Land uses for the existing conditions were then converted to land cover based on the assumptions presented in Table 2.

Table 2
Land Use Conversions to Land Cover

Land Use	Land Cover							
	Effective Impervious percent	Forest percent	Grass percent	Bare ground percent	1990 Develop-ment	1998 Develop-ment	Total	Notes
Open Space	0%	80%	20%	0%	0%	0%	100%	2
Agriculture	0%	0%	50%	50%	0%	0%	100%	2
SFR Rural	1.0%	49.5%	49.5%	0%	0%	0%	100%	1

Table 2 (cont.) Land Use Conversions to Land Cover								
Land Use	Land Cover							
	Effective Impervious percent	Forest percent	Grass percent	Bare ground percent	1990 Develop-ment	1998 Develop-ment	Total	Notes
SFR Low	3%	30%	67%	0%	0%	0%	100%	2
Park/Recreation	15%	10%	60%	15%	0%	0%	100%	2
SFR Med	18%	0%	82%	0%	0%	0%	100%	1
Public Institution	20%	0%	60%	20%	0%	0%	100%	2
Greenhouse	25%	0%	40%	35%	0%	0%	100%	2
SFR High	41%	0%	59%	0%	0%	0%	100%	1
Multi-family	67%	0%	33%	0%	0%	0%	100%	1
ROW	86%	0%	14%	0%	0%	0%	100%	1
Commercial	86%	0%	14%	0%	0%	0%	100%	1
Industrial	86%	0%	14%	0%	0%	0%	100%	1
1990 Development	0%	0%	0%	0%	100%	0%	100%	3
1998 Development	0%	0%	0%	0%	0%	100%	100%	3

1. Land cover from Snohomish County. 2002. Hydrologic Modeling Protocols, Ver. 1.4.
2. Otak assumed land covers based on aerial photography observations.
3. See Otak Memo dated Nov. 12, 2009 for development later than 1990 and development later than 1998.

Soils

Soils were assigned to the subbasins based on the Natural Resources Conservation Service (NRCS) Soil Survey. This NRCS Soil Survey was downloaded directly from the NRCS web site in GIS format.

Each soil type was assigned a hydrologic soil group. The hydrologic soil group is based on a soil's ability to infiltrate after prolonged wetting. Hydrologic soil group A is the most infiltrative soil and D is the least. Table 3 presents the soils found with the City of Woodinville. Figure 4 shows the aerial extents of each of the soils.

Table 3 Soils Types		
Soil Name	Soil Abbreviation	Hydrologic Soil Group[1]
Alderwood	Ag	C
Arents, Alderwood	Am	B
Arents, Everett	An	B

Table 3 (cont.) Soils Types		
Soil Name	Soil Abbreviation	Hydrologic Soil Group[1]
Briscot	Br	D
Earlmont	Ea	C
Everett	Ev	A
Gravel Pit	PITS	A
Indianola	In	A
Kitsap	Kp	C
McKenna	Mc	D
Norma	No	D
Seattle	Sk	D
Snohomish	Sr	D
Tukwila	Tu	D
Urban	Ur	D

1. Hydrologic soil group based on Department of Ecology 2005 Stormwater Management Manual for Western Washington.

Composite Curve Number Calculation

Curve numbers are based upon the land cover and the soil type. Area-weighted composite curve numbers were calculated for each subbasin based on the curve number assumptions presented in Table 4. Curve numbers for forest, grass, and bare ground are from the NRCS Urban Hydrology for Small Watersheds, TR-55 (1986). Curve numbers for 1990 and 1998 Development are based on Otak's November 12, 2009 analysis.

Table 4 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

Composite curve numbers represent only the pervious portion of the land. Impervious areas were not included in the composite curve numbers. The impervious areas were subtotaled separately by subbasin as typically required as input for the SBUH method. Appendix B shows the composite curve numbers used for each subbasin.

Table 5 presents the composite curve numbers for all 99 subbasins and how the curve numbers and flow rates have changed as development has occurred.

Appendix C provides a detailed description of the methodology that was developed in order to create a cost effective approach to estimate existing detention, match observed field conditions, and utilize the amount and type of data available from the City.

Time of Concentration

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 (fps) for the distance of the measured basin length.

Flow Routing

This analysis uses limited flow routing methods to evaluate runoff at different points in the drainage system. The analysis included combined subbasins, flow diversions, and limited use of level pool routing.

Combined Subbasins

In order to efficiently simulate the City's drainage network, the city-wide hydraulic analysis did not attempt to model the individual branches of the City's storm drainage system and combine these branches within a composite model. Rather, for this city-wide analysis, each point of interest was described by combining all of the subbasins contributing to the drainage at that point of interest, and computing a new composite curve number for the combined subbasin. Additionally, new time concentrations were estimated for each combined subbasin.

Flow Diversions

Two diversion structures within the City's stormwater system along 124th Avenue NE were included in this city-wide analysis. The diverted flows were accounted for by distributing the upstream subbasin areas to each of the downstream combined subbasins proportionally to the hydraulic capacity of the downstream conveyance systems.

Table 5
Change in CN Value and Flow Rates as a Result of Development

Combined Subbasin ID	Contributing Subbasins[1]	Total Area[2] (ac)	Forested Condition[2]			Pre 2002 Development Condition			Existing Condition (Development Post 2002)		
			Composite CN Value (100% Pervious)	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)
JC10+	JC10, JC11, JC12, JC13	118.32	61.3	3.96	6.13	73.6	31.5	41.4	73.6	31.5	41.4
JC11+	JC11, JC 12	39.37	67.9	2.00	3.52	77.4	9.4	12.8	77.4	9.4	12.8
JC11	JC11	14.38	69.8	0.91	1.59	80.8	4.0	5.4	80.8	4.0	5.4
JC12	JC12	24.99	66.8	1.18	2.13	75.2	6.4	8.7	75.2	6.4	8.7
JC13	JC13	73.22	57.5	1.93	3.11	70.6	21.6	27.9	70.6	21.6	27.9
SRW10+	SRW10, SRW11 (15%), SRW12 (15%), SRW13 (5%), SRW14 (5%), SRW15 (5%)	23.08	64.9	0.94	1.53	60.4	4.9	6.2	62.4	4.9	6.3
SRW11de	SRW11 (15%), SRW12 (15%), SRW13 (5%), SRW14 (5%), SRW15 (5%)	3.39	55.6	0.08	0.13	57.8	0.4	0.5	67.2	0.5	0.7
SRW11dw	SRW11 (85%), SRW12 (85%), SRW13 (95%), SRW14 (95%), SRW15 (95%)	40.13	59.1	1.17	1.85	67.8	6.8	9.4	72.4	7.9	10.8
SRW11+	SRW11, SRW12, SRW13 (40%), SRW14 (40%), SRW15 (40%)	24.71	56.2	0.59	0.97	59.4	3.4	4.5	68.0	4.1	5.7
SRW12+	SRW12, SRW13 (40%), SRW14 (40%), SRW15 (40%)	18.78	53.7	0.37	0.64	71.3	4.0	5.4	71.3	4.0	5.4
SRW13de	SRW13 (40%), SRW14 (40%), SRW15 (40%), SRW15 (40%)	17.27	64.4	0.69	1.14	76.6	4.0	5.5	76.6	4.0	5.5
SRW13dw	SRW13 (60%), SRW14 (60%), SRW15 (60%), SRW15 (60%)	25.90	64.4	1.03	1.71	76.6	6.0	8.2	76.6	6.0	8.2
SRW13+	SRW13, SRW14, SRW15	31.37	62.3	1.11	1.77	77.4	7.9	10.7	77.4	7.9	10.7
SRW14+	SRW14, SRW15	23.13	70.0	1.48	2.58	76.2	6.0	8.1	76.2	6.0	8.1
SRW15	SRW15	11.80	70.0	0.78	1.35	74.8	2.7	3.8	74.8	2.7	3.8
SRW20	SRW20	27.12	70.0	1.71	2.97	72.3	7.2	9.5	72.3	7.2	9.5
SRW30+	SRW30, SRW31, SRW32, SRW33	194.22	46.0	1.73	3.62	71.2	26.0	37.7	71.1	25.9	37.7
SRW31+	SRW31, SRW32, SRW33	188.15	45.2	1.49	3.25	71.0	26.1	37.8	71.0	26.0	37.7
SRW32	SRW32	144.00	38.8	0.08	1.03	71.9	18.8	28.0	71.9	18.7	27.9
SRW33	SRW33	28.31	66.8	1.33	2.38	72.3	5.1	7.3	72.3	5.1	7.3
SRW40+	SRW40, SRW41, SRW42, SRW43, SRW44, SRW45, SRW46, SRW47	262.26	63.6	9.92	15.60	68.5	24.3	37.5	68.1	23.7	36.7

Table 5 (cont.)
Change in CN Value and Flow Rates as a Result of Development

Combined Subbasin ID	Contributing Subbasins[1]	Total Area[1] (ac)	Forested Condition[2]			Pre 2002 Development Condition			Existing Condition (Development Post 2002)		
			Composite CN Value (100% Pervious)	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)
SRW41+	SRW41, SRW42, SRW43, SRW44, SRW45, SRW46, SRW47	242.19	63.2	8.98	14.06	68.3	23.3	35.8	67.9	22.7	35.0
SRW42+	SRW42, SRW43, SRW44, SRW45, SRW46, SRW47	89.67	60.8	2.90	4.52	72.4	9.8	15.6	72.4	9.8	15.6
SRW44+	SRW44, SRW45	35.80	70.0	2.30	4.00	71.7	4.4	7.1	71.7	4.4	7.1
SRW45	SRW45	16.10	70.0	1.05	1.82	68.0	1.6	2.7	68.0	1.6	2.7
SRW47	SRW47	12.20	66.4	0.56	1.02	74.6	1.6	2.6	74.6	1.6	2.6
SRW46	SRW46	85.53	62.5	3.05	4.70	68.9	6.0	10.1	67.8	5.5	9.4
SRW51+	SRW51, SRW52, SRW53	82.15	50.8	1.27	2.29	63.6	11.1	15.4	63.6	11.1	15.4
SRW52	SRW52	16.84	38.3	0.00	0.11	50.6	0.8	0.9	50.6	0.8	0.9
SRW53	SRW53	44.79	45.6	0.38	0.81	71.0	6.1	9.2	71.0	6.1	9.2
SRW60	SRW60	188.73	67.8	9.29	15.76	62.3	19.7	28.1	62.3	19.7	28.1
SRW70+	SRW70, SRW71, SRW72, SRW11 (85%), SRW12 (85%), SRW13 (95%), SRW14 (95%), SRW15 (95%)	79.07	59.6	2.38	3.75	70.7	13.7	19.1	73.0	14.9	20.5
SRW71+	SRW71	34.42	65.8	1.48	2.58	75.7	7.8	10.7	75.7	7.8	10.7
SRW72	SRW72	4.51	70.0	0.29	0.51	78.2	1.4	1.9	78.2	1.4	1.9
SRE40	SRE40	11.27	70.0	0.74	1.29	48.1	2.9	3.6	48.1	2.9	3.6
SRE50	SRE50	569.85	36.4	0.00	1.84	75.0	67.1	100.3	74.9	66.5	99.6
SRN20+	SRN20, SRN 10	98.48	62.0	3.42	5.35	59.4	16.0	20.8	59.4	16.0	20.8
SRN20	SRN20	84.09	60.6	2.70	4.21	58.9	10.3	13.7	58.9	10.4	13.7
SRN10	SRN10	14.39	69.7	0.85	1.46	72.9	5.5	6.9	72.9	5.5	6.9
SRN30	SRN30	24.08	32.5	0.00	0.00	75.8	6.3	8.6	75.8	6.3	8.6
WC10+	WC10, WC11, WC12, WC13, WC13.5, WC14, WC15, WC16, WC17, WC18, WC19.1, WC19.2	648.75	44.7	4.57	10.48	57.6	57.6	75.8	57.6	57.6	75.7
WC11	WC11	20.33	30.4	0.00	0.00	55.4	3.9	4.7	55.4	3.9	4.7

Table 5 (cont.)
Change in CN Value and Flow Rates as a Result of Development

Combined Subbasin ID	Contributing Subbasins[1]	Total Area[2] (ac)	Forested Condition[2]			Pre 2002 Development Condition			Existing Condition (Development Post 2002)		
			Composite CN Value (100% Pervious)	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)
WC12+	WC12, WC13, WC13.5, WC14	305.65	50.1	4.34	7.98	60.5	16.6	26.0	60.4	16.5	25.8
WC13	WC13	172.00	55.0	3.80	6.33	64.2	11.0	18.6	64.1	11.0	18.5
WC14+	WC14, WC13.5	89.16	50.5	1.34	2.43	59.1	4.4	7.1	58.8	4.4	7.0
WC13.5	WC13.5	57.93	58.6	1.64	2.61	66.7	5.6	8.8	66.2	5.4	8.6
WC15++	WC15, WC16, WC17, WC18, WC19.1, WC19.2	256.10	39.6	0.34	2.13	52.8	33.8	41.3	52.9	33.8	41.3
WC15+	WC15, WC16, WC17	156.40	41.7	0.59	1.81	54.7	15.6	19.2	54.7	15.6	19.2
WC15	WC15	103.64	44.5	0.74	1.67	56.0	9.8	12.4	56.0	9.8	12.4
WC16+	WC16, WC17	52.76	36.2	0.00	0.18	52.0	6.3	7.7	52.0	6.3	7.7
WC16	WC16	31.93	33.6	0.00	0.00	50.3	4.9	6.0	50.3	4.9	6.0
WC18+	WC18, WC19.1, WC19.2	99.70	36.3	0.00	0.32	49.0	17.1	20.9	49.2	17.1	20.9
WC19.1+	WC19.1, WC19.2	62.97	36.0	0.00	0.19	47.8	5.7	6.9	48.0	5.7	6.9
LBE05	LBE05	25.17	62.6	0.90	1.40	71.7	6.5	8.4	71.7	6.5	8.4
LBE11+	LBE11, LBE12, LBE13, LBE13.5, LBE14, LBE15	135.21	61.4	4.54	7.06	72.2	47.0	59.4	72.2	47.0	59.4
LBE15+	LBE15, LBE13, LBE13.5, LBE14, LBE12	113.37	63.0	4.18	6.74	72.7	38.2	48.5	72.7	38.2	48.5
LBE13+	LBE13, LBE13.5, LBE14, LBE12	100.26	62.1	3.51	5.55	72.4	32.6	41.6	72.4	32.6	41.6
LBE13.5	LBE13.5	8.56	70.0	0.53	0.92	72.0	1.1	1.7	72.0	1.1	1.7
LBE14+	LBE14, LBE12	59.33	61.3	1.98	3.08	72.5	18.1	23.4	72.5	18.1	23.4
LBE14	LBE14	34.57	66.5	1.60	2.86	73.6	8.8	11.9	73.6	8.8	11.9
LBE15	LBE15	13.10	70.0	0.84	1.45	79.0	5.8	7.2	79.0	5.8	7.2
LBE10+	LBE10, LBE16, LBE17, LBE18, LBE19, LBE20	244.23	67.6	11.43	18.89	71.4	40.6	55.3	71.7	40.9	55.7
LBE16	LBE16	8.48	70.0	0.54	0.95	78.1	3.7	4.6	78.1	3.7	4.6

Table 5 (cont.)
Change in CN Value and Flow Rates as a Result of Development

Combined Subbasin ID	Contributing Subbasins[1]	Total Area[2] (ac)	Forested Condition[2]			Pre 2002 Development Condition			Existing Condition (Development Post 2002)		
			Composite CN Value (100% Pervious)	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)
SRW41+	SRW41, SRW42, SRW43, SRW44, SRW45, SRW46, SRW47	242.19	63.2	8.98	14.06	68.3	23.3	35.8	67.9	22.7	35.0
SRW42+	SRW42, SRW43, SRW44, SRW45, SRW46, SRW47	89.67	60.8	2.90	4.52	72.4	9.8	15.6	72.4	9.8	15.6
SRW44+	SRW44, SRW45	35.80	70.0	2.30	4.00	71.7	4.4	7.1	71.7	4.4	7.1
SRW45	SRW45	16.10	70.0	1.05	1.82	68.0	1.6	2.7	68.0	1.6	2.7
SRW47	SRW47	12.20	66.4	0.56	1.02	74.6	1.6	2.6	74.6	1.6	2.6
SRW46	SRW46	85.53	62.5	3.05	4.70	68.9	6.0	10.1	67.8	5.5	9.4
SRW51+	SRW51, SRW52, SRW53	82.15	50.8	1.27	2.29	63.6	11.1	15.4	63.6	11.1	15.4
SRW52	SRW52	16.84	38.3	0.00	0.11	50.6	0.8	0.9	50.6	0.8	0.9
SRW53	SRW53	44.79	45.6	0.38	0.81	71.0	6.1	9.2	71.0	6.1	9.2
SRW60	SRW60	188.73	67.8	9.29	15.76	62.3	19.7	28.1	62.3	19.7	28.1
SRW70+	SRW70, SRW71, SRW72, SRW11 (85%), SRW12 (85%), SRW13 (95%), SRW14 (95%), SRW15 (95%)	79.07	59.6	2.38	3.75	70.7	13.7	19.1	73.0	14.9	20.5
SRW71+	SRW71	34.42	65.8	1.48	2.58	75.7	7.8	10.7	75.7	7.8	10.7
SRW72	SRW72	4.51	70.0	0.29	0.51	78.2	1.4	1.9	78.2	1.4	1.9
SRE40	SRE40	11.27	70.0	0.74	1.29	48.1	2.9	3.6	48.1	2.9	3.6
SRE50	SRE50	569.85	36.4	0.00	1.84	75.0	67.1	100.3	74.9	66.5	99.6
SRN20+	SRN20, SRN 10	98.48	62.0	3.42	5.35	59.4	16.0	20.8	59.4	16.0	20.8
SRN20	SRN20	84.09	60.6	2.70	4.21	58.9	10.3	13.7	58.9	10.4	13.7
SRN10	SRN10	14.39	69.7	0.85	1.46	72.9	5.5	6.9	72.9	5.5	6.9
SRN30	SRN30	24.08	32.5	0.00	0.00	75.8	6.3	8.6	75.8	6.3	8.6
WC10+	WC10, WC11, WC12, WC13, WC13.5, WC14, WC15, WC16, WC17, WC18, WC19.1, WC19.2	648.75	44.7	4.57	10.48	57.6	57.6	75.8	57.6	57.6	75.7
WC11	WC11	20.33	30.4	0.00	0.00	55.4	3.9	4.7	55.4	3.9	4.7

Table 5 (cont.)
Change in CN Value and Flow Rates as a Result of Development

Combined Subbasin ID	Contributing Subbasins[1]	Total Area[2] (ac)	Forested Condition[2]			Pre 2002 Development Condition			Existing Condition (Development Post 2002)		
			Composite CN Value (100% Pervious)	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)
WC12+	WC12, WC13, WC13.5, WC14	305.65	50.1	4.34	7.98	60.5	16.6	26.0	60.4	16.5	25.8
WC13	WC13	172.00	55.0	3.80	6.33	64.2	11.0	18.6	64.1	11.0	18.5
WC14+	WC14, WC13.5	89.16	50.5	1.34	2.43	59.1	4.4	7.1	58.8	4.4	7.0
WC13.5	WC13.5	57.93	58.6	1.64	2.61	66.7	5.6	8.8	66.2	5.4	8.6
WC15++	WC15, WC16, WC17, WC18, WC19.1, WC19.2	256.10	39.6	0.34	2.13	52.8	33.8	41.3	52.9	33.8	41.3
WC15+	WC15, WC16, WC17	156.40	41.7	0.59	1.81	54.7	15.6	19.2	54.7	15.6	19.2
WC15	WC15	103.64	44.5	0.74	1.67	56.0	9.8	12.4	56.0	9.8	12.4
WC16+	WC16, WC17	52.76	36.2	0.00	0.18	52.0	6.3	7.7	52.0	6.3	7.7
WC16	WC16	31.93	33.6	0.00	0.00	50.3	4.9	6.0	50.3	4.9	6.0
WC18+	WC18, WC19.1, WC19.2	99.70	36.3	0.00	0.32	49.0	17.1	20.9	49.2	17.1	20.9
WC19.1+	WC19.1, WC19.2	62.97	36.0	0.00	0.19	47.8	5.7	6.9	48.0	5.7	6.9
LBE05	LBE05	25.17	62.6	0.90	1.40	71.7	6.5	8.4	71.7	6.5	8.4
LBE11+	LBE11, LBE12, LBE13, LBE13.5, LBE14, LBE15	135.21	61.4	4.54	7.06	72.2	47.0	59.4	72.2	47.0	59.4
LBE15+	LBE15, LBE13, LBE13.5, LBE14, LBE12	113.37	63.0	4.18	6.74	72.7	38.2	48.5	72.7	38.2	48.5
LBE13+	LBE13, LBE13.5, LBE14, LBE12	100.26	62.1	3.51	5.55	72.4	32.6	41.6	72.4	32.6	41.6
LBE13.5	LBE13.5	8.56	70.0	0.53	0.92	72.0	1.1	1.7	72.0	1.1	1.7
LBE14+	LBE14, LBE12	59.33	61.3	1.98	3.08	72.5	18.1	23.4	72.5	18.1	23.4
LBE14	LBE14	34.57	66.5	1.60	2.86	73.6	8.8	11.9	73.6	8.8	11.9
LBE15	LBE15	13.10	70.0	0.84	1.45	79.0	5.8	7.2	79.0	5.8	7.2
LBE10+	LBE10, LBE16, LBE17, LBE18, LBE19, LBE20	244.23	67.6	11.43	18.89	71.4	40.6	55.3	71.7	40.9	55.7
LBE16	LBE16	8.48	70.0	0.54	0.95	78.1	3.7	4.6	78.1	3.7	4.6

Table 5 (cont.)
Change in CN Value and Flow Rates as a Result of Development

Combined Subbasin ID	Contributing Subbasins[1]	Total Area[2] (ac)	Forested Condition[2]			Pre 2002 Development Condition			Existing Condition (Development Post 2002)		
			Composite CN Value (100% Pervious)	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)
LBE17+	LBE17, LBE18, LBE19, LBE20	191.36	66.7	8.54	13.91	71.3	29.1	40.4	71.7	29.5	40.9
LBE17++	LBE17, LBE18	86.08	70.0	4.85	7.93	74.2	17.9	23.7	74.2	17.9	23.7
LBE18	LBE18	32.52	70.0	2.04	3.54	73.8	7.0	9.7	73.8	7.0	9.7
LBE30	LBE30	15.51	70.5	1.04	1.79	77.9	6.7	8.3	77.9	6.7	8.3
LBE40+	LBE40, LBE41, LBE42, LBE43, LBE44, LBE45, LBE47, LBE48	115.19	53.7	2.29	3.91	56.5	24.9	30.7	60.4	25.1	32.0
LBE41+	LBE41, LBE42, LBE43, LBE44, LBE45	75.13	48.4	0.91	1.75	55.2	13.1	16.1	58.7	13.1	16.9
LBE42+	LBE42, LBE44	47.30	52.4	0.85	1.48	56.6	4.4	5.6	59.1	4.4	6.2
LBE44	LBE44	8.47	30.8	0.00	0.00	47.3	1.7	2.0	47.3	1.7	2.0
LBE45+	LBE45, LBE43	23.34	43.7	0.15	0.35	57.5	7.3	9.0	57.6	7.3	9.0
LBE43	LBE43	8.57	39.0	0.01	0.06	52.2	2.3	2.8	52.2	2.3	2.8
LBE47	LBE47	25.05	63.2	0.93	1.51	57.8	8.6	10.5	66.8	8.8	11.0
LBE48	LBE48	10.11	70.0	0.64	1.12	75.1	3.9	5.0	75.1	3.9	5.0
LBW15+	LBW15, LBW16	29.90	54.0	0.61	1.04	57.1	2.4	3.2	65.1	3.1	4.9
LBW15	LBW15	15.60	67.8	0.81	1.46	75.1	3.7	5.1	75.7	3.8	5.2
LBW16	LBW16	14.30	39.0	0.01	0.11	42.9	0.2	0.2	56.7	0.4	0.6
LBW21	LBW21	7.30	30.0	0.00	0.00	34.5	0.0	0.0	43.4	0.0	0.1
LBW30	LBW30	36.42	43.5	0.22	0.53	50.7	2.1	2.5	59.4	2.1	3.3
LBW40+	LBW40, LBW45	134.42	55.4	3.06	5.06	66.5	15.2	23.0	64.9	14.0	21.3
LBW45	LBW45	69.34	70.0	4.21	7.23	73.9	10.7	15.7	70.9	9.0	13.6
LBW50+	LBW50, LBW55	27.41	49.4	0.37	0.69	60.0	2.7	3.9	60.0	2.7	3.9
LBW55	LBW55	14.39	56.7	0.36	0.58	69.1	2.8	3.9	69.1	2.8	3.9

Table 5 (cont.)
Change in CN Value and Flow Rates as a Result of Development

Combined Subbasin ID	Contributing Subbasins[1]	Total Area[2] (ac)	Forested Condition[2]			Pre 2002 Development Condition			Existing Condition (Development Post 2002)		
			Composite CN Value (100% Pervious)	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)	Pervious CN Value[3]	25-year Flow Rate (cfs)	100-year Flow Rate (cfs)
LBW60+	LBW60, LBW65	135.69	58.9	3.91	6.20	67.7	23.3	31.8	67.6	23.2	31.7
LBW65	LBW65	83.03	68.8	4.67	8.27	77.7	24.0	31.7	77.3	23.8	31.5
LBW70	LBW70	36.63	33.4	0.00	0.00	54.9	5.4	6.7	54.9	5.4	6.7
SN20	SN20	62.49	70.0	3.98	6.91	74.6	8.8	13.7	74.6	8.8	13.7
SS10+	SS10, SS20	220.69	70.4	13.27	22.24	75.9	31.5	46.5	75.5	30.8	45.6
LL10+	LL10, LL20, LL30, LL40, LL50, LL60, LL70, LL80	474.90	65.5	19.82	31.43	72.2	50.3	75.5	72.2	50.3	75.4
LL20	LL20	57.54	60.0	1.78	2.79	67.3	5.2	8.7	67.3	5.2	8.7
LL30+	LL30, LL40, LL50, LL60, LL70	300.78	63.9	11.57	18.35	71.2	34.3	51.8	71.1	34.3	51.7
LL40+	LL40, LL50, LL60, LL70	236.69	67.3	11.20	18.93	74.1	32.1	47.5	74.1	32.0	47.4
LL50	LL50	13.35	51.6	0.22	0.40	68.9	4.7	6.0	69.0	4.7	6.0
LL60	LL60	140.79	68.5	7.63	13.50	74.4	21.2	31.9	74.2	20.9	31.6
LL70	LL70	35.24	70.0	2.14	3.69	75.9	6.3	9.0	75.9	6.3	9.0
LL80	LL80	53.45	70.0	3.33	5.77	74.4	7.7	11.7	74.4	7.7	11.7

1. Percent indicating only portion of basin in case of diversion.
2. Assume that the basin boundaries are the same in all conditions and are delineated based on existing information.
3. Impervious CN Values are assumed to be 98 for HGS A, B, C, D and 100 for water cover.

Level Pool Routing

Level pool routing was applied to three areas that had significant storage areas that provide flow attenuation within the City's drainage system. These three areas are Lake Leota, a wetland/pond in subbasin LBW50, and a backwater condition upstream of subbasin LBE11. Level pool routing provides more realistic peak discharge results to the downstream pipes in these cases. Storage volumes were estimated using measurements in GIS. Discharge was approximated by the capacity of the outlet structure or natural channel.

Hydraulics

The stormwater pipe GIS database is a collection of several sources of data including: survey grade mapping by Otak, global positioning system (GPS) mapping by the City, visual inspections, and other sources. For most of the stormwater pipes, elevations and pipe depths were not available. Because of the lack of pipe depth and elevation data, a simplified hydraulic analysis was completed. The capacity of each pipe was analyzed using the methodology as presented in the Federal Highway Administration's (FHWA) HDS-5 (2005) publication. Assumptions include:

- Pipe length was set at 300 feet because accurate pipe lengths were unknown.
- Headwater depth allowed to reach three feet above the pipe crown (assumes three feet of cover).
- Tailwater set equal to the mid-point of the outlet of the pipe.
- The slope was set at 2% for pipes 24 inches and less, 1% for pipes between 24 and 48 inches, and 0.5% for pipes 48 inches and greater. Typically, these values forced a solution to inlet control.

The hydraulic capacities of pipes under these hydraulic assumptions were estimated and presented in Table 6.

Table 6
Typical Pipe Capacities

Pipe Size (in)	Capacity for smooth pipe (cfs)	Capacity for corrugated pipe (cfs)
12	5.8	3.3
15	10.2	5.9
18	16.2	9.5
24	30.2	20.3
30	47.3	30.0
36	70.9	48.0
42	98.5	71.7

Table 6 (cont.) Typical Pipe Capacities		
Pipe Size (in)	Capacity for smooth pipe (cfs)	Capacity for corrugated pipe (cfs)
48	128.5	89.3
54	169.0	120.7
60	212.5	158.3
72	316.7	251.7
84	445.3	371.1

Results

The city-wide hydraulic analysis compared the estimated pipe capacity and the calculated peak discharge for approximately 300 pipe locations within the City's drainage system. The analysis looks at both the 25-year and 100-year, 24-hour storm events.

The city-wide hydraulic analysis shows that approximately 25% of the analyzed pipes do not have sufficient capacity for the 24-hour, 25-year rainfall event. Approximately 27% of the analyzed pipes do not have sufficient capacity for the 24-hour, 25-year rainfall event and 37% in the 24-hour, 100-year rainfall event. The results of this analysis are presented in Appendix B and Figures 5 through 11. The discharges and capacities of the culverts along Little Bear Creek (presented in the technical memorandum by Otak dated July 11, 2008) have also been included in both the tabular and graphical results.

The areas of insufficient capacity are located throughout the City. However, some of the larger problem areas are in the Little Bear Creek culvert crossings, Woodin Creek basin, and upstream of Lake Leota.

While several of the capacity problems are associated with drainage complaints received from the public or City staff, the majority of the undersized pipes do not correlate to reported problem areas. Probable explanations may include:

- The design storm has a short duration and high intensity rainfall, so the pipe may be undersized for less than an hour during a 25-year event. This level of overflow may not be noticed by the public.
- The overflow may cause minor standing water that does not impede the traveled roadways or impact private property.
- Overflow routes may allow flood waters to spread out or flow harmlessly downstream, so they do not cause damage or other problems.

Recommendations

The results of the city-wide hydraulic analysis identify portions of the City's storm drainage pipes that appear to have inadequate conveyance capacity. Because the city-wide hydraulic analysis is an estimation of the conveyance capacity, we caution anyone from interpreting the results without appreciating the assumptions and methods used in the analysis.

- Do not include all undersized pipes on the CIP list. Be selective by choosing systems that:
  - Coincide with drainage complaints/City maintenance concerns.
  - Have a higher potential for damage when overtopping occurs.
  - Use rating/ranking system.
  - Current method is to list pipes that are >150% over capacity.
- When new developments connect to storm pipes that are already shown to be under capacity, require a downstream analysis to include refined analysis, such as survey of system.
- Continue to update City GIS database.
- For streets that will be reconstructed, upgrade culverts when shown as undersized.

These results are based on the GIS information available at the time of the analysis. Pipes showing inadequate conveyance capacity in this analysis should be evaluated using more detailed pipe information, such as pipe length and slope, invert elevations, depth of cover, backwater influences, and the interconnectivity of the surrounding drainage systems. In most cases, a detailed pipe network model should be developed as part of the engineering analysis associated with a capital project or system upgrade.

References

Department of Ecology (2001). Stormwater Management Manual for Western Washington.

Federal Highway Administration (2005). Hydraulic Design of Highway Culverts (HDS-5).

MGS (2006). Regional Precipitation Frequency Analysis and Spatial Mapping for Precipitation for 24-hour duration for Washington.

NRCS (1986). Urban Hydrology for Small Watersheds.TR-55.

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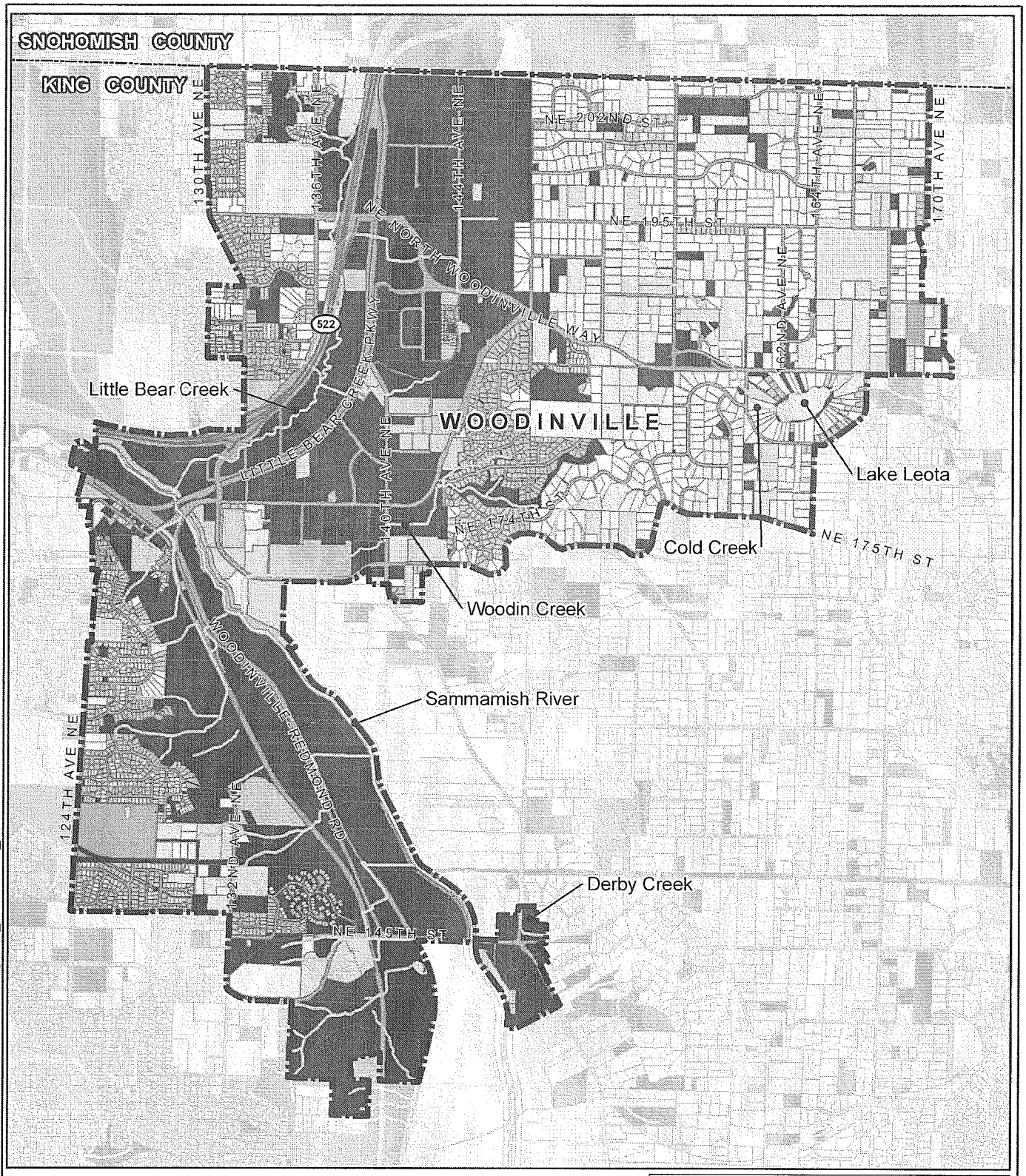
Snohomish County (2002). Volume 1: Hydrologic Modeling Protocols Version 1.4.

Figures



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LEGEND

N

- Streams
- Lake
- City Limits
- Parcel Boundary
- County Boundary

LAND USE

- Agriculture
- Commercial
- Greenhouse
- Industrial
- Multi Family
- Open Space
- Park/Recreation
- Public Institution
- ROW
- Single Family Residence (SFR) High
- SFR Low
- SFR Med
- SFR Rural

0 0.25 0.5 Miles

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and from Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

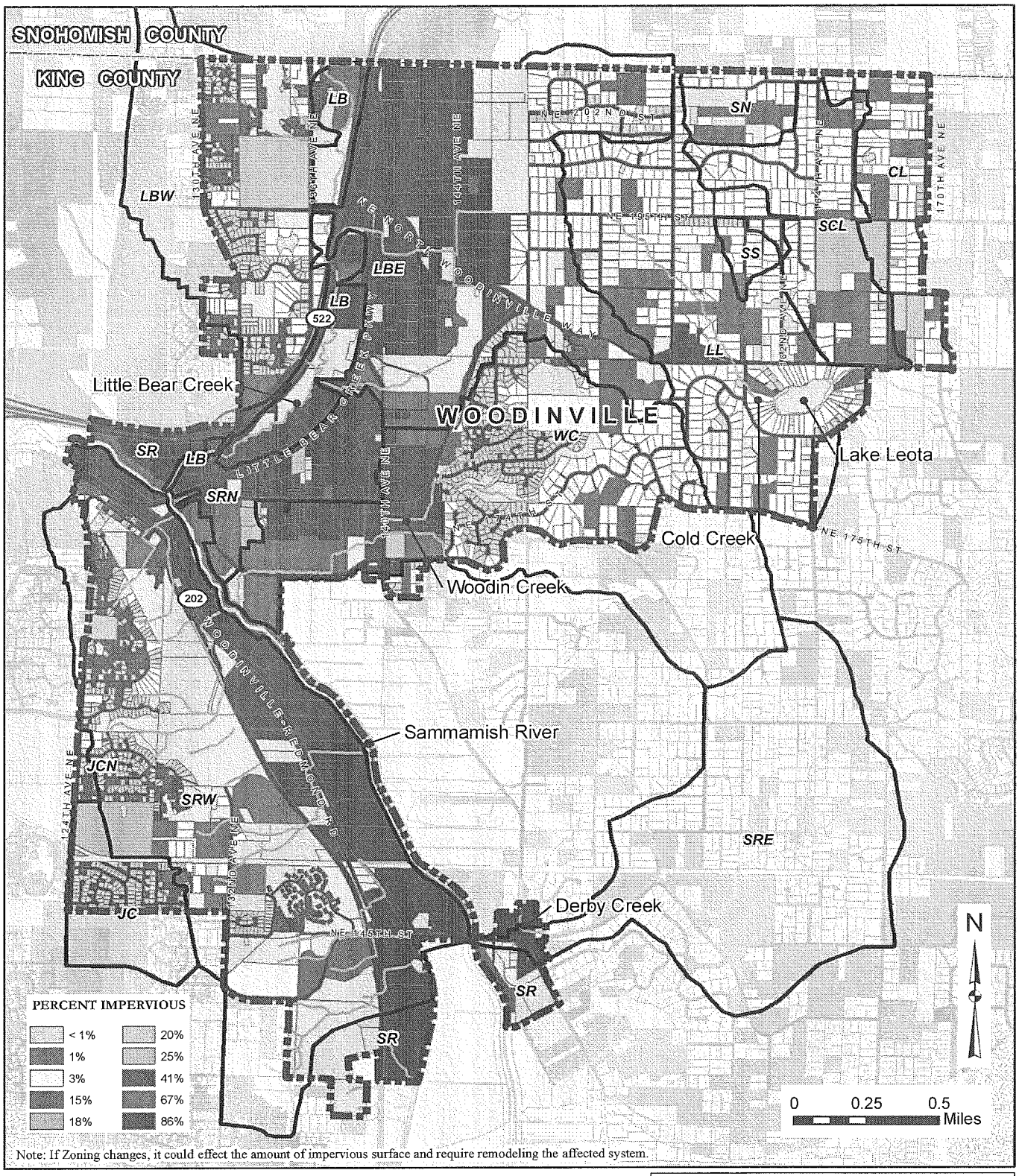
FIGURE 1

EXISTING IMPERVIOUS SURFACE LAND DESIGNATION

CITY OF WOODINVILLE

otak

MARCH 2010



Note: If Zoning changes, it could effect the amount of impervious surface and require remodeling the affected system.

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LEGEND

- City Limits
- County Boundary
- SR Subbasin Boundary
- Parcel Boundary
- Lake
- Streams

Basin Name and Abbreviation

Cottage Lake (CL)	School North (SN)
Juanita Creek (JC)	School South (SS)
Juanita Creek (JC)	Sammamish River (SR)
Little Bear (LB)	Sammamish River East (SRE)
Little Bear East (LBE)	Sammamish River North (SRN)
Little Bear West (LBW)	Sammamish River West (SRW)
Lake Leota (LL)	Woodin Creek (WC)

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries, future land use impervious area), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies).
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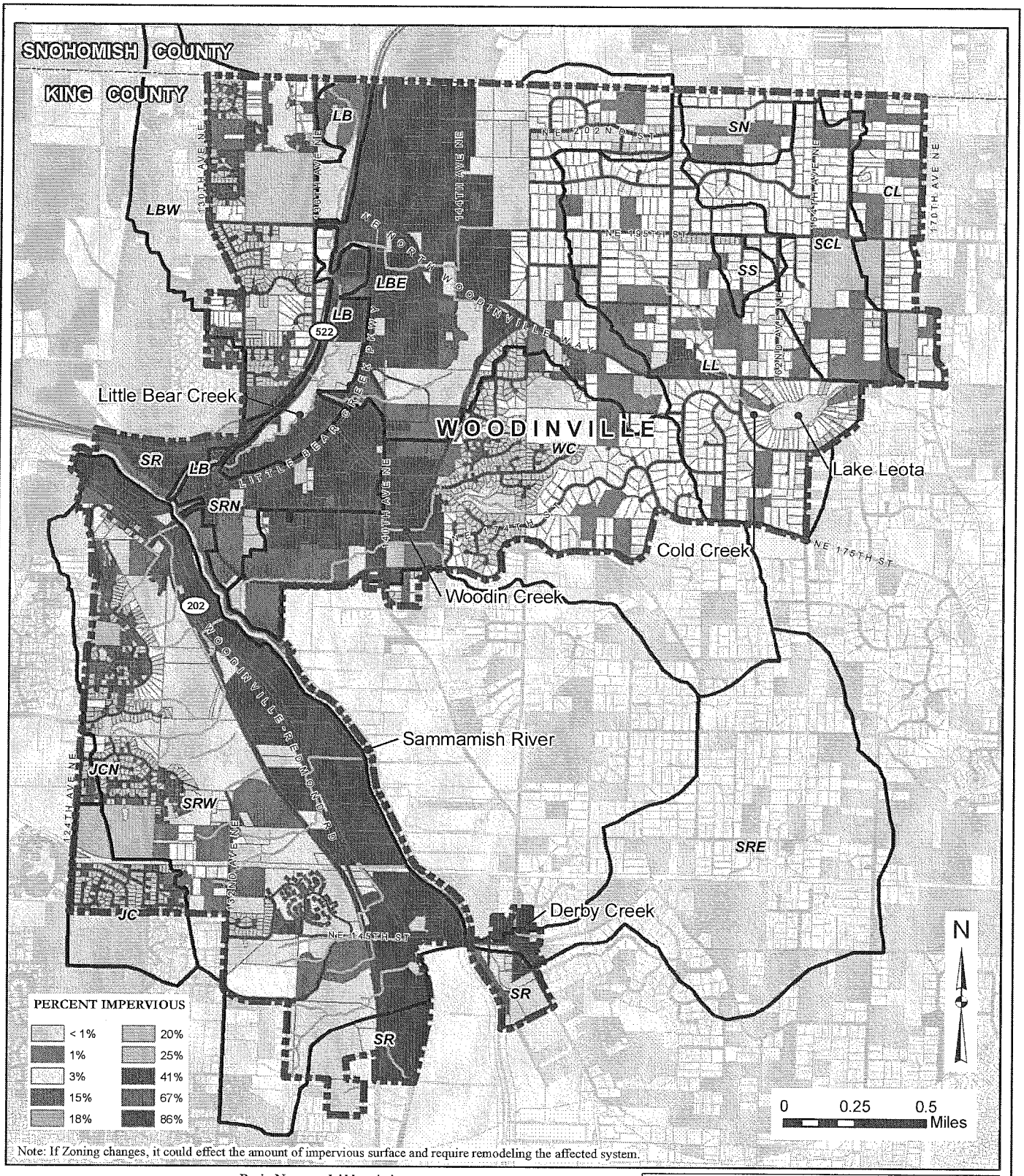
STORMWATER MANAGEMENT PLAN

FIGURE 2

FUTURE IMPERVIOUS PERCENT AREA

CITY OF WOODINVILLE

OCTOBER 2010



Note: If Zoning changes, it could effect the amount of impervious surface and require remodeling the affected system.

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LEGEND

- City Limits
- County Boundary
- SR Subbasin Boundary
- Parcel Boundary
- Lake
- Streams

Basin Name and Abbreviation

Cottage Lake (CL)	School North (SN)
Juanita Creek (JC)	School South (SS)
Juanita Creek (JC)	Sammamish River (SR)
Little Bear (LB)	Sammamish River East (SRE)
Little Bear East (LBE)	Sammamish River North (SRN)
Little Bear West (LBW)	Sammamish River West (SRW)
Lake Leota (LL)	Woodin Creek (WC)

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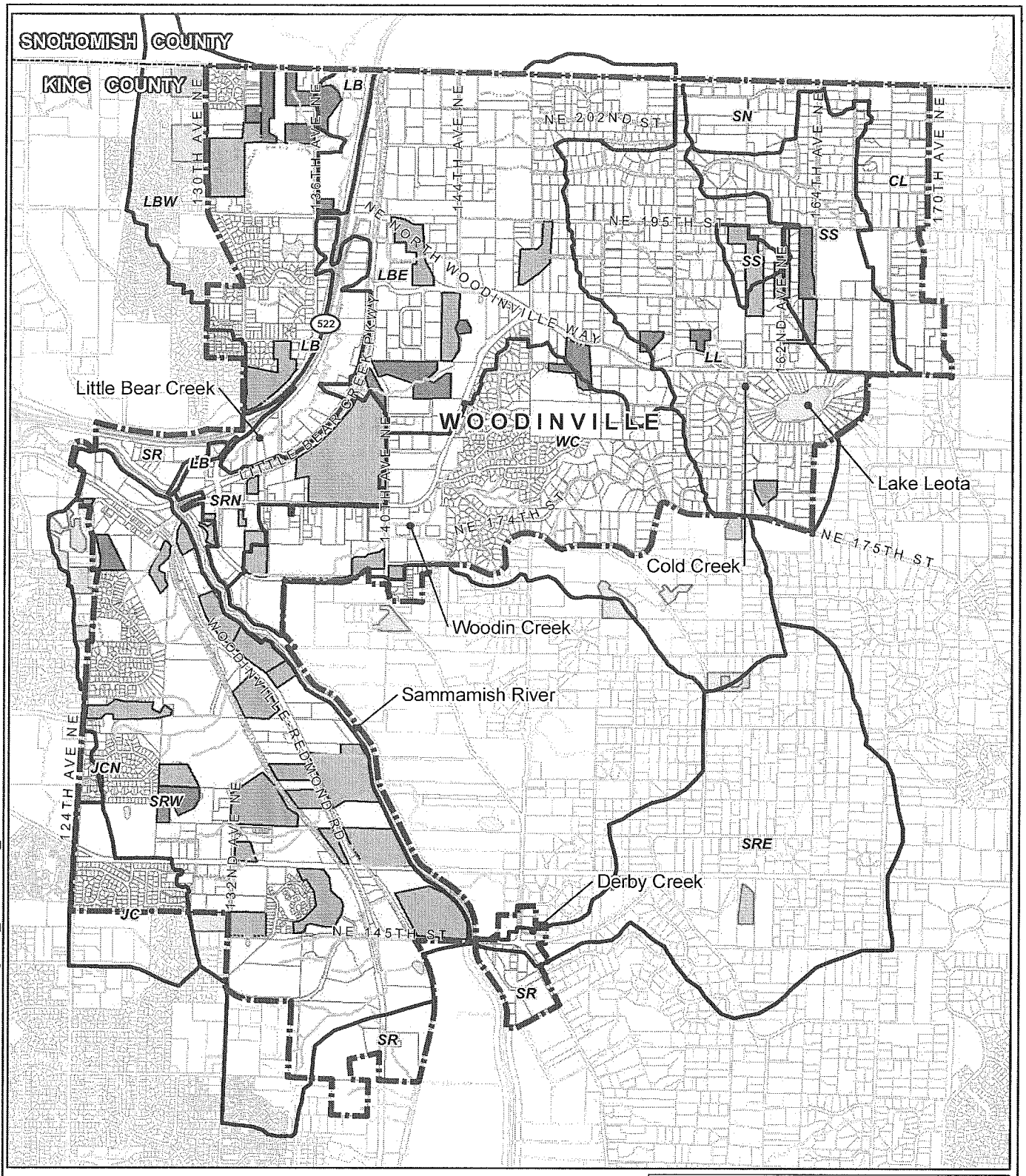
STORMWATER MANAGEMENT PLAN

FIGURE 2

FUTURE IMPERVIOUS SURFACE LAND DESIGNATION

CITY OF WOODINVILLE

OCTOBER 2010



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N

LEGEND

- City Limits
- County Boundary
- SR Subbasin Boundary
- Lake
- Streams

New Development

- New Development Between 1990 - 2002
- New Development After 2002
- Parcel Boundary

0 0.25 0.5 Miles

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and from Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

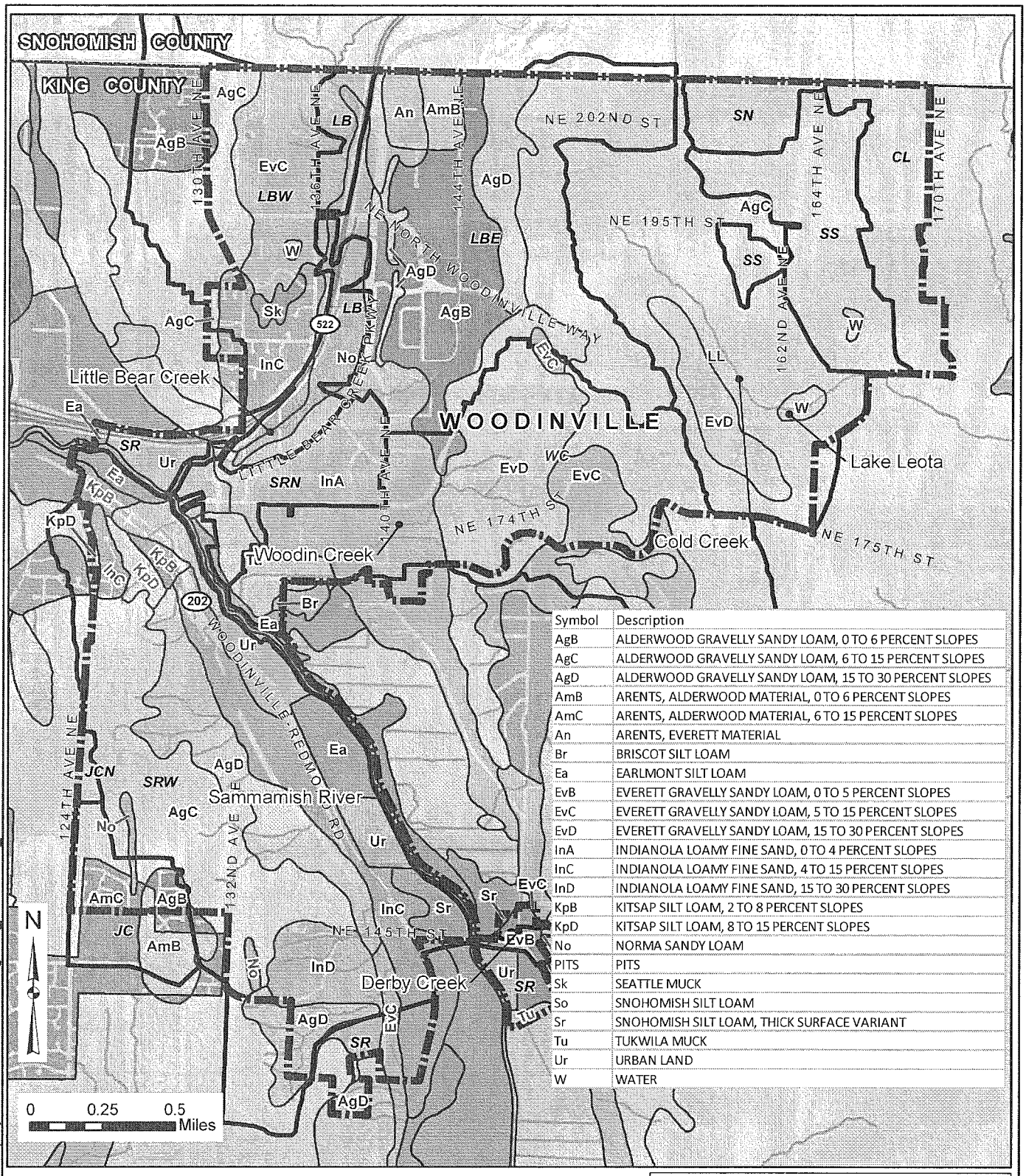
FIGURE 3

NEW DEVELOPMENT AFTER 1990

CITY OF WOODINVILLE

otak

OCTOBER 2010



Symbol	Description
AgB	ALDERWOOD GRAVELLY SANDY LOAM, 0 TO 6 PERCENT SLOPES
AgC	ALDERWOOD GRAVELLY SANDY LOAM, 6 TO 15 PERCENT SLOPES
AgD	ALDERWOOD GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES
AmB	ARENTS, ALDERWOOD MATERIAL, 0 TO 6 PERCENT SLOPES
AmC	ARENTS, ALDERWOOD MATERIAL, 6 TO 15 PERCENT SLOPES
An	ARENTS, EVERETT MATERIAL
Br	BRISCOT SILT LOAM
Ea	EARLMONT SILT LOAM
EvB	EVERETT GRAVELLY SANDY LOAM, 0 TO 5 PERCENT SLOPES
EvC	EVERETT GRAVELLY SANDY LOAM, 5 TO 15 PERCENT SLOPES
EvD	EVERETT GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES
InA	INDIANOLA LOAMY FINE SAND, 0 TO 4 PERCENT SLOPES
InC	INDIANOLA LOAMY FINE SAND, 4 TO 15 PERCENT SLOPES
InD	INDIANOLA LOAMY FINE SAND, 15 TO 30 PERCENT SLOPES
KpB	KITSAP SILT LOAM, 2 TO 8 PERCENT SLOPES
KpD	KITSAP SILT LOAM, 8 TO 15 PERCENT SLOPES
No	NORMA SANDY LOAM
PITS	PITS
Sk	SEATTLE MUCK
So	SNOHOMISH SILT LOAM
Sr	SNOHOMISH SILT LOAM, THICK SURFACE VARIANT
Tu	TUKWILA MUCK
Ur	URBAN LAND
W	WATER

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LEGEND

City Limits
County Boundary
Basin Boundary
Highway
Streams

Soil Type as Classified by NRCS

AgB, AgC, AgD, AmB, AmC, An, Br, Ea, EvB, EvC, EvD, InA, InC, InD, KpB, KpD, No, PITS, Sk, So, Sr, Tu, Ur, W

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies), NRCS soils data
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE 4

SOILS
(AS CLASSIFIED BY NRCS)

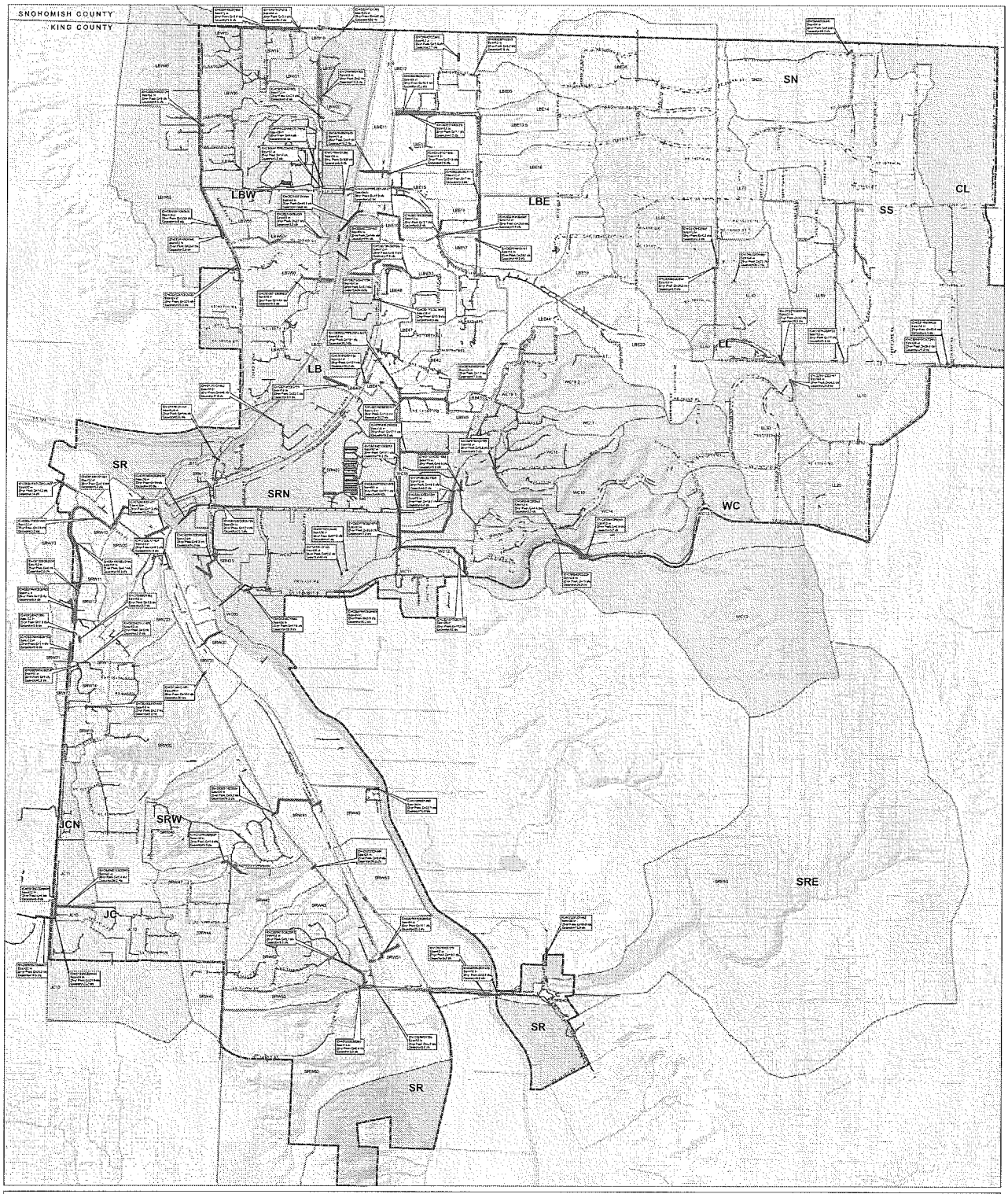
CITY OF WOODINVILLE

OCTOBER 2010

Woodinville SWM Plan Update
City of Woodinville, WA

City-Wide Hydraulics Map

April 2010



Legend

- Stream
- Stormwater Open Channel
- City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- 0% - 100%
- 101% - 150%
- 151% - 300%
- > 300%
- Woodinville City Limits
- Land Use (Revised by Otak 10/12/09)
- Waterbody

Subbasin Boundary

- Cottage Lake
- Jaunita Creek
- Jaunita Creek North
- Little Bear
- Little Bear East
- Little Bear West
- Lake Leota
- School North
- School River East
- Sammamish River
- Sammamish River North
- Sammamish River West
- School South
- Woodin Creek

N

1 inch = 500 feet

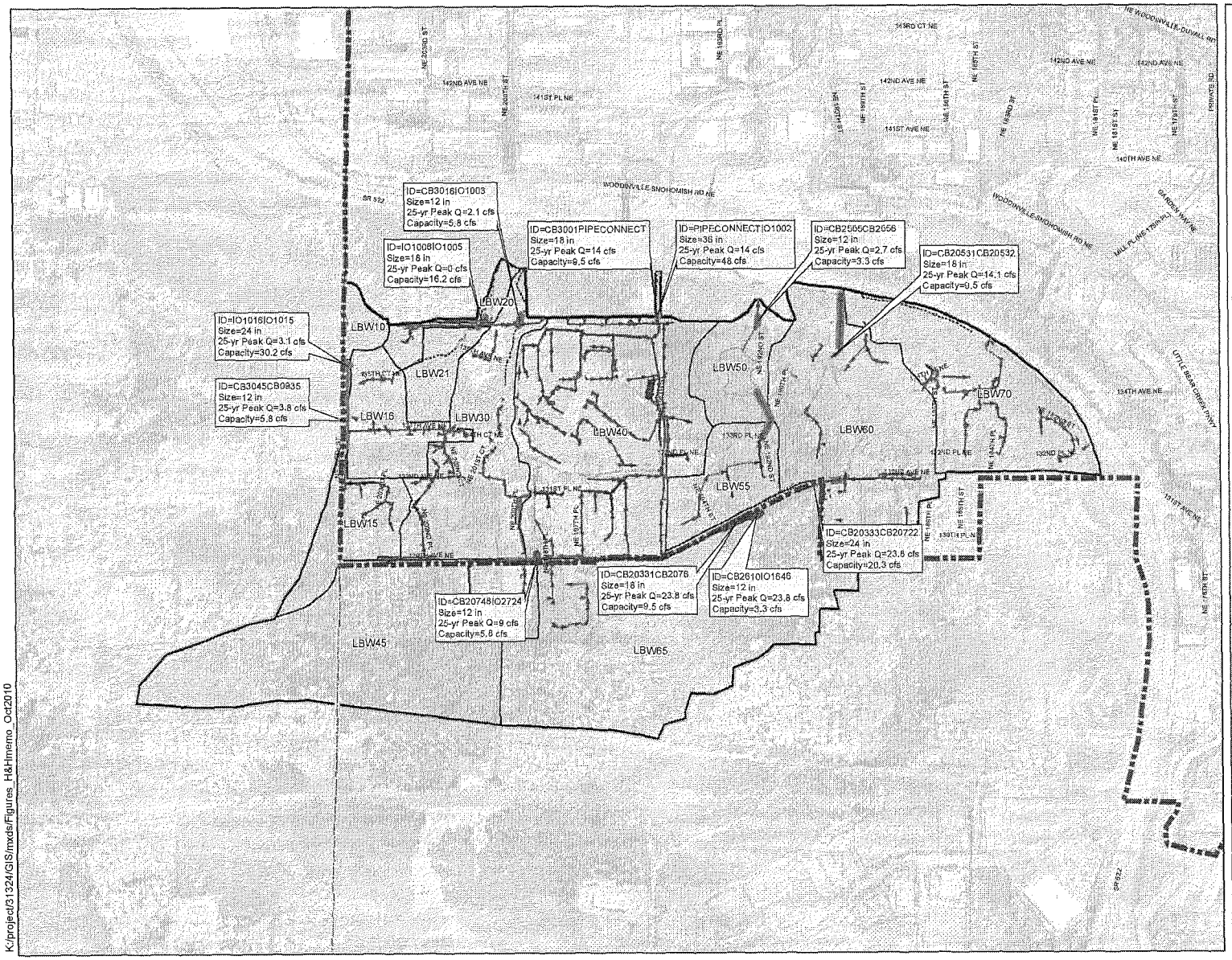
0 500 1,000 2,000 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by the est. from the City of Woodinville, King County GIS and Snohomish County GIS. This data is of the same accuracy and is meant for planning purposes only.

City of Woodinville data received February 16, 2010

Notes:

1- 290 pipe segments were analyzed for hydraulic capacity based on the 25-year and 100-year events.
2- Discharges for all sub-basins shown were calculated using the Santa Barbara Urban Hydrograph (SBUH) methodology.
3- Composite curve numbers were estimated based on land use and soil type.
4- Detention in developments later than 1990 was accounted for by adjusting the curve number.
5- Pipe capacity was calculated for most pipe segments by assuming inlet control.
6- Headwater depth is assumed to be 3 feet above pipe crown.
7- Pipes are assumed to be free of debris.



Legend

- Stream
- Stormwater Open Channel

City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- 0% - 100%
- 101% - 150%
- 151% - 300%
- > 300%
- Woodinville City Limits
- County Boundary
- Waterbody
- Little Bear West Subbasins
- Little Bear West Basin

N

0 350 700 1,400 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial imagery from 2005.

STORMWATER MANAGEMENT PLAN

FIGURE 6

LITTLE BEAR WEST BASIN
CITY-WIDE HYDRAULIC ANALYSIS

CITY OF WOODINVILLE

otak

OCTOBER 2010

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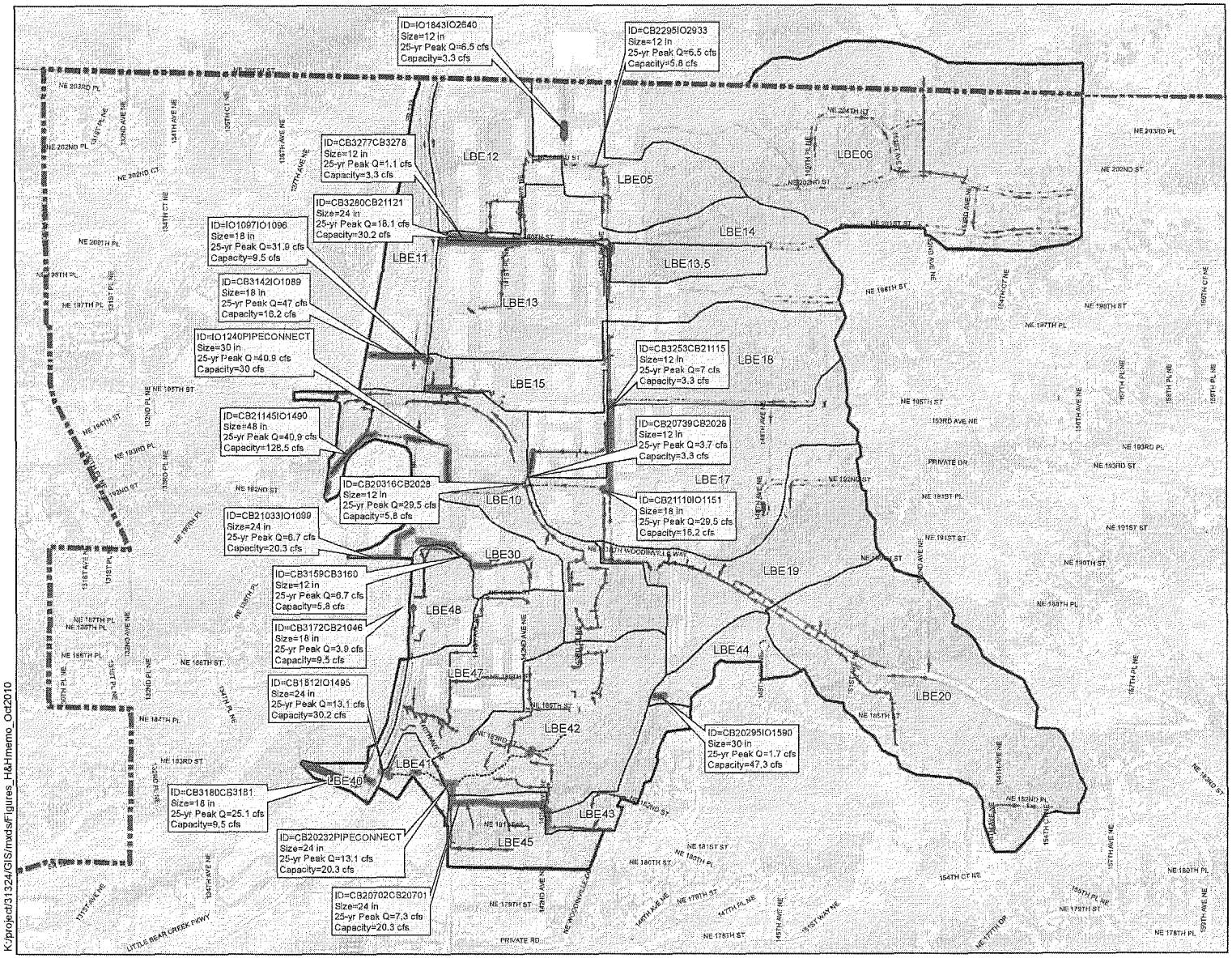

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Legend

- Stream
- Stormwater Open Channel

City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- Woodinville City Limits
- County Boundary
- Waterbody
- Little Bear East Basin
- LBE60 Little Bear East Subbasins

N

0 350 700 1,400 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial Imagery from 2005.

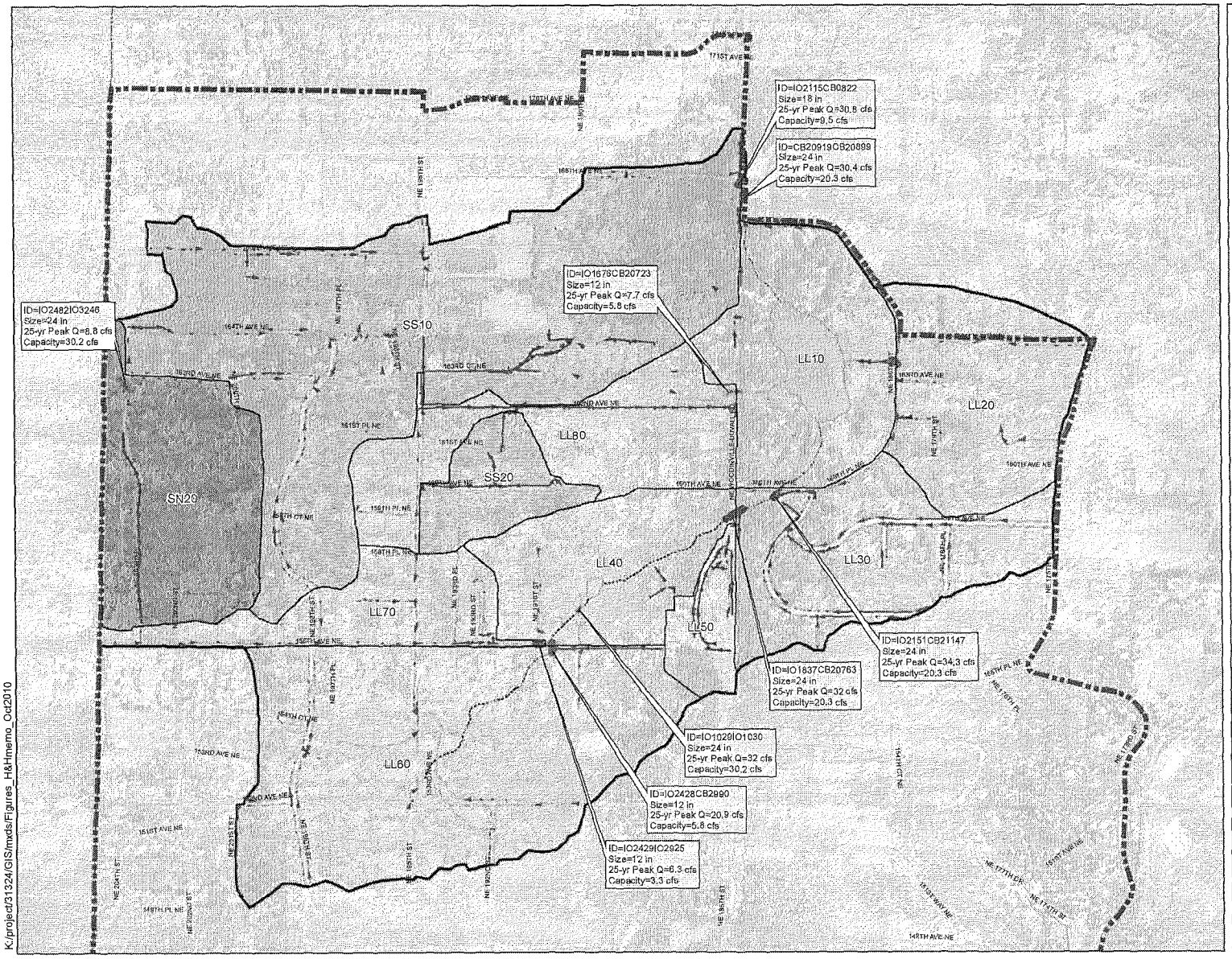
STORMWATER MANAGEMENT PLAN

FIGURE 7

LITTLE BEAR EAST BASIN
CITY-WIDE HYDRAULIC ANALYSIS

CITY OF WOODINVILLE

OCTOBER 2010



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Legend

- Stream
- Stormwater Open Channel

City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- 0% - 100%
- 101% - 150%
- 151% - 300%
- > 300%
- Woodinville City Limits
- Waterbody
- County Boundary
- School South Basin
- School North Basin
- Lake Leota Basin
- LL20 Lake Leota Subbasins and School South Subbasins

N

0 350 700 1,400 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial imagery from 2005.

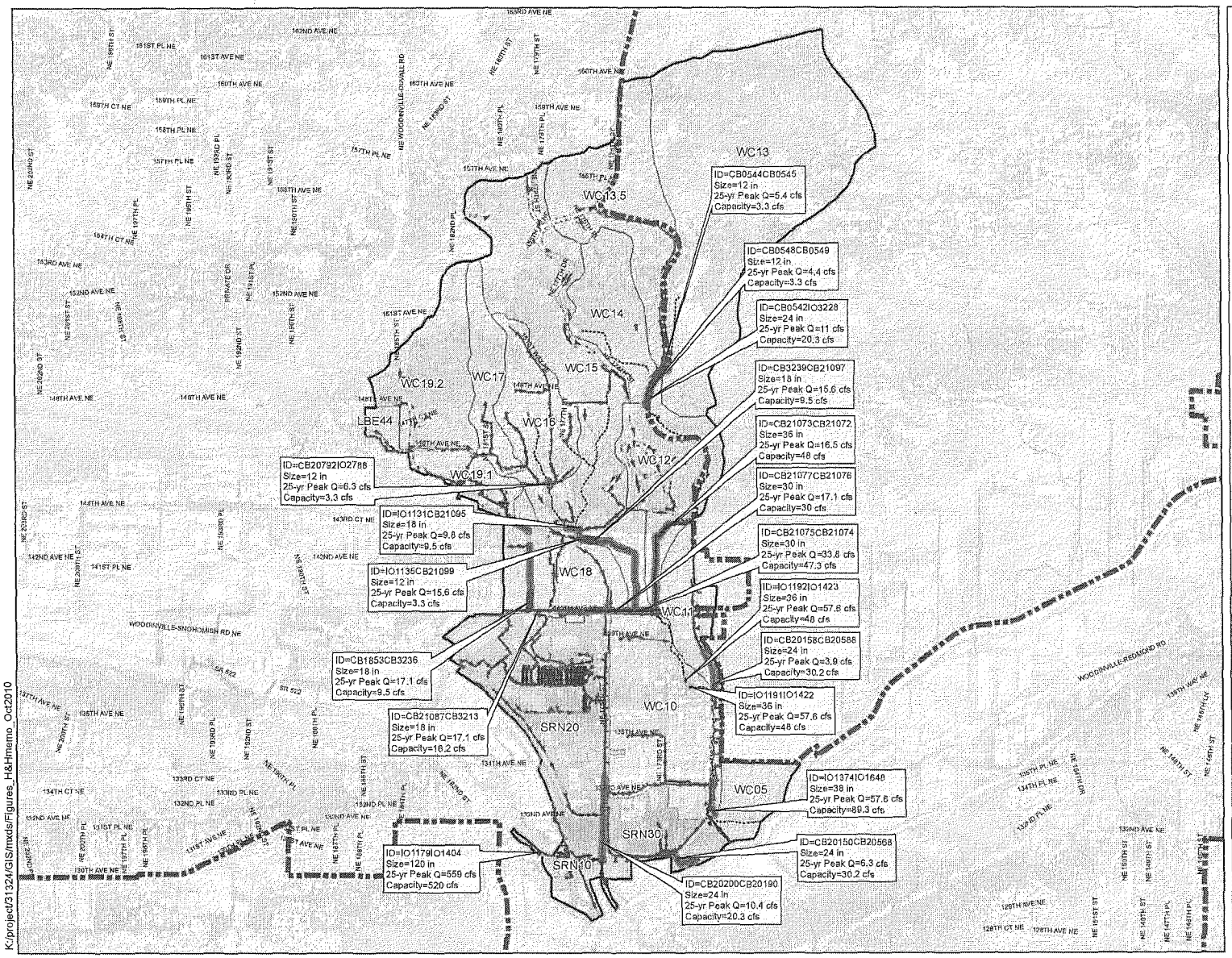
STORMWATER MANAGEMENT PLAN

FIGURE 8

LAKE LEOTA AND SCHOOL BASINS
CITY-WIDE HYDRAULIC ANALYSIS

CITY OF WOODINVILLE

OCTOBER 2010



Legend

- Stream
- Stormwater Open Channel

City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- 0% - 100%
- 101% - 150%
- 151% - 300%
- > 300%
- Woodinville City Limits
- Waterbody
- County Boundary
- Sammamish River North Basin
- Woodin Creek Basin
- WC16 Sammamish River North Subbasins and Woodin Creek Subbasins

N

0 350 700 1,400 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial Imagery from 2005.

STORMWATER MANAGEMENT PLAN

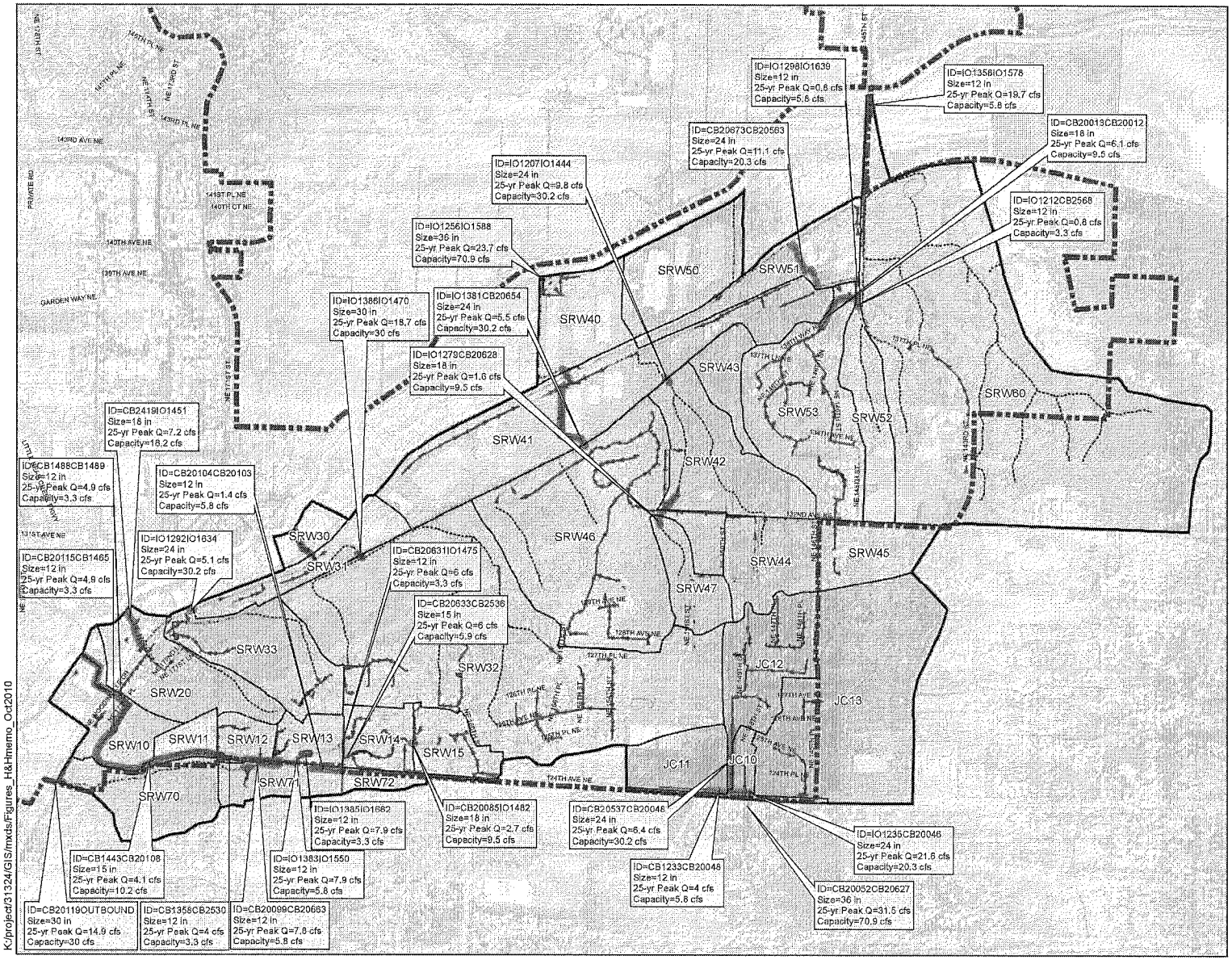
FIGURE 9

WOODIN CREEK AND SAMMAMISH RIVER NORTH BASINS CITY-WIDE HYDRAULIC ANALYSIS

CITY OF WOODINVILLE

OCTOBER 2010

K:/project/31324/GIS/mxds/Figures_H&Hmemo_Oct2010



Legend

- Stream
- Stormwater Open Channel

City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- 0% - 100%
- 101% - 150%
- 151% - 300%
- > 300%
- Woodinville City Limits
- Waterbody
- County Boundary
- Juanita Creek Basin
- Sammamish River West Basin
- SRW44 Juanita Creek Subbasins and Sammamish River West Subbasins

N

0 350 700 1,400 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial Imagery from 2005.

STORMWATER MANAGEMENT PLAN

FIGURE 10

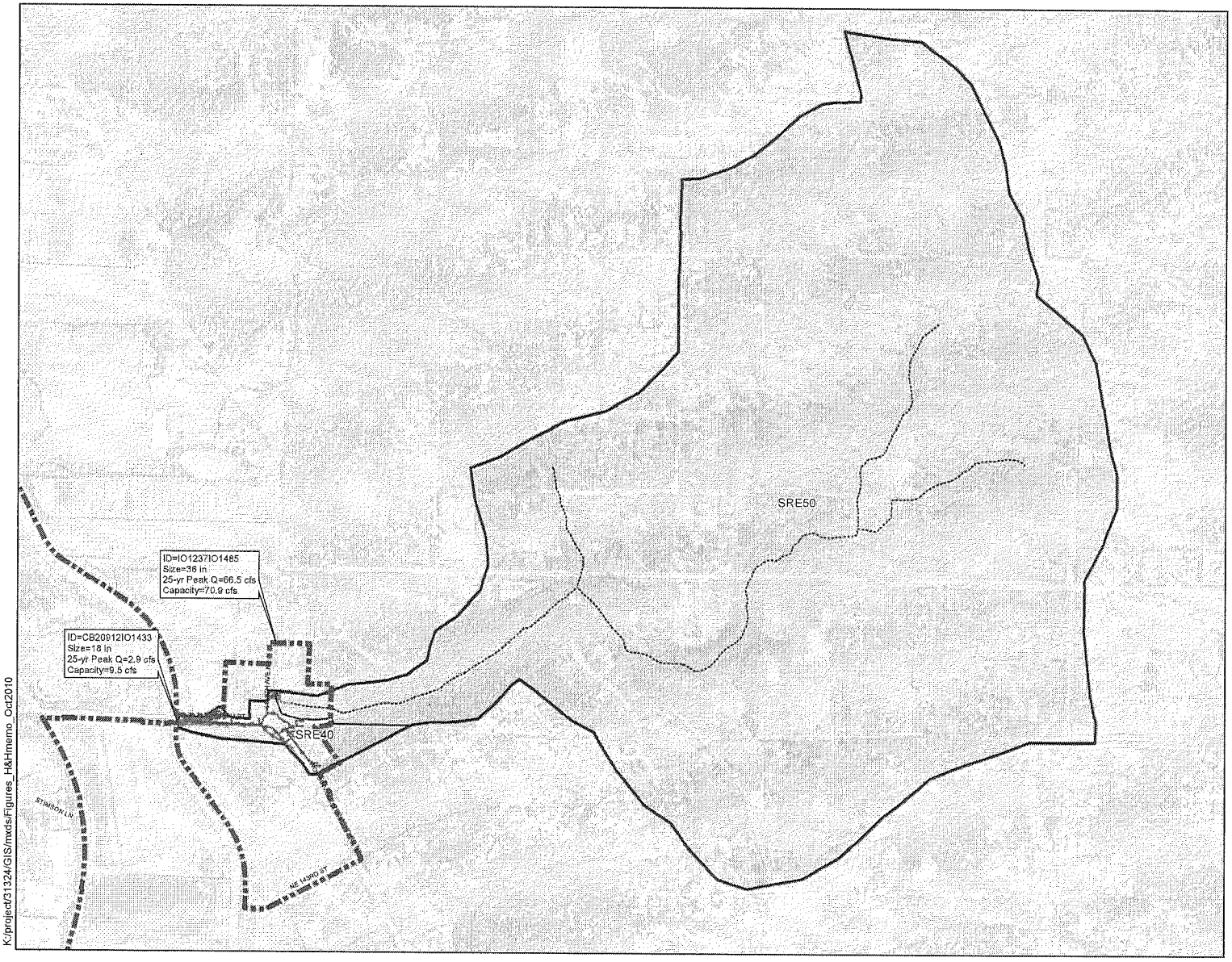
SAMMAMISH RIVER WEST AND JUANITA CREEK BASINS CITY-WIDE HYDRAULIC ANALYSIS

CITY OF WOODINVILLE

otak

OCTOBER 2010

K:/project/31324/GIS/mxds/Figures_H&Hmemo_Oct2010



Legend

- Stream
- Stormwater Open Channel

City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- 0% - 100%
- 101% - 150%
- 151% - 300%
- > 300%
- Woodinville City Limits
- Waterbody
- County Boundary
- Sammamish River East Basin
- SRE50 Sammamish River East Subbasins

N

0 350 700 1,400 Feet

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc., from the City of Woodinville, King County GIS and Snohomish County GIS. This data is not to survey accuracy and is meant for planning purposes only.

City of Woodinville data received Feb. 16, 2010. Aerial Imagery from 2005.

STORMWATER MANAGEMENT PLAN

FIGURE 11

SAMMAMISH RIVER EAST BASIN
CITY-WIDE HYDRAULIC ANALYSIS

CITY OF WOODINVILLE

otak

OCTOBER 2010

K:/project/31324/GIS/mxds/Figures_H&Hmemo_Oct2010

Appendix A—Little Bear Creek at Woodinville Flood Analysis Memorandum (Otak, 2008)

Memorandum

10230 NE Points Drive
Suite 400
Kirkland, WA 98033
Phone (425) 822-4446
Fax (425) 827-9577

To: Richard A. Leahy, City of Woodinville
Thomas E. Hansen, PE, City of Woodinville

From: Scott Stoneman, PE
Greg Laird, PE

Copies:

Date: July 11, 2008

Subject: Little Bear Creek at Woodinville Flood Analysis

Project No.: 31210

Introduction

Woodinville was one of the areas in the region hit hardest by the December 3, 2007 storm. Flood waters from Little Bear Creek caused property damage and forced road closures of city street and highways SR-522 and SR-202 when the creek overtopped the roads. The City of Woodinville desires to know the cause of the flooding and if action in their part is needed to reduce future flooding.

This memo provides a hydraulic/hydrologic investigation of the December 3, 2007 Little Bear Creek flood event within the City of Woodinville. This investigation provides an estimation of the design capacity of five culvert crossings within the City of Woodinville, the estimated peak flow of the flood event, the recurrence interval of the flood, a flood delineation map, and provides recommendations for which culvert should be replaced.

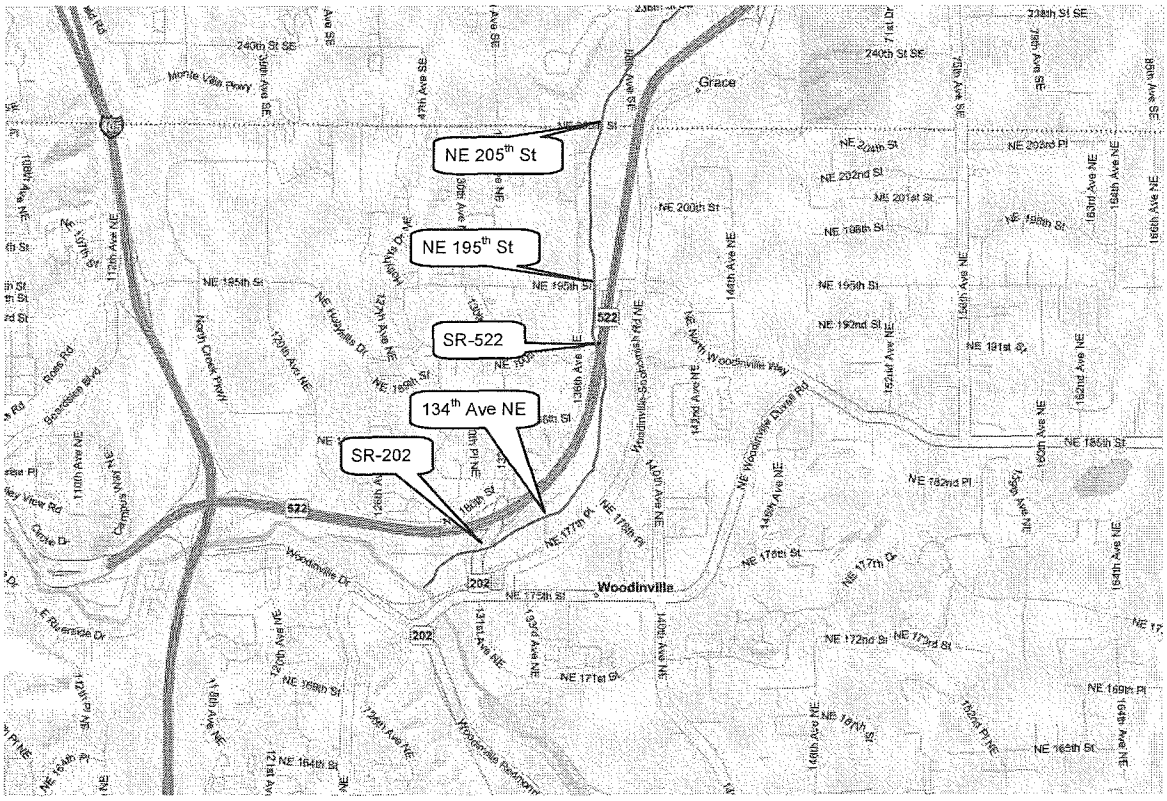
Existing Culvert Capacity

Five culverts along Little Bear Creek were analyzed for their design capacity. The culverts starting upstream at the Snohomish County/City of Woodinville boundary include the crossings at NE 205th Street, NE 195th Street, SR-522, 134th Avenue NE, and SR-202 (Figure 1).

Dimensions, materials, and inlet configurations data were collected for each culvert. During the site visit, the height to backwater overflow, relative to the culvert invert, was surveyed. The overflow is the lowest elevation in which water can flow through an alternate route than the culvert, such as over a road, or in the case of the SR-202 culvert, over the adjacent parking lot.

Invert and overflow heights were then roughly adjusted to match the NAVD88 datum by use of 2003 King County LIDAR mapping. In each case, the overflow measurement was set to elevation found on the LIDAR map. The overflow measurement was used because the road surfaces are much more accurate than the creek bottom on the LIDAR mapping.

Figure 1 – Vicinity Map



To estimate the water surface elevations resulting from the specific stream flow discharges in Little Bear Creek, a HEC-RAS model was then constructed to include all five culverts. The elevations of the culvert inverts and roadways plus the culvert dimensions were included in the HEC-RAS model. To reflect the geometry of the creek in the model, one channel section was approximated and used for the entire reach. The channel is not critical, since the culverts are the constricting elements of the Little Bear Creek system. The assumption was borne out, since the model indicates the culverts are inlet controlled, which means that the capacity of the culverts to convey stream flows is limited by how well the stream flow enters the culvert, as opposed to the depth of water at the culvert outlet, or the friction within the culvert.

For reference, the WSDOT Hydraulics Manual requires that culverts be designed so that the headwater to depth (HW/D) ratio should be less than 1.25 for the 25-year event. WSDOT also requires that no overtopping of the traveled roadway can occur during the 100-year event. Table 1 presents each of the five culvert's capacity rating for both the 25- and 100-year events based on the surveyed data and the HEC-RAS model.

Table 1
Estimated Capacity of the Existing Culverts

Location	Size/Type	Cross-sectional area (sf)	25-yr Design Capacity – 1.25 HW/D (cfs)	Height to Overflow (ft)	100-yr Design Capacity – Overtopping (cfs)
NE 205th Street	6' high x 10' wide concrete box	60	520	12	830
NE 195th Street	(2) 4' high x 7' wide concrete box	56	420	6	460
SR-522	(2) 5.2' high x 7' wide CMP arch	56	460	7	500
134th Avenue NE	(3) 5' diameter concrete pipe	59	510	10	820
SR-202	6' high x 10' wide concrete box	60	520	9	620

The NE 195th Street has the least capacity of the five culverts, likely resulting in the most frequent flooding of the five culverts. The NE 205th Street and 134th Avenue NE culverts have the greatest capacities for the 100-year event and likely result in the least frequent flooding.

Peak Discharge Estimates

The 2- through 100-year discharge rates have been estimated for Little Bear Creek down to NE 205th Street by Snohomish County. The discharge rates were calculated using a calibrated HSPF model of the basin within Snohomish County based on 2003 existing land use.

Discharges were then estimated at each of the downstream culverts by assuming that the discharge increases proportionally to the increase of tributary drainage area. Tributary drainage areas were taken from *King Co. Watershed Modeling Services - Green River Water Quality Assessment, and Sammamish-Washington, Analysis and Modeling Program Watershed Modeling Calibration Report.* Table 2 presents the approximate tributary drainage basin area at each of the culverts and the corresponding discharge based on the NE 205th Street culvert discharge.

Table 2
Statistical Peak Discharges

Location	Drainage Area (acres)	Basin Size Ratio	25-yr Discharge (cfs)	100-yr Discharge (cfs)
NE 205th Street	8,508	100%	486	658
NE 195th Street	9,185	108%	525	710
SR-522	9,462	111%	540	732
134th Avenue NE	9,594	113%	548	742
SR-202	9,781	115%	559	756

Table 3 compares the statistical flood discharges (Table 2) to the culvert capacities (Table 1). Note that four of the five culverts are undersized for either the 25- or 100-year events or both. The only culvert that meets both the 25- and 100-year criteria is the NE 205th Street culvert. Furthermore, as

the Little Bear Creek subbasin becomes more built-out in the future, the peak flows will increase causing the culverts to flood more frequently.

Table 3
Comparison of Statistical Peak Discharges to Culvert Capacity

Location	25-yr			100-yr		
	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%**

Bold indicates that culvert is undersized.

December 3, 2007 Flood Discharge

The discharge of flood events can most readily be estimated by measuring high water marks at locations upstream of where the stream is confined through a controlling section, for instance, upstream of a culvert or a bridge. It is also important that the culvert or bridge does not overtop because the discharge is then very sensitive to the water surface elevation.

Snohomish County collected photos and eyewitness accounts of the flooding that occurred at the NE 205th Street culvert. Water backed up behind the culvert and flooded the neighbor's house; however, it did not overtop the roadway. The water was said to have come within two feet of the top of the roadway.

HEC-RAS modeling indicates that a water surface two feet below the roadway results in a discharge of approximately 710 cfs. Further refinement of this peak discharge estimate may include making an appointment with the adjacent homeowner and surveying the high-water marks on the house shown on the photographs and creek cross-sections in the area.

Discharge was then estimated at each of the downstream culverts by assuming that the discharge increases proportionally to the increase of tributary drainage area, similarly to above. Table 4 presents the discharge based on the NE 205th Street culvert estimated discharge of 710 cfs.

Table 4
December 3, 2007 Estimated Flood Discharge

Location	December 3, 2007 Estimated Discharge (cfs)	100-yr Design Capacity - Overtopping (cfs)	Percent of Design Capacity
NE 205th Street	710	830	86%
NE 195th Street	766	460	**167%**
SR-522	790	500	**158%**
134th Avenue NE	801	820	98%
SR-202	816	620	**132%**

Bold indicates that culvert is undersized.

Table 4 also compares the December 3, 2007 estimated flood discharges to design capacities of the culverts. Note that three of the five culverts overtopped during the December 3, 2007 event. Only the culverts at NE 205th Street and 134th Avenue NE did not overtop, which concurs with reporting and evidence.

A stump was reported to have clogged the SR-202 culvert. This exacerbated the flood problem and sent additional water down SR-202, under the railroad trestle, and beyond. Our modeling indicates that even if the culvert was not clogged, water would have overtopped the landscape area south of this culvert and then over the adjacent parking lot.

December 3, 2007 Flood Recurrence Interval

As stated above, the 2- through 100-year discharge rates have been estimated for Little Bear Creek down to NE 205th Street by Snohomish County. The estimated 100-year discharge rate for current land use at the NE 205th Street culvert is 658 cfs. Based solely on the reported high water level relative to NE 205th Street, the December 3, 2007 event is estimated at 710 cfs, which is 8% greater. Note that there are inherent uncertanties associated with both the estimated discharge for the December 3, 2007 flood event based on the reported high water level and the estimated discharge for the 100-year event based on the HSPF model completed in 2003. By these discharge estimates, the December 3, 2007 event can be said to be approximately the 100-year event.

The Office of the Washington State Climatologist (OWSC) has written a report on the December 2007 Record Flooding. OWSC described the contribution of three storms that hit the Puget Sound area. On December 1, snow fell throughout western Washington. On December 2, the snow changed to rain, and wind between 40 and 50 mph was observed between Olympia and Bellingham. On December 3, near record rainfall occurred around western Washington. The rain gage closest to Woodinville is operated by a private citizen and recorded 3.43 for December 3 and 4.89 for the period of December 1 through 4. Other gages nearby have similar values. According to data compiled by King County Surface Water Design Manual (2005), the 25-year, 24-hour precipitation ranges from 3.0 to 3.2 inches in the Woodinville vicinity and the 100-year, 24-hour precipitation

ranges from 3.7 to 3.8 inches. This shows that the December flood event was a result of a precipitation event greater than the 25-year 24-hour precipitation. However, the 1.27 to 1.54 inches of precipitation (rain and snow) that fell in the area on December 1 and 2 saturated the area's soils causing the December 3 precipitation to produce greater amounts of runoff than if the December 3 storm had occurred by itself. For example, a runoff curve number of 75 (low density urban area in good draining soils) will behave more like a CN of 88 with a wet antecedent condition. This equates to a 76 percent increase in the runoff generated by the 3.4 inch storm. For a CN of 85 (medium density urban areas with slow infiltrating soils) will behave more like a CN of 94. This equates to a 47 percent increase in the runoff generated by the 3.4 inch storm.

Therefore, the wet days of weather preceding the December 3 event likely caused at least a 25 percent increase in runoff and more likely over a 50 percent increase in runoff.

Flood Delineation Map

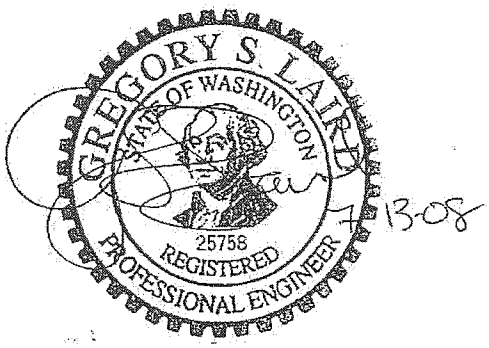
A flood delineation map was approximated for the December 3, 2007 event (Figure 2). The delineation map was created in GIS by overlaying the HEC-RAS water surface onto the LIDAR bare earth surface. The two surfaces were subtracted, using GIS, resulting in a new surface representing the water depth. Positive water depths were taken as flooded areas. Flood boundaries were then redrawn with engineering judgment using the modeled flood delineation as a guide.

Conclusion

The December 2007 flood was the largest flood on record for Little Bear Creek. It is approximately the 100-year recurrence interval. The high discharge was a result of an unusually large amount of precipitation and continuing increase of development in the tributary basin. The five culvert crossings analyzed were subjected to peak discharges greater than typically designed for, and resulted in overtopping of three of the five culvert crossings. All of the culverts except for the one at NE 205th Street are shown to be undersized by WSDOT design standards.

There has been some concern raised that development in the Little Bear Creek basin may have contributed to increase in flooding. Converting a rural basin to more residential and commercial land use will increase the amount of runoff from storm events. However, recent storm water management standards have required flow control facilities be installed to reduce the amount of runoff caused by increased amounts of impervious surfaces. In Snohomish County, these flow control facilities are designed to limit the peak discharges from developed to pre-developed conditions. In the Little Bear Creek basin, the Highway 9 widening and the Brightwater Wastewater Treatment facility are two significant developments to have occurred in recent years. These developments have flow control facilities and there were no reported failures of these facilities during the December events.

The culvert crossings at NE 195th Street, SR-522, 134th Avenue NE, and SR-202 need increased capacity in order to meet current hydraulic design criteria and to reduce the flooding problems. Increasing the capacity at these crossings will require either retrofitting or replacing the culverts. The culvert improvements will need to meet Washington State Department of Fish and Wildlife guidelines, which typically include constructing an oversized culvert that spans more than the width of the creek. Note that the NE 195th Street and 134th Avenue NE culverts are owned by the City of Woodinville, where the SR-522 and SR-202 are within the Washington State Department of Transportation right-of-way.



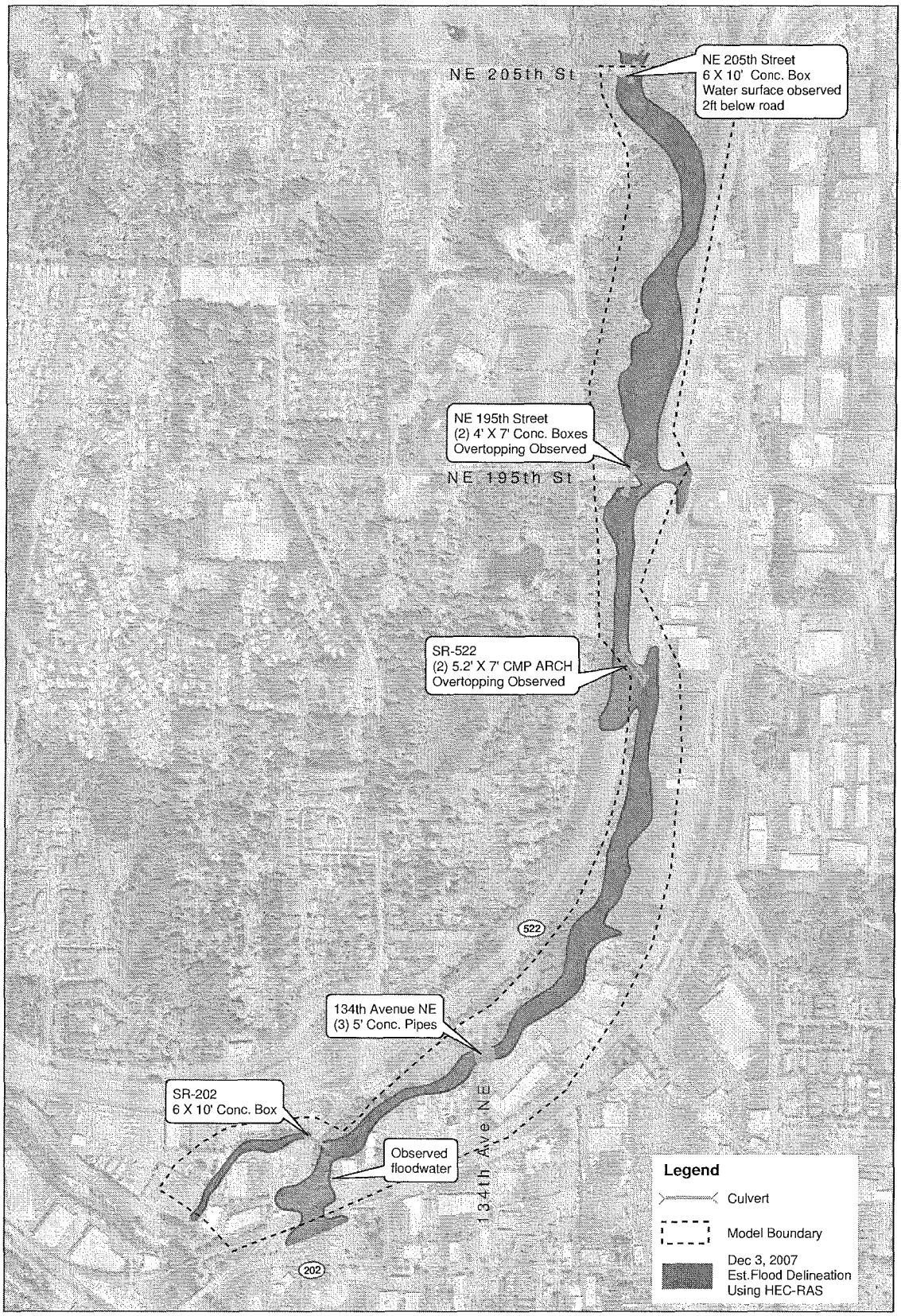


Figure 2

Little Bear Creek
Dec. 3, 2007 Flood Delineation
Woodinville, WA

Source: DEM data obtained from Puget Sound LIDAR Consortium and Otak GIS.
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

0 315 630 1,260 Feet

FILE: K:/project/31210/Figure1.mxd

Appendix B—Calculations

Hydrologic Soil Groups

City of Woodinville
created by: sjs
checked by: jlc

Purpose: Assign hydrologic soil groups to GIS mapped soils based on the following.

Common Name	GIS Soil Type ID	Assigned Hydrologic Soil Group
Alderwood	AgB	C
Alderwood	AgC	C
Alderwood	AgD	C
Alderwood	Alderwood gravelly sandy loam, 2 to 8 percent slopes	C
Alderwood	Alderwood gravelly sandy loam, 8 to 15 percent slopes	C
Alderwood	Alderwood gravelly sandy loam, 15 to 25 percent slopes	C
Arents, Alderwood	AmB	B
Arents, Alderwood	AMC	B
Arents, Everett	An	B
Briscot	Br	D
Earlmont	Ea	C
Everett	EvB	A
Everett	EvC	A
Everett	EvD	A
Everett	Everett gravelly sandy loam, 0 to 8 percent slopes	A
Everett	Everett gravelly sandy loam, 8 to 15 percent slopes	A
Gravel Pit	PITS	A
Indianola	InA	A
Indianola	InC	A
Indianola	InD	A
Indianola	Indianola Loamy Sand, 15 to 25 percent slopes	A
Kitsap	KpB	C
Kitsap	KpD	C
Kitsap	Kitsap silt loam, 8 to 25 percent slopes	C
McKenna	McKenna gravelly silt loam, 0 to 8 percent slopes	D
Norma	No	D
Norma	Norma loam	D
Seattle	Sk	D
Snohomish	Sr	D
Tukwila	Tu	D
Unknown	0	C
Urban	Ur	D
Urban	Urban Land	D
Water	W	Water

Data Source:
Hydrologic Soil Groups from Dept. of Ecology. 2001. Stormwater Management Manual for Western Washington

Conversion from Land Use to Land Cover

City of Woodinville
created by: sjs/jlc
checked by: jlc

Purpose: Convert GIS mapped land uses to land cover based on the following table.

Land Uses

Land Use	Impervious percent	Forest percent	Grass percent	Bare ground percent	1990 Develop-ment	1998 Develop-ment	Total	*Notes*
Open Space	0%	80%	20%	0%	0%	0%	100%	*2*
Agriculture	0%	0%	50%	50%	0%	0%	100%	*2*
SFR Rural	1.0%	49.5%	49.5%	0%	0%	0%	100%	*1*
SFR Low	3%	30%	67%	0%	0%	0%	100%	*2*
Park/Recreation	15%	10%	60%	15%	0%	0%	100%	*2*
SFR Med	18%	0%	82%	0%	0%	0%	100%	*1*
Public Institution	20%	0%	60%	20%	0%	0%	100%	*2*
Greenhouse	25%	0%	40%	35%	0%	0%	100%	*2*
SFR High	41%	0%	59%	0%	0%	0%	100%	*1*
Multi Family	67%	0%	33%	0%	0%	0%	100%	*1*
ROW	86%	0%	14%	0%	0%	0%	100%	*1*
Commercial	86%	0%	14%	0%	0%	0%	100%	*1*
Industrial	86%	0%	14%	0%	0%	0%	100%	*1*
1990 Development	0%	0%	0%	0%	100%	0%	100%	*3*
1998 Development	0%	0%	0%	0%	0%	100%	100%	*3*

1. Land cover from Snohomish County. 2002. Hydrologic Modeling Protocols, Ver. 1.4.
2. Otak assumed land covers
3. See Otak Memo dated Nov. 12, 2009 for development later than 1990 and development later than 1998.

Curve Numbers

City of Woodinville
created by: sjs
checked by: jlc

Purpose: Assign curve numbers for each soil group and land cover based on the following.

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
Water	100	100	100	100	80	60

Source: NRCS. 1986. Urban Hydrology for Small Watersheds.TR-55. Tables 2-2a, 2-2b, and 2-2c.

Forest CN is woods in good condition.

Grass CN is open space and/or pasture in fair condition.

Bare Ground CN is the same as dirt roads.

For development later than 1990 and 1998, see Otak Memo dated Nov. 12, 2009

Table 2-2a Runoff curve numbers for urban areas 1/

Cover description: Cover type and hydrologic condition	Average percent impervious area 2/	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, 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 (excluding 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

Table 2-2b Runoff curve numbers for cultivated agricultural lands 1/

Cover description: Cover type	Treatment 2/	Hydrologic condition 3/	Curve numbers for hydrologic soil group: A	B	C	D
Fallow	Bare soil	—	77	86	91	94

Table 2-2c Runoff curve numbers for other agricultural lands 1/

Cover description: Cover type	Hydrologic condition	Curve numbers for hydrologic soil group: A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. 2/	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Woods. 3/	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 4/	55	70	77

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

Method: Use "Pivot Table" to subtotal subbasin areas and compute composite curve numbers from exported GIS soil/landuse/subbasin data.

PIVOT TABLE

		Sum of Area		Basin								
Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	JC10	JC11	JC12	JC13	LB10	LB20	LB30	LBE05	LBE06
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A					0.79	6.53			
14%	69.0		B				8.68				10.64	0.57
14%	79.0		C				1.33		0.13		0.96	4.03
14%	84.0		D					2.23	13.22		0.23	
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C		11.90	0.00						
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A						7.34			
14%	69.0		B								0.50	
14%	79.0		C						0.03		2.21	
14%	84.0		D					0.30	8.05			
14%	100.0		Water									
33%	49.0	Multi Family	A									
33%	69.0		B				18.67					
33%	79.0		C	0.08		0.17	0.85		0.09			
33%	84.0		D						2.36			
33%	100.0		Water									
100%	33.8	Open Space	A						6.91	13.31		
100%	57.8		B		0.15	0.28	0.64					
100%	71.8		C	0.19	1.51	2.74	0.07		0.01		8.92	32.86
100%	78.4		D			0.26			17.26	2.65		
100%	100.0		Water									
85%	50.8	Park/Recreation	A									
85%	69.6		B									
85%	79.4		C									
85%	84.1		D					0.27				
85%	100.0		Water					0.03				
80%	54.8	Public Institution	A									
80%	72.3		B				0.00					
80%	81.0		C									
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A					0.54	11.43	2.44		
14%	69.0		B	0.06		1.54	10.85				1.46	0.02
14%	79.0		C	3.07	0.82	4.15	3.76		1.89		0.25	9.96
14%	84.0		D			0.42		0.43	11.58	5.09	0.01	0.01
14%	100.0		Water									
59%	49.0	SFR High	A							0.02		
59%	69.0		B	0.60		0.75	3.48					
59%	79.0		C	0.11	0.01	3.09	1.19					
59%	84.0		D			0.00						
59%	100.0		Water									
97%	43.1	SFR Low	A						1.89	0.24		
97%	64.7		B				0.01					
97%	76.2		C									41.88
97%	81.8		D						2.18			
97%	100.0		Water									
82%	49.0	SFR Med	A									
82%	69.0		B	1.26		3.49	18.73					
82%	79.0		C	0.35		6.41	4.81					12.12
82%	84.0		D			0.82	0.12					
82%	100.0		Water									
99%	39.5	SFR Rural	A							9.42		
99%	62.0		B									
99%	74.5		C			0.85						9.91
99%	80.5		D							2.83		
99%	100.0		Water									
100%	60.0	1998 Developmen	A							6.87		
100%	60.0		B									
100%	60.0		C									
100%	60.0		D							0.29		
100%	60.0		Water									
100%	60.0	1990 Developmen	A									
100%	65.0		B									
100%	70.0		C				0.01					
100%	80.0		D									
100%	80.0		Water									
		Grand Total		5.73	14.38	24.99	73.22	4.59	90.89	43.17	25.17	111.37

basin name	JC10	JC11	JC12	JC13	LB10	LB20	LB30	LBE05	LBE06
area	5.73	14.38	24.99	73.22	4.59	90.89	43.17	25.17	111.37
pervious Area	2.39	10.70	16.10	32.78	0.86	37.35	36.55	11.19	95.28
Pervious CN	72.6	80.8	75.2	70.6	77.0	66.6	48.4	71.7	74.9
impervious	58%	26%	36%	55%	81%	59%	15%	56%	14%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	LBE10	LBE11	LBE12	LBE13	LBE13.5	LBE14	LBE15	LBE16	LBE17
		Sum of Area										
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A		2.02	0.01	1.64		0.02			
14%	69.0		B			19.79	0.12		6.18			
14%	79.0		C	4.46	0.13	0.00	7.29		5.38	0.84	7.73	23.57
14%	84.0		D	1.20	5.00	0.27						
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A		1.35		2.83					
14%	69.0		B			1.81	0.64		0.54			
14%	79.0		C	4.99			16.02	1.19	0.00	11.51	0.00	6.79
14%	84.0		D		0.11							
14%	100.0		Water									
33%	49.0	Multi Family	A									
33%	69.0		B									
33%	79.0		C	0.13					0.00			
33%	84.0		D									
33%	100.0		Water									
100%	33.8	Open Space	A		0.02							
100%	57.8		B			0.65						
100%	71.8		C	6.54				7.37	11.05	0.00	0.02	3.07
100%	78.4		D	0.37	0.00							
100%	100.0		Water									
85%	50.8	Park/Recreation	A									
85%	69.6		B									
85%	79.4		C									
85%	84.1		D									
85%	100.0		Water									
80%	54.8	Public Institution	A									
80%	72.3		B									
80%	81.0		C									
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A	0.29	7.67	1.33	1.78		0.04			
14%	69.0		B			0.88	0.83		1.09			
14%	79.0		C	5.02	1.21		1.22	0.00	2.22	0.75	0.62	2.32
14%	84.0		D	6.31	4.34	0.02						
14%	100.0		Water									
59%	49.0	SFR High	A									
59%	69.0		B									
59%	79.0		C	0.16								
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A									
97%	64.7		B									
97%	76.2		C						8.04			10.58
97%	81.8		D	0.00								
97%	100.0		Water									
82%	49.0	SFR Med	A									
82%	69.0		B									
82%	79.0		C									
82%	84.0		D									
82%	100.0		Water									
99%	39.5	SFR Rural	A									
99%	62.0		B									
99%	74.5		C									1.07
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A									
100%	60.0		B									
100%	60.0		C	0.67								
100%	60.0		D	0.01								
100%	60.0		Water									
100%	60.0	1990 Developmen	A									
100%	65.0		B									
100%	70.0		C	14.23							0.12	6.16
100%	80.0		D									
100%	80.0		Water									
		Grand Total		44.38	21.85	24.76	32.37	8.56	34.57	13.10	8.48	53.57

basin name	LBE10	LBE11	LBE12	LBE13	LBE13.5	LBE14	LBE15	LBE16	LBE17
area	44.38	21.85	24.76	32.37	8.56	34.57	13.10	8.48	53.57
pervious Area	25.07	3.08	4.03	4.53	7.53	21.02	1.84	1.31	25.13
Pervious CN	71.7	65.8	66.4	72.7	72.0	73.6	79.0	78.1	74.6
impervious	44%	86%	84%	86%	12%	39%	86%	85%	53%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE
Sum of Area

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	LBE18	LBE19	LBE20	LBE30	LBE40	LBE41	LBE42	LBE43	LBE44
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A		1.15				0.05			
14%	69.0		B									
14%	79.0		C	7.58	4.70	0.12	2.20			0.02		
14%	84.0		D									
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A					0.74				
14%	69.0		B									
14%	79.0		C	0.85	1.43		7.32			3.20		
14%	84.0		D					1.14				
14%	100.0		Water									
33%	49.0	Multi Family	A						0.20	0.80	1.72	
33%	69.0		B									
33%	79.0		C	1.32			0.23			0.86	1.15	
33%	84.0		D				1.04					
33%	100.0		Water									
100%	33.8	Open Space	A		0.27	3.18		0.01		5.74	0.01	0.00
100%	57.8		B									
100%	71.8		C	13.24	8.01	4.57				10.70	0.01	
100%	78.4		D					0.13				
100%	100.0		Water									
85%	50.8	Park/Recreation	A						0.76			
85%	69.6		B									
85%	79.4		C									
85%	84.1		D									
85%	100.0		Water									
80%	54.8	Public Institution	A									
80%	72.3		B									
80%	81.0		C									
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A		1.77	2.85		1.68	0.41	0.68	2.01	2.62
14%	69.0		B									
14%	79.0		C	1.65	4.83	5.14	4.13	0.62		1.13	0.76	0.18
14%	84.0		D				0.04	0.58				
14%	100.0		Water									
59%	49.0	SFR High	A									
59%	69.0		B									
59%	79.0		C							0.27		
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A			1.76					0.49	0.02
97%	64.7		B									
97%	76.2		C	7.09	7.07	19.40						
97%	81.8		D									
97%	100.0		Water									
82%	49.0	SFR Med	A						0.34		2.40	4.66
82%	69.0		B									
82%	79.0		C								0.01	
82%	84.0		D									
82%	100.0		Water									
99%	39.5	SFR Rural	A			1.95						0.99
99%	62.0		B									
99%	74.5		C	0.76	4.32	24.04						
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A			2.89			2.70	5.32		
100%	60.0		B									
100%	60.0		C			3.52				6.13		
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A						0.03			
100%	65.0		B									
100%	70.0		C	0.03	2.33		0.56			4.00		
100%	80.0		D									
100%	80.0		Water									
		Grand Total		32.52	35.87	69.41	15.51	4.90	4.49	38.83	8.57	8.47

basin name	LBE18	LBE19	LBE20	LBE30	LBE40	LBE41	LBE42	LBE43	LBE44
area	32.52	35.87	69.41	15.51	4.90	4.49	38.83	8.57	8.47
pervious Area	22.74	23.68	61.54	2.89	0.81	3.79	33.29	3.81	5.21
Pervious CN	73.8	73.0	69.1	77.9	67.0	57.3	61.0	52.2	47.3
impervious	30%	34%	11%	81%	84%	16%	14%	56%	38%

Subbasin Area and Composite CN Calculations

City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Sum of Area

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	LBE45	LBE47	LBE48	LBW10	LBW15	LBW16	LBW20	LBW21	LBW30
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A	1.43								
14%	69.0		B									
14%	79.0		C	0.09	11.85	3.92						
14%	84.0		D									
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A									
14%	69.0		B									
14%	79.0		C		3.79	1.91						
14%	84.0		D									
14%	100.0		Water									
33%	49.0	Multi Family	A	6.00	0.03							
33%	69.0		B									
33%	79.0		C	5.56								
33%	84.0		D									
33%	100.0		Water									
100%	33.8	Open Space	A		0.30			0.11	2.25	1.84	3.71	4.25
100%	57.8		B									
100%	71.8		C		0.19	1.44						
100%	78.4		D									
100%	100.0		Water									
85%	50.8	Park/Recreation	A									
85%	69.6		B									
85%	79.4		C									
85%	84.1		D									
85%	100.0		Water									
80%	54.8	Public Institution	A									2.76
80%	72.3		B									
80%	81.0		C									
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A	1.22	1.72		1.08	0.41	0.00	0.33	0.00	1.66
14%	69.0		B									
14%	79.0		C	0.44	4.15	2.84		3.32	0.01			1.88
14%	84.0		D									
14%	100.0		Water									
59%	49.0	SFR High	A						0.00		0.01	0.05
59%	69.0		B									
59%	79.0		C					0.80	0.00			0.46
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A				1.99	0.07	2.16		1.41	0.66
97%	64.7		B									
97%	76.2		C					2.52	2.54			0.48
97%	81.8		D									
97%	100.0		Water									
82%	49.0	SFR Med	A					0.01	0.25		0.03	0.10
82%	69.0		B									
82%	79.0		C					4.90	0.65			2.23
82%	84.0		D									
82%	100.0		Water									
99%	39.5	SFR Rural	A				0.47	0.04				1.36
99%	62.0		B									
99%	74.5		C					3.14				5.06
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A	0.03	2.23		0.02	0.23	6.43	0.31	2.14	9.40
100%	60.0		B									
100%	60.0		C	0.00	0.80			0.04	0.00			0.02
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A									3.85
100%	65.0		B									
100%	70.0		C									2.20
100%	80.0		D									
100%	80.0		Water									
		Grand Total		14.77	25.05	10.11	3.57	15.60	14.30	2.47	7.30	36.42

basin name	LBE45	LBE47	LBE48	LBW10	LBW15	LBW16	LBW20	LBW21	LBW30
area	14.77	25.05	10.11	3.57	15.60	14.30	2.47	7.30	36.42
pervious Area	4.29	6.54	2.66	2.57	11.07	13.99	2.19	7.25	32.10
Pervious CN	62.4	66.8	75.1	42.9	75.7	56.7	37.9	43.4	59.4
impervious	71%	74%	74%	28%	29%	2%	11%	1%	12%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	LBW40	LBW45	LBW50	LBW55	LBW60	LBW65	LBW70	LL10	LL20
				Sum of Area								
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A									
14%	69.0		B									
14%	79.0		C									
14%	84.0		D									
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A									
14%	69.0		B									
14%	79.0		C									
14%	84.0		D									
14%	100.0		Water									
33%	49.0	Multi Family	A							0.24		
33%	69.0		B									
33%	79.0		C									
33%	84.0		D									
33%	100.0		Water									
100%	33.8	Open Space	A	2.95		1.51		5.21		0.15		1.27
100%	57.8		B									
100%	71.8		C		9.83			0.06	3.75		5.27	1.10
100%	78.4		D	0.00				5.05		0.44		
100%	100.0		Water								8.84	
85%	50.8	Park/Recreation	A									
85%	69.6		B									
85%	79.4		C						5.13			
85%	84.1		D									
85%	100.0		Water									
80%	54.8	Public Institution	A	34.50								
80%	72.3		B									
80%	81.0		C	0.11					9.40			
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A	4.54		0.88	0.96	7.06	1.25	9.04		
14%	69.0		B									
14%	79.0		C	1.78	7.04		1.71	0.50	21.49		5.21	4.62
14%	84.0		D	0.12				1.14		2.14		
14%	100.0		Water									
59%	49.0	SFR High	A	0.45			0.01	2.11	0.85	0.44		
59%	69.0		B									
59%	79.0		C	0.53	9.12		0.08	0.22	28.09			
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A	0.35		7.61		7.00		3.66		6.07
97%	64.7		B									
97%	76.2		C	3.12	11.90			3.00	4.27		28.50	27.43
97%	81.8		D			0.02		4.04		0.10		
97%	100.0		Water			2.10					0.08	
82%	49.0	SFR Med	A	2.44		0.91	3.84	15.79	0.32	7.08		
82%	69.0		B									
82%	79.0		C	1.08	6.39		7.79	0.48	6.98		7.83	1.43
82%	84.0		D					1.01				
82%	100.0		Water									
99%	39.5	SFR Rural	A									4.28
99%	62.0		B									
99%	74.5		C		7.35						7.40	8.01
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A	0.28								
100%	60.0		B									
100%	60.0		C		17.72				1.50			
100%	60.0		D	0.13								
100%	60.0		Water									
100%	60.0	1990 Developmen	A	3.60						13.34		2.81
100%	65.0		B									
100%	70.0		C	9.09								0.52
100%	80.0		D									
100%	80.0		Water									
		Grand Total		65.08	69.34	13.02	14.39	52.66	83.03	36.63	63.12	57.54

basin name	LBW40	LBW45	LBW50	LBW55	LBW60	LBW65	LBW70	LL10	LL20
area	65.08	69.34	13.02	14.39	52.66	83.03	36.63	63.12	57.54
pervious Area	51.48	57.97	11.81	9.96	40.69	47.52	25.28	56.30	52.18
Pervious CN	58.3	70.9	52.2	69.1	56.1	77.3	54.9	79.7	67.3
impervious	21%	16%	9%	31%	23%	43%	31%	11%	9%

Subbasin Area and Composite CN Calculations
City of Woodinville
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checked by: jlc

PIVOT TABLE

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	LL30	LL40	LL50	LL60	LL70	LL80	SRE40	SRE50	SRN10
				Sum of Area								
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A		0.77	4.70				2.83	1.11	0.60
14%	69.0		B									
14%	79.0		C			1.54					1.03	
14%	84.0		D									3.30
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A									0.01
14%	69.0		B									
14%	79.0		C									
14%	84.0		D									2.76
14%	100.0		Water									
33%	49.0	Multi Family	A									
33%	69.0		B									
33%	79.0		C									
33%	84.0		D									
33%	100.0		Water									
100%	33.8	Open Space	A	1.60		0.00				1.04	1.19	
100%	57.8		B									
100%	71.8		C	1.17	2.26	2.17	3.24	3.87	6.21	0.00	51.80	
100%	78.4		D							0.50		
100%	100.0		Water									
85%	50.8	Park/Recreation	A							0.13		
85%	69.6		B									
85%	79.4		C									
85%	84.1		D							0.06		0.27
85%	100.0		Water									
80%	54.8	Public Institution	A									
80%	72.3		B									
80%	81.0		C									
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A	4.94	0.32	1.42	0.55			3.17	0.38	4.40
14%	69.0		B									
14%	79.0		C	6.20	1.38	2.62	13.22	5.90	4.72		45.75	
14%	84.0		D							0.48		3.06
14%	100.0		Water									
59%	49.0	SFR High	A		0.01							
59%	69.0		B									
59%	79.0		C		0.05		0.00				0.11	
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A	23.93	1.17	0.01	4.07			0.00	1.64	
97%	64.7		B									
97%	76.2		C	23.73	22.16	0.60	90.58	21.66	27.88		300.72	
97%	81.8		D									
97%	100.0		Water									
82%	49.0	SFR Med	A		0.20							
82%	69.0		B									
82%	79.0		C				0.62	3.05			2.29	
82%	84.0		D									
82%	100.0		Water									
99%	39.5	SFR Rural	A		0.76		0.81			2.46		
99%	62.0		B									
99%	74.5		C	2.53	16.00	0.27	25.29	0.76	6.07	0.58	155.72	
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A		0.91	0.01						
100%	60.0		B									
100%	60.0		C		1.32	0.00	2.42				7.52	
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A									
100%	65.0		B									
100%	70.0		C						8.57		0.59	
100%	80.0		D									
100%	80.0		Water									
		Grand Total		64.09	47.32	13.35	140.79	35.24	53.45	11.27	569.85	14.39

basin name	LL30	LL40	LL50	LL60	LL70	LL80	SRE40	SRE50	SRN10
area	64.09	47.32	13.35	140.79	35.24	53.45	11.27	569.85	14.39
pervious Area	53.06	44.26	4.49	125.74	28.96	48.50	5.63	517.25	2.20
Pervious CN	60.0	72.9	69.0	74.2	75.9	74.4	48.1	74.9	72.9
impervious	17%	6%	66%	11%	18%	9%	50%	9%	85%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	SRN20	SRN30	SRW10	SRW11	SRW12	SRW13	SRW14	SRW15	SRW20
			Sum of Area									
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C		0.12							
100%	86.5		D		0.71							
100%	100.0		Water									
14%	49.0	Commercial	A	13.00								
14%	69.0		B									
14%	79.0		C			2.89						0.49
14%	84.0		D	1.89		0.86						1.88
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A									
14%	69.0		B									
14%	79.0		C			3.08						
14%	84.0		D			0.19						0.00
14%	100.0		Water									
33%	49.0	Multi Family	A									
33%	69.0		B									
33%	79.0		C		1.63	0.53						5.54
33%	84.0		D		3.75	0.35						0.08
33%	100.0		Water									
100%	33.8	Open Space	A	2.06	0.00	2.20	0.02	0.01				0.74
100%	57.8		B									
100%	71.8		C			2.13		0.09	0.00	0.89	0.46	6.56
100%	78.4		D	0.01		0.33						2.42
100%	100.0		Water									
85%	50.8	Park/Recreation	A	0.00	0.93							
85%	69.6		B									
85%	79.4		C		0.68							
85%	84.1		D	0.03	6.81							
85%	100.0		Water									
80%	54.8	Public Institution	A	0.08	2.75							
80%	72.3		B									
80%	81.0		C						5.13			
80%	85.3		D		0.38	0.01						0.02
80%	100.0		Water									
14%	49.0	ROW	A	10.51	0.10	0.03	0.05	1.08				
14%	69.0		B									
14%	79.0		C		0.05	2.53	0.86	0.50	0.90	2.37	2.27	0.06
14%	84.0		D	1.89	2.62	1.96						7.03
14%	100.0		Water									
59%	49.0	SFR High	A					1.93				
59%	69.0		B									
59%	79.0		C			0.33		0.22	1.19	5.63	1.43	0.27
59%	84.0		D			0.06						0.20
59%	100.0		Water									
97%	43.1	SFR Low	A			1.29	0.00					
97%	64.7		B									
97%	76.2		C			0.23					1.09	0.05
97%	81.8		D									
97%	100.0		Water									
82%	49.0	SFR Med	A			0.05		1.55				0.99
82%	69.0		B									
82%	79.0		C			0.36		0.83	1.01	2.44	3.24	0.62
82%	84.0		D			0.28						0.17
82%	100.0		Water									
99%	39.5	SFR Rural	A									
99%	62.0		B									
99%	74.5		C									
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A	0.11			4.92	0.01				0.00
100%	60.0		B									
100%	60.0		C				0.08	0.00				
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A	53.86	1.21							
100%	65.0		B									
100%	70.0		C								3.31	
100%	80.0		D	0.65	2.33							
100%	80.0		Water									
		Grand Total		84.09	24.08	19.69	5.93	6.23	8.23	11.33	11.80	27.12

basin name	SRN20	SRN30	SRW10	SRW11	SRW12	SRW13	SRW14	SRW15	SRW20
area	84.09	24.08	19.69	5.93	6.23	8.23	11.33	11.80	27.12
pervious Area	60.59	16.21	8.84	5.14	3.56	5.76	6.54	8.65	14.70
Pervious CN	58.9	75.8	61.1	60.3	57.0	80.4	78.0	74.8	72.3
impervious	28%	33%	55%	13%	43%	30%	42%	27%	46%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Sum of Area

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	SRW30	SRW31	SRW32	SRW33	SRW40	SRW41	SRW42	SRW43	SRW44
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A		0.20				3.19			
14%	69.0		B									
14%	79.0		C		0.23		0.04	0.05	0.26			
14%	84.0		D						0.48			
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C			15.74						
75%	86.3		D			3.47						
75%	100.0		Water									
14%	49.0	Industrial	A		1.07		0.03		8.44			
14%	69.0		B									
14%	79.0		C					0.03				
14%	84.0		D		0.03				0.75			
14%	100.0		Water									
33%	49.0	Multi Family	A									
33%	69.0		B									
33%	79.0		C							1.14		
33%	84.0		D									
33%	100.0		Water									
100%	33.8	Open Space	A		2.86	9.24	0.50		9.30			
100%	57.8		B									
100%	71.8		C			56.05	11.05		7.43	18.89	8.83	5.16
100%	78.4		D		0.16	0.03						
100%	100.0		Water									
85%	50.8	Park/Recreation	A									
85%	69.6		B									
85%	79.4		C									
85%	84.1		D									
85%	100.0		Water									
80%	54.8	Public Institution	A									
80%	72.3		B									
80%	81.0		C				0.00					
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A		8.26	2.97	0.84		7.81			
14%	69.0		B									
14%	79.0		C		0.95	8.95	3.73		5.06	1.10	0.76	0.98
14%	84.0		D		1.76	0.20	0.91		3.18			
14%	100.0		Water									
59%	49.0	SFR High	A									
59%	69.0		B									
59%	79.0		C			8.31	2.80				0.00	0.36
59%	84.0		D			0.34						
59%	100.0		Water									
97%	43.1	SFR Low	A									
97%	64.7		B									
97%	76.2		C			6.40	1.04			0.58		4.59
97%	81.8		D									
97%	100.0		Water									
82%	49.0	SFR Med	A		0.28		0.10					
82%	69.0		B									
82%	79.0		C			22.64	3.10					1.48
82%	84.0		D			0.23						
82%	100.0		Water									
99%	39.5	SFR Rural	A									
99%	62.0		B									
99%	74.5		C			3.05				7.14	0.04	7.14
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A									
100%	60.0		B									
100%	60.0		C			0.71						
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A	1.67	0.02			1.65	13.86			
100%	65.0		B									
100%	70.0		C			5.67	3.89	16.62	2.23	3.18	0.00	
100%	80.0		D	4.40	0.03		0.29	1.73	5.00			
100%	80.0		Water									
		Grand Total		6.07	15.84	144.00	28.31	20.07	66.99	32.03	9.63	19.70

basin name	SRW30	SRW31	SRW32	SRW33	SRW40	SRW41	SRW42	SRW43	SRW44
area	6.07	15.84	144.00	28.31	20.07	66.99	32.03	9.63	19.70
pervious Area	6.07	5.05	120.88	21.78	20.01	41.91	30.24	8.98	18.24
Pervious CN	74.5	44.3	71.9	72.3	70.0	59.2	72.4	71.9	74.5
impervious	0%	68%	16%	23%	0%	37%	6%	7%	7%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	SRW45	SRW46	SRW47	SRW50	SRW51	SRW52	SRW53	SRW60	SRW70
		Sum of Area										
100%	60.5	Agriculture	A								2.01	
100%	75.5		B									
100%	83.0		C									
100%	86.5		D								0.97	
100%	100.0		Water									
14%	49.0	Commercial	A					2.49				
14%	69.0		B									
14%	79.0		C					0.80				
14%	84.0		D									
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C		0.11							
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A				0.54	6.30			24.48	
14%	69.0		B									
14%	79.0		C					0.10			0.83	
14%	84.0		D				8.71					
14%	100.0		Water									
33%	49.0	Multi Family	A		0.01							
33%	69.0		B									
33%	79.0		C		0.88							8.80
33%	84.0		D									
33%	100.0		Water									
100%	33.8	Open Space	A		5.22		0.36	2.22	7.67	0.36	18.99	
100%	57.8		B	1.85								
100%	71.8		C	0.33	35.23	2.38		1.46	4.77	12.00	49.55	0.78
100%	78.4		D				1.39		1.28	0.00	0.68	
100%	100.0		Water									
85%	50.8	Park/Recreation	A									
85%	69.6		B									
85%	79.4		C									
85%	84.1		D								0.01	
85%	100.0		Water								0.00	
80%	54.8	Public Institution	A									
80%	72.3		B									
80%	81.0		C								10.96	
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A		1.77		0.32	5.25	1.43	0.50	7.34	
14%	69.0		B	0.44								
14%	79.0		C	0.67	1.82	0.15		1.91	0.30	5.78	7.82	1.19
14%	84.0		D				0.60			0.01	0.52	
14%	100.0		Water								0.01	
59%	49.0	SFR High	A						0.15	0.22		
59%	69.0		B									
59%	79.0		C		0.20					3.79	13.07	0.11
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A						1.21		7.99	
97%	64.7		B	2.68								
97%	76.2		C	1.02	1.35	4.50					11.83	3.93
97%	81.8		D								2.34	
97%	100.0		Water									
82%	49.0	SFR Med	A									
82%	69.0		B	3.09								
82%	79.0		C	0.38	0.26					1.98	0.12	0.03
82%	84.0		D									
82%	100.0		Water									
99%	39.5	SFR Rural	A								17.92	
99%	62.0		B									
99%	74.5		C		6.21	5.08				0.78	11.28	
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A									
100%	60.0		B									
100%	60.0		C		8.50							
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A		0.69		1.34	0.01	0.02	1.44		
100%	65.0		B									
100%	70.0		C	5.64	23.29	0.09				17.92		8.48
100%	80.0		D				12.93					
100%	80.0		Water									
		Grand Total		16.10	85.53	12.20	26.18	20.52	16.84	44.79	188.73	23.33

basin name	SRW45	SRW46	SRW47	SRW50	SRW51	SRW52	SRW53	SRW60	SRW70
area	16.10	85.53	12.20	26.18	20.52	16.84	44.79	188.73	23.33
pervious Area	14.41	81.60	11.88	17.44	6.04	15.25	37.36	144.94	16.24
Pervious CN	68.0	67.8	74.6	77.5	50.9	50.6	71.0	62.3	73.3
impervious	11%	5%	3%	33%	71%	9%	17%	23%	30%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	SRW71	SRW72	SN20	SS10	SS20	WC05	WC10	WC11	WC12
			Sum of Area									
100%	60.5	Agriculture	A								0.01	
100%	75.5		B									
100%	83.0		C						1.00			
100%	86.5		D						2.47	0.00		
100%	100.0		Water									
14%	49.0	Commercial	A							31.26	1.52	3.37
14%	69.0		B									
14%	79.0		C				2.13					
14%	84.0		D									
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A									
14%	69.0		B									
14%	79.0		C									
14%	84.0		D									
14%	100.0		Water									
33%	49.0	Multi Family	A							9.29	5.03	2.51
33%	69.0		B									
33%	79.0		C						3.12			
33%	84.0		D						8.82	10.53	0.01	
33%	100.0		Water									
100%	33.8	Open Space	A							2.64	0.78	0.58
100%	57.8		B									
100%	71.8		C	0.87	0.04	15.36	5.27					
100%	78.4		D									
100%	100.0		Water									
85%	50.8	Park/Recreation	A									
85%	69.6		B									
85%	79.4		C						1.46			
85%	84.1		D									
85%	100.0		Water									
80%	54.8	Public Institution	A							0.82	3.35	0.23
80%	72.3		B									
80%	81.0		C				24.18					
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A							2.28	2.98	8.21
14%	69.0		B									
14%	79.0		C	2.10	1.98	3.50	18.16	0.75				
14%	84.0		D						0.00	2.76	0.03	
14%	100.0		Water									
59%	49.0	SFR High	A									
59%	69.0		B									
59%	79.0		C		0.05							
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A								0.00	13.83
97%	64.7		B									
97%	76.2		C	1.59	0.57	25.61	98.80	7.97				
97%	81.8		D									
97%	100.0		Water				0.42					
82%	49.0	SFR Med	A								0.00	13.87
82%	69.0		B									
82%	79.0		C	1.45	1.87	0.01	0.80	0.76				
82%	84.0		D									
82%	100.0		Water									
99%	39.5	SFR Rural	A								0.00	1.88
99%	62.0		B									
99%	74.5		C			18.02	32.50	2.90				
99%	80.5		D									
99%	100.0		Water				2.53					
100%	60.0	1998 Developmen	A									
100%	60.0		B									
100%	60.0		C				7.75					
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A							0.22	6.48	
100%	65.0		B									
100%	70.0		C	5.08	0.01		6.37	9.40				
100%	80.0		D							6.88	0.14	
100%	80.0		Water									
		Grand Total		11.09	4.51	62.49	198.91	21.78	16.87	66.67	20.33	44.49

basin name	SRW71	SRW72	SN20	SS10	SS20	WC05	WC10	WC11	WC12
area	11.09	4.51	62.49	198.91	21.78	16.87	66.67	20.33	44.49
pervious Area	8.98	2.44	58.54	173.16	20.73	8.65	22.02	12.39	29.87
Pervious CN	72.7	78.2	74.6	75.8	73.3	83.3	63.3	55.4	45.5
impervious	19%	46%	6%	13%	5%	49%	67%	39%	33%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE
Sum of Area

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	WC13	WC13.5	WC14	WC15	WC16	WC17	WC18	WC19.1	WC19.2
100%	60.5	Agriculture	A									
100%	75.5		B									
100%	83.0		C									
100%	86.5		D									
100%	100.0		Water									
14%	49.0	Commercial	A				9.70			21.01		
14%	69.0		B									
14%	79.0		C							0.56		
14%	84.0		D									
14%	100.0		Water									
75%	59.7	Greenhouse	A									
75%	75.1		B									
75%	82.7		C									
75%	86.3		D									
75%	100.0		Water									
14%	49.0	Industrial	A									
14%	69.0		B									
14%	79.0		C									
14%	84.0		D									
14%	100.0		Water									
33%	49.0	Multi Family	A				1.20			3.56	0.00	
33%	69.0		B									
33%	79.0		C				0.17			4.27	0.39	
33%	84.0		D									
33%	100.0		Water									
100%	33.8	Open Space	A	11.88	0.54		15.73	1.83	0.04	0.01	0.79	11.12
100%	57.8		B									
100%	71.8		C	8.11	4.21		1.16	0.01				0.55
100%	78.4		D									
100%	100.0		Water									
85%	50.8	Park/Recreation	A	7.09								
85%	69.6		B									
85%	79.4		C	0.14								
85%	84.1		D									
85%	100.0		Water									
80%	54.8	Public Institution	A	12.98								
80%	72.3		B									
80%	81.0		C	0.37								
80%	85.3		D									
80%	100.0		Water									
14%	49.0	ROW	A	6.66	3.88	0.45	6.57	6.08	1.76	4.95	5.06	2.75
14%	69.0		B									
14%	79.0		C	5.58	4.39	0.08	3.14	0.66		1.28	0.53	0.05
14%	84.0		D									
14%	100.0		Water									
59%	49.0	SFR High	A				0.21	1.39	0.32		1.07	0.03
59%	69.0		B									
59%	79.0		C									0.01
59%	84.0		D									
59%	100.0		Water									
97%	43.1	SFR Low	A	11.63	9.66	17.41	16.37	0.43	8.53		0.32	9.31
97%	64.7		B									
97%	76.2		C	58.49	27.79	3.17	29.24	0.58	3.48		0.22	2.79
97%	81.8		D									
97%	100.0		Water									
82%	49.0	SFR Med	A		0.23	0.02	15.86	19.31	4.84	0.12	12.04	7.77
82%	69.0		B									
82%	79.0		C	0.30	0.45		0.56	1.63	0.00	0.14	0.15	0.13
82%	84.0		D									
82%	100.0		Water									
99%	39.5	SFR Rural	A	11.90	2.23	9.10	0.52					2.29
99%	62.0		B									
99%	74.5		C	27.71	2.03	1.02	3.20		1.86			2.95
99%	80.5		D									
99%	100.0		Water									
100%	60.0	1998 Developmen	A									1.00
100%	60.0		B									
100%	60.0		C	0.96	2.50							1.66
100%	60.0		D									
100%	60.0		Water									
100%	60.0	1990 Developmen	A	2.25						0.82		
100%	65.0		B									
100%	70.0		C	5.93								
100%	80.0		D									
100%	80.0		Water									
		Grand Total		172.00	57.93	31.24	103.64	31.93	20.83	36.73	20.57	42.40

basin name	WC13	WC13.5	WC14	WC15	WC16	WC17	WC18	WC19.1	WC19.2
area	172.00	57.93	31.24	103.64	31.93	20.83	36.73	20.57	42.40
pervious Area	155.16	49.52	30.06	81.58	21.76	17.93	7.53	12.85	38.15
Pervious CN	64.1	66.2	46.5	56.0	50.3	54.0	57.3	49.1	47.7
impervious	10%	15%	4%	21%	32%	14%	80%	38%	10%

Subbasin Area and Composite CN Calculations
City of Woodinville
created by: sjs
checked by: jlc

PIVOT TABLE

Pervious Percent	Pervious Composite CN	Modified Land Use	Hyd Soil Type	Sum of Area: Grand Total
100%	60.5	Agriculture	A	2.02
100%	75.5		B	
100%	83.0		C	1.12
100%	86.5		D	4.16
100%	100.0		Water	
14%	49.0	Commercial	A	109.38
14%	69.0		B	45.98
14%	79.0		C	96.35
14%	84.0		D	30.56
14%	100.0		Water	
75%	59.7	Greenhouse	A	
75%	75.1		B	
75%	82.7		C	27.74
75%	86.3		D	3.47
75%	100.0		Water	
14%	49.0	Industrial	A	53.12
14%	69.0		B	3.48
14%	79.0		C	65.27
14%	84.0		D	22.03
14%	100.0		Water	
33%	49.0	Multi Family	A	30.59
33%	69.0		B	18.67
33%	79.0		C	36.93
33%	84.0		D	26.94
33%	100.0		Water	
100%	33.8	Open Space	A	164.53
100%	57.8		B	3.57
100%	71.8		C	462.86
100%	78.4		D	32.97
100%	100.0		Water	8.84
85%	50.8	Park/Recreation	A	8.92
85%	69.6		B	
85%	79.4		C	7.41
85%	84.1		D	7.45
85%	100.0		Water	0.04
80%	54.8	Public Institution	A	57.46
80%	72.3		B	0.00
80%	81.0		C	50.15
80%	85.3		D	0.41
80%	100.0		Water	
14%	49.0	ROW	A	182.77
14%	69.0		B	17.19
14%	79.0		C	283.40
14%	84.0		D	59.24
14%	100.0		Water	0.01
59%	49.0	SFR High	A	9.27
59%	69.0		B	4.84
59%	79.0		C	82.06
59%	84.0		D	0.60
59%	100.0		Water	
97%	43.1	SFR Low	A	164.17
97%	64.7		B	2.68
97%	76.2		C	962.05
97%	81.8		D	8.67
97%	100.0		Water	2.60
82%	49.0	SFR Med	A	115.39
82%	69.0		B	26.58
82%	79.0		C	116.18
82%	84.0		D	2.63
82%	100.0		Water	
99%	39.5	SFR Rural	A	68.39
99%	62.0		B	
99%	74.5		C	412.04
99%	80.5		D	2.83
99%	100.0		Water	2.53
100%	60.0	1998 Developmen	A	45.83
100%	60.0		B	
100%	60.0		C	63.82
100%	60.0		D	0.43
100%	60.0		Water	
100%	60.0	1990 Developmen	A	109.16
100%	65.0		B	
100%	70.0		C	165.50
100%	80.0		D	34.38
100%	80.0		Water	
		Grand Total		4327.67

basin name	
area	4327.67
pervious Area	3260.05
Pervious CN	68.2
impervious	25%

Single Basin SBUH/Level Pool Routing Analysis

City of Woodinville
created by: sjs
checked by:

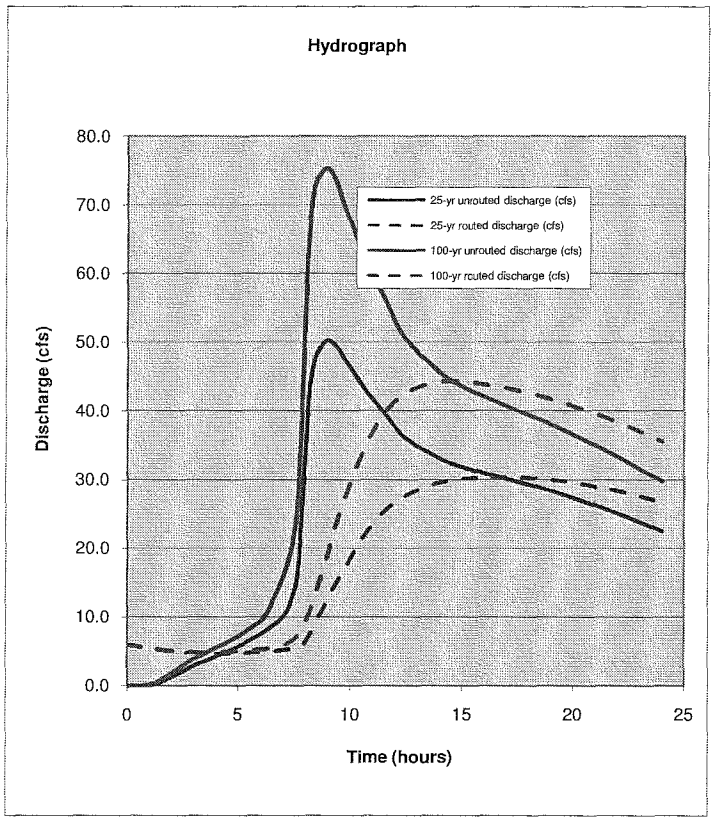
Purpose: Calculate routed discharge for basins with significant detention.
Basin: Lake Leota - LL10+
Method: Use Excel built-in SBUH and Level Pool Routing add-in tools.

Stage-Storage-Discharge Table

Surface Area = 10.7 acres (measured in cad using aerial photo)
outlet - assume cipolletti weir

weir base width (ft)	5
begin stage (ft)	0.5

stage (ft)	area (ac)	storage (ac-ft)	discharge (cfs)
0	10.7	0	0
0.5	10.7	5.35	6.0
1	10.7	10.7	16.8
1.5	10.7	16.05	30.9
2	10.7	21.4	47.6
2.5	10.7	26.75	66.5



SBUH Input

	25-yr	100-yr
25-yr, 24-hr precip (in)	3.3	4.0
SCS Storm	Type IA	

copied from subbasin combination calculations

area (ac)	474.9
pervious area (ac)	413.5
pervious CN-value	72.2
percent impervious	13%
basin length (ft)	8700
tc (min)	88.0

Results

	25-yr	100-yr
unrouted discharge (cfs)	50.3	75.4
routed discharge (cfs)	30.4	44.3

Single Basin SBUH/Level Pool Routing Analysis

City of Woodinville
created by: sjs
checked by:

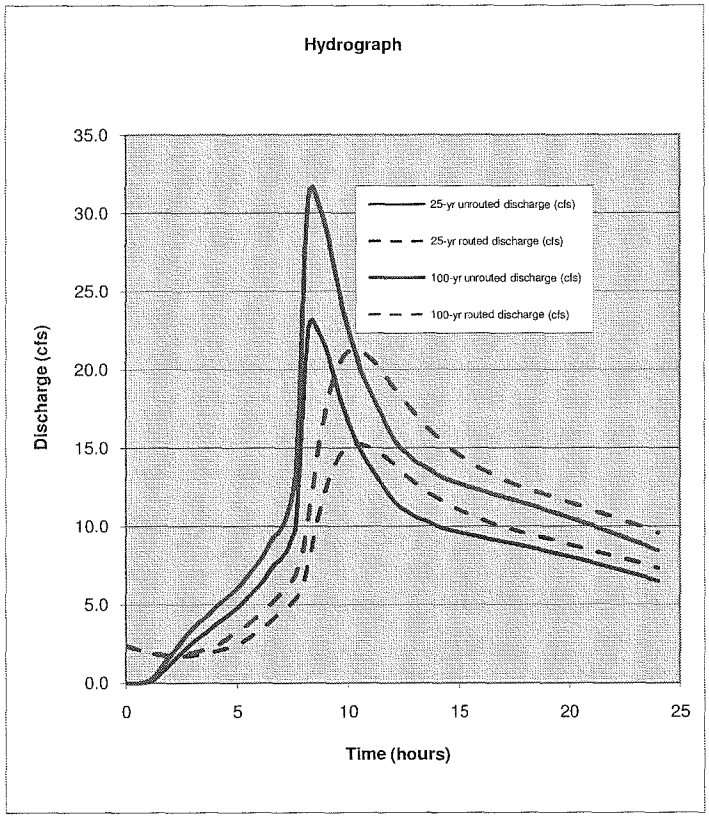
Purpose: Calculate routed discharge for basins with significant detention.
Basin: Little Bear Creek West 60 (LBW60+)
Method: Use Excel built-in SBUH and Level Pool Routing add-in tools.

Stage-Storage-Discharge Table

Surface Area = 2acres (approximated using aerial photo)
outlet - assume cipolletti weir (adjust width so that nearly entire volume is used)

weir base width (ft)	2
begin stage (ft)	0.5

stage (ft)	area (ac)	storage (ac-ft)	discharge (cfs)
0	2	0	0
0.5	2	1	2.4
1	2	2	6.7
1.5	2	3	12.4
2	2	4	19.0
2.5	2	5	26.6



SBUH Input

	25-yr	100-yr
25-yr, 24-hr precip (in)	3.3	4.0
SCS Storm	Type IA	

copied from subbasin combination calculations

area (ac)	135.7
pervious area (ac)	88.2
pervious CN-value	67.6
percent impervious	35%
basin length (ft)	5000
tc (min)	63.3

Results

	25-yr	100-yr
unrouted discharge (cfs)	23.2	31.7
routed discharge (cfs)	15.3	21.3

Single Basin SBUH/Level Pool Routing Analysis

City of Woodinville
created by: sjs
checked by:

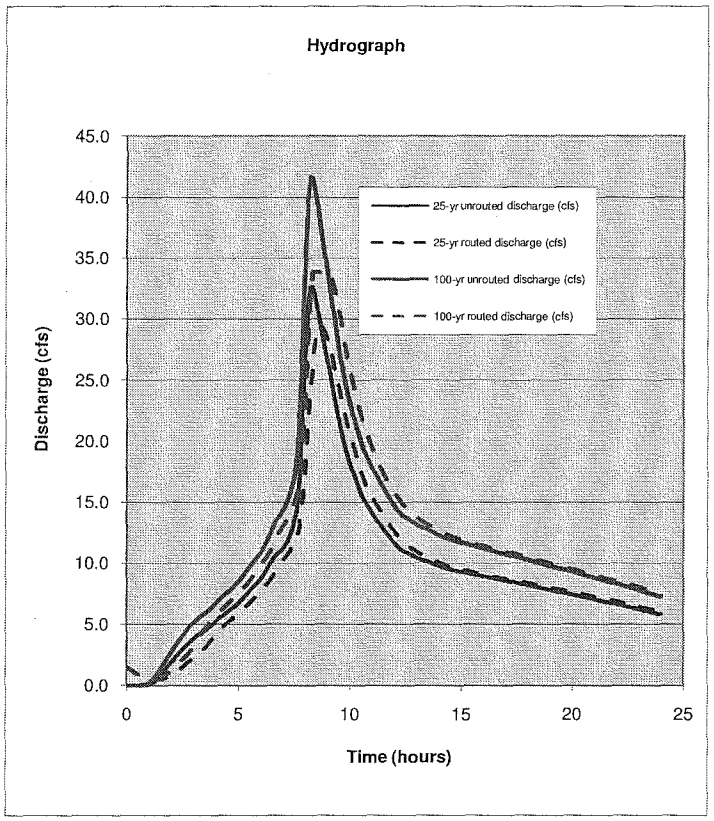
Purpose: Calculate routed discharge for basins with significant detention.
Basin: Little Bear Creek East (LBE13+)
Method: Use Excel built-in SBUH and Level Pool Routing add-in tools.

Stage-Storage-Discharge Table

Surface Area = .25 acres (approximated using aerial photo, 1000ftx10ft)
outlet - assume cipolletti weir (adjust width so that nearly entire volume is used)

weir base width (ft)	0.9
begin stage (ft)	0.5

stage (ft)	area (ac)	storage (ac-ft)	discharge (cfs)
0	0.25	0	0
1	0.25	0.25	3.0
2	0.25	0.5	8.6
3	0.25	0.75	15.7
4	0.25	1	24.2
5	0.25	1.25	33.9



SBUH Input

	25-yr	100-yr
25-yr, 24-hr precip (in)	3.3	4.0
SCS Storm	Type IA	

copied from subbasin combination calculations

area (ac)	100.3
pervious area (ac)	37.1
pervious CN-value	72.4
percent impervious	63%
basin length (ft)	2800
tc (min)	48.7

Results

	25-yr	100-yr
unrouted discharge (cfs)	32.6	41.6
routed discharge (cfs)	29.4	33.9

Single Basin SBUH/Level Pool Routing Analysis

City of Woodinville
created by: sjs
checked by:

Purpose: Calculate routed discharge for basins with significant detention.
Basin: Little Bear Creek East (LBE15+)
Method: Use Excel built-in SBUH and Level Pool Routing add-in tools.

Stage-Storage-Discharge Table

Surface Area = .50 acres (approximated using aerial photo, 1000ftx20ft)
outlet - assume cipolletti weir (adjust width so that nearly entire volume is used)

weir base width (ft)	1.2
begin stage (ft)	0.5

stage (ft)	area (ac)	storage (ac-ft)	discharge (cfs)
0	0.5	0	0
1	0.5	0.5	4.0
2	0.5	1	11.4
3	0.5	1.5	21.0
4	0.5	2	32.3
5	0.5	2.5	45.2

SBUH Input

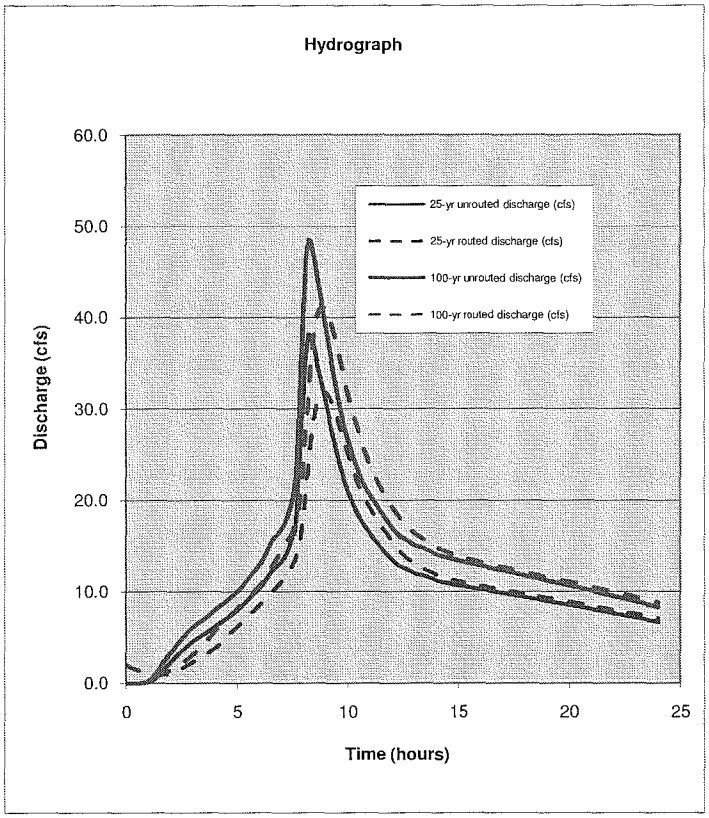
	25-yr	100-yr
25-yr, 24-hr precip (in)	3.3	4.0
SCS Storm	Type IA	

copied from subbasin combination calculations

area (ac)	113.4
pervious area (ac)	39.0
pervious CN-value	72.7
percent impervious	66%
basin length (ft)	2800
tc (min)	48.7

Results

	25-yr	100-yr
unrouted discharge (cfs)	38.2	48.5
routed discharge (cfs)	31.9	41.2



City of Woodinville Precipitation
City of Woodinville
created by: sjs
checked by: jlc

Purpose: Precipitation depths summarized in table below are used in the SBUH analysis.

Recurrence Interval	24-hr Precipitation Depths within the City Limits of Woodinville (in)		
	min	max	average
6-mo	1.41	1.56	1.5
2-yr	2.0	2.2	2.1
10-yr	2.7	2.9	2.8
25-yr	3.2	3.4	3.3
100-yr	3.9	4.1	4.0

source: MGS Engineering Consultants and Oregon Climate Service 1/2006. GIS IMG File.

SBUH Calculations and Combined Subbasin Area/CN Calculations

City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: Calculate peak discharges for the 25-yr and 100-yr events using the SBUH methodology.

Method:
1. Calculate area, pervious area, pervious CN, and percent impervious for the combined subbasins based on the subbasins areas and composite CNs.
2. Measured basin lengths were estimated using GIS for each of the combined subbasins
3. Approximate time of concentration based on an initial 30 minutes for sheet flow to concentrate plus concentrated flow velocity at 2.5 fps for the distance of the measured basin length.
4. Calculate the 25- and 100-yr peak flows using SBUH method (built-in Excel function). Precipitation is referenced on attached sheet.
5. Override values based on attached calculations. For example, the Lake Leota basin has additional natural storage/detention routing calculations.

combined subbasin ID	contributing subbasins (with percent indicating only portion of basin in case of diversion)	area (ac)	Perv. Area (ac)	Perv. CN	Percent Impervious	Meas'd Basin Length (ft)	Tc (min)	25-yr Peak Q (cfs)	100-yr Peak Q (cfs)	Override values 25-yr Peak Q (cfs)	Override values 100-yr Peak Q (cfs)
JC10+	JC10 JC11 JC12 JC13	118.3	62.0	73.6	48%	3300	52	31.5	41.4		
JC11+	JC11 JC12	39.4	26.8	77.4	32%	3300	52	9.4	12.8		
JC11	JC11	14.4	10.7	80.8	26%	1800	42	4.0	5.4		
JC12	JC12	25.0	16.1	75.2	36%	1800	42	6.4	8.7		
JC13	JC13	73.2	32.8	70.6	55%	2400	46	21.6	27.9		
SRW10+	SRW10 SRW11(15%) SRW12(15%) SRW13(5%) SRW14(5%) SRW15(5%)	23.1	11.2	62.4	51%	5700	68	4.9	6.3		
SRW11de	SRW11(15%) SRW12(15%) SRW13(5%) SRW14(5%) SRW15(5%)	3.4	2.4	67.2	31%	5700	68	0.5	0.7		
SRW11dw	SRW11(85%) SRW12(85%) SRW13(95%) SRW14(95%) SRW15(95%)	40.1	27.3	72.4	32%	3900	56	7.9	10.8		
SRW11+	SRW11 SRW12 SRW13(40%) SRW14(40%) SRW15(40%)	24.7	17.1	68.0	31%	3900	56	4.1	5.7		
SRW12+	SRW12 SRW13(40%) SRW14(40%) SRW15(40%)	18.8	11.9	71.3	36%	3200	51	4.0	5.4		
SRW13de	SRW13(40%) SRW14(40%) SRW15(40%) SRW15(40%)	17.3	11.8	76.6	31%	3200	51	4.0	5.5		
SRW13dw	SRW13(60%) SRW14(60%) SRW15(60%) SRW15(60%)	25.9	17.8	76.6	31%	3200	51	6.0	8.2		
SRW13+	SRW13 SRW14 SRW15	31.4	21.0	77.4	33%	2600	47	7.9	10.7		
SRW14+	SRW14 SRW15	23.1	15.2	76.2	34%	1900	43	6.0	8.1		
SRW15	SRW15	11.8	8.6	74.8	27%	1200	38	2.7	3.8		
SRW20	SRW20	27.1	14.7	72.3	46%	2400	46	7.2	9.5		
SRW30+	SRW30 SRW31 SRW32 SRW33	194.2	153.8	71.1	21%	6000	70	25.9	37.7		
SRW31+	SRW31 SRW32 SRW33	188.2	147.7	71.0	21%	5400	66	26.0	37.7		
SRW32	SRW32	144.0	120.9	71.9	16%	4800	62	18.7	27.9		
SRW33	SRW33	28.3	21.8	72.3	23%	2300	45	5.1	7.3		
SRW40+	SRW40 SRW41 SRW42 SRW43 SRW44 SRW45 SRW46 SRW47	262.3	227.3	68.1	13%	6300	72	23.7	36.7		
SRW41+	SRW41 SRW42 SRW43 SRW44 SRW45 SRW46 SRW47	242.2	207.3	67.9	14%	5900	69	22.7	35.0		
SRW42+	SRW42 SRW43 SRW44 SRW45 SRW47	89.7	83.7	72.4	7%	3700	55	9.8	15.6		
SRW44+	SRW44 SRW45	35.8	32.6	71.7	9%	1800	42	4.4	7.1		
SRW45	SRW45	16.1	14.4	68.0	11%	1500	40	1.6	2.7		
SRW47	SRW47	12.2	11.9	74.6	3%	1400	39	1.6	2.6		
SRW46	SRW46	85.5	81.6	67.8	5%	5900	69	5.5	9.4		
SRW51+	SRW51 SRW52 SRW53	82.2	58.7	63.6	29%	4300	59	11.1	15.4		
SRW52	SRW52	16.8	15.3	50.6	9%	2500	47	0.8	0.9		
SRW53	SRW53	44.8	37.4	71.0	17%	3100	51	6.1	9.2		
SRW60	SRW60	188.7	144.9	62.3	23%	5100	64	19.7	28.1		
SRW70+	SRW70 SRW71 SRW72 SRW11(95%) SRW12(95%) SRW13(95%) SRW14(95%) SRW15(95%)	79.1	55.0	73.0	30%	4600	61	14.9	20.5		
SRW71+	SRW71 SRW72 SRW13(60%) SRW14(60%) SRW15(60%)	34.4	24.0	75.7	30%	2900	49	7.8	10.7		
SRW72	SRW72	4.5	2.4	78.2	46%	1600	41	1.4	1.9		
SRE40	SRE40	11.3	5.6	48.1	50%	1100	37	2.9	3.6		
SRE50	SRE50	569.9	517.3	74.9	9%	8000	83	66.5	99.6		
SRN20+	SRN20 SRN10	98.5	62.8	59.4	36%	3600	54	16.0	20.8		
SRN20	SRN20	84.1	60.6	58.9	28%	4000	57	10.4	13.7		
SRN10	SRN10	14.4	2.2	72.9	85%	4000	57	5.5	6.9		
SRN30	SRN30	24.1	16.2	75.8	33%	1200	38	6.3	8.6		
WC10+	WC10 WC11 WC12 WC13 WC13.5 WC14 WC15 WC16 WC17 WC18 WC19.1 WC19.2	648.7	478.8	57.6	26%	11000	103	57.6	75.7		

SBUH Calculations and Combined Subbasin Area/CN Calculations

City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: Calculate peak discharges for the 25-yr and 100-yr events using the SBUH methodology.

Method:
1. Calculate area, pervious area, pervious CN, and percent impervious for the combined subbasins based on the subbasins areas and composite CNs.
2. Measured basin lengths were estimated using GIS for each of the combined subbasins
3. Approximate time of concentration based on an initial 30 minutes for sheet flow to concentrate plus concentrated flow velocity at 2.5 fps for the distance of the measured basin length.
4. Calculate the 25- and 100-yr peak flows using SBUH method (built-in Excel function). Precipitation is referenced on attached sheet.
5. Override values based on attached calculations. For example, the Lake Leota basin has additional natural storage/detention routing calculations.

combined subbasin ID	contributing subbasins (with percent indicating only portion of basin in case of diversion)								area (ac)	Perv. Area (ac)	Perv. CN	Percent Impervious	Meas'd Basin Length (ft)	Tc (min)	25-yr Peak Q (cfs)	100-yr Peak Q (cfs)	Override values 25-yr Peak Q (cfs)	Override values 100-yr Peak Q (cfs)
WC11	WC11								20.3	12.4	55.4	39%	2100	44	3.9	4.7		
WC12+	WC12	WC13	WC13.5	WC14					305.6	264.6	60.4	13%	8900	89	16.5	25.8		
WC13	WC13								172.0	155.2	64.1	10%	3900	56	11.0	18.5		
WC14+	WC14	WC13.5							89.2	79.6	58.8	11%	3500	53	4.4	7.0		
WC13.5	WC13.5								57.9	49.5	66.2	15%	3500	53	5.4	8.6		
WC15++	WC15	WC16	WC17	WC18	WC19.1	WC19.2			256.1	179.8	52.9	30%	3800	55	33.8	41.3		
WC15+	WC15	WC16	WC17						156.4	121.3	54.7	22%	3800	55	15.6	19.2		
WC15	WC15								103.6	81.6	56.0	21%	3800	55	9.8	12.4		
WC16+	WC16	WC17							52.8	39.7	52.0	25%	2300	45	6.3	7.7		
WC16	WC16								31.9	21.8	50.3	32%	2300	45	4.9	6.0		
WC18+	WC18	WC19.1	WC19.2						99.7	58.5	49.2	41%	5200	65	17.1	20.9		
WC19.1+	WC19.1	WC19.2							63.0	51.0	48.0	19%	2600	47	5.7	6.9		
LBE05	LBE05								25.2	11.2	71.7	56%	5400	66	6.5	8.4		
LBE11+	LBE11	LBE12	LBE13	LBE13.5	LBE14	LBE15			135.2	42.0	72.2	69%	2800	49	47.0	59.4		
LBE15+	LBE15	LBE13	LBE13.5	LBE14	LBE12				113.4	39.0	72.7	66%	2800	49	38.2	48.5	31.9	41.2
LBE13+	LBE13	LBE13.5	LBE14	LBE12					100.3	37.1	72.4	63%	2800	49	32.6	41.6	29.4	33.9
LBE13.5	LBE13.5								8.6	7.5	72.0	12%	2800	49	1.1	1.7		
LBE14+	LBE14	LBE12							59.3	25.0	72.5	58%	2800	49	18.1	23.4		
LBE14	LBE14								34.6	21.0	73.6	39%	2000	43	8.8	11.9		
LBE15	LBE15								13.1	1.8	79.0	86%	2000	43	5.8	7.2		
LBE10+	LBE10	LBE16	LBE17	LBE18	LBE19	LBE20			244.2	159.5	71.7	35%	8200	85	40.9	55.7		
LBE16	LBE16								8.5	1.3	78.1	85%	1900	43	3.7	4.6		
LBE17+	LBE17	LBE18	LBE19	LBE20					191.4	133.1	71.7	30%	8200	85	29.5	40.9		
LBE17++	LBE17	LBE18							86.1	47.9	74.2	44%	8200	85	17.9	23.7		
LBE18	LBE18								32.5	22.7	73.8	30%	2500	47	7.0	9.7		
LBE30	LBE30								15.5	2.9	77.9	81%	1900	43	6.7	8.3		
LBE40+	LBE40	LBE41	LBE42	LBE43	LBE44	LBE45	LBE47	LBE48	115.2	60.4	60.4	48%	3300	52	25.1	32.0		
LBE41+	LBE41	LBE42	LBE43	LBE44	LBE45				75.1	50.4	58.7	33%	800	35	13.1	16.9		
LBE42+	LBE42	LBE44							47.3	38.5	59.1	19%	1800	42	4.4	6.2		
LBE44	LBE44								8.5	5.2	47.3	38%	1200	38	1.7	2.0		
LBE45+	LBE45	LBE43							23.3	8.1	57.6	65%	2400	46	7.3	9.0		
LBE43	LBE43								8.6	3.8	52.2	56%	2000	43	2.3	2.8		
LBE47	LBE47								25.0	6.5	66.8	74%	3000	50	8.8	11.0		
LBE48	LBE48								10.1	2.7	75.1	74%	2100	44	3.9	5.0		
LBW15+	LBW15	LBW16							29.9	25.1	65.1	16%	1500	40	3.1	4.9		
LBW15	LBW15								15.6	11.1	75.7	29%	1500	40	3.8	5.2		
LBW16	LBW16								14.3	14.0	56.7	2%	1900	43	0.4	0.6		
LBW21	LBW21								7.3	7.2	43.4	1%	900	36	0.0	0.1		
LBW30	LBW30								36.4	32.1	59.4	12%	2400	46	2.1	3.3		
LBW40+	LBW40	LBW45							134.4	109.4	64.9	19%	3300	52	14.0	21.3		
LBW45	LBW45								69.3	58.0	70.9	16%	3800	55	9.0	13.6		

SBUH Calculations and Combined Subbasin Area/CN Calculations

City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: Calculate peak discharges for the 25-yr and 100-yr events using the SBUH methodology.

Method:
1. Calculate area, pervious area, pervious CN, and percent impervious for the combined subbasins based on the subbasins areas and composite CNs.
2. Measured basin lengths were estimated using GIS for each of the combined subbasins
3. Approximate time of concentration based on an initial 30 minutes for sheet flow to concentrate plus concentrated flow velocity at 2.5 fps for the distance of the measured basin length.
4. Calculate the 25- and 100-yr peak flows using SBUH method (built-in Excel function). Precipitation is referenced on attached sheet.
5. Override values based on attached calculations. For example, the Lake Leota basin has additional natural storage/detention routing calculations.

combined subbasin ID	contributing subbasins (with percent indicating only portion of basin in case of diversion)								area (ac)	Perv. Area (ac)	Perv. CN	Percent Impervious	Meas'd Basin Length (ft)	Tc (min)	25-yr Peak Q (cfs)	100-yr Peak Q (cfs)	Override values: 25-yr Peak Q (cfs)	Override values: 100-yr Peak Q (cfs)
LBW50+	LBW50	LBW55							27.4	21.8	60.0	21%	2400	46	2.7	3.9		
LBW55	LBW55								14.4	10.0	69.1	31%	1600	41	2.8	3.9		
LBW60+	LBW60	LBW65							135.7	88.2	67.6	35%	5000	63	23.2	31.7	14.1	19.7
LBW65	LBW65								83.0	47.5	77.3	43%	2400	46	23.8	31.5		
LBW70	LBW70								36.6	25.3	54.9	31%	2400	46	5.4	6.7		
SN20	SN20								62.5	58.5	74.6	6%	2100	44	8.8	13.7		
SS10+	SS10	SS20							220.7	193.9	75.5	12%	5900	69	30.8	45.6		
LL10+	LL10	LL20	LL30	LL40	LL50	LL60	LL70	LL80	474.9	413.5	72.2	13%	8700	88	50.3	75.4	30.4	44.3
LL20	LL20								57.5	52.2	67.3	9%	1600	41	5.2	8.7		
LL30+	LL30	LL40	LL50	LL60	LL70				300.8	256.5	71.1	15%	6000	70	34.3	51.7		
LL40+	LL40	LL50	LL60	LL70					236.7	203.4	74.1	14%	5600	67	32.0	47.4		
LL50	LL50								13.4	4.5	69.0	66%	1500	40	4.7	6.0		
LL60	LL60								140.8	125.7	74.2	11%	2600	47	20.9	31.6		
LL70	LL70								35.2	29.0	75.9	18%	3700	55	6.3	9.0		
LL80	LL80								53.5	48.5	74.4	9%	2800	49	7.7	11.7		

Pipe Capacity Calculations
City of Woodinville
created by: sjs
checked by: jlc

Purpose: Calculate typical storm pipe and culvert capacities based on typical pipe configurations.
Method: Use built-in excel function that solves the FHWA HDS-5 methodology.
Assumptions:

1. Slope varies from 2% for smaller dia. pipes to 0.5% for large dia. pipes.
2. Maximum headwater depth is set at 3 feet above the pipe crown.
3. Tailwater is set equal to the half the diameter of the pipe.

Round Concrete or Polyethylene

Pipe Size (in)	n-value	assum'd Length (ft)	assum'd slope (ft/ft)	Headwtr (ft)	Tailwtr (ft)	Calc'd Capacity (cfs)
12	0.013	300	0.02	4.0	0.5	5.8
15	0.013	300	0.02	4.3	0.6	10.2
18	0.013	300	0.02	4.5	0.8	16.2
24	0.013	300	0.02	5.0	1.0	30.2
30	0.013	300	0.01	5.5	1.3	47.3
36	0.013	300	0.01	6.0	1.5	70.9
42	0.013	300	0.01	6.5	1.8	98.5
48	0.013	300	0.005	7.0	2.0	128.5
54	0.013	300	0.005	7.5	2.3	169.0
60	0.013	300	0.005	8.0	2.5	212.5
72	0.013	300	0.005	9.0	3.0	316.7
84	0.013	300	0.005	10.0	3.5	445.3

Round CMP

Pipe Size (in)	n-value	assum'd Length (ft)	assum'd slope (ft/ft)	Headwtr (ft)	Tailwtr (ft)	Calc'd Capacity (cfs)
12	0.024	300	0.02	4.0	0.5	3.3
15	0.024	300	0.02	4.3	0.6	5.9
18	0.024	300	0.02	4.5	0.8	9.5
24	0.024	300	0.02	5.0	1.0	20.3
30	0.024	300	0.01	5.5	1.3	30.0
36	0.024	300	0.01	6.0	1.5	48.0
42	0.024	300	0.01	6.5	1.8	71.7
48	0.024	300	0.005	7.0	2.0	89.3
54	0.024	300	0.005	7.5	2.3	120.7
60	0.024	300	0.005	8.0	2.5	158.3
72	0.024	300	0.005	9.0	3.0	251.7
84	0.024	300	0.005	10.0	3.5	371.1

Manning Roughness Values
City of Woodinville
created by: sjs
checked by: jlc

Purpose: Assign Manning's roughness values to pipes materials reported by GIS database

Material reported by GIS	Assigned Manning's Roughness
CMP	0.024
CONC	0.013
Concrete	0.013
CP	0.024
CPEP	0.011
DI	0.013
HDPE	0.011
OTHER	0.024
PCV	0.011
PVC	0.011
Steel	0.013
0	0.024
(blank)	0.024
????	0.024

note: blank and unknown values are conservatively assumed to have an n-value of 0.024.

Hydraulic Capacity Performance Analysis
City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: A hydraulic capacity performance analysis for selected pipe segments throughout the City is summarized below.
Method:
1. Input pipe segment related to the GIS database pipe ID.
2. Input combined subbasin ID based on location of pipe and contributing subbasins.
3. 25-yr and 100-yr peak discharges are looked up automatically from SBUH calculation spreadsheet.
4. Pipe size and type are looked up from GIS database.
5. Approximate capacity is looked up from pipe capacity calculations.
6. Percent capacity during 25-year peak flow event equal to 25-year peak dischage divided by approximate capacity.

Pipe ID	combined subbasin ID	25-yr Peak Discharge (cfs)	100-yr Peak Discharge (cfs)	Pipe Size (in)	Pipe Type	n-value	Approx. Capacity (cfs)	Percent Capacity during 25-yr Peak Flow	comment
CB20052CB20627	JC10+	31.5	41.4	36	Concrete	0.013	70.9	44%	
CB20046CB20052	JC10+	31.5	41.4	36	Concrete	0.013	70.9	44%	
CB20048CB20046	JC11+	9.4	12.8	24	CMP	0.024	20.3	47%	
CB1233CB20048	JC11	4.0	5.4	12	Concrete	0.013	5.8	69%	
CB20537CB20048	JC12	6.4	8.7	24	Concrete	0.013	30.2	21%	
CB20538CB20537	JC12	6.4	8.7	24	Concrete	0.013	30.2	21%	
IO1235CB20046	JC13	21.6	27.9	24	CMP	0.024	20.3	106%	
IO1843IO2640	LBE05	6.5	8.4	12	0	0.024	3.3	198%	
CB2294IO2932	LBE05	6.5	8.4	12	Concrete	0.013	5.8	112%	
IO2442CB2292	LBE05	6.5	8.4	12	HDPE	0.011	5.8	112%	
IO2443IO3208	LBE05	6.5	8.4	12	Concrete	0.013	5.8	112%	
CB2295IO2933	LBE05	6.5	8.4	12	Concrete	0.013	5.8	112%	
IO1088UNDEFINED	LBE11+	47.0	59.4	42	CMP	0.024	71.7	66%	
CB3142IO1089	LBE11+	47.0	59.4	18	HDPE	0.011	16.2	291%	
IO1090CB3142	LBE11+	47.0	59.4	18	CONC	0.013	16.2	291%	
IO1097IO1096	LBE15+	31.9	41.2	18	OTHER	0.024	9.5	335%	
CB21120IO1154	LBE13.5	1.1	1.7	12	CMP	0.024	3.3	34%	
CB3277CB3278	LBE13.5	1.1	1.7	12	CMP	0.024	3.3	34%	
CB3274CB3277	LBE13.5	1.1	1.7	12	CMP	0.024	3.3	34%	
CB21118CB21116	LBE13.5	1.1	1.7	12	CMP	0.024	3.3	34%	
CB21117CB21118	LBE13.5	1.1	1.7	48	CMP	0.024	89.3	1%	
IO1156IO1155	LBE14+	18.1	23.4	24	CMP	0.024	20.3	89%	
CB21121IO1157	LBE14+	18.1	23.4	24	CONC	0.013	30.2	60%	
CB3280CB21121	LBE14+	18.1	23.4	24	CONC	0.013	30.2	60%	
CB3281CB3280	LBE14+	18.1	23.4	24	CMP	0.024	20.3	89%	
CB21122CB3281	LBE14+	18.1	23.4	24	CONC	0.013	30.2	60%	
UNDEFINEDCB21028	LBE15	5.8	7.2	18	HDPE	0.011	16.2	36%	
CB21129CB21128	LBE15	5.8	7.2	18	HDPE	0.011	16.2	36%	
CB21130CB21129	LBE15	5.8	7.2	18	HDPE	0.011	16.2	36%	
CB21131CB21130	LBE15	5.8	7.2	15	DI	0.013	10.2	57%	
IO1241IO1489	LBE10+	40.9	55.7	48	Concrete	0.013	128.5	32%	
CB21145IO1490	LBE10+	40.9	55.7	48	DI	0.013	128.5	32%	
IO1080CB21145	LBE10+	40.9	55.7	48	DI	0.013	128.5	32%	
IO1082IO1081	LBE10+	40.9	55.7	36	CONC	0.013	70.9	58%	
PIPECONNECTIO1083	LBE10+	40.9	55.7	30	Concrete	0.013	47.3	86%	
IO1240PIPECONNECT	LBE10+	40.9	55.7	30	CMP	0.024	30.0	136%	
CB20721IO1245	LBE10+	40.9	55.7	36	CMP	0.024	48.0	85%	
CB20611CB20721	LBE10+	40.9	55.7	36	HDPE	0.011	70.9	58%	
CB20606CB20611	LBE10+	40.9	55.7	36	HDPE	0.011	70.9	58%	
IO1231CB20606	LBE10+	40.9	55.7	36	HDPE	0.011	70.9	58%	
CB20739CB2028	LBE16	3.7	4.6	12	0	0.024	3.3	114%	
CB2643CB20739	LBE16	3.7	4.6	60	CMP	0.024	158.3	2%	
CB20316CB2028	LBE17+	29.5	40.9	12	HDPE	0.011	5.8	510%	
CB21110IO1151	LBE17+	29.5	40.9	18	CONC	0.013	16.2	183%	
CB21111CB21110	LBE17++	17.9	23.7	24	CMP	0.024	20.3	88%	
CB21112CB21111	LBE17++	17.9	23.7	24	CMP	0.024	20.3	88%	
CB21113CB21112	LBE17++	17.9	23.7	24	CMP	0.024	20.3	88%	
CB21114CB21113	LBE17++	17.9	23.7	24	CMP	0.024	20.3	88%	
CB21115CB21114	LBE18	7.0	9.7	24	CMP	0.024	20.3	35%	
CB3253CB21115	LBE18	7.0	9.7	12	CMP	0.024	3.3	213%	
CB21033IO1099	LBE30	6.7	8.3	24	CMP	0.024	20.3	33%	
CB2493CB21033	LBE30	6.7	8.3	24	CMP	0.024	20.3	33%	

Hydraulic Capacity Performance Analysis
City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: A hydraulic capacity performance analysis for selected pipe segments throughout the City is summarized below.
Method:

1. Input pipe segment related to the GIS database pipe ID.
2. Input combined subbasin ID based on location of pipe and contributing subbasins.
3. 25-yr and 100-yr peak discharges are looked up automatically from SBUH calculation spreadsheet.
4. Pipe size and type are looked up from GIS database.
5. Approximate capacity is looked up from pipe capacity calculations.
6. Percent capacity during 25-year peak flow event equal to 25-year peak dischage divided by approximate capacity.

Pipe ID	combined subbasin ID	25-yr Peak Discharge (cfs)	100-yr Peak Discharge (cfs)	Pipe Size (in)	Pipe Type	n-value	Approx. Capacity (cfs)	Percent Capacity during 25-yr Peak Flow	comment
IO3270CB2493	LBE30	6.7	8.3	18	0	0.024	9.5	70%	
IO3269CB2493	LBE30	6.7	8.3	18	CMP	0.024	9.5	70%	
IO1296CB20324	LBE30	6.7	8.3	24	Concrete	0.013	30.2	22%	
CB3161IO1101	LBE30	6.7	8.3	18	CMP	0.024	9.5	70%	
CB21035CB3161	LBE30	6.7	8.3	18	CMP	0.024	9.5	70%	
CB3160CB21035	LBE30	6.7	8.3	12	PVC	0.011	5.8	115%	
CB3159CB3160	LBE30	6.7	8.3	12	PVC	0.011	5.8	115%	
CB21034CB3159	LBE30	6.7	8.3	18	CONC	0.013	16.2	41%	
CB3158CB21034	LBE30	6.7	8.3	18	CMP	0.024	9.5	70%	
CB3172CB21046	LBE48	3.9	5.0	18	CMP	0.024	9.5	41%	
IO1107CB3172	LBE48	3.9	5.0	18	CONC	0.013	16.2	24%	
CB3181IO1122	LBE40+	25.1	32.0	18	CMP	0.024	9.5	263%	
CB3180CB3181	LBE40+	25.1	32.0	18	CMP	0.024	9.5	263%	
IO1158IO1117	LBE40+	25.1	32.0	36	CONC	0.013	70.9	35%	
CB1812IO1495	LBE41+	13.1	16.9	24	Concrete	0.013	30.2	43%	
IO1243CB1812	LBE41+	13.1	16.9	24	Concrete	0.013	30.2	43%	
IO3303IO3304	LBE41+	13.1	16.9	60	CMP	0.024	158.3	8%	
PIPECONNECTIO1415	LBE41+	13.1	16.9	72	CMP	0.024	251.7	5%	
CB20232PIPECONNECT	LBE41+	13.1	16.9	24	CMP	0.024	20.3	64%	
IO1184CB20232	LBE42+	4.4	6.2	72	CMP	0.024	251.7	2%	
IO3265IO3266	LBE42+	4.4	6.2	72	CMP	0.024	251.7	2%	
CB20295IO1590	LBE44	1.7	2.0	30	Concrete	0.013	47.3	4%	
CB20231CB20232	LBE45+	7.3	9.0	18	Concrete	0.013	16.2	45%	
CB21090CB21091	LBE45+	7.3	9.0	18	CONC	0.013	16.2	45%	
CB20701CB21090	LBE45+	7.3	9.0	18	CONC	0.013	16.2	45%	
CB20702CB20701	LBE45+	7.3	9.0	24	CMP	0.024	20.3	36%	
CB2581CB2590	LBE45+	7.3	9.0	24	Concrete	0.013	30.2	24%	
CB2582CB2581	LBE45+	7.3	9.0	24	Concrete	0.013	30.2	24%	
CB2583CB2582	LBE45+	7.3	9.0	24	CMP	0.024	20.3	36%	
CB2579CB2583	LBE45+	7.3	9.0	24	CMP	0.024	20.3	36%	
CB2580CB2579	LBE43	2.3	2.8	18	CMP	0.024	9.5	24%	
CB2578CB2580	LBE43	2.3	2.8	24	CMP	0.024	20.3	11%	
CB20502CB2578	LBE43	2.3	2.8	24	CMP	0.024	20.3	11%	
CB20501CB20502	LBE43	2.3	2.8	15	CMP	0.024	5.9	39%	
CB20500CB20501	LBE43	2.3	2.8	15	CMP	0.024	5.9	39%	
IO1016IO1015	LBW15+	3.1	4.9	24	CONC	0.013	30.2	10%	
CB3044CB3043	LBW15	3.8	5.2	12	HDPE	0.011	5.8	65%	
CB0935CB3044	LBW15	3.8	5.2	12	HDPE	0.011	5.8	65%	
CB3045CB0935	LBW15	3.8	5.2	12	HDPE	0.011	5.8	65%	
IO1018CB3045	LBW15	3.8	5.2	12	HDPE	0.011	5.8	65%	
IO1006IO1005	LBW21	0.0	0.1	18	CONC	0.013	16.2	0%	
CB3016IO1003	LBW30	2.1	3.3	12	CONC	0.013	5.8	36%	
CB3016IO1003	LBW40+	14.0	21.3	12	CONC	0.013	5.8	242%	
PIPECONNECTIO1002	LBW40+	14.0	21.3	36	CMP	0.024	48.0	29%	
CB3001PIPECONNECT	LBW40+	14.0	21.3	18	CMP	0.024	9.5	147%	
CB20748IO2724	LBW45	9.0	13.6	12	Concrete	0.013	5.8	156%	
CB20356CB20748	LBW45	9.0	13.6	18	HDPE	0.011	16.2	56%	
CB2657CB20356	LBW45	9.0	13.6	18	HDPE	0.011	16.2	56%	
CB2555CB2556	LBW50+	2.7	3.9	12	CMP	0.024	3.3	83%	
CB2375IO1569	LBW55	2.8	3.9	12	HDPE	0.011	5.8	49%	
CB2173CB2375	LBW55	2.8	3.9	12	HDPE	0.011	5.8	49%	
CB20532IO1575	LBW60+	14.1	19.7	24	CMP	0.024	20.3	70%	

Hydraulic Capacity Performance Analysis
City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: A hydraulic capacity performance analysis for selected pipe segments throughout the City is summarized below.
Method:

1. Input pipe segment related to the GIS database pipe ID.
2. Input combined subbasin ID based on location of pipe and contributing subbasins.
3. 25-yr and 100-yr peak discharges are looked up automatically from SBUH calculation spreadsheet.
4. Pipe size and type are looked up from GIS database.
5. Approximate capacity is looked up from pipe capacity calculations.
6. Percent capacity during 25-year peak flow event equal to 25-year peak dischage divided by approximate capacity.

Pipe ID	combined subbasin ID	25-yr Peak Discharge (cfs)	100-yr Peak Discharge (cfs)	Pipe Size (in)	Pipe Type	n-value	Approx. Capacity (cfs)	Percent Capacity during 25-yr Peak Flow	comment
CB20531CB20532	LBW60+	14.1	19.7	18	CMP	0.024	9.5	148%	
CB20325IO1502	LBW65	23.8	31.5	28	0	0.024	20.3	118%	
PIPECONNECTCB20325	LBW65	23.8	31.5	24	CPEP	0.011	30.2	79%	
CB20722PIPECONNECT	LBW65	23.8	31.5	24	CMP	0.024	20.3	118%	
CB20333CB20722	LBW65	23.8	31.5	24	CMP	0.024	20.3	118%	
CB20332CB20333	LBW65	23.8	31.5	24	CMP	0.024	20.3	118%	
CB2610IO1646	LBW65	23.8	31.5	12	CMP	0.024	3.3	726%	
CB20331CB2076	LBW65	23.8	31.5	18	CMP	0.024	9.5	250%	
CB20919CB20899	LL10+	30.4	44.3	24	CMP	0.024	20.3	150%	
CB20900CB20919	LL10+	30.4	44.3	24	CMP	0.024	20.3	150%	
IO1883CB20900	LL10+	30.4	44.3	24	Concrete	0.013	30.2	101%	
IO2115CB0822	SS10+	30.8	45.6	18	CMP	0.024	9.5	323%	
IO1884IO2704	LL80	7.7	11.7	12	Concrete	0.013	5.8	133%	
IO1676CB20723	LL80	7.7	11.7	12	CPEP	0.011	5.8	133%	
CB0644CB0645	LL20	5.2	8.7	12	Concrete	0.013	5.8	89%	
IO2104CB0644	LL20	5.2	8.7	12	HDPE	0.011	5.8	89%	
IO2151CB21147	LL30+	34.3	51.7	24	CMP	0.024	20.3	169%	
CB20763IO2667	LL40+	32.0	47.4	24	0	0.024	20.3	158%	
IO1837CB20763	LL40+	32.0	47.4	24	0	0.024	20.3	158%	
IO1029IO1030	LL40+	32.0	47.4	24	CONC	0.013	30.2	106%	
CB2990IO2924	LL60	20.9	31.6	12	HDPE	0.011	5.8	361%	
IO2428CB2990	LL60	20.9	31.6	12	HDPE	0.011	5.8	361%	
IO2429IO2925	LL70	6.3	9.0	12	CMP	0.024	3.3	191%	
IO2485IO3247	SN20	8.8	13.7	24	Concrete	0.013	30.2	29%	
IO2482IO3246	SN20	8.8	13.7	24	Concrete	0.013	30.2	29%	
IO2482IO3246	SRN10	5.5	6.9	24	Concrete	0.013	30.2	18%	
CB23024CB20675	SRN20+	16.0	20.8	30	CMP	0.024	30.0	53%	
CB20190VT	SRN20	10.4	13.7	24	CMP	0.024	20.3	51%	
CB20200CB20190	SRN20	10.4	13.7	24	CMP	0.024	20.3	51%	
CB20199CB20200	SRN20	10.4	13.7	24	CMP	0.024	20.3	51%	
CB20189CB20199	SRN20	10.4	13.7	24	CMP	0.024	20.3	51%	
CB20188CB20189	SRN20	10.4	13.7	24	CMP	0.024	20.3	51%	
CB20187CB20188	SRN20	10.4	13.7	24	CMP	0.024	20.3	51%	
CB20567IO1498	SRN30	6.3	8.6	24	HDPE	0.011	30.2	21%	
CB20568CB20567	SRN30	6.3	8.6	24	HDPE	0.011	30.2	21%	
CB20150CB20568	SRN30	6.3	8.6	24	HDPE	0.011	30.2	21%	
IO1374IO1648	WC10+	57.6	75.7	48	CMP	0.024	89.3	64%	48" equivalent
IO1246IO1497	WC10+	57.6	75.7	65	Concrete	0.013	212.5	27%	
IO1191IO1422	WC10+	57.6	75.7	36	CMP	0.024	48.0	120%	
IO1192IO1423	WC10+	57.6	75.7	36	CMP	0.024	48.0	120%	
CB20588IO1571	WC11	3.9	4.7	24	CMP	0.024	20.3	19%	
CB20158CB20588	WC11	3.9	4.7	24	Concrete	0.013	30.2	13%	
CB20161CB20160	WC11	3.9	4.7	24	CPEP	0.011	30.2	13%	
CB20162CB20161	WC11	3.9	4.7	24	CPEP	0.011	30.2	13%	
CB21066CB21065	WC12+	16.5	25.8	36	CONC	0.013	70.9	23%	
CB21067CB21066	WC12+	16.5	25.8	36	CONC	0.013	70.9	23%	
CB21068CB21067	WC12+	16.5	25.8	36	CONC	0.013	70.9	23%	
CB21069CB21068	WC12+	16.5	25.8	36	CONC	0.013	70.9	23%	
CB21070CB21069	WC12+	16.5	25.8	36	CONC	0.013	70.9	23%	
CB21071CB21070	WC12+	16.5	25.8	36	CONC	0.013	70.9	23%	
CB21072CB21071	WC12+	16.5	25.8	36	CONC	0.013	70.9	23%	
CB21073CB21072	WC12+	16.5	25.8	36	CMP	0.024	48.0	34%	

Hydraulic Capacity Performance Analysis
City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: A hydraulic capacity performance analysis for selected pipe segments throughout the City is summarized below.
Method:

1. Input pipe segment related to the GIS database pipe ID.
2. Input combined subbasin ID based on location of pipe and contributing subbasins.
3. 25-yr and 100-yr peak discharges are looked up automatically from SBUH calculation spreadsheet.
4. Pipe size and type are looked up from GIS database.
5. Approximate capacity is looked up from pipe capacity calculations.
6. Percent capacity during 25-year peak flow event equal to 25-year peak dischage divided by approximate capacity.

Pipe ID	combined subbasin ID	25-yr Peak Discharge (cfs)	100-yr Peak Discharge (cfs)	Pipe Size (in)	Pipe Type	n-value	Approx. Capacity (cfs)	Percent Capacity during 25-yr Peak Flow	comment
CB0542IO3228	WC13	11.0	18.5	24	CMP	0.024	20.3	54%	
CB0543CB0542	WC13	11.0	18.5	24	CMP	0.024	20.3	54%	
CB20904CB20902	WC13	11.0	18.5	24	0	0.024	20.3	54%	
CB20905CB20904	WC13	11.0	18.5	24	0	0.024	20.3	54%	
INCOMINGCB20905	WC13	11.0	18.5	24	0	0.024	20.3	54%	
CBIO2955	WC14+	4.4	7.0	12	CMP	0.024	3.3	133%	
CB0549CB0550	WC14+	4.4	7.0	12	CMP	0.024	3.3	133%	
CB0548CB0549	WC14+	4.4	7.0	12	CMP	0.024	3.3	133%	
CB0547CB0548	WC14+	4.4	7.0	12	CMP	0.024	3.3	133%	
CB0546CB0547	WC13.5	5.4	8.6	12	CMP	0.024	3.3	166%	
CB0545CB0546	WC13.5	5.4	8.6	12	CMP	0.024	3.3	166%	
CB0544CB0545	WC13.5	5.4	8.6	12	CMP	0.024	3.3	166%	
CB21074CB21063	WC15++	33.8	41.3	30	CONC	0.013	47.3	71%	
CB21075CB21074	WC15++	33.8	41.3	30	CONC	0.013	47.3	71%	
UNDEFINEDCB21075	WC15+	15.6	19.2	24	CONC	0.013	30.2	52%	
CB20745CB20743	WC15+	15.6	19.2	21	Concrete	0.013	16.2	96%	
CB20744CB20745	WC15+	15.6	19.2	21	Concrete	0.013	16.2	96%	
CB20842CB20744	WC15+	15.6	19.2	18	Concrete	0.013	16.2	96%	
CB20843CB20842	WC15+	15.6	19.2	18	Concrete	0.013	16.2	96%	
CB21097CB20843	WC15+	15.6	19.2	24	CONC	0.013	30.2	52%	
CB3239CB21097	WC15+	15.6	19.2	18	CMP	0.024	9.5	163%	
CB21098CB3239	WC15+	15.6	19.2	18	CMP	0.024	9.5	163%	
CB21099CB21098	WC15+	15.6	19.2	18	CMP	0.024	9.5	163%	
IO1135CB21099	WC15+	15.6	19.2	12	CMP	0.024	3.3	474%	
CB21095IO1132	WC15	9.8	12.4	24	CMP	0.024	20.3	48%	
IO1131CB21095	WC15	9.8	12.4	18	CMP	0.024	9.5	103%	
CB21096CB21095	WC16+	6.3	7.7	18	CMP	0.024	9.5	66%	
IO1133CB21096	WC16+	6.3	7.7	18	CMP	0.024	9.5	66%	
CB20792IO2788	WC16+	6.3	7.7	12	CMP	0.024	3.3	191%	
CB20791CB20792	WC16	4.9	6.0	18	Concrete	0.013	16.2	30%	
CB21076CB21075	WC18+	17.1	20.9	30	CONC	0.013	47.3	36%	
CB21077CB21076	WC18+	17.1	20.9	30	CMP	0.024	30.0	57%	
CB21081CB21077	WC18+	17.1	20.9	30	CMP	0.024	30.0	57%	
CB21081CB21080	WC18+	17.1	20.9	30	CMP	0.024	30.0	57%	
CB21082CB21080	WC18+	17.1	20.9	30	CMP	0.024	30.0	57%	
CB21083CB21082	WC18+	17.1	20.9	24	CONC	0.013	30.2	57%	
CB21084CB21083	WC18+	17.1	20.9	24	CONC	0.013	30.2	57%	
CB3213CB21084	WC18+	17.1	20.9	18	CONC	0.013	16.2	106%	
CB21087CB3213	WC18+	17.1	20.9	18	CONC	0.013	16.2	106%	
CB3236CB21087	WC18+	17.1	20.9	18	CONC	0.013	16.2	106%	
CB1853CB3236	WC18+	17.1	20.9	18	CMP	0.024	9.5	180%	
CB1854CB1853	WC19.1+	5.7	6.9	12	Concrete	0.013	5.8	98%	
CB1855CB1854	WC19.1+	5.7	6.9	12	Concrete	0.013	5.8	98%	
IO1379CB1855	WC19.1+	5.7	6.9	18	Concrete	0.013	16.2	35%	
CB20677IO1663	WC19.1+	5.7	6.9	24	CMP	0.024	20.3	28%	
CB20715CB20677	WC19.1+	5.7	6.9	24	Concrete	0.013	30.2	19%	
IO1237IO1485	SRE50	66.5	99.6	36	Concrete	0.013	70.9	94%	
IO1236IO1484	SRE50	66.5	99.6	36	Concrete	0.013	70.9	94%	
IO1352IO1556	SRE50	66.5	99.6	36	Concrete	0.013	70.9	94%	
CB20912IO1433	SRE40	2.9	3.6	18	CMP	0.024	9.5	31%	
CB0847CB20912	SRE40	2.9	3.6	18	CPEP	0.011	16.2	18%	
CB0842CB0847	SRE40	2.9	3.6	18	DI	0.013	16.2	18%	

Hydraulic Capacity Performance Analysis
City of Woodinville
created by: sjs/jlc
checked by: sjs

Purpose: A hydraulic capacity performance analysis for selected pipe segments throughout the City is summarized below.
Method:

1. Input pipe segment related to the GIS database pipe ID.
2. Input combined subbasin ID based on location of pipe and contributing subbasins.
3. 25-yr and 100-yr peak discharges are looked up automatically from SBUH calculation spreadsheet.
4. Pipe size and type are looked up from GIS database.
5. Approximate capacity is looked up from pipe capacity calculations.
6. Percent capacity during 25-year peak flow event equal to 25-year peak dischage divided by approximate capacity.

Pipe ID	combined subbasin ID	25-yr Peak Discharge (cfs)	100-yr Peak Discharge (cfs)	Pipe Size (in)	Pipe Type	n-value	Approx. Capacity (cfs)	Percent Capacity during 25-yr Peak Flow	comment
CB20638IO1592	SRW10+	4.9	6.3	30	0	0.024	30.0	16%	
CB20640CB20638	SRW10+	4.9	6.3	30	Concrete	0.013	47.3	10%	
IO1339CB20640	SRW10+	4.9	6.3	30	Concrete	0.013	47.3	10%	
CB1499IO1543	SRW10+	4.9	6.3	12	Concrete	0.013	5.8	85%	
CB1489CB1499	SRW10+	4.9	6.3	12	CMP	0.024	3.3	150%	
CB1488CB1489	SRW10+	4.9	6.3	12	CMP	0.024	3.3	150%	
CB1469CB1488	SRW10+	4.9	6.3	12	HDPE	0.011	5.8	85%	
CB1468CB1469	SRW10+	4.9	6.3	15	HDPE	0.011	10.2	49%	
CB1466CB1468	SRW10+	4.9	6.3	15	HDPE	0.011	10.2	49%	
CB1465CB1466	SRW10+	4.9	6.3	12	Concrete	0.013	5.8	85%	
CB20115CB1465	SRW10+	4.9	6.3	12	CMP	0.024	3.3	150%	
CB1464CB20115	SRW10+	4.9	6.3	12	HDPE	0.011	5.8	85%	
CB2539CB1464	SRW10+	4.9	6.3	12	HDPE	0.011	5.8	85%	
CB1449CB2539	SRW11de	0.5	0.7	12	0	0.024	3.3	15%	
CB2397CB1449	SRW11de	0.5	0.7	12	0	0.024	3.3	15%	
CB1448CB2397	SRW11de	0.5	0.7	12	0	0.024	3.3	15%	
CB1447CB1448	SRW11de	0.5	0.7	12	0	0.024	3.3	15%	
CB1446CB1447	SRW11de	0.5	0.7	12	0	0.024	3.3	15%	
CB1445CB1446	SRW11de	0.5	0.7	12	0	0.024	3.3	15%	
CB20108CB1445	SRW11de	0.5	0.7	12	0	0.024	3.3	15%	
CB20188IO1568	SRW11dw	7.9	10.8	24	Concrete	0.013	30.2	26%	flow split
CB1443CB20108	SRW11+	4.1	5.7	15	HDPE	0.011	10.2	40%	
CB1442CB1443	SRW11+	4.1	5.7	15	HDPE	0.011	10.2	40%	
CB1440CB1442	SRW11+	4.1	5.7	15	HDPE	0.011	10.2	40%	
CB1439CB1440	SRW11+	4.1	5.7	15	HDPE	0.011	10.2	40%	
CB1434CB1438	SRW11+	4.1	5.7	15	0	0.024	5.9	69%	
CB1433CB1434	SRW12+	4.0	5.4	15	HDPE	0.011	10.2	39%	
CB20636CB1433	SRW12+	4.0	5.4	15	CMP	0.024	5.9	68%	
CB1358CB2530	SRW12+	4.0	5.4	12	CMP	0.024	3.3	122%	
CB1359CB1358	SRW12+	4.0	5.4	12	CMP	0.024	3.3	122%	
CB1410CB1359	SRW12+	4.0	5.4	12	CMP	0.024	3.3	122%	
CB1409CB1410	SRW12+	4.0	5.4	15	0	0.024	5.9	68%	
CB1408CB1409	SRW12+	4.0	5.4	15	0	0.024	5.9	68%	
CB1407CB1408	SRW12+	4.0	5.4	15	0	0.024	5.9	68%	
CB1406CB1407	SRW12+	4.0	5.4	15	HDPE	0.011	10.2	39%	
CB1405CB2396	SRW11dw	7.9	10.8	18	Concrete	0.013	16.2	49%	flow split
CB20095CB1405	SRW13+	7.9	10.7	18	0	0.024	9.5	83%	
IO1384CB20095	SRW13+	7.9	10.7	18	0	0.024	9.5	83%	
IO1383IO1550	SRW13+	7.9	10.7	12	HDPE	0.011	5.8	137%	
IO1385IO1662	SRW13+	7.9	10.7	12	CMP	0.024	3.3	242%	
CB20631IO1475	SRW14+	6.0	8.1	12	CMP	0.024	3.3	182%	
CB2536CB20631	SRW14+	6.0	8.1	15	CMP	0.024	5.9	101%	
CB20633CB2536	SRW14+	6.0	8.1	15	CMP	0.024	5.9	101%	
CB20085IO1482	SRW15	2.7	3.8	18	0	0.024	9.5	29%	
CB20119OUTBOUND	SRW70+	14.9	20.5	30	0	0.024	30.0	50%	
CB1504CB20119	SRW70+	14.9	20.5	30	CMP	0.024	30.0	50%	
CB20663IO1477	SRW71+	7.8	10.7	24	HDPE	0.011	30.2	26%	
CB20099CB20663	SRW71+	7.8	10.7	12	HDPE	0.011	5.8	134%	
CB2396CB20099	SRW71+	7.8	10.7	24	HDPE	0.011	30.2	26%	
IO1284CB2396	SRW72	1.4	1.9	12	0	0.024	3.3	44%	
CB20103IO1552	SRW72	1.4	1.9	12	CMP	0.024	3.3	44%	
CB20104CB20103	SRW72	1.4	1.9	12	Concrete	0.013	5.8	25%	

Hydraulic Capacity Performance Analysis
City of Woodinville
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checked by: sjs

Purpose: A hydraulic capacity performance analysis for selected pipe segments throughout the City is summarized below.
Method:

1. Input pipe segment related to the GIS database pipe ID.
2. Input combined subbasin ID based on location of pipe and contributing subbasins.
3. 25-yr and 100-yr peak discharges are looked up automatically from SBUH calculation spreadsheet.
4. Pipe size and type are looked up from GIS database.
5. Approximate capacity is looked up from pipe capacity calculations.
6. Percent capacity during 25-year peak flow event equal to 25-year peak dischage divided by approximate capacity.

Pipe ID	combined subbasin ID	25-yr Peak Discharge (cfs)	100-yr Peak Discharge (cfs)	Pipe Size (in)	Pipe Type	n-value	Approx. Capacity (cfs)	Percent Capacity during 25-yr Peak Flow	comment
CB20106CB20104	SRW72	1.4	1.9	12	CMP	0.024	3.3	44%	
IO1285CB20106	SRW72	1.4	1.9	12	CMP	0.024	3.3	44%	
CB2419IO1451	SRW20	7.2	9.5	18	Concrete	0.013	16.2	45%	
CB1565CB2419	SRW20	7.2	9.5	18	Concrete	0.013	16.2	45%	
CB20664IO1561	SRW31+	26.0	37.7	48	HDPE	0.011	128.5	20%	
CB20665CB20664	SRW31+	26.0	37.7	48	HDPE	0.011	128.5	20%	
IO1292IO1634	SRW33	5.1	7.3	24	HDPE	0.011	30.2	17%	
IO1386IO1470	SRW32	18.7	27.9	30	CMP	0.024	30.0	62%	
IO1256IO1588	SRW40+	23.7	36.7	36	HDPE	0.011	70.9	33%	
CB20672IO1562	SRW41+	22.7	35.0	36	Concrete	0.013	70.9	32%	
CB20137CB20672	SRW41+	22.7	35.0	24	Concrete	0.013	30.2	75%	
CB20138CB20137	SRW41+	22.7	35.0	24	0	0.024	20.3	112%	
CB20130CB20138	SRW46	5.5	9.4	15	0	0.024	5.9	93%	
CB20669CB20130	SRW46	5.5	9.4	24	PVC	0.011	30.2	18%	
CB20668CB20669	SRW46	5.5	9.4	24	PVC	0.011	30.2	18%	
CB20655CB20668	SRW46	5.5	9.4	24	PVC	0.011	30.2	18%	
CB20656CB20655	SRW46	5.5	9.4	24	PVC	0.011	30.2	18%	
CB20654CB20656	SRW46	5.5	9.4	24	PVC	0.011	30.2	18%	
IO1381CB20654	SRW46	5.5	9.4	24	DI	0.013	30.2	18%	
IO1207IO1444	SRW42+	9.8	15.6	24	Concrete	0.013	30.2	32%	
IO1207IO1444	SRW47	1.6	2.6	24	Concrete	0.013	30.2	5%	
CB20628CB20617	SRW47	1.6	2.6	18	DI	0.013	16.2	10%	
IO1279CB20628	SRW47	1.6	2.6	18	CMP	0.024	9.5	17%	
CB20559IO1429	SRW51+	11.1	15.4	24	CMP	0.024	20.3	55%	
CB20562CB20560	SRW51+	11.1	15.4	24	CMP	0.024	20.3	55%	
CB20563CB20562	SRW51+	11.1	15.4	24	CMP	0.024	20.3	55%	
CB20673CB20563	SRW51+	11.1	15.4	24	CMP	0.024	20.3	55%	
CB20561CB20673	SRW51+	11.1	15.4	24	CMP	0.024	20.3	55%	
IO1289CB20143	SRW51+	11.1	15.4	24	CMP	0.024	20.3	55%	
IO1210IO1446	SRW51+	11.1	15.4	24	Concrete	0.013	30.2	37%	
IO1298IO1639	SRW52	0.8	0.9	12	Concrete	0.013	5.8	13%	
CB2568IO1640	SRW52	0.8	0.9	12	Concrete	0.013	5.8	13%	
IO1212CB2568	SRW52	0.8	0.9	12	0	0.024	3.3	23%	
CB1052CB1051	SRW53	6.1	9.2	18	CMP	0.024	9.5	64%	
CB20011CB1052	SRW53	6.1	9.2	18	CMP	0.024	9.5	64%	
CB20012CB20011	SRW53	6.1	9.2	18	CMP	0.024	9.5	64%	
CB20013CB20012	SRW53	6.1	9.2	18	CMP	0.024	9.5	64%	
IO1358IO1578	SRW60	19.7	28.1	12	HDPE	0.011	5.8	341%	
Little Bear Creek Culverts									
IO3307IO3306		486.0	658.0	6'x10' Conc. Box			520.0	93%	from Otak Memo dated 7/11/2008
IO1008IO1395		525.0	710.0	(2) 5'x7' Conc. Box			420.0	125%	from Otak Memo dated 7/11/2008
CB20612IO1647		540.0	732.0	(2) 5.2'x7'CMPA			460.0	117%	from Otak Memo dated 7/11/2008
IO1177IO1402		548.0	742.0	(3) 5' Conc. Pipe			510.0	107%	from Otak Memo dated 7/11/2008
IO1179IO1404		559.0	756.0	6'x10' Conc. Box			520.0	108%	from Otak Memo dated 7/11/2008

	Summary
total number of pipes analyzed	298
total number of pipes greater than 100% capacity during 25-yr peak flow	74
percent of pipes greater than 100% capacity during 25-yr peak flow	25%

Appendix C—Comparison of Methods for Modeling Detention Technical Memorandum (Otak, 2009)

Technical Memorandum

10230 NE Points Drive
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Phone (425) 822-4446
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To: Tom Hanson

From: Scott Stoneman

Copies: Joe Simmler, Greg Laird

Date: November 12, 2009

Subject: Woodinville SWM Plan Update
Comparison of Methods for Modeling Detention

Project No.: 31324

Background and Rational

Per Task B5 of our Scope of Work (dated April 7, 2009), Otak has been conducting a City-wide Hydraulic Analysis to evaluate the capacity of the City's existing storm drains under both existing and future land-use conditions. The initial formulation of our model identified the contributing drainage areas for the City's network of pipes using the Santa Barbara Urban Hydrograph (SBUH) method. Initial results showed that over one-third of the storm drain pipes did not have sufficient capacity for the 25-year peak flow event, which is contrary to the City's experience.

This initial formulation of the model, appeared to be over estimating peak discharges. In order to modify the model to match observed field conditions, we adjusted the model in an attempt to include consideration for the effect that existing detention facilities were providing throughout the City.

Purpose and Objective

The purpose of this memorandum is to document the methodology that was developed in order to create a cost effective approach to estimate existing detention, match observed field conditions, and utilize the amount and type of data available from the City. Due to the limited amount of data that existed for each of the City's existing detention facilities, alternative methods were developed and tested to account for detention, without conducting flow routing through each individual detention facility.

Approach and Methodology

Detention facilities are designed to reduce the release rate of stormwater to a pre-developed condition. Currently, the state, county, and City standard for the pre-developed condition is defined as the forested condition. However, prior to 2005, the pre-developed condition was defined to be

the existing land use condition at or before 1979, which was typically forest or grass for the larger developments.

By reassigning the runoff curve number for those subbasins that have detention facilities to a value more similar to pre-developed land cover, the runoff from that subbasin into the City's storm drain could be modified to more closely approximate the performance of the detention facility.

To test this hypothesis, we compared our initial model formulation to a new revised model formulation using the adjusted Curve Number, and also using a formulation that included detention routing. To accomplish this comparison, the SBUH method was used to determine the size of the detention facility that met the targeted release rate. Three formulations were compared: the initial model formulation without detention, the model formulation using detention routing, and the model formulation where the Curve Number was adjusted to approximate detention.

These three model formulations were compared and contrasted under eight different scenarios, as presented in Table 1. Initial runoff rates were tested using four different hydrologic soil groups. Also tested was the significance of the proportion of the subbasin that is served by the detention facility.

Results

Table 1 summarizes the results of modeling detention by routing and by adjusting the Curve Number in terms of percent reduction in peak discharge, as compared to modeling a basin without detention (i.e. the initial model formulation).

Table 1
Comparison of Methods for Modeling Detention

Case No.	NRCS Hydrologic Soil Goup	Portion of Basin with Detention	Adjusted CN	Percent Reduction in Peak Discharge - Detention Routing	Percent Reduction in Peak Discharge – Adjusted Curve Number	Difference in Methods
1	A	20%	60	40%	45%	5%
2	A	50%	60	74%	77%	3%
3	B	20%	65	39%	40%	1%
4	B	50%	65	72%	71%	1%
5	C	20%	70	34%	35%	1%
6	C	50%	70	62%	63%	1%
7	D	20%	80	24%	23%	1%
8	D	50%	80	45%	45%	<1%

The adjusted Curve Numbers used in this analysis, as seen in Table 1, are higher than the pre-developed forested Curve Numbers. These Curve Numbers were increased in order to reduce the over-attenuation effects of the composite Curve Numbers and to better match the detention routing method. Detail spreadsheets are attached.

The results show that taking into account detention can significantly reduce the peak discharge, even when only as little as 20 percent of the basin is routed though detention. Comparing the detention routing and adjusted Curve Number together, there is a 1- 5 percent difference in the cases tested.

Recommendations

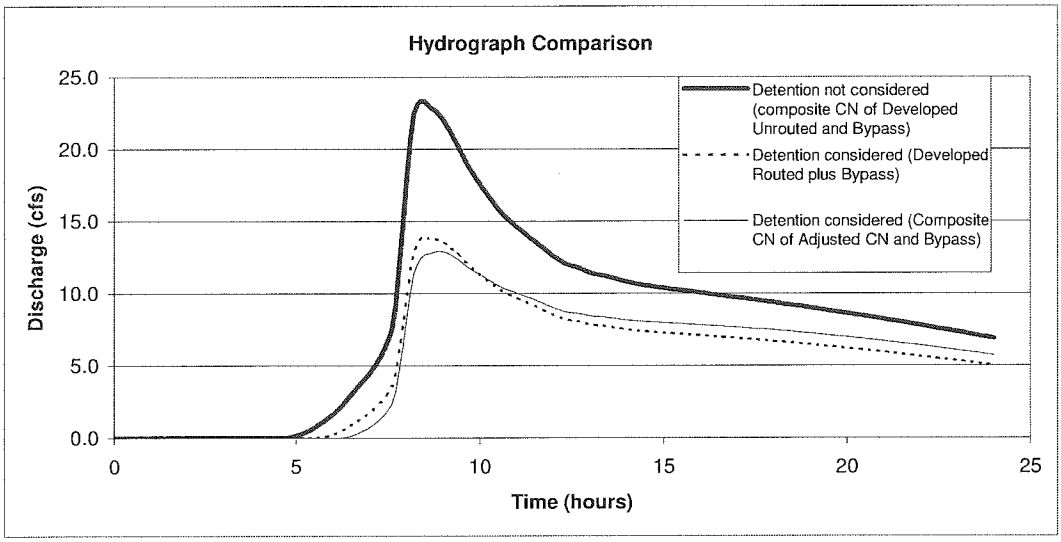
Based on these results, the Curve Number was adjusted to reflect pre-development (forested) conditions in order to account for detention in the City-Wide Hydraulic Analysis. However, the age of the detention facility would also need to be considered in the selection of the appropriate Curve Number.

Design requirements for pond sizing have become more stringent over the years. Prior to 1990, ponds were sized using the Y&W method, which resulted in small detention facilities that did not significantly reduce the peak flow. Between 1990 and 1998, ponds were sized using the SBUH method, which resulted in pond sizes of approximately 8,000 cubic feet (cf) per developed impervious acre. After 1998, ponds were sized using the KCRTS methodology, which resulted in pond sizes of approximately 18,000 cf per developed impervious acre.

In order to take into account of the larger ponds sized after 1998, the Curve Number is adjusted to 60. This is similar to ponds sized using the SBUH method for Type A soils, as in Cases 1 and 2. Cases 1 and 2 included ponds that had a total detention storage of 11,000 cf per developed impervious acre, which is the maximum volume of runoff generated from the 24-hour, 25-year event. For the ponds built between 1990 and 1998, the Curve Number shown in Table 1 are recommended. Detention facilities constructed prior to 1990 will not be included in the City-wide Hydraulic Analysis since they do not appreciably reduce peak discharges.

Attachments

Comparison of Methods for Modeling Detention -
Case 1 (Type A soil, 20% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	100.0	25.0	25.0	25.0		125.0		125.0
cn	78.0	98.0	30.0	60.0		82.0		74.4
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	13.91	13.94	0.00	0.78	0.00	**23.37**	**13.91**	**12.93**
						Reduction in Peak Discharge ->	**40%**	**45%**
						Percent difference ->		**4%**

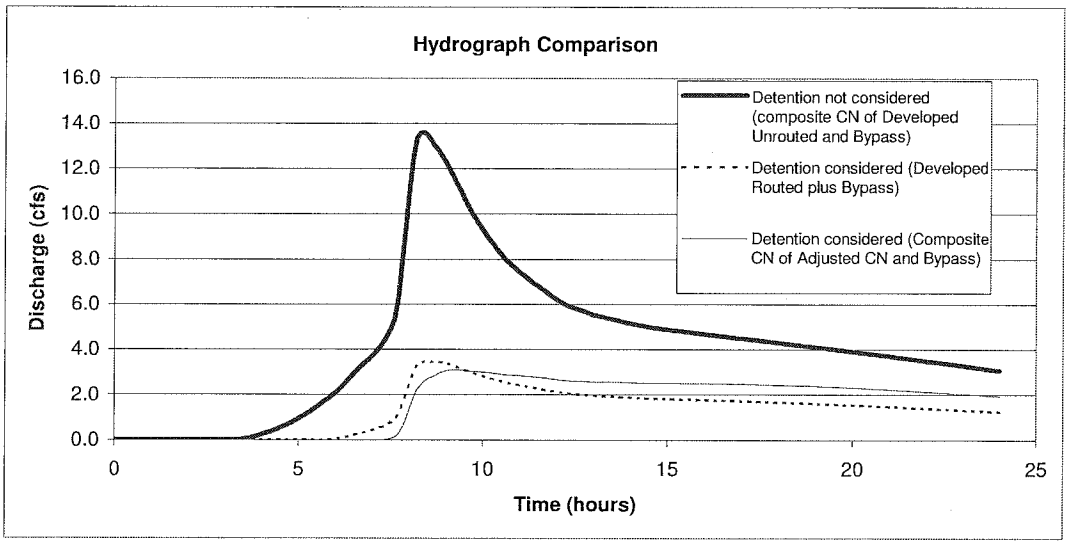
1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in)	0.01	<- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft)	10	
total volume used (ac-ft)	6.3	
total volume used (cf/ac)	11000	

stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.00
2	2	0.00
4	4	0.00
6	6	0.00
8	8	0.00
10	10	0.00

25-yr precip (in)	3.3
SCS Storm	Type IA

Comparison of Methods for Modeling Detention -
Case 2 (Type A soil, 50% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	25.0	25.0	25.0	25.0		50.0		50.0
cn	78.0	98.0	30.0	60.0		88.0		69.0
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	3.48	13.94	0.00	0.78	0.00	**13.61**	**3.48**	**3.09**
						Reduction in Peak Discharge ->	**74%**	**77%**
						Percent difference ->		**3%**

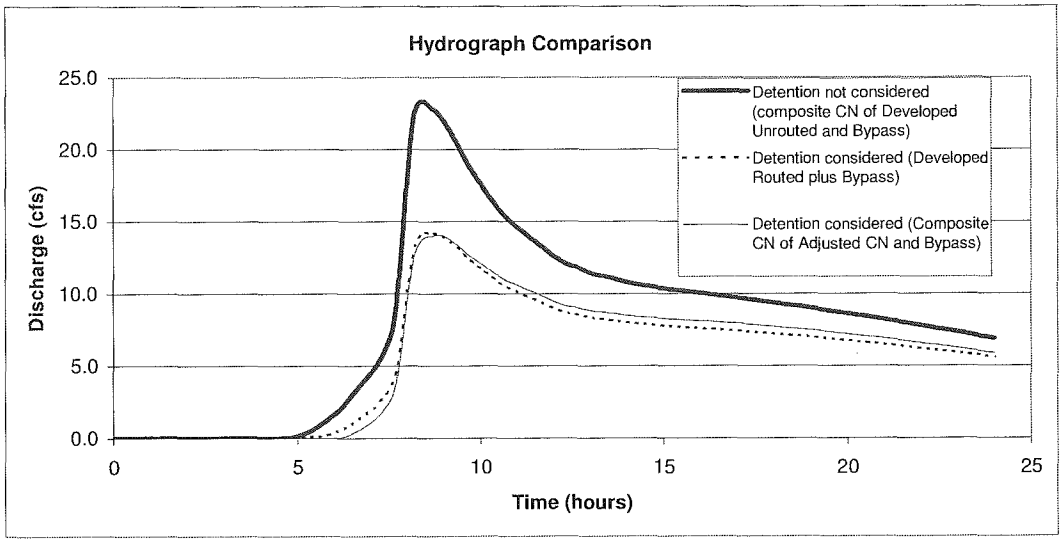
1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in)	0.01	<- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft)	10	
total volume used (ac-ft)	6.3	
total volume used (cf/ac)	11000	

stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.0
2	2	0.0
4	4	0.0
6	6	0.0
8	8	0.0
10	10	0.0

25-yr precip (in)	3.3
SCS Storm	Type IA

Comparison of Methods for Modeling Detention -
Case 3 (Type B soil, 20% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	100.0	25.0	25.0	25.0		125.0		125.0
cn	78.0	98.0	55.0	65.0		82.0		75.4
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	13.91	13.94	0.56	1.15	0.58	**23.37**	**14.27**	**14.05**
						Reduction in Peak Discharge ->	**39%**	**40%**
						Percent difference ->		**1%**

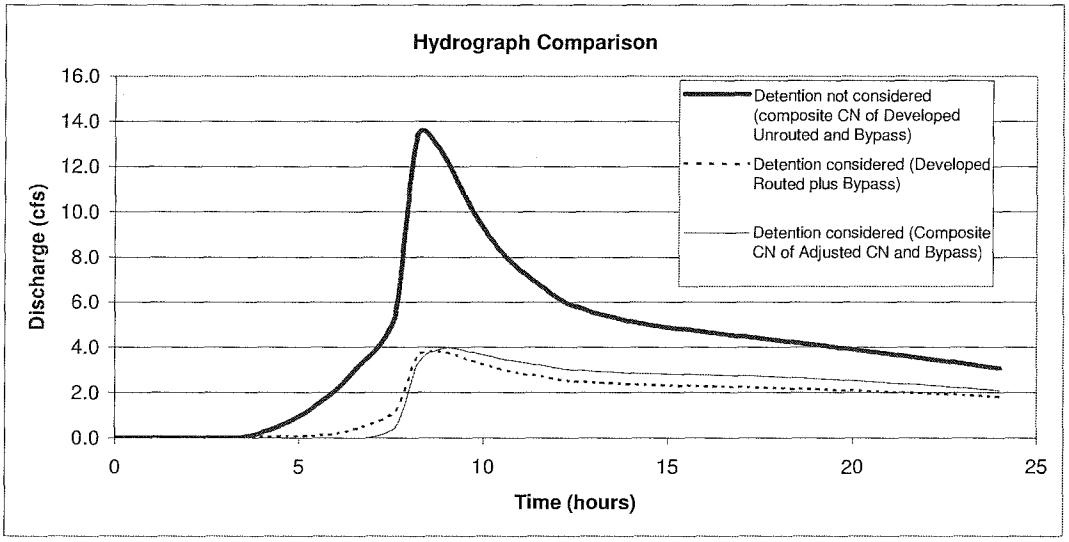
1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in)	3	<- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft)	10	
total volume used (ac-ft)	5.6	
total volume used (cf/ac)	9700	

stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.0
2	2	0.3
4	4	0.5
6	6	0.6
8	8	0.7
10	10	0.8

25-yr precip (in)	3.3
SCS Storm	Type IA

Comparison of Methods for Modeling Detention -
Case 4 (Type B soil, 50% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	25.0	25.0	25.0	25.0		50.0		50.0
cn	78.0	98.0	55.0	65.0		88.0		71.5
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	3.48	13.94	0.56	1.15	0.58	**13.61**	**3.84**	**3.98**
						Reduction in Peak Discharge ->	**72%**	**71%**
						Percent difference ->		**1%**

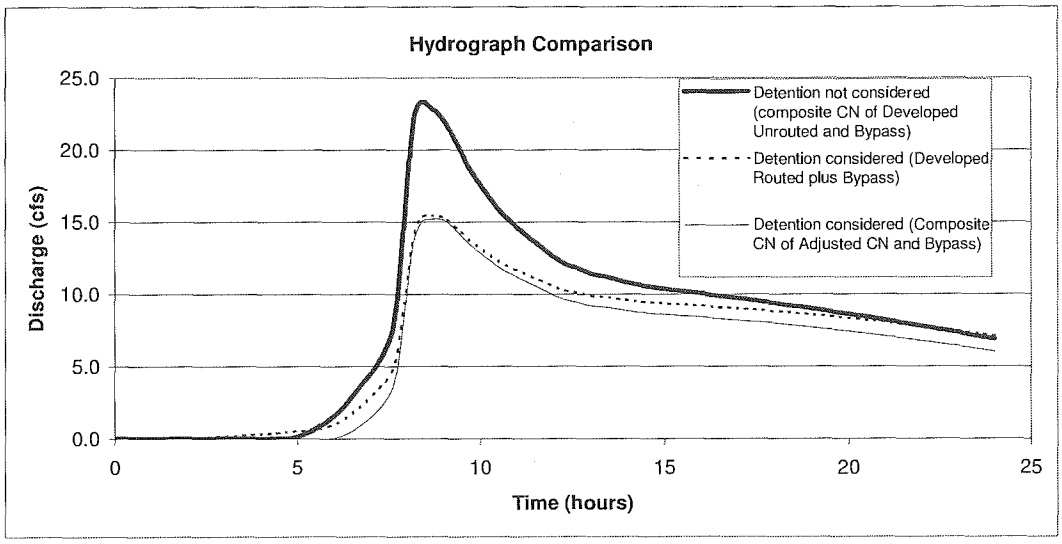
1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in)	3	<- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft)	10	
total volume used (ac-ft)	5.6	
total volume used (cf/ac)	9700	

stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.0
2	2	0.3
4	4	0.5
6	6	0.6
8	8	0.7
10	10	0.8

25-yr precip (in)	3.3
SCS Storm	Type IA

Comparison of Methods for Modeling Detention -
Case 5 (Type C soil, 20% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	100.0	25.0	25.0	25.0		125.0		125.0
cn	78.0	98.0	70.0	70.0		82.0		76.4
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	13.91	13.94	2.16	2.16	2.13	**23.37**	**15.50**	**15.24**
						Reduction in Peak Discharge ->	**34%**	**35%**
						Percent difference ->		**1%**

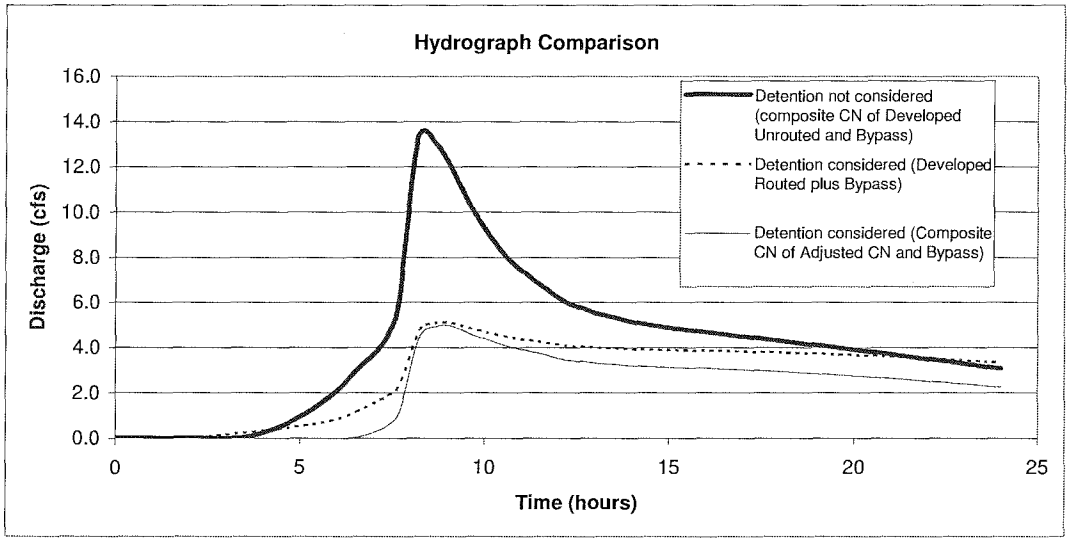
1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in) 5.5 <- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft) 5
total volume used (ac-ft) 3.4
total volume used (cf/ac) 5900

stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.0
2	1	1.2
4	2	1.6
6	3	2.0
8	4	2.3
10	5	2.6

25-yr precip (in) 3.3
SCS Storm Type IA

Comparison of Methods for Modeling Detention -
Case 6 (Type C soil, 50% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	25.0	25.0	25.0	25.0		50.0		50.0
cn	78.0	98.0	70.0	70.0		88.0		74.0
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	3.48	13.94	2.16	2.16	2.13	**13.61**	**5.14**	**4.99**
						Reduction in Peak Discharge ->	**62%**	**63%**
						Percent difference ->		**1%**

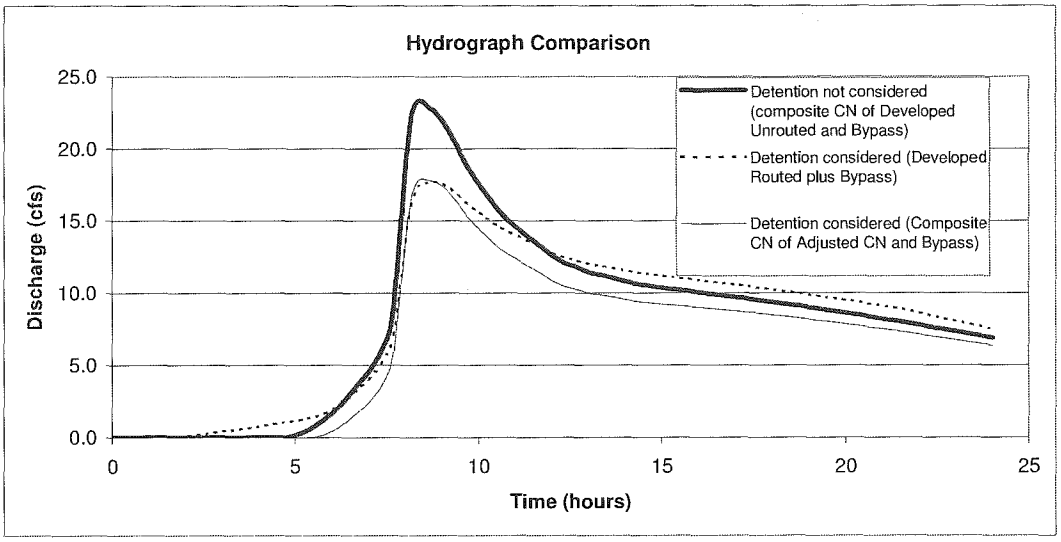
1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in)	5.5	<- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft)	5	
total volume used (ac-ft)	3.4	
total volume used (cf/ac)	5900	

stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.0
2	1	1.2
4	2	1.6
6	3	2.0
8	4	2.3
10	5	2.6

25-yr precip (in)	3.3
SCS Storm	Type IA

Comparison of Methods for Modeling Detention -
Case 7 (Type D soil, 20% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	100.0	25.0	25.0	25.0		125.0		125.0
cn	78.0	98.0	77.0	80.0		82.0		78.4
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	13.91	13.94	4.36	5.53	4.33	**23.37**	**17.72**	**17.94**
Reduction in Peak Discharge ->							**24%**	**23%**
Percent difference ->								**1%**

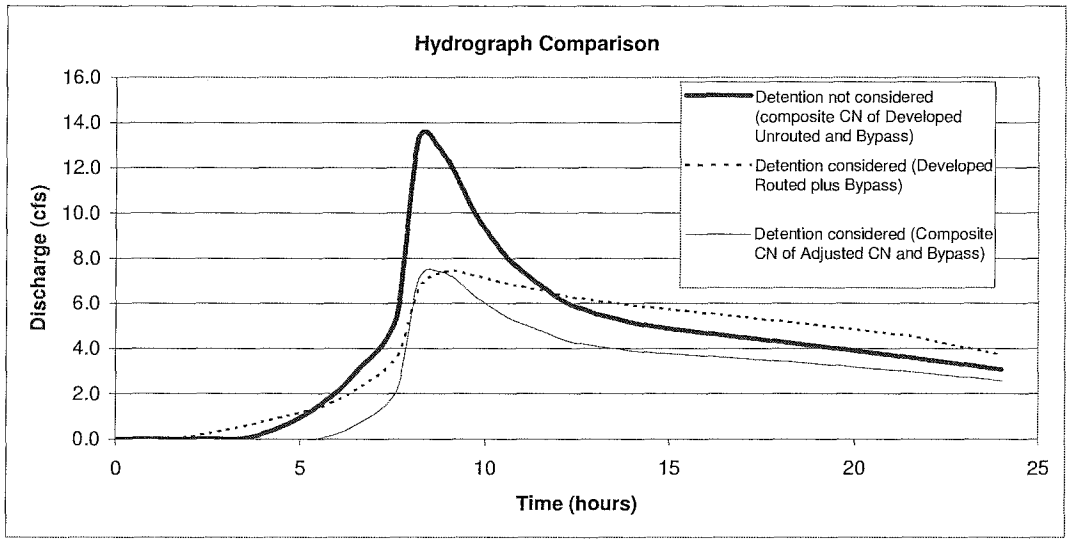
1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in)	9 <- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft)	5
total volume used (ac-ft)	2.0
total volume used (cf/ac)	3400

stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.0000
2	1	3.1070
4	2	4.3940
6	3	5.3815
8	4	6.2140
10	5	6.9475

25-yr precip (in)	3.3
SCS Storm	Type IA

Comparison of Methods for Modeling Detention -
Case 8 (Type D soil, 50% of basin has detention)
City-Wide Hydraulic Analysis - City of Woodinville
created by: sjs
checked by:



	Bypass Area[1]	Developed Unrouted	Pre-developed	Adjusted CN[2]	Developed Routed[3]	Detention not considered (composite CN of Developed Unrouted and Bypass)	Detention considered (Developed Routed plus Bypass)	Detention considered (Composite CN of Adjusted CN and Bypass)
area (ac)	25.0	25.0	25.0	25.0		50.0		50.0
cn	78.0	98.0	77.0	80.0		88.0		79.0
tc (min)	60.0	30.0	30.0	30.0		60.0		60.0
peak discharge (cfs) ->	3.48	13.94	4.36	5.53	4.33	**13.61**	**7.44**	**7.52**
						Reduction in Peak Discharge ->	**45%**	**45%**
						Percent difference ->		**1%**

1. Assume CN value of 78 for bypass area because that is approximately the calculated average CN value for the City-wide Analysis.
2. Adjust Pre-developed CN so that both methods of considering detention match best.
3. Route using Modified Puls (Level-Pool) using the following facility, which matches the predeveloped discharge.

orifice dia (in)	9	<- adjust orifice so that developed routed discharge matches predeveloped discharge.
total volume (ac-ft)	5	
total volume used (ac-ft)	2.0	
total volume used (cf/ac)	3400	

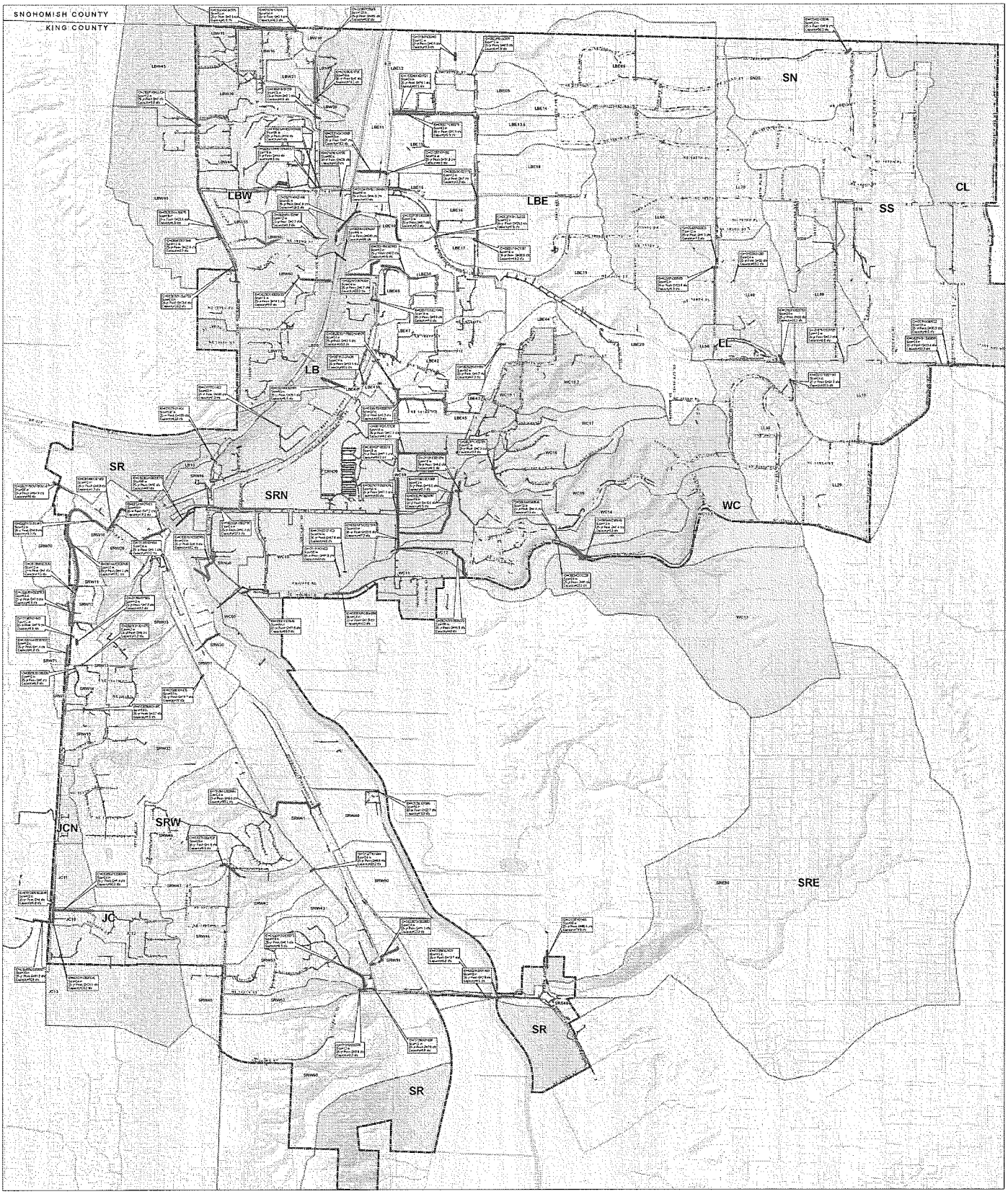
stage (ft)	storage (ac-ft)	discharge (cfs)
0	0	0.0
2	1	3.1
4	2	4.4
6	3	5.4
8	4	6.2
10	5	6.9

25-yr precip (in)	3.3
SCS Storm	Type IA

Woodinville SWM Plan Update
City of Woodinville, WA

City-Wide Hydraulics Map

April 2010



Legend

- Stream
- Stormwater Open Channel

City of Woodinville Stormwater Pipes 02/16/10

Size

- unknown size
- <= 12"
- <= 24"
- > 24"

Pipes Analyzed (25-yr percent capacity)

- 0% - 100%
- 101% - 150%
- 151% - 300%
- > 300%
- Woodinville City Limits
- Land Use (Revised by Otak 10/12/09)
- Waterbody

Subbasin Boundary

- Cottage Lake
- Jaunita Creek
- Jaunita Creek North
- Little Bear
- Little Bear East
- Little Bear West
- Lake Leota
- School North
- School River East
- Sammamish River
- Sammamish River North
- Sammamish River West
- School South
- Woodin Creek

N

1 inch = 500 feet

0 500 1,000 2,000 Feet

Disclaimer: The information shown is this map is assembled GIS data created and acquired by Otak Inc. from the City of Woodinville, King County GIS and Snohomish County GIS. This data is not in survey accuracy and is meant for planning purposes only.

City of Woodinville data received February 16, 2010

Notes:

1- 290 pipe segments were analyzed for hydraulic capacity based on the 25-year and 100-year events.
2- Discharges for all sub-basins shown were calculated using the Santa Barbara Urban Hydrograph (SBUH) methodology.
3- Composite curve numbers were estimated based on land use and soil type.
4- Detention in developments later than 1990 was accounted for by adjusting the curve number.
5- Pipe capacity was calculated for most pipe segments by assuming inlet control.
6- Headwater depth is assumed to be 3 feet above pipe crown.
7- Pipes are assumed to be free of debris.

Appendix C
Ranking and Rating of Problem Areas

print close

printed on: **October 20, 2010**

CSR Report - Customer Service Request Summary

Category: All Department: Drainage / Surface Water

10/20/2007 to 10/20/2010

Review statistics at the bottom of this report

Date Rec'd	Topic	Description	Assigned To	Request Location	Case No	Date Closed
12/03/2007	Drainage / Surface Water	The culvert at the end of our driveway looks like it is smashed - water is backed up on to the street and is trying to drain into the other ditch, which appears to be blocked on the other end. Neighbors say there is another similar situation up the street from us. My address is 17315 232nd Ave NE Woodinville WA 98077		17315 232nd Ave NE Woodinville WA 98077	20074307	12/10/2007 7 DAYS
12/11/2007	Drainage / Surface Water	Concerns of the under mined rocks on the city's property. Rocks have fallen in the creek and are heading towards the culvert along with other debris.		Creek by Hollywood Schoolhouse	20074316	05/01/2008 140
12/13/2007	Drainage / Surface Water	States that the culvert at 132nd NE and NE 177th is plugged.			20074320	12/07/2007
01/08/2008	Drainage / Surface Water	Uncontrolled sheet flow of water across WD Road		Wood-Duvall Road east of 151st	20084335	01/10/2008 2 DAYS
01/26/2008	Drainage / Surface Water	During the big December 2nd storm last year (2007) our basement flooded. Our home is located on NE Woodinville Duvall Rd and during nearly every rain event there are puddles that form along the road and our property. The basement flooding was the result of drainage seeping through a crack in the foundation of our home. We are concerned that, even with repairs to our house, without proper drainage of the road runoff that we could have another flood. Who at the city do I contact to discuss this issue?		NE Woodinville Duvall Road	20084351	02/15/2008 21
03/25/2008	Drainage / Surface Water	There is ivy growing into the storm drains on 181st Street, blocking them. These storm drains drain into Woodinville Heights Park.		181st Street above Woodinville Heights Park	20084412	01/16/2009 281 DAYS
05/07/2008	Drainage / Surface Water	The City of Woodinville water engineers delivered sandbags to		13030 NE 198th Ct.	20084438	05/09/2008 2 DAYS

		us to divert water in our backyard over a year ago, but they have not picked them up. Can they please pick them up? Furthermore, our backyard is slowly sinking due to the amount of water flowing through our backyard. We would like to resolve this issue with the the help of city (we live at 13030 NE 198th Ct.), but we have lived here seven years and the problem still exists. We want live here for another 15 years, but frankly I am ready to move partly due to the issue. According to my wife, the water engineers from city promised to regrade the backyard. And, in fact, the city regraded a small part of it, which looks great, but not the majority of the yard (in fact, you left two unsightly holes in that majority portion to allow water to flow through better). Can you please regrade the rest of backyard like had originally promised us?			
07/11/2008	Drainage / Surface Water	Call early next week please. She lives in the area where we are going to have King Co. ditch maintenance in the next couple of weeks. She has improved and landscape the area in the right of way in front of her house. She has constructed swales to improve water quality of the storm runoff. Please meet with her on site and look at the situation. If the improvements are working and don't cause problems, make sure that King Co. leaves them alone. If they do create a problem, call me and lets look at them on –site together before the County comes through.		20084475	07/28/2008 17 DAYS
07/15/2008	Drainage / Surface Water	Culvert needs to be dug out	19510 144th Avenue NE	20084484	03/16/2009 244
08/13/2008	Drainage / Surface Water	When is rock going to be placed where KC did the ditching?	14602 NE 174 St	20084510	01/16/2009 156
08/20/2008	Drainage / Surface Water	The City and KC storm drainage systems meet at this corner. Water is sheet flowing across the intersection and running across properties in front of her and settling on her property. She would like the City to evaluate our system and fix the problem.	NE 175th & 164 Ave NE	20084509	04/29/2009 251
08/22/2008	Drainage / Surface Water	Re: D95098. THe Himmelspach's feel the City should be	139 Ave NE S. of NE 175th St	20084507	02/10/2009 172

		responsible for the maintenance of the drainage facility D95098. They feel that since their system ties into the one in the street they should not be responsible for the maintenance of the system that is in the street.			
08/26/2008	Drainage / Surface Water	We live at 20448 134th AVE NE--we are the home directly impacted by the removal of the tarp from the retention pond. We have dealt with bad odors, a horrifying view, and mesquitos and other bugs all summer long. Our first step in the process of visualing improving the view of the pond is to request that the city "maintains" it's cleanliness (kill-off the growing moss, etc...), paint the chain-link fence black, and paint the concrete structures a forest green (something to help blend the look of the concrete with the natural green-belt. I know the HOA is willing to work with the city to get some things done. These suggestions are minor and I believe should be handled soley by the city. Please contact me or my husband for questions. I will gladly fill-out additional paperwork if necessary.	Near 20448 134th AVE NE	20084513	02/10/2009
08/27/2008	Drainage / Surface Water	Has a slow draining CB in driveway. Would like street CB's checked to see if they are backing system up.		20084506	11/05/2008 70
08/28/2008	Drainage / Surface Water	Storm drain on ES of 124th just before NE 149 St. (N. entrance to Kingsgate) needs to be cleaned off.	124th Ave NE & NE 149 St.	20084514	10/22/2008 55
09/20/2008	Drainage / Surface Water	I am writing to express concern about the impact of observed dumping of yard waste on a city storm water facility that drains into a wetland. Across the street from 13318 NE 190TH PL, there is a pipe that carries storm water into a wet land. The pipe appears to be on private property. The outlet end of this pipe extends into the marsh area of the wet land. The end of this pipe appears to have been completely buried by large quantities of yard waste (sod, tree trunks, tree limbs, earth, clippings, etc), possibly dumped over the course of several years. The dumped material extends into the marsh area of the wet land. I am concerned that this pipe	Across the street from 13318 NE 190TH PL	20084530	04/30/2009 222

		may now be plugged and may no longer function. I do not want my identity disclosed.			
09/29/2008	Drainage / Surface Water	There are two catch basins close together. One appears to work while the other doesn't drain as well and water flows across the road coming close to callers driveway. Please check it.	147th NE and 134th Ct NE (Chateau Woods)	20084537	11/17/2008 49
10/16/2008	Drainage / Surface Water	The gully in front of my home is not draining properly and has standing water. I am worried about mosquitoes in the summer and flooding in the winter. Who is responsible for maintaining it? Is it the homeowner or the city?		20084556	10/22/2008 6
10/31/2008	Drainage / Surface Water	Kids blocked culvert with rocks. Please unclog.	146 Ave NE & NE 182nd St	20084569	11/05/2008 6
11/07/2008	Drainage / Surface Water	I am so impressed with the " no lake in Woodinville" anymore!!!! It's so awesome to not have the worry of whether I can go under the trestle or not. Thanks for the good drainage project. Pam Matthew		20084572	11/12/2008 5
01/08/2009	Drainage / Surface Water	I am a resident of Woodinville and I wanted to take a moment a congratulate the city on the wonderful job you have done with the drainage under the tressel. Last year when we had the flooding this area was a mess that made national news in a bad way. Whatever you have done has greatly improved that area and now there is no puddle of water or flooding issue. Congrats.		20094624	03/10/2009 60
03/25/2009	Drainage / Surface Water	Concerned about standing water in the ditch in front of her house.	17625 155 Pl NE	20094663	04/29/2009 35
07/08/2009	Drainage / Surface Water	My understanding is that you recently had some in water work done across one of your rivers and your contractor used a water filled pvc "bladder dam". can you confirm this and if so who was the contractor as that i can get in touch with them. thanks! Todd Stratton 660-607-7938		20094732	07/27/2009 19
07/09/2009	Drainage / Surface Water	Storm drain in front of home is still overflowing. Please repair.		20094733	10/14/2009 97
10/23/2009	Drainage / Surface Water	siltation in culvert is causing water to cross driveway and into street. Needs to be cleaned out and possibly have catch basin		20094769	11/09/2009 17

		placed in line to prevent future problems.			
11/02/2009	Drainage / Surface Water	Good afternoon, I live on 198th place, a cul-de-sac that is off 130th. I have a storm drain in the front of my house and there is also one on 130th just north of my cul-de-sac. I regulary clean out the drain by my house and the other day I went to the drain on 130th to clean it out as well. I noticed that because of the 'dip' in the road where the curb meets the road, the water sailed past this drain and went on down to the drain in front of my house. Since my yard has flooded several times through the years, it would be great to have the drain on 130th repaired so it could receive a it's share of rain water, leaving my drain not so overloaded with debris, leaves, and water. Thank you for your time in this matter. Best regards, Sheri Van Tent 425-577-1649	198th place, a cul-de-sac that is off 130th	20094776	
11/06/2009	Drainage / Surface Water	The storm drain grate in front of my house is broken. WFD was here this morning and a fireman said he almost broke an ankle when he stepped on it. It needs to be replaced ASAP. I live at 19260 162nd Ave. NE. The drain is on the WEST side of the street.		20094780	
12/01/2009	Drainage / Surface Water	I would like to know what the lot to lot drainage policy is in Woodinville?		20094791	03/02/2010 92
05/23/2010	Drainage / Surface Water	Hi, I would like to know when rain barrells will be available feom the city for purchase. Thanks.		20104839	06/03/2010 10
06/14/2010	Drainage / Surface Water	I have a neighbor that is located on higher ground compared with my property. He has recently installed a french drain, along with a very large reservoir next to our property on higher ground. The water now causes our property to flood excessively. Is there any laws or codes I can refer to, in order to convince him to correct the issue? Please help.		20104851	
06/25/2010	Drainage / Surface Water	Culvert in front of house is blocked. Please address.		20104853	

CSR's received within this time period: **31**
CSR's received and closed within this time period: **27**
Percentage of CSR's received and closed within this time period: **87.10%**
0

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						Criteria Ranking														
					weight->	3	3	3	3	1	1	1	1	2	2	2				
RANK	Otak ID	CIP Name	Updated ID	Address	Problem Description (1)	Flood Location	Flood Source	Flood Frequency	Flood Magnitude	Streambank Erosion	Hillside Erosion	Water Quality	Habitat	Aesthetics	Economic Impact	Complaint History	City Responsibility	Weighted Total Score (Out of 115)	Cost Range	Est. Cost ($1,000)	Notes
1	None	Woodin Creek CIP	PCIP5	140th Ave NE & NE 171st St	Previous Project. SWM-20: Woodin Creek Sedimentation Facility - Evaluate alternatives for sediment collection facility on the main stem of Woodin Creek near 171st: Alt A = install in-line facilty in 24-inch pipe south of Albertsons; Alt 2 = Reroute Woodin Creek through Reinwood Detention pond and redesign pond for sediment collection.	5	5	5	5	5	0	3	3	3	5	5	3	100	High	$ 2,633	2007 Cost was $560K; Will be more costly to address all related problems in 171st and Woodin Creek area.
2	None	See #1	PCIP7	133rd Ave NE & NE 171st St	Previous Project. SWM-23A: 171st Storm Drainage - Install 3,000 LF new drainage system to serve as high flow bypass for Woodin Creek. Will provide regional conveyance system to collect runoff from NE 171st Street and southern downtown area and away from Woodin Creek.	5	5	5	5	3	0	3	3	3	5	5	3	98	-	See #1	2007 Cost was $920K; Will be high cost when combined with other Woodin Creek/171st Issues; Permitting challenge - pipe must cross Woodin Creek.
3	None	See #1	PCIP8	133rd Ave NE & NE 171st St	Previous Project. SWM-23B: 171st Regional SW Facility - Regional stormwater facility in Woodin Creek Park (underground vault or surface pond).	5	5	5	5	3	0	3	3	3	5	5	3	98	-	See #1	High when combined with other Woodin Creek/171st Issues.
4	10	See #1	C555	17130 131st Ave	Related to problems around 171st and Woodin Creek area. High flow vaults need cleaning often after rain events. (See PCIP 5, 7, 8)	5	5	5	5	3	0	3	3	3	5	5	3	98	-	See #1	H&H analysis shows adequate of capacity in this system. See PCIP 5, 7, and 8.
5	None	Chateau Reach CIP	PCIP3	15600 Woodinville Redmond Road NE	Previous Project. SWM-13: Chateau Reach - Install channel erosion control measures and possibly a silt control pond to protect reach from deterioration and reduce impact to downstream drainage system. Silt deposits create flooding problem on SR-202. See Also CS 48 and PS 12 and 14.	5	5	3	5	3	0	3	0	3	5	5	5	93	Medium	$ 608	2007 Cost was $400K; Owner to grant the City an easement during the redevelopment, so City can complete construction.
6	12	See #5	PS12 (same as PS14)	15540 Woodinville Redmond Rd NE	drainage area overflow - floods parking lot and road	5	5	3	5	3	0	3	0	3	5	5	5	93	-	See #5	Area of Chateau Reach Project (SWM-13) from 2006 plan. Need erosion control measures and sediment control pond to control silt that is clogging pipes and causing flooding. 2006 Cost Est was $380K
7	14	See #5	PS14 (same as PS12)	15530 Woodinville Redmond Road NE	stormwater filled parking lot up to about 3' in fall 2007	5	5	3	5	3	0	3	0	3	5	5	5	93	-	See #5	See #PS12
8	3	See #5	C548	15500 SR 202	Flooding problem from sediment from creek. We have made a collection area for sediment but it is on private property. See also PS 12 and 14 and PCIP3	5	5	3	5	3	0	3	0	3	5	5	5	93	-	See #5	Need to implement a sediment management plan/strategy (multiple projects needed for implementation) for the tributary to the Sammamish River.
9	110	Lake Leota and NE 180th Street CIP	PS28 (same as PS29, CS58)	16250 NE 180th Street	Water from City Street Flowing into private property, plugged storm drain, silt entering into Lake Leota. Occurs after every heavy rainfall , after City has spread sand during the winter, snowfall that leads to slugs.	3	5	5	5	0	3	3	0	3	3	5	5	89	Medium	$ 947	Add curb or other feature to keep water on the road so it can be collected (if there is a nearby collection point)--needs to be field verified.
10	111	See #9	PS29 (same as PS28, CS58)	16204 NE 180th Street	Southside of (east end) of Lake Leota: Water runs off/drainage coming off 164th hillside over and beyond 180th Street, which enter the T-drain designed for this runoff. Erosion, flooding, pollutants. See survey for more detail.	3	5	5	5	0	3	3	0	3	3	5	5	89	-	See #9	Same as #PS28.
11	1	NE Woodinville Duvall Road CIP	CS46 (same as CS56)	14170 175th ST	Water flows down 175th. Pipe downsizes and takes 90 degree turn and blows out lid (18" hits CB and turns 90 deg to 12"). System needs curb inlets (see CS56) and upsized pipe for last 2 pipe runs.	5	5	5	5	0	0	0	0	3	3	5	5	89	Low	$ 102	Upsize 12" pipe and subsequent downstream system.
12	11	See #11	CS56 (same as CS46)	140th and 175th	Water flows down 175th. Possible curb inlets and upsize of pipes should be installed at intersection of 140th and 175th. See CS56.	5	5	5	5	0	0	0	0	3	3	5	5	89	-	See #11	Install curb inlets and upsize pipes.
13	None	See #11	H87	NE 178th ST and NE Woodinville Duvall RD	See also CS46 and CS56. H&H Modeling shows existing pipe at 163% of capacity during the 25-year Peak Flow for the first three pipe segments, 474% of capacity during the 25-year Peak Flow (WC15+: CB3239CB21097 (18"), CB21098CB3239, (18"), CB21099CB21098 (18"), IO1135CB21099 (12"))	5	5	5	5	0	0	0	0	3	3	5	5	89	-	See #11	See related city complatints.
14	2	147th PL NE CIP	CS47	17819 147th PL NE	CB is in a low spot, floods electrical vault. Large cottonwood tree with leaves that plug often.	5	5	5	5	0	0	0	0	5	3	5	3	87	Low	$ 40	Add additional CBs to collect water before low spot to reduce flooding of electrical vault.
15	6	Cottonwood Treets at 14300 NE Wood-Duvall Road CIP	CS51	14300 NE Wood-Duvall Road	Near Westview Gardens Apartments. Cottonwood tree has taken over ditch and Type 2.	5	5	5	5	0	0	0	0	5	3	5	3	87	Low	$ 57	Remove tree and replace damaged storm system. Assumed this causes flooding and damaged pipes.
16	None	Litte Bear Creek Culvert at 134th Ave NE CIP	PCIP2	LBC and 134th Ave NE	Previous Project. SWM-9B: 134th Culvert Replacement - remove culverts and replace with a bridge over LBC at 134th; Previous design did not bid well; Needs redesign.	5	5	3	3	3	0	0	5	3	3	5	5	85	High	$ 1,691	2007 Cost was $700K
17	20	See #16	C565	Little Bear Creek and 134th St NE	Little Bear Creek Crossing (see PCIP2)	5	5	3	3	3	0	0	5	3	3	5	5	85	-	$ -	Least flooded extent during Dec 2007 Storm; Bridge was designed and bid in 2005, then put on hold. Design must reflect flow impacts to/from other LBC projects.
18	25	144th Ave NE CIP	PS25	19628 144th Ave NE	standing water after every rain	5	5	5	5	0	0	0	0	3	3	5	3	85	Low	$ 153	Same as #PS26, #PS27. Need to replace the catchbasin and potential add additional inlets.
19	26	See #18	PS26 (same as PS25)	19600 144th Ave NE	standing water in storm basin, the catch basin is sinking	5	5	5	5	0	0	0	0	3	3	5	3	85	-	See #18	Same as #PS25, #PS27.

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					weight->	3	3	3	3	1	1	1	1	2	2	2				
RANK	Otak ID	CIP Name	Updated ID	Address	Problem Description (1)	Flood Location	Flood Source	Flood Frequency	Flood Magnitude	Streambank Erosion	Hillside Erosion	Water Quality	Habitat	Aesthetics	Economic Impact	Complaint History	City Responsibility	Weighted Total Score (Out of 115)	Cost Range	Est. Cost ($1,000)	Notes
20	27	See #18	PS27 (same as PS25)	19606 144th Ave NE	standing water at drain	5	5	5	5	0	0	0	0	3	3	5	3	85	-	See #18	Same as #PS25, #PS26.
21	None	See #18	H73	NE North Woodinville Way north of 144th Ave NE, 144th Ave NE and NE 193rd PL	See also PS25, 26, and 27. H&H Modeling shows existing pipe at 510%, 183% of capacity during the 25-year Peak Flow (LBE17+: CB20316CB2028 (12"), CB21110IO1151 (18"))	5	5	5	5	0	0	0	0	3	3	5	3	85	-	See #18	Medium score is based on also needing downstream improvements. Upsize pipe.
22	None	See #18	H74	144th Ave NE and NE 193rd PL	See also PS25, 26, and 28. H&H Modeling shows existing pipe at 213% of capacity during the 25-year Peak Flow (LBE18: CB21115CB21114 (24"))	5	5	5	5	0	0	0	0	3	3	5	3	85	-	See #18	Medium score is based on also needing downstream improvements. Upsize pipe.
23	8	136th Ave NE and NE 205th Street CIP	CS53	136th AVE and 205th	Deep culvert crosses 136th St. Could use CB and 40ft of pipe to add more access.	5	5	5	5	0	0	0	0	3	3	5	3	85	Low	$ 153	Add CB and 40' of pipe.
24	5	137th PL NE CIP	CS50	14404 137th PL NE	Access road has ditch with small culvert. Every time somebody travels seems to plug, and flows onto street.	5	5	5	5	0	0	0	0	3	5	5	1	85	Low	$ 48	Upsize culvert.

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RANK	Otak ID	CIP Name	Updated ID	Address	Problem Description (1)	Flood Location	Flood Source	Flood Frequency	Flood Magnitude	Streambank Erosion	Hillside Erosion	Water Quality	Habitat	Aesthetics	Economic Impact	Complaint History	City Responsibility	Weighted Total Score (Out of 115)	Cost Range	Est. Cost ($1,000)	Notes
CIP Projects Above, Additional Drainage Complaints Below																					
25	18		CS63	Little Bear Creek and 195th St NE	Little Bear Creek Crossing - WSDOT right-of-way	5	5	3	5	3	0	0	3	5	5	3	1	83	High	$ -	Increase of capacity. Design must reflect flow impacts to/from other LBC projects. **WSDOT Responsibility - cost not included in City CIP.**
26	19		CS64	Little Bear Creek and SR 522	Little Bear Creek Crossing - WSDOT right-of-way	5	5	3	5	3	0	0	3	5	5	3	1	83	High	$ -	Increase of capacity. Design must reflect flow impacts to/from other LBC projects. **WSDOT Responsibility - cost not included in City CIP.**
27	21		CS66	Little Bear Creek and SR 202 (131st Ave NE)	Little Bear Creek Crossing - WSDOT right-of-way	5	5	3	5	3	0	0	3	5	5	3	1	83	High	$ -	Increase of capacity. Design must reflect flow impacts to/from other LBC projects. **WSDOT Responsibility - cost not included in City CIP.**
28	22		CS67	126th PL NE and Railroad	126th PL Drainage onto RR Right of Way.	3	5	5	5	0	0	0	0	3	5	5	3	83	Low	$ 50	Add storm pipe as needed to re-route drainage off the Railroad ROW.
29	None		H75	139th Ave NE and NE 181st PL	H&H Modeling shows existing pipe at 263% of capacity during the 25-year Peak Flow (LBE40+: CB3181IO1122 (18"), CB3180CB3181 (18"))	5	5	5	3	0	0	0	0	3	5	5	3	83	Medium	$ 1,000	Location of "Garden Reach" Capital project. Upsize 700LF pipe and associated stream improvement.
30	7		CS52	14200 NE North Woodinville Way	Water coming out of the hillside. Possible place for French Drains.	3	5	5	5	0	3	0	0	3	3	5	3	82	Low	$ 100	Investigate if a french drain would be sufficient. It would need proper maintenance to function properly.
31	24		PS24	12403 NE 146th PL	street floods	5	5	5	5	0	0	0	0	3	3	3	3	81	Low	$ 50	Add stormwater pipe/collection system.
32	None		PCIP1	LBC and 132nd Ave NE (near SR 202 onramp)	Previous Project. SWM-9A: 132nd Culvert Removal - Remove 3 existing culverts and restore LBC channel at 132nd.	3	5	3	3	3	3	0	3	3	3	5	5	80	Medium	$ 250	2007 Cost was $355K
33	16		PS16	19835 Woodinville Snohomish Rd NE	west shoulder become very saturated after rain due to lack of drainage - possibly plugged drain	5	5	5	5	0	0	0	0	3	3	0	5	79	Low	$ 250	Investigate if this is a maintenance issue that can be easily resolved or stormwater infrastructure needs to be added to fix the problem.
34	3		KC37	13413 NE 143RD PL	Runoff causing erosion in deep ravine.	3	5	5	1	5	5	3	3	3	0	5	3	77	Medium	$ 250	Stabilize stream bank. Area of project from old plan (PCIP9: NE 143rd/137th NE Road Improvements) to add drainage system to stabilize the road embankment.
35	4		KC38 (same as KC40)	14800 NE 145TH ST	148th Pl NE & Wood-Red Rd; Flooding from ditch? Related to 06-0250.	3	5	5	5	0	0	0	0	0	3	5	3	76	Low	$ 50	Unplug ditch and restore conveyance.
36	6		KC40 (same as KC38)	14800 NE 145TH ST	148th Pl NE & Wood-Red Rd; Referred from WLRD Farmland.	3	5	5	5	0	0	0	0	0	3	5	3	76	-	See #35	Unplug ditch and restore conveyance.
37	6		PS6	13150 NE 203rd PL	1. crawl space wet from runoff from surrounding development 2. rain washes dirt into intersection 3. Excessive dirt and concrete rinse from contractors runs down street 4. leaves clog up drains	5	5	5	5	0	0	0	0	3	3	0	3	75	Low	$ 50	Crawl space is a private issue. Dirt and leaves are a maintenance issue.
38	19		PS19	14674 126th Ave NE	Lot and the street behind house has a lot of standing water on sidewalks and streets	5	5	5	5	0	0	0	0	3	3	0	3	75	Low	$ 50	Add stormwater conveyance system to collect water in the low point.
39	115		PS33	14935 NE 147th Court	Drainage under NE 147th Place partially blocked inside by large rock(s). Periodically overflows during storms. Occurs after heavy rainfall of 24 hours +. Culvert refills with gravel and rocks after heavy runoff. Water and gravel floods.	5	5	5	5	3	0	0	3	3	3	0	0	75	Low	$ 150	Assume a stream culvert being impacted. Remove large rocks and debris to restore the drainage system. Maintenance Referral? May need to upsize culvert.
40	5		PS5	17705 130th Ave NE	plugged creek	5	5	3	5	0	0	0	0	3	5	0	3	73	Low	$ 150	Channel reconstruction is required.
41	7		PS7	19440 160th Ave NE	No storm drain so water from street flows into house	3	5	5	5	0	0	0	0	0	3	3	3	72	Low	$ 250	Adding drainage for 200' of 12" line on 160th Ave (confirm length and of capacity).
42	31		PS31	19742 170th Ave NE	Water pond across from house number 19742. Water from hill on west side of 170th flows onto street; drain doesn't have adequate of capacity. Occurs after heavy rainfall. Submerges two driveways. Ongoing problem.	3	5	5	5	0	3	0	0	3	3	0	3	72	Low	$ 150	Evaluate of capacity of system and upsize if need be. May need a collection ditch.
43	1		KC35 (same as KC36,39)	14209 WOODINVILLE-REDMOND RD NE	Neighbor plugged ag ditch for irrigation, Referral from ADAP. Overflow from ditch. Stream on prop plugged/flooding. Inv found.	3	3	5	5	0	0	0	0	0	3	3	5	70	Low	$ 50	To unplug ditch and restore conveyance.
44	2		KC36 (same as KC35, 39)	14123 WOODINVILLE-REDMOND RD NE	Neighbor plugged ag ditch for irrigation, Referral from ADAP. Overflow from ditch. Stream on prop plugged/flooding. Inv found.	3	3	5	5	0	0	0	0	0	3	3	5	70	-	See #44	To unplug ditch and restore conveyance.
45	5		KC39 (same as KC35, 36)	14223 WOODINVILLE-REDMOND RD NE	Neighbor plugged ag ditch for irrigation, Referral from ADAP. Overflow from ditch. Stream on prop plugged/flooding. Inv found.	3	3	5	5	0	0	0	0	0	3	3	5	70	-	See #44	To unplug ditch and restore conveyance.
46	119		PS32	18610 NE 133rd Street	Ditch along the front of house. Heavy rain keeps eroding the ditch (mostly due to heavy flow in ditch). There is never enough rip-rap in the ditch. Erosion will eventually damage the road.	5	5	5	1	0	5	0	0	5	3	0	3	70	Low	$ 50	Redesign ditch to ensure less velocity therefore less erosion.
47	15		PS15	13030 NE 198th St	water flows through back yard	3	5	5	5	0	0	0	0	3	3	0	3	69	Low	$ 50	Add a stormwater pipe to reroute flows. Source of water needs to be confirmed.
48	2		PS2	19430 162nd Ave NE	water from trail drains onto lawn	5	5	5	5	0	0	0	0	3	0	0	3	69	Low	$ 50	Small drainage pipe to ditch to be added.

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					weight->	3	3	3	3	1	1	1	1	1	2	2	2			
RANK	Otak ID	CIP Name	Updated ID	Address	Problem Description (1)	Flood Location	Flood Source	Flood Frequency	Flood Magnitude	Streambank Erosion	Hillside Erosion	Water Quality	Habitat	Aesthetics	Economic Impact	Complaint History	City Responsibility	Weighted Total Score (Out of 115)	Cost Range	Est. Cost ($1,000)	Notes
49	116		PS34	19112 NE 181st Place Apt.G201	Rainwater held up in a huge puddle. Occurs after 1 day of rainfall. Huge puddle of water driving through, and the sidewalk seems to be submerged. People may slip on the sidewalk.	5	5	5	3	0	0	0	0	3	3	0	3	69	Low	$ 30	Add a stormwater pipe to reroute flows. Source of water needs to be confirmed.
50	13		PS13	20461 134th Ave NE	water flowing down the hill can wash out our street entrance and adjacent properties	5	5	5	3	3	0	0	0	3	0	0	3	66	Low	$ 50	Add pipe or make a ditch.
51	18		PS18	15726 126th Ave NE	water from retention pond runs in front of house in ravine where waterline is buried and exposing it.	3	3	5	5	0	3	0	0	3	3	0	3	66	Low	$ 100	Water from retention pond should be outletted into the existing stormwater, so it is no longer running overland.
52	None		PCIP4	136th Ave NE & NE 188th Pl	Previous Project: SWM-15: 136th Storm Drainage Improvement - Install 700 LF of piped drainage system on 136th Ave NE to replace drywells and tie NE 188th Pl to NE 186th St.	5	5	3	1	0	3	5	0	0	0	5	3	66	Medium	$ 1,000	2007 Cost was $175K; some pavement erosion; need to protect groundwater
53	None		PCIP10	18900 136th Ave NE	Previous Project (not previously numbered): Garden Reach - Replace 18-inch pipe with 700 LF, 24-inch storm drain and stream enhancement.	3	3	3	3	3	0	3	0	0	3	5	3	64	-	See #52	2007 Cost was $290K; need easement from property owner; project to be constructed with re-development of property.
54	1		PS1	19660 157th PL NE	Stormdrain appears to be uphill, ditch pools prior to draining	3	5	5	5	0	0	0	0	3	0	0	3	63	Low	$ 50	Re-grade soil or relocate the Catch Basin to a lower elevation.
55	10		PS10	17010 NE 190th St	water from school crosses street and into culvert which then runs onto private property creating an uncontrolled stream	3	5	5	5	0	0	0	0	3	0	0	3	63	Low	$ 250	Add culvert to conveyance to fix collection/conveyance.
56	4		PS4	13209 NE 201st CT	water from neighborhood flows through yard towards drainage pool	3	3	5	5	0	0	0	0	3	3	0	3	63	Low	$ 250	Investigate storm system connectivity for footing drain.
57	8		PS8	20341 170th Ave NE	water flows like a river from the properties behind us from an arena behind the property	3	3	5	5	0	0	0	0	3	3	0	3	63	High	$ 250	This is a private issue. Fix collection/conveyance line.
58	None		H71	139th Ave E and NE 195th ST	H&H Modeling shows existing pipe at 291% of capacity during the 25-year Peak Flow (LBE11+: CB3142IO1089 (18"), IO1090CB3142 (18"))	5	5	3	1	0	0	0	0	3	5	0	3	61	High	$ 1,500	Medium score is based on also needing downstream improvements. Upsize pipe.
59	17		PS17	18810 165th PL NE	water redirected on two developments and it all flows into my property.	3	3	5	5	0	0	0	0	0	3	0	3	60	Low	$ 250	Add a stormwater pipe to reroute flows off of private property.
60	7		KC41	14624 NE 178TH ST	Stream on prop plugged/flooding. Inv found	3	3	5	1	3	3	3	3	3	0	0	3	57	Medium	$ 250	Stabilize stream bank.
61	3		PS3	19190 162nd Ave NE	storm drainage stream flows through my NGPE and backs up at the property line where it goes underground	3	3	5	5	0	0	0	0	3	0	0	3	57	Low	$ 250	Add a stormwater pipe. Extend Stormwater drain.
62	None		H70	129th Pl NE and NE 203rd ST	H&H Modeling shows existing pipe at 198% of capacity during the 25-year Peak Flow (LBE05: IO843IO2640 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 1,000	Medium score is based on also needing downstream improvements. Upsize pipe.
63	None		H72	139th Ave E and NE 195th ST	H&H Modeling shows existing pipe at 335% of capacity during the 25-year Peak Flow (LBE15+: IO1097IO1096 (18"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
64	None		H76	136th Ave NE and NE 200th St	H&H Modeling shows existing pipe at 242% of capacity during the 25-year Peak Flow, 147% of capacity during the 25-year Peak Flow (LBW40+: CB3016IO1003 (12"), CB3001PIPECONNECT (18"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
65	None		H77	130th Ave NE and NE 200th PL	H&H Modeling shows existing pipe at 156% of capacity during the 25-year Peak Flow (LBW45: CB20748IO2724 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
66	None		H78	136th Ave NE and NE 192nd ST	H&H Modeling shows existing pipe at 148% of capacity during the 25-year Peak Flow (LWB60+: CB20531CB20532 (18"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
67	None		H79	130th Place NE and NE 192nd ST	H&H Modeling shows existing pipe at 726% of capacity during the 25-year Peak Flow, 250% of capacity during the 25-year Peak Flow (LWB65: CB2610IO1646 (12"), CB20331CB2076 (18"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
68	None		H80	167th Ave NE and NE 185th Ave/NE Woodinville Duvall Road	H&H Modeling shows existing pipe at 150% of capacity during the 25-year Peak Flow, 150% of capacity during the 25-year Peak Flow (LL10+: CB20919CB20899 (24"), CB20900CB20919 (24"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
69	None		H81	168th PL NE and NE 185th Ave	H&H Modeling shows existing pipe at 323% of capacity during the 25-year Peak Flow (SS10+: IO2115CB0822 (18"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
70	None		H82	160th PL NE and NE 183rd ST	H&H Modeling shows existing pipe at 169% of capacity during the 25-year Peak Flow (LL30+: IO2151CB21147 (24"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
71	None		H83	178th ST and NE Woodinville Duvall Road	H&H Modeling shows existing pipe at 158% of capacity during the 25-year Peak Flow, 158% of capacity during the 25-year Peak Flow (LL40+: CB20763IO2667 (24"), IO1837CB20763 (24"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
72	None		H84	156th Ave NE and NE 190th ST	H&H Modeling shows existing pipe at 361% of capacity during the 25-year Peak Flow, 361% of capacity during the 25-year Peak Flow (LL60: CB2990IO2924 (12"), IO2428CB2990 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
73	None		H85	156th Ave NE and NE 188th PL	H&H Modeling shows existing pipe at 191% of capacity during the 25-year Peak Flow (LL70: IO2429IO2925 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
74	None		H86	NE 173rd St and 155th PL NE	H&H Modeling shows existing pipe at 166% of capacity during the 25-year Peak Flow for all three pipe segments (WC13.5: CB0546CB0547 (12"), CB0545CB0546 (12"), CB0544CB0545 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
75	None		H88	NE 178th PL and 146th Ave NE	H&H Modeling shows existing pipe at 191% of capacity during the 25-year Peak Flow (WC16+: CB20792IO2788 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
76	None		H89	NE 181st and 140th Ave NE	H&H Modeling shows existing pipe at 180% of capacity during the 25-year Peak Flow (WC18+: CB1853CB3236 (18"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
77	None		H90	NE 173rd PL and NE Woodinville DR	H&H Modeling shows existing pipe at 150% of capacity during the 25-year Peak Flow for all three pipe segments (SRW10+: CB1489CB1499 (12"), CB1488CB1489 (12"), CB20115CB1465 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
78	None		H91	NE 169th ST and 124th Ave NE	H&H Modeling shows existing pipe at 242% of capacity during the 25-year Peak Flow (SRW13+: IO1385IO1662 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.

City of Woodinville
Draft Ranking and Rating of Public Survey Complaints
Project #31324
Last Update: 12/22/2010
Prepared by: JLC/SJS/AMM

Shown and ordered based on total score.
Scores of 85 or higher considered for CIP at this time.

						Criteria Ranking														
					weight->	3	3	3	3	1	1	1	1	2	2	2				
RANK	Otak ID	CIP Name	Updated ID	Address	Problem Description (1)	Flood Location	Flood Source	Flood Frequency	Flood Magnitude	Streambank Erosion	Hillside Erosion	Water Quality	Habitat	Aesthetics	Economic Impact	Complaint History	City Responsibility	Weighted Total Score (Out of 115)	Cost Range	Est. Cost ($1,000)	Notes
79	None		H92	121st Ave NE and Juanita-Woodinville Way	H&H Modeling shows existing pipe at 182% of capacity during the 25-year Peak Flow (SRW14+: C820631IO1475 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
80	None		H93	NE 145th St at the Sammamish River Trail	H&H Modeling shows existing pipe at 341% of capacity during the 25-year Peak Flow (SRW60: IO13581O1578 (12"))	5	5	3	1	0	0	0	0	3	3	0	3	57	Medium	$ 250	Medium score is based on also needing downstream improvements. Upsize pipe.
81	9		KC43	13728 NE 136TH PL	GROUNDWATER IMPACT TO PROPERTY.	3	3	5	5	0	0	0	0	3	0	0	0	51	Low	$ 50	Add a small trench drain to connect to City system.
82	None		PCIP9	NE 143rd St & 137th Ave NE	Previous Project (not previously numbered). NE 143rd / 137th NE Road Improvement - Install drainage control to stabilize existing road.	0	0	0	0	0	5	0	0	3	3	5	3	30	Low	$ 50	Low for portion of project cost related to stormwater. Could be combined with a transporation project to enhance roadway.
83	None		PCIP6	Various	Previous Project. SWM-22: WRIA 8 Restoration Projects - Enhance confluences of Derby Creek and Woodin Creek at discharge to Sammamish River. Tier 1 Samammish River projects recommended by the WRIA 8 Steering Committee in the WRIA 8 Chinook Salmon Conservation Plan.	0	0	0	0	3	0	5	5	0	0	5	3	29	Medium	$ 1,000	WRIA Funded Project; No flooding
84	13		CS58	Leota Lake Filter	Leota Loop Lake filter. There is a CB insert and always called out for maintenance work. Ditching areas need to be ditched.	0	0	0	0	0	0	5	3	3	0	5	3	27	-	See #9	Replace catch basin filter system (assumes system costs less then $250K)
85	20		PS20 (same as CS70)	20228 134th Ave NE	stormwater pond does not have a cover (see CS70)	0	0	0	0	0	0	3	0	5	0	5	3	24	High	$ 1,500	
86	25		CS70 (same as PS20)	NE 205th St & 134th Ave NE	Pond at Georgian Heights 4 (one house east of 134th). Open bottom detention pond has concrete walls; situated very close to residences; Pond functions well, but mosquitoes and scent are problems. May need a lid or conversion to an underground tank.	0	0	0	0	0	0	3	0	5	0	5	3	24	Low	See above	
87	11		KC45	14522 NE 190TH ST	ONGOING WATER QUALITY PROBLEM AT; Eng Rev	0	0	0	0	0	0	5	5	3	0	0	3	19	Low	$ 250	ID source of Water Quality problem and identify solution.
88	11		PS11	15376 129th Ave NE	gooey algae	0	0	0	0	0	0	3	3	5	0	0	3	17	Medium	$ 1,500	Private pond. Convert to a water quality facility with flow control such as a constructed wetland.
89	23		CS68	Little Bear Creek and 205th St NE	Little Bear Creek Crossing	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A		2008 analysis does not show flooding at this culvert.
	9		PS9	12442 NE 164th St	sidewalk is crumbling causing loose pebbles to impede storm drain	Sidewalk Issue. Not drainage related.													N/A		
	21		PS21	15815 Woodinville Redmond Rd	clogged drains	Maintenance Referral													N/A		Maintenance referral to unclog stormwater drain.
	22		PS22	12522 NE 147th PL	drains do not appear to work	Maintenance Referral													N/A		Maintenance referral to unclog stormwater drain.
	23		PS23	19628 144th Ave NE	plugged storm drain	Maintenance Referral													N/A		Maintenance referral to unclog stormwater drain.
	30		PS30	15511 129th Ave NE	Plugged storm drain and standing water. Water over 1/2 of road.	Maintenance Referral													N/A		Maintenance referral to unclog stormwater drain.
	8		KC42	12230 NE WOODINVILLE DR	EXISTING COMM FACILITY NOT	Cannot be ranked. Lack of information.													N/A		
	10		KC44	14507 127TH AVE NE	MAINTENACE OF ROADSIDE DITCH.	Maintenance Referral													N/A		Maintain ditch
	4		CS49		RR crossing on SR 202 and 144XX. Railroad trash rack plugs and overflows down over SR202.	Maintenance Referral													N/A		
	9		CS54	190th PL 133XX	Residents dump yard debris in outlet to wetlands. We often check during yard work seasons. (Not a current problem)	Not a current problem.													N/A		
	12		CS57	144th and NE N Wood-Duvall Way 191XX and 144th Ave	Ditch is in need of ditching.	Maintenance Referral													N/A		Maintenance referral.
	14		CS59	146xx-148xx and 124th AVE NE	Ditch is full of reed canary grass and needs to be ditched. This backs up lower system in Kingsgate in heavy rains.	Maintenance Referral													N/A		
	15		CS60	Wood-Duvall SnoCo from 19th North to Sno Co line.	No complaint description, but number on the map so I didn't want to delete this row. Need to discuss with Brenda.	Not a current problem.													N/A		
	16		CS61	13716 and Little Bear Creek	Ferguson's: Trash rack plugs with leaves. Water year round	Maintenance Referral													N/A		
	17		CS62		No complaint description, but number on the map so I didn't want to delete this row. Need to discuss with Brenda.	Not a current problem.													N/A		
	24		CS69	144th Ave NE	144th Ave Plugged system on vactor list to be completed during dry weather.	Maintenance Referral													N/A		

Maximum Possible 115

Total Est. Cost (all projects): $23,512,000

15 years	$1,568,000
20 years	$1,176,000
25 years	$941,000

City of Woodinville
Draft Ranking and Rating of Public Survey Complaints
Project #31324
Last Update: 12/22/2010
Prepared by: JLC/SJS/AMM

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																			30 years	$784,000	

Appendix D
Capital Improvement Projects—
Summaries and Cost Opinions

PROJECT SUMMARY SHEET

Project Title: Woodin Creek CIP

Project Location: 140th Ave NE and NE 171st St., Woodin Creek Basin

Problem Description: Along Woodin Creek approximately between 133rd Ave NE to 140th Ave NE along NE 171st St. there is sediment accumulation that has blocked culverts and other stormwater conveyance infrastructure causing flooding of NE 171st street along the creek. Area along NE 171st Street and 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 sedimentation; however the creek is very flat along the stretch identified in the project sketch which could cause sediment to accumulate. The City often experiences lane closures on NE 171st St. during the 5 to 10-year storm event due to flooding of the roadway from Woodin Creek.

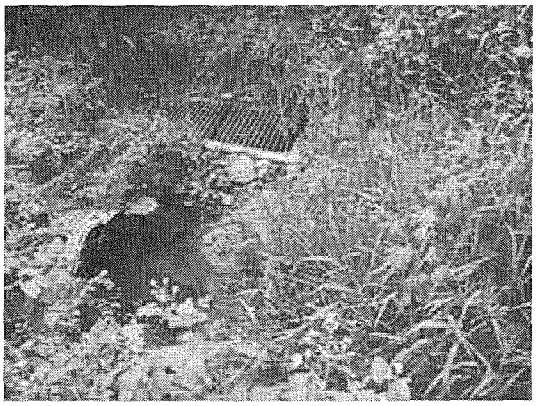
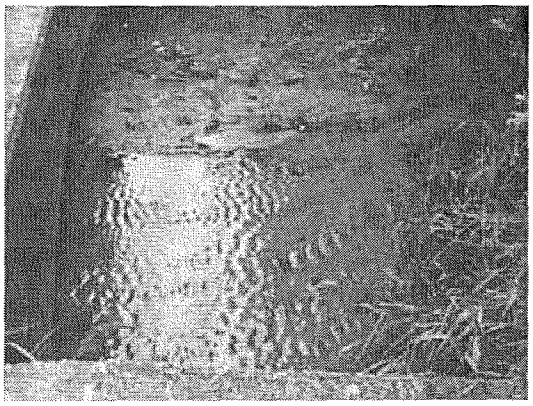
Design Considerations: This drainage complaint involves both public and private stormwater. In the upper reaches of the Woodin Creek tributaries, within both the City and King County, there are erosion issues as a result of development on steep hillside slopes. There are two existing stormwater ponds on the northern tributary along Woodinville-Duvall Way at NE 178th Street that outlet through a conveyance on the north side of the Albertsons commercial complex. The southern tributary crosses NE 171st Street (near 143rd Place NE) and runs north and then west along the south side of the Albertsons commercial complex. Just upstream of the Albertsons commercial complex there is an existing stormwater pond located at NE 178th St and NE Woodinville-Duvall Road. The two systems join and outlet to the open channel portion of Woodin Creek at 140th Ave NE about 250-feet north of NE 171st Street.

Project Description: There is a long standing reoccurring problem of excessive sediment accumulation in Woodin Creek. Complete a detailed survey of the stormwater system that drains to Woodin Creek in the study area along NE 171st. Solution 1: Raise the road up one foot in elevation and construct a separate storm system (~3000 LF (1000 LF of 42" stormwater pipe and 2000 LF of 24" 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 roadway at critical locations. Add a high flow diversion system within the roadway.

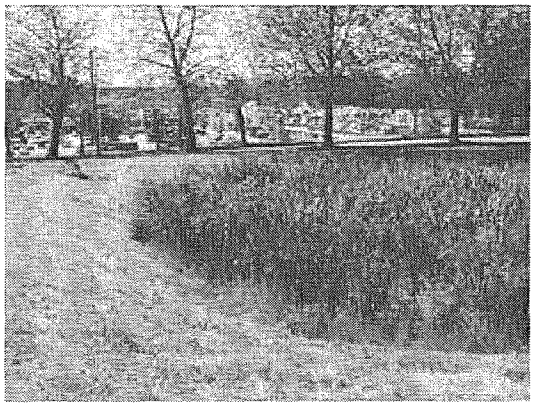
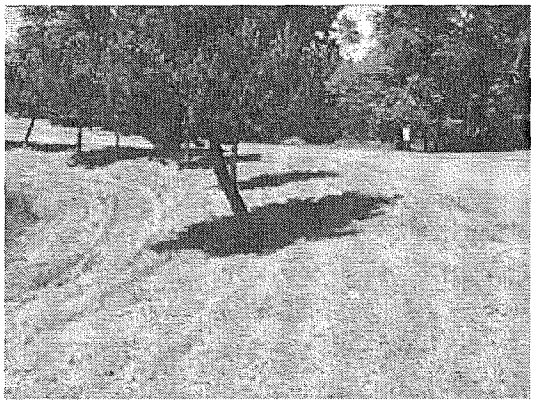
Note: If redevelopment occurs north of NE 171st St. (existing Mobile Home Park) some issues on Woodin Creek may be solved during the redevelopment.

Estimated Project Cost: $2,993,000

Photos:

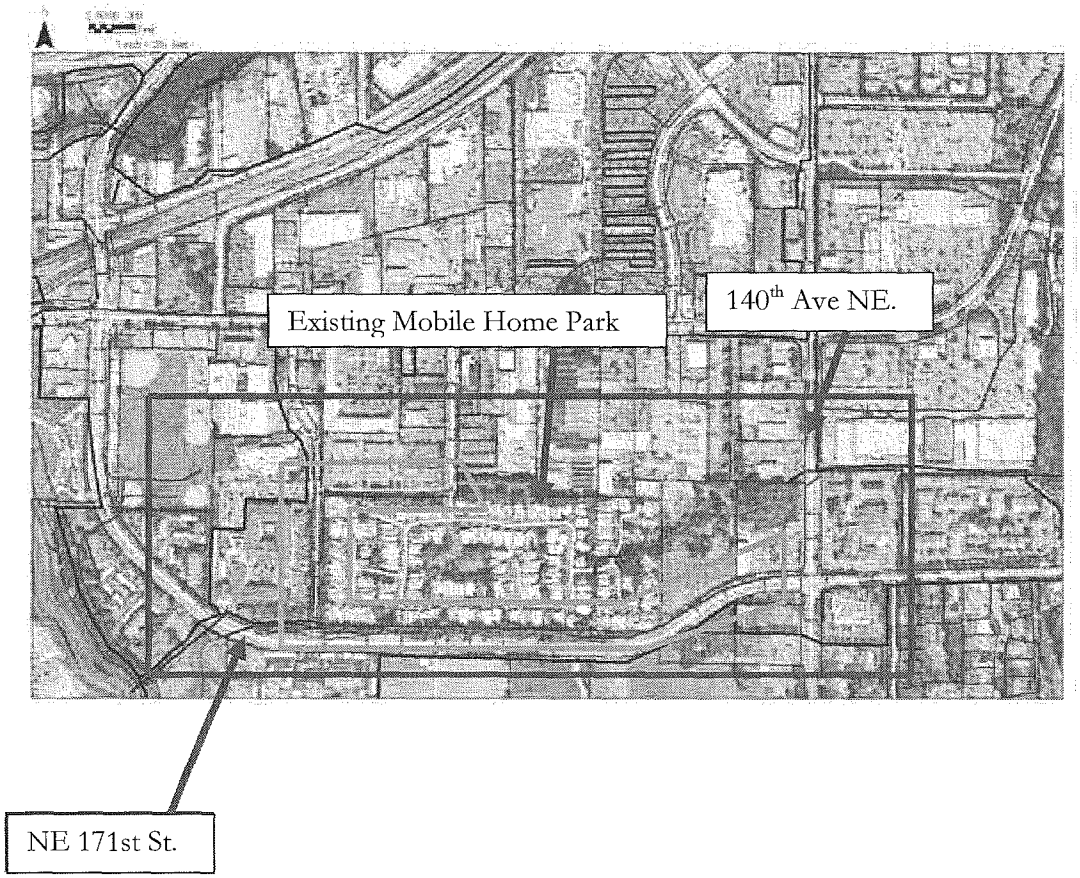



Photos of Woodin Creek sedimentation problem.

Photos of detention ponds upstream of Woodin Creek's sedimentation problem.

PROJECT SKETCH



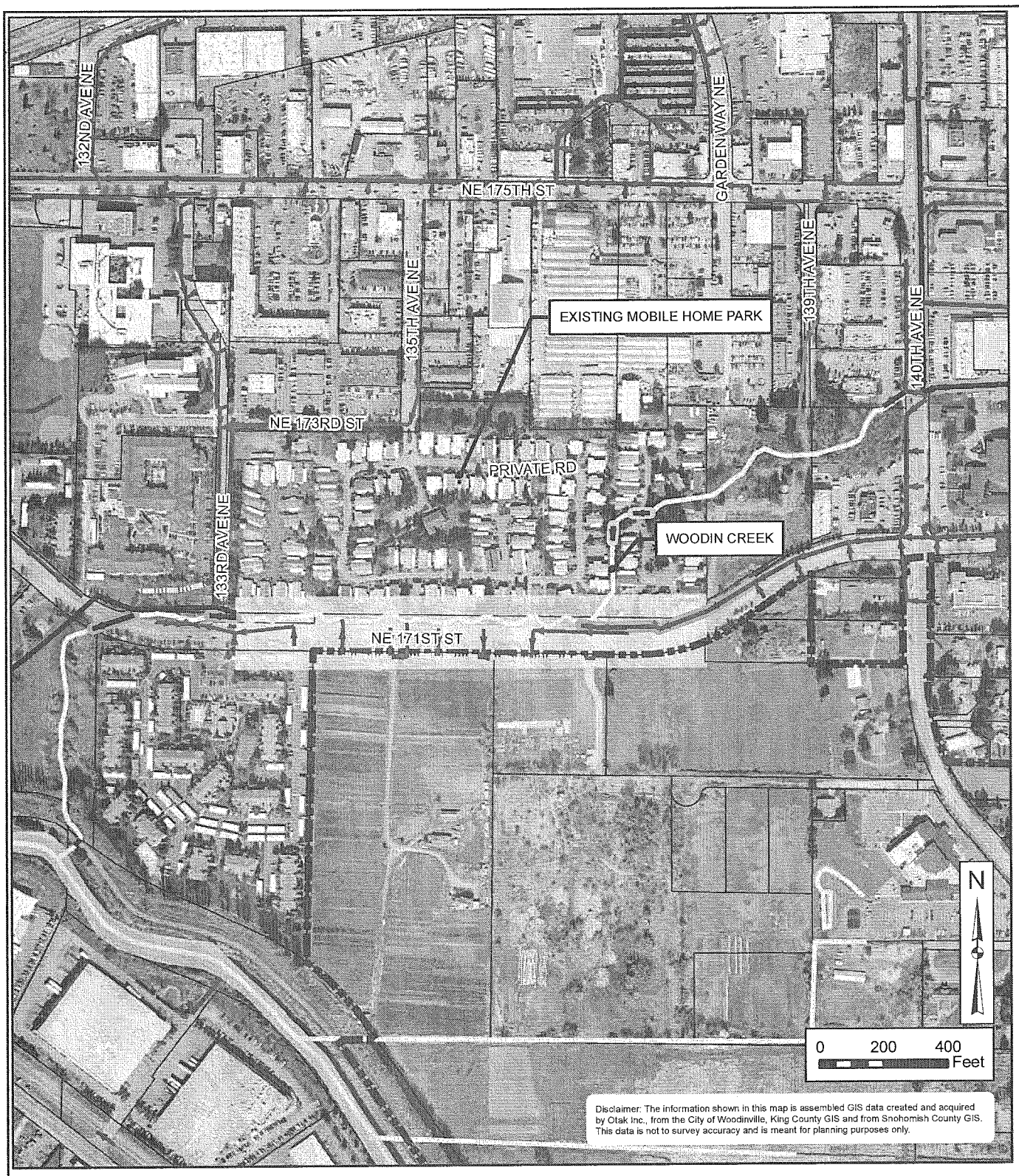
PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT:	Woodin Creek CIP: Solution #1	CHECKED BY:	AMM/LM
BY:	JLC	DATE:	12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	CATCH BASIN TYPE 1L	10	EA	$ 1,500.00	$ 15,000
2	CATCH BASIN, TYPE 2, 48 IN DIA	6	EA	$ 3,500.00	$ 21,000
3	CONNECT TO EXISTING STRUCTURE	2	EA	$ 1,000.00	$ 2,000
4	EXTRUDED CURB	700	LF	$ 17.00	$ 11,900
5	FILL AND COMPACT, COMMON BORROW	1,500	CY	$ 35.00	$ 52,500
6	LANDSCAPE RESTORATION	1	LS	$ 2,500.00	$ 2,500
7	PAVEMENT RESTORATION	34,500	SF	$ 5.60	$ 193,200
8	REMOVE PAVEMENT	1,500	SY	$ 22.00	$ 33,000
9	SIDEWALK RESTORATION	3,500	SF	$ 13.00	$ 45,500
10	STORM SEWER PIPE, 24 IN DIA	2,000	LF	$ 85.00	$ 170,000
11	STORM SEWER PIPE, 42 IN DIA	1,000	LF	$ 175.00	$ 175,000
12	STORM SYSTEM SURVEY	1	LS	$ 25,000.00	$ 25,000
13	UTILITY RELOCATIONS (NO COST TO THE CITY)	1	LS	$ -	$ -
14	WATER QUALITY TREATMENT VAULT	1.0	AC-FT	$ 350,000.00	$ 350,000
				Subtotal	$ 1,096,600
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 109,660
	TRAFFIC CONTROL	15%	(See Note 4)		$ 164,490
	MISC BID ITEMS	30%			$ 328,980
				Subtotal	$ 1,699,730
	MOBILIZATION (GENERAL REQUIREMENT)	5%			$ 84,987
				Construction Subtotal (Rounded)	$ 1,785,000
	CONTINGENCY	10%			$ 178,500
	STATE SALES TAX	10%	(see Note 5)		$ 169,575
	ENGINEERING/LEGAL/ADMIN	20%			$ 357,000
	CONSTRUCTION MANAGEMENT	5%			$ 89,250
	PERMITTING	3%			$ 53,550
				Project Subtotal (Rounded)	$ 2,633,000
	LAND ACQUISITION (see note 6)		AC		
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 2,633,000**

Notes:

1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Sales tax is not always required on municipal roadway projects. However, tax is included in planning level estimates, as not all stormwater work is directly related to roadway drainage.
6. Land Acquisition unit costs include Administrative Costs and Condemnation.



LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

Approximate Location of CIP

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.1

WOODIN CREEK CIP

CITY OF WOODINVILLE

JUNE 2010

PROJECT SUMMARY SHEET

Project Title: Chateau Reach CIP

Project Location: 15600 Woodinville-Redmond Road (SR 202), Sammamish River Watershed

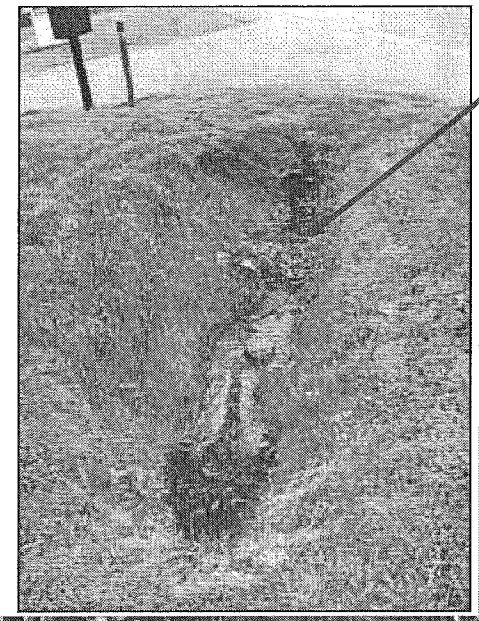
Problem Description: Erosion and excess silt deposit problems in channel causes flooding of SR 202 and near-by commercial area. This is a recurring problem that has been on the City's CIP list for years. A previous project concept was contingent on private property owners granting the City an easement during redevelopment of the surrounding property.

Design Considerations: This drainage complaint involves both public and private stormwater. Right-of-way constraints and required easements may affect the design of this project. Installation of an on-line stormwater facility may require permitting of a Hydraulic Project Approval (HPA).

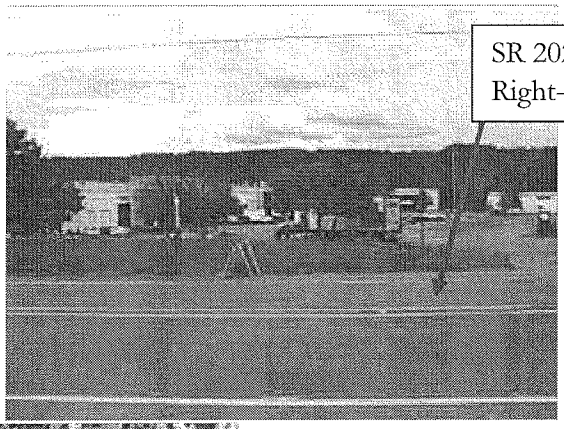
Project Description: Identify sources of sediment and install erosion control measures where City has right-of-way. Retrofit existing upstream sediment facility upstream of SR202. This facility is currently on private property. This would require the purchase of the property containing the private facility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

Estimated Project Cost: $608,000

Photos:



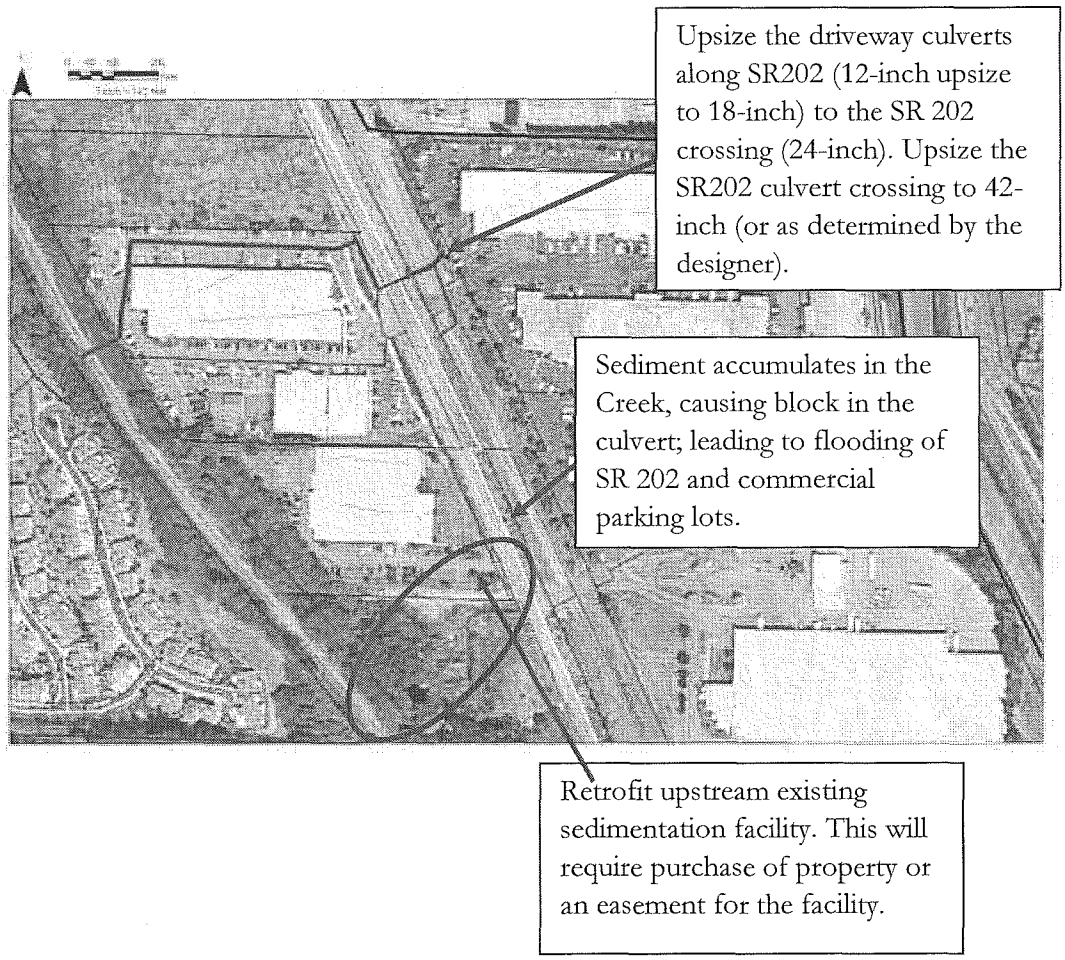
Creek flowing to the north along SR 202.



SR 202 (60' of Right-of-Way)

Sediment accumulates in the Creek, causing block in the culvert; leading to flooding of SR 202 and commercial parking lot.

PROJECT SKETCH

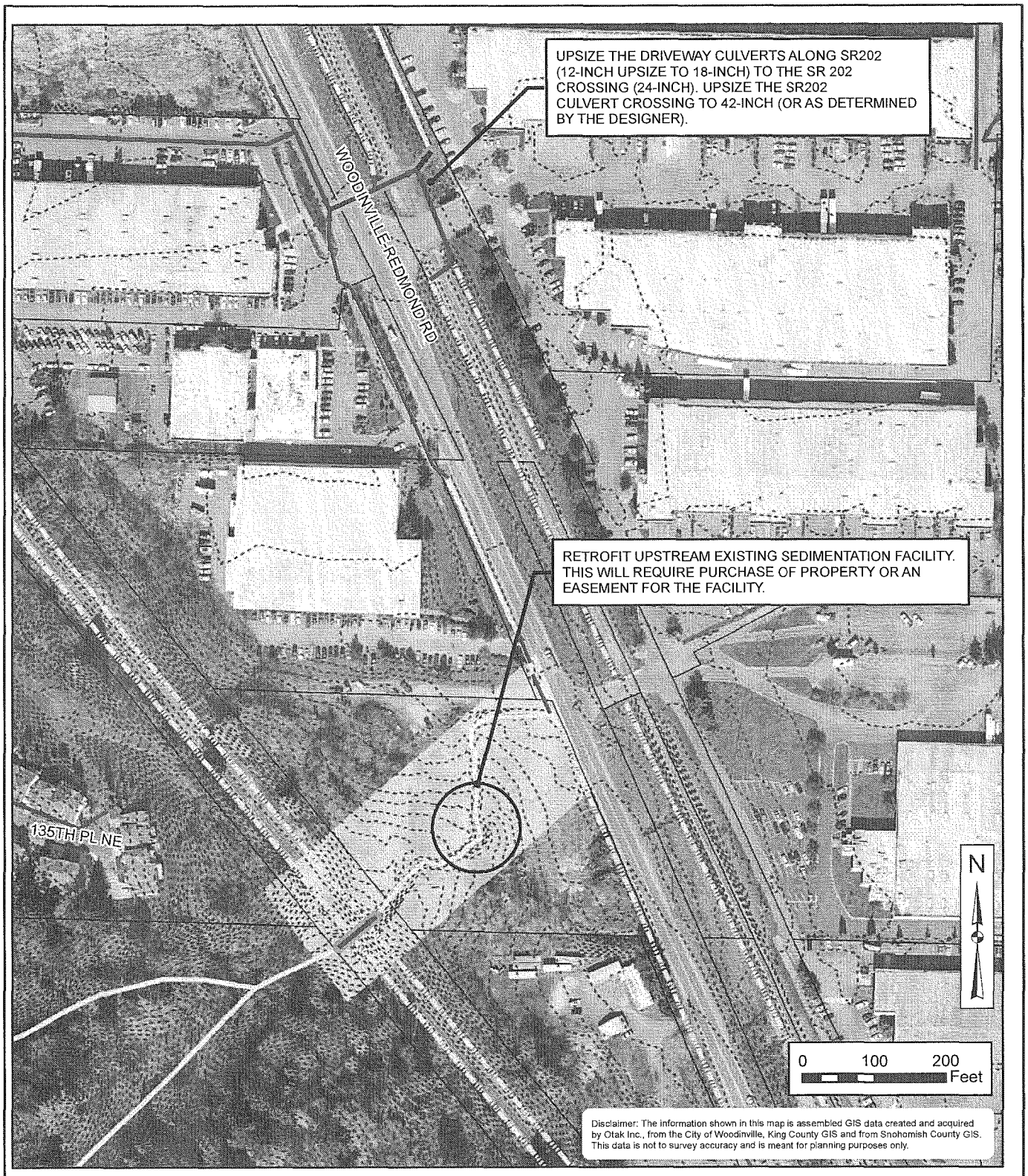


PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: Chateau Reach CIP
BY: JLC
CHECKED BY: AMM/LM
DATE: 12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	ADJUST FLOW CONTROL STRUCTURE	1	EA	$ 850.00	$ 850
2	CATCH BASIN TYPE 1L	2	EA	$ 1,500.00	$ 3,000
3	CATCH BASIN, TYPE 2, 48 IN DIA	1	EA	$ 3,500.00	$ 3,500
4	CLEARING AND GRUBBING	1	LS	$ 1,500.00	$ 1,500
5	HYDROSEEDING	1,400	SY	$ 2.50	$ 3,500
6	PAVEMENT RESTORATION	1,750	SF	$ 5.60	$ 9,800
7	POND EXCAVATION (includes fine grading)	950	CY	$ 20.00	$ 19,000
8	RIPARIAN PLANTING	1	LS	$ 5,000.00	$ 5,000
9	STORM SEWER PIPE, 18 IN DIA	350	LF	$75.00	$ 26,250
10	STORM SEWER PIPE, 42 IN DIA (BORED UNDER ROAD and RR)	175	LF	$ 750.00	$ 131,250
				Subtotal	$ 203,650
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 20,365
	TRAFFIC CONTROL	15%	(See Note 4)		$ 30,548
	MISC BID ITEMS	30%			$ 61,095
				Subtotal	$ 315,658
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 31,566
				Construction Subtotal (Rounded)	$ 347,000
	CONTINGENCY	10%			$ 34,700
	STATE SALES TAX	9.5%	(see Note 5)		$ 32,965
	ENGINEERING/LEGAL/ADMIN	25%			$ 86,750
	CONSTRUCTION MANAGEMENT	10%			$ 34,700
	PERMITTING	15%			$ 52,050
				Project Subtotal (Rounded)	$ 588,000
	LAND EASEMENT ACQUISITION (see note 6)		EASEMENT		$ 20,000
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 608,000**

Notes:
1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Sales tax is not always required on municipal roadway projects. However, tax is included in planning level estimates, as not all stormwater work is directly related to roadway drainage.
6. Land Acquisition unit costs include Administrative Costs and Condemnation.



LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

Approximate Location of CIP

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.2

CHATEAU REACH CIP

CITY OF WOODINVILLE

JUNE 2010

PROJECT SUMMARY SHEET

Project Title: Lake Leota and NE 180th Street CIP

Project Location: 16200 NE 180th Street near Lake Leota (south side of Lake)

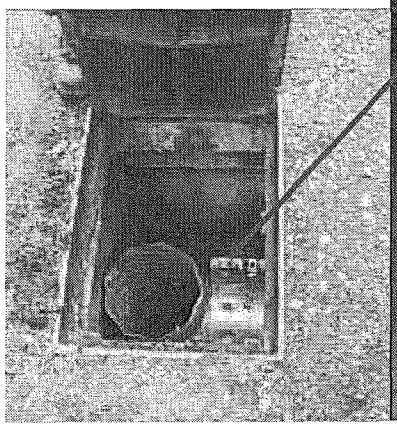
Problem Description: Stormwater runoff from NE 180th Street and private property on the upstream (south) hillside of NE 180th Street is not being treated before entering Lake Leota. During storm events there are an insufficient number of inlets to collect stormwater from the roadway and water flows toward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

Design Considerations: This drainage complaint involves both public and private stormwater. There is an existing frop-tee in a catch basin (picture below) to help minimize sediment entering Lake Leota; however the public still expresses concern regarding sedimentation entering Lake Leota and the flooding of homes on NE 180th Street.
The bioretention units need to be installed within the right-of-way (total right-of-way width of ~60'). The existing discharge point is on private property, so the City may need to work with the property owner to obtain a stormwater easement. Potential conflicts with existing power poles that may conflict with one of the locations of the proposed bioretention stormwater quality facility. Moving the utility poles would not be an additional cost for the City.

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 of existing ditch (LID demonstration project). 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.

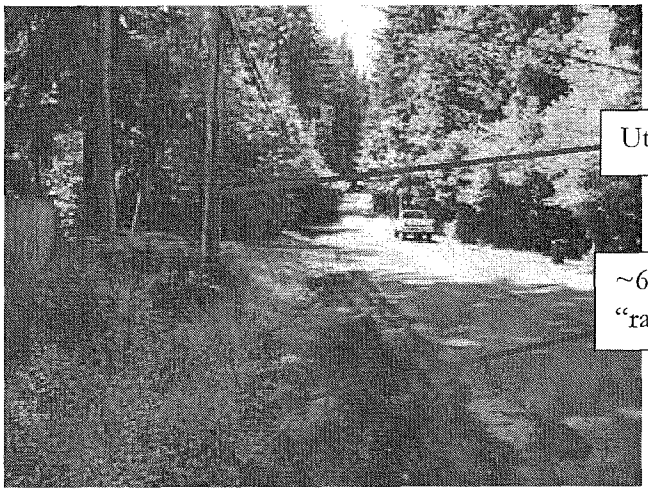
Estimated Project Cost: $1,150,000

Photos:



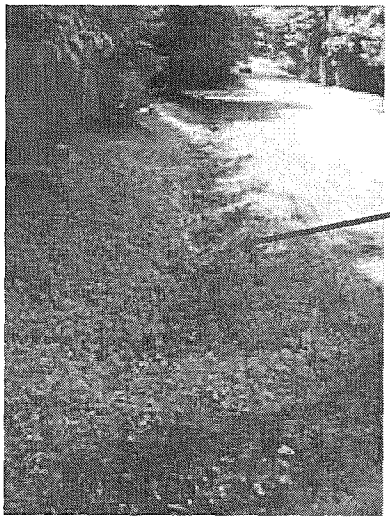
Existing Grate. (Same Structure Pictured)

Existing Catch Basin (Same Structure Pictured)



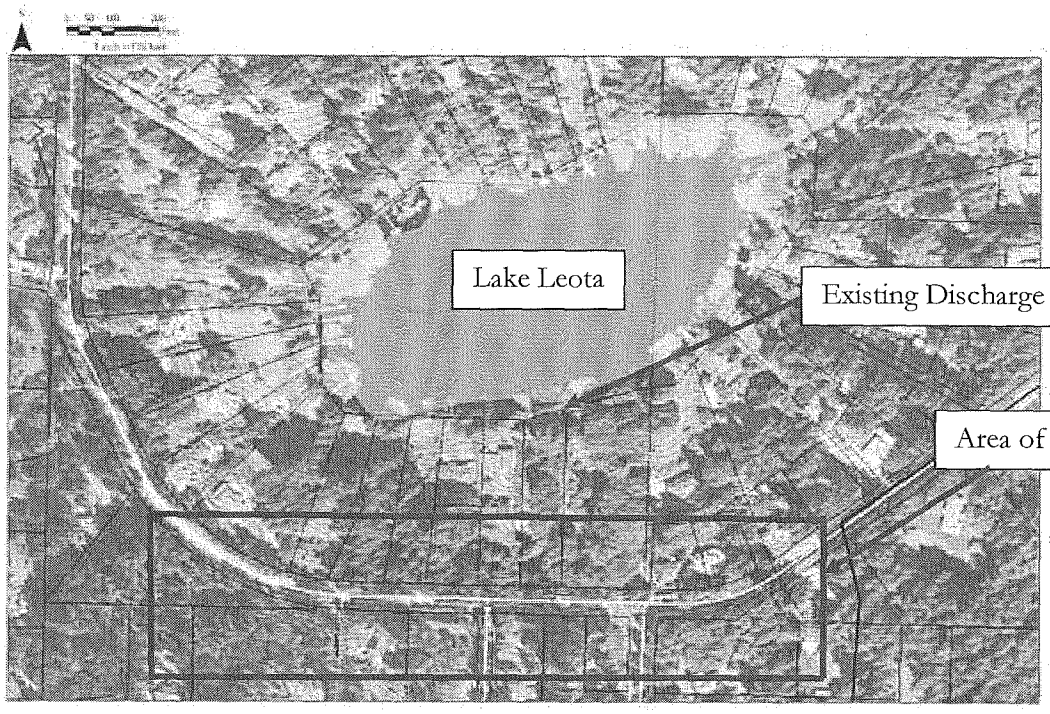
Utility Pole

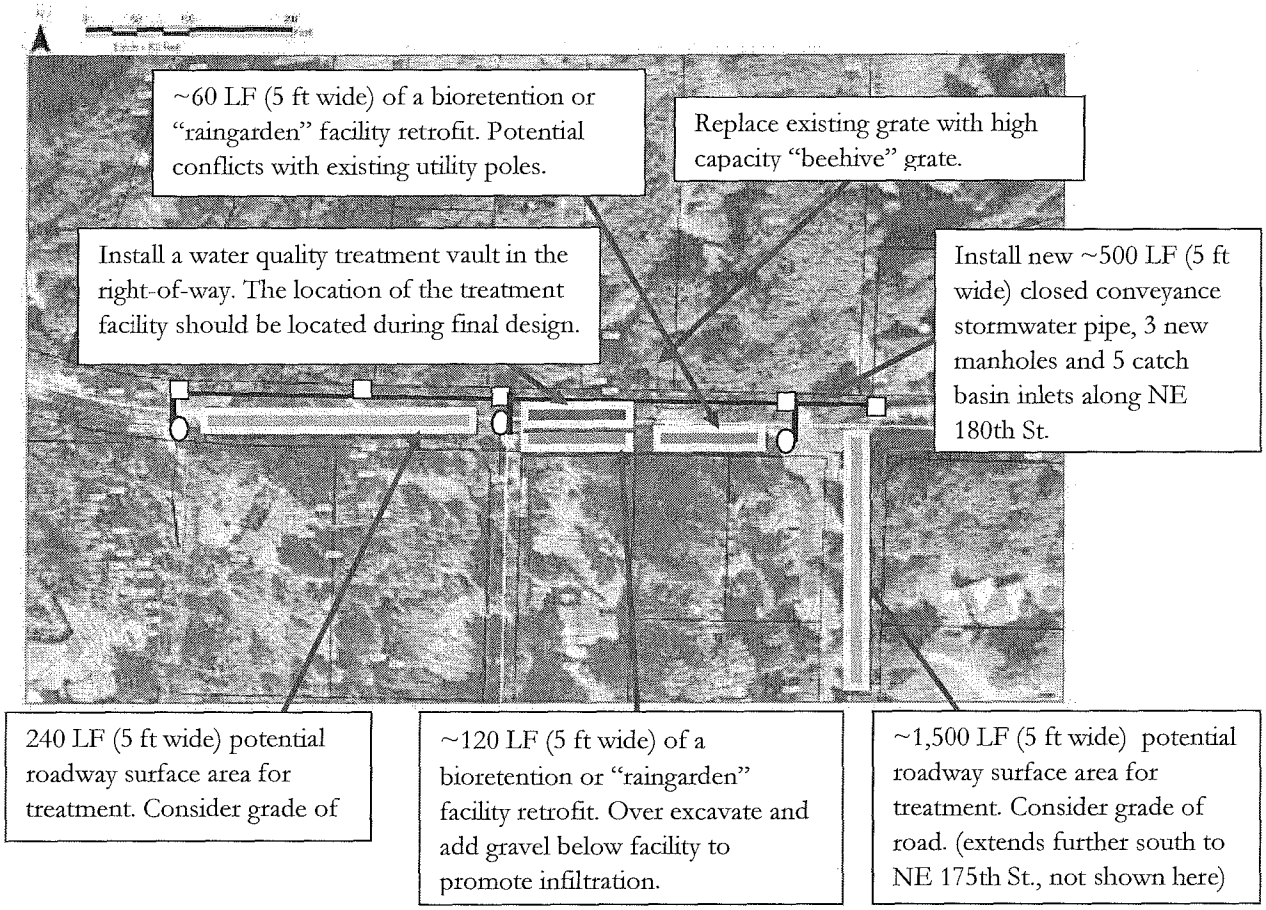
~60 LF of a bioretention or "raingarden" facility retrofit.



~120 LF of a bioretention or "raingarden" facility retrofit of existing ditch.

PROJECT SKETCH



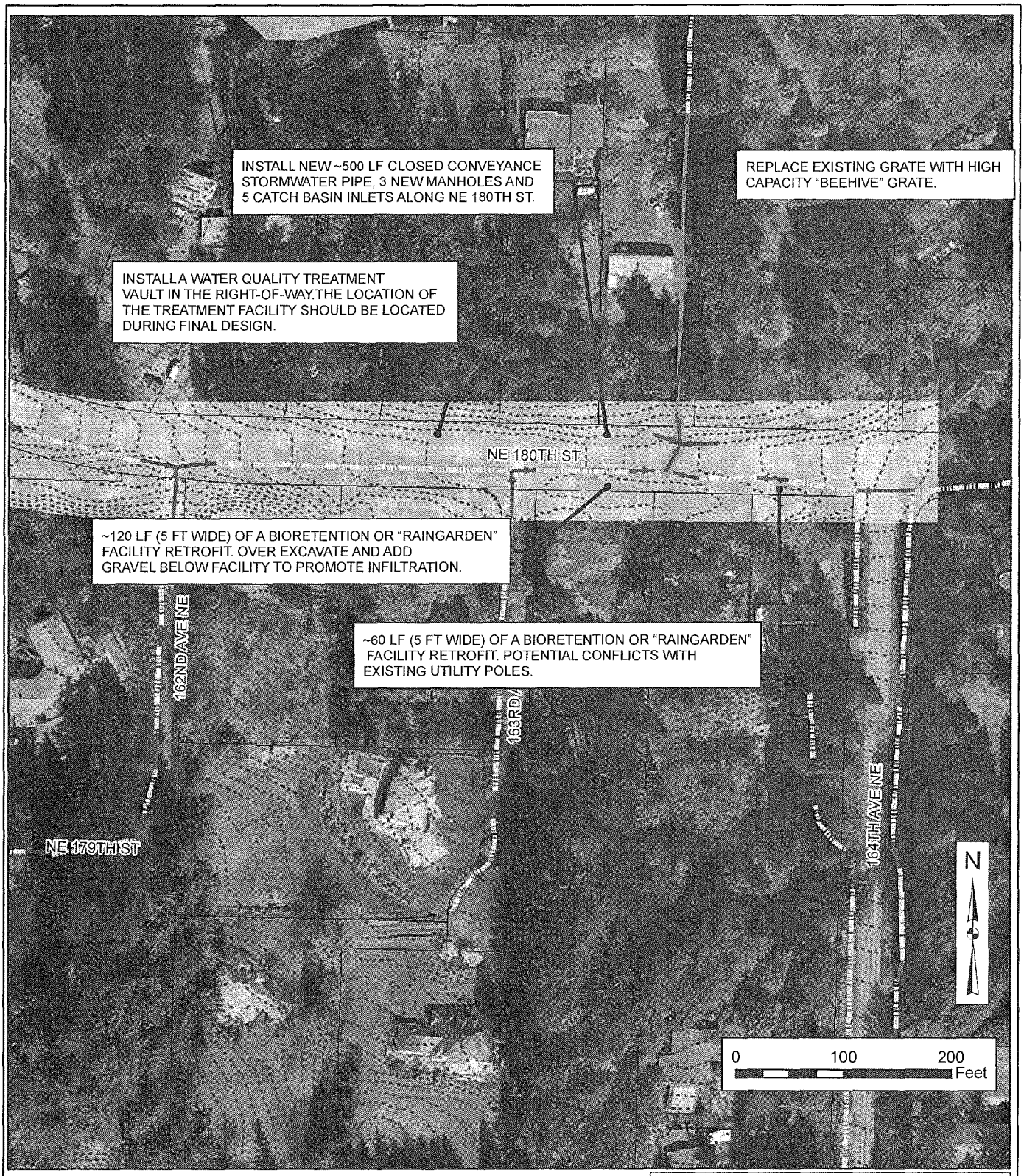

~60 LF (5 ft wide) of a bioretention or "raingarden" facility retrofit. Potential conflicts with existing utility poles.
Replace existing grate with high capacity "beehive" grate.
Install a water quality treatment vault in the right-of-way. The location of the treatment facility should be located during final design.
Install new ~500 LF (5 ft wide) closed conveyance stormwater pipe, 3 new manholes and 5 catch basin inlets along NE 180th St.
240 LF (5 ft wide) potential roadway surface area for treatment. Consider grade of
~120 LF (5 ft wide) of a bioretention or "raingarden" facility retrofit. Over excavate and add gravel below facility to promote infiltration.
~1,500 LF (5 ft wide) potential roadway surface area for treatment. Consider grade of road. (extends further south to NE 175th St., not shown here)

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT:	Lake Leota and NE 180th Street CIP	CHECKED BY:	AMM/LM
BY:	JLC	DATE:	12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	BIORETENTION FACILITY	3,825	SF	$ 17.00	$ 65,025
2	CATCH BASIN TYPE 1L	5	EA	$ 1,500.00	$ 7,500
3	CATCH BASIN, TYPE 2, 48 IN DIA	3	EA	$ 3,500.00	$ 10,500
4	CLEARING AND GRUBBING	1	LS	$ 5,000.00	$ 5,000
5	CONNECT TO EXISTING STRUCTURE	4	EA	$ 1,000.00	$ 4,000
6	DITCH EXCAVATION INCL. HAUL	250	CY	$ 95.00	$ 23,750
7	FILL AND COMPACT, COMMON BORROW	110	CY	$ 35.00	$ 3,850
8	HYDROSEEDING	250	SY	$ 2.50	$ 625
9	LANDSCAPE RESTORATION	1	LS	$ 3,000.00	$ 3,000
10	PAVEMENT RESTORATION	1,500	SF	$ 5.60	$ 8,400
11	RIPARIAN PLANTING	1	LS	$ 5,000.00	$ 5,000
12	STORM SEWER PIPE, 12 IN DIA	500	LF	$ 60.00	$ 30,000
13	TRASH RACK	10	EA	$ 650.00	$ 6,500
14	UTILITY RELOCATIONS (NO COST TO THE CITY)	2	LS	$ -	$ -
15	WATER QUALITY TREATMENT VAULT	0.50	AC-FT	$ 350,000.00	$ 175,000
				Subtotal	$ 348,150
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 34,815
	TRAFFIC CONTROL	15%	(See Note 4)		$ 52,223
	MISC BID ITEMS	30%			$ 104,445
				Subtotal	$ 539,633
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 53,963
				Construction Subtotal (Rounded)	$ 594,000
	CONTINGENCY	10%			$ 59,400
	STATE SALES TAX	9.5%	(see Note 5)		$ 56,430
	ENGINEERING/LEGAL/ADMIN	25%			$ 148,500
	CONSTRUCTION MANAGEMENT	10%			$ 59,400
	PERMITTING	5%			$ 29,700
				Project Subtotal (Rounded)	$ 947,000
	LAND ACQUISITION (see note 6)		AC		$ -
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 947,000**

Notes:
1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Sales tax is not always required on municipal roadway projects. However, tax is included in planning level estimates, as not all stormwater work is directly related to roadway drainage.
6. Land Acquisition unit costs include Administrative Costs and Condemnation.



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LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

City Limits

County Boundary

Parcel Boundary

Streams

Stormwater Open Channel

Approximate Location of CIP

Contour 2 ft

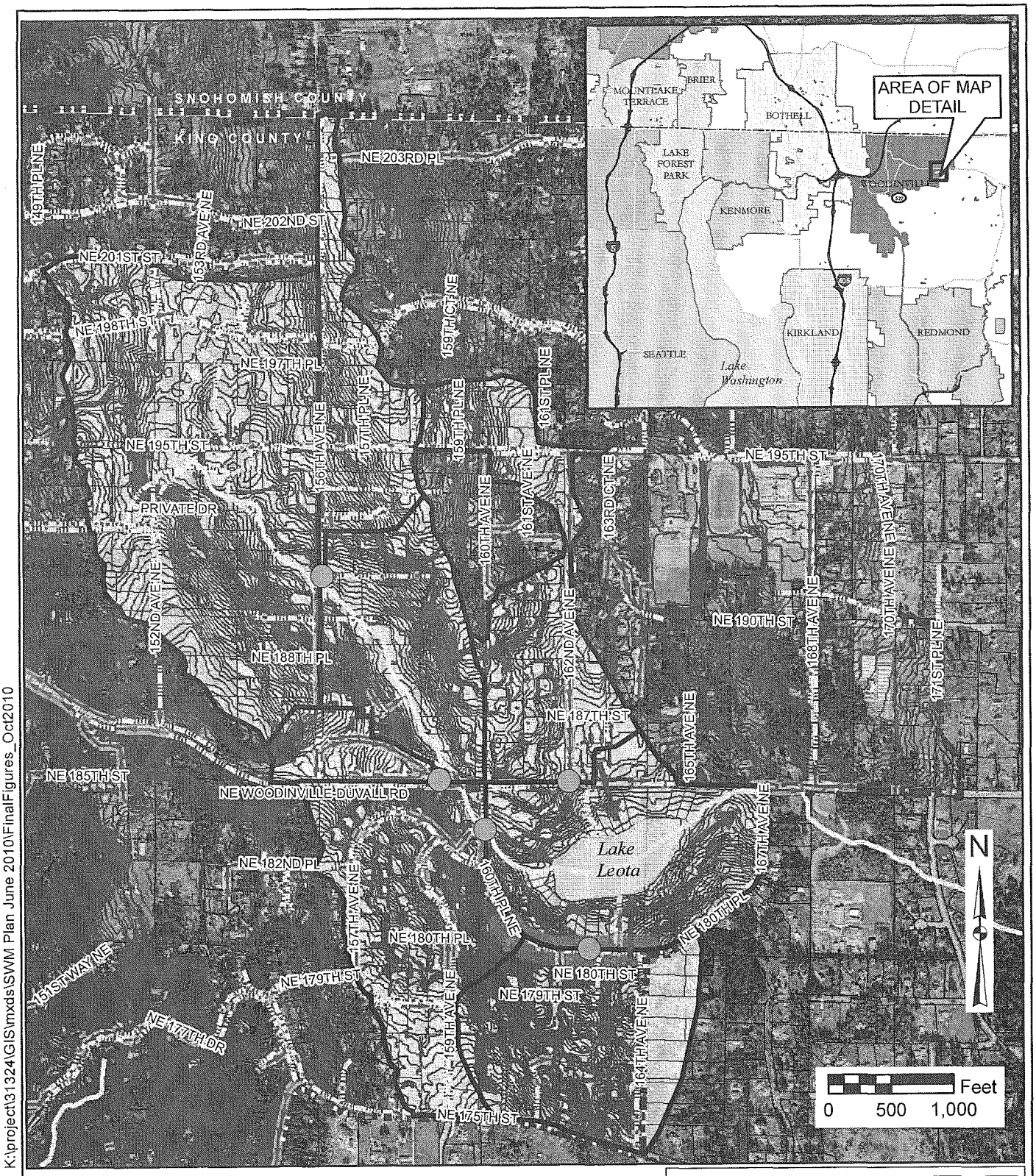
STORMWATER MANAGEMENT PLAN

FIGURE D.3.A

LAKE LEOTA AND NE 180TH ST. CIP

CITY OF WOODINVILLE

OCTOBER 2010



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LEGEND

CITY OF WOODINVILLE - STORMWATER PIPES 02/16/10

SIZE

- unknown size
- <= 12"
- <= 24"
- > 24"

Potential Raingarden Location

Approximate Location of Water Quality Vault *

City Limits

County Boundary

Parcel Boundary

Lake Leota Watershed

Stormwater Open Channel

Streams

Subbasin Boundary

Contour 2ft

* The raingardens locations are to be determined within the Lake Leota watershed.

STORMWATER MANAGEMENT PLAN

FIGURE D.3.B

LAKE LEOTA AND NE 180TH ST. CIP

CITY OF WOODINVILLE

OCTOBER 2010

PROJECT SUMMARY SHEET

Project Title: NE Woodinville Duvall Road CIP

Project Location: 100 feet east of 140th Ave NE and 175th St NE intersection along NE Woodinville Duvall Road

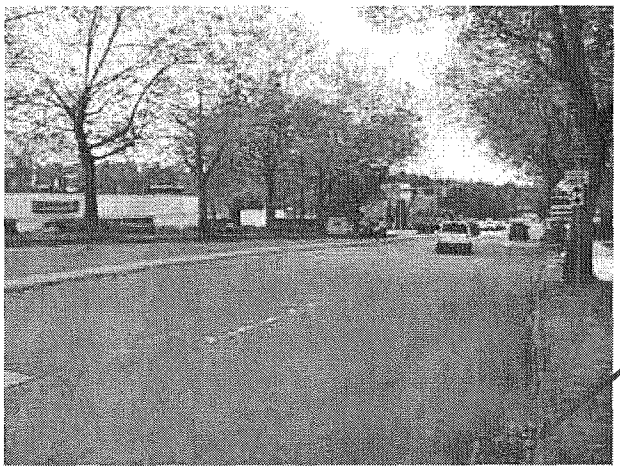
Problem Description: A primary conveyance line (12-inch) along NW Woodinville Duvall Road takes a 90 degree direction change in a catch basin and then crosses to the center of the road as an 8-inch stormwater pipe. At this point it turns 90-degrees in a second structure and continues as a 12-inch stormwater 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 140th Ave NE and 175th St NE intersection where it temporarily ponds due to the lack of inlet capacity. This causes traffic disruption.

Design Considerations: None

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 a curb cut inlet frames and grates on upstream structures along NE Woodinville Duvall Road to minimize clogging due to street tree leaf litter.

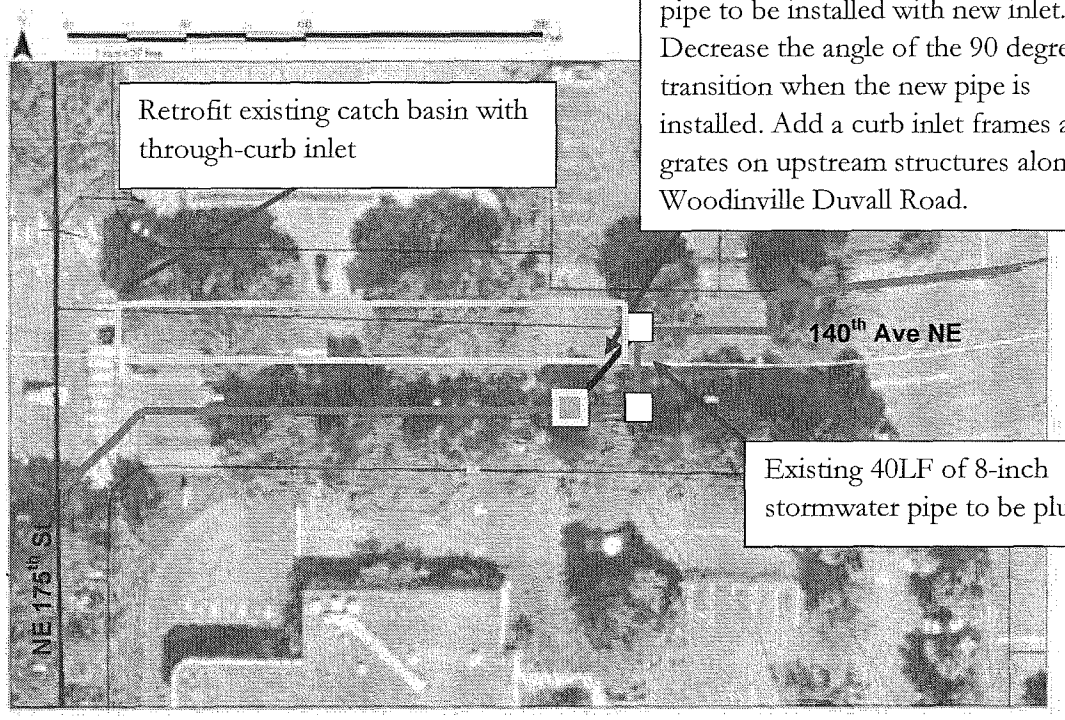
Estimated Project Cost: $102,000

Photos:



Location of 90 degree bend in stormwater conveyance system.

PROJECT SKETCH



Proposed 50LF of 12-inch stormwater pipe to be installed with new inlet. Decrease the angle of the 90 degree transition when the new pipe is installed. Add a curb inlet frames and grates on upstream structures along NE Woodinville Duvall Road.

Retrofit existing catch basin with through-curb inlet

Existing 40LF of 8-inch stormwater pipe to be plugged.

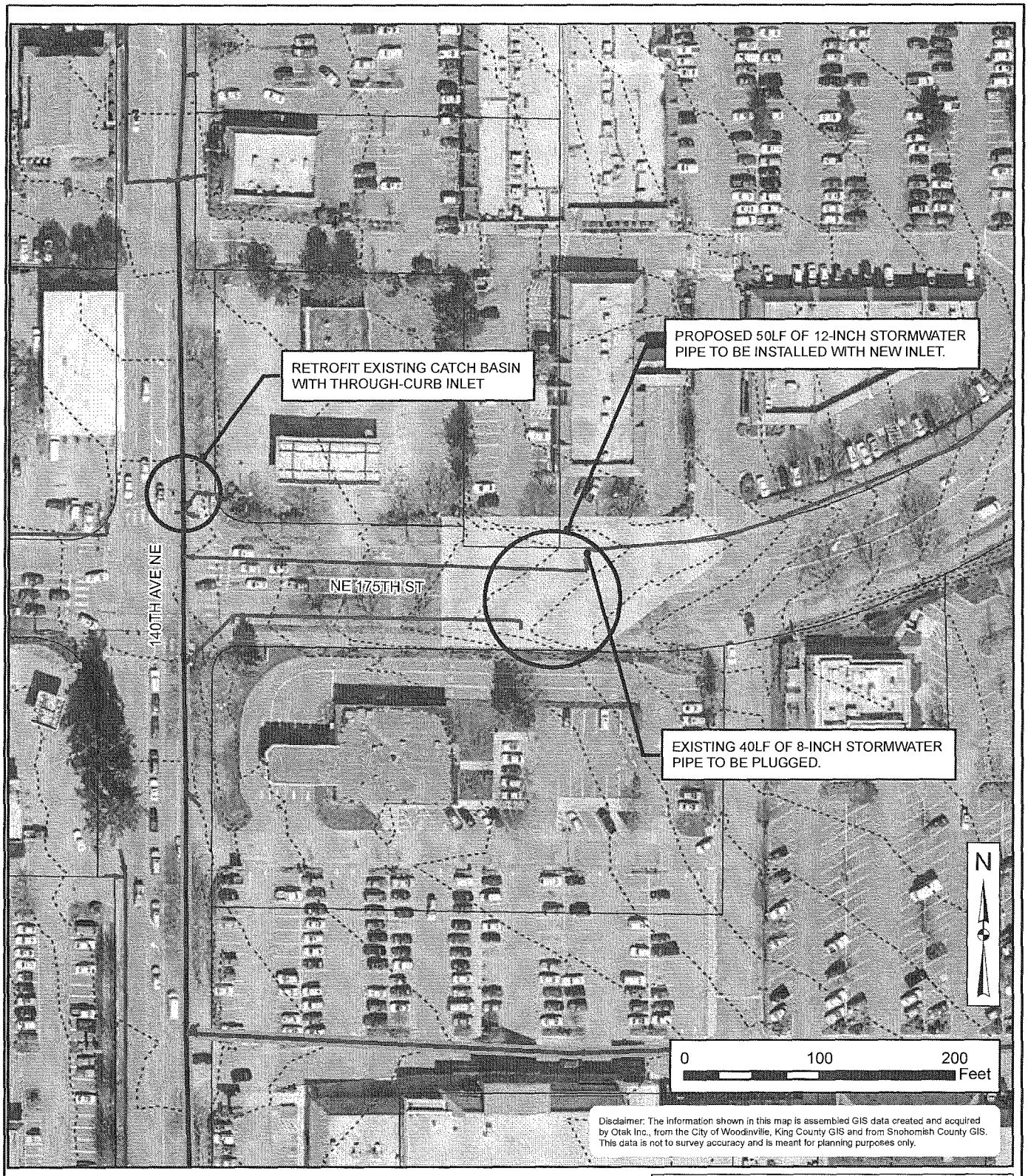
PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT:	NE Woodinville Duvall Road Stormwater Conveyance CIP	CHECKED BY:	AMM/LM
BY:	JLC	DATE:	12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	CATCH BASIN TYPE 1L	2	EA	$ 1,500.00	$ 3,000
2	CATCH BASIN, TYPE 2, 48 IN DIA	2	EA	$ 3,500.00	$ 7,000
3	CONNECT TO EXISTING STRUCTURE	2	EA	$ 1,000.00	$ 2,000
4	PAVEMENT RESTORATION	250	SF	$ 5.60	$ 1,400
5	REMOVE PAVEMENT	30	SY	$ 22.00	$ 660
6	SIDEWALK RESTORATION	150	SF	$ 13.00	$ 1,950
7	STORM SEWER PIPE, 12 IN DIA	120	LF	$ 60.00	$ 7,200
8	CURB INLET	6	EA	$ 2,000.00	$ 12,000
9	PLUG EXISTING STRUCTURE	1	LS	$ 250.00	$ 250
				Subtotal	$ 35,460
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 3,546
	TRAFFIC CONTROL	15%	(See Note 4)		$ 5,319
	MISC BID ITEMS	30%			$ 10,638
				Subtotal	$ 54,963
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 5,496
				Construction Subtotal (Rounded)	$ 60,000
	CONTINGENCY	10%			$ 6,000
	STATE SALES TAX	9.5%	(see Note 5)		$ 5,700
	ENGINEERING/LEGAL/ADMIN	30%			$ 18,000
	CONSTRUCTION MANAGEMENT	15%			$ 9,000
	PERMITTING	5%			$ 3,000
				Project Subtotal (Rounded)	$ 102,000
	LAND ACQUISITION (see note 6)		AC		$ -
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 102,000**

Notes:

1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Sales tax is not always required on municipal roadway projects. However, tax is included in planning level estimates, as not all stormwater work is directly related to roadway drainage.
6. Land Acquisition unit costs include Administrative Costs and Condemnation.



LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

Approximate Location of CIP

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 f

STORMWATER MANAGEMENT PLAN

FIGURE D.4

NE WOODINVILLE DUVALL ROAD CIP

CITY OF WOODINVILLE

otak

JUNE 2010

PROJECT SUMMARY SHEET

Project Title: 147th PL NE CIP

Project Location: Near 17819 147th Place NE near NE 178th St.

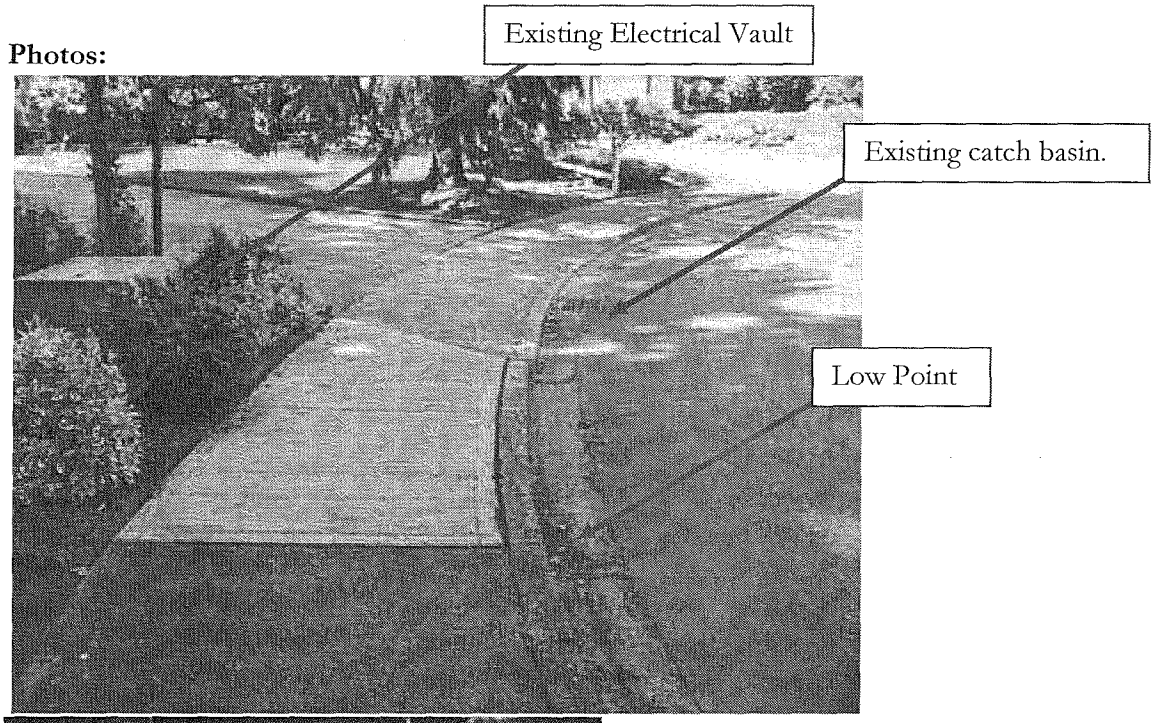
Problem Description: There are not a sufficient number of catch basin inlets at the low point of 147th Place NE. As a result, flooding of a nearby electrical vault occurs along with standing water in the roadway.

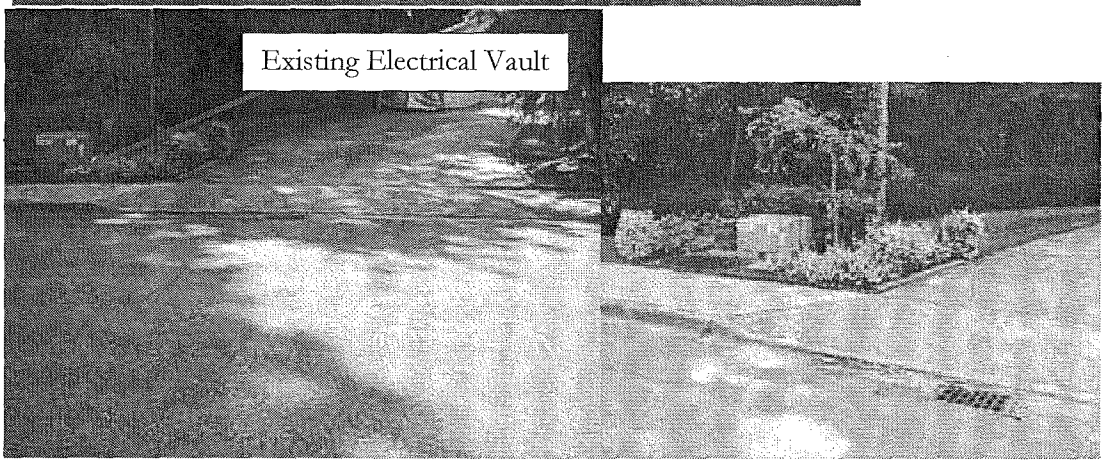
Design Considerations: Utility conflicts should be considered in the design of this CIP.

Project Description: Install a new through-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 20LF of 12-inch stormwater pipe to the northeast of the lowpoint. 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.

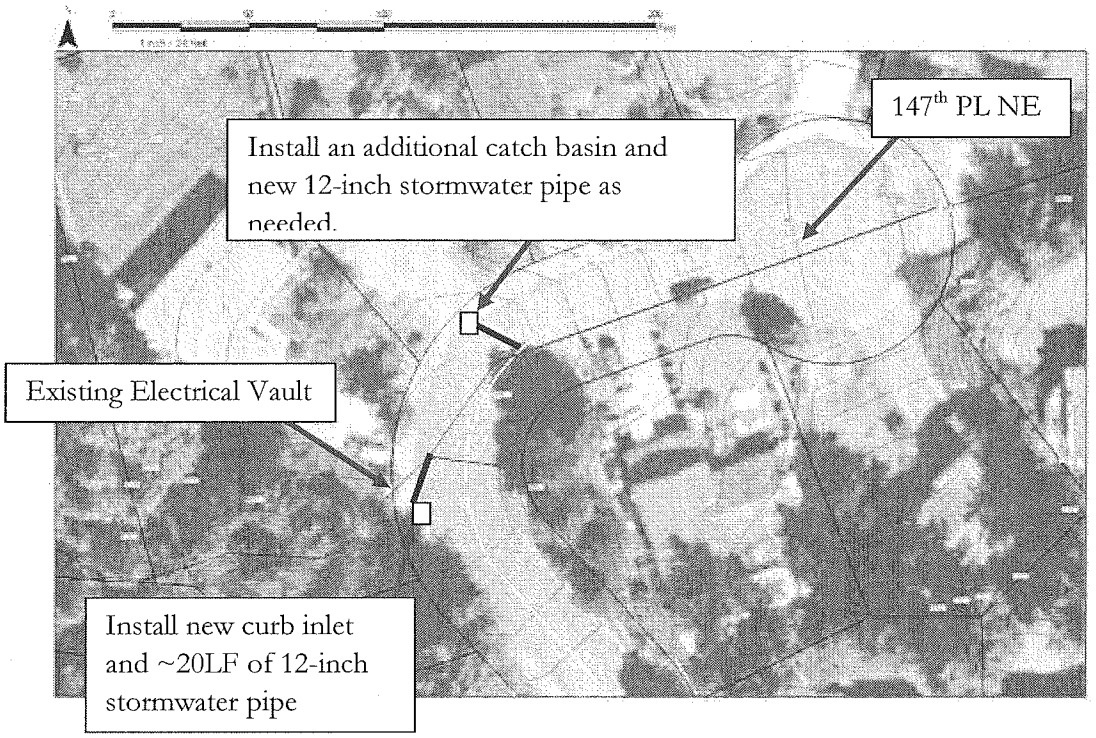
Estimated Project Cost: $40,000

Photos:


Existing Electrical Vault
Existing catch basin.
Low Point


Existing Electrical Vault

PROJECT SKETCH



PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: 147th PL NE CIP
BY: JLC
CHECKED BY: AMM/LM
DATE: 12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	CATCH BASIN, TYPE 2, 48 IN DIA	1	EA	$ 3,500.00	$ 3,500
2	CONNECT TO EXISTING STRUCTURE	2	EA	$ 1,000.00	$ 2,000
3	FILL AND COMPACT, COMMON BORROW	10	CY	$ 35.00	$ 350
4	PAVEMENT RESTORATION	120	SF	$ 5.60	$ 672
5	REMOVE PAVEMENT	15	SY	$ 22.00	$ 330
6	SIDEWALK RESTORATION	100	SF	$ 13.00	$ 1,300
7	STORM SEWER PIPE, 12 IN DIA	50	LF	$ 60.00	$ 3,000
8	CURB INLET	2	EA	$ 2,000.00	$ 4,000
				Subtotal	$ 15,152
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 1,515
	TRAFFIC CONTROL	10%	(See Note 4)		$ 1,515
	MISC BID ITEMS	30%			$ 4,546
				Subtotal	$ 22,728
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 2,273
				Construction Subtotal (Rounded)	$ 25,000
	CONTINGENCY	10%			$ 2,500
	STATE SALES TAX	9.5%	(see Note 5)		$ 2,375
	ENGINEERING/LEGAL/ADMIN	25%			$ 6,250
	CONSTRUCTION MANAGEMENT	10%			$ 2,500
	PERMITTING	5%			$ 1,250
				Project Subtotal (Rounded)	$ 40,000
	LAND ACQUISITION (see note 6)		AC		$ -
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 40,000**

Notes:

1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
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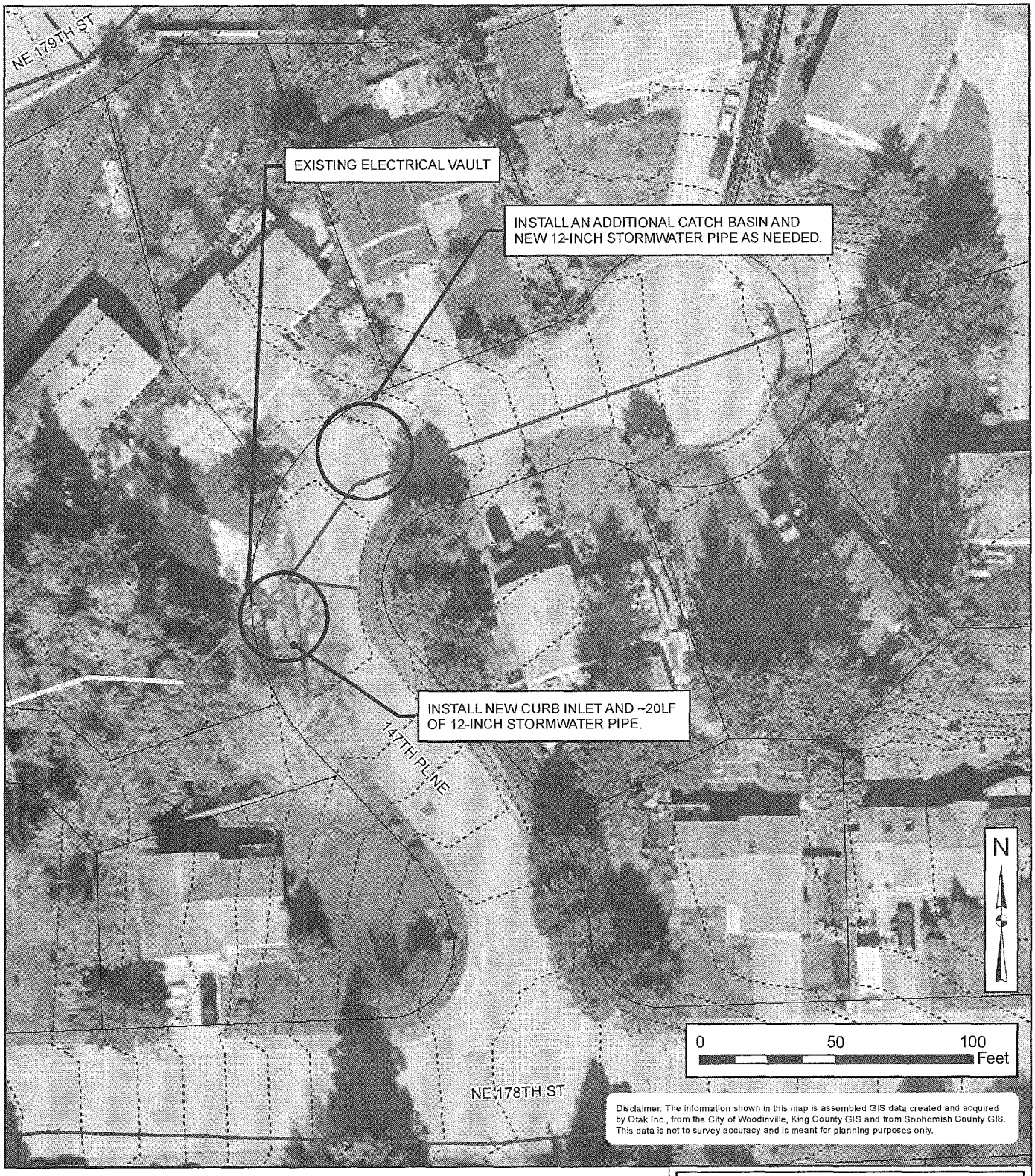
5. Sales tax is not always required on municipal roadway projects. However, tax is included in planning level estimates, as not all stormwater work is directly related to roadway drainage.
6. Land Acquisition unit costs include Administrative Costs and Condemnation.



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

LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.5

147TH PL NE CIP

CITY OF WOODINVILLE

OCTOBER 2010

PROJECT SUMMARY SHEET

Project Title: Cottonwood Trees at 14300 NE Wood-Duvall Road CIP

Project Location: 14300 NE Wood-Duvall Road near the Westview Garden Apartments

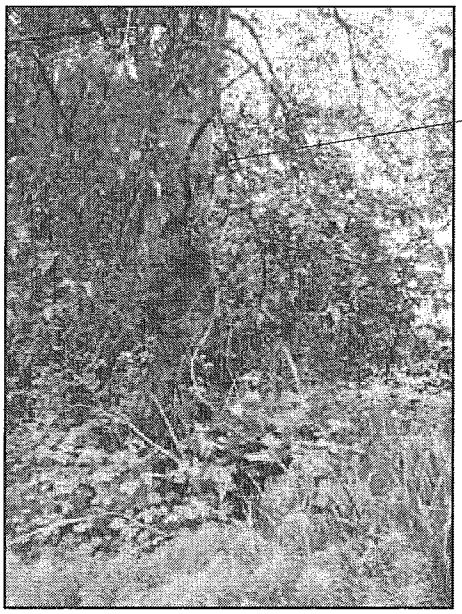
Problem Description: There are two large cottonwood trees whose root systems are intruding on a nearby Type 2 catch basin and conveyance pipe. The roots have caused extensive stormwater infrastructure damage and require frequent maintenance.

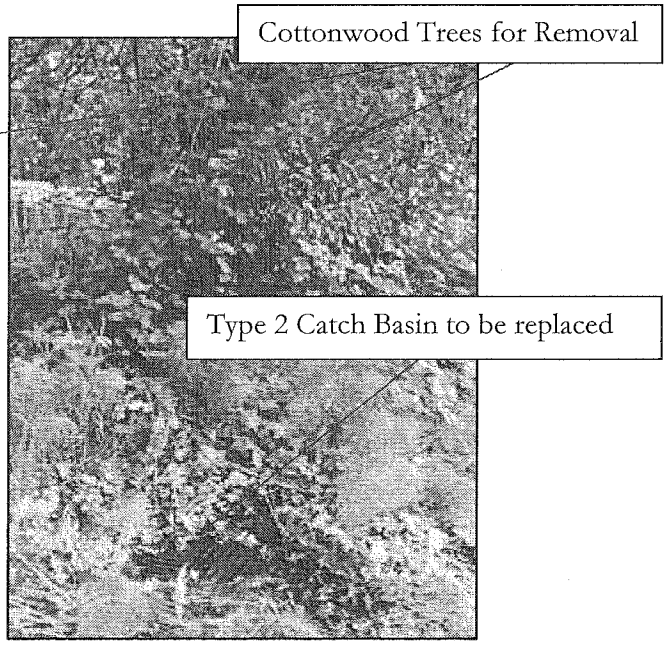
Design Considerations: The trees are located within public right-of-way.

Project Description: Remove two cottonwood trees per Woodinville Municipal Code 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.

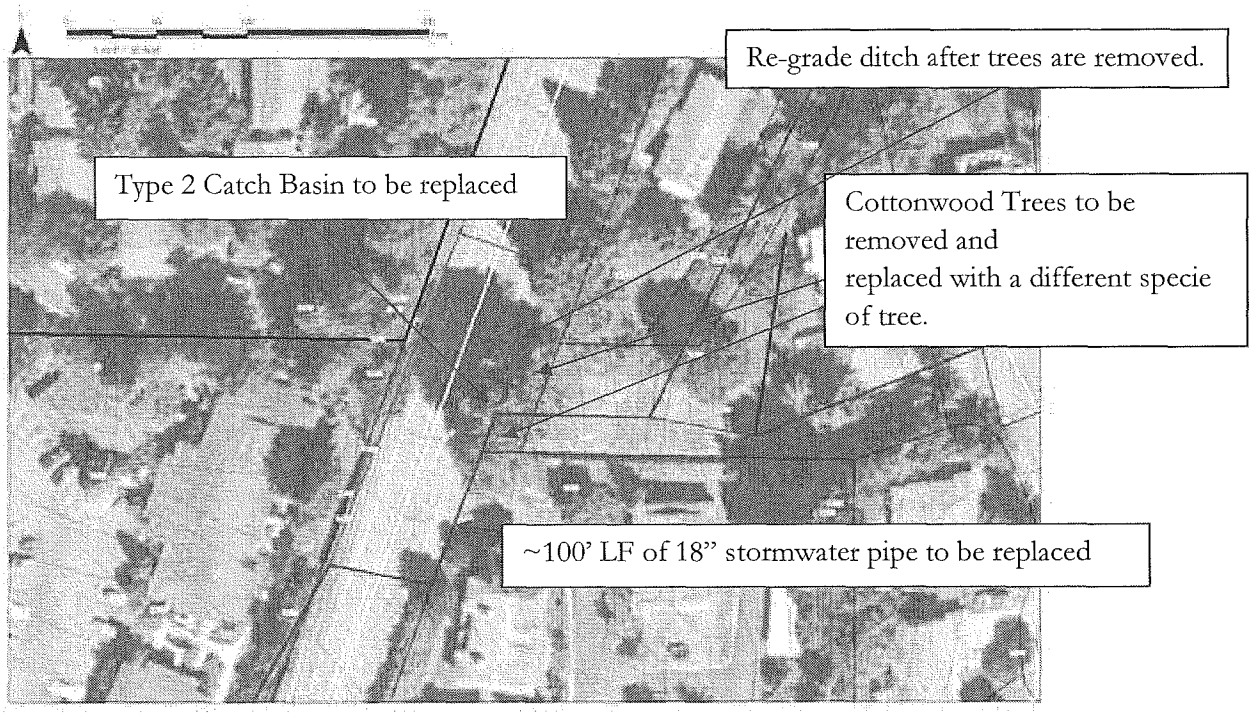
Estimated Project Cost: $57,000

Photos:




Cottonwood Trees for Removal
Type 2 Catch Basin to be replaced

PROJECT SKETCH



PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: Cottonwood Trees at 14300 NE Wood-Duvall Road CIP **CHECKED BY:** AMM/LM
BY: JLC **DATE:** 12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	CATCH BASIN, TYPE 2, 48 IN DIA	1	EA	$ 3,500.00	$ 3,500
2	CONNECT TO EXISTING STRUCTURE	2	EA	$ 1,000.00	$ 2,000
3	DITCH EXCAVATION INCL. HAUL	20	CY	$ 95.00	$ 1,900
4	FILL AND COMPACT, COMMON BORROW	25	CY	$ 35.00	$ 875
5	LANDSCAPE RESTORATION	1	LS	$ 2,500.00	$ 2,500
6	STORM SEWER PIPE, 18 IN DIA	100	LF	$ 75.00	$ 7,500
7	TRASH RACK	1	EA	$ 650.00	$ 650
8	TREE REMOVAL	1	LS	$ 2,000.00	$ 2,000
				Subtotal	$ 20,925
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 2,093
	TRAFFIC CONTROL	15%	(See Note 4)		$ 3,139
	MISC BID ITEMS	30%			$ 6,278
				Subtotal	$ 32,434
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 3,243
				Construction Subtotal (Rounded)	$ 36,000
	CONTINGENCY	10%			$ 3,600
	STATE SALES TAX	9.5%	(see Note 5)		$ 3,420
	ENGINEERING/LEGAL/ADMIN	25%			$ 9,000
	CONSTRUCTION MANAGEMENT	10%			$ 3,600
	PERMITTING	5%			$ 1,800
				Project Subtotal (Rounded)	$ 57,000
	LAND ACQUISITION (see note 6)		AC		$ -
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 57,000**

Notes:
1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
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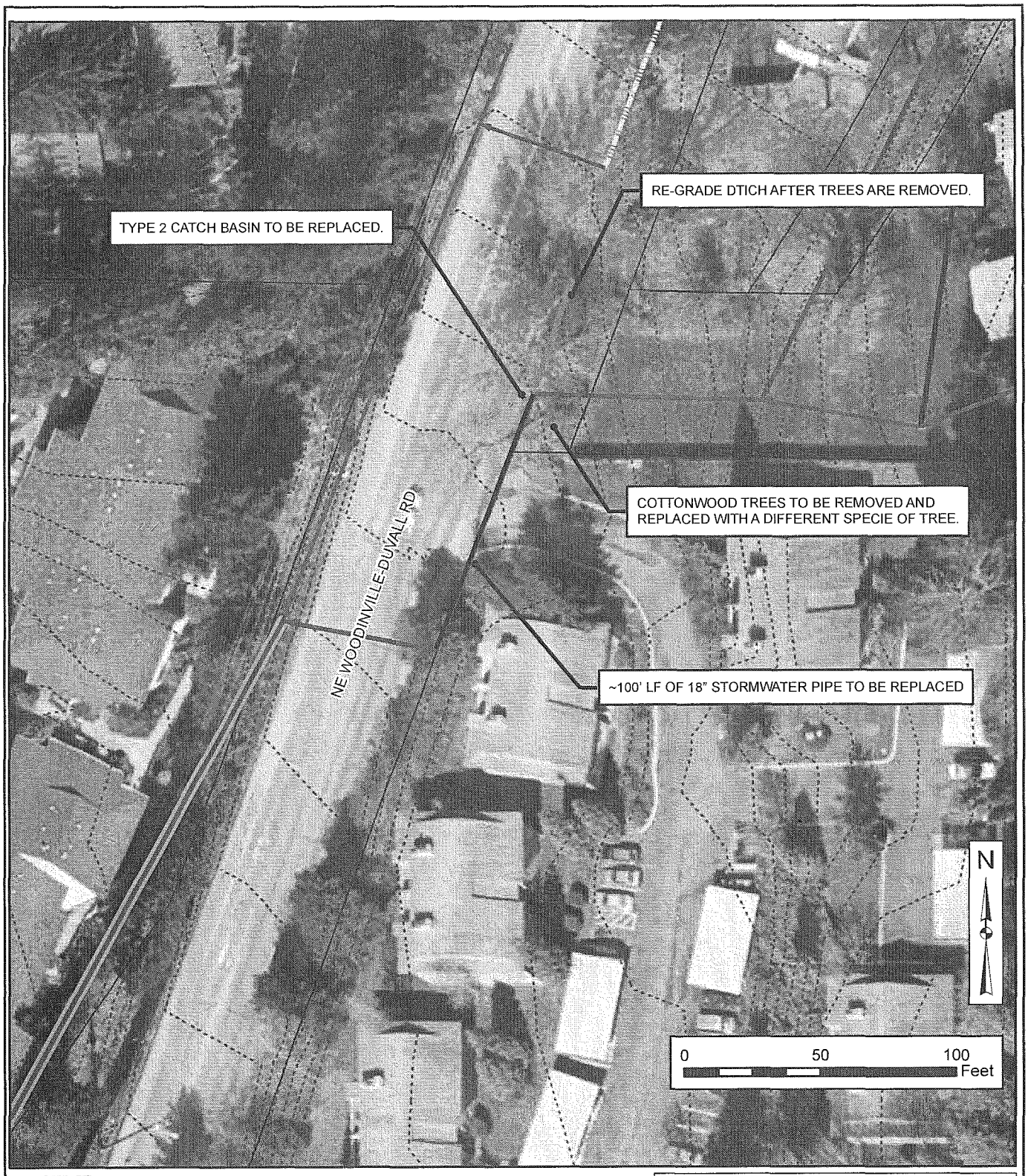


LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.6

COTTONWOOD TREES AT 14300 NE WOOD-DUVALL ROAD CIP

CITY OF WOODINVILLE

JUNE 2010

PROJECT SUMMARY SHEET

Project Title: Little Bear Creek Culvert at 134th Ave NE CIP

Project Location: Little Bear Creek Culvert at 134th Ave NE

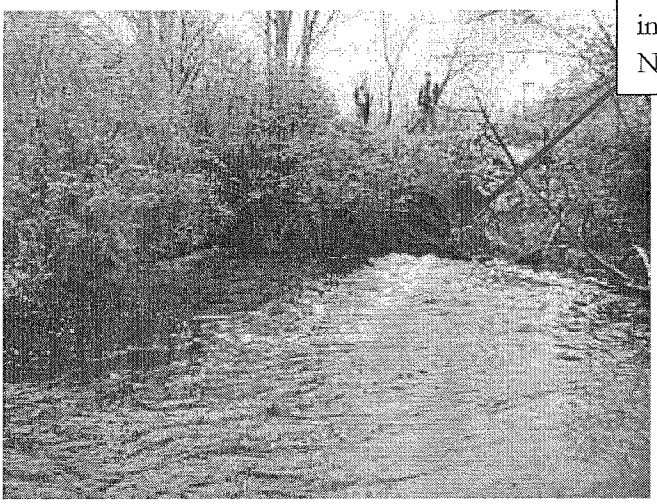
Problem Description: Downstream sections of three 60-inch pipes were damaged during December 3, 2007 flood. The culverts are perched, creating a fish barrier, and there is a continued risk of erosion and potential roadway failure. The creek alignment also shifted, eroding the upstream roadway embankment.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

Design Considerations: The City is currently working on a temporary design for this CIP. Fish passage flows and depths per WDFW standards. Bank stabilization per Integrated Stream Bank Stabilization Guidelines from Washington State Aquatic Habitat Guidelines Program. City has held preliminary meetings with WDFW. The City is currently installing a temporary fix and replacing the downstream sections of the three 60-inch pipes. The City is also providing riprap energy dissipation at downstream end and bank stabilization at the upstream end to protect the roadway and to direct creek away into all three culverts.

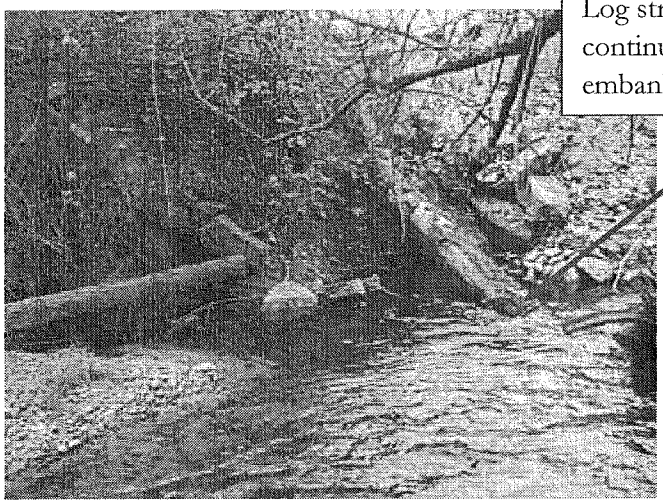
Project Description: Replace four 60" culverts with a bridge that is one lane, 14-feet wide and has a 70' span. Deep foundations for the abutments will be necessary. Likely either drilled shaft or pile abutments will be needed.

Estimated Project Cost: $1,691,155

Photos:

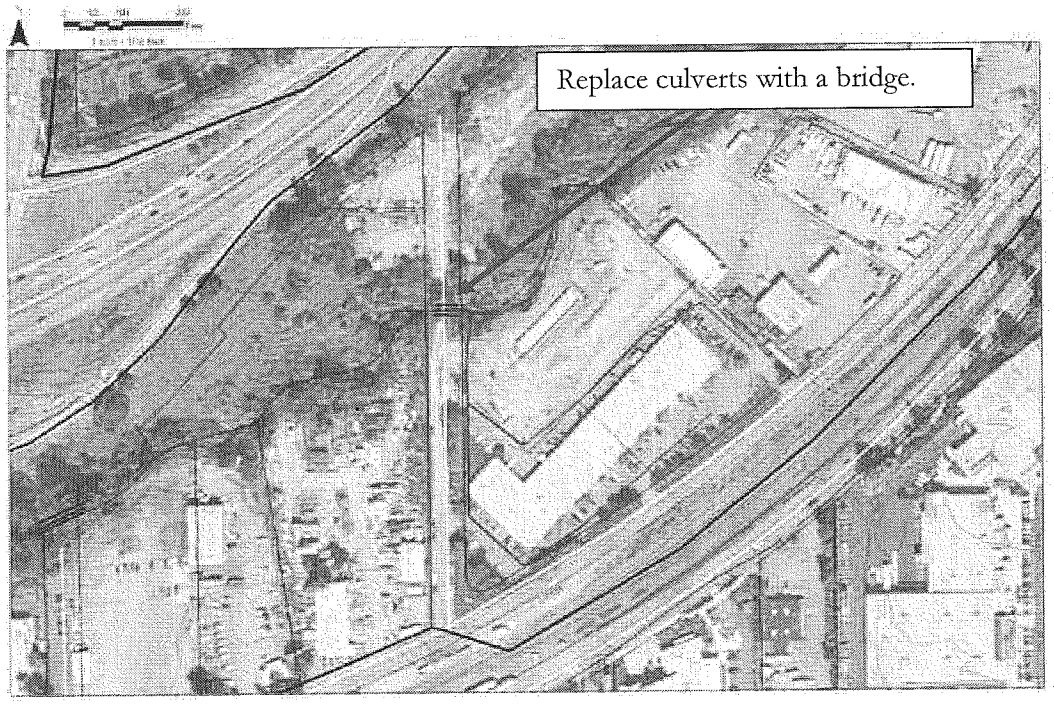


Most southern of the three 60-inch culverts under 134th Avenue NE



Log structure undermined with continued erosion at upstream embankment

PROJECT SKETCH



PROJECT ESTIMATING WORKSHEET

PROJECT NAME **134th culvert replacement with bridge**
DATE **21-May-07**
ESTIMATOR NAME **Tom Hansen**

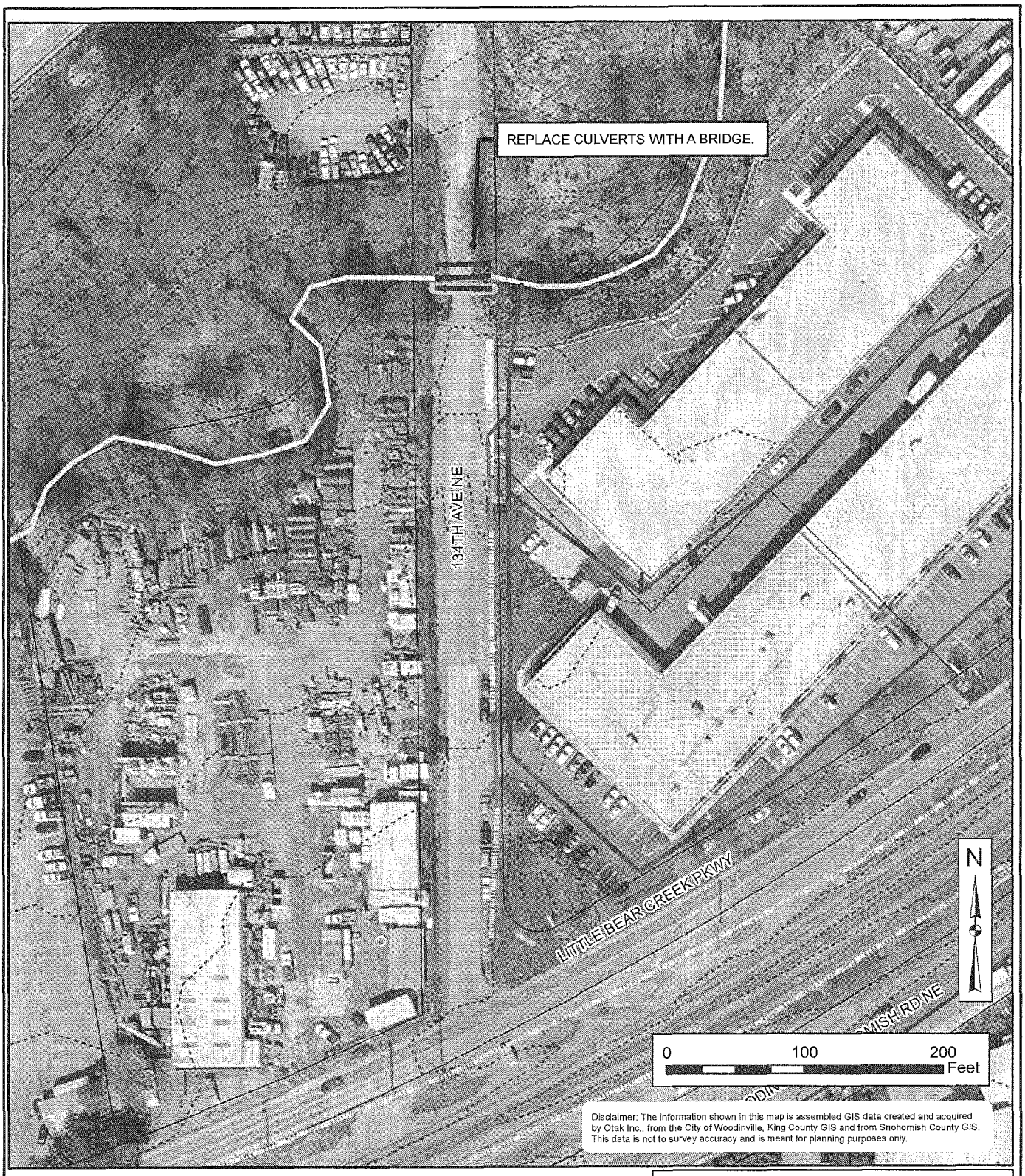
TOTAL EST PROJECT COST: **$1,691,153**

CONCEPT DESCRIPTION: *Constrct bridge at this location per previous plans*

ITEM	UNIT	LENGTH '	WIDTH '	DEPTH '	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing	AC				1	$10,000	$10,000
Removal of Strs and Obs	LS				1	$10,000	$10,000
Removing Asphalt pavement	SY				0	$12	$0
Removing Fence	LF				0	$3	$0
Sawcutting Asphalt Pavement	LF				500	$4	$2,000
Removing paint stripe	LF				0	$1	$0
Removing lane markers	per hundred				0	$50	$0
Removing plastic stripe	LF				0	$5	$0
Temp traffic Barrier	LF				0	$25	$0
Roadway Ex incl. Haul	CY				800	$25	$20,000
Pond Excavation incl. haul	CY				0	$15	$0
Roadway Ex incl. Haul	CY				1,000	$30	$30,000
Gravel Borrow incl haul	TON				500	$20	$10,000
Common Borrow incl Haul (till)	TON				0	$12	$0
Cement	CY				0	$190	$0
Unsuit Found. Ex incl. Haul	CY				0	$22	$0
Geotextile fabric for soil reinf	SY				711	$10	$7,110
Quarry Spalls	TON				0	$25	$0
Underdrain pipe 6 in to 8 in dia	LF				100	$15	$1,500
Drain Pipe 6 in to 8 in dia	LF				50	$15	$750
Storm Sewer Pipe 12 in dia	LF				0	$35	$0
Storm Sewer Pipe 18 in dia	LF				280	$60	$16,800
Storm Sewer Pipe 24 in dia	LF				0	$50	$0
Storm Sewer pipe 30 in dia	LF				0	$60	$0
Catch Basin Type 1	EACH				0	$1,000	$0
Catch Basin Type 1L	EACH				0	$1,100	$0
Catch Basin Type 2 - 48in dia	EACH				0	$4,500	$0
Catch Basin Type 2-54 in dia	EACH					$5,000	$0
Catch Basin Type 2 - 60 in dia	EACH					$6,000	$0
Catch Basin Type 2 - 60 w/ oil	EACH				0	$6,500	$0
Detention Pipe 72 in dia	LF				0	$120	$0
Storm Filter Vault	EACH				1	$60,000	$60,000
Shoring or Extra Ex.	LS				1	$30,000	$30,000
Control Density Fill	CY				50	$120	$6,000
Crushed Surf Top course	TON				80	$40	$3,200
Crushed Surf Top course	TON				100	$40	$4,000
Crushed Surf Base course	TON				490	$25	$12,250
Asphalt Treated Base	TON				0	$80	$0
HMA Asphalt pavement	TON				140	$105	$14,700
HMA Asphalt pavement	TON				0	$105	$0
HMA Asphalt pavement	TON				0	$85	$0
Planing Bituminous Pavement	SY				0	$8	$0
Paving driveways	EACH				0	$500	$0
Pavement Repair Ex incl Haul	SY				0	$30	$0
Temporary pavement striping	LF				0	$1	$0
Bridge Superstructure	SF				2500	$175	$437,500

PROJECT ESTIMATING WORKSHEET

Br. Foundation Conc.	CY	100	$800	$80,000
Bridge Rail	LF	0	$200	$0
Drilled shaft	LF	420	$200	$84,000
pile	LF	0	$150	$0
Str Ex. Class A incl Haul	CY	300	$15	$4,500
Underdrain pipe 6 in dia	LF	0	$15	$0
Gravel Bkfl for Drains	CY	0	$20	$0
Gravel Bkfl for walls	CY	0	$20	$0
Conc. Block Wall	SF	0	$50	$0
Rock Wall	SF	0	$20	$0
Sheet piles	SF		$10	$0
Soil Nail Retaining Wall	SF	0	$60	$0
Temporary Erosion Control	LS	1	$25,000	$25,000
Erosion Control Fabric	SY	3000	$5	$15,000
Seed, Fert and Mulch	ACRE	10	$8,000	$80,000
Topsoil Type A	CY	100	$30	$3,000
Bark Mulch	CY	100	$30	$3,000
Sod lawn	SY	0	$10	$0
Seeded lawn	SY	0	$2	$0
Landscaping Plants	LS	1	$10,000	$10,000
Street Trees	EACH	0	$350	$0
Irrigation System	LS	0	$30,000	$0
Water Meter	EA	0	$25,000	$0
Silt Fence	LF	600	$5	$3,000
CB inserts	EA	0	$65	$0
Street Cleaning	HOUR	8	$60	$480
Cem Conc. Curb and Gutter	LF	0	$20	$0
Extruded Curb	LF	400	$8	$3,200
Cem Conc. Sidewalk	SY	0	$30	$0
Pedestrian handrail	LF	220	$120	$26,400
Concrete Driveways	SY	0	$35	$0
Raised Pvmt markers	HUND	1	$400	$400
Paint Stripe	LF	0	$1	$0
Traffic Items	LS	1	$5,000	$5,000
Permanent Signing	LS	0	$40,000	$0
Traffic Signal	LS	0	$350,000	$0
Luminaire Pole	EACH	0	$8,000	$0
Conc. Traffic Barrier	LF	0	$150	$0
Guardrail	LF	220	$22	$4,840
Guardrail Terminal Section	EACH	4	$3,000	$12,000
Fence	LF	500	$15	$7,500
Traffic Control Labor	HOUR	200	$45	$9,000
Monument, Case, and Cover	EACH	1	$350	$350
Adjust Utilities	EACH	5	$350	$1,750
Roadside Cleanup	LS	1	$5,000	$5,000
Trimming and Cleaning	LS	1	$5,000	$5,000
SUBTOTAL				$1,064,230
MOBILIZATION @7%				$74,496
CONST. AMOUNT				$1,138,726
				$0
CONSTRUCTION TOTAL				$1,138,726
	PERCENT			
permitting				$ 40,000
DESIGN ENGR	15%			$170,809
CONST MGMT.	10%			$113,873
CONTINGENCY	20%			$227,745
RIGHT OF WAY	SF	0	$15.00	$0.00
TOTAL PROJECT COST				**$1,691,153**



LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.7

LITTLE BEAR CREEK CULVERT AT 134TH AVE NE CIP

CITY OF WOODINVILLE

JUNE 2010

PROJECT SUMMARY SHEET

Project Title: 144th Ave NE CIP

Project Location: 19600 144th Ave NE near NE 195th St.

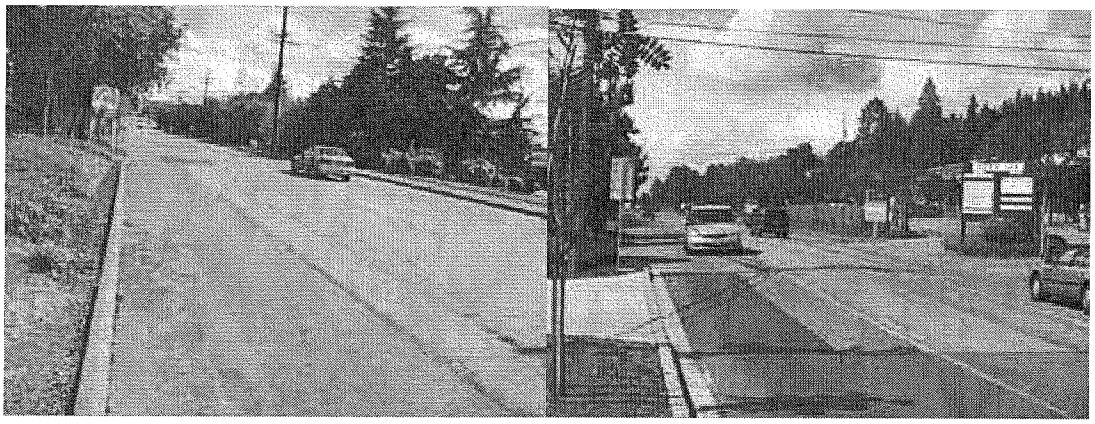
Problem Description: There have been reported problems of flooding of local businesses along 144th Ave NE. The City installed an additional catch basin to alleviate this problem; however, degraded, undersized pipes still cause problems. The ditch along 144th Ave NE needs frequent maintenance and causes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

Design Considerations: Potential fish and wildlife design requirements depending on how the downstream open channel conveyances are categorized by Washington Department of Fish and Wildlife (WDFW). A sanitary sewer runs parallel to the 12-inch pipe.

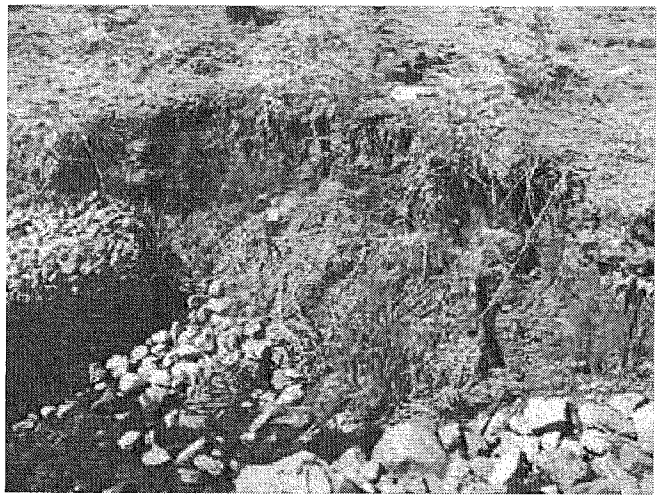
Project Description: Upsize 100LF of existing 12" stormwater conveyance line on 144th Ave NE to provide capacity for the 25-year storm event. Replace 215LF of ditch that runs along 144th Ave NE with a closed pipe system. Replace 110LF existing 12" pipe and 235LF of 18" pipe.

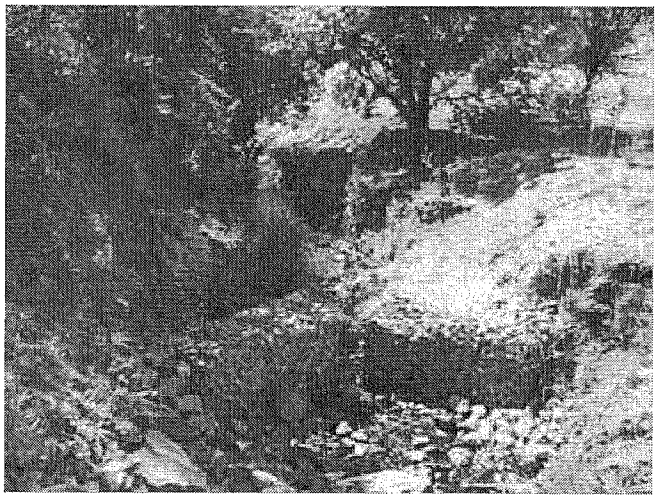
Estimated Project Cost: $153,000

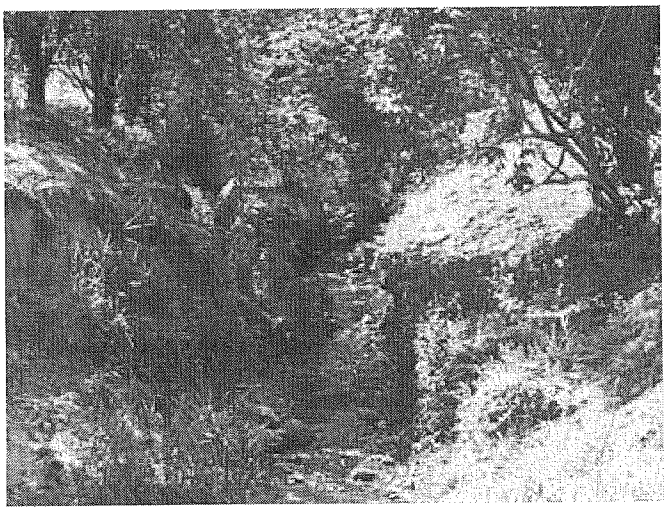
Photos on 144th Ave NE:



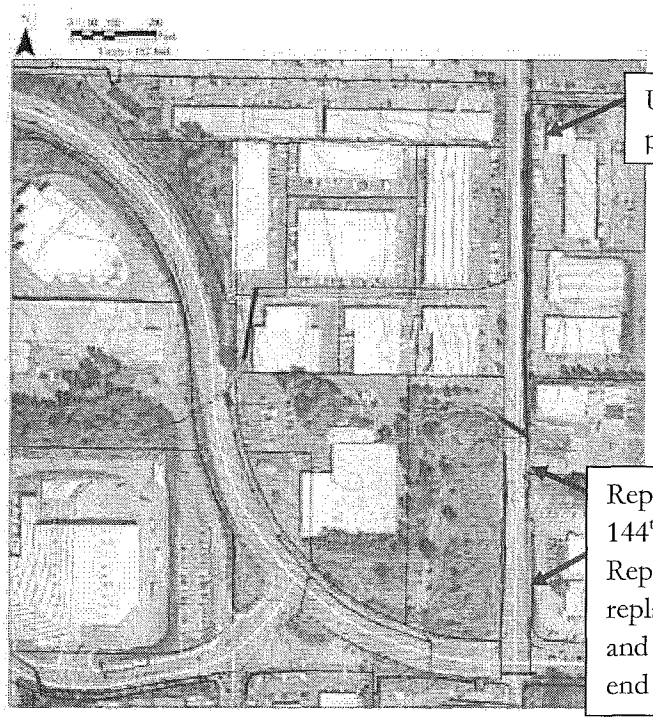
Photos on Creek downstream of existing 18-inch outfall stormwater pipe:







PROJECT SKETCH



Upsize 100 LF of identified undersized 12" pipes.

Replace 215 LF of ditch along 144th Ave NE with 18-inch pipe. Replace 235 LF existing 18" pipe, replace 110 LF existing 12" pipe and add Type 2 CB on upstream end of cross culvert

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: 144th Ave NE CIP — CHECKED BY: AMM/LM
BY: JLC — DATE: 12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	CATCH BASIN TYPE 1L	2	EA	$ 1,500.00	$ 3,000
2	CATCH BASIN, TYPE 2, 48 IN DIA	1	EA	$ 3,500.00	$ 3,500
3	CLEARING AND GRUBBING	1	LS	$ 1,500.00	$ 1,500
4	COMMON EXCAVATION for PIPE REMOVAL	150	CY	$ 15.00	$ 2,250
5	CONNECT TO EXISTING STRUCTURE	3	EA	$ 1,000.00	$ 3,000
6	FILL AND COMPACT, COMMON BORROW	100	CY	$ 35.00	$ 3,500
7	HYDROSEEDING	75	SY	$ 2.50	$ 188
8	LANDSCAPE RESTORATION	1	LS	$ 2,500.00	$ 2,500
9	PAVEMENT RESTORATION	335	SF	$ 5.60	$ 1,876
10	REMOVE PAVEMENT	40	SY	$ 22.00	$ 880
11	STORM SEWER PIPE, 18 IN DIA	100	LF	$ 75.00	$ 7,500
12	STORM SEWER PIPE, 24 IN DIA	335	LF	$ 85.00	$ 28,475
				Subtotal	$ 58,169
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 5,817
	TRAFFIC CONTROL	10%	(See Note 4)		$ 5,817
	MISC BID ITEMS	30%			$ 17,451
				Subtotal	$ 87,253
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 8,725
				Construction Subtotal (Rounded)	$ 96,000
	CONTINGENCY	10%			$ 9,600
	STATE SALES TAX	9.5%	(see Note 5)		$ 9,120
	ENGINEERING/LEGAL/ADMIN	25%			$ 24,000
	CONSTRUCTION MANAGEMENT	10%			$ 9,600
	PERMITTING	5%			$ 4,800
				Project Subtotal (Rounded)	$ 153,000
	LAND ACQUISITION (see note 6)		AC		$ -
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 153,000**

Notes:
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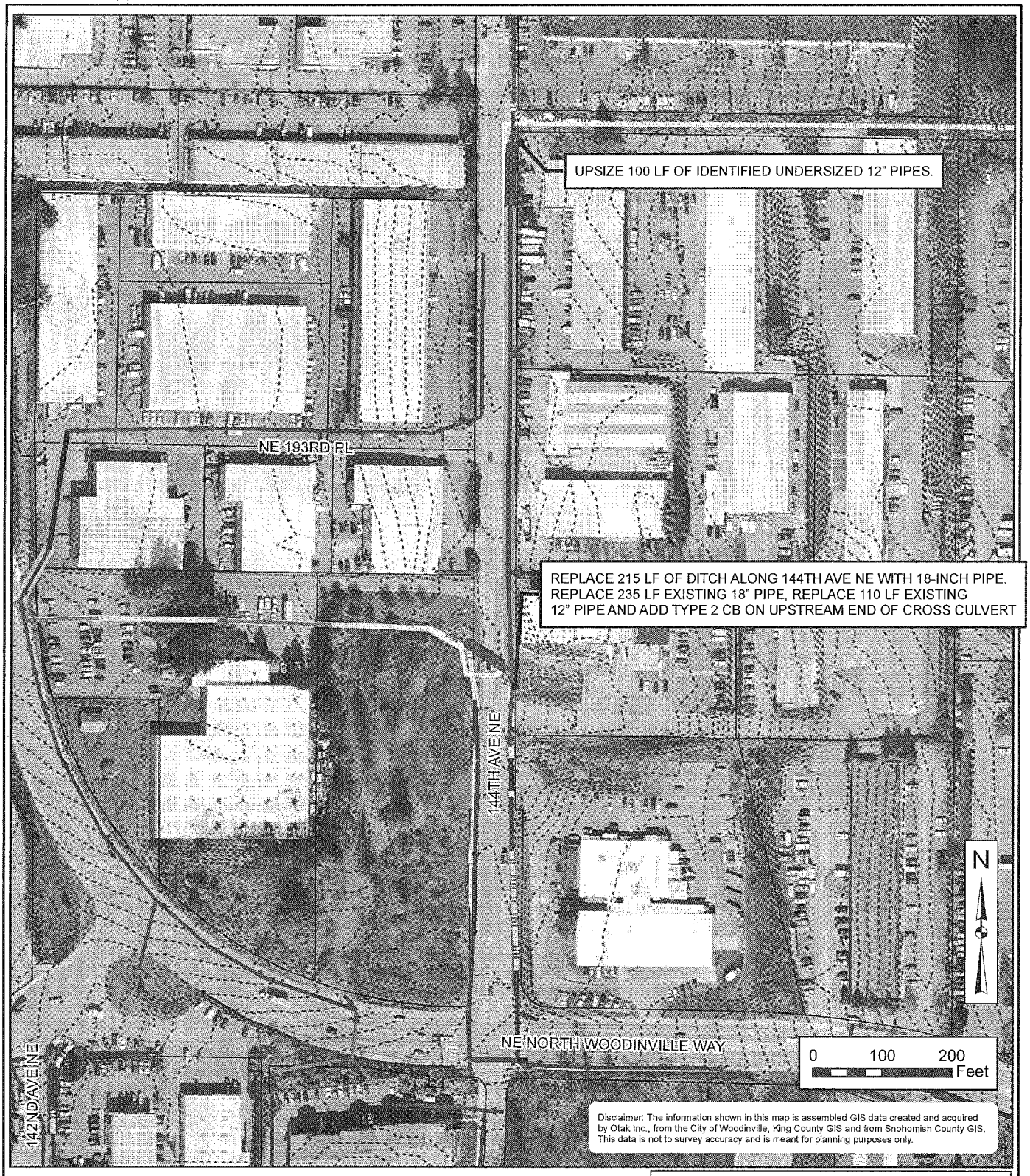

LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

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Stormwater Open Channel

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.8

144TH AVE NE CIP

CITY OF WOODINVILLE

otak

JUNE 2010

PROJECT SUMMARY SHEET

Project Title: 136th Ave NE and NE 205th Street CIP

Project Location: 136th Ave NE and NE 205th Street, Little Bear Creek West Basin

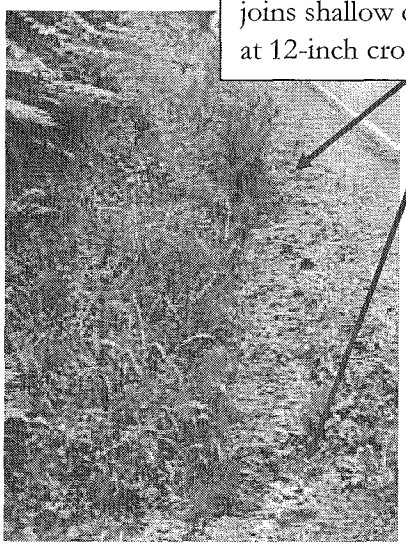
Problem Description: An existing 12-inch culvert along NE 205th under 136th Ave NE becomes plugged and causes roadside flooding. The side slope of the ditch along 205th is too steep and gravel continues to cave into the culvert entrance.

Design Considerations: This project is located within public right-of-way. Maintain adequate freeboard between structure rim and edge of roadway.

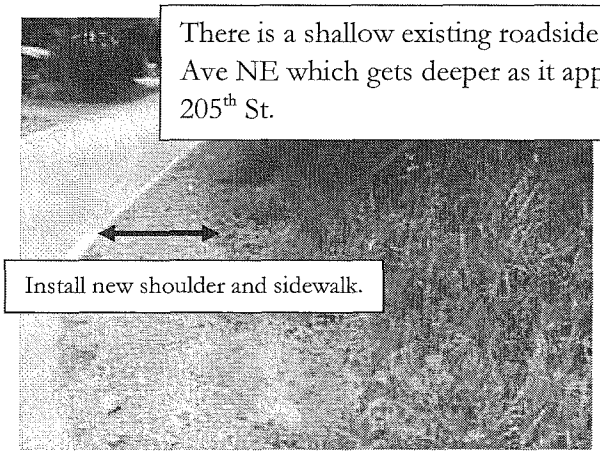
Project Description: Replace 100LF of existing 12" culvert with a new 12" culvert. Add two additional catch basins. Extend closed pipe system an additional 130 LF west along NE 205th St. Install 100 LF of new stormwater conveyance and two new catch basins along 136th Ave NE. Install new shoulder and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

Estimated Project Cost: $153,000

Photos:

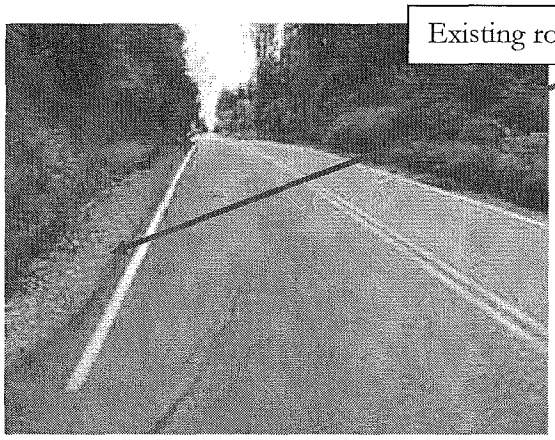


Existing roadside ditch on NE 205th St joins shallow ditch from 136th Ave NE at 12-inch cross culvert



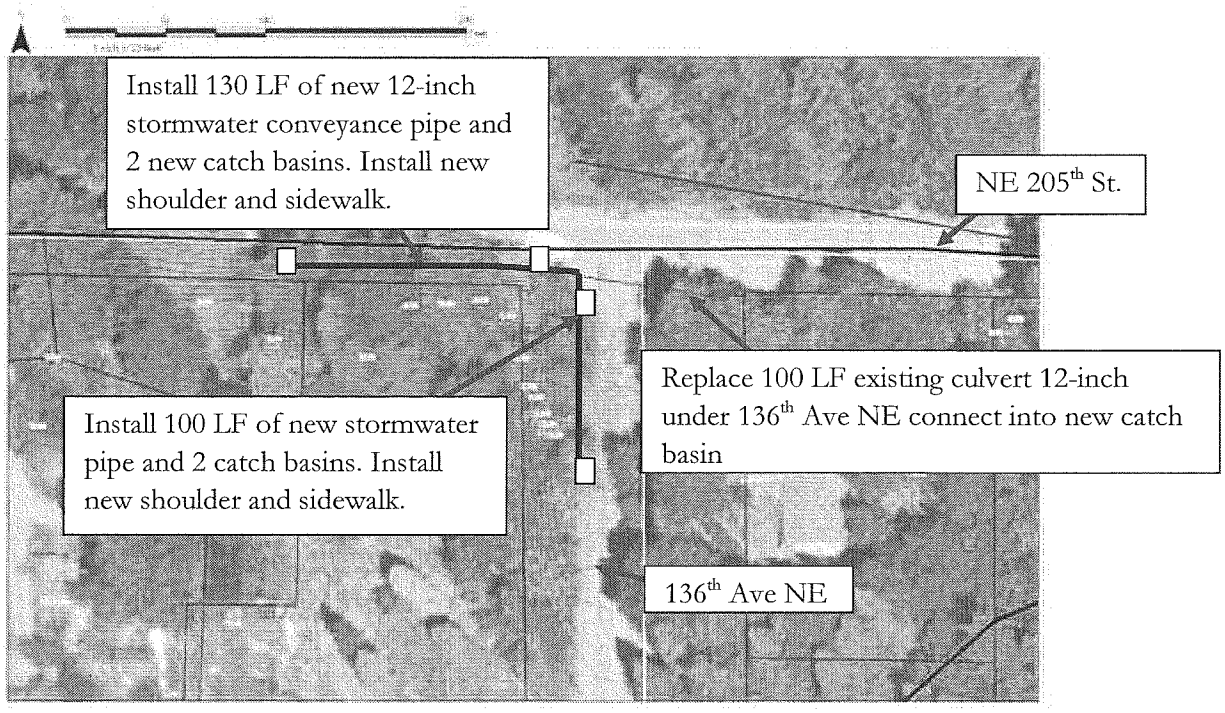
There is a shallow existing roadside ditch on 136th Ave NE which gets deeper as it approaches NE 205th St.

Install new shoulder and sidewalk.



Existing roadside ditch on NE 205th St

PROJECT SKETCH

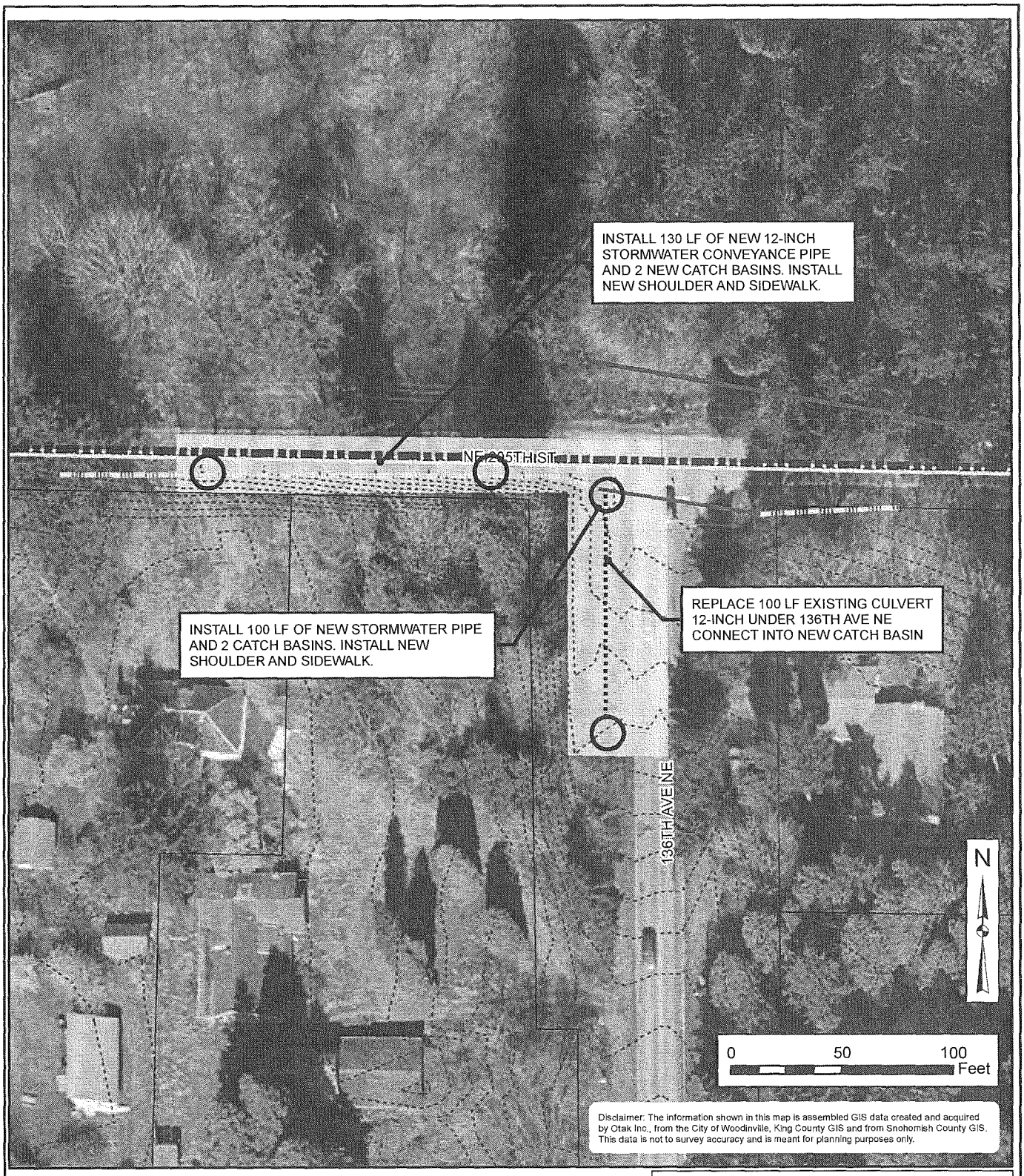


PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: 136th Ave NE and NE 205th Street CIP — CHECKED BY: AMM/LM
BY: JLC — DATE: 12/21/2010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	BEEHIVE GRATE	1	EA	$ 500.00	$ 500
2	CATCH BASIN, TYPE 2, 48 IN DIA	4	EA	$ 3,500.00	$ 14,000
3	CLEARING AND GRUBBING	1	LS	$ 1,500.00	$ 1,500
4	COMMON EXCAVATION for PIPE REMOVAL	30	CY	$ 15.00	$ 450
5	CONNECT TO EXISTING STRUCTURE	1	EA	$ 1,000.00	$ 1,000
6	FILL AND COMPACT, COMMON BORROW	75	CY	$ 35.00	$ 2,625
7	HYDROSEEDING	200	SY	$ 2.50	$ 500
8	LANDSCAPE RESTORATION	1	LS	$ 1,500.00	$ 1,500
9	NEW SIDEWALK	1,100	SF	$ 13.00	$ 14,300
10	STORM SEWER PIPE, 12 IN DIA	330	LF	$ 60.00	$ 19,800
11	TRASH RACK	3	EA	$ 650.00	$ 1,950
				Subtotal	$ 58,125
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 5,813
	TRAFFIC CONTROL	10%	(See Note 4)		$ 5,813
	MISC BID ITEMS	30%			$ 17,438
				Subtotal	$ 87,188
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 8,719
				Construction Subtotal (Rounded)	$ 96,000
	CONTINGENCY	10%			$ 9,600
	STATE SALES TAX	9.5%	(see Note 5)		$ 9,120
	ENGINEERING/LEGAL/ADMIN	25%			$ 24,000
	CONSTRUCTION MANAGEMENT	10%			$ 9,600
	PERMITTING	5%			$ 4,800
				Project Subtotal (Rounded)	$ 153,000
	LAND ACQUISITION (see note 6)		AC		$ -
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 153,000**

Notes:
1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Sales tax is not always required on municipal roadway projects. However, tax is included in planning level estimates, as not all stormwater work is directly related to roadway drainage.
6. Land Acquisition unit costs include Administrative Costs and Condemnation.



LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

Approximate Location of CIP

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.9

136TH AVE NE AND NE 205TH STREET CIP

CITY OF WOODINVILLE

otak

JUNE 2010

PROJECT SUMMARY SHEET

Project Title: 137th PL NE CIP

Project Location: 137th PL NE between NE 145th St. and NE 143rd St.

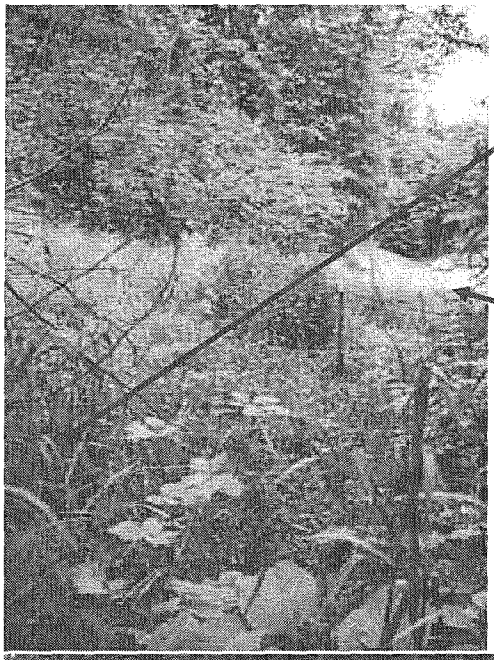
Problem Description: Runoff from private property overtops an existing culvert (also on private property) and causes overflow into a public road. Runoff comes from a conveyance ditch and from seeps from adjacent steep hillside. In the winter, water on the roadway has caused icy conditions in this location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

Design Considerations: Consider partnering with the private landowner to share the cost of upgrading the private system to better handle stormwater runoff (i.e. larger culvert, better collection system, etc).

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.

Estimated Project Cost: $48,000

Photos:

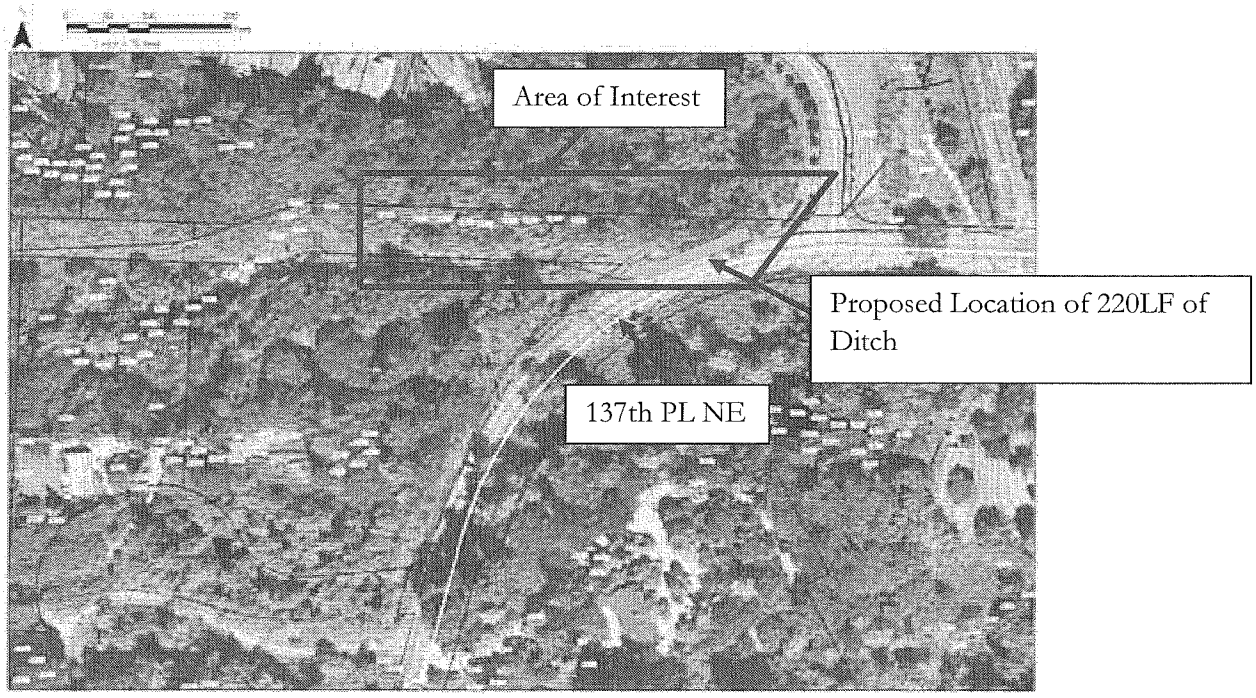


Private Property near culvert. When the culvert is plugged, the downstream public roadway floods.

Public roadway that floods.

Public roadway that floods.

PROJECT SKETCH



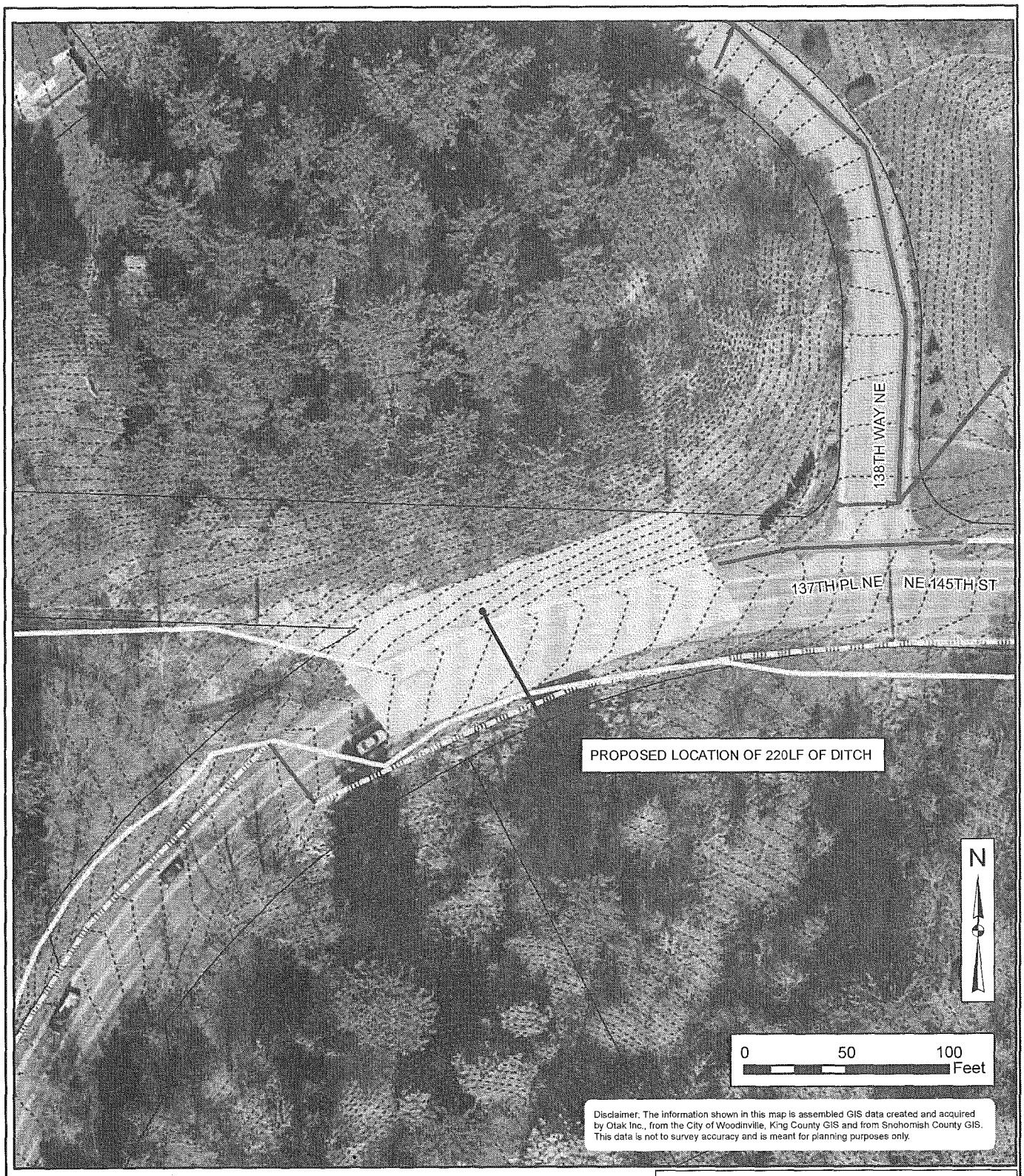
PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: 137th PL NE CIP between NE 143rd and NE 145th **CHECKED BY:** AMM/LM
BY: JLC **DATE:** 12/21/21010

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	DITCH EXCAVATION INCL. HAUL	50	CY	$ 95.00	$ 4,750
2	HYDROSEEDING	250	SY	$ 2.50	$ 625
3	BOULDERS	5	EA	$ 85.00	$ 425
4	CULVERT, 12 IN DIA	100	LF	$ 85.00	$ 8,500
5	TRASH RACK	2	EA	$ 650.00	$ 1,300
				Subtotal	$ 15,600
	EROSION & SEDIMENTATION CONTROL	10%	(See Note 3)		$ 1,560
	TRAFFIC CONTROL	10%	(See Note 4)		$ 1,560
	MISC BID ITEMS	30%			$ 4,680
				Subtotal	$ 23,400
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 2,340
				Construction Subtotal (Rounded)	$ 26,000
	CONTINGENCY	10%			$ 2,600
	STATE SALES TAX	9.5%	(see Note 5)		$ 2,470
	ENGINEERING/LEGAL/ADMIN (INCL. DOWNSTREAM ANALYSIS)	30%			$ 7,800
	CONSTRUCTION MANAGEMENT	10%			$ 2,600
	PERMITTING	25%			$ 6,500
				Project Subtotal (Rounded)	$ 48,000
	LAND ACQUISITION (see note 6)		AC		$ -
2010 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 48,000**

Notes:

1. The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Sales tax is not always required on municipal roadway projects. However, tax is included in planning level estimates, as not all stormwater work is directly related to roadway drainage.
6. Land Acquisition unit costs include Administrative Costs and Condemnation.



LEGEND

CITY OF WOODINVILLE STORMWATER PIPES 02/16/10

SIZE	PIPES ANALYZED (25YR % CAPACITY)
unknown size	0% - 100%
<= 12"	101% - 150%
<= 24"	151% - 300%
> 24"	> 300%

Stormwater Open Channel

Approximate Location of CIP

City Limits

County Boundary

Parcel Boundary

Streams

Contour 2 ft

STORMWATER MANAGEMENT PLAN

FIGURE D.10

137TH PL NE CIP

CITY OF WOODINVILLE

otak

JUNE 2010

Appendix E
Western Washington Phase II
Municipal Stormwater Permit

Issuance Date: January 17, 2007
Effective Date: February 16, 2007
Expiration Date: February 15, 2012
Modification Date: June 17, 2009

WESTERN WASHINGTON PHASE II MUNICIPAL STORMWATER PERMIT

National Pollutant Discharge Elimination System and
State Waste Discharge General Permit for Discharges
from Small Municipal Separate Storm Sewers
in Western Washington

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
OLYMPIA, WASHINGTON 98504-7600

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1251 et seq.

Until this permit expires, is modified, or revoked, permittees that have properly obtained coverage under this permit are authorized to discharge to waters of the state in accordance with the special and general conditions which follow.

Kelly Susewind, P.E., P.G.
Water Quality Program Manager
Department of Ecology

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APPENDIX 6. Street Waste Disposal
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SPECIAL CONDITIONS

Notice: If legislation related to this Permit is passed into law, Ecology will, as necessary, modify, revoke and re-issue or terminate this Permit to carry out legislative requirements. Any such modification will be in accordance with G14 *General Permit Modification and Revocation* and the provisions of WAC 173-226-230.

S1. PERMIT COVERAGE AREA AND PERMITTEES

A. Geographic Area of Permit Coverage

This Permit is applicable to owners or operators of regulated small municipal separate storm sewer systems (MS4s) located west of the eastern boundaries of the following counties: Whatcom, Skagit, Snohomish, King, Pierce, Lewis and Skamania.

1. For all cities required to obtain coverage under this permit, the geographic area of coverage is the entire incorporated area of the city.
2. For all counties required to have coverage under this Permit, the geographic area of coverage is the urbanized areas and urban growth areas associated with cities under the jurisdictional control of the county. The geographic area of coverage also includes any urban growth area contiguous to urbanized areas under the jurisdictional control of the county.
3. For secondary permittees required to obtain coverage under this permit, the minimum geographic area of coverage is all areas identified under S1.A.1. and S1.A.2. At the time of permit coverage, Ecology may establish a geographic area of coverage specific to an individual secondary permittee.
4. All regulated small MS4s owned or operated by the permittees named in S1.D.2.a. and located in another city or county area requiring coverage under either the Phase I Municipal *Stormwater Permit* or the *Eastern Washington Phase II Municipal Stormwater Permit* are also covered under this permit.

B. Regulated Small Municipal Separate Storm Sewer Systems (MS4s)

All operators of regulated small municipal separate storm sewer systems (MS4s) are required to apply for and obtain coverage under this Permit or be permitted under a separate individual permit, unless waived or exempted in accordance with condition S1.C.

1. A **regulated small MS4**:
   a. Is a "Small MS4" as defined in the *Definitions and Acronyms* section at the end of this Permit; and
   b. Is located within, or partially located within, an urbanized area as defined by the latest decennial census conducted by the U.S. Bureau of Census, or designated by the Department pursuant to 40 CFR 123.35(b) or 40 CFR 122.26(f); and
   c. Discharges stormwater from the MS4 to a surface water of Washington State; and

d. Is not eligible for a waiver or exemption under S1.C. below.

2. All other operators of MS4s, including special purpose districts, which meet the criteria for a regulated small MS4 shall obtain coverage under this Permit. Other operators of municipal separate storm sewers may include, but are not limited to: flood control, or diking and drainage districts, schools including universities, and correctional facilities that own or operate a small MS4 serving non-agricultural land uses.

3. Any other operators of small MS4s may be required by the Department to obtain coverage under this permit or an alternative NPDES permit if the Department determines the small MS4 is a significant source of pollution to surface waters of the state. Notification of the Department's determination that permit coverage is required will be through the issuance of an Administrative Order issued in accordance with RCW 90.48.

4. The owner or operator of a regulated small MS4 may obtain coverage under this Permit as a permittee, co-permittee, or secondary permittee as defined in S1.D.1. below.

5. Pursuant to 40 CFR 122.26(f), any person or organization may petition Ecology to require that additional municipal separate storm sewers obtain coverage under this permit. The process for petitioning Ecology is:

   a. The person or organization shall submit a complete petition in writing to Ecology. A complete petition shall address each of the relevant factors for petitions outlined on Ecology's website.

   b. In making its determination on the petition, Ecology may request additional information from either the petitioner or the jurisdiction.

   c. Ecology will make a final determination on a complete petition within 180 days of receipt of the petition and inform both the petitioner and the municipal separate storm sewer of the decision, in writing.

   d. If Ecology's final determination is that the candidate municipal separate storm sewer will be regulated, Ecology will issue an order to the municipal separate storm sewer requiring them to obtain coverage under this Permit. The order will specify:

      i. The geographic area of permit coverage for the municipal separate storm sewer system;

      ii. Any modified dates or deadlines for developing and implementing the Stormwater Management Program in S5. or S6., as appropriate to the municipal separate storm sewer system, and for submitting their first annual report; and

      iii. A deadline for the operator of the municipal separate storm sewer system to submit a complete Notice of Intent (see Appendix 5) to Ecology.

C. Owners and operators of an otherwise regulated small MS4 are not required to obtain coverage under this Permit if:

1. The small MS4 is operated by:

   a. The federal government on military bases or other federal lands; or by the United States Military, the Bureau of Land Management, the United States Park Service or other federal agencies;

   b. Federally recognized Indian Tribes located within Indian Country Lands; or

   c. The Washington State Department of Transportation.

   or:

2. The portions of the small MS4 located within the census defined urban area(s) serve a total population of less than 1000 people and a, b, and c, below all apply:

   a. The small MS4 is not contributing substantially to the pollutant loadings of a physically interconnected MS4 that is regulated by the NPDES stormwater program.

   b. The discharge of pollutants from the small MS4 have not been identified as a cause of impairment of any water body to which the MS4 discharges.

   c. In areas where an EPA approved TMDL has been completed, stormwater controls on the MS4 have not been identified as being necessary.

   In determining the total population served both resident and commuter populations shall be included. For example:

   - For publicly operated school complexes including universities and colleges the total population served would include the sum of the average annual student enrollment plus staff.
   - For flood control, diking, and drainage districts the total population served would include residential population and any non-residents regularly employed in the areas served by the small MS4.

D. Obtaining coverage under this Permit

All operators of **regulated small MS4s** are required to apply for and obtain coverage in accordance with this section, unless waived or exempted in accordance with section S1.C.

1. Permittees: unless otherwise noted, the term "Permittee" shall include Permittee, Co-Permittee, and Secondary Permittee, as defined below:

   a. "Permittee" is a city, town, or county owning or operating a regulated small MS4 applying and receiving a permit as a single entity.

   b. "Co-Permittee" is any operator of a regulated small MS4 that is applying jointly with another applicant for coverage under this Permit. Co-Permittees own or operate a regulated small MS4 located within or adjacent to another regulated small MS4.

c. A "Secondary Permittee" is an operator of regulated small MS4 that is not a city, town or county. Secondary Permittees include special purpose districts and other MS4s that meet the criteria for a regulated small MS4 in S1.B. above.

2. Operators of **regulated small MS4s** shall submit either an individual application to the Department or a Notice of Intent (NOI). Applications submitted after January 17, 2007 must be made using the NOI provided in Appendix 5. The NOI is also available on Ecology's website.

   a. All cities, towns and counties listed in i and ii below and operating regulated small MS4s shall apply as either a Permittee or Co-Permittee.

      i. Cities of: Aberdeen, Algona, Anacortes, Arlington, Auburn, Bainbridge Island, Battle Ground, Bellevue, Bellingham, Black Diamond, Bonney Lake, Bothell, Bremerton, Brier, Buckley, Burien, Burlington, Camas, Centralia, Clyde Hill, Covington, Des Moines, DuPont, Duvall, Edgewood, Edmonds, Enumclaw, Everett, Federal Way, Ferndale, Fife, Fircrest, Gig Harbor, Granite Falls, Issaquah, Kelso, Kenmore, Kent, Kirkland, Lacey, Lake Forest Park, Lake Stevens, Lakewood, Longview, Lynnwood, Maple Valley, Marysville, Medina, Mercer Island, Mill Creek, Milton, Monroe, Mountlake Terrace, Mount Vernon, Mukilteo, Newcastle, Normandy Park, Oak Harbor, Olympia, Orting, Pacific, Port Orchard, Port Angeles, Poulsbo, Puyallup, Redmond, Renton, Sammamish, SeaTac, Sedro-Woolley, Shoreline, Snohomish, Steilacoom, Sumner, Tukwila, Tumwater, University Place, Vancouver, Washougal, Woodinville, and Yarrow Point.

      ii. Counties: Cowlitz, Kitsap, Thurston, Skagit, and Whatcom.

   b. All other **regulated small MS4s** shall apply as a Secondary Permittee or as a Co-Permittee.

   c. The following cities, towns and counties submitted either an application or a NOI for coverage to Ecology prior to January 17, 2007:

      i. Cities and towns: Aberdeen, Algona, Arlington, Auburn, Bainbridge Island, Battle Ground, Bellevue, Bellingham, Black Diamond, Bonney Lake, Bothell, Bremerton, Brier, Buckley, Burien, Burlington, Camas, Centralia, Clyde Hill, Covington, Des Moines, DuPont, Duvall, Edgewood, Edmonds, Enumclaw, Everett, Federal Way, Ferndale Fife, Fircrest, Gig Harbor, Granite Falls, Issaquah, Kelso, Kenmore, Kent, Kirkland, Lacey, Lake Forest Park, Lake Stevens, Lakewood, Longview, Lynnwood, Maple Valley, Marysville, Medina, Mercer Island, Mill Creek, Milton, Monroe, Mountlake Terrace, Mount Vernon, Mukilteo, Newcastle, Normandy Park, Oak Harbor, Olympia, Orting, Pacific, Port Orchard, Poulsbo, Puyallup, Redmond, Renton, Sammamish, SeaTac, Sedro-Woolley, Shoreline, Snohomish, Steilacoom, Sumner, Tukwila, Tumwater, University Place, Vancouver, Washougal, Woodinville, and Yarrow Point

      ii. Counties: Cowlitz, Kitsap, Thurston, Skagit, and Whatcom.

d. All operators of regulated small MS4s located in jurisdictions listed in S1.D.2.a. shall submit to Ecology a NOI or individual permit application before the effective date of this permit, with the following exceptions:

   i. Operators of regulated small MS4s located in the Cities of Aberdeen, Anacortes, Centralia, Oak Harbor, and Port Angeles shall submit a NOI or application to Ecology no later than 30 days after the effective date of this permit.

   ii. Operators of regulated small MS4s listed in S1.D.2.c. do not need to submit a new application to be covered under this permit.

e. For operators of regulated small MS4s listed in S1.D.2.c., coverage under this permit is automatic and begins on the effective date of this permit, unless:

   i. The operator chooses to reapply before the effective date of this permit; or

   ii. The operator will be relying on another entity to satisfy one or more of their permit obligations in accordance with S1.D.2.g. and S1.D.3.d. below; or

   iii. The operator chooses be a Co-Permittee in accordance with S1.D.2.f. and S1.D.3.c. below; or

   iv. The operator chooses to opt out of this General Permit. Any operator of a regulated small MS4 that is opting out of this permit shall submit an application for an individual MS4 permit in accordance with 40 CFR 122.33(b)(2)(ii) no later than the effective date of this permit.

f. Operators of regulated small MS4s which want to be covered under this permit as Co-Permittees shall submit to Ecology a joint NOI.

g. Operators of regulated small MS4s which are relying on another entity to satisfy one or more of their permit obligations shall submit a NOI to Ecology.

h. Operators of small MS4s designated by Ecology pursuant to S1.B.3. of this permit shall submit a NOI to Ecology within 120 days of receiving notification from Ecology that permit coverage is required.

3. Application Requirements

   a. NOIs shall be submitted to:

      Department of Ecology
      Water Quality Program
      Municipal Stormwater Permits
      P.O. Box 47696
      Olympia, WA 98504-7696

   b. For NOIs submitted after January 17, 2007, the permit applicant shall provide public notice of the application in accordance with WAC 173-226-130(5). The applicant or co-applicant shall include a certification that the public notification requirements of WAC 173-226-130(5) have been satisfied. Unless Ecology responds in writing, coverage under this Permit will be effective 60 days after

receipt of a complete NOI. A complete NOI shall include the certification of public notice.

c. Permittees applying as co-applicants shall submit a joint NOI. The joint NOI shall clearly identify the areas of the MS4 for which each of the co-applicants are responsible.

d. Permittees relying on another entity or entities to satisfy one or more of their permit obligations shall notify Ecology in writing. The notification shall include a summary of the permit obligations that will be carried out by another entity. The summary shall identify the other entity or entities and shall be signed by the other entity or entities. During the term of the permit, permittees may terminate or amend shared responsibility arrangements by notifying Ecology, provided this does not alter implementation deadlines.

e. Secondary permittees required to have coverage under this Permit, and the NPDES and State Waste Discharge Permit for Discharges from Small Municipal Separate Storm Sewers in Eastern Washington or the NPDES and State Waste Discharge Permit for Discharges from Large and Medium Municipal *Separate Storm Sewers*, may obtain coverage by submitting a single NOI.

S2. AUTHORIZED DISCHARGES

A. This Permit authorizes the discharge of stormwater to surface waters and to ground waters of the state from municipal separate storm sewer systems owned or operated by each Permittee covered under this permit, in the geographic area covered pursuant to S1.A. These discharges are subject to the following limitations:

1. Discharges to ground waters of the state through facilities regulated under the Underground Injection Control (UIC) program, Chapter 173-218 WAC, are not covered under this Permit.

2. Discharges to ground waters not subject to regulation under the federal Clean Water Act are covered in this permit only under state authorities, Chapter 90.48 RCW, the Water Pollution Control Act.

B. This Permit authorizes discharges of non-stormwater flows to surface waters and to ground waters of the state from municipal separate storm sewer systems owned or operated by each Permittee covered under this permit, in the geographic area covered pursuant to S1.A, only under the following conditions:

1. The discharge is authorized by a separate National Pollutant Discharge Elimination System (NPDES) or State Waste Discharge permit.

2. The discharge is from emergency fire fighting activities.

3. The discharge is from another illicit or non-stormwater discharge that is managed by the Permittee as provided in Special Condition S5.C.3.b. or S6.C.3.b.

These discharges are also subject to the limitations in S2.A.1. and S.2.A.2. above.

C. This Permit does not relieve entities that cause illicit discharges, including spills, of oil or hazardous substances, from responsibilities and liabilities under state and federal laws and regulations pertaining to those discharges.

D. Discharges from municipal separate storm sewers constructed after the effective date of this permit shall receive all applicable state and local permits and use authorizations, including compliance with Chapter 43.21C RCW (the State Environmental Policy Act).

E. This Permit does not authorize discharges of stormwater to waters within Indian Reservations except where authority has been specifically delegated to Ecology by the U.S. Environmental Protection Agency. The exclusion of such discharges from this Permit does not waive any rights the State may have with respect to the regulation of the discharges.

S3. RESPONSIBILITIES OF PERMITTEES

A. Each Permittee covered under this Permit is responsible for compliance with the terms of this Permit for the regulated small MS4s that they own or operate. Compliance with (1) or (2) below is required as applicable to each permittee, whether the permittee has applied for coverage as a permittee, co-permittee, or secondary permittee.

1. All city, town and county permittees are required to comply with all conditions of this Permit, including any appendices referenced therein, except for Special Condition S6 *Stormwater Management Program for Secondary Permittees.*

2. All secondary permittees are required to comply with all conditions of this Permit, including any appendices referenced therein, except for Special Conditions S8.C. *Monitoring* and S5 *Stormwater Management Program for Cities, Towns and Counties.*

B. Permittees may rely on another entity to satisfy one or more of the requirements of this Permit. Permittees that are relying on another entity to satisfy one or more of their permit obligations remain responsible for permit compliance if the other entity fails to implement permit conditions. Permittees may rely on another entity provided all the requirements of 40 CFR 122.35(a) are satisfied, including but not limited to:

1. The other entity, in fact, implements the Permit requirements.

2. The other entity agrees to take on responsibility for implementation of the Permit requirement(s) as indicated on the NOI.

S4. COMPLIANCE WITH STANDARDS

A. In accordance with RCW 90.48.520, the discharge of toxicants to waters of the state of Washington which would violate any water quality standard, including toxicant standards, sediment criteria, and dilution zone criteria is prohibited. The required response to such discharges is defined in section S4.F., below.

B. This Permit does not authorize a discharge which would be a violation of Washington State Surface Water Quality Standards (Chapter 173-201A WAC), Ground Water Quality Standards (Chapter 173-200 WAC), Sediment Management Standards (Chapter 173-204 WAC), or human health-based criteria in the national Toxics Rule (Federal Register, Vol.

57, NO. 246, Dec. 22, 1992, pages 60848-60923). The required response to such discharges is defined in section S4.F., below.

C. The Permittee shall reduce the discharge of pollutants to the maximum extent practicable (MEP).

D. The Permittee shall use all known, available, and reasonable methods of prevention, control and treatment (AKART) to prevent and control pollution of waters of the state of Washington.

E. In order to meet the goals of the Clean Water Act, and comply with S4.A., S4.B., S4.C., and S4.D. each Permittee shall comply with all of the applicable requirements of this Permit as identified in S3 Responsibilities of Permittees.

F. A Permittee remains in compliance with S4. despite any discharges prohibited by S4.A. or S4.B., when the Permittee undertakes the following response toward long-term water quality improvement:

1. A Permittee shall notify Ecology in writing within 30 days of becoming aware, based on credible site-specific information, that a discharge from the municipal separate storm sewer owned or operated by the Permittee is causing or contributing to a known or likely violation of Water Quality Standards in the receiving water. Written notification provided under this subsection shall, at a minimum, identify the source of the site-specific information, describe the nature and extent of the known or likely violation in the receiving water, and explain the reasons why the MS4 discharge is believed to be causing or contributing to the problem. For ongoing or continuing violations, a single written notification to Ecology will fulfill this requirement.

2. In the event that Ecology determines, based on a notification provided under S4.F.1. or through any other means, that a discharge from a municipal separate storm sewer owned or operated by the Permittee is causing or contributing to a violation of Water Quality Standards in a receiving water, Ecology will notify the Permittee in writing that an adaptive management response outlined in S4.F.3. below is required, unless Ecology also determines that (a) the violation of Water Quality Standards is already being addressed by a Total Maximum Daily Load or other enforceable water quality cleanup plan; or (b) Ecology concludes the violation will be eliminated through implementation of other permit requirements.

3. Adaptive Management Response

   a. Within 60 days of receiving a notification under S4.F.2., or by an alternative date established by Ecology, the Permittee shall review its Stormwater Management Program and submit a report to Ecology. The report shall include:

      i. A description of the operational and/or structural BMPs that are currently being implemented to prevent or reduce any pollutants that are causing or contributing to the violation of Water Quality Standards, including a qualitative assessment of the effectiveness of each BMP.

ii. A description of potential additional operational and/or structural BMPs that will or may be implemented in order to apply AKART on a site-specific basis to prevent or reduce any pollutants that are causing or contributing to the violation of Water Quality Standards.

iii. A description of the potential monitoring or other assessment and evaluation efforts that will or may be implemented to monitor, assess, or evaluate the effectiveness of the additional BMPs.

iv. A schedule for implementing the additional BMPs including, as appropriate: funding, training, purchasing, construction, monitoring, and other assessment and evaluation components of implementation.

b. Ecology will, in writing, acknowledge receipt of the report within a reasonable time and notify the Permittee when it expects to complete its review of the report. Ecology will either approve the additional BMPs and implementation schedule or require the Permittee to modify the report as needed to meet AKART on a site-specific basis. If modifications are required, Ecology will specify a reasonable time frame in which the Permittee shall submit and Ecology will review the revised report.

c. The Permittee shall implement the additional BMPs, pursuant to the schedule approved by Ecology, beginning immediately upon receipt of written notification of approval.

d. The Permittee shall include with each subsequent annual report a summary of the status of implementation and the results of any monitoring, assessment or evaluation efforts conductedduring the reporting period. If, based on the information provided under this subsection, Ecology determines that modification of the BMPs or implementation schedule is necessary to meet AKART on a site-specific basis, the Permittee shall make such modifications as Ecology directs. In the event there are ongoing violations of water quality standards despite the implementation of the BMP approach of this section, the Permittee may be subject to compliance schedules to eliminate the violation under WAC 173-201A-510(4) and WAC 173-226-180 or other enforcement orders as Ecology deems appropriate during the term of this permit.

e. Provided the Permittee is implementing the approved adaptive management response under this section, the Permittee remains in compliance with Condition S4., despite any on-going violations of Water Quality Standards identified under S4.F.A or B above.

f. The adaptive management process provided under Section S.4.F is not intended to create a shield for the Permittee from any liability it may face under 42 U.S.C. 9601 *et seq.* or RCW 70.105D.

G. Ecology may modify or revoke and reissue this General Permit in accordance with G14 General *Permit Modification and Revocation*, if Ecology becomes aware of additional control measures, management practices or other actions beyond what is required in this Permit that are necessary to:

1. Reduce the discharge of pollutants to the MEP,
2. Comply with the state AKART requirements, or
3. Control the discharge of toxicants to waters of the State of Washington.

S5. STORMWATER MANAGEMENT PROGRAM FOR CITIES, TOWNS AND COUNTIES

A. Each Permittee shall develop and implement a Stormwater Management Program (SWMP). A SWMP is a set of actions and activities comprising the components listed in S5.B. and S5.C.1. through S5.C.5., and any additional actions necessary to meet the requirements of applicable TMDLs (see S7). The SWMP shall be designed to reduce the discharge of pollutants from the regulated small MS4 to the maximum extent practicable and to protect water quality. This section applies to all cities, towns and counties covered under this Permit, including cities, towns and counties that are co-permittees. Where the term "Permittee" is used in this section the requirements apply to all cities, towns and counties covered under this Permit.

1. The SWMP shall be developed and implemented in accordance with the schedules contained in this section and shall be fully developed and implemented no later than 180 days prior to the expiration date of this Permit. At a minimum the Permittee's SWMP shall be implemented throughout the geographic area subject to this Permit as described in S1.A.
2. Each Permittee shall prepare written documentation of the SWMP. The SWMP documentation shall be organized according to the program components in S5.C. and shall be updated at least annually for submittal with the Permittee's annual reports to Ecology (see S9 *Reporting and Record Keeping*). The SWMP documentation shall include:
   a. A description of each of the program components included in S5.C., and
   b. Any additional actions implemented by the Permittee pursuant to S5.C., and
   c. Any additional actions necessary to meet the requirements of applicable TMDLs pursuant to S7 *Compliance with Total Maximum Daily Load Requirements*.
3. The SWMP shall include an ongoing program for gathering, tracking, maintaining, and using information to evaluate SWMP development, implementation and permit compliance and to set priorities.
   a. Beginning no later than January 1, 2009, each Permittee shall track the cost or estimated cost of development and implementation of each component of the SWMP. This information shall be provided to Ecology upon request.
   b. Each Permittee shall track the number of inspections, official enforcement actions and types of public education activities as stipulated by the respective program component. This information shall be included in the annual report.

4. The SWMP described herein supersedes SWMP descriptions provided by permit applicants in individual applications submitted to the Department prior to the effective date of this permit.

   Notwithstanding the schedules for implementation of SWMP components contained in this permit, Permittees that are already implementing some or all of the SWMP components in this section shall continue implementation of those components of their SWMP. Permittees shall not repeal existing local requirements to control stormwater that go beyond the requirements of this permit for new development and redevelopment sites.

5. Coordination among permittees

   a. Coordination among entities covered under municipal stormwater NPDES permits may be necessary to comply with certain conditions of the SWMP. The SWMP should include, when needed, coordination mechanisms among entities covered under a municipal stormwater NPDES permit to encourage coordinated stormwater-related policies, programs and projects within adjoining or shared areas.

      i. Coordination mechanisms shall clarify roles and responsibilities for the control of pollutants between physically interconnected MS4s permittees covered by a municipal stormwater permit.

      ii. Coordination mechanisms shall coordinate stormwater management activities for shared water bodies among permittees to avoid conflicting plans, policies and regulations.

   b. The SWMP should include coordination mechanisms among departments within each jurisdiction to eliminate barriers to compliance with the terms of this permit.

B. The SWMP shall be designed to reduce the discharge of pollutants from regulated small MS4s to the maximum extent practicable (MEP), meet state AKART requirements, and protect water quality. Notwithstanding the schedules for implementation of SWMP components contained in this Permit, permittees who are implementing some or all of the SWMP components in this section shall continue implementation of those components of their SWMP.

C. The SWMP shall include the components listed below. To the extent allowable under state or federal law, all components are mandatory for city, town or county permittees covered under this Permit. In accordance with 40 CFR 122.35(a) and Special Condition S3, a city, town or county may rely on another entity to implement one or more of the components in this section.

   1. <u>Public Education and Outreach</u>

      The SWMP shall include an education program aimed at residents, businesses, industries, elected officials, policy makers, planning staff and other employees of the Permittee. The goal of the education program is to reduce or eliminate behaviors and

practices that cause or contribute to adverse stormwater impacts. An education program may be developed locally or regionally.

The minimum measures are:

a. No later than two years after the effective date of this Permit, the Permittee shall provide an education and outreach program for the area served by the MS4. The outreach program shall be designed to achieve measurable improvements in the target audience's understanding of the problem and what they can do to solve it.

   Education and outreach efforts shall be prioritized to target the following audiences and subject areas:

   i. General public

      - General impacts of stormwater flows into surface waters.
      - Impacts from impervious surfaces.
      - Source control BMPs and environmental stewardship actions and opportunities in the areas of pet waste, vehicle maintenance, landscaping and buffers.

   ii. General public, businesses, including home-based and mobile businesses

      - BMPs for use and storage of automotive chemicals, hazardous cleaning supplies, carwash soaps and other hazardous materials.
      - Impacts of illicit discharges and how to report them.

   iii. Homeowners, landscapers and property managers

      - Yard care techniques protective of water quality.
      - BMPs for use and storage of pesticides and fertilizers.
      - BMPs for carpet cleaning and auto repair and maintenance.
      - Low Impact Development techniques, including site design, pervious paving, retention of forests and mature trees.
      - Stormwater pond maintenance.

   iv. Engineers, contractors, developers, review staff and land use planners

      - Technical standards for stormwater site and erosion control plans.
      - Low Impact Development techniques, including site design, pervious paving, retention of forests and mature trees.
      - Stormwater treatment and flow control BMPs.

b. Each Permittee shall measure the understanding and adoption of the targeted behaviors for at least one targeted audience in at least one subject area. The resulting measurements shall be used to direct education and outreach resources most effectively, as well as to evaluate changes in adoption of the targeted behaviors.

c. Each Permittee shall track and maintain records of public education and outreach activities.

2. Public Involvement and Participation

   The SWMP shall include ongoing opportunities for public involvement through advisory councils, watershed committees, participation in developing rate-structures, stewardship programs, environmental activities or other similar activities. Each Permittee shall comply with applicable State and local public notice requirements when developing their SWMP.

   The minimum performance measures are:

   a. No later than one year from the effective date of this Permit, all permittees shall create opportunities for the public to participate in the decision-making processes involving the development, implementation and update of the Permittee's entire SWMP. Each Permittee shall develop and implement a process for consideration of public comments on their SWMP.

   b. Each Permittee shall make their SWMP, the annual report required under S9.A and all other submittals required by this Permit, available to the public. The annual report, and SWMP that was submitted with the latest annual report, shall be posted on the permittee's website. To comply with the posting requirement, a permittee that does not maintain a website may submit the updated SWMP in electronic format to the Department for posting on the Department's website.

3. Illicit Discharge Detection and Elimination

   The SWMP shall include an ongoing program to detect and remove illicit connections and discharges as defined in 40 CFR 122.26(b)(2), including any spills not under the purview of another responding authority, into the municipal separate storm sewers owned or operated by the Permittee. Permittees shall fully implement an ongoing illicit discharge detection and elimination program no later than 180 days prior to the expiration date of this Permit.

   The minimum performance measures are:

   a. A municipal storm sewer system map shall be developed no later than four years from the effective date of this permit. Municipal storm sewer system maps shall be periodically updated and shall include the following information:

      i. The location of all known municipal separate storm sewer outfalls and receiving waters and structural stormwater BMPs owned, operated, or maintained by the Permittee. Each Permittee shall map the attributes listed below for all storm sewer outfalls with a 24 inch nominal diameter or larger, or an equivalent cross-sectional area for non-pipe systems:

         - Tributary conveyances (indicate type, material, and size where known).
         - Associated drainage areas.
         - Land use.

      ii. Each Permittee shall initiate a program to develop and maintain a map of all connections to the municipal separate storm sewer authorized or allowed by the Permittee after the effective date of this Permit.

iii. Geographic areas served by the Permittee's MS4 that do not discharge stormwater to surface waters.

iv. Each Permittee shall make available to Ecology, upon request, municipal storm sewer system map(s) depicting the information required in S5.C.3.a.i. through iii above. The preferred format of submission will be an electronic format with fully described mapping standards. An example description is provided on Ecology WebPages under Core Services, GIS Data.

v. Upon request, and to the extent appropriate, permittees shall provide mapping information to co-permittees and secondary permittees.

b. Each Permittee shall develop and implement an ordinance or other regulatory mechanism to effectively prohibit non-stormwater, illicit discharges into the Permittee's municipal separate storm sewer system to the maximum extent allowable under State and Federal law. The ordinance or other regulatory mechanism shall be adopted no later than 30 months from the effective date of this Permit.

i. The regulatory mechanism does <u>not</u> need to prohibit the following categories of non-stormwater discharges:

- Diverted stream flows.
- Rising ground waters.
- Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)).
- Uncontaminated pumped ground water.
- Foundation drains.
- Air conditioning condensation.
- Irrigation water from agricultural sources that is commingled with urban stormwater.
- Springs.
- Water from crawl space pumps.
- Footing drains.
- Flows from riparian habitats and wetlands.
- Non-stormwater discharges covered by another NPDES permit.
- Discharges from emergency fire fighting activities in accordance with S2 *Authorized Discharges*.

ii. The regulatory mechanism shall prohibit the following categories of non-stormwater discharges unless the stated conditions are met:

- Discharges from potable water sources, including water line flushing, hyperchlorinated water line flushing, fire hydrant system flushing, and pipeline hydrostatic test water. Planned discharges shall be de-chlorinated to a concentration of 0.1 ppm or less, pH-adjusted, if necessary, and volumetrically and velocity controlled to prevent re-suspension of sediments in the MS4.

- Discharges from lawn watering and other irrigation runoff. These shall be minimized through, at a minimum, public education activities (see section S5.C.1) and water conservation efforts.
- Dechlorinated swimming pool discharges. The discharges shall be dechlorinated to a concentration of 0.1 ppm or less, pH-adjusted and reoxygenized if necessary, volumetrically and velocity controlled to prevent re-suspension of sediments in the MS4. Swimming pool cleaning wastewater and filter backwash shall not be discharged to the MS4.
- Street and sidewalk wash water, water used to control dust, and routine external building wash down that does not use detergents. The Permittee shall reduce these discharges through, at a minimum, public education activities (see section S5.C.1.) and/or water conservation efforts. To avoid washing pollutants into the MS4, Permittees must minimize the amount of street wash and dust control water used. At active construction sites, street sweeping must be performed prior to washing the street.
- Other non-stormwater discharges. The discharges shall be in compliance with the requirements of a stormwater pollution prevention plan reviewed by the Permittee, which addresses control of such discharges.

iii. The Permittee's SWMP shall, at a minimum, address each category in ii above in accordance with the conditions stated therein.

iv. The SWMP shall further address any category of discharges in i or ii above if the discharges are identified as significant sources of pollutants to waters of the State.

v. The ordinance or other regulatory mechanism shall include escalating enforcement procedures and actions.

vi. The Permittee shall develop an enforcement strategy and implement the enforcement provisions of the ordinance or other regulatory mechanism.

c. Each Permittee shall develop and implement an ongoing program to detect and address non-stormwater discharges, including spills, and illicit connections into the Permittee's municipal separate storm sewer system. The program shall be fully implemented no later than 180 days prior to the expiration date of this Permit and shall include:

i. Procedures for locating priority areas likely to have illicit discharges, including at a minimum: evaluating land uses and associated business/industrial activities present; areas where complaints have been registered in the past; and areas with storage of large quantities of materials that could result in spills.

ii. Field assessment activities, including visual inspection of priority outfalls identified in i, above, during dry weather and for the purposes of verifying outfall locations, identifying previously unknown outfalls, and detecting illicit discharges.

- Receiving waters shall be prioritized for visual inspection no later than three years from the effective date of this Permit, with field assessments of three high priority water bodies made no later than four years from the effective date of this Permit. Field assessments on at least one high priority water body shall be made each year thereafter.
- Screening for illicit connections shall be conducted using: Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments, Center for Watershed Protection, October 2004, or another methodology of comparable effectiveness.

iii. Procedures for characterizing the nature of, and potential public or environmental threat posed by, any illicit discharges found by or reported to the Permittee. Procedures shall include detailed instructions for evaluating whether the discharge must be immediately contained and steps to be taken for containment of the discharge.

Compliance with this provision shall be achieved by investigating (or referring to the appropriate agency) within 7 days, on average, any complaints, reports or monitoring information that indicates a potential illicit discharge, including spills; and immediately investigating (or referring) problems and violations determined to be emergencies or otherwise judged to be urgent or severe.

iv. Procedures for tracing the source of an illicit discharge; including visual inspections, and when necessary, opening manholes, using mobile cameras, collecting and analyzing water samples, and/or other detailed inspection procedures.

v. Procedures for removing the source of the discharge; including notification of appropriate authorities; notification of the property owner; technical assistance for eliminating the discharge; follow-up inspections; and escalating enforcement and legal actions if the discharge is not eliminated.

Compliance with this provision shall be achieved by initiating an investigation within 21 days of a report or discovery of a suspected illicit connection to determine the source of the connection, the nature and volume of discharge through the connection, and the party responsible for the connection. Upon confirmation of the illicit nature of a storm drain connection, Permittees shall use their enforcement authority in a documented effort to eliminate the illicit connection within 6 months.

d. Permittees shall inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.

i. No later than 180 days prior to the expiration date of this Permit, distribute appropriate information to target audiences identified pursuant to S5.C.1.

ii. No later than two years from the effective date of this Permit, publicly list and publicize a hotline or other local telephone number for public reporting of spills and other illicit discharges. Keep a record of calls received and follow-up actions taken in accordance with S5.C.3.c.ii. through v. above; include a summary in the annual report (see section S9 Reporting and Record Keeping Requirements).

e. Permittees shall adopt and implement procedures for program evaluation and assessment, including tracking the number and type of illicit discharges, including spills, identified; inspections made; and any feedback received from public education efforts. A summary of this information shall be included in the Permittee's annual report (see section S9 Reporting and Recordkeeping Requirements).

f. Each Permittee will provide appropriate training for municipal field staff on the identification and reporting of illicit discharges into MS4s.

i. No later than thirty months after the effective date of this Permit, each Permittee shall ensure that all municipal field staff who are responsible for identification, investigation, termination, cleanup, and reporting illicit discharges, including spills, and illicit connections are trained to conduct these activities. Follow-up training shall be provided as needed to address changes in procedures, techniques or requirements. Permittees shall document and maintain records of the training provided and the staff trained.

ii. No later than three years after the effective date of this Permit, an ongoing training program shall be developed and implemented for all municipal field staff, which, as part of their normal job responsibilities, might come into contact with or otherwise observe an illicit discharge or illicit connection to the storm sewer system shall be trained on the identification of an illicit discharge/connection, and on the proper procedures for reporting and responding to the illicit discharge/connection. Follow-up training shall be provided as needed to address changes in procedures, techniques or requirements. Permittees shall document and maintain records of the training provided and the staff trained.

4. <u>Controlling Runoff from New Development, Redevelopment and Construction Sites</u>

Each Permittee shall develop, implement, and enforce a program to reduce pollutants in stormwater runoff to a regulated small MS4 from new development, redevelopment and construction site activities. This program shall be applied to all sites that disturb a land area 1 acre or greater, including projects less than one acre that are part of a larger common plan of the development or sale. The program shall apply to private and public development, including roads. The "Technical Thresholds" in Appendix 1 shall be applied to all sites 1 acre or greater, including

projects less than one acre that are part of a larger common plan of the development or sale.

The minimum performance measures are:

a. The program shall include an ordinance or other enforceable mechanism that addresses runoff from new development, redevelopment, and construction site projects. Pursuant to S5.A.4., in adopting this ordinance or other regulatory mechanism, existing local requirements to apply stormwater controls at smaller sites, or at lower thresholds than required pursuant to S5.C.4., shall be retained. The ordinance or other enforceable mechanism shall be adopted and effective no later than February 16, 2010. The ordinance or other enforceable mechanism shall include, at a minimum:

   i. The Minimum Requirements, technical thresholds, and definitions in Appendix 1 or an equivalent approved by Ecology under the NPDES Phase I Municipal Stormwater Permit, for new development, redevelopment, and construction sites. Adjustment and variance criteria equivalent to those in Appendix 1 shall be included. More stringent requirements may be used, and/or certain requirements may be tailored to local circumstances through the use of basin plans or other similar water quality and quantity planning efforts. Such local requirements shall provide equal protection of receiving waters and equal levels of pollutant control to those provided in Appendix 1.

   ii. A site planning process and BMP selection and design criteria that, when used to implement the minimum requirements in Appendix 1 (or equivalent approved by Ecology under the Phase I Permit) will protect water quality, reduce the discharge of pollutants to the maximum extent practicable and satisfy the State requirement under Chapter 90.48 RCW to apply all known, available and reasonable methods of prevention, control and treatment (AKART) prior to discharge. Permittees shall document how the criteria and requirements will protect water quality, reduce the discharge of pollutants to the maximum extent practicable, and satisfy State AKART requirements.

   Permittees who choose to use the site planning process and BMP selection and design criteria in the 2005 *Stormwater Management Manual for Western Washington,* or an equivalent manual approved by the Department under the Phase I Permit, may cite this choice as their sole documentation to meet this requirement.

   iii. The legal authority, through the approval process for new development, to inspect private stormwater facilities that discharge to the Permittee's MS4.

   iv. Provisions to allow non-structural preventive actions and source reduction approaches such as Low Impact Development Techniques (LID), measures to minimize the creation of impervious surfaces and measures to minimize the disturbance of native soils and vegetation. Provisions for LID should take into account site conditions, access and long term maintenance.

v. If the Permittee chooses to allow construction sites to apply the "Erosivity Waiver" in Appendix 1, Minimum Requirement #2, the ordinance or regulatory mechanism shall include appropriate, escalating enforcement sanctions for construction sites that provide notice to the Permittee of their intention to apply the waiver but do not meet the requirements (including timeframe restrictions, limits on activities that result in non-stormwater discharges, and implementation of appropriate BMPs to prevent violations of water quality standards) to qualify for the waiver.

b. The program shall include a permitting process with plan review, inspection and enforcement capability to meet the standards listed in (i) through (iv) below, for both private and public projects, using qualified personnel (as defined in *Definitions and Acronyms*). At a minimum, this program shall be applied to all sites that disturb a land area 1 acre or greater, including projects less than one acre that are part of a larger common plan of the development or sale. The process shall be in place no later than February 16, 2010.

i. Except as provided in S5.C.4.b.vii. below, review of all stormwater site plans for proposed development activities.

ii. Except as provided in S5.C.4.b.vii. below, inspect, prior to clearing and construction, all known development sites that have a high potential for sediment transport as determined through plan review based on definitions and requirements in Appendix 7 Determining Construction Site Sediment Damage Potential.

iii. Except as provided in S5.C.4.b.vii. below, inspect all known permitted development sites during construction to verify proper installation and maintenance of required erosion and sediment controls. Enforce as necessary based on the inspection.

iv. Inspect all permitted development sites upon completion of construction and prior to final approval or occupancy to ensure proper installation of permanent stormwater controls such as stormwater facilities and structural BMPs. Also, verify a maintenance plan is completed and responsibility for maintenance is assigned. Enforce as necessary based on the inspection.

v. Compliance with the inspection requirements in (ii), (iii) and (iv) above shall be determined by the presence and records of an established inspection program designed to inspect all sites. Compliance during this permit term shall be determined by achieving at least 80% of scheduled inspections.

vi. An enforcement strategy shall be developed and implemented to respond to issues of non-compliance.

vii. If the Permittee chooses to allow construction sites to apply the "Erosivity Waiver" in Appendix 1, Minimum Requirement #2, the Permittee is not required to review the construction stormwater pollution prevention plans as part of the site plan review in (i) above, and is not required to perform

the construction phase inspections identified in (ii) and (iii) above related to construction sites which are eligible for the erosivity waiver.

c. The program shall include provisions to verify adequate long-term operation and maintenance (O&M) of post-construction stormwater facilities and BMPs that are permitted and constructed pursuant to (b) above. These provisions shall be in place no later than February 16, 2010 and shall include:

   i. Adoption of an ordinance or other enforceable mechanism that clearly identifies the party responsible for maintenance, requires inspection of facilities in accordance with the requirements in (ii) through (iv) below, and establishes enforcement procedures.

   ii. Each Permittee shall establish maintenance standards that are as protective or more protective of facility function than those specified in Chapter 4 of Volume V of the 2005 *Stormwater Management Manual for Western Washington*. For facilities which do not have maintenance standards, the Permittee shall develop a maintenance standard.

      (1) The purpose of the maintenance standard is to determine if maintenance is required. The maintenance standard is not a measure of the facilities required condition at all times between inspections. Exceeding the maintenance standard between the period of inspections is not a permit violation.

      (2) Unless there are circumstances beyond the Permittee's control, when an inspection identifies an exceedence of the maintenance standard, maintenance shall be performed:

         - Within 1 year for typical maintenance of facilities, except catch basins.
         - Within 6 months for catch basins.
         - Within 2 years for maintenance that requires capital construction of less than $25,000.

         Circumstances beyond the Permittee's control include denial or delay of access by property owners, denial or delay of necessary permit approvals, and unexpected reallocations of maintenance staff to perform emergency work. For each exceedence of the required timeframe, the Permittee must document the circumstances and how they were beyond their control.

   iii. Annual inspections of all stormwater treatment and flow control facilities (other than catch basins) permitted by the Permittee according to S5.C.4.b. unless there are maintenance records to justify a different frequency. The Permittee shall take appropriate maintenance actions in accordance with the adopted maintenance standards.

      Reducing the inspection frequency shall be based on maintenance records of double the length of time of the proposed inspection frequency. In the absence of maintenance records, the Permittee may substitute written

statements to document a specific less frequent inspection schedule. Written statements shall be based on actual inspection and maintenance experience and shall be certified in accordance with G19 *Certification and Signature*.

iv. Inspections of all new flow control and water quality treatment facilities, including catch basins, for new residential developments that are a part of a larger common plan of development or sale, every 6 months during the period of heaviest house construction (i.e., 1 to 2 years following subdivision approval) to identify maintenance needs and enforce compliance with maintenance standards as needed.

d. The program shall include a procedure for keeping records of inspections and enforcement actions by staff, including inspection reports, warning letters, notices of violations, and other enforcement records. Records of maintenance inspections and maintenance activities shall be maintained. Permittees shall keep records of all projects disturbing more than one acre, and all projects of any size that are part of a common plan of development or sale that is greater than one acre that are approved after the effective date of this Permit.

e. The program shall make available copies of the "Notice of Intent for Construction Activity" and copies of the "Notice of Intent for Industrial Activity" to representatives of proposed new development and redevelopment. Permittees will continue to enforce local ordinances controlling runoff from sites that are also covered by stormwater permits issued by Ecology.

f. No later than February 16, 2010, each Permittee shall verify that all staff responsible for implementing the program to control stormwater runoff from new development, redevelopment, and construction sites, including permitting, plan review, construction site inspections, and enforcement, are trained to conduct these activities. Follow-up training shall be provided as needed to address changes in procedures, techniques or staffing. Permittees shall document and maintain records of the training provided and the staff trained.

5. <u>Pollution Prevention and Operation and Maintenance for Municipal Operations</u>

Within three years of the effective date of this Permit, each Permittee shall develop and implement an operations and maintenance (O&M) program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations.

The minimum performance measures are:

a. Each Permittee shall establish maintenance standards that are as protective, or more protective, of facility function than those specified in Chapter 4 of Volume V of the 2005 *Stormwater Management Manual for Western Washington*. For facilities which do not have maintenance standards, the Permittee shall develop a maintenance standard.

i. The purpose of the maintenance standard is to determine if maintenance is required. The maintenance standard is not a measure of the facilities

required condition at all times between inspections. Exceeding the maintenance standard between inspections and/or maintenance is not a permit violation.

ii. Unless there are circumstances beyond the Permittees control, when an inspection identifies an exceedence of the maintenance standard, maintenance shall be performed:

- Within 1 year for typical maintenance of facilities, except catch basins.
- Within 6 months for catch basins.
- Within 2 years for maintenance that requires capital construction of less than $25,000.

Circumstances beyond the Permittee's control include denial or delay of access by property owners, denial or delay of necessary permit approvals, and unexpected reallocations of maintenance staff to perform emergency work. For each exceedence of the required timeframe, the Permittee shall document the circumstances and how they were beyond their control.

b. Annual inspection of all municipally owned or operated permanent stormwater treatment and flow control facilities, other than catch basins, and taking appropriate maintenance actions in accordance with the adopted maintenance standards. The annual inspection requirement may be reduced based on inspection records.

Reducing the inspection frequency shall be based on maintenance records of double the length of time of the proposed inspection frequency. In the absence of maintenance records, the Permittee may substitute written statements to document a specific less frequent inspection schedule. Written statements shall be based on actual inspection and maintenance experience and shall be certified in accordance with G19 *Certification and Signature*.

c. Spot checks of potentially damaged permanent treatment and flow control facilities (other than catch basins) after major (greater than 24-hour-10-year recurrence interval rainfall) storm events. If spot checks indicate widespread damage/maintenance needs, inspect all stormwater treatment and flow control facilities that may be affected. Conduct repairs or take appropriate maintenance action in accordance with maintenance standards established above, based on the results of the inspections.

d. Inspection of all catch basins and inlets owned or operated by the Permittee at least once before the end of the permit term. Clean catch basins if the inspection indicates cleaning is needed to comply with maintenance standards established in the 2005 *Stormwater Management Manual for Western Washington*. Decant water shall be disposed of in accordance with Appendix 6 *Street Waste Disposal*.

Inspections may be conducted on a "circuit basis" whereby a sampling of catch basins and inlets within each circuit is inspected to identify maintenance needs. Include in the sampling an inspection of the catch basin immediately upstream of any system outfall. Clean all catch basins within a given circuit for which the

inspection indicates cleaning is needed to comply with maintenance standards established under S5.C.4.c., above.

As an alternative to inspecting catch basins on a "circuit basis," the Permittee may inspect all catch basins, and clean only catch basins where cleaning is needed to comply with maintenance standards.

e. Compliance with the inspection requirements in b, c and d above shall be determined by the presence of an established inspection program designed to inspect all sites. Compliance during this permit term shall be determined by achieving an annual rate of at least 95% of inspections no later than 180 days prior to the expiration date of this permit.

f. Establishment and implementation of practices to reduce stormwater impacts associated with runoff from streets, parking lots, roads or highways owned or maintained by the Permittee, and road maintenance activities conducted by the Permittee. The following activities shall be addressed:

- Pipe cleaning
- Cleaning of culverts that convey stormwater in ditch systems
- Ditch maintenance
- Street cleaning
- Road repair and resurfacing, including pavement grinding
- Snow and ice control
- Utility installation
- Pavement striping maintenance
- Maintaining roadside areas, including vegetation management
- Dust control

g. Establishment and implementation of policies and procedures to reduce pollutants in discharges from all lands owned or maintained by the Permittee and subject to this Permit, including but not limited to: parks, open space, road right-of-way, maintenance yards, and stormwater treatment and flow control facilities. These policies and procedures shall address, but are not limited to:

- Application of fertilizer, pesticides, and herbicides including the development of nutrient management and integrated pest management plans.
- Sediment and erosion control.
- Landscape maintenance and vegetation disposal.
- Trash management.
- Building exterior cleaning and maintenance.

h. Develop and implement an on-going training program for employees of the Permittee whose construction, operations or maintenance job functions may impact stormwater quality. The training program shall address the importance of protecting water quality, the requirements of this Permit, operation and maintenance standards, inspection procedures, selecting appropriate BMPs, ways to perform their job activities to prevent or minimize impacts to water quality, and procedures for reporting water quality concerns, including potential illicit

discharges. Follow-up training shall be provided as needed to address changes in procedures, techniques or requirements. Permittees shall document and maintain records of training provided.

i. Development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) for all heavy equipment maintenance or storage yards, and material storage facilities owned or operated by the Permittee in areas subject to this Permit that are not required to have coverage under the *General NPDES Permit for Stormwater Discharges Associated with Industrial Activities* or another NPDES permit that covers stormwater discharges associated with the activity. Implementation of non-structural BMPs shall begin immediately after the pollution prevention plan is developed. A schedule for implementation of structural BMPs shall be included in the SWPPP. Generic SWPPPs that can be applied at multiple sites may be used to comply with this requirement. The SWPPP shall include periodic visual observation of discharges from the facility to evaluate the effectiveness of the BMP.

j. Records of inspections and maintenance or repair activities conducted by the Permittee shall be maintained in accordance with S9 *Reporting Requirements*.

S6. STORMWATER MANAGEMENT PROGRAM FOR SECONDARY PERMITTEES

A. This section applies to all secondary permittees, whether coverage under this Permit is obtained individually or as a co-permittee with a city, town or county or another secondary permittee.

1. To the extent allowable under state, federal or local law, all components are mandatory for each Secondary Permittee covered under this Permit, whether covered as an individual permittee or as a co-permittee.

2. Each Secondary Permittee shall develop and implement a stormwater management program (SWMP). The SWMP shall be designed to reduce the discharge of pollutants from regulated small MS4s to the maximum extent practicable and protect water quality.

3. Unless an alternate implementation schedule is established by Ecology as a condition of permit coverage, the SWMP shall be developed and implemented in accordance with the schedules contained in this section and shall be fully developed and implemented no later than180 days before the expiration date of this Permit. Notwithstanding the schedules in this Permit, secondary permittees that are already implementing some or all of the required SWMP components shall continue implementation of those components.

4. Secondary permittees may implement parts of their SWMP in accordance with the schedule for cities, towns and counties in S5, provided they have signed a memorandum of understanding or other agreement to jointly implement the activity or activities with one or more jurisdictions listed in S1.D.2.a., and submitted a copy of the agreement to Ecology.

5. Each Secondary Permittee shall prepare written documentation of the SWMP. The SWMP documentation shall be organized according to the program components in S6.D below and shall be updated at least annually for submittal with the Permittee's annual reports to Ecology (see S9 *Reporting Requirements*). The SWMP documentation shall include:

   a. A description of each of the program components included in S6.D.1. through S6.D.6., and

   b. Any additional actions necessary to meet the requirements of applicable TMDLs pursuant to S7 *Compliance with Total Maximum Daily Load Requirements.*

B. Coordination

The SWMP shall include mechanisms to encourage coordinated stormwater-related policies, programs and projects within a watershed and interconnected MS4s. Where relevant and appropriate, the SWMP shall also include coordination among departments of the Secondary Permittee to ensure compliance with the terms of this Permit.

C. Legal Authority

To the extent allowable under state law and federal law, each Secondary Permittee shall be able to demonstrate that they can operate pursuant to legal authority which authorizes or enables the Secondary Permittee to control discharges to and from municipal separate storm sewers owned or operated by the Secondary Permittee.

This legal authority may be a combination of statutes, ordinances, permits, contracts, orders, interagency agreements, or similar instruments.

D. Stormwater Management Program for Secondary Permittees

The term "Secondary Permittees" means drainage, diking, flood control, or diking and drainage districts, ports (other than the ports of Seattle and Tacoma), public colleges and universities, and any other owners or operators of municipal separate storm sewers located within the municipalities that are listed as permittees in S1.B.

SWMP components

1. <u>Public Education and Outreach</u>

   Each Secondary Permittee shall implement the following stormwater education strategies:

   a. Storm drain inlets owned and operated by the Secondary Permittee that are located in maintenance yards, in parking lots, along sidewalks, and at pedestrian access points shall be clearly and permanently labeled with the message "Dump no waste" and indicating the point of discharge as a river, lake, bay, or groundwater.

      i. No later than three years from the date of permit coverage, at least 50 percent of these inlets shall be labeled.

ii. No later than 180 days prior expiration date of this Permit, or as established as a condition of coverage by Ecology, all of these inlets shall be labeled.

iii. As identified during visual inspection and regular maintenance of storm drain inlets per the requirements of S6.D.3.d. and S6.D.6.a.i. below, or as otherwise reported to the Secondary Permittee, any inlet having a label that is no longer clearly visible and/or easily readable shall be re-labeled within 90 days.

b. Each year beginning no later than three years from the date of permit coverage, public ports, colleges and universities shall distribute educational information to tenants and residents on the impact of stormwater discharges on receiving waters, and steps that can be taken to reduce pollutants in stormwater runoff. Different combinations of topics shall be addressed each year, and, before the expiration date of this Permit, where relevant, tenants and residents shall receive educational information about the following topics:

i. How stormwater runoff affects local waterbodies

ii. Proper use and application of pesticides and fertilizers

iii. Benefits of using well-adapted vegetation

iv. Alternative equipment washing practices including cars and trucks that minimize pollutants in stormwater

v. Benefits of proper vehicle maintenance and alternative transportation choices; proper handling and disposal of vehicle wastes, including the location of hazardous waste collection facilities in the area

vi. Hazards associated with illicit connections

vii. Benefits of litter control and proper disposal of pet waste

Compliance with this requirement can be achieved through participation in the local jurisdiction's public education and outreach programs.

2. Public Involvement and Participation

No later than 180 days before the expiration date of this Permit, or as established as a condition of coverage by the Ecology, each Secondary Permittee shall:

a. Publish a public notice in the local newspaper or on the Permittee's website and solicit public review of their SWMP.

b. Make the latest updated version of the SWMP available to the public. If the Secondary Permittee maintains a website, the SWMP shall be posted on the Secondary Permittee's website.

3. Illicit Discharge Detection and Elimination

Each Secondary Permittee shall:

a. From the date of permit coverage, comply with all relevant ordinances, rules, and regulations of the local jurisdiction(s) in which the Secondary Permittee is located that govern non-stormwater discharges.

b. No later than one year from the date of permit coverage, develop and adopt appropriate policies prohibiting illicit discharges, and identify possible enforcement mechanisms for those policies. No later than eighteen months from the date of permit coverage, develop and implement an enforcement plan using these mechanisms to ensure compliance with illicit discharge policies. These policies shall address, at a minimum: illicit connections and non-stormwater discharges, including spills of hazardous materials and improper disposal of pet waste and litter.

   i. Non-stormwater discharges covered by another NPDES permit and discharges from emergency fire fighting activities are allowed in the MS4 in accordance with S2 *Authorized Discharges*.

   ii. The policies do not need to prohibit the following categories of non-stormwater discharges:

      - Diverted stream flows
      - Rising ground waters
      - Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20))
      - Uncontaminated pumped ground water
      - Foundation drains
      - Air conditioning condensation
      - Irrigation water from agricultural sources that is commingled with urban stormwater
      - Springs
      - Water from crawl space pumps
      - Footing drains
      - Flows from riparian habitats and wetlands

   iii. The policies shall prohibit the following categories of non-stormwater discharges unless the stated conditions are met:

      - Discharges from potable water sources, including water line flushing, hyperchlorinated water line flushing, fire hydrant system flushing, and pipeline hydrostatic test water. Planned discharges shall be de-chlorinated to a concentration of 0.1 ppm or less, pH-adjusted if necessary, and volumetrically and velocity controlled to prevent resuspension of sediments in the MS4.

      - Discharges from lawn watering and other irrigation runoff. These discharges shall be minimized through, at a minimum, public education activities and water conservation efforts conducted by the Secondary Permittee and/or the local jurisdiction.

- Dechlorinated swimming pool discharges. The discharges shall be dechlorinated to a concentration of 0.1 ppm or less, pH-adjusted and reoxygenated if necessary, and volumetrically and velocity controlled to prevent resuspension of sediments in the MS4. Swimming pool cleaning wastewater and filter backwash shall not be discharged to the MS4.
- Street and sidewalk wash water, water used to control dust, and routine external building wash down that does not use detergents. The Secondary Permittee shall reduce these discharges through, at a minimum, public education activities and/or water conservation efforts conducted by the Secondary Permittee and/or the local jurisdiction. To avoid washing pollutants into the MS4, the Secondary Permittee shall minimize the amount of street wash and dust control water used. At active construction sites, street sweeping shall be performed prior to washing the street.
- Other non-stormwater discharges shall be in compliance with the requirements of a stormwater pollution prevention plan reviewed by the Permittee which addresses control of such discharges.

iv. The Secondary Permittee's SWMP shall, at a minimum, address each category in iii above in accordance with the conditions stated therein.

v. The SWMP shall further address any category of discharges in ii or iii above if the discharge is identified as a significant source of pollutants to waters of the State.

c. No later than 180 days before the expiration date of this Permit, or as established as a condition of coverage by Ecology, develop a storm sewer system map showing the locations of all known storm drain outfalls, labeled receiving waters and delineated areas contributing runoff to each outfall. Make the map (or completed portions of the map) available on request to the Department and/or to other Permittees or Secondary Permittees. The preferred, but not required, format of submission will be an electronic format with fully described mapping standards. An example description is provided on Ecology WebPages.

d. Conduct field inspections and visually inspect for illicit discharges at all known outfalls that discharge to surface waters. Visually inspect at least one third (on average) of all known outfalls each year beginning no later than two years from the date of permit coverage. Develop and implement procedures to identify and remove any illicit discharges. Keep records of inspections and follow-up activities.

e. No later than 180 days before the expiration date of this Permit, or as established as a condition of coverage by the Ecology, develop and implement a spill response plan that includes coordination with a qualified spill responder.

f. No later than two years from permit coverage date, provide staff training or coordinate with existing training efforts to educate relevant staff on proper best

management practices for preventing illicit discharges, including spills. All relevant staff shall be trained.

4. Construction Site Stormwater Runoff Control

   From the date of permit coverage, each Secondary Permittee shall:

   a. Comply with all relevant ordinances, rules, and regulations of the local jurisdiction(s) in which the Secondary Permittee is located that govern construction phase stormwater pollution prevention measures.

   b. For all construction projects under the control of the Secondary Permittee which, require a construction stormwater permit, Secondary Permittees shall obtain coverage under the NPDES General Permit for Stormwater Discharges Associated with Construction Activities or an alternative individual NPDES permit prior to discharging construction related stormwater.

   c. Coordinate with the local jurisdiction regarding projects owned and operated by other entities which discharge into the Secondary Permittee's MS4, to assist the local jurisdiction with achieving compliance with all relevant ordinances, rules, and regulations of the local jurisdiction(s).

   d. Provide training or coordinate with existing training efforts to educate relevant staff in erosion and sediment control BMPs and requirements, or hire trained contractors to perform the work.

   e. Coordinate as requested with the Department or the local jurisdiction to provide access for inspection of construction sites or other land disturbances, which are under the control of the Secondary Permittee during the active grading and/or construction period.

5. Post-Construction Stormwater Management for New Development and Redevelopment

   From the date of permit coverage, each Secondary Permittee shall:

   a. Comply with all relevant ordinances, rules and regulations of the local jurisdiction(s) in which the Secondary Permittee is located that govern post-construction stormwater pollution prevention measures.

   b. Coordinate with the local jurisdiction regarding projects owned and operated by other entities which discharge into the Secondary Permittee's MS4, to assist the local jurisdiction with achieving compliance with all relevant ordinances, rules, and regulations of the local jurisdiction(s).

6. Pollution Prevention and Good Housekeeping for Municipal Operations

   Each Secondary Permittee shall:

   a. No later than three years from the date of permit coverage, develop and implement a municipal operation and maintenance (O&M) plan to minimize stormwater pollution from activities conducted by the Secondary Permittee. The O&M Plan shall include appropriate pollution prevention and good

housekeeping procedures for all of the following operations, activities, and/or types of facilities that are present within the Secondary Permittee's boundaries.

i. Stormwater collection and conveyance system, including catch basins, stormwater sewer pipes, open channels, culverts, structural stormwater controls, and structural runoff treatment and/or flow control facilities. The O&M Plan shall address, but is not limited to: scheduled inspections and maintenance activities, including cleaning and proper disposal of waste removed from the system. Secondary Permittees shall properly maintain stormwater collection and conveyance systems owned or operated by the Secondary Permittee and regularly inspect and maintain all structural post-construction stormwater BMPs to ensure facility function.

   For facilities located in Western Washington, Secondary Permittees shall establish maintenance standards that are as protective or more protective of facility function than those specified in Chapter 4 Volume V of the 2005 Stormwater Management Manual for Western Washington,

   For facilities located in Eastern Washington, Secondary Permittees shall establish maintenance standards that are as protective or more protective of facility function than those specified in Chapters 5, 6 and 8 of the Stormwater Management Manual for Eastern Washington (2004),

   Secondary Permittees shall conduct spot checks of stormwater treatment and flow control facilities following a 24 hour storm event with a 10-year or greater recurrence interval.

ii. Roads, highways, and parking lots. The O&M Plan shall address, but is not limited to: deicing, anti-icing, and snow removal practices; snow disposal areas; material (e.g. salt, sand, or other chemical) storage areas; all-season BMPs to reduce road and parking lot debris and other pollutants from entering the MS4.

iii. Vehicle fleets. The O&M Plan shall address, but is not limited to: storage, washing, and maintenance of Secondary Permittee vehicle fleets; and fueling facilities. Secondary Permittees shall conduct all vehicle and equipment washing and maintenance in a self-contained covered building or in designated wash and/or maintenance areas.

iv. External building maintenance. The O&M Plan shall address, building exterior cleaning and maintenance including cleaning, washing, painting and other maintenance activities.

v. Parks and open space. The O&M Plan shall address, but is not limited to: proper application of fertilizer, pesticides, and herbicides; sediment and erosion control; BMPs for landscape maintenance and vegetation disposal; and trash management.

vi. Material storage areas, heavy equipment storage areas, and maintenance areas. Secondary Permittees shall develop and implement a Stormwater Pollution Prevention Plan to protect water quality at each of these facilities

owned or operated by the Secondary Permittee and not covered under the General NPDES Permit for Stormwater Discharges Associated with Industrial Activities or under another NPDES permit that covers stormwater discharges associated with the activity.

vii. Other facilities that would reasonably be expected to discharge contaminated runoff. The O&M Plan shall address proper stormwater pollution prevention practices for each facility.

b. From the date of coverage under this Permit, Secondary Permittees shall also have permit coverage for all facilities operated by the Secondary Permittee that are required to be covered under the General NPDES Permit for Stormwater Discharges Associated with Industrial Activities.

c. The O&M Plan shall include sufficient documentation and records as necessary to demonstrate compliance with the O&M Plan requirements in S6.D.6.a.i through vii above.

d. Train all employees whose construction, operations, or maintenance job functions may impact stormwater quality. The training shall address:

i. The importance of protecting water quality,

ii. The requirements of this Permit,

iii. Operation and maintenance requirements,

iv. Inspection procedures,

v. Ways to perform their job activities to prevent or minimize impacts to water quality, and

vi. Procedures for reporting water quality concerns, including potential illicit discharges.

S7. COMPLIANCE WITH TOTAL MAXIMUM DAILY LOAD REQUIREMENTS

The following requirements apply if an applicable Total Maximum Daily Load (TMDL) is approved for stormwater discharges from MS4s owned or operated by the Permittee. Applicable TMDLs are TMDLs which have been approved by EPA on or before the date permit coverage is granted.

A. For applicable TMDLs listed in Appendix 2, affected permittees shall comply with the specific requirements identified in Appendix 2. Each Permittee shall keep records of all actions required by this Permit that are relevant to applicable TMDLs within their jurisdiction. The status of the TMDL implementation shall be included as part of the annual report submitted to Ecology.

Where monitoring is required in Appendix 2, the Permittee shall conduct the monitoring according to a Quality Assurance Project Plan (QAPP) approved by Ecology.

B. For applicable TMDLs not listed in Appendix 2, compliance with this Permit shall constitute compliance with those TMDLs.

C. For TMDLs that are approved by EPA after this Permit is issued, Ecology may establish TMDL related permit requirements through future permit modification if Ecology determines implementation of actions, monitoring or reporting necessary to demonstrate reasonable further progress toward achieving TMDL waste load allocations, and other targets, are not occurring and shall be implemented during the term of this Permit or when this Permit is reissued. Permittees are encouraged to participate in development of TMDLs within their jurisdiction and to begin implementation.

S8. MONITORING

A. Permittees are not required to conduct water sampling or other testing during the effective term of this Permit, with the following exceptions:

1. Any water quality monitoring required for compliance with TMDLs, pursuant to section S7 *Compliance with Total Maximum Daily Load Requirements* and Appendix 2 of this Permit, and
2. Any sampling or testing required for characterizing illicit discharges pursuant to section S5.C.3. or S6.D.3. of this Permit.

B. The Permittee shall provide the following information in each annual report:

1. A description of any stormwater monitoring or studies conducted by the Permittee during the reporting period. If stormwater monitoring was conducted on behalf of the Permittee, or if studies or investigations conducted by other entities were reported to the Permittee, a brief description of the type of information gathered or received shall be included in the annual report(s) covering the time period(s) the information was received.
2. An assessment of the appropriateness of the BMPs identified by the Permittee for each component of the SWMP; and any changes made, or anticipated to be made, to the BMPs that were previously selected to implement the SWMP, and why.
3. Information required pursuant to S8.C.2. below.

C. Preparation for future, long-term monitoring

This section does not apply to secondary permittees. However, secondary permittees are required to provide information, maps and access for sampling efforts, as necessary. Secondary permittees are encouraged to participate in the monitoring program.

1. All cities, towns and counties shall prepare to participate in the implementation of a comprehensive long-term monitoring program. The monitoring program will include two components: stormwater monitoring and targeted Stormwater Management Program (SWMP) effectiveness monitoring. Stormwater monitoring is intended to characterize stormwater runoff quantity and quality at a limited number of locations in a manner that allows analysis of loadings and changes in conditions over time and generalization across the permittees' jurisdictions. Stormwater program effectiveness monitoring is intended to improve stormwater management efforts by evaluating issues that significantly affect the success of, or confidence in, stormwater controls. The monitoring program can include long-term monitoring

and short-term studies. The results of the monitoring program will be used to support the adaptive management process and lead to refinements of the SWMP.

a. Stormwater monitoring

Cities having a population greater than 10,000 and counties having a population greater than 25,000 shall identify sites for long-term stormwater monitoring. Adequate sites will be those completely mapped as required in S5.C.3.a. and be suitable for permanent installation and operation of flow-weighted composite sampling equipment. No later than December 31, 2010:

i. Each county having a population greater than 100,000 shall identify three outfalls or conveyances where stormwater sampling could be conducted. One outfall or conveyance shall represent commercial land use, the second shall represent low-density residential land use and the third will represent medium-to-high density residential land use.

ii. Each city having a population greater than 75,000 shall identify three outfalls or conveyances where stormwater sampling could be conducted. One outfall or conveyance shall represent commercial land use, the second shall represent high-density residential land use and the third will represent industrial land use.

iii. Each county having a population between 25,000 and 100,000 shall identify two outfalls or conveyances where stormwater sampling could be conducted. One outfall shall represent commercial land use and the second one will represent low-density residential land use.

iv. Each city having a population between 10,000 and 75,000 shall identify two outfalls or conveyances where stormwater sampling could be conducted. One outfall shall represent commercial land use and the second will represent high-density residential land use.

v. Permittees shall select outfalls or conveyances based on known water quality problems and/or targeted areas of interest for future monitoring. The Permittee shall document:

- Why sites were selected;
- Possible site constraints for installation of and access to monitoring equipment;
- A brief description of the contributing drainage basin including size in acreage, dominant land use, and other contributing land uses;
- Any water quality concerns in the receiving water of each selected outfall or conveyance.

b. SWMP effectiveness monitoring

i. Each city, town and county shall prepare to conduct monitoring to determine the effectiveness of the Permittee's SWMP at controlling stormwater-related problems that are directly addressed by actions in the SWMP. This

component of the monitoring program shall be designed to answer the following types of questions:

- How effective is a targeted action or narrow suite of actions?
- Is the SWMP achieving a targeted environmental outcome?

ii. No later than December 31, 2010, each city, town and county shall identify at least two suitable questions and select sites where monitoring will be conducted. This monitoring shall include, at a minimum, plans for stormwater, sediment or receiving water monitoring of physical, chemical and/or biological characteristics. This monitoring may also include data collection and analysis of other measures of program effectiveness, problem identification and characterizing discharges for planning purposes.

iii. For each question, the Permittee shall develop a monitoring plan containing the following elements:

- A statement of the question, an explanation of how and why the issue is significant to the Permittee, and a discussion of whether and how the results of the monitoring may be significant to other MS4s.
- A specific hypothesis about the issue or management actions that will be tested.
- Specific parameters or attributes to be measured.
- Expected modifications to management actions depending on the outcome of hypothesis testing.

2. Monitoring program reporting requirements

a. The fourth annual report shall:

i. Describe the status of identification of sites for stormwater monitoring, if required for the Permittee.

ii. Include a summary of proposed questions for the SWMP effectiveness monitoring and describe the status of developing the monitoring plan, including the proposed purpose, design, and methods.

b. To comply with the requirements of all or part(s) of this section, permittees in a single Urbanized Area or WRIA may choose to submit a collaborative report or reports in lieu of separate reports.

S9. REPORTING REQUIREMENTS

A. No later than March 31 of each year beginning in 2008, each Permittee shall submit an annual report. The reporting period for the first annual report will be from the effective date of this permit through December 31, 2007. The reporting period for all subsequent annual reports will be the previous calendar year.

B. Two printed copies and an electronic (PDF) copy of each document shall be submitted to Ecology. All submittals shall be delivered to:

Department of Ecology
Water Quality Program
Municipal Stormwater Permits
P.O. Box 47696
Olympia, WA 98504-7696

C. Each Permittee is required to keep all records related to this permit and the SWMP for at least five years. Except for the requirements of the annual reports described in this permit, records shall be submitted to Ecology only upon request,

D. Each Permittee shall make all records related to this permit and the Permittee's SWMP available to the public at reasonable times during business hours. The Permittee will provide a copy of the most recent annual report to any individual or entity, upon request.

1. A reasonable charge may be assessed by the Permittee for making photocopies of records.
2. The Permittee may require reasonable advance notice of intent to review records related to this Permit.

E. The annual report for cities, towns, and counties

Each annual report shall include the following:

1. A copy of the Permittee's current Stormwater Management Program as required by S5.A.2.
2. Submittal of Appendix 3 – *Annual Report Form for Cities, Towns, and Counties,* which is intended to summarize the Permittees compliance with the conditions of this permit, including:
   a. Status of implementation of each component of the SWMP in section S5 *Stormwater Management Program for Cities, Towns and Counties.*
   b. An assessment of the Permittee's progress in meeting the minimum performance standards established for each of the minimum control measures of the SWMP.
   c. A description of activities being implemented to comply with each component of the SWMP, including the number and type of inspections, enforcement actions, public education and involvement activities, and illicit discharges detected and eliminated.
   d. The Permittee's SWMP implementation schedule and plans for meeting permit deadlines, and the status of SWMP implementation to date. If permit deadlines are not met, or may not be met in the future, include: reasons why, corrective steps taken and proposed, and expected dates that the deadlines will be met.
   e. A summary of the Permittee's evaluation of their SWMP, according to sections S5.A.4. and S8.B.2.
   f. If applicable, notice that the MS4 is relying on another governmental entity to satisfy any of the obligations under this permit.

g. Updated information from the prior annual report plus any new information received during the reporting period, pursuant to S8.B.2. above.

h. Certification and signature pursuant to G19.D, and notification of any changes to authorization pursuant to G19.C.

3. Permittees shall include with the annual report, notification of any annexations, incorporations or jurisdictional boundary changes resulting in an increase or decrease in the Permittee's geographic area of permit coverage during the reporting period, and implications for the SWMP.

4. Permittees shall include with the annual report submitted no later than March 31, 2011 information that at a minimum includes:

   a. A summary of identified barriers to the use of low impact development (LID) within the area covered by the permit and measures to address the barriers. Each individual Permittee must complete this summary.

   b. A report completed by an individual Permittee or in cooperation with multiple Permittees describing, at a minimum:

      i. LID practices that are currently available and that can reasonably be implemented within this permit term.

      ii. Potential or planned non-structural actions and LID techniques to prevent stormwater impacts.

      iii. Goals and metrics to identify, promote, and measure LID use.

      iv. Potential or planned schedules for the Permittee(s) to require and implement the non-structural and LID techniques on a broader scale in the future.

F. Annual report for Secondary Permittees

All Secondary Permittees shall complete the *Annual Report Form for Secondary Permittees* (Appendix 4) and submit it along with any supporting documentation to Ecology.

1. The *Annual Report Form for Secondary Permittees* is intended to summarize the Permittees compliance with the conditions of this permit, including:

   a. Status of implementation of each component of the SWMP in section S6 *Stormwater Management Program for Secondary Permittees* of this permit.

   b. An assessment of the Permittee's progress in meeting the minimum performance standards established for each of the minimum control measures of the SWMP.

   c. A summary of the Permittee's evaluation of their SWMP, according to section S8.B.2.

   d. If applicable, notice that the MS4 is relying on another governmental entity to satisfy any of the obligations under this permit.

e. Updated information from the prior annual report plus any new information received during the reporting period pursuant to S8.B.1 and S8.B.2.

f. Certification and signature pursuant to G19.D, and notification of any changes to authorization pursuant to G19.C.

2. Secondary Permittees shall include with the annual report a notification of any jurisdictional boundary changes resulting in an increase or decrease in the Permittee's geographic area of permit coverage during the reporting period, and implications for the SWMP.

GENERAL CONDITIONS

G1. DISCHARGE VIOLATIONS

All discharges and activities authorized by this Permit shall be consistent with the terms and conditions of this Permit.

G2. PROPER OPERATION AND MAINTENANCE

The Permittee shall at all times properly operate and maintain all facilities and systems of collection, treatment, and control (and related appurtenances) which are installed or used by the Permittee for pollution control to achieve compliance with the terms and conditions of this Permit.

G3. NOTIFICATION OF DISCHARGE, INCLUDING SPILLS

If a Permittee has knowledge of a discharge, including spills, into or from a municipal storm sewer which could constitute a threat to human health, welfare, or the environment, the Permittee shall

A. Take appropriate action to correct or minimize the threat to human health, welfare and/or the environment, and,

B. Notify the Ecology regional office and other appropriate spill response authorities immediately but in no case later than within 24 hours of obtaining that knowledge. The Ecology Northwest Regional Office 24-hour number is 425-649-7000 and for the Southwest Regional Office the number is 360-407-6300.

C. Immediately report discharges, including spills, which might cause bacterial contamination of shellfish, such as might result from broken sewer lines and failing onsite septic systems, to the Ecology regional office and to the Department of Health, Shellfish Program. The Department of Health's shellfish 24-hour number is 360-236-3330.

D. Immediately report spills or discharges of oils or hazardous materials to the Ecology regional office and to the Washington Emergency Management Division at 1-800-258-5990.

G4. BYPASS PROHIBITED

The intentional bypass of stormwater from all or any portion of a stormwater treatment BMP whenever the design capacity of the treatment BMP is not exceeded, is prohibited unless the following conditions are met:

A. Bypass is: (1) unavoidable to prevent loss of life, personal injury, or severe property damage; or (2) necessary to perform construction or maintenance-related activities essential to meet the requirements of the Clean Water Act (CWA); and

B. There are no feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated stormwater, or maintenance during normal dry periods.

"Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

G5. RIGHT OF ENTRY

The permittee shall allow an authorized representative of Ecology, upon the presentation of credentials and such other documents as may be required by law at reasonable times:

A. To enter upon the Permittee's premises where a discharge is located or where any records must be kept under the terms and conditions of this Permit;

B. To have access to, and copy at reasonable cost and at reasonable times, any records that must be kept under the terms of the Permit;

C. To inspect at reasonable times any monitoring equipment or method of monitoring required in the Permit;

D. To inspect at reasonable times any collection, treatment, pollution management, or discharge facilities; and

E. To sample at reasonable times any discharge of pollutants.

G6. DUTY TO MITIGATE

The Permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this Permit which has a reasonable likelihood of adversely affecting human health or the environment.

G7. PROPERTY RIGHTS

This permit does not convey any property rights of any sort, or any exclusive privilege.

G8. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in the Permit shall be construed as excusing the Permittee from compliance with any other applicable federal, state, or local statutes, ordinances, or regulations.

G9. MONITORING

A. Representative Sampling:

Samples and measurements taken to meet the requirements of this Permit shall be representative of the volume and nature of the monitored discharge, including representative sampling of any unusual discharge or discharge condition, including bypasses, upsets, and maintenance-related conditions affecting effluent quality.

B. Records Retention:

The Permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original recordings for continuous monitoring

instrumentation, copies of all reports required by this Permit, and records of all data used to complete the application for this permit, for a period of at least five years. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the permittee or when requested by the Ecology. On request, monitoring data and analysis shall be provided to Ecology.

C. Recording of Results:

For each measurement or sample taken, the Permittee shall record the following information: (1) the date, exact place and time of sampling; (2) the individual who performed the sampling or measurement; (3) the dates the analyses were performed; (4) who performed the analyses; (5) the analytical techniques or methods used; and (6) the results of all analyses.

D. Test Procedures:

All sampling and analytical methods used to meet the monitoring requirements in this permit shall conform to the Guidelines Establishing Test Procedures for the Analysis of Pollutants contained in 40 CFR Part 136, unless otherwise specified in this permit or approved in writing by Ecology.

E. Flow Measurement:

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated, and maintained to ensure that the accuracy of the measurements are consistent with the accepted industry standard for that type of device. Frequency of calibration shall be in conformance with manufacturer's recommendations or at a minimum frequency of at least one calibration per year. Calibration records should be maintained for a minimum of three years.

F. Lab Accreditation:

All monitoring data, except for flow, temperature, conductivity, pH, total residual chlorine, and other exceptions approved by Ecology, shall be prepared by a laboratory registered or accredited under the provisions of, Accreditation of Environmental Laboratories, Chapter 173-50 WAC. Soils and hazardous waste data are exempted from this requirement pending accreditation of laboratories for analysis of these media by Ecology.

G. Additional Monitoring:

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G10. REMOVED SUBSTANCES

With the exception of decant from street waste vehicles, the Permittee shall not allow collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of stormwater to be resuspended or reintroduced to the storm sewer system or to waters of the state. Decant from street waste vehicles resulting

from cleaning stormwater facilities may be reintroduced only when other practical means are not available and only in accordance with the Street Waste Disposal Guidelines in Appendix 4.

G11. SEVERABILITY

The provisions of this Permit are severable, and if any provision of this Permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this Permit shall not be affected thereby.

G12. REVOCATION OF COVERAGE

The director may terminate coverage under this General Permit in accordance with Chapter 43.21B RCW and Chapter 173-226 WAC. Cases where coverage may be terminated include, but are not limited to the following:

A. Violation of any term or condition of this general permit;

B. Obtaining coverage under this general permit by misrepresentation or failure to disclose fully all relevant facts;

C. A change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge;

D. A determination that the permitted activity endangers human health or the environment, or contributes significantly to water quality standards violations;

E. Failure or refusal of the permittee to allow entry as required in Chapter 90.48.090 RCW;

F. Nonpayment of permit fees assessed pursuant to Chapter 90.48.465 RCW;

Revocation of coverage under this general permit may be initiated by Ecology or requested by any interested person.

G13. TRANSFER OF COVERAGE

The director may require any discharger authorized by this General Permit to apply for and obtain an individual permit in accordance with Chapter 43.21B RCW and Chapter 173-226 WAC.

G14. GENERAL PERMIT MODIFICATION AND REVOCATION

This General Permit may be modified, revoked and reissued, or terminated in accordance with the provisions of WAC 173-226-230. Grounds for modification, revocation and reissuance, or termination include, but are not limited to the following:

A. A change occurs in the technology or practices for control or abatement of pollutants applicable to the category of dischargers covered under this General Permit;

B. Effluent limitation guidelines or standards are promulgated pursuant to the CWA or Chapter 90.48 RCW, for the category of dischargers covered under this General Permit;

C. A water quality management plan containing requirements applicable to the category of dischargers covered under this General Permit is approved; or

D. Information is obtained which indicates that cumulative effects on the environment from dischargers covered under this General Permit are unacceptable.

E. Changes in state law that reference this permit.

G15. REPORTING A CAUSE FOR MODIFICATION OR REVOCATION

A Permittee who knows or has reason to believe that any activity has occurred or will occur which would constitute cause for modification or revocation and reissuance under Condition G12, G14, or 40 CFR 122.62 must report such plans, or such information, to Ecology so that a decision can be made on whether action to modify, or revoke and reissue this Permit will be required. Ecology may then require submission of a new or amended application. Submission of such application does not relieve the Permittee of the duty to comply with this Permit until it is modified or reissued.

G16. APPEALS

A. The terms and conditions of this General Permit, as they apply to the appropriate class of dischargers, are subject to appeal within thirty days of issuance of this General Permit, in accordance with Chapter 43.21B RCW, and Chapter 173-226 WAC.

B. The terms and conditions of this General Permit, as they apply to an individual discharger, are appealable in accordance with chapter 43.21B RCW within thirty days of the effective date of coverage of that discharger. Consideration of an appeal of General Permit coverage of an individual discharger is limited to the General Permit's applicability or nonapplicability to that individual discharger.

C. The appeal of General Permit coverage of an individual discharger does not affect any other dischargers covered under this General Permit. If the terms and conditions of this General Permit are found to be inapplicable to any individual discharger(s), the matter shall be remanded to Ecology for consideration of issuance of an individual permit or permits.

D. Modifications of this Permit are appealable in accordance with Chapter 43.21B RCW and Chapter 173-226 WAC.

G17. PENALTIES

40 CFR 122.41(a)(2) and (3), 40 CFR 122.41(j)(5), and 40 CFR 122.41(k)(2) are hereby incorporated into this Permit by reference.

G18. DUTY TO REAPPLY

The Permittee must apply for permit renewal at least 180 days prior to the specified expiration date of this permit.

G19. CERTIFICATION AND SIGNATURE

All applications, reports, or information submitted to the Department shall be signed and certified.

A. All permit applications shall be signed by either a principal executive officer or ranking elected official.

B. All reports required by this Permit and other information requested by the Department shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   1. The authorization is made in writing by a person described above and submitted to the Department, and

   2. The authorization specifies either an individual or a position having responsibility for the overall development and implementation of the stormwater management program. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

C. Changes to authorization. If an authorization under condition G19.B.2 is no longer accurate because a different individual or position has responsibility for the overall development and implementation of the stormwater management program, a new authorization satisfying the requirements of condition G19.B.2 must be submitted to the Department prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this Permit shall make the following certification:

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that Qualified Personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violations."

G20. NON-COMPLIANCE NOTIFICATION

In the event it is unable to comply with any of the terms and conditions of this permit, the Permittee must:

A. Notify Ecology of the failure to comply with the permit terms and conditions in writing within 30 days of becoming aware that the non-compliance has occurred. The written notification must include all of the following:

   1. A description of the non-compliance, including dates.
   2. Beginning and end dates of the non-compliance, and if the compliance has not been corrected, the anticipated date of correction.
   3. Steps taken or planned to reduce, eliminate, or prevent reoccurrence of the non-compliance.

B. Take appropriate action to stop or correct the condition of non-compliance.

G21. UPSETS

Permittees must meet the conditions of 40 CFR 122.41(n) regarding "Upsets." The conditions are as follows:

A. Definition. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

B. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (C) of this condition are met. Any determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, will not constitute final administrative action subject to judicial review.

C. Conditions necessary for demonstration of upset. A permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed contemporaneous operating logs, or other relevant evidence that:

   1. An upset occurred and that the Permittee can identify the cause(s) of the upset;
   2. The permitted facility was at the time being properly operated; and
   3. The Permittee submitted notice of the upset as required in 40 CFR 122.41(l)(6)(ii)(B) (24-hour notice of noncompliance).
   4. The Permittee complied with any remedial measures required under 40 CFR 122.41(d) (Duty to Mitigate).

D. Burden of proof. In any enforcement proceeding, the Permittee seeking to establish the occurrence of an upset has the burden of proof.

DEFINITIONS AND ACRONYMS

AKART means all known, available, and reasonable methods of prevention, control and treatment.

All known, available and reasonable methods of prevention, control and treatment refers to the State Water Pollution Control Act, Chapter 90.48.010 and 90.48.520 RCW.

Applicable TMDL means a TMDL which has been approved by EPA on or before the issuance date of this Permit, or prior to the date that the Permittee's application is received by Ecology, or prior to a modification of this Permit, whichever is later.

Beneficial Uses means uses of waters of the states which include but are not limited to use for domestic, stock watering, industrial, commercial, agricultural, irrigation, mining, fish and wildlife maintenance and enhancement, recreation, generation of electric power and preservation of environmental and aesthetic values, and all other uses compatible with the enjoyment of the public waters of the state.

Best Management Practices ("BMPs") are the schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices approved by the Department that, when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of Washington State.

BMP means Best Management Practice.

Bypass means the diversion of stormwater from any portion of a stormwater treatment facility.

Common plan of development or sale means a site where multiple separate and distinct construction activities may be taking place at different times on different schedules, but still under a single plan. Examples include: phased projects and projects with multiple filings or lots, even if the separate phases or filings/lots will be constructed under separate contract or by separate owners (e.g. a development where lots are sold to separate builders); a development plan that may be phased over multiple years, but is still under a consistent plan for long-term development; and projects in a contiguous area that may be unrelated but still under the same contract, such as construction of a building extension and a new parking lot at the same facility. If the project is part of a common plan of development or sale, the disturbed area of the entire plan shall be used in determining permit requirements.

Component or **Program Component** means an element of the Stormwater Management Program listed in S5 Stormwater Management Program for Cities, Towns, and Counties or S6 Stormwater Management Program for Secondary Permittees of this permit.

Co-permittee means an operator of a regulated small MS4 which is applying jointly with another applicant for coverage under this permit. A co-permittee is an owner or operator of a regulated small MS4 located within or adjacent to another regulated MS4. A co-permittee is only responsible for complying with the conditions of this permit relating to discharges from the MS4 the co-permittee owns or operates. See also 40 CFR 122.26(b)(1)

CWA means Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub.L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. (6-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq.

Detailed Implementation Plan means the formal implementation plan for a Total Maximum Daily Load (TMDL) or water quality clean-up plan.

DIP means Detailed Implementation Plan.

Director means the Director of the Washington State Department of Ecology, or an authorized representative.

Discharge for the purpose of this permit means, unless indicated otherwise, any discharge from a MS4 owned or operated by the permittee.

Entity means another governmental body, or public or private organization, such as another permittee, a conservation district, or volunteer organization.

40 CFR means Title 40 of the Code of Federal Regulations, which is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the federal government.

General Permit means a permit which covers multiple dischargers of a point source category within a designated geographical area, in lieu of individual permits being issued to each discharger.

Ground water means water in a saturated zone or stratum beneath the surface of the land or below a surface water body.

Heavy equipment maintenance or storage yard means an uncovered area where any heavy equipment, such as mowing equipment, excavators, dump trucks, backhoes, or bulldozers are washed or maintained, or where at least five pieces of heavy equipment are stored.

Hydraulically Near means runoff from the site discharges to the sensitive feature without significant natural attenuation of flows that allows for suspended solids removal. See Appendix 7 Determining Construction Site Sediment Damage Potential for a more detailed definition.

Hyperchlorinated means water that contains more than 10 mg/Liter chlorine. Disinfection of water mains and appurtenances requires a chlorine residual of 10 mg/L at the end of the disinfection period. This level is well above the Maximum Residual Disinfectant Level of an annual average of 4 mg/Liter chlorine for potable water.

Illicit connection means any man-made conveyance that is connected to a municipal separate storm sewer without a permit, excluding roof drains and other similar type connections. Examples include sanitary sewer connections, floor drains, channels, pipelines, conduits, inlets, or outlets that are connected directly to the municipal separate storm sewer system.

Illicit discharge means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities.

Large Municipal Separate Storm Sewer System means all municipal separate storm sewer systems located in an incorporated place with a population of 250,000 or more, a county with unincorporated urbanized areas with a population of 250,000 or more according to the 1990 decennial census by the Bureau of Census.

Low Density Residential Land Use means, for the purpose of permit section S8 Monitoring, one unit per 1-5 acres.

Low Impact Development (LID) means a stormwater management and land development strategy applied at the parcel and subdivision scale that emphasizes conservation and use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely mimic pre-development hydrologic functions.

Major Municipal Separate Storm Sewer Outfall means a municipal separate storm sewer outfall from a single pipe with an inside diameter of 36 inches or more, or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive stormwater from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of 12 acres or more).

Material Storage Facilities means an uncovered area where bulk materials (liquid, solid, granular, etc.) are stored in piles, barrels, tanks, bins, crates, or other means.

Maximum Extent Practicable (MEP) refers to paragraph 402(p)(3)(B)(iii) of the federal Clean Water Act which reads as follows: Permits for discharges from municipal storm sewers shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques, and system, design, and engineering methods, and other such provisions as the Administrator or the State determines appropriate for the control of such pollutants.

Medium Municipal Separate Storm Sewer System means municipal separate storm sewer systems located in an incorporated place with a population of more than 100,000 but less than 250,000, or a county with unincorporated urbanized areas of more than 100,000 but less than 250,000 according to the 1990 decennial census by the Bureau of Census.

MEP means Maximum Extent Practicable.

MTRs means Minimum Technical Requirements.

Municipal Separate Storm Sewer System (MS4) means a conveyance, or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains):

(i) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State Law) having jurisdiction over disposal of wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States.

(ii) designed or used for collecting or conveying stormwater.

(iii) which is not a combined sewer; and (iv) which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

National Pollutant Discharge Elimination System (NPDES) means the national program for issuing, modifying, revoking, and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Federal Clean Water Act, for the discharge of pollutants to surface waters of the state from point sources. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington Department of Ecology.

Notice of Intent (NOI) means the application for, or a request for coverage under this General Permit pursuant to WAC 173-226-200.

Notice of Intent for Construction Activity and **Notice of Intent for Industrial Activity** mean the application forms for coverage under the *Baseline General Permit for Stormwater Discharges Associated with Industrial Activities.*

Outfall means point source as defined by 40 CFR 122.2 at the point where a municipal separate storm sewer discharges to waters of the State and does not include open conveyances connecting two municipal separate storm sewer systems, or pipes, tunnels, or other conveyances which connect segments of the same stream or other waters of the State and are used to convey waters of the State.

Permittee unless otherwise noted, the term "Permittee" includes Permittee, Co-Permittee, and Secondary Permittee, as defined below:

(i) A "Permittee" is a city, town, or county owning or operating a regulated small MS4 applying and receiving a permit as a single entity.

(ii) A "Co-Permittee" is any operator of a regulated small MS4 that is applying jointly with another applicant for coverage under this Permit. Co-Permittees own or operate a regulated small MS4 located within or adjacent to another regulated small MS4.

(iii) A "Secondary Permittee" is an operator of regulated small MS4 that is not a city, town or county.

Physically Interconnected means that one MS4 is connected to a second MS4 in such a way that it allows for direct discharges to the second system. For example, the roads with drainage systems and municipal streets of one entity are physically connected directly to a MS4 belonging to another entity.

Pollutant Generating Impervious Surfaces (PGIS) are surfaces considered to be significant sources of pollutants in stormwater runoff. Such surfaces include those that are subject to vehicular use, industrial activities, or storage of erodible or leachable materials that receive direct rainfall or run-on or blow-in of rainfall. Metal roofs are considered to be PGIS unless coated with an inert, non-leachable material. Roofs that are subject to venting of indoor pollutants from manufacturing, commercial or other operations or processes are also considered PGIS. A surface, whether paved or not, shall be considered PGIS if it is regularly used by motor vehicles. The following are considered regularly-used surfaces: roads, unvegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unfenced fire lanes, vehicular equipment storage yards, and airport runways.

Process Wastewater means any water which, during manufacture or processing, comes into direct contact with or results form the production or use of any raw material, intermediate product, finished product, by product, or waste product.

Qualified Personnel or Consultant means someone who has had professional training in the aspects of stormwater management for which they are responsible and are under the functional control of the Permittee.

RCW means the Revised Code of Washington State.

Regulated Small Municipal Separate Storm Sewer System (MS4) means a Municipal Separate Storm Sewer System which is automatically designated for inclusion in the Phase II stormwater permitting program by its location within an Urbanized Area, or by designation by the NPDES permitting authority and is not eligible for a waiver or exemption under S1.C.

Replaced impervious surfaces means, for structures, the removal and replacement of any exterior impervious surfaces or foundation; or, for other impervious surfaces, the removal down to bare soil, or base course, and replacement. Exemptions and partial exemptions are defined in Appendix 1 of this Permit.

Runoff is water that travels across the land surface and discharges to water bodies either directly or through a collection and conveyance system. See also "Stormwater."

Shared Waterbodies means waterbodies, including downstream segments, lakes and estuaries that receive discharges from more than one permittee.

Secondary Permittee is an operator of regulated small municipal separate storm sewer system which is not a city, town or county. Secondary Permittees include special purpose districts and other MS4s that meet the criteria for a regulated small MS4 in S1.B.

Significant contributor means a discharge contributes a loading of pollutants considered to be sufficient to cause or exacerbate the deterioration of receiving water quality or instream habitat conditions.

Sediment/Erosion-Sensitive Feature means an area subject to significant degradation due to the effect of construction runoff or areas requiring special protection to prevent erosion. See Appendix 6 Determining Construction Site Sediment Transport Potential for a more detailed definition.

Small Municipal Separate Storm Sewer System or **Small MS4** is a conveyance or system of conveyances including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels and/or storm drains which is:

a. Owned or operated by a city, town, county, district, association or other public body created pursuant to State law having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under State law such as a sewer districts, flood control districts or drainage districts, or similar entity.

b. Designed or used for collecting or conveying stormwater.

c. Not a combined sewer system,

d. Not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

e. Not defined as "large" or "medium" pursuant to 40 CFR 122.26(b)(4) & (7) or designated under 40 CFR 122.26 (a)(1)(v).

Small MS4s include systems similar to separate storm sewer systems in municipalities such as: universities, large publicly owned hospitals, prison complexes, highways and other thoroughfares. Storm sewer systems in very discrete areas such as individual buildings do not require coverage under this Permit.

Small MS4s do *not* include storm drain systems operated by non-governmental entities such as: individual buildings, private schools, private colleges, private universities, and industrial and commercial entities.

Stormwater means runoff during and following precipitation and snowmelt events, including surface runoff and drainage.

Stormwater Associated with Industrial and Construction Activity means the discharge from any conveyance which is used for collecting and conveying stormwater, which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant, or associated with clearing grading and/or excavation, and is required to have an NPDES permit in accordance with 40 CFR 122.26.

Stormwater Management Manual for Western Washington means the 5-volume technical manual (Publication Nos. 99-11 through 15 for the 2001 version and Publication Nos. 05-10-029-033 for the 2005 version (The 2005 version replaces the 2001 version) prepared by Ecology for use by local governments that contains BMPs to prevent, control, or treat pollution in storm water.

Stormwater Management Program (SWMP) means a set of actions and activities designed to reduce the discharge of pollutants from the regulated small MS4 to the maximum extent practicable and to protect water quality, and comprising the components listed in S5 or S6 of this Permit and any additional actions necessary to meet the requirements of applicable

Total Maximum Daily Load (TMDL) means a water cleanup plan. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the water body can be used for the purposes the state has designated. The calculation must also account for seasonable variation in water quality. Water quality standards are set by states, territories, and tribes. They identify the uses for each water body, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use. The Clean Water Act, section 303, establishes the water quality standards and TMDL programs.

Urbanized Area (UA) is a land area comprising one or more places and the adjacent densely settled surrounding area that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile. For the year 2000 Census, the U.S. Census Bureau classified "urban" as all territory, population, and housing units located within an Urbanized Area (UA) or an Urban Cluster (UC). It delineated UA and UC boundaries to encompass densely settled territory, which consists of: core census

block groups or blocks that have a population density of at least 1,000 people per square mile and surrounding census blocks that have an overall density of at least 500 people per square mile. In addition, under certain conditions, less densely settled territory may be part of each UA or UC. The U.S. Census Bureau announced the "Census 2000 Urbanized Areas" on May 1, 2002. More information can be found at the U.S. Census Bureau website.

Urban/higher density rural subbasins means any subbasin or portion thereof that is within or proposed to be within the urban growth area (UGA), or any rural area subbasin or portion thereof fifty percent or more of which is comprised of lots smaller than 5 acres in size.

Vehicle Maintenance or Storage Facility means an uncovered area where any vehicles are regularly washed or maintained, or where at least 10 vehicles are stored.

Waters of the State includes those waters as defined as "waters of the United States" in 40 CFR Subpart 122.2 within the geographic boundaries of Washington State and "waters of the state" as defined in Chapter 90.48 RCW which includes lakes, rivers, ponds, streams, inland waters, underground waters, salt waters and all other surface waters and water courses within the jurisdiction of the State of Washington.

Water Quality Standards means Surface Water Quality Standards, Chapter 173-201A WAC, Ground Water Quality Standards, Chapter 173-200 WAC, and Sediment Management Standards, Chapter 173-204 WAC.

Appendix F
Water Quality

Appendix F: Water Quality

F.1 Purpose

This Appendix provides an overview of the water quality program, the regulations and requirements that guide the program, and the current status of the waterways.

F.2 Background

In 1972 the Federal Water Pollution Control Act Amendment was enacted to address the growing public awareness and concern for controlling water pollution. It was amended in 1977, and became commonly known as the Clean Water Act (CWA). The CWA established the basic structure for regulating discharges of pollutants into the waters of the United States and gave the Environmental Protection Agency (EPA) the authority to implement pollution control programs. The CWA also set water quality standards for all contaminants in surface waters and made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. It also recognized the need for planning to address the critical problems posed by non-point source pollution. All states are required to be in compliance with the CWA.

In 1993, in response to the CWA, the City adopted Woodinville Municipal Code (WMC) Chapter 14.06 Water Quality Standards which adopts Chapter 9.12 of the King County Code, as modified by King County Ordinance No. 10636. This code prohibits the discharge of contaminants into surface water, stormwater, and ground water, and outlines preventive measures to restrict contaminants from entering such waters. In 2003, the City reinforced its commitment to protecting water quality by adopting City Ordinance 350, codified in WMC 1.07.030, by establishing discharge of contaminants into surface water, stormwater, or ground water as a civil violation.

Consistent with the adopted code, the City's water quality program aims to protect the health, safety and welfare of the residents and the integrity of the City's resources for the benefit of all by minimizing or eliminating water quality degradation; preserving and enhancing the suitability of waters for recreation, fishing, and other beneficial uses; and preserving and enhancing the aesthetic quality and biotic integrity of the water.

Any violations to the adopted water quality codes are enforced in accordance with the WMC. When a violation occurs, immediate corrective actions are required. Depending on the violation, monetary penalties may be levied.

As discussed in Chapter 2 – Regulatory Compliance, the City is also subject to the National Pollutant Discharge Elimination System (NPDES) program, which aims to protect water quality in accordance with the CWA.

F.3 Water Quality Pollution Sources

Point Sources

Point sources, as defined by the Clean Water Act, are discrete conveyances such as pipes or man-made ditches that discharge pollutants into waters of the United States. This includes not only discharges from municipal sewage plants and industrial facilities, but also collected storm drainage from larger urban areas, certain animal feedlots and fish farms, some types of ships, tank trucks, offshore oil platforms, and collected runoff from construction sites.

The City is required under the NPDES Phase II permit program to develop and implement a stormwater management program that is designed to reduce the discharge of pollutants from its municipal separate storm sewer system (MS4) to the maximum extent practicable and to protect water quality.

Non-Point Sources

Non-point source (NPS) pollution, unlike pollution from discrete point source conveyance systems, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and across the ground. As the runoff moves, it picks up and carries away natural and manmade pollutants, depositing them into lakes, rivers, wetlands, coastal waters, and underground sources of drinking water. Loadings of NPS pollutants enter water bodies via sheet flow rather than through a pipe, ditch or other point source conveyance system.

Agricultural activities, construction activities, urban runoff, and septic systems are typical sources of NPS pollution. Sediment, nutrients, pesticides, pathogens (bacteria and viruses), oil, grease, toxic chemicals, trash, fertilizers, animal wastes, and heavy metals are examples of NPS pollutants. These can be washed into the streams and water bodies if proper best management practices (BMPs) are not implemented.

A non-point pollution source can be difficult to determine. Potential sources include surface water runoff from agricultural lands, construction sites, urban areas, streets, and forest lands; underground sources such as leaking septic tanks; or discharges from vehicles and boats. Methods to control NPS pollution include public education to limit activities that produce pollution, monitoring of construction sites to ensure proper erosion control practices have been employed, and proper maintenance of municipal and private systems to prevent pollutants from accumulating in the storm system and being discharged downstream.

F.4 Water Quality Monitoring Program

Under the existing NPDES Phase II Permit, the City is required to prepare for future stormwater outfall and program effectiveness monitoring. It is likely that in the next permit term (beginning in 2012) the City will be required to implement these monitoring programs.

The monitoring requirements are similar to those already in place for Phase I permittees with the exception of BMP effectiveness monitoring. It is anticipated that these monitoring programs will involve substantial investment of staff time and resources for equipment purchase and installation, sample collection and lab analysis, data analysis, record keeping, and annual reporting.

While not required by state or federal regulations, the City's water quality program has been performing water quality monitoring over the past decade to allow better understanding of current conditions and to track changes in natural systems. The City currently utilizes City staff and community volunteers to collect data at water quality monitoring sites on several streams and lakes throughout the City. The samples are tested and the results are shared with both King and Snohomish counties.

Streams

Since 2000, the City has been monitoring Little Bear Creek, Woodin Creek, and Derby Creek, which are all tributaries of the Sammamish River. Temperature monitors have been placed at each of the creeks, and have been recording hourly temperature data since 2003. See Figure F.1 for the locations of the monitoring sites. King County has had a water quality monitoring program for the Sammamish River since 1979. The County also has been monitoring Little Bear Creek at the mouth and at a site in Snohomish County. Snohomish County has four monitoring sites on Little Bear Creek.

Sampling of the creeks is the responsibility of the City Public Works Department. A monthly water sample is taken at a designated site at each creek. In the past, sampling has been coordinated with Snohomish County; however the City no longer coordinates sampling with the County due to changes in way the County monitors and records data for Little Bear Creek associated with its NPDES permit. The water samples are then taken to North Creek Analytical Laboratory (NCA) where the samples are tested and analyzed. Since sampling is only performed once a month, the results are a snapshot of the water quality in the creeks. See Tables F-5 through F-7 at the end of this appendix for water quality results.

The water samples are analyzed for the following parameters:

- **Total Suspended Solids**—a measure of all solid particulates that are suspended in the water column. The most common type of particulate is sediment from the banks and streambed; other sources may include nearby disturbed lands, possibly due to agriculture or construction activities.
- **Fecal Coliform**—a portion of the coliform group which is present in the intestinal tract and feces of warm blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium. Broken sewer pipes, failed septic systems, wildlife droppings, pet waste, and pasture runoff are typical sources of fecal coliform.

City of Woodinville

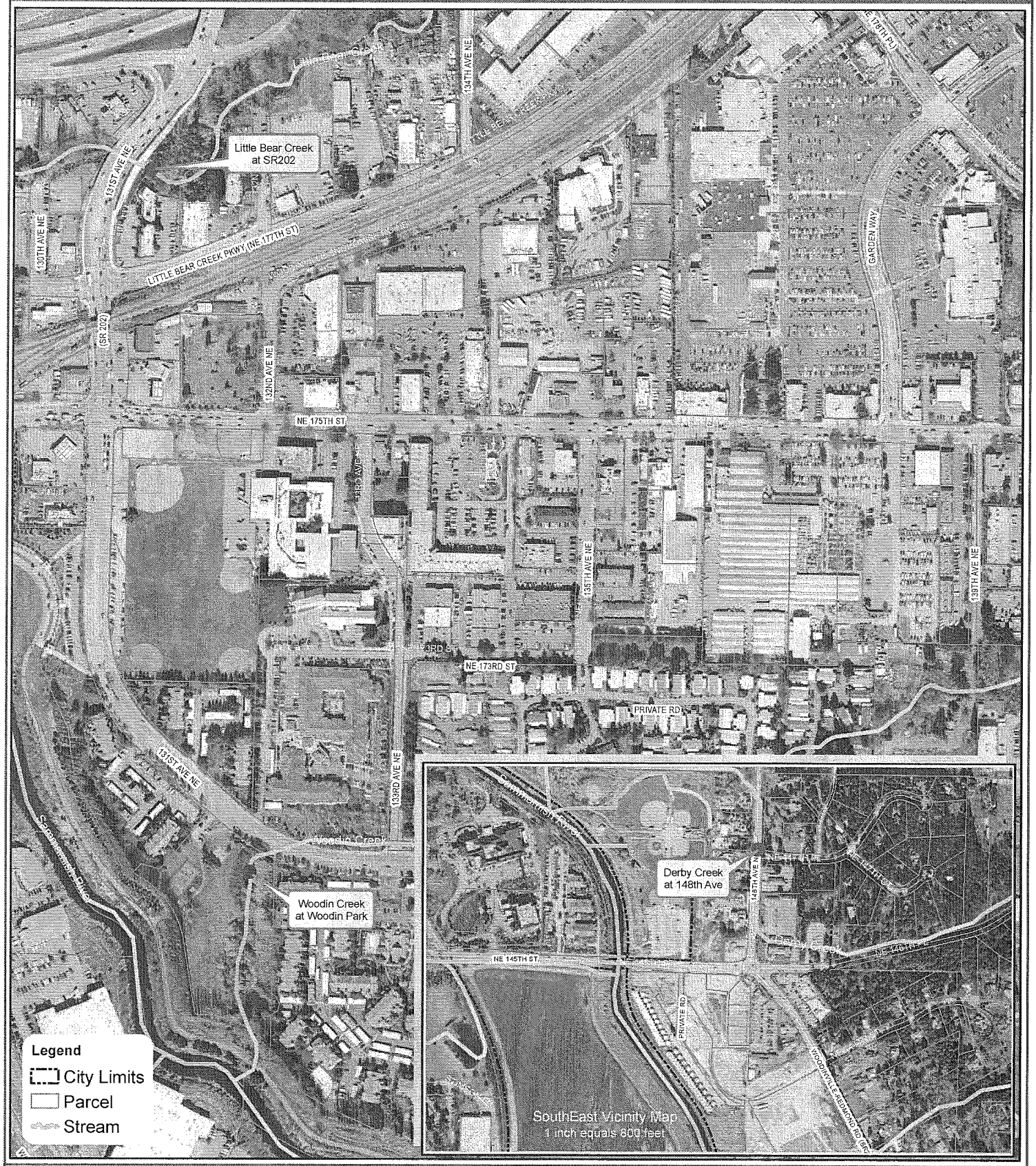


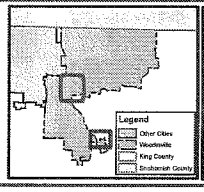
Figure F.1

Water Quality Monthly Sampling Sites

0 100 200 400 Feet

1 inch equals 400 feet

File Name: Water Quality Sampling Site Map.mxd



NO	DESIGN/REVISION	DATE	BY
1	Locations	02/08/06	BGS
2			
3			
4			
5			

City of Woodinville
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Woodinville, WA 98072
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- **Nitrate, Nitrite, and Total Phosphorus**—commonly found in fertilizers. They are nutrients to algae and can lead to algae blooms. Algae blooms are a nuisance to residents and water resource users, and are a potential safety threat if blooms become dominated by species that can produce toxins.
- **Lead, Zinc, and Copper**—heavy metals that are not naturally found in large quantities. Common sources include runoff from parking lots and roads due to vehicular traffic. Copper can also be found in some fertilizers.

Table F-1 outlines the water quality criteria for each of the sampling parameters and the regulations that set each of the criteria. Water quality sampling results through 2009 are presented in Tables F-2 through F-4 for each of the monitored streams. Temperature data for 2009 is also included in the tables.

Table F-1
Water Quality Criteria

Parameter	Limits	Regulation
Fecal Coliform (CFU/ml)	Fecal coliform organisms shall not exceed a geometric mean value of 100 cfu (colony forming units)/100mL, with not more than 10% exceeding 200 cfu/100 mL	WAC 173-201A-200
Nitrate/Nitrite (mg/l)	10 mg/l	EPA Quality Criteria for Water 1986
Total Phosphorus (mg/l)	0.1 mg/l	National Water-Quality Assessment Program, USGS, Circular 1136, 1996
Total Suspended Solids (mg/l)	25 mg/l	US Army Corps of Engineers Fisheries Handbook 1991
Lead (mg/l)	Little Bear Creek: 0.001 Woodin Creek: 0.002 Derby Creek: 0.002 Based on average water hardness	WAC 173-201A-240
Zinc (mg/l)	Little Bear Creek: 0.07 Woodin Creek: 0.08 Derby Creek: 0.09 Based on average water hardness	WAC 173-201A-240
Copper (mg/l)	Little Bear Creek: 0.007 Woodin Creek: 0.009 Derby Creek: 0.011 Based on average water hardness	WAC 173-201A-240

Temperature (° F)	Shall not exceed 64° F due to human activities. When natural conditions exceed 64° F, no human-caused temperature increases will be allowed which will raise the 7-day average of the daily maximum temperatures (7-DAD Max) by more than 0.54° F.	WAC 173-201A-200

Table F-2
Little Bear Creek Water Quality Data

Parameter	Maximum	Minimum	Average
Fecal Coliform (CFU/ml)	17,000	0.5	746.2
Nitrate/Nitrite (mg/l)	3.75	0.27	0.84
Total P (mg/l)	0.2800	0.0003	0.0654
Total Suspended Solids (mg/l)	52.0	0.5	6.8
Lead (mg/l)	0.0070	0.0005	0.0010
Zinc (mg/l)	0.3020	0.0005	0.0115
Copper (mg/l)	0.0646	0.0005	0.0021
Temperature (° F)	65.2	34.8	48.5

Average fecal coliform measurements in Little Bear Creek exceed the WAC standard. All other parameters are within their respective measurable limits.

Table F-3
Woodin Creek Water Quality Data

Parameter	Maximum	Minimum	Average
Fecal Coliform (CFU/ml)	4,100	0.5	474.9
Nitrate/Nitrite (mg/l)	3.6	0.0	1.0
Total P (mg/l)	0.3700	0.0025	0.0667
Total Suspended Solids (mg/l)	120.0	0.5	9.5
Lead (mg/l)	0.0466	0.0005	0.0018
Zinc (mg/l)	0.1040	0.0005	0.0144
Copper (mg/l)	0.0187	0.0005	0.0021
Temperature (° F)	70.4	33.0	51.2

Average fecal coliform measurements in Woodin Creek exceed the WAC standard. All other parameters are within their respective measurable limits.

Table F-4 Derby Creek Water Quality Data			
Parameter	Maximum	Minimum	Average
Fecal Coliform (CFU/ml)	2,200	0.5	133.3
Nitrate/Nitrite (mg/l)	4.4	0.7	3.4
Total P (mg/l)	0.3400	0.0025	0.0570
Total Suspended Solids (mg/l)	120.0	0.5	5.0
Lead (mg/l)	0.0368	0.0005	0.0010
Zinc (mg/l)	0.0220	0.0005	0.0050
Copper (mg/l)	0.0646	0.0005	0.0017
Temperature (° F)	65.3	31.5	49.3

Average fecal coliform measurements in Derby Creek exceed the WAC standard. All other parameters are within their respective measurable limits.

Lake Leota

Lake Leota is located in the eastern part of the City. It is a part of the Bear Creek basin and the Cold Creek sub-basin, and is supplied by surface and ground water. Surface water drainage is collected mostly from developed properties and paved roadways.

Since 1994, the Lake Leota Community Club has participated in the King County Lake Stewardship Program. Lake Leota residents volunteer to collect data and water samples for the purpose of monitoring the condition of the lake. Data collected include temperature, Secchi depth, chlorophyll a, total phosphorous, total nitrogen, and phytoplankton. This data is given to King County for analysis, with the results summarized in an annual Lake Monitoring Report. A copy of the report is provided to the City annually. In 2005, the City amended the King County Surface Water Management Services Interlocal Agreement to include the lake stewardship program.

Currently the conditions in Lake Leota rank in the mid-range of mesotrophic on the trophic scale. Lake Leota has good water quality and moderate phytoplankton populations.

Bluegreen algae continues to be only a minor component of the community, which is dominated by golden algae.

The milfoil in the lake has continued to grow luxuriantly, and the community reports the plant has produced a wide band around the edge of the lake which is beginning to impact access to the open water. Milfoil has been identified as a species considered native to Washington, *Myriophyllum verticillatum*, based on DNA analyses by an academic expert on the genus *Myriophyllum*. However, its aggressive colonizing and spreading behavior is very unlike other known occurrences in the region. There is some question about whether or not the milfoil in Lake Leota may be a hybrid with another species.

The water has a light yellow color, reflecting the presence of large organic molecules. This indicates that water clarity may be slightly impacted by color in addition to algae and inorganic particles. The profile data also indicate that internal loading of phosphorus to the water column continues to be an important process occurring in the lake.

The average lake temperature ranges from approximately 40° F to 75° F annually.

F.5 Future Monitoring Requirements

Under the existing NPDES Phase II Permit discussed in Section 2.3 – Stormwater Management Requirements, the City is required to prepare for future stormwater outfall and program effectiveness monitoring. It is likely that in the next permit term (beginning in 2012), that the City will be required to implement these monitoring programs. These monitoring requirements are similar to those already in place for Phase I permittees with the exception of BMP effectiveness monitoring. It is anticipated that these monitoring programs will involve substantial investment of staff time and resources for equipment purchase and installation, sample collection and lab analysis, data analysis, record keeping, and annual reporting.

F.6 Recommendations

Based on the water quality monitoring data collected to date, the City's streams and lakes reflect common trends among urbanized systems. Elevated levels of fecal coliform could indicate point source pollutants (such as from a sewer line illicitly plumbed into a storm sewer line) or non-point source pollutants that are accumulating City-wide. The following recommendations aim to protect and improve water quality in the City's waterways.

In accordance with the NPDES Phase II permit, implement storm water public education and maintenance activities to reduce non-point source pollutants to the City's waterways.

Continue habitat restoration projects to improve shading on creeks. Higher quality vegetation on creek banks helps to lower water temperatures and filter pollutants in surface water runoff.

Continue the water quality monitoring program for Little Bear, Derby and Woodin Creeks.

Continue working with Ecology on development and implementation of detailed water quality improvement implementation plans for the TMDLs on Little Bear Creek and the Bear-Evans Watershed.

Continue King County Lake Stewardship Program for Lake Leota. Continue partnering with local residents to collect water quality data and look for long term solutions to algae production.

Continue storm system inventory. Begin mapping private systems on the banks of water bodies. Once completed, use the inventory to identify point sources of pollutants discharging to the stormwater system.

Evaluate basin areas for regional water quality facilities. Regional facilities could capture both point and non-point source pollutants before they are washed downstream into the natural channels.

Obtain grants to assist in the funding of the monitoring programs and CIP projects. Evaluate the need for water quality modeling to track long term trends and predict water quality impacts from proposed projects and activities.

City of Woodinville

Woodin Creek Water Quality Data

Table F-5

	Date	Fecal Coliforms (org/100ml)	Nitrate/Nitrite (mg/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)	Hardness (mg/l)
Year 2000	Oct	780.0	0.852	0.0849	19	0.00189	0.0158	0.00274	
	Nov	580.0	0.975	0.0025	63	0.00295	0.0230	0.00497	
Year 2001	Jan	0.5	1.170	0.0697	2	0.00050	0.0712	0.00176	
	Feb	23.0	1.130	0.0367	2	0.00108	0.0050	0.00120	
	Mar	310.0	0.941	0.0559	6		0.0050		
	Apr	55.0	1.120	0.0450	7	0.00050	0.0050	0.00151	
	May	27.0	0.668	0.0447	2	0.00050	0.0050	0.00106	
	June	0.5	0.634	0.0600	5	0.00050	0.0050	0.00124	
	July	200.0	0.540	0.0795	2	0.00050	0.0050	0.00149	
	Aug	0.5	0.351	0.1450	13	0.00402	0.0257	0.00512	
	Sept	2,800.0	0.769	0.0620	2	0.00050	0.0050	0.00050	
	Oct	1,200.0	0.807	0.0660	4	0.00050	0.0050	0.00184	
	Nov	0.5	0.764	0.0428	2	0.00050	0.0050	0.00120	
	Dec	580.0	0.578	0.0803	14	0.00405	0.0262	0.00356	
Year 2002	Jan	800.0	0.906	0.0529	6	0.00288	0.0227	0.00443	
	Feb	170.0	1.340	0.0416	2	0.00116	0.0136	0.00195	
	Mar	100.0	1.460	0.0316	2	0.00050	0.0050	0.00050	
	Apr	300.0	1.120	0.0357	2	0.00050	0.0116	0.00126	
	May	45.0	1.180	0.0387	2	0.00050	0.0050	0.00121	
	June	2,000.0	1.200	0.1130	11	0.00239	0.0262	0.00382	
	July	0.5	1.120	0.0740	2	0.00050	0.0050	0.00103	
	Aug	500.0	0.957	0.0646	2	0.00050	0.0050	0.00128	
	Sept	280.0	0.818	0.0519	4	0.00100	0.0100	0.00100	
	Oct	660.0	0.900	0.0468	4	0.00100	0.0100	0.00100	
	Nov	150.0	0.802	0.0456	2	0.00050	0.0050	0.00190	
	Dec	300.0	0.943	0.0405	2	0.00050	0.0050	0.00118	
Year 2003	Jan	430.0	1.230	0.0378	2	0.00050	0.0050	0.00050	
	Feb	160.0	1.130	0.0345	2	0.00050	0.0050	0.00050	
	Mar	55.0	1.160	0.0327	2	0.00050	0.0050	0.00050	
	Apr	140.0	0.879	0.0381	2	0.00050	0.0108	0.00200	
	May	91.0	0.922	0.0472	2	0.00050	0.0050	0.00050	
	June	350.0	0.926	0.0698	2	0.00050	0.0102	0.00050	
	July	220.0	0.731	0.1090	2	0.00050	0.0162	0.00160	
	Aug	200.0	0.815	0.0743	2	0.00050	0.0129	0.00110	
	Sept	56.8	0.828	0.3700	120	0.01450	0.0933	0.01410	
	Oct								
	Nov	82.8	0.849		2	0.00107	0.0130	0.00142	
	Dec	230.0	0.875	0.0289	2	0.00050	0.0050	0.00147	76.1
Year 2004	Jan	380.0	3.580	0.0488	9	0.00176	0.0205	0.00280	50.3
	Feb	81.0	1.460	0.0262	2	0.00050	0.0050	0.00050	78.1
	Mar	110.0	1.100	0.0348	2	0.00050	0.0126	0.00151	74.9
	Apr	240.0	0.673	0.0879	2	0.00050	0.00500	0.00117	76.6
	May	1,700.0	0.840	0.0507	2	0.00050	0.00500	0.00050	82.3
	June	640.0	0.747	0.0591	2	0.00050	0.00500	0.00050	74.6
	July	3,200.0	0.647	0.0622	9.5	0.00050	0.0114	0.00149	70.3
	Aug	940.0	0.543	0.0674	6.5	0.00050	0.00500	0.00050	79
	Sept	2,600.0	0.594	0.0025	2	0.00050	0.00500	0.00484	63.2
	Oct	4,100.0	0.653	0.0450	2	0.00050	0.00500	0.00050	71.6
	Nov	260.0	1.160	0.0329	2	0.00050	0.00500	0.00100	84.7
	Dec	46.0	1.670	0.0368	2	0.00050	0.0814	0.00132	69.7
Year 2005	Jan	20	1.150	0.0196	2	0.00050	0.013	0.0005	79.6
	Feb	55	1.160	0.01485	2	0.00050	0.01	0.0005	76
	Mar	63	0.893	0.0473	2	0.0005	0.005	0.0005	77.1
	Apr	420	1.050	0.0494	2	0.0005	0.005	0.0005	67.5
	May	140	1.070	0.0441	2	0.0005	0.01	0.001	75.2

City of Woodinville

Woodin Creek Water Quality Data

Table F-5

	Date	Fecal Coliforms (org/100ml)	Nitrate/Nitrite (mg/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)	Hardness (mg/l)
	June	340	0.882	0.0517	2	0.0005	0.005	0.00112	69.4
	July	400	0.952	0.058	2	0.0005	0.005	0.0005	76.5
	Aug	580	0.823	0.061	2	0.0005	0.0124	0.0005	80.6
	Sept	770	0.763	0.089	10	0.0005	0.005	0.0005	92
	Oct	260	0.771	0.033	2	0.0005	0.005	0.0005	79.8
	Nov	1200	0.220	0.141	50	0.0048	0.0322	0.0054	26.3
	Dec	170	1.250	0.031	2	0.0005	0.0101	0.00113	85.8
Year 2006	Jan	1100	0.498	0.111	84	0.00745	0.0471	0.00533	28.5
	Feb	71	1.950	0.034	2	0.00128	0.0328	0.00353	56.1
	Mar	77	1.260	0.005	2	0.0005	0.0163	0.00190	63.3
	Apr	460	1.080	0.005	2	0.0005	0.0118	0.00107	82.5
	May	170	0.995	0.0539	2	0.0005	0.005	0.00050	81.6
	June	380.0	1.270	0.0424	2.0	0.0005	0.0050	0.00132	83.8
	July	380.0	0.828	0.0630	34.0	0.0005	0.0050	0.00050	75.1
	Aug	900.0	0.831	0.0970	2.0	0.00164	0.0154	0.00235	84.3
	Sept	700	0.881	0.061	2	0.0005	0.0050	0.00050	77.2
	Oct	67	0.743	0.07	43	0.00183	0.017	0.00259	82.4
	Nov	990	0.378	0.28	2	0.00152	0.0228	0.00402	41.7
	Dec	400	1.130	0.065	2	0.0005	0.0106	0.00185	88.2
Year 2007	Jan	150	1.110	0.062	18	0.00266	0.0322	0.00286	81.1
	Feb	85	1.360	0.245	2	0.0005	0.0121	0.00136	85.6
	Mar	350	0.036	0.179	98	0.0466	0.104	0.01710	46.6
	Apr	81	1.150	0.068	2	0.0005	0.005	0.00050	92.6
	May	62	0.977	0.115	2	0.0005	0.0103	0.00107	73
	June	350	0.799	0.0780	4.0	0.0005	0.0123	0.00199	75.1
	July	1000	1.040	0.0930	2.0	0.0113	0.0050	0.00117	85.6
	Aug	790	0.915	0.1840	2.0	0.00050	0.0050	0.00050	91.0
	Sept	350	0.895	0.08	2	0.0005	0.0106	0.00050	96.2
	Oct	440	0.632	0.069	2	0.0005	0.0154	0.00246	57.5
	Nov	160	1.010	0.059	2	0.0005	0.005	0.00050	88.3
	Dec	31	1.170	0.037	2	0.0005	0.005	0.00050	85.3
Year 2008	Jan	160	0.713	0.061	10	0.00131	0.0258	0.00277	42
	Feb	97	0.976	0.045	5.5	0.0005	0.017	0.00178	72.7
	Mar	1300	1.210	0.039	2	0.0005	0.0245	0.00142	80.9
	Apr	17	1.250	0.0149	2	0.0005	0.0116	0.00133	85.5
	May	37	0.986	0.03	2	0.0005	0.005	0.00100	87.2
	June	280.0	1.040	0.0700	5.5	0.0005	0.0108	0.00157	83.8
	July	-	0.724	0.2480	110.0	0.0068	0.0742	0.01870	40.9
	Aug	88.0	0.878	0.0680	2.0	0.0005	0.005	0.00050	83.8
	Sept	146	0.785	0.058	2	0.0005	0.0050	0.00050	83.6
	Oct	170	0.947	0.051	10	0.0005	0.005	0.00128	84.6
	Nov	254	0.284	0.092	17	0.00282	0.0327	0.00559	26.7
	Dec	8	1.010	0.039	2	0.0005	0.005	0.00050	80.6
Year 2009	Jan	170	2.200	0.024	7	0.001	0.012	0.00200	49
	Feb	228	1.300	0.04	2	0.01	0.004	0.00050	98
	Mar	320	0.800	0.048	23	0.003	0.03	0.00050	53
	Apr	56	1.900	0.097	43	0.009	0.064	0.00800	37
	May	170	0.700	0.027	1	0.0005	0.006	0.00300	68
	June	990.0	1.000	0.0540	1.0	0.0030	0.0020	0.00050	84.0
	July	470.0	1.200	0.1200	10.0	0.0010	0.0060	0.00300	84.0
	Aug	340.0	1.000	0.0720	2.0	0.002	0.0005	0.00300	85.0
	Sept	2400	1.100	0.09	6	0.0005	0.0100	0.00600	69
	Oct	860	1.000	0.045	0.5	0.0005	0.002	0.00050	80
	Nov	80	0.880	0.042	1	0.002	0.0005	0.00100	85
	Dec	510	1.100	0.025	1	0.0005	0.002	0.00050	83

City of Woodinville
Little Bear Creek Water Quality Data
Table F-6

	Date	Fecal Coliforms (CFU/100ml)	Nitrate/Nitrite (mg/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)	Hardness (mg/l)
Year 1997	Sept	420.0	0.708	0.0536	2	0.00050	0.00902	0.00158	
	Oct	2,700.0	2.370	0.0025	12	0.00050	0.00569	0.00329	
	Nov	580.0	0.968	0.0268	2	0.00100	0.00250	0.00219	
	Dec	230.0	1.290	0.0156	2	0.00100	0.00460	0.00256	
Year 1998	Jan	220.0	1.420	0.0206	16	0.00302	0.01660	0.00729	
	Feb	630.0	1.350	0.0273	8	0.00145	0.00434	0.00216	
	Mar	260.0	1.130	0.0640	20	0.00290	0.00981	0.00243	
	Apr	1,100.0	0.724	0.1510	28	0.00386	0.02670	0.00371	
	May	250.0	2.230	0.1010	2	0.00050	0.00500	0.00050	
Year 2000	May	410.0	0.719	0.0439	4	0.00050	0.01410	0.00136	
	June	160.0	0.782	0.0569	5	0.00050	0.00500	0.00132	
	July	51.0	0.677	0.0662	2	0.00114	0.00500	0.00242	
	Aug	27.0	0.650	0.0754	4	0.00050	0.00500	0.00222	
	Sept	32.0	0.639	0.0507	2	0.00050	0.00500	0.00050	
	Oct	510.0	0.671	0.0912	6	0.00050	0.00500	0.00192	
	Nov	190.0	0.783	0.0025	2	0.00050	0.00500	0.00050	
	Dec	100.0	0.915	0.0596	2	0.00050	0.01420	0.00134	
Year 2001	Jan	800.0	1.140	0.0797	2	0.00050	0.00500	0.00148	
	Feb	200.0	1.170	0.0519	6	0.00139	0.00500	0.00111	
	Mar	310.0	0.941	0.0559	6		0.00500	0.06460	
	Apr	55.0	1.120	0.0450	7	0.00050	0.00500	0.00151	
	May	27.0	0.668	0.0447	2	0.00050	0.00500	0.00106	
	June	0.5	0.634	0.0600	4	0.00050	0.05070	0.00135	
	July	500.0	0.540	0.0795	2	0.00050	0.00500	0.00149	
	Aug	4,500.0	0.534	0.1480	17	0.00285	0.02020	0.00399	
	Sept	160.0	0.580	0.0691	2	0.00050	0.00500	0.00050	
	Oct	1,900.0	0.658	0.0730	5	0.00050	0.00500	0.00159	
	Nov	0.5	0.712	0.0541	2	0.00050	0.00500	0.00136	
	Dec	220.0	1.700	0.0456	10	0.00050	0.00500	0.00161	
Year 2002	Jan	300.0	1.130	0.1190	34	0.00306	0.01860	0.00451	
	Feb	2,800.0	1.160	0.0648	10	0.00159	0.00500	0.00185	
	Mar	150.0	0.936	0.0561	6	0.00102	0.01140	0.00188	
	Apr	600.0	0.771	0.0474	5	0.00050	0.00500	0.00119	
	May	130.0	0.774	0.0371	5	0.00050	0.00500	0.00129	
	June	540.0	0.705	0.0769	7	0.00050	0.01360	0.00389	
	July	280.0	0.682	0.0635	2	0.00050	0.00500	0.00050	
	Aug	200.0	0.621	0.1660	10	0.00476	0.04730	0.00500	
	Sept	300.0	0.899	0.2720	8	0.00100	0.01000	0.00100	
	Oct	200.0	0.840	0.0927	11	0.00100	0.01000	0.00130	
	Nov	140.0	0.722	0.0714	2	0.00050	0.00500	0.00103	
	Dec	130.0	0.764	0.0681	4	0.00050	0.00500	0.00050	
Year 2003	Jan	69.0	1.290	0.0511	2	0.00050	0.00500	0.00050	
	Feb	150.0	0.975	0.0499	2	0.00050	0.00500	0.00050	
	Mar	290.0	1.000	0.0556	2	0.00050	0.00500	0.00050	
	Apr	1,700.0	0.833	0.0876	2	0.00050	0.00500	0.00266	
	May	670.0	0.666	0.0530	2	0.00050	0.00500	0.00050	
	June	340.0	0.601	0.0580	2	0.00050	0.00500	0.00105	
	July	7,100.0	0.367	0.0567	2	0.00050	0.01090	0.00050	
	Aug	120.0	0.344	0.0499	2	0.00050	0.00500	0.00050	
	Sept	3,500.0	0.524	0.1450	8	0.00108	0.01290	0.00239	
	Oct	210.0	0.427	0.0630	2	0.00050	0.00500	0.00050	
	Nov	210.0	0.677	0.0003	2	0.00050	0.00500	0.00050	
	Dec	41.0	1.150	0.0313	2	0.00050	0.00500	0.00152	
Year 2004	Jan	260.0	1.570	0.0649	12	0.00156	0.01460	0.00263	34.3
	Feb	140.0	1.250	0.0386	4	0.00050	0.00500	0.00148	49.5
	Mar	230.0	0.921	0.0419	7	0.00050	0.00500	0.00130	45.1
	Apr	80.0	0.500	0.0476	2	0.00050	0.00500	0.00050	54.4
	May	500.0	0.611	0.0474	2	0.00050	0.00500	0.00050	68.6
	June	490.0	0.481	0.0508	2	0.00050	0.00500	0.00050	59.8
	July	140.0	0.420	0.0548	2	0.00050	0.00500	0.00050	60.1

City of Woodinville
Little Bear Creek Water Quality Data
Table F-6

	Date	Fecal Coliforms (CFU/100ml)	Nitrate/Nitrite (mg/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)	Hardness (mg/l)
	Aug	310.0	0.271	0.0540	2	0.00050	0.00500	0.00050	
	Sept	760.0	0.377	0.0523	2	0.00050	0.01120	0.00136	56.2
	Oct	420.0	0.450	0.0548	5	0.00050	0.00500	0.00050	63.3
	Nov	260.0	1.250	0.0456	5	0.00050	0.00500	0.00204	54.7
	Dec	210.0	1.620	0.0455	2	0.00050	0.00500	0.00140	42.7
Year 2005	Jan	82	3.750	0.0293	2	0.00050	0.00500	0.00166	56.8
	Feb	87	1.100	0.0376	2	0.00050	0.00500	0.001	53.8
	Mar	58	0.828	0.0601	2	0.0005	0.00500	0.0005	47.0
	Apr	65	0.842	0.051	2	0.0005	0.00500	0.0005	49.7
	May	1800	0.595	0.0436	2	0.001	0.01000	0.001	56.6
	June	1700	0.507	0.0528	2	0.0005	0.00500	0.00123	53.2
	July	140	0.530	0.053	2	0.0005	0.00050	0.0005	74.5
	Aug	120	0.368	0.042	2	0.0005	0.01030	0.0005	71.0
	Sept	360	0.363	0.048	2	0.0005	0.00500	0.0005	76.5
	Oct	240	0.573	0.034	2	0.0005	0.00500	0.0005	68.5
	Nov	900	0.401	0.112	32	0.00289	0.02780	0.00539	53.3
	Dec	180	1.260	0.039	2	0.0005	0.00500	0.00109	56.9
Year 2006	Jan	540	1.280	0.086	52	0.00386	0.03240	0.00481	47.3
	Feb	17000	1.540	0.0450	14	0.0010	0.0150	0.0023	32.6
	Mar	420	1.020	0.0050	2	0.0005	0.0147	0.0013	49.5
	Apr	110	0.757	0.0360	2	0.0005	0.0050	0.0012	57.1
	May	100	0.647	0.0786	2	0.0005	0.00500	0.0005	62.6
	June	2800	0.555	0.051	2	0.0005	0.00500	0.00102	57.3
	July	170	0.491	0.057	26	0.0005	0.01060	0.00176	63.6
	Aug	320	0.450	0.045	8	0.00307	0.02400	0.00294	73.9
	Sept	320	0.510	0.052	2	0.0005	0.00500	0.0005	66.2
	Oct	250	0.705	0.041	10	0.0005	0.00500	0.00118	65.9
	Nov	2300	0.480	0.28	6	0.00152	0.02280	0.00402	61.4
	Dec	51	1.080	0.089	2	0.0005	0.01220	0.00212	56
Year 2007	Jan	310	0.931	0.058	11	0.0005	0.01340	0.0015	26.8
	Feb	240	1.020	0.0750	2	0.0005	0.0050	0.0005	60.1
	Mar	330	0.664	0.0800	14	0.0032	0.0285	0.0030	54.7
	Apr	110	0.716	0.0760	2	0.0005	0.0050	0.0005	64.2
	May	51	0.599	0.202	2	0.0005	0.00500	0.0005	58.4
	June	2600	0.482	0.059	2	0.0005	0.00500	0.00127	62.9
	July	290	0.428	0.074	6	0.0005	0.02170	0.0005	74.7
	Aug	140	0.380	0.213	7	0.0005	0.00500	0.0005	75
	Sept	59	0.458	0.068	2	0.0005	0.00500	0.0005	72.6
	Oct	2700	0.498	0.067	9	0.0005	0.00500	0.00158	64.6
	Nov	38	0.655	0.075	2	0.0005	0.00500	0.0005	71.3
	Dec	65	1.080	0.045	4.5	0.0005	0.00500	0.00113	55.7
Year 2008	Jan	66	1.000	0.09	22	0.00143	0.02160	0.00291	46.5
	Feb	160	0.855	0.0590	14	0.0005	0.0165	0.0017	50.8
	Mar	70	0.821	0.0600	2	0.0005	0.0165	0.0019	70.5
	Apr	220	0.914	0.0590	4	0.0005	0.0050	0.0010	58.8
	May	73	0.659	0.049	2	0.0005	0.00500	0.0005	59
	June	11000	0.676	0.059	9	0.0005	0.00500	0.00182	49.6
	July	-	0.645	0.229	44	0.00325	0.06220	0.0101	55
	Aug	70	0.487	0.067	2	0.0005	0.00500	0.0005	69.6
	Sept	103	0.515	0.058	2	0.0005	0.00500	0.00103	66.9
	Oct	94	0.560	0.055	6	0.0005	0.00500	0.00133	67.5
	Nov	196	0.454	0.084	14	0.0018	0.02890	0.00361	50.6
	Dec	16	0.752	0.05	2	0.0005	0.00500	0.0005	60.7
Year 2009	Jan	36	1.800	0.047	22	0.0005	0.01700	0.0005	37.0
	Feb	56	1.200	0.0600	8	0.0070	0.0020	0.0030	65.0
	Mar	164	0.950	0.0480	16	0.0005	0.3020	0.0030	53.0
	Apr	146	3.000	0.0390	13	0.0010	0.0130	0.0020	46.0
	May	460	0.560	0.039	9	0.001	0.00900	0.0005	48
	June	250	0.530	0.064	1	0.002	0.00200	0.0005	71
	July	630	0.510	0.043	6	0.0005	0.00050	0.001	71
	Aug	370	0.450	0.049	20	0.004	0.00050	0.002	74
	Sept	540	0.470	0.041	9	0.0005	0.00200	0.004	72
	Oct	160	0.630	0.04	0.5	0.0005	0.00300	0.0005	68
	Nov	70	0.640	0.048	10.00	0.001	0.00300	0.002	63
	Dec	20	0.970	0.028	0.50	0.0005	0.00050	0.001	55

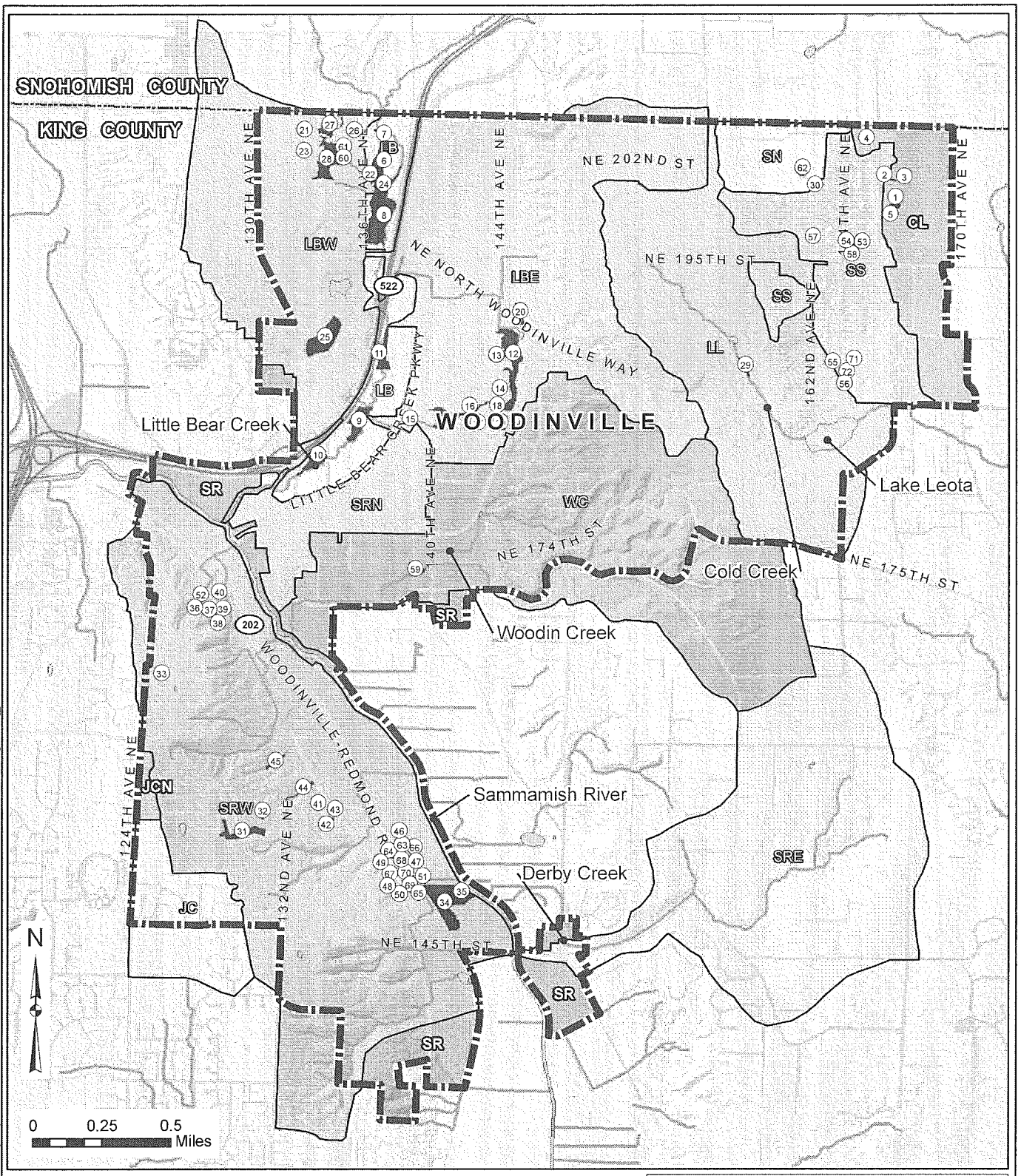
City of Woodinville
Derby Creek Water Quality Data
Table F-7

	Date	Fecal Coliforms (org/100ml)	Nitrate/Nitrite (mg/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)	Hardness (mg/l)
Year 2000	Oct	23.0	3.800	0.0464	2	0.0005	0.005	0.00050	
	Nov	7.2	3.780	0.0025	2	0.0005	0.005	0.00050	
Year 2001	Jan	1.0	3.830	0.0777	9	0.0005	0.005	0.00117	
	Feb	0.5	3.390	0.0398	2	0.0005	0.005	0.00050	
	Mar	310.0	0.941	0.0559	6	0.0368	0.005	0.06460	
	Apr	55.0	1.120	0.0450	7	0.0005	0.005	0.00151	
	May	27.0	0.668	0.0447	2	0.0005	0.005	0.00106	
	June	0.5	3.940	0.0498	2	0.0005	0.005	0.00125	
	July	300.0	3.550	0.0555	2	0.0005	0.005	0.00050	
	Aug	460.0	3.460	0.0691	2	0.0005	0.005	0.00105	
	Sept	300.0	3.690	0.0558	2	0.0005	0.005	0.00050	
	Oct	2.3	3.300	0.0549	35	0.0005	0.005	0.00050	
	Nov	0.5	3.350	0.0498	9	0.0005	0.005	0.00113	
	Dec	380.0	2.720	0.1010	34	0.0016	0.005	0.00281	
Year 2002	Jan	350.0	2.430	0.0509	8	0.0005	0.005	0.00309	
	Feb	180.0	2.990	0.0309	2	0.0005	0.005	0.00050	
	Mar	50.0	3.500	0.0324	2	0.0005	0.005	0.00050	
	Apr	55.0	3.370	0.0332	2	0.0005	0.005	0.00133	
	May	5.3	3.850	0.0344	2	0.0005	0.005	0.00112	
	June	58.0	3.660	0.0434	2	0.0005	0.005	0.00500	
	July	240.0	3.360	0.0389	2	0.0005	0.005	0.00500	
	Aug	20.0	3.390	0.0347	2	0.0005	0.005	0.00500	
	Sept	34.0	3.630	0.0389	4	0.0010	0.010	0.00100	
	Oct	52.0	0.975	0.0382	4	0.0010	0.010	0.00100	
	Nov	36.0	3.300	0.0492	2	0.0005	0.005	0.00500	
	Dec	38.0	3.990	0.0426	12	0.0005	0.005	0.00115	
Year 2003	Jan	5.0	3.100	0.0101	38	0.0005	0.0050	0.00050	
	Feb	33.0	3.420	0.0397	2	0.0005	0.0050	0.00050	
	Mar	12.0	3.650	0.0414	2	0.0005	0.0050	0.00050	
	Apr	0.5	3.240	0.0647	7	0.0011	0.0050	0.00564	
	May	64.0	3.740	0.0503	4	0.0005	0.0220	0.00050	
	June	200.0	3.760	0.0463	2	0.0005	0.0050	0.00050	
	July	120.0	3.540	0.0419	2	0.0005	0.0050	0.00050	
	Aug	41.0	3.860	0.0385	2	0.0005	0.0050	0.00050	
	Sept	97.5	3.910	0.0777	2	0.0005	0.0050	0.00050	
	Oct								
	Nov	75.0	3.880		2	0.0005	0.0050	0.00050	
	Dec	89.0	3.800	0.0326	2	0.0005	0.0050	0.00050	
Year 2004	Jan	130.0	3.580	0.0488	9	0.0005	0.0050	0.00172	50.3
	Feb	16.0	1.460	0.0262	2	0.0005	0.0050	0.00050	78.1
	Mar	60.0	3.120	0.0334	2	0.0005	0.0050	0.00050	79.9
	Apr	20.0	3.420	0.0487	2	0.0005	0.0050	0.00131	87.5
	May	30.0	3.750	0.0419	2	0.0005	0.0050	0.00050	100
	June	69.0	3.600	0.0464	2	0.0005	0.0050	0.00050	91.9
	July	260.0	3.640	0.0443	2	0.0005	0.0050	0.00050	94.1
	Aug	150.0	3.570	0.0407	2	0.0005	0.0050	0.00050	101
	Sept	760.0	3.520	0.0529	2	0.0005	0.0050	0.00050	89.1
	Oct	170	3.690	0.0373	2	0.0005	0.0050	0.00050	93.5
	Nov	43.0	3.600	0.0395	2	0.0005	0.0050	0.00050	107
	Dec	200.0	3.780	0.0472	2	0.0005	0.0050	0.00050	79.9
Year 2005	Jan	56	1.140	0.027	2	0.0005	0.0050	0.00050	90.1
	Feb	87	3.600	0.02815	2	0.0005	0.0050	0.00050	83.8
	Mar	70	4.030	0.0657	2	0.0005	0.005	0.00050	74.9
	Apr	280	3.390	0.0948	2	0.0005	0.005	0.00050	75.7
	May	430	3.580	0.0446	2	0.001	0.01	0.00100	90.4
	June	700	3.420	0.0595	2	0.001	0.01	0.00100	95.7
	July	28	1.270	0.056	2	0.0005	0.005	0.00153	87.7
	Aug	580	0.823	0.061	2	0.0005	0.005	0.00201	80.6

City of Woodinville
Derby Creek Water Quality Data
Table F-7

	Date	Fecal Coliforms (org/100ml)	Nitrate/Nitrite (mg/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)	Hardness (mg/l)
	Sept	410	4.000	0.047	7.5	0.0005	0.005	0.00050	108
	Oct	79	3.840	0.005	2	0.0005	0.005	0.00050	101
	Nov	420	3.540	0.098	7.5	0.0005	0.005	0.00050	101
	Dec	12	3.780	0.049	2	0.0005	0.005	0.00050	100
Year 2006	Jan	490.0	3.400	0.1170	120	0.0032	0.0155	0.00430	66.4
	Feb	29	3.140	0.037	4	0.0005	0.005	0.00147	46.3
	Mar	20	3.100	0.005	2	0.0005	0.005	0.00050	85.4
	Apr	73	3.600	0.019	2	0.0005	0.005	0.00113	94.9
	May	9.0	3.7200	0.0503	2.0	0.0005	0.0050	0.00050	97.5
	June	110.0	3.3000	0.0500	2.0	0.0005	0.0050	0.00050	93.9
	July	2200	3.7600	0.0470	2.0	0.0005	0.0050	0.00203	102
	Aug	93	3.6200	0.0440	2.0	0.0005	0.0050	0.00050	100
	Sept	230	3.7400	0.0470	2.0	0.0005	0.0050	0.00050	93.8
	Oct	57	4.0400	0.0440	2.0	0.0005	0.0050	0.00050	97.3
	Nov	8	3.5600	0.2350	2.0	0.0005	0.0050	0.00050	102
	Dec	2	4.0000	0.1020	2.0	0.0005	0.0050	0.00103	99.5
Year 2007	Jan	5.0	3.600	0.0450	2	0.0005	0.0050	0.00050	57.2
	Feb	2	3.960	0.068	2	0.0005	0.005	0.00050	92.4
	Mar	18	3.600	0.055	2	0.0005	0.005	0.00110	91.3
	Apr	5	4.020	0.07	2	0.00122	0.005	0.00050	105
	May	10.0	3.7800	0.1090	2.0	0.0005	0.0050	0.00050	86.8
	June	64.0	3.0400	0.0680	2.0	0.0005	0.0050	0.00050	102.0
	July	31	3.6600	0.0580	4.0	0.0005	0.0050	0.00050	102
	Aug	54	3.6100	0.1580	5.0	0.0005	0.0050	0.00050	110
	Sept	270	3.4900	0.0800	2.0	0.0005	0.0050	0.00050	105
	Oct	55	3.5600	0.0590	5.0	0.0005	0.0050	0.00120	102
	Nov	9	3.8900	0.0720	2.0	0.0005	0.0050	0.00050	105
	Dec	12	3.6300	0.0460	2.0	0.0005	0.0050	0.00050	94.9
Year 2008	Jan	23.0	3.340	0.0460	2	0.0005	0.0050	0.00105	73.5
	Feb	3	3.360	0.05	2	0.0005	0.005	0.00050	89.4
	Mar	17	3.680	0.04	2	0.0005	0.005	0.00050	99.1
	Apr	6	3.260	0.194	4	0.0005	0.005	0.00050	101
	May	26.0	3.4600	0.3400	2.0	0.0005	0.0050	0.00050	101.0
	June	31.0	3.5600	0.0810	2.0	0.0005	0.0050	0.00050	103.0
	July	-	3.6800	0.0740	5.0	0.0005	0.0050	0.00101	95.4
	Aug	32	3.4300	0.0640	2.0	0.0005	0.0050	0.00050	97.6
	Sept	9	3.3300	0.0570	2.0	0.0005	0.0050	0.00050	98.8
	Oct	14	3.7000	0.0450	2.0	0.0005	0.0050	0.00050	102
	Nov	70	3.2000	0.0710	2.0	0.0005	0.0050	0.00216	95.1
	Dec	4	3.7600	0.0470	8.5	0.0005	0.0050	0.00050	97.7
Year 2009	Jan	38.0	3.900	0.0300	5	0.0005	0.0005	0.00050	54
	Feb	2	4.400	0.12	3	0.004	0.0005	0.00050	110
	Mar	32	3.000	0.037	4	0.0005	0.003	0.00300	80
	Apr	52	3.500	0.037	9	0.001	0.001	0.00200	84
	May	14.0	3.2000	0.0340	5.0	0.0005	0.0005	0.00050	87.0
	June	1,100.0	3.8000	0.0480	2.0	0.0005	0.0005	0.00050	98.0
	July	10	4.1000	0.0570	6.0	0.0005	0.0005	0.00300	98
	Aug	40	4.2000	0.0470	0.5	0.0010	0.0005	0.00600	110
	Sept	140	4.4000	0.0390	5.0	0.0005	0.0005	0.00400	110
	Oct	70	3.6000	0.0420	0.5	0.0005	0.0005	0.00050	93
	Nov	20	3.7000	0.0440	2.0	0.0020	0.0005	0.00050	100
	Dec	5	3.5000	0.0300	0.5	0.0010	0.0005	0.00200	85

Appendix G
Wetland Locations and Calculations



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

LEGEND

- City Limits
- County Boundary
- Highway
- Streams
- 20 ft Contour
- Wetlands

Basin Boundary

- Cottage Lake (CL)
- Juanita Creek (JC)
- Juanita Creek North (JCN)
- Little Bear (LB)
- Little Bear East (LBE)
- Little Bear West (LBW)
- Lake Leota (LL)
- School North (SN)
- School South (SS)
- Sammamish River (SR)
- Sammamish River East (SRE)
- Sammamish River North (SRN)
- Sammamish River West (SRW)
- Woodin Creek (WC)

Disclaimer: The information shown in this map is assembled GIS data created and acquired by Otak Inc.(basin boundaries), from the City of Woodinville (city limits, hydrology,parcel boundaries,streets), King County GIS (county boundary,water bodies, topology using LIDAR)
This data is not to survey accuracy and is meant for planning purposes only.

STORMWATER MANAGEMENT PLAN

FIGURE G.1

WETLANDS

CITY OF WOODINVILLE

OCTOBER 2010

City of Woodinville

SWM Plan Update

Wetland Areas and Locations

This data is generated from the City's wetland data, dated 9/18/2009.

ID Number (Otak Assigned)	Basin Location	Acres	Name of Development	Category	Type	Address
1	CL	0.63	Campbell Native Growth Protection Area	Wetland		19730 166TH AV NE
2	CL	0.05	Harper Wetland Area	Wetland		20020 166TH AV NE
3	CL	0.03	Harper Wetland Area	Wetland		20020 166TH AV NE
4	CL	0.11	Weisel SP (SPA2001-004)	Wetland		20310 164TH AV NE
5	CL	0.05	Campbell BLA (BLA97-054)	Wetland	Class III Wetland	19724 166TH AV NE
6	LB	2.91	Georgian Heights Sensitive Area	Wetland		20140 137TH AV NE
7	LB	0.66	Georgian Heights Phase 2 Sensitive Area Tract	Wetland		13645 NE 205TH ST
8	LB	8.70	City of Woodinville	Wetland	Class II Wetland	20140 137TH AV NE
9	LB	3.26	KC assessor map	Wetland		13716 NE 177TH PL
10	LB	1.97	Unknown 1	Wetland		13248 NE 177TH PL
11	LB	2.14	Unknown 2	Wetland		18707 139TH AV NE
12	LBE	5.82	Woodinview Heights (SEP99-019)	Wetland	Class II Wetland	14390 NE 189TH PL
13	LBE	0.05	Woodinview Heights (SEP99-019)	Wetland	Class II Wetland	18821 144TH AV NE
14	LBE	0.15	Woodinview Heights (SEP99-019)	Wetland	Class II Wetland	18608 144TH AV NE 98072
15	LBE	0.46	TRF Pacific (SEP95-029)	Wetland	Class III Wetland	18200 WOODINVILLE-SNOHOMISH RD
16	LBE	3.78	Sirkin Rezone	Wetland	Class II Wetland	18565 142ND AV NE
17	LBE	0.15	Sirkin Rezone	Wetland	Class III Wetland	18565 142ND AV NE
18	LBE	0.14	Sirkin Rezone	Wetland	Class II Wetland	18565 142ND AV NE
19	LBE	0.89	Sirkin Rezone	Wetland	Class II Wetland	18565 142ND AV NE
20	LBE	0.58	Unknown 3	Wetland		14400 NE NORTH WOODINVILLE WY
21	LBW	0.27	Boehmer Native Growth Protection Easement	Wetland		20312 132ND AV NE
22	LBW	0.40	Georgian Heights Sensitive Area	Wetland		20140 137TH AV NE
23	LBW	0.34	Wenzl SP	Wetland		13230 NE 202ND CT
24	LBW	1.89	City of Woodinville	Wetland	Class II Wetland	20140 137TH AV NE
25	LBW	5.87	Unknown 4	Wetland		13524 NE 188TH PL
26	LBW	0.24	Varanda Lane Georgian Heights Phase V Final Plat	Wetland	Class II Wetland	20223 136TH AV NE
27	LBW	2.19	Georgian Heights Phase IV Final Plat	Wetland		13457 NE 205TH ST
28	LBW	5.17	Georgian Heights Phase IV Final Plat	Wetland		20117 136TH AV NE
29	LL	0.41	Bonterra (Blacketer) Final Plat	Wetland		18613 160TH AV NE
30	SN	0.13	Lehman	Wetland		16202 NE 200TH CT
31	SRW	2.72	Miller's Ridge Native Growth Protection Easement	Wetland		15320 128TH AV NE
32	SRW	0.53	Miller's Ridge Native Growth Protection Easement	Wetland		15400 132ND AV NE
33	SRW	0.23	Winchester Meadows Wetland	Wetland		16350 124TH PL NE
34	SRW	7.72	Unknown 5	Wetland		14066 NE 145TH ST
35	SRW	1.61	Unknown 6	Wetland		14066 NE 145TH ST
36	SRW	0.08	KC assessors map	Wetland		17041 128TH PL NE
37	SRW	0.15	KC assessors map	Wetland		16680 128TH PL NE
38	SRW	0.06	KC assessors map	Wetland		16680 128TH PL NE
39	SRW	0.04	KC assessors map	Wetland		17080 128TH PL NE
40	SRW	0.19	KC assessors map	Wetland		16920 128TH PL NE
41	SRW	0.11	Rolling Meadows	Wetland	Class II Wetland	15400 132ND AV NE
42	SRW	0.05	Rolling Meadows	Wetland	Class III Wetland	15400 132ND AV NE
43	SRW	0.02	Rolling Meadows	Wetland	Class III Wetland	15400 132ND AV NE

ID Number (Otak Assigned)	Basin Location	Acres	Name of Development	Category	Type	Address
44	SRW	0.40	Rolling Meadows	Wetland	Class II Wetland	15400 132ND AV NE
45	SRW	0.33	Rolling Meadows	Wetland	Class II Wetland	15400 132ND AV NE
46	SRW	0.35	Calwest-1526059100	Wetland		15000 WOODINVILLE-REDMOND RD NE
47	SRW	0.24	Calwest-1526059100	Wetland		
48	SRW	0.29	Calwest-1526059100	Wetland		15010 WOODINVILLE-REDMOND RD
49	SRW	0.16	Calwest-1526059100	Wetland		15000 WOODINVILLE-REDMOND RD NE
50	SRW	0.00	Calwest-1526059100	Wetland		
51	SRW	0.00	Calwest-1526059100	Wetland		15010 WOODINVILLE-REDMOND RD
52	SRW	0.02	Unknown 7	Wetland	Class II Wetland	17041 128TH PL NE
53	SS	0.80	Powers Short Plat Native Growth Protection Easement	Wetland		19619 166TH AV NE
54	SS	0.04	Powers SP (SPA98-009)	Wetland	Class II Wetland	19619 166TH AV NE
55	SS	0.03	Cedar Heights (SEP96-070)	Wetland		18703 165TH AV NE
56	SS	0.03	Cedar Heights (SEP96-070)	Wetland		18725 164TH AV NE
57	SS	0.15	Unknown 8	Wetland	Class III Wetland	16218 NE 195TH ST
58	SS	0.05	Tarnowski	Wetland	Class III Wetland	
59	WC	0.46	Unknown 9	Wetland	Class III Wetland	17105 140TH AV NE
60	LBW	0.00	Varanda Lane Georgian Heights Phase V Final Plat	Wetland	Class II Wetland	20223 136TH AV NE
61	LBW	0.00	Georgian Heights Phase IV Final Plat	Wetland		20223 136TH AV NE
62	SN	0.00	Lehman	Wetland		
63	SRW	0.00	Calwest-1526059100	Wetland		15000 WOODINVILLE-REDMOND RD NE
64	SRW	0.00	Calwest-1526059100	Wetland		15000 WOODINVILLE-REDMOND RD NE
65	SRW	0.02	Calwest-1526059100	Wetland		15010 WOODINVILLE-REDMOND RD
66	SRW	0.02	Calwest-1526059100	Wetland		15010 WOODINVILLE-REDMOND RD
67	SRW	0.01	Calwest-1526059100	Wetland		
68	SRW	0.01	Calwest-1526059100	Wetland		
69	SRW	0.10	Calwest-1526059100	Wetland		15010 WOODINVILLE-REDMOND RD
70	SRW	0.10	Calwest-1526059100	Wetland		15010 WOODINVILLE-REDMOND RD
71	SS	0.02	Cedar Heights (SEP96-070)	Wetland		18703 165TH AV NE
72	SS	0.02	Cedar Heights (SEP96-070)	Wetland		18703 165TH AV NE
	Total Acres	***66.60***				

Appendix H
Habitat Assessment Reports

APPENDIX A

LITTLE BEAR CREEK HABITAT ASSESSMENT
July 2002
(Excerpted Portion due to Report Size)

See Resolution No. 272 for full report
Or

Link to the Master Plans page on the City Website for full report by Sections
http://www.ci.woodinville.wa.us/Work/ParksPlans.asp

LITTLE BEAR CREEK CORRIDOR HABITAT ASSESSMENT

Woodinville, Washington

Prepared for:

THE CITY OF WOODINVILLE
17301 133rd Avenue NE
Woodinville, Washington 98072-8534

WOOD0000-0010

Prepared by:

DAVID EVANS AND ASSOCIATES, INC.
415 – 118th Avenue SE
Bellevue, Washington 98005-3518

July 2002

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EXECUTIVE SUMMARY

The City of Woodinville is bisected by several creeks, the largest of which is Little Bear Creek. Little Bear Creek is recognized as an important salmon-bearing stream within the Lake Washington – Cedar – Sammamish Basin (Water Resource Inventory Area 8). With the listing of chinook salmon as a threatened species under the Endangered Species Act (ESA), numerous cities, including the City of Woodinville, have undergone stream inventories to document existing habitat conditions in streams within their jurisdiction. The City of Woodinville contracted with David Evans and Associates, Inc. (DEA) to prepare this Little Bear Creek Corridor Habitat Assessment. The project goals were to document existing fish and wildlife habitat conditions and utilization, and identify potential restoration opportunities along Little Bear Creek within the City of Woodinville. This assessment provides a detailed analysis of stream and riparian habitat conditions, fish and wildlife utilization, and includes data that assisted in the determination of limiting factors as they relate to ESA listed salmon.

Because of project specific goals, and a desire to have the results comparable to other on-going stream inventory efforts, DEA utilized the *Inventory Methods for Wadable Streams in King County* (King County, 2001a) as the primary methodology. Both the King County 1991 (Appendix B) and 2001a (Appendix C) protocols are based on the methods defined in the *USDA Forest Service Stream Habitat Classification and Inventory Procedures for Northern California* (McCain et al., 1990) as modified by King County staff. Additional data as outlined in the United States Forest Service (USFS) – *Stream Inventory Handbook for Region 6, Version 2.1* (USFS, 2001) was included.

Existing stream and watershed conditions were quantified by using watershed and habitat parameters as defined by the "Matrix of Pathways and Indicators" developed by the National Marine Fisheries Service (NMFS) (Table S-1). The "Matrix of Pathways and Indicators" summarizes important parameters for six major pathways that are vital for the continued survival of salmon including:

- Water Quality;
- Habitat Access;
- Habitat Elements;
- Channel Condition and Dynamics;
- Flow/Hydrology; and
- Watershed Conditions.

These six major pathways are further broken down into a total of 18 "indicators." As an example, the water quality pathway is composed of three indicators: temperature, sediment/turbidity, and chemical contamination/nutrients. Scientifically sound data was collected during this assessment to accurately assign the appropriate "condition" to each indicator as defined by the NMFS. The indicator conditions are classified as either: "properly functioning," "at risk," or "not properly functioning." Criteria for each condition is defined by a range or goal based on the best available scientific data available, but criteria are not absolute, and may be adjusted for unique watersheds (NMFS, 1996). Within this report, definitions and determinations of an indicators status are distinguishable by font. Definitions are italicized and determinations are in bold font. Existing conditions were documented to a level of detail that would allow for future trend analysis. Should

the criteria for the Matrix of Pathways and Indicators change, an appropriate condition for each indicator could be assigned based on the results presented in this report.

This report has also consolidated numerous supporting references such as salmon spawning survey data from the Washington Department of Fish and Wildlife (WDFW), and presents all the raw data for ease of record keeping and as an aid to future researchers. Furthermore, opportunities for restoration have been listed and prioritized based on the findings present within this report.

Little Bear Creek is currently utilized by at least nine species of fish including resident, adfluvial, and anadromous species. Resident fish spend their entire life in a specific stream. Adfluvial fish spawn and sometimes rear in a stream, but migrate to a lake to mature before returning to a stream to spawn. Anadromous fish spawn and rear in freshwater, but reach maturity at sea prior to returning to freshwater to start the process over again. Resident species documented in Little Bear Creek include coast range sculpins (*Cottus aleuticus*), western brook lampreys (*Lampretra richardsoni*), and cutthroat trout (*Oncorhynchus clarki*). Cutthroat trout are somewhat unique in that resident, adfluvial, and anadromous forms may utilize the same stream depending upon watershed conditions, life history type, and access to the ocean. Species that utilize the adfluvial life history include cutthroat trout and kokanee salmon (*O. nerka* [freshwater sockeye]). Anadromous species documented in Little Bear Creek include chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and sockeye salmon (*O. nerka*). Some species such as pink (*O. gorbuscha*) and chum (*O. keta*) salmon have rarely been observed in Little Bear Creek. However, due to their scarcity, they are not part of an established population, rather, they are strays from another watershed. Undocumented species such as steelhead trout (*O. mykiss*) could potentially utilize Little Bear Creek.

The results of this assessment indicate that Little Bear Creek is very similar to most urbanized Puget Sound lowland streams in that it has been severely impacted by past and current land-use activities. The percentage of total impervious surface has increased to about 37 percent and road density to 5.9 kilometers per square kilometer (km/km^2) (2.28 mi/mi^2) in the past 12 years (Purser and Simmonds, Snohomish County Surface Water Management, unpublished data as reported by Kerwin, 2001). Out of the 18 indicators examined, one was found to be partially **properly functioning** (temperature). Three were found to range from **not properly functioning to at risk** (varied by reach), three were **at risk**, while the remaining 11 were **not properly functioning**. The results are summarized below.

Although the existing habitat conditions reflect those frequently associated with an urbanized basin, Little Bear Creek is still an important salmon-bearing stream. Little Bear Creek possess numerous opportunities for enhancement and restoration that could significantly improve conditions for salmonids. The City of Woodinville is currently undertaking several stream restoration projects along the Little Bear Creek Corridor. Appendix R outlines current habitat enhancement projects along the corridor.

Little Bear Creek was segmented into three reaches based on land use and permanent landmarks. Reach 1 is defined as extending from the mouth to the SR 202 culvert crossing. Reach 2 is defined as extending from the SR 202 culvert crossing to the SR 522 culvert crossing. Reach 3 is defined as extending from the SR 522 culvert crossing to the NE 205th Street culvert crossing.

The majority of Reach 1 is developed up to the banks. The banks are armored with riprap and there are signs of localized erosion. This riprap should be removed. It is recommended that the banks be restored and stabilized using bioengineering methods. Improvements to the mouth such as the installation of large woody debris and create scour pools would also improve existing habitat conditions.

The amount of bank armoring (riprap) in Reach 2 is significantly less than in Reach 1. However, there are opportunities for riprap removal, and bank restoration and stabilization using bioengineering methods. There are areas of riparian habitat between Little Bear Creek and SR 522 that are candidates for acquisition. Connectivity between these areas and Little Bear Creek could be improved. In this reach there are culverted outfalls from regional and private storm drainage systems, and tributaries that could be used to create off-channel habitat.

There are similar opportunities in Reach 3, especially in the lowermost section. Riprap removal, bank restoration and stabilization using bioengineering methods, installation of large woody debris, and improved connectivity between remaining riparian habitat would improve existing conditions in Reach 3.

The majority of the Little Bear Creek corridor is privately owned. The City has acquired four parcels along the corridor. The Washington State Department of Transportation owns one parcel, and the SR 522 right-of-way through which segments of Little Bear Creek flow. It is recommended that the City look for opportunities to partner with residents, property owners, business owners, and other agencies on habitat enhancement projects. As redevelopment occurs along this corridor, an evaluation of potential habitat improvement opportunities should be undertaken to determine what could be done to restore and enhance the habitat. Potential improvements are outlined later in this report.

The following properties are outside the Little Bear Creek corridor, but within the watershed, that the City should evaluate for possible acquisition to preserve undeveloped upland forest habitat:

- North of Woodinville High School and west of 136th Avenue NE
- Northeast of 144th Avenue NE and NE 195th Street
- Southwest of North Woodinville Way and NE Woodinville Duvall Road

Purchase of these properties would help to maintain the amount of impervious area within the watershed, provide areas for groundwater recharge, and provide water quality benefits.

Table S-1:
Matrix of Pathway and Indicators Summary

PATHWAY	INDICATORS	BASELINE CONDITIONS
Water Quality	Temperature	Juvenile Migration and Rearing = Not Properly Functioning to At Risk Adult Migration and Spawning = Properly Functioning
	Sediment	Not Properly Functioning
	Chemical Contamination & Nutrients	Not Properly Functioning
Habitat Access	Physical Barriers	At Risk
Habitat Elements	Substrate	At Risk
	Large Woody Debris	Not Properly Functioning
	Pool Frequency	Not Properly Functioning
	Pool Quality/Depth	At Risk (not properly functioning in Reach 1)
	Off-Channel Habitat	Not Properly Functioning
	Refugia	Not Properly Functioning
Channel Conditions and Dynamics	Width/Depth Ratio	Reach 1: Not Properly Functioning Reach 2 and 3: At Risk
	Streambank Condition	Not Properly Functioning
	Floodplain Connectivity	Not Properly Functioning
Flow/Hydrology	Change in Peak/Base Flows	At Risk
	Increase in Drainage Network	Not Properly Functioning
Watershed Conditions	Road Density and Location	Not Properly Functioning
	Disturbance History	Not Properly Functioning
	Riparian Reserve/Conservation Areas	Not Properly Functioning (at risk in Reach 3)

Based on the results of this assessment, several additional actions have been outlined that could potentially improve existing habitat conditions in Little Bear Creek. These recommended actions include:

1. Obtain, preserve, and enhance land along Little Bear Creek to minimize further habitat degradation from continued development along the Little Bear Creek corridor. Undeveloped properties along the corridor with quality riparian habitat should be high priority acquisitions, such as, the properties to the north of the City's "Lumpkin" property (east of 134th Avenue NE crossing). Another area to consider would be the properties to the west of 134th Avenue NE as described in item 7.
2. Immediately initiate a program to reestablish conifers within the riparian zone throughout the Little Bear Creek corridor.
3. Restore hardened rip/rap banks along Little Bear Creek. Include creation of pool, and addition of large woody debris as part of the restoration plan.
4. Retrofit potential pollution-generating sites such as large parking lots and roadways with pollution prevention and storm flow retention facilities where such facilities are presently absent.
5. Reforest upland areas dominated by introduced species such as reed canarygrass and Himalayan blackberry.

6. Create off-channel habitat at each culverted tributary confluence with Little Bear Creek. This can be accomplished by daylighting the maximum extent of culverted tributary possible at each confluence.
7. The City of Woodinville should investigate the feasibility of purchasing the wrecking yard on 134th Avenue NE along the west side of Little Bear Creek. If this lot could be purchased several stream enhancement opportunities could occur. The first goals would be to remove soil contaminants within the lot and remove all structures. The second goal would be to use this crossing for enhancement efforts between Little Bear Creek and Highway 522 within Reach 2. Once these actions were completed the 134th Avenue NE crossing could be permanently removed, or replaced with a bridge.
8. The newly purchased city property immediately upstream of NE 195th Street is an ideal site for intensive in-stream, riparian, and upland habitat restoration activities. Actions that would benefit Little Bear Creek at this site include removal of bank armoring, creation of pool habitat, removal of impervious surface (pavement) and non-native vegetation, and installation of large woody debris, and riparian and upland vegetation.
9. Maintain regular street sweeping, storm drainage system cleaning, and add sediment traps where feasible. This will reduce the amount of sediment entering Little Bear Creek.

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1.0 INTRODUCTION

At the request of the City of Woodinville, David Evans and Associates, Inc. (DEA) conducted a Corridor Habitat Assessment along Little Bear Creek in King County during 2001. This assessment was carried out by accomplishing several tasks including: existing data collection and review, habitat and presence surveys for fish and wildlife, and documentation of findings.

The project goals were to document existing fish and wildlife habitat conditions and utilization, and identify potential restoration opportunities along Little Bear Creek within the City of Woodinville (Figures 1 and 2). DEA initially focused on collecting existing data for review and determination of data gaps. Once all readily available information was obtained and reviewed, the specific parameters and methods to be documented by DEA biologists were finalized. Fieldwork began during the spring of 2001 and continued through October 2001.

DEA biologists surveyed the entire stretch of Little Bear Creek that occurs within the City of Woodinville from June 25, through August 1, 2001. A total of 3,484.1 meters (2.2 miles) of stream was surveyed from the mouth of Little Bear Creek at the Sammamish River to the crossing under NE 205th Street along the City of Woodinville and Snohomish County line. Little Bear Creek was segmented into three reaches based on current land use and location of permanent landmarks (Figures 2 and 3). Reach 1 began at the mouth of Little Bear Creek and extended to the downstream end of the culverts under State Route (SR) 202. Reach 1 is composed of primarily industrial and commercial development. Reach 2 began at the downstream side of the culverts under SR 202 and extended to the upstream side of the culverts under Highway 522. Reach 2 is composed of primarily commercial development and public park/open space. Reach 3 began at the upstream side of Highway 522 and ended at NE 205th Street, which follows the City of Woodinville and Snohomish County line. Reach 3 is composed primarily of residential development.

Because Endangered Species Act (ESA) considerations are an important facet of current stream-related surveys, DEA also focused on collecting data that would assist in the determination of limiting factors as they relate to ESA listed salmonids. This included data required to address the Matrix of Pathways and Indicators developed by the National Marine Fisheries Service (NMFS): DEA utilized two versions of the Matrix. The original version was developed by the NMFS in 1996 and encompasses the entire Pacific Northwest (Appendix L-1). The Mt. Baker – Snoqualmie National Forest modified several of the indicators as originally outlined by the NMFS (Appendix L-2). In each case where the modified NMFS version is used it is cited as "NMFS as modified by the Mt. Baker – Snoqualmie National Forest." If the original NMFS version is used it is cited as "NMFS, 1996." A definition of *properly functioning*, *at risk*, and *not properly functioning* is provided for each condition, and a copy of the modified version is provided as an appendix.

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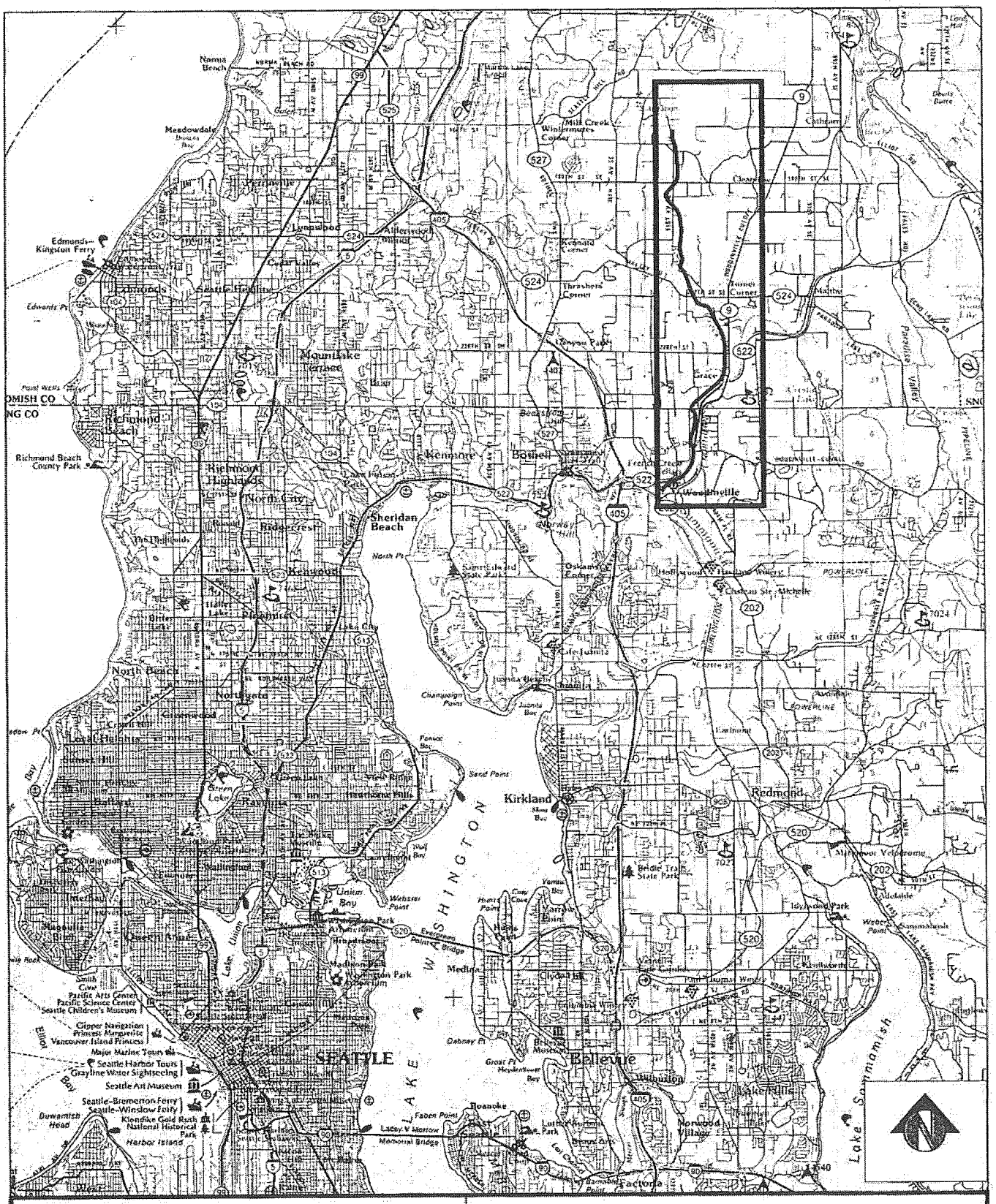

Vicinity Map

City of Woodinville - Little Bear Creek

WOOD0000-0010

September 2001

FIG. 1

DAVID EVANS AND ASSOCIATES INC

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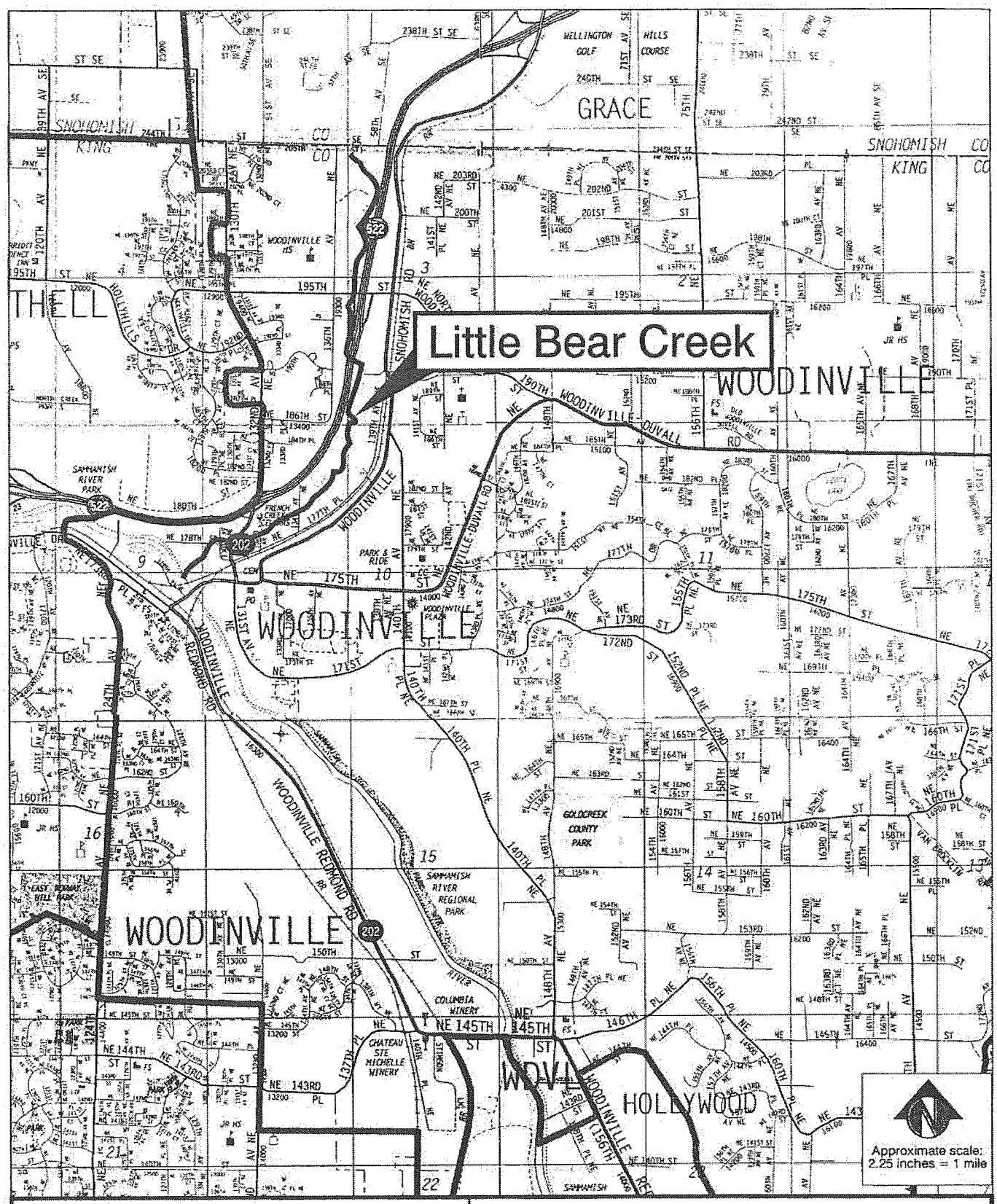

Site Map

City of Woodinville - Little Bear Creek

WOOD0000-0010

September 2001

FIG. 2

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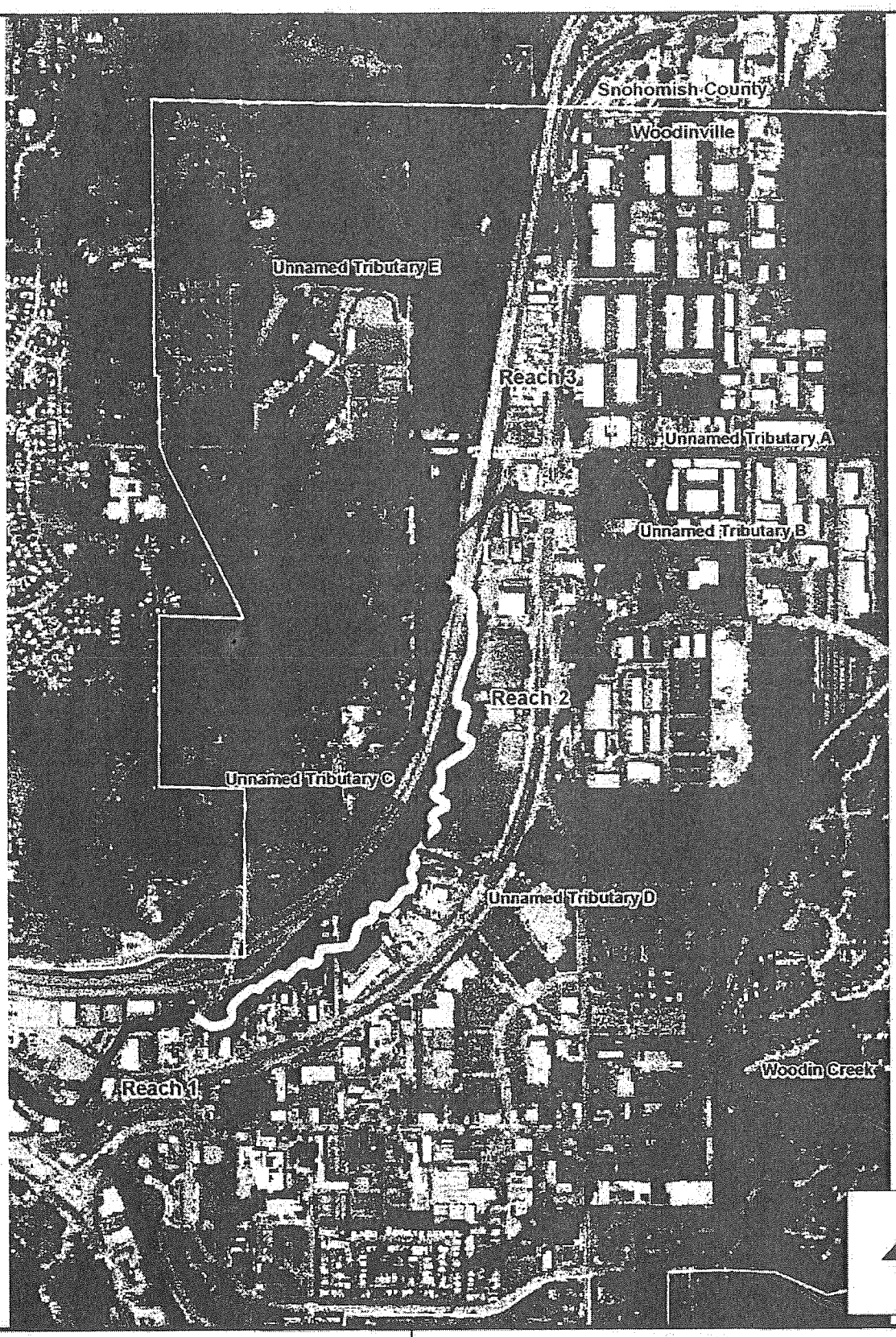


SOURCE

Aerial photo provided by City of Woodinville, representing 1999 conditions.

Site Map
Little Bear Creek Corridor Habitat Assessment

City of Woodinville - Little Bear Creek

WOOD0000-0010

May 2002

FIG. 3

DAVID EVANS AND ASSOCIATES INC

Gx0471

2.0 METHODOLOGY

A Little Bear Creek Corridor Habitat Assessment was conducted between June 25, 2001, and September 1, 2001, to evaluate existing habitat conditions of Little Bear Creek within the City of Woodinville, King County, Washington. The methodology utilized was an enhanced combination of several protocols that results in collecting data for 16 general tasks. DEA used aspects of two King County protocols (1991 and 2001a), and the U.S. Forest Service (USFS) protocol (USFS, 2001). The combining of aspects from all three methodologies results in a comprehensive habitat analysis that is compatible and comparable with other data collected using any of these methodologies. The stream survey included the following tasks:

1. Measure temperature, dissolved oxygen, conductivity, turbidity, and pH at the beginning and end of each project stream utilizing a Horiba U-10 water quality meter.
2. Measure stream flow with a Swoffer flow meter.
3. Measure stream gradient in each reach.
4. Document condition, type, and size of every culvert encountered within each stream to include sediment accumulation, fish passage, and photo documentation.
5. Categorize each habitat type into one of the 22 channel geomorphic types as outlined by McCain et al., 1990.
6. Measure the length, average depth, and average width of each habitat type.
7. Measure the length, tailout depth, maximum depth, average depth, and width of each pool encountered.
8. Measure bankfull width at several representative riffles within each reach.
9. Document the length, diameter, species, decay class, and zone of influence for each piece of woody debris longer than 2 meters (6.6 feet) and wider than 10 centimeters (3.9 inches) encountered within the stream channel.
10. Conduct a Wolman Pebble count in at least two representative riffles per reach. Increase the number of measures as reach length and complexity increase.
11. Document substrate composition visually throughout the stream.
12. Document riparian species composition and age.
13. Document the species and location of any fish or wildlife observed during the survey.
14. Document the location of all side channels or tributaries encountered.
15. Document the degree of bank armoring and severe erosion along each stream reach.
16. Photo document representative stream reaches and features of note encountered during the survey.

2.1 EXISTING DATA

A listing of initial existing data collected on fish and wildlife habitat, species presence and abundance, water quality and hydrology, and land use along Little Bear Creek was previously presented to the City of Woodinville (Appendix A). Additional literature collected after the initial review of existing data is cited within the text and reference section as appropriate.

2.2 FISHERIES RELATED DATA

2.2.1 In-stream Habitat

DEA utilized the *Inventory Methods for Wadable Streams in King County* (King County, 2001a) as the primary methodology. Both the King County 1991 (Appendix B) and 2001a (Appendix C) protocols are based on the methods defined in the *USDA Forest Service Stream Habitat Classification and Inventory Procedures for Northern California* (McCain et al., 1990) as modified by King County staff. Habitat units are defined as one of 22 habitat types listed in Table 1 below. Additional data as outlined in the USFS – *Stream Inventory Handbook for Region 6, Version 2.1* (USFS, 2001) was included.

Table 1:
Stream Habitat Types

1.	Low gradient riffle	12.	Lateral scour pool - bedrock formed
2.	High gradient riffle	13.	Dammed pool
3.	Cascade	14.	Glide
4.	Secondary channel pool	15.	Run
5.	Backwater pool - boulder formed	16.	Step run
6.	Backwater pool – rootwad formed	17.	Mid-channel pool
7.	Backwater pool – log formed	18.	Edgewater
8.	Trench/chute	19.	Channel confluence pool
9.	Plunge pool	20.	Lateral scour pool - boulder formed
10.	Lateral scour pool - log formed	21.	Pocket water
11.	Lateral scour pool - rootwad formed	22.	Corner pool

Source: McCain et al., 1990.

King County surveyed most of the entire length of Little Bear Creek in 1999 (King County, 2001b). Because of variations in project goals and methodologies only select results from their previous survey were incorporated into this report. Specifically, DEA used their bankfull width to depth ratio, scour, and bank stability data.

A hip-chain was used to measure habitat lengths and create station numbers. The hip-chain was zeroed at the lowermost starting point at each stream reach and utilized to document the location of each feature or action taken along the stream reach. Each habitat unit was defined as occupying only the area actually wetted at the time of the survey. Habitat width was measured with a 22.9-meter (75-foot) tape, habitat length with a hip chain, and habitat depth with a 1.2-meter (4-foot) stick graduated in centimeters. DEA biologists used the U.S. Geological Survey (USGS) standard of defining "left bank" (LB) and "right bank" (RB) as when facing downstream.

2.2.2 Fish Abundance and Distribution

Data collected by the Washington State Department of Fish and Wildlife (WDFW) and King County was used to document the presence, abundance, and distribution of salmonids in Little Bear Creek (WDFW, 2001a). Additional data was collected through field investigations.

DEA biologists electrofished four locations along the mainstem of Little Bear Creek on August 24 and 31, 2001, prior to the arrival of returning adult salmon. Sites electrofished included

immediately upstream of the mouth, upstream of SR 202, downstream and upstream of 134th Avenue NE, upstream of NE 195th Street, downstream of NE 205th Street (Figure 2), and several sites in one unnamed tributary (Figure 3 – Unnamed Tributary D). DEA utilized a Smith-Root Model 12 electrofisher with a frequency setting of 60 Hz and output voltage of 500 volts. All fish captured were first placed in a bucket of water containing a "pinch" of Tricaine Methanesulfonate prior to species identification and measurement of total length. Tricaine Methanesulfonate relaxes the fish for ease of handling, and reduces injuries and oxygen consumption. After handling, all fish were placed in a second bucket with fresh water to recuperate prior to release.

All fish observed during the habitat survey from June 25, 2001, to September 1, 2001, were identified to the species level when possible. Additional surveys directed at encountering returning/spawning adult salmonids were conducted between September 20, and October 18, 2001. The number and location of redds, and whether spawning behavior was occurring was also noted. Accessible points such as trail and road crossings were surveyed. DEA biologists also surveyed extended sections of various reaches to document the upper extent of spawning and potential presence of barriers.

2.2.3 Riparian Habitat

DEA biologists used aerial photo interpretation and ground truthing to document riparian scale and composition. The width of potential riparian habitat analyzed incorporated 61 meters (200 feet) from the stream edge along each side of the stream for a total corridor width of 122 meters (400 feet). The amount of riparian habitat and impervious surface within the 122-meter (400-foot) corridor was then calculated. DEA used aerial photographs from 1999 that were expanded to a scale of 2.54-centimeter (1-inch) equaling 31.40 meters (103 feet). The amount of forest, shrub/grass, gravel, and impervious area within 60.96 meters (200 feet) of each side of the stream was then calculated with a PLANIX 7 – Tamaya digital planimeter. The species composition, age, and structure were then listed and documented by ground truthing. The stream side vegetation was also classified as coniferous, deciduous, or mixed. Plant species were identified according to Cooke (1997), Pojar and MacKinnon (1994), and Hitchcock and Cronquist (1973).

2.2.4 Water Quality and Hydrology

2.2.4.1 Water Quality

Existing water quality data for Little Bear Creek was obtained from both King and Snohomish counties. Published water quality data for Little Bear Creek as it flows through the City of Woodinville is available in *Water Quality of Small Streams – Western King County 1990 – 1993* (King County, 1994).

Published water quality data for Little Bear Creek in Snohomish County is available in *The State of the Waters: Water Quality in Snohomish County's Rivers, Streams, and Lakes – 2000 Assessment* (Snohomish County, 2000). Additional water quality data for Little Bear Creek in Snohomish County was obtained by contacting the Snohomish County Public Works – Surface Water Management (Thornburgh, personal communication, 2001).

Additional water quality data was collected by DEA. A Horiba U-10 water quality meter was used on several occasions to document temperature, pH, conductivity, dissolved oxygen, and turbidity.

Furthermore, two temperature monitors were deployed in Little Bear Creek between June 15, and October 18, 2001, to document stream temperature on an hourly basis. DEA utilized two 32K waterproof Stowaway Tidbit monitors set to collect hourly readings. One was installed in Little Bear Creek near its confluence with the Sammamish River, and the other was installed near the King and Snohomish county line immediately downstream of NE 205th Street.

2.2.4.2 Hydrology

Hydrology data for Little Bear Creek was obtained from King County (2001c). Hydrology data is collected in King County at the SR 202 crossing of Little Bear Creek in the City of Woodinville (Station #30). DEA biologists also used a Swoffer Model 2100 flow meter on two occasions to document site specific conditions. The first measurement was made on June 25, 2001, at the beginning of the in-stream habitat survey near the confluence of Little Bear Creek and the Sammamish River. The second event occurred on August 29, 2001, to document variation of flow at Little Bear Creek as it enters Woodinville at NE 205th Street, and near its confluence with the Sammamish River.

2.3 WILDLIFE RELATED DATA

2.3.1 Habitat Availability

DEA biologists mapped plant communities by interpreting aerial photographs and ground-truthing. DEA translated plant communities into habitat types. Biologists established 17 circular plots with a 10-meter (32.8-foot) radius in representative locations between the creek and the nearest development in all habitat types. DEA identified dominant, common, and infrequent plant species; estimated tree diameter at breast height (DBH); counted snags, stumps, and logs; observed trees for raptor nests; and assessed overall condition of each habitat area.

2.3.2 Wildlife Presence

2.3.2.1 Birds

DEA biologists surveyed birds on May 18, May 31, and June 18, 2001, using the variable circular-plot method (Reynolds et al., 1980). Surveys began at sunrise and ended by 9:15 AM (Robbins, 1981). DEA established 20-meter (65.6-foot) radius plots in all habitat types and surveyed for 10 minutes in each plot, recording species observed visually and aurally both in and outside of the plots. Biologists surveyed 16 plots on May 18, and 13 plots on subsequent survey days.

2.3.2.2 Bats and Owls

DEA biologists surveyed for owls at seven stations on June 19, and July 7, 2001, by soliciting birds with amplified taped recordings and listening for a response with the unaided ear. At each of 7 stations, located in each habitat type in the study area, biologists broadcast calls for approximately 1 minute and listened for a period of approximately 3 minutes. DEA repeated this procedure 3 times at each station. Although there was no standard distance between stations, we chose stations that were far enough apart to avoid double counting while still covering the entire study area. Biologists scanned each station and the surrounding areas with a 20 to 160 kHz bat detector at 1- to 2-minute intervals for approximately 10 minutes and recorded all frequencies of all detections.

2.3.2.3 Mammals

DEA biologists recorded all mammal species observed during all visits to the study area. Biologists searched for, examined, and recorded all mammal sign, including tracks, scats (wildlife excrement), and runways (animal trails). In addition to the site visits conducted for the wildlife and habitat analyses, DEA biologists also documented mammal observations while conducting the stream survey.

2.3.2.4 Reptiles and Amphibians

DEA biologists conducted reptile and amphibian surveys on May 31, and conducted searches during stream surveys. Biologists overturned logs and debris and searched at the bases of plants and along Little Bear Creek. DEA biologists identified and recorded all individuals observed. All captured specimens were returned to the point of capture unharmed and all overturned logs and debris were placed back in their original location.

3.0 HISTORIC CONDITIONS

To better understand existing conditions and possible future trends, historic conditions must be considered. The focus of this report is on fish, wildlife, habitat, and restoration potential along the Little Bear Creek corridor through the City of Woodinville. Although very little site-specific information on the historic conditions of Little Bear Creek as they relate to fish and wildlife is known, some data is available. The "historic conditions" defined as that time from the retreat of the Vashon Glacier approximately 14,000 years ago to the present can be segmented into pre European settlement and post European settlement time periods. The transition between pre and post European settlement time period near Woodinville occurred during the early 1870s. A brief overview is provided below.

3.1 PRE EUROPEAN SETTLEMENT

For the purposes of this report the pre European time period began approximately 14,000 years ago with the retreat of the glaciers and lasted until the arrival of the European settlers in 1870. The Sammamish River Valley was historically dominated primarily by giant western red cedar trees (*Thuja plicata*). Other conifers such as Douglas fir (*Pseudotsuga menziesii*) and Sitka spruce (*Picea sitchensis*) were also present. Several stumps of these remnant trees were observed along the banks of Little Bear Creek during the 2001 survey conducted by DEA. They often had burn marks and "spring board" notches where planks were used by loggers to reach the desired cut location above the tree buttress. Furthermore, old cedar tree stump fragments were also encountered during the in-stream habitat survey and classified as woody debris when they met or exceeded the length and width parameters.

Lake Washington was larger and deeper than at present, and the Sammamish River was longer, and contained numerous meanders and oxbows. The Sammamish River was about 30 miles long, heavily forested to its banks, and very difficult to navigate due to the abundance of fallen trees (King County, 2001d). Besides being lined with large trees, "swamp land" abutted both banks especially near its mouth. The Sammamish River was previously known as Squak Slough, and while the local Indians

were also known as the Squaks, they were really part of the Simump tribe (Stickney and McDonald, 1977). The native Americans lived primarily near Lake Sammamish, but traveled and camped along the Sammamish River. The Sammamish River corridor was also likely utilized by several other tribes as an east-west route.

3.2 ARRIVAL OF EUROPEAN SETTLERS

One of the first Europeans known to have traveled up the Sammamish River was Sam Hancock, who in 1850 explored for coal in the region (Stickney and McDonald, 1977). The earliest land claims in the Woodinville area were by George Wilson and Columbus Greenleaf in 1870 (King County, 2001d). In 1871 the Woodins became the first settlers after rowing across Lake Washington with all their goods and building a log cabin along the bank of the Sammamish River. They passed a couple other homesteads on their journey up the Sammamish River. Other families slowly moved into the area to log the local forests and establish homesteads. By 1897 four families owned most of the land along Little Bear Creek in Township 26 North, Range 5 East (Appendix E). Each of these landholders owned approximately one-quarter section along Little Bear Creek in what today is known as the City of Woodinville. The City of Woodinville was given its name in honor of the first pioneers, Ira and Susan Woodin sometime around 1887. The railway network grew rapidly in the area from 1877 through 1888 and was used extensively for both timber and coal transport. The railroad reached Woodinville in 1877 and Issaquah in 1888. By the 1890s several stores, hotels, saw mills, meat markets, and other enterprises became established.

Logging the old-growth forest was the primary occupation during this period. The local rivers played an important role in the transport of timber prior to the arrival of railroad. However, as the land was cleared and large first-growth trees became more distant, farming became more prevalent. The Sammamish River valley had been mostly cleared of giant western red cedar trees by the early 1920s. What was referred to as "stump farms" dotted the landscape during this time, but were gradually being cleared. Because heavy equipment was scarce and consisted primarily of horse drawn devices, the most common method of stump removal was by dynamiting and then burning the stump. As the stumps were removed, farming the rich river valley became the primary occupation in the area and the local population grew.

Other events related to logging and navigation that would result in changes to Little Bear Creek were occurring closer to Seattle during this same time period. In the 1880s a small channel and lock was built at Montlake to carry logs to mills. Lake Washington originally drained into the Black River that flowed into the Duwamish River prior to reaching Elliott Bay. In 1912 the Cedar River was diverted from the Black River into Lake Washington. This resulted in the replacement of the Black River as Lake Washington's outlet with the Cedar River as a new inlet. The Hiram M. Chittenden Locks and a fish ladder were completed by 1916 resulting in Lake Washington being lowered 2.7 meters (9 feet). In the early 1920's the historically slow and meandering Sammamish River was straightened, narrowed, and later dredged. By the 1930s stocks of chum and pink salmon had been extirpated, but three new stocks including Baker River sockeye, Green River coho and chinook salmon had been introduced (Goetz, proceedings from Conference, 2000).

Little is known about the composition and distribution of fish and wildlife during the early days of Little Bear Creek. Early accounts say the land was occupied by deer, cougar, bear, and migratory

waterfowl (Stickney and McDonald, 1977). Additional stories mention settlers being confined to their cabins during bad weather and hearing the howling of wolves, and others mention trapping bear, otter, raccoon, muskrat, and mink. Waterfowl were apparently abundant in the adjacent marshes since hunters would travel from Seattle to hunt the area, and Indians used the area extensively to hunt ducks. Duck clubs were present along the river that catered to wealthy Seattle residents. They hunted mallards, teal, and widgeon using decoys and feed to attract them within the marshy areas. Many of the adjacent marshes were drained as a result of the lowering of Lake Washington.

Settlers make no mention of salmon in the early accounts. Although it was noted that the local Indians hunted ducks along the marshy land adjacent to the Sammamish River, no reference to salmon is made. According to one resident, fishing in the Sammamish River during the early 1920s was not very good (Repman, personal communication, 2001). Mr. Repman recalled catching bullheads, chub, and an occasional chum salmon as a youth. It is likely that native populations of anadromous salmonids had drastically declined by this time. However, populations of resident kokanee (land-locked sockeye) were very abundant in the Lake Washington System during this time period (King County, 2000a). Mr. Repman was also an avid hunter who targeted grouse, quail, and pheasant (introduced). Between 1925 and 1970 he did not see any bear, cougar, or deer. According to Mr. Repman, deer showed-up later, after the surrounding uplands had been logged, and were more prevalent after the 1970s.

Based on a review of the first aerial photographs of Little Bear Creek during 1936 (Appendix F), riparian vegetation had been cleared from much of the stream by this time. The lower most reach downstream of what would become SR 202 was totally devoid of riparian vegetation by this time. Further upstream, thin segments of riparian vegetation lined some sections of the stream. The stream banks became more forested upstream of what would become NE 195th Street during 1936.

The local population around Woodinville began to expand rapidly after World War II. The City of Woodinville had been agricultural and very rural until a large influx of people began arriving from the 1950s through the 1970s. The creation of Interstate 405 in the 1960s and Highway 522 allowed for the exponential expansion of the area as developers began building and selling entire neighborhoods. By the 1980s, rural Woodinville had completely changed into its current suburban landscape. Woodinville was part of unincorporated King County until 1993.

4.0 EXISTING CONDITIONS

4.1 LITTLE BEAR CREEK WATERSHED

Little Bear Creek is a 12.4-kilometer (7.7-mile) long second order stream that drains a 3,885-hectare (9,600-acre) watershed in both Snohomish and King counties, Washington. Approximately 3,108 hectares (7,680 acres) (80 percent) of the upper watershed are located in Snohomish County while 777 hectares (1,920 acres) (20 percent) are in King County. While in King County, Little Bear Creek flows through the City of Woodinville for approximately 3.5 kilometers (2.2 miles) from NE 205th Street to its mouth on the Sammamish River at River Mile (RM) 5.4 (Figure 4). The headwaters of Little Bear

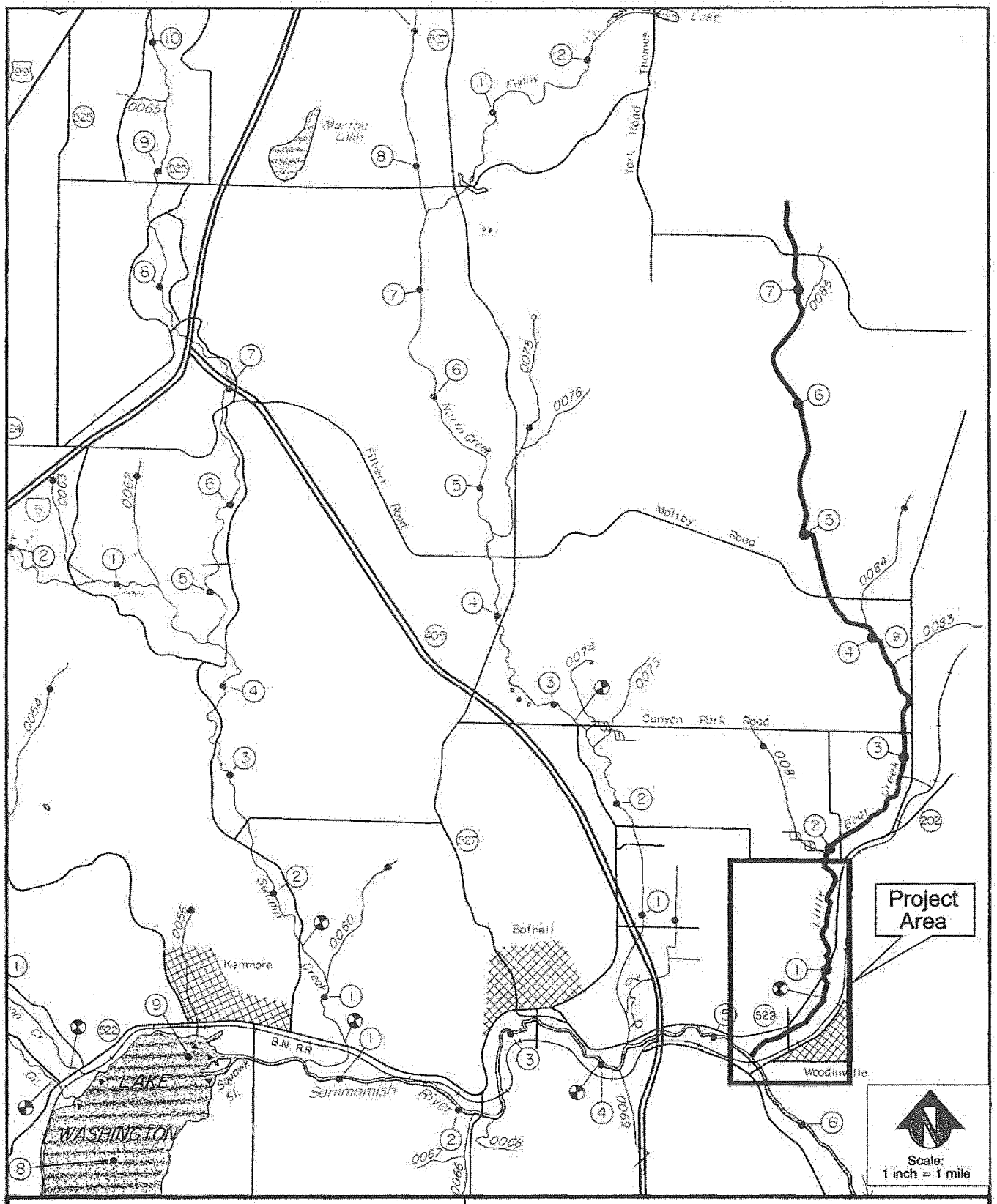
Creek are located in a peat bog 2.4 kilometers (1.5 miles) west of Clearview in Snohomish County. The elevation along Little Bear Creek varies from 76 meters (250 feet) near its headwaters to 6 meters (20 feet) at its confluence with the Sammamish River. Based on these elevations, the overall gradient of Little Bear Creek is about 0.6 percent. Other reports state the overall gradient is about 0.8 percent based on an elevation of 94.50 meters (310 feet) near Clearview (Kerwin, 2001).

4.2 CITY OF WOODINVILLE

The City of Woodinville currently covers 1,461 hectares (3,610 acres) and has a population of 9,294 people. The population is expected to reach 13,400 people by the year 2010 based on 1990 census data. Land use within the city is composed of residential (59.0 percent), commercial (9.2 percent), industrial (13.4 percent), park/open space (1.2 percent), public right-of-way (11.8 percent) and other (5.4 percent) designations.

4.3 FISHERIES

Little Bear Creek has been utilized by at least nine resident and anadromous species of fish. This includes anadromous, adfluvial, and resident salmonids, and sculpins and lampreys. Table 2 below lists the common name, scientific name, and documentation source for each species known to have utilized Little Bear Creek. Some species such as chum and pink salmon have been documented only once. Chinook salmon occur seasonally in low numbers, while other species such as sockeye and coho salmon, and cutthroat trout can be very abundant. Undocumented species could also occasionally utilize Little Bear Creek as well. An example of undocumented species that could be present includes steelhead trout (*Oncorhynchus mykiss*) and other species of sculpin (*Cottus* spp.). Native char (bull trout/Dolly varden) were not considered in this report due to a lack of documentation and absence of suitable habitat. Native char have never been documented in Little Bear Creek, and although it is theoretically possible that if they were to enter the Sammamish River they could investigate Little Bear Creek, the downstream limit of successful char spawning is always upstream of the winter snow line (WDFW, 1999). Because the headwaters of Little Bear Creek originate at an elevation of about 94.50 meters (310 feet), suitable char spawning habitat is not present in Little Bear Creek due to elevated stream temperatures throughout the basin. If bull trout were to ever be present in Little Bear Creek, it would likely be foraging adults or sub-adults, or possibly wayward adults searching for suitable spawning habitat.



SOURCE
Williams et al. 1975

WDFW - Lower Sammamish River Drainage

City of Woodinville - Little Bear Creek

WOOD0000-0010

November 2001

FIG. 4

DAVID EVANS AND ASSOCIATES INC

Gx0317

Table 2:
Fish Species Documented in Little Bear Creek

#	Common Name	Scientific Name	Source
1.	Coast Range Sculpin	*Cottus aleuticus*	DEA
2.	Western Brook Lamprey	*Lampretra richardsoni*	DEA
3.	Cutthroat Trout	*Oncorhynchus clarki*	DEA
4.	Pink Salmon	*Oncorhynchus gorbuscha*	WDFW
5.	Chum Salmon	*Oncorhynchus keta*	WDFW
6.	Coho Salmon	*Oncorhynchus kisutch*	WDFW, King County, & DEA.
7.	Sockeye Salmon	*Oncorhynchus nerka*	WDFW & King County, & DEA
8.	Kokanee	*Oncorhynchus nerka*	WDFW & King County, & DEA
9.	Chinook Salmon	*Oncorhynchus tshawytscha*	WDFW, NMFS, & King County.

At least 40 different non-native species of fish have been introduced into the Lake Washington watershed since the arrival of the first European settlers. However, many of these introduced species did not survive and today approximately 24 species remain (Kerwin, 2001). A listing of 21 species of native and non-native fish that have been documented within the greater Lake Washington watershed are included in Table 3 below. Introduced species have become prevalent in both Lake Washington and Lake Sammamish, and continue to adversely impact native salmonids. Although the list presented in Table 3 below is not all-inclusive, it provides evidence of the shear abundance of non-native species of fish that still inhabit the Lake Washington watershed. Some of these species listed in Table 3 likely utilize the Sammamish River and therefore potentially the lowermost reach of Little Bear Creek. The likelihood of any of these additional undocumented species being present in Little Bear Creek varies by species.

Table 3:
Additional Fish Species Documented in the Greater Lake Washington Watershed

#	Common Name	Scientific Name	Native or Introduced	Resident or Anadromous	Status
1.	White sturgeon	*Acipenser transmontanus*	Locks created access	Anadromous	Rare visitor
2.	Largescale sucker	*Catostomus macrocheilus*	Native	Resident	Unknown
3.	Lake whitefish	*Coregonus clupeaformis*	Introduced in 1899	Resident	No longer present
4.	Prickly sculpin	*Cottus asper*	Native	Resident	Abundant
5.	Shorthead sculpin	*Cottus confusus*	Native	Resident	Abundant
6.	Carp	*Cyprinus carpio*	Introduced	Resident	Locally abundant
7.	Three-spine stickleback	*Gasterosteus aculeatus*	Native	Both	Unknown
8.	Brown bullhead	*Ictalurus nebulosus*	Introduced	Resident	Unknown
9.	Pumpkinseed	*Lepomis gibbosus*	Introduced	Resident	Sparse
10.	Pacific staghorn sculpin	*Leptocottus armatus*	Native	Both	Sparse
11.	Smallmouth bass	*Micropterus dolomieui*	Introduced	Resident	Abundant
12.	Largemouth bass	*Micropterus salmoides*	Introduced	Resident	Abundant
13.	Peamouth	*Mylocheilus caurinus*	Native	Resident	Unknown
14.	Olympic mudminnow	*Novumbra hubbsi*	Unknown	Resident	Rare: one siting
15.	Steelhead trout	*Oncorhynchus mykiss*	Native	Both	Stock depressed
16.	Yellow perch	*Perca flavescens*	Introduced	Resident	Abundant
17.	Black crappie	*Pomoxis nigromaculatus*	Introduced	Resident	Sparse
18.	Northern Squawfish	*Ptychocheilus oregonensis*	Native	Resident	Unknown
19.	Bull trout	*Salvelinus confluentus*	Native	Both	Rare
20.	Longfin smelt	*Spirinchus thaleichthys*	Native	Resident	Unknown
21.	Tench	*Tinca tinca*	Introduced	Resident	Unknown

4.3.1 Chinook Salmon

The Puget Sound chinook salmon evolutionarily significant unit (ESU) was designated as threatened on March 24, 1999 (64 FR 14308). This ESU includes all naturally spawned spring, summer, and fall runs of chinook salmon in the Puget Sound region. Puget Sound chinook salmon critical habitat was designated on February 16, 2000 (65 FR 7777). Critical habitat is designated to include all marine, estuarine and river reaches that could be utilized by chinook salmon in the Puget Sound region. This incorporates the riverbed, bank, and riparian zone in all rivers currently or historically utilized by Puget Sound chinook salmon. Based on the fact that fall run chinook salmon utilize Little Bear Creek, the stream and shoreline are designated critical habitat.

Salmon spawning ground survey data from the WDFW from 1952 through 2000 indicates that chinook salmon utilization of Little Bear Creek is typically limited to less than 8 individuals (Table 4). The maximum daily count was 28 chinook salmon on October 21, 1981, but was typically between 1 and 5 (Appendix J). The highest yearly count occurred in 1981 when a total of 62 chinook salmon were counted (Table 4). The majority of higher counts occurred between RM 4.4 and 5.5. Sightings were made as early as September 29, and live fish were observed as late as November 3. Although the WDFW has surveyed Little Bear Creek since 1952, the first documented adult chinook salmon did not occur in Little Bear Creek until 1971 when one carcass was found on November 11 between RM 4.4 and 5.4.

Table 4:
Chinook Salmon Summary for Little Bear Creek based on WDFW Salmon Spawning Ground Survey Data

Year	Live Count	Dead Count	Total Count
1971	0	1	1
1972	0	1	1
1973	0	1	1
1974	3	3	6
1975	4	1	5
1976	13	12	25
1977	2	16	18
1978	11	40	51
1979	0	1	1
1980	0	2	2
1981	20	42	62
1982	0	3	3
1983	0	3	3
1984	0	4	4
1985	11	4	15
1986	0	5	5
1987	7	3	10
1988	0	6	6
1989	1	3	4
1990	0	0	0
1991	0	0	0
1992	0	0	0

Table 4 continued

Year	Live Count	Dead Count	Total Count
1993	0	0	0
1994	0	7	7
1995	0	0	0
1996	1	4	5
1997	0	0	0
1998	0	0	0
1999	0	0	0
2000	0	0	0
Total	73	162	235
Average	2.4	5.4	7.8

During the King County surveys from 1996 to 1999, year to year sightings have varied from zero to 12 observations. These numbers represent the minimum number of fish present since the entire stream was not surveyed. However, it does further indicate that Little Bear Creek is not heavily utilized by chinook salmon.

The origin of chinook salmon in Little Bear Creek is uncertain. Straying from either Bear Creek and/or the Issaquah Creek Hatchery is highly probable. Plants of fry and fingerling chinook salmon directly into Little Bear Creek totaled 1,083,300 from 1983 through 1992 (Appendix H). These were all fall chinook from the Issaquah Hatchery. No more plants by the WDFW are currently planned for Little Bear Creek (Foley, personal communication, 2001). In May of 2001, the Issaquah Creek Hatchery released 2,194,773 juvenile chinook salmon into Issaquah Creek. Some of the juveniles from the Issaquah Creek Hatchery and from naturally produced spawners in Bear Creek may utilize the lower segment of Reach 1 during their outmigration through the Sammamish River.

Juvenile chinook salmon typically exhibit either ocean-type or stream-type life history strategies. The primary difference between these strategies is residence time and growth rates. For the purposes of this report, residence time is important. Juvenile chinook salmon within the Lake Washington watershed exhibit the ocean-type strategy which means they rapidly exit their natal stream after emergence from the gravel (Fresh, personal communication, 2000). Data collected and analyzed by the WDFW indicate that the majority of the total juvenile out-migration in Bear Creek (immediately east of Little Bear Creek) occurred after mid-April, but varied between years (Seiler, 2001). The overall out-migration period ranges from mid-January through late June, but spikes between March and June. These trends can be expected to be "similar" to what occurs in Little Bear Creek.

4.3.2 Coho Salmon

Puget Sound/Strait of Georgia coho salmon was designated as a candidate for listing under the ESA on July 25, 1995 (60 FR 38011). If its status is changed to either threatened or endangered in the future, critical habitat may be designated at that time.

Salmon spawning ground survey data from the WDFW from 1952 through 2000 indicates "fair" numbers of coho salmon consistently spawn in Little Bear Creek, but during some years they are very abundant. The average total number of coho salmon observed each year in Little Bear Creek is

approximately 380 (1952 through 2000 excluding 1962 and 1969 [no data]). However, from 1976 to 1978 when the WDFW conducted intensive salmon spawning surveys at Little Bear Creek an average of approximately 2,700 coho were observed per year (range = 1,448 to 4,852). The abundance of coho salmon in Little Bear Creek appears to have dropped in the late 1980s to early 1990s. Prior to 1991 the yearly average total number of observations was approximately 460, after 1991 the yearly average was 68 with a high of 168 in 1995.

The two highest single day counts included 197 on December 14, 1979, and 191 on December 11, 1987 (Appendix J). Both of these daily counts only represent the adults observed between RM 4.4 and 5.5 on a specific day, and therefore, do not represent the total number of spawning adults in Little Bear Creek. From 1988 through 2000, the highest daily counts have been 40, 45, 46, 36, 9, 26, 4, 48, 38, 68, 25, 12, and 36, respectively. As previously stated, these numbers are not absolute in that they can only be used as an indicator of abundance. Numerous factors such as time of year, observer bias, survey effort, survey timing, flow, water clarity, and weather can all play a role in the total number of observations.

Unlike chinook salmon, coho juveniles spend from 1 to 2 years in freshwater before heading to sea. Their extended period of rearing in freshwater makes them especially vulnerable to changes in habitat, water quality, and hydrology. Following this period of freshwater residence, the juveniles migrate downstream to Lake Washington and then the ocean. They then spend about 18 months at sea before returning to their stream of origin for spawning (Wydoski and Whitney, 1979). Returning adult coho salmon stray within a watershed, and between watersheds.

Low numbers of juvenile coho salmon were captured in Reach 1, 2, and 3 during our electrofishing survey on August 24, and 31, 2001 (Appendix K). The total coho catch in Reach 1 was three juveniles during 110 seconds of effort, or one per 36.7 seconds. Juvenile coho represented 8.3 percent of the catch in Reach 1. One of the three coho had a clipped adipose fin and was therefore likely from the Issaquah Hatchery. The hatchery coho was much larger than the others with a total length of 10.7 centimeters (4.2 inches) versus an average length of 8.6 centimeters (3.4 inches) for the naturally produced coho (range: 8.4 to 8.9 centimeters [3.3 to 3.5 inches]). Two coho were captured in Reach 2 during 320 seconds of effort.

Electrofishing in Reach 3 produced the most coho, except that all the captures occurred in the upper-most section downstream of NE 205th Street. A total of nine juvenile coho were captured in the upper section of Reach 3 during 141 seconds of effort. This equates to one coho per 15.7 seconds of effort. Juvenile coho represented 20.4 percent of the salmonid catch in the upper section of Reach 3. Juvenile coho in the upper section of Reach 3 were smaller than those captured in Reach 1 with an average length of 7.8 centimeters (3.08 inches) ranging from 7.6 to 8.3 centimeters (3 to 3.25 inches). Overall, juvenile coho represented 7.7 percent of the total catch in Little Bear Creek. No coho were captured immediately upstream of NE 195th Street although 29 cutthroat trout and six sculpins were caught. No hatchery coho were captured in any section of Reach 2 or Reach 3.

The WDFW has planted 2,927,707 emergent, fingerling, fry, pre-smolt, and smolt coho salmon into Little Bear Creek between 1952 and 1978, and 1,161,763 between 1984 and 1997 (Appendix H). This does not include additional plants by the tribes, schools, or other organizations. During March of 2001, the Issaquah Creek Hatchery released two different size classes into Issaquah Creek totaling

2,250,549 (Appendix I). One of these juvenile coho was captured in Reach 1 of Little Bear Creek on August 24, 2001.

4.3.3 Sockeye Salmon

Sockeye salmon differ from other species of salmon in that juveniles require a lake environment to exist, where they spend 12 to 15 months maturing prior to going to sea (Wydoski and Whitney, 1979). Returning adult sockeye enter Lake Washington in late June and July, reside in Lake Washington until late August, and then spawn in numerous tributaries between September through early December (peaking in mid-October). An average female will produce approximately 4,000 eggs that hatch in 6 to 9 weeks, and then reside within the substrate for another 2 to 3 weeks. The newly hatched juveniles migrate from the tributaries into Lake Washington between January and April, but typically peak during March. These fish are the progeny of transplants from Baker River around the 1930s.

Kokanee are sockeye salmon that spend their entire life in freshwater. They are segmented into early-run and late-run races. Early-run kokanee spawn from August through September while the late-run spawns from October through December (King County, 2000a). The early-run variance is native to the Lake Washington system and has received much notice lately due to a decline in abundance. The late-run are the progeny of hatchery fish from Lake Whatcom planted in Big Bear Creek in the 1930s and 3.5 million planted in Lake Sammamish between 1976 and 1979 (King County, 2000a). However, the total number of kokanee planted in the Lake Washington system was approximately 35 million fry and fingerlings.

Several organizations have petitioned the United States Fish and Wildlife Service (USFWS) to list the early-run kokanee as an endangered species. To date, the USFWS has not responded to these petitions despite the population crash that occurred in the 1980s. During 2000, efforts were initiated to capture, rear, and then release early-run kokanee in order to increase the egg-to-fry survival rate. As of yet, these efforts have failed due to a lack of captured adult spawners.

Kokanee have been documented in Little Bear Creek (King County, 2000a). According to King County, up to 221 kokanee spawned in the lower most section of Reach 1 between September 27, through November 8, 1999. Kokanee were observed spawning in Little Bear Creek by DEA biologists during a water quality-monitoring event on September 20, 2001. Between 6 and 10 kokanee ranging from 17.8 to 35.6 centimeters (7 to 14 inches) long were observed immediately below the NE 178th Street culvert. The exact number is uncertain due to a lack of visibility under the overhanging cluster of Japanese knotweed where several more were hiding. One female between 17.8 to 20.3 centimeters (7 and 8 inches) long was observed digging a redd immediately under the downstream culvert edge in the center of a low-gradient riffle. Several others, suspected to be males, would occasionally be by her side, but dart between the redd and the cluster of Japanese knotweed along the left-bank. A minimum of four were observed, and several others were under the overhanging cluster of Japanese knotweed, and "thrashing/splashing noises" were emanating from under the cluster of knotweed. One additional redd was identified immediately downstream of the railroad crossing near the mouth (upstream of the Sammamish River trail crossing). The timing of these observations does not conclusively categorize them as either early or late-run kokanee, but leads to the possibility that they could be either. Some researchers have stated that during 1996, the timing of the early-run in Issaquah Creek extended from August 14, through September 16 (Ostergaard 1988 as reported by King County, 2000). Due to yearly

variations in water temperature and run timing, these dates are not absolute. However, due to the closeness between the observed spawning of kokanee in Little Bear Creek on September 20th, it is possible that these fish were a component of the early-run race.

Sockeye salmon are occasionally the most abundant spawning anadromous salmonid in Little Bear Creek. Based on salmon spawning ground data from the WDFW, adult sockeye salmon were first observed in Little Bear Creek in 1970 (WDFW, 2001). Low numbers (n) were observed in 1970 (n = 14), 1975 (n = 1), 1976 (n = 8), 1977 (n = 2), 1978 (n = 34), 1979 (n = 91), but began to increase substantially during 1987 when over 2,000 spawning adults were observed (Appendix J). Exceptionally large numbers of sockeye salmon spawned in Little Bear Creek in 1996 when 4,716 were recorded. Based on observations during field visits this year, 2001 will be another productive year for sockeye in Little Bear Creek.

4.3.4 Chum Salmon

Chum salmon often spawn near tidewater and begin to migrate back to the ocean soon after emergence. Spawning primarily occurs between October through December, and outmigration between March and June (Wydoski and Whitney, 1979). Chum salmon were considered extirpated from Lake Washington by the early 1930s (Goetz, proceedings from Conference, 2000). However, they are occasionally observed in tributaries to both Lake Washington and Lake Sammamish. Only two chum salmon have been observed in Little Bear Creek during the WDFW annual salmon spawning ground surveys from 1952 through 2000. These two adults were observed between RM 4.4 and 5.5 on November 6, 1976 (Appendix J). Based on the low number of observations of chum salmon in Little Bear Creek, these adults likely strayed from either the Cedar River or other Puget Sound watersheds.

4.3.5 Pink Salmon

Pink and chum salmon are similar in that they have a short residence time in freshwater as both adults and juveniles. Spawning occurs primarily between August and September (Wydoski and Whitney, 1979). Pink salmon were also considered extirpated from Lake Washington by the early 1930s (Goetz, proceedings from Conference, 2000). Only one adult pink salmon has been observed in Little Bear Creek (WDFW, 2001). The single adult was observed dead between RM 0.0 and 1.1 on November 1, 1977 (Appendix J). Based on the single observation of a pink salmon in Little Bear Creek, this adult was likely a strayed from a different Puget Sound watershed.

4.3.6 Cutthroat Trout

The life history of cutthroat trout is very diverse. Sea-run, adfluvial, and resident forms utilize the Lake Washington system. The resident form is likely the most abundant trout and the only resident salmonid in Little Bear Creek. During our electrofishing survey on August 24 and 31, 2001, cutthroat trout increased in abundance as we progressed upstream. They represented 8.6 percent of the catch in Reach 1 (n = 3), 50.8 percent in Reach 2 (n = 32), and 76.2 percent in Reach 3 (n = 64). Overall, cutthroat trout represented 54.4 percent of the total catch in Little Bear Creek. The largest specimen captured was in Reach 3 and was 21.6 centimeters (8.5 inches) long (Appendix K).

4.3.7 Western Brook Lamprey

Three species of lamprey have been documented in the State of Washington including the western brook lamprey (*Lampetra richardsoni*), Pacific lamprey (*Entosphenus tridentatus*), and river lamprey (*Lampetra ayresi*). Of these, only the western brook lamprey was documented in Little Bear Creek by DEA.

Adult western brook lampreys are the smallest of the lamprey family by being usually less than 17.8 centimeters (7 inches) in length (Wydoski and Whitney, 1979). They are slender, have dull/ nonfunctional teeth, may live for up to 6 years, and spend their entire life in freshwater. Unlike other species of lampreys, the brook lamprey does not attach themselves to other fish. Spawning occurs in small-excavated "nests" from April to July. Up to 12 adults may use a single nest and die soon after spawning. Juveniles are called ammocoetes and are non-parasitic filter feeders that consume primarily microscopic plant and animal matter such as diatoms, algae, and detritus.

Western brook lampreys were observed in Reaches 2 and 3, and in Tributary D as depicted on Figure 3 immediately downstream of 140th Place NE. Spawning behavior in the form of nest building and quivering was noted in the large pool immediately downstream of NE 205th Street and in a low-gradient riffle in Reach 2. In Reach 3 approximately 12 spawning lampreys were observed on June 15, 2001, at the NE 205th Street site. It is interesting to note that the same site along the edge (RB) of the pool near the tailout was later used by sockeye salmon for spawning. Numerous other sightings of lampreys occurred throughout Reaches 2 and 3 during the survey.

4.3.8 Coastrange Sculpin

The coastrange sculpin inhabits medium to large streams along the West Coast from California to Alaska. They grow to 7.6 to 10.2 centimeters (3 to 4 inches) long depending on geographic location, and spawn from mid-February to June (Wydoski and Whitney, 1979). They feed primarily on aquatic insects but will eat stray salmonid eggs when available. Large adult sculpins may feed on salmonid fry but are in-turn eaten by larger salmon and trout.

Sculpins are the most difficult fish in Washington to identify to species because of their morphological variations and small size (Wydoski and Whitney, 1979). At least 11 species occur in Washington State, some of which may hybridize and result in similar characteristics that further complicates species identification. Some of the characteristics that distinguish the coastrange sculpin from other species include its non-contiguous dorsal fin (separated to base), distinct tubular nostril, lack of palatine teeth, and absence of prickles and dark vertical bars (Wydoski and Whitney, 1979).

DEA documented coastrange sculpins throughout Little Bear Creek (Appendix K). Sculpins represented 82.9 percent of the catch in Reach 1 (n = 29), 46 percent in Reach 2 (n = 29), and 13.1 percent in Reach 3 (n = 23). The overall catch in Little Bear Creek was 37.9 percent. Although the majority of specimens captured were coastrange sculpins, some differed and may have been reticulated sculpins. The variation included the presence of a slightly contiguous dorsal fin on larger specimens.

4.3.9 Mollusks and Crawfish

Other aquatic species observed in Little Bear Creek include mollusks, crawfish, and macroinvertebrates. The western pearlshell (*Margaritifera falcata*) has been documented within

upper Little Bear Creek within Snohomish County. Several shells were observed in Little Bear Creek within King County, but no live specimens were documented during the DEA stream survey. These shells likely floated downstream during flood events. Another mollusk referred to as the Asian clam (*Coricula fluminea*) was observed in the Sammamish River near the mouth of Little Bear Creek during the DEA stream survey. The Asian clam is an introduced species known to be present in the Colombia River, but never previously documented in the Sammamish River. Crawfish are also present in the Sammamish River and Little Bear Creek. However, their presence in Little Bear Creek appears to be limited to the lowermost section of Reach 1.

4.4 STREAM HABITAT

DEA biologists surveyed the entire section of Little Bear Creek within the City of Woodinville between its mouth to NE 205th Street from June 25, through August 1, 2001. A total of 3,484.1 meters (2.2 miles) of stream was surveyed from the mouth of Little Bear Creek at the Sammamish River to the crossing under NE 205th Street along the City of Woodinville and Snohomish County line (Table 5). Little Bear Creek was segmented into three reaches. Reach 1 began at the mouth of Little Bear Creek and extended to the downstream end of the culverts under SR 202. Reach 2 started at the downstream side of the culverts under SR 202 and extended to the upstream side of the culverts under Highway 522. Reach 3 began at the upstream side of Highway 522 and ended at NE 205th Street, which follows the City of Woodinville and Snohomish County line.

Table 5:
Survey Summary for Reach 1, 2, and 3 of Little Bear Creek in Woodinville, Washington (WDFW Stream Number 08-0080)

	Reach 1	Reach 2	Reach 3
Date Surveyed	6/25/01	6/26/01 – 7/6/01	7/19/01 – 8/1/01
Total Length Surveyed	388.2 meters (0.24 mile)	1,725.7 meters (1.07 miles)	1,370.2 meters (0.85 mile)
Bank Full Width	4.5 – 6.6, x[1] = 5.8 meters	3.1 – 8.8, x = 6.2 meters	5.6 – 8.2, x = 6.9 meters
Total # of Habitat Units (NSOs)	14	105	94
Total Habitat Area	1,773.58 m²	9,267.05 m²	7,379.52 m²
Percent Pool by Area	13.74%	34.01%	36.57%
Percent Glide by Area	15.04%	20.48%	21.34%
Percent Riffle by Area	71.22%	47.67%	42.09%
# Hardened Crossings	3	4	3
Percent Armoring	98.3%	13.7%	15.5%
Placed Structures	6 log weirs	0	5 rip/rap weirs
Gradient	0.25 – 1.25%	0.56 – 1.2%	0.31 - 0.87%
Sinuosity	1.01	1.15	1.08
Number Wolman Measurements	2	5	4
% Fines < 6 mm	19 – 40%, x = 29.5%	15 – 41%, x = 27%	13 – 31%, x = 21.5%
Wolman Pebble Count D-50	x = 20.6 mm	x = 21.9 mm	x = 29.6 mm
Dominant Substrate Type	Coarse gravel	Coarse gravel	Coarse gravel
Flow Measurement (8/24/01)	15.02 cfs	Not measured	13.77 cfs

Note #1: X = mean measurement.

4.4.1 Pool/Riffle Habitat

Pools and riffles are the basic components of stream habitat. The percentage and quality of these basic components help define the overall health of a stream. They are also key parameters that help

support both resident and anadromous populations of salmonids as well as other aquatic species that depend on a "healthy" stream.

Pool Habitat: Pools are used by adult salmonids for cover and resting, and pool tailouts are key spawning sites for many species. Juveniles depend on pools for cover, feeding, and refuge during extremes in stream flow. As the quantity and quality of pool habitat decreases, so does the abundance of aquatic life (salmonids, insects, mollusks, etc.). The importance of pool habitat and their associated tailouts can not be overstated. All spawning sockeye in Little Bear Creek observed during our studies were spawning in pool tailouts or the transition between the pool and their associated tailout. Although riffle habitat is also used in streams such as Little Bear Creek, riffles tend to be too shallow to be used consistently by most salmonids.

Pools are typically formed by stationary features such as large woody debris and boulders, abrupt changes in elevation, and changes in the direction of flow and substrate. The loss of large conifers within the riparian zone that contribute to in-stream woody debris and removal of in-stream wood has reduced the abundance and quality of pool habitat. Additional factors such as reduction in sinuosity, increased sedimentation, and changes in hydroperiod have further reduced habitat complexity.

In order to rate a stream within an urbanized environment, comparisons are made to more natural streams that have not been as heavily impacted by anthropogenic factors. Several researchers as well as state and federal agencies have suggested some basic standards upon which to rate a stream. Because of the wide variation in streams, bankfull width (BFW) and gradient are typically used as the parameters to which the standards are based. This is done so that comparisons are made to similar sized streams. Regardless of size, the overall area of pool habitat in a stream is typically expected to be about 40 percent to 60 percent to be considered optimum (Peterson et al., 1992).

Pool Frequency: The NMFS (1996) utilizes channel width (BFW) to develop a desired pool frequency (# pools/mile). Since the average BFW varied by reach, the desired pool frequency also varies. A stream is considered *properly functioning* if it meets the desired pool frequency and the large woody debris standards for properly functioning is also met (NMFS, 1996). A stream is considered *at risk* if it meets the desired pool frequency but large woody debris recruitment is inadequate to maintain pools overtime. A stream is considered to be *not properly functioning* if it does not meet the pool frequency standards. A comparison of the NMFS pool frequency standards and results of the DEA survey are presented below in Table 6.

Table 6:
Pool Frequency Data for Little Bear Creek, Woodinville

Reach	BFW	NMFS Match	NMFS Goal	Actual
Reach 1	19.0 ft.	20 ft.	56 pools/mile	21 pools/mile
Reach 2	20.3 ft.	20 ft.	56 pools/mile	43 pools/mile
Reach 3	22.6 ft.	25 ft.	47 pools/mile	41 pools/mile
Average	20.7 ft.	20 ft.	56 pools/mile	40 pools/mile

Based on the results presented in Table 6, pool frequency in Little Bear Creek is **not properly functioning**. This conclusion is strengthened by the fact that large woody debris recruitment is not sufficient to maintain existing pools over time due to the absence of large mature conifers within most of the riparian zone. Furthermore, the overall number of pools per kilometer in Little Bear Creek as it

flows through the City of Woodinville is 24.7 (40/mile), and the overall percentage of pool habitat is 33.1 percent. This further indicates that the frequency of pool habitat is below optimum levels.

Pool Quality: Although the number of pools is very important, another important factor is the residual depth, which is defined as the maximum depth minus tailout depth. The premise of residual depth is that deeper pools provide more cover, are more stable, and can be utilized by larger salmonids such as chinook. Shallow pools provide less cover, can be rapidly filled by sediment, and do not provide good refugia for salmonids.

The NMFS (1996) considers that pool quality is *properly functioning* when they contain pools >1 meter (3.3 feet) deep with good cover and cool water, and minor reduction of pool volume by fine sediment. Pool quality is *at risk* when few pools >1 meter (3.3 feet) are present or have inadequate cover/temperature, and only a moderate reduction in pool volume by fine sediment. Pool quality is *not properly functioning* when no pools are >1 meter (3.3 feet) deep and have inadequate cover/temperature, and there is a major reduction of pool volume by fine sediment. The NMFS Matrix of Pathways and Indicators does not mention "residual depth," therefore maximum depth will be used.

Within Reach 1, none of the five pools had a maximum depth >0.90 meter (2.9 feet). The maximum pool depth was 0.90 meter (2.9 feet), average pool depth was 0.60 meter (2 feet), average maximum depth was 0.85 meter (2.8 feet), average residual depth was 0.55 meter (1.8 feet), and maximum residual depth was 0.70 meter (2.3 feet). These pools also lacked "good" cover and "cool" water. Therefore, pool quality in Reach 1 is **not properly functioning**.

Reach 2 contained 46 pools, but only eight (17.4 percent) had a maximum depth equal to or >1 meter (3.3 feet). The maximum pool depth was 1.1 meter (3.6 feet), average pool depth was 0.43 meter (1.4 feet), average maximum depth was 0.73 meter (2.4 feet), average residual depth was 0.55 meter (1.8 feet), and maximum residual depth was 0.90 meter (2.9 feet). Although some of the pools contained good cover, most did not. Therefore, pool quality in Reach 2 is considered **at risk**.

Pool quality increased in Reach 3 due to the presence of deeper pools. Reach 3 contained 35 pools, nine (25.7 percent) of which had a maximum depth equal to or greater than 1 meter (3.3 feet). The maximum pool depth was 1.71 meter (5.6 feet), average pool depth was 0.39 meter (1.3 feet), average maximum depth was 0.75 meter (2.5 feet), average residual depth was 0.54 meter (1.8 feet), and maximum residual depth was 1.51 meter (4.9 feet). Compared to Reaches 1 and 2, the percentage of deeper pools increased and overall water temperature decreased, but few pools were considered to provide adequate cover. A reduction in pool volume due to fines was observed. Although conditions improved in Reach 3, pool quality is considered **at risk**. The overall pool quality in Little Bear Creek as it flows through the City of Woodinville is considered also **at risk** because few pools are greater than 1 meter (3.3 feet) deep.

Riffle Habitat: Riffles are also important spawning areas in many streams, and support a myriad of macroinvertebrates that provide the primary food source for juvenile salmonids as well as other species of fish. Gradient and water depth dictates the suitability for salmonid spawning while embeddedness and overall abundance of fines influence productivity. The NMFS (1996) states that gravel or cobble should be the dominant substrate, with embeddedness being less than 20 percent to be *properly functioning*. In other words, the interstitial spaces between the gravel or cobble should not be filled with more than 20 percent fines, and the gravel should not be compacted. Although

salmonids can and do spawn in gravel containing excess fines, the egg-to-fry ratio may be low. This could result in few, if any eggs surviving to the fry stage due to suffocation and entrapment.

Table 7 below summarizes the pool, riffle, and glide habitat parameters quantified by this survey. The raw data are provided in Appendix M. Table 7 is segmented by reach in order to capture trends as Little Bear Creek flows through the City of Woodinville. Overall, Reach 1 near the mouth of Little Bear Creek has been severely degraded while Reach 2 and 3 still contain "fair" habitat. Although pool habitat is **not properly functioning** based on NMFS standards, Reaches 2 and 3 of Little Bear Creek do contain a fair amount of suitable habitat (although somewhat degraded). The primary factors that have degraded pool habitat in Little Bear Creek are the lack of in-stream large woody debris, and relatively heavy sediment load.

Table 7:
Pool, Riffle, and Glide Habitat Summary for Reach 1, 2, and 3 of Little Bear Creek

	Reach 1	Reach 2	Reach 3
Total Habitat Area	1,773.58 m²	9,267.05 m²	7,379.52 m²
Total Pool Area	243.66 m²	3,151.51 m²	2,698.64 m²
Total Glide Area	266.81 m²	1,898.24 m²	1,574.86 m²
Total Riffle Area	1,263.11 m²	4,417.305 m²	3,106.02 m²
Percent Pool by Area	13.74%	34.01%	36.57%
Percent Glide by Area	15.04%	20.48%	21.34%
Percent Riffle by Area	71.22%	47.67%	42.09%
Number of Pools	5 (4 of 5 man made)	46	35
Pools per Kilometer	12.88	26.66	25.54
Total Length of Pool Habitat	74.8 meters	548.2 meters	421.9 meters
Dominant Pool Type	Plunge	Scour	Scour
Average Length of Pools	14.96 meters	11.92 meters	12.05 meters
Average Residual Pool Depth	0.55 meter	0.55 meter	0.54 meter
Maximum Residual Depth	0.70 meter	0.90 meter	1.51 meter
Maximum Pool Depth	0.90 meter	1.1 meter	1.71 meter
Average Maximum Pool Depth	0.85 meter	0.73 meter	0.75 meter
Average Pool Depth	0.60 meter	0.43 meter	0.39 meter
Average Pool Width	4.02 meters	6.10 meters	6.19 meters
Number of Riffles	4	43	40
Total Length of Riffle Habitat	246.80 meters	841.4 meters	634.28 meters
Average Length of Riffles	61.70 meters	19.57 meters	15.86 meters
Average Width of Riffles	5.35 meters	4.80 meters	4.81 meters
Average Depth of Riffles	0.34 meter	0.20 meter	0.16 meter
Number of Glides	5	16	19
Total Length of Glides	66.60 meters	336.1 meters	313.98 meters
Average Length of Glide Habitat	13.32 meters	19.57 meters	16.53 meters
Average Width of Glides	4.1 meters	4.75 meters	5.09 meters
Average Depth of Glides	0.43 meter	0.34 meter	0.25 meter

4.4.2 Large Woody Debris

Large woody debris (LWD) is a critical component of stream habitat because it creates pools, structure, and habitat diversity. Large pieces of coniferous trees provide the best habitat since they

are long-lived and will not decay as rapidly as deciduous trees. Large pieces will also stay stationary during high flows and scour out pool habitat as water velocity is redirected around them.

The USFS protocol for LWD west of the Cascades segments wood into three size categories based on length and diameter (USFS, 2001). Small LWD must have a diameter >30.5 centimeters (12 inches) at a length of 7.62 meter (25 feet) from the large end. Medium LWD must have a diameter >61 centimeters (24 inches) at a length of 15.24 meter (50 feet) from the large end. Large LWD must have a diameter >0.91 meter (36 inches) at a length of 15.24 meter (50 feet) from the large end. The NMFS recommends that streams should have a minimum of 80 pieces of LWD per 1.61 km (1 mile) that are at least 15.24 meter (50 feet) long with a diameter of at least 61 centimeters (24 inches) to be *properly functioning*.

Both the USFS and NMFS standards are larger than what is now typically found in Puget Sound lowland streams. Although present in some streams in low numbers, LWD of this size are more appropriately categorized as remnant key pieces. Because of their scarcity, the new standard of measuring and categorizing pieces >2 meters (6.6 feet) long and wider than 10 centimeters (3.9 inches) has been adopted by several jurisdictions. Although these smaller pieces are not as influential as the key pieces, they do provide some function. By measuring and categorizing their size, abundance, and species, a more accurate account of existing habitat conditions can be obtained. Appendix N contains all the specific details of each piece of wood >2 meters (6.6 feet) long and 10 centimeters (4 inches) wide encountered in Little Bear Creek as it flows through the City of Woodinville.

Only 5 pieces large enough to meet the NMFS standard were recorded throughout the 3.48 kilometers (2.2 miles) of stream surveyed within the City of Woodinville. Researchers have documented that the occurrence of smaller pieces of wood such as those inventoried during this survey in natural streams occur at a rate of 150 to 460 pieces per kilometer (0.62 mile) (Peterson et al., 1992). The total number of pieces of LWD greater than 2 meters (6.6 feet) long per kilometer (0.62 mile) in Little Bear Creek is 110.5. Based on the NMFS criteria, large woody debris is **not properly functioning** in Little Bear Creek. Table 8 below summarizes our findings by reach, and the raw data are presented in Appendix N.

Table 8:
Woody Debris Summary for Reach 1, 2, and 3 of Little Bear Creek

	Reach 1	Reach 2	Reach 3
Total Wood Inventoried	16 pieces	217 pieces	152 pieces
# NMFS Woody Debris	0	4	1
Pieces (> 2 m long) per Meter	0.04	0.13	0.11
Pieces (> 2 m long) per kilometer	47.31	125.75	110.93
Distance between Pieces	24.26 meters	7.95 meters	9.01 meters
% Coniferous Woody Debris	66.7% (weirs)	23.6%	34.5%
% Deciduous Woody Debris	33.3%	76.4%	65.5%
Dominant Conifer Species	Cedar	Cedar	Cedar
Dominant Deciduous Species	Alder	Alder	Alder
Average Length	3.66 meters	3.31 meters	3.74 meters
Average Diameter	32.5 cm	29.2 cm	27 cm
# Stumps	0	18	10
# Log Jams	0	4	3

Note: The results for Reach 1 were skewed due to the presence of log weirs.

4.4.3 Sediment and Substrate

Stream substrate varies significantly on all scales, and no survey method is perfect at documenting substrate composition on the reach scale. DEA utilized the Wolman (1954) pebble count due to its ease of use, comparability with existing data, and acceptance by both King County and the USFS. However, the Wolman pebble count method focuses on riffle habitat and hence does document substrate composition in pool tailouts. Pool tailouts are often extensively used for spawning.

Variation in substrate occurs by watershed, stream, reach, and habitat type. The substrate also varies on the site-specific scale when analyzing either lateral or longitudinal change. This variation in conjunction with the numerous methods of assessing substrate composition has created difficulties in adequately documenting and interpreting the results of sampling efforts. However, the variation in substrate composition on the watershed scale is one of the many factors that allows for a diverse benthic community to exist such as macroinvertebrates, mollusks, and numerous species of fish that reside within the substrate during their larval stage. A few of the factors that influence substrate composition include flow, gradient, sediment load, and location within the watershed.

Sediment: The focus of most stream substrate assessments is to determine the percentage of fines in potential salmonid spawning habitat. The percentage of fines is then used to infer the quality of spawning habitat because too many fines can degrade in-stream habitat and adversely impact salmonid spawning success. Streams in urbanized watersheds "tend" to have a larger percentage of smaller particles (May, 1996). The NMFS Matrix, as modified by the Mt. Baker/Snoqualmie National Forest, uses percent fines as an indicator of the quality of potential spawning and rearing habitat. Percent fines is used for assessing both spawning and incubation habitat. However, the size range depends on if the field data is collected from the stream surface (<6 millimeters [0.24 inch]) or from within the substrate (<0.85 millimeter [0.03 inch]). The Wolman pebble count collects stream substrate surface data. Therefore, based on NMFS Matrix values as modified by the Mt. Baker/Snoqualmie National Forest that includes surface fines: ≤20 percent fines (<6 millimeters [0.24 inch]) and low turbidity is considered *properly functioning* in most watersheds, 12 percent to 20 percent fines and moderate turbidity is considered *at risk*, and >20 percent fines and high turbidity is considered *not properly functioning* (Appendix L-2).

The results of the Wolman pebble count data collected in Little Bear Creek highlights the variability of fines (Table 9). Data was collected at 11 riffles, the percent fines <6 millimeter (0.24 inch) ranged from 13 percent to 41 percent, with an overall average of 25.45 percent. Based on these results, the sediment indicator at the local level ranges from **properly functioning** to **not properly functioning,** but averages in the **at risk** range. Assuming this data is representative and enough samples were collected to identify possible trends, an overall general trend of fewer fines per reach occurred as sampling progressed upstream. The average percent fines in Reach 1 was 29.5 percent, Reach 2 was 27 percent, and Reach 3 was 21.5 percent. These reach averages are all greater than 20 percent, and therefore indicates that the overall sediment indicator for Little Bear Creek is **not properly functioning**.

Table 9:
Substrate Composition Based on Wolman Pebble Counts in Little Bear Creek, Woodinville

#	Reach #	NSO	Location	Fines <6 mm	D35	D50	D84	D95
1.	1	1	R1: Station 18.4	40%	1.9 mm	16.0 mm	175.8 mm	299.3 mm
2.	1	14	R8: Imm. D. stream SR 202	19%	14.2 mm	25.1 mm	132.4 mm	203.4 mm
3.	2	2	Imm. U. stream SR 202	21%	19.2 mm	29.6 mm	64.9 mm	99.5 mm
4.	2	15	R9	41%	1.9 mm	10.1 mm	30.7 mm	44.0 mm
5.	2	27	Station 558.9, UW Bug site	26%	9.6 mm	16.5 mm	35.0 mm	50.7 mm
6.	2	56	R26: Station 1015	32%	8.0 mm	17.9 mm	30.9 mm	43.2 mm
7.	2	76	NSO 76	15%	27.0 mm	35.5 mm	67.5 mm	93.8 mm
8.	3	3	R2	13%	22.9 mm	30.6 mm	57.1 mm	78.1 mm
9.	3	38	R23	24%	20.1 mm	48.7 mm	48.7 mm	61.1 mm
10.	3	50	R30	18%	16.1 mm	22.7 mm	58.4 mm	87.5 mm
11.	3	81	R49	31%	7.4 mm	16.2 mm	41.9 mm	63.9 mm

Wolman pebble count data also documents larger particle size distribution (D35 – D95). The "D" represents distribution, while the adjoining number represents the percentile of interest. The D35 equates to the distribution of the 35 percentile of the particle size distribution. Whereas the D50 is the median particle size of a distribution that divides the distribution in two equal parts (mid-point/median). Another way of expressing this concept is that a percentile is a sediment size indicated by the cumulative distribution curve for a particle "percent finer" value. Therefore, D35 means 35 percent of the sample was smaller than the cumulative particle size (diameter in millimeters) documented at the riffle. In the case of the first sample site, 35 percent of the pebbles measured were smaller than 1.9 millimeter (0.075 inch) in diameter. The data in the form of a cumulative distribution curve from each of the sample sites is provided in Appendix O.

Substrate: The NMFS utilizes both embeddedness and substrate composition as the indicators for substrate quality. The percentage embeddedness is obtained visually and is extremely subjective. The NMFS criteria for *properly functioning* is a dominance of gravel or cobble (interstitial spaces clear) and embeddedness <20 percent, *at risk* is gravel and cobble subdominant or if dominant embeddedness is between 20 percent and 30 percent, and *not properly functioning* if bedrock, sand, silt or small gravel dominant or if gravel and cobble dominant embeddedness is >30 percent.

Based on the D50 results, the median gravel size in riffles throughout Little Bear Creek in the City of Woodinville ranged from medium to very coarse gravel. The D50 in Reach 1 ranged from 16 to 25.1 millimeters (0.63 to 0.99 inch) with the average being 20.55 millimeters (0.81 inch) (coarse gravel). The D50 in Reach 2 ranged from 10.1 to 35.5 millimeters (0.40 to 1.4 inches) with the average being 21.92 millimeters (0.86 inch) (coarse gravel). The D50 in Reach 3 ranged from 16.2 to 48.7 millimeters (0.64 to 1.92 inches) with the average being 29.55 millimeters (1.16 inches) (coarse gravel). Although more samples should be taken to increase confidence levels, there appears to be a trend of increasing D50 results as the upstream distance from Reach 1 increases. Although coarse gravel was dominant, interstitial spaces were not clear, and embeddedness averaged from 20 percent to 30 percent (sometimes >30 percent). Based on these results, the Habitat Element Pathway – Substrate Indicator is **at risk**.

4.4.4 Off-Channel Habitat/Refugia

The availability of "adequate" off-channel habitat and refugia are indicators of a stream's ability to provide a safe haven for primarily juvenile fish during high flow events. These are generally areas of lower stream velocity that can be accessed during flood events, but also includes low energy areas during normal stream flows such as backwater areas with cover, ponds, and oxbows.

Few side-channels, oxbows, or other types of potential off-channel habitat/refugia exist along Little Bear Creek. Although a few potential off-channel habitat and refugia sites were noted, they were not adequately abundant or distributed in Little Bear Creek. It appears that hydromodifications in the form of rip/rap armoring throughout Reach 1, and sections of Reaches 2 and 3 in conjunction with the loss of adjacent wetlands and tributaries that are culverted into Little Bear Creek, the indicator for off-channel habitat and refugia are **not properly functioning**.

4.4.5 Channel Condition and Dynamics

The channel condition and dynamics pathway includes three primary indicators assessed by the NMFS. These include: (1) width/depth ratio, (2) streambank condition, and (3) floodplain connectivity. Additional parameters not included in the Matrix of Pathways and Indicators developed by the NMFS (1996) that also provide insight into channel conditions and dynamics of a stream include: channel sinuosity and percent armoring. Although no specific percentages have been defined by the federal agencies for these last two indicators, they provide insight into the degree of anthropogenic influences that have been placed upon a stream. Both channel sinuosity and percent armoring are often closely associated with each other in that as the percentage of armoring increases the overall sinuosity decreases.

Width/Depth Ratio: The width/depth ratio concept relies on the premise that a stream channel will incise when banks are armored. This channel down cutting is created as high-flows that would normally spill-out into and over the adjacent stream banks are forced to stay within the defined channel by the presence of armoring (typically large rip/rap). The hydrologic impacts of urbanization typically widen and/or deepen a stream channel when the banks are not armored, but streamside development will often have the opposite effect (May et al., 1997).

The NMFS (1996) states that a *properly functioning* stream has a width/depth ratio of <10, an *at risk* stream has a ratio between 10 to 12, and the ratio for a *not properly functioning* stream is >12 (Appendix L-1). Based on the results of King County (2001b), the width/depth ratio for Reaches 1 through 3 is 5.8, 5.3, and 8.0, respectively. Based on their data, this indicator is **properly functioning** throughout Reaches 1 through 3. Although this could possibly be true for Reaches 2 and 3, it does not seem possible that Reach 1 could be properly functioning given that 98.3 percent is armored close to the bankfull line. Based on this, and that May et al., (1997) found varying results, this indicator as currently defined does not appear to be suited for urbanized streams in Puget Sound. Considering these issues, the width/depth ratio in Reach 1 is considered by DEA to be **not properly functioning**, and **at risk** in Reaches 2 and 3.

Streambank Condition: Streambank condition refers to the percentage of the bank that is stable and the percentage that is actively eroding. The NMFS (1996) defines a *properly functioning* streambank as being >90 percent stable with <10 percent actively eroding, 80 percent to 90 percent stable when *at risk*, and <80 percent stable when *not properly functioning*. This indicator also appears at least

partially flawed since a streambank that is completely armored would be considered stable using this approach and would be categorized as properly functioning. If the banks contain a predominance of gravels and not fines, the addition of new gravels to a stream channel can be beneficial. King County (2001b) reported that Reach 1 was 32 percent armored, 32 percent full scour, 33 percent low scour, and zero percent stable. Reach 2 was 9 percent armored, 18 percent full scour, 46 percent low scour, and 27 percent stable (King County, 2001b). Reach 3 was 6 percent armored, 16 percent full scour, 26 percent low scour, and 52 percent stable (King County, 2001b).

DEA biologists documented 98.3 percent armoring in Reach 1 distributed equally between the left and right banks. The percent armoring in Reach 2 varied depending upon bank (Table 10). The right bank (RB) was armored for a distance of 185.6 meters (608.9 feet) or 10.7 percent, while the left bank (LB) was armored for 288.4 meters (946.2 feet) or 16.7 percent. This discrepancy is due to the abundance of businesses along the left bank, and the relatively long distance between the right bank and Highway 522. Several sites along the left bank were experiencing localized sloughing as a result of streambank encroachment and absence of riparian vegetation (Appendix D – Reach 2 Photo 7). The percent armoring in Reach 3 also varied depending upon bank. The right bank was armored for a distance of 225.6 meters (740.2 feet) or 16.5 percent, while the left bank was armored for a distance of 198.5 meters (651.2 feet) or 14.5 percent. Based on these results, the streambank condition indicator is **not properly functioning**.

Table 10:
Bank Armoring Along Little Bear Creek in Woodinville

#	Reach	Bank	Downstream Station (m)	Upstream Station (m)	Length	Comment
1.	1	RB	6.6	388.2	381.6 meters	Rip/rap +
2.	1	LB	6.6	388.2	381.6 meters	Rip/rap +
3.	2	RB	0.0	39.7	39.7 meters	SR 202 culvert
4.	2	LB	0.0	39.7	39.7 meters	SR 202 culvert
5.	2	LB	128.6	138.2	9.6 meters	Rip/rap
6.	2	RB	196.0	226.5	30.5 meters	132nd Ave culvert
7.	2	LB	196.0	226.5	30.5 meters	132nd Ave culvert
8.	2	LB	254.5	274	19.5 meters	Rip/rap
9.	2	LB	311.4	315.2	3.8 meters	Rip/rap
10.	2	RB	487.1	498.6	11.5 meters	134th Ave culvert
11.	2	LB	487.1	498.6	11.5 meters	134th Ave culvert
12.	2	LB	778.4	786.0	7.6 meters	Gabion weir
13.	2	LB	839	846.1	7.1 meters	Rip/rap
14.	2	LB	870.9	898.5	27.6 meters	Rip/rap
15.	2	LB	1262.7	1274.2	11.5 meters	Rip/rap
16.	2	LB	1281.2	1286.3	5.1 meters	Rip/rap
17.	2	LB	1380.7	1390.2	9.5 meters	CMP discharge
18.	2	RB	1595.7	1637.1	41.4 meters	Old crossing +
19.	2	LB	1595.7	1615.6	19.9 meters	Old crossing +
20.	2	LB	1651.7	1666.7	15.0 meters	Rip/rap
21.	2	RB	1666.7	1725.7	62.5 meters	Hwy 522 culvert
22.	2	LB	1666.7	1725.7	62.5 meters	Hwy 522 culvert
23.	3	RB	0.0	17.1	17.1 meters	Rip/rap deflector
24.	3	LB	135.3	155.4	20.1 meters	Rip/rap - On-ramp

Table 10 continued

#	Reach	Bank	Downstream Station (m)	Upstream Station (m)	Length	Comment
25.	3	LB	267.6	273.1	5.5 meters	Rip/rap - On-ramp
26.	3	RB	277.7	313.6	35.9 meters	Rip/rap - House
27.	3	LB	271.3	313.6	42.3 meters	Rip/Rap - On-ramp
28.	3	RB	313.6	350.2	36.6 meters	NE 195th Street culvert
29.	3	LB	313.6	350.2	36.6 meters	NE 195th Street culvert
30.	3	RB	350.2	396.0	45.8 meters	Old business
31.	3	LB	350.2	396.0	45.8 meters	Old business
32.	3	LB	616.9	634.9	18.0 meters	Hwy 522 edge
33.	3	RB	915.3	1005.5	90.2 meters	Old Bridge + yards
34.	3	LB	915.3	934.5	19.2 meters	Old Bridge
35.	3	LB	1297.5	1308.5	11.0 meters	House

Floodplain Connectivity: The floodplain indicator as defined by the NMFS (1996) includes hydrologic linkage between adjacent off-channel areas, wetlands, and riparian vegetation and succession. This indicator does not specify quantifiable measurements, but relies on subjective inferences of frequently linked, reduced linkage, and severe reduction in linkage. Based on the lack of off-channel habitat, adjacent wetlands, and greater than 10 percent armoring along all three reaches, this indicator is **not properly functioning**.

4.4.6 Riparian Habitat

Riparian habitat is defined as the land adjoining the stream that influences stream habitat and its processes. The composition and quantity of riparian habitat directly influences temperature, sedimentation, productivity, habitat complexity, and the streams disturbance regime. An "intact" riparian zone buffers the stream from outside elements. One issue today is how large does a buffer have to be to protect a stream from anthropogenic influences. A buffer of 30.5 meters (100 feet) is often used for salmonid-bearing streams. However, many researchers have documented that a 30.5-meter (100-foot) buffer is not sufficient in protecting a stream and its processes from all anthropogenic influences, especially when the quality of the existing buffer is low. Some researchers have suggested that if the goal is to truly protect a valuable resource, than buffer width should be at least 100 meters (328 feet). However, this width can be adjusted downward depending on the maturity and overall percentage of the existing riparian habitat. Furthermore, it is also recognized that the composition of the entire watershed plays a vital role in a stream's overall health. On the watershed scale, the percent or fraction of total impervious area has been found to have a direct correlation with a stream's productivity (May et al., 1997).

This report will focus on a linear corridor adjacent to the stream, 61 meters (200 feet) from each bank or 122 meters (400 feet) total width. Site specific conditions within the City of Woodinville based on aerial photographs from 1999 indicate the width of the Little Bear Creek vegetated riparian buffer varies considerably by reach (Appendix G).

The width of the vegetated riparian buffer in Reach 1 averages about 7.6 meters (25 feet) wide and is abutted by development along both banks. The overall 121.9-meter (400-foot) wide corridor

within Reach 1 was composed of 64.36 percent impervious surface, 27.97 percent shrub/grass habitat, 5.11 percent forest habitat, and 2.59 percent gravel area.

The width of the vegetated buffer in Reach 2 varied between the left and right banks. The left bank ranges from 7.6 to 22.9 meters (25 to 75 feet) wide (average width about 7.6 meters [25 feet]) and is abutted by businesses. The right bank ranges from 15.2 to >61 meters (50 to >200 feet) wide (average width about 45.7 meters [150 feet]) and is abutted by Highway 522. The overall 122-meter (400-foot) wide corridor within Reach 2 was composed of 19.38 percent impervious surface, 46.46 percent shrub/grass habitat, 21.63 percent forest habitat, and 12.52 percent gravel area.

The width of the vegetated riparian buffer along both banks of Reach 3 varies from 15.2 to >61 meters (50 to >200 feet). The right bank is relatively unconstrained while the left bank is defined by Highway 522. The overall 122-meter (400-foot) corridor in Reach 3 was composed of 17.12 percent impervious surface, 1.55 percent gravel area, 45.76 percent forested habitat, and 35.56 percent shrub/grass habitat (Table 11).

Table 11:
Land Use Based on 1999 Aerial Photograph
Along Little Bear Creek, Woodinville

Land Use	Reach 1	Reach 2	Reach 3	Total
Developed Impervious	64.36%	19.38%	17.12%	24.05%
Gravel - cleared impervious	2.59%	12.52%	1.55%	6.56%
Forested Habitat	5.11%	21.63%	45.76%	29.94%
Shrub/Grass Habitat	27.97%	46.46%	35.56%	39.45%

Based on the photo interpretation of the 1999 aerial photographs (Appendix G), two trends are apparent. The percentage of developed impervious (developed and gravel [cleared impervious]) surface is significantly higher along the lower reaches while the percentage of forested habitat significantly decreases. The high percentage (12.52 percent) of cleared gravel area along Reach 2 may be an indicator that more development is planned and that the percentage of developed impervious surface will continue to increase within potential buffer habitat.

The remaining riparian buffer and upland forest habitat is of vital importance to the continued functionality of Little Bear Creek. However, the composition of the buffer along Little Bear Creek is varied, and typically dominated by deciduous trees and non-native species of grasses and shrubs. Red alder (*Alnus rubra*), Himalayan blackberry (*Rubus procerus*), bittersweet nightshade (*Solanum dulcamara*), and reed canarygrass (*Phalaris arundinacea*) are abundant throughout Reaches 1 and 2, and the lowermost section of Reach 3. Japanese knotweed (*Polyonum cuspidatum*), another introduced species is also present and locally abundant, but not as widespread as the other aforementioned invasive species.

A continuous 61-meter (200-foot) riparian buffer along each bank composed of mature coniferous forest with numerous adjoining wetlands should be the goal along the Little Bear Creek corridor. Based on our survey results, these target conditions are absent, but scattered sections along the left bank of Reach 3 do possess some of the desired traits.

The remaining buffer is composed of primarily deciduous trees, shrubs, and grasses. A detailed list of the species observed along Little Bear Creek is contained in Tables 12, 13, 14, and 15 below. As mentioned previously, red alder is the most abundant tree species along Little Bear Creek, followed by black cottonwood (*Populus balsamifera*), big-leaf maple (*Acer macrophyllum*), and willow (*Salix* spp). Other species such as Douglas fir and western red-cedar become more prevalent in Reach 3. Two Pacific yew (*Taxus brevifolia*) trees were observed along Reach 2. These are long-lived small conifer trees that were used extensively by native Americans and are a source of the cancer fighting drug taxol. The two observed along Little Bear Creek are remnants from pre-settlement. Once gone, Pacific yews will likely not become reestablished because of the absence of mature coniferous forest.

Table 12:
Tree Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	2, 3.	Vine maple	*Acer circinatum*	Native.
2.	1, 2, 3.	Big-leaf maple	*Acer macrophyllum*	Native.
3.	1, 2, 3.	Red alder	*Alnus rubra*	Native.
4.	2, 3.	Black hawthorne	*Crataegus douglasii*	Native.
5.	1, 3.	Oregon ash	*Fraxinus latifolia*	Native.
6.	1, 2, 3.	Sitka spruce	*Picea sitchensis*	Native.
7.	1	Shore pine	*Pinus contorta*	Native.
8.	1, 2, 3.	Black cottonwood	*Populas balsamifera*	Native.
9.	1, 2, 3.	Bitter cherry	*Prunus emarginata*	Native.
10.	1, 2, 3.	Douglas fir	*Pseudotsuga menziesii*	Native.
11.	2, 3.	Cascara buckthorn	*Rhamnus purshiana*	Native.
12.	1, 2, 3.	Pacific willow	*Salix lasiandra*	Native.
13.	2, 3.	Scouler willow	*Salix scouleriana*	Native.
14.	1, 2, 3.	Sitka willow	*Salix sitchensis*	Native.
15.	2.	Pacific yew	*Taxus brevifolia*	Native.
16.	2, 3.	Western red cedar	*Thuja plicata*	Native.
17.	2, 3.	Western hemlock	*Tsuga heterophylla*	Native.

Shrubs and vines are abundant along Little Bear Creek. The most common along the stream bank include Himalayan blackberry, bittersweet nightshade, and Pacific ninebark (*Physocarpus capitatus*). Others such as Scotch broom (*Cytisus scoparius*) are also abundant, but typically occur beyond the riparian zone, especially within the disturbed areas between Little Bear Creek and Highway 522 along Reaches 2 and 3.

Table 13:
Shrub and Vine Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	1, 2, 3.	Red-twig dogwood	*Cornus sericea*	Native.
2.	2	Beaked hazelnut	*Corylus cornuta*	Native.
3.	1, 2, 3.	Scotch broom	*Cytisus scoparius*	Introduced, invasive.
4.	2	Salal	*Gaultheria shallon*	Native.
5.	3.	Black twinberry	*Lonicera involucrata*	Native.
6.	2, 3.	Indian plum	*Oemleria cerasiformis*	Native.
7.	3.	Devil's club	*Oplopanax horridus*	Native.
8.	1, 2, 3.	Pacific ninebark	*Physocarpus capitatus*	Native.
9.	2, 3.	Sword fern	*Polysticum munitum*	Native.
10.	3.	Stink currant	*Ribes bracteosum*	Native.
11.	2	Wild rose	*Rosa* spp.	Native.
12.	1, 2, 3.	Evergreen blackberry	*Rubus laciniatus*	Introduced, invasive.
13.	2, 3.	Thimble berry	*Rubus parviflorus*	Native.
14.	1, 2, 3.	Himalayan blackberry	*Rubus procera*	Introduced, invasive.
15.	1, 2	Salmonberry	*Rubus spectabilis*	Native.
16.	2, 3.	Trailing blackberry	*Rubus ursinus*	Native.
17.	2	Red elderberry	*Sambucus racemosa*	Native.
18.	2, 3.	Douglas spirea	*Spiraea douglasii*	Native.
19.	3.	Highbush-cranberry	*Viburnum edule*	Native.

Herbs represent the most diverse subset of plants encountered along Little Bear Creek. The most common groups include the grasses and weeds. The herb category also contains the largest percentage of introduced species, many of which are invasive. They typically are the first group of species to colonize disturbed areas and once present are difficult to remove. Some of these species such as reed canarygrass and bittersweet nightshade can be extremely abundant, and have established extensive monocultures within the riparian zone. Others such as purple loosestrife and yellow flag iris are present but sparse.

Table 14:
Herb Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	2	Creeping bentgrass	*Agrostis stolonifera*	Introduced.
2.	3.	Pearly everlasting	*Anaphalis margaritacea*	Native.
3.	1, 2, 3.	Lady fern	*Athyrium felix-femina*	Native.
4.	2, 3.	Canada thistle	*Cirsium arvense*	Introduced, invasive.
5.	3	Poison hemlock	*Conium maculatum*	Introduced.
6.	1, 2, 3.	Morning glory	*Convolvulus arvensis*	Introduced, invasive.
7.	2	Bristly hawksbeard	*Crepis setosa 'Haller'*	Introduced.
8.	2	Orchard grass	*Dactylis glomerata*	Introduced.
9.	2	Bleeding heart	*Dicentra formosa*	Native.
10.	1, 2	Fireweed	*Epilobium* sp.	Introduced.
11.	2	Field horsetail	*Equisetum arvense*	Native.
12.	1, 2	Giant horsetail	*Equisetum telmateia*	Native.

Table 14 continued

#	Reach #	Common Name	Scientific Name	Comment
13.	2	Tall fescue	*Festuca arundinacea*	Introduced.
14.	2, 3.	Bedstraw	*Galium aparine*	Native.
15.	2, 3.	Robert geranium	*Geranium robertianum*	Introduced, invasive.
16.	3.	Big-leaf avens	*Geum macrophyllum*	Native.
17.	1	St. John's-wort	*Hypericum perforatum*	Introduced, invasive, noxious.
18.	1, 2	Yellow touch-me-not	*Impatiens noli-tangere*	Introduced.
19.	1, 2	Yellow-flag iris	*Iris pseudacorus*	Introduced, invasive.
20.	1, 2,	Soft rush	*Juncus effusus*	Native.
21.	2	Daggerleaf rush	*Juncus ensifolius*	Native.
22.	3	Duck weed	*Lemna minor*	Native.
23.	2, 3.	Birdsfoot trefoil	*Lotus corniculatus*	Introduced, invasive.
24.	3	Skunk cabbage	*Lysichitum americanum*	Native.
25.	2, 3.	Purple loosestrife	*Lythrum salicaria*	Introduced, invasive.
26.	2	False lily-of-the-valley	*Maianthemum dilatatum*	Native.
27.	2, 3.	Small water forget-me-not	*Myosotis laxa*	Native.
28.	2	Common evening primrose	*Oenothera biennis*	Introduced – N.E. USA.
29.	1, 2, 3.	Reed canarygrass	*Phalaris arundinacea*	Introduced, invasive.
30.	1	English plantain	*Plantago major*	Introduced.
31.	1, 2, 3.	Japanese knotweed	*Polygonum cuspidatum*	Introduced, invasive.
32.	2, 3.	Bracken fern	*Pteridium aquilinum*	Native.
33.	2, 3.	Creeping buttercup	*Ranunculus repens*	Introduced, invasive.
34.	2	Water cress	*Rorippa nasturtium-aquaticum*	Introduced.
35.	2	Red sorrel	*Rumex acetosella*	Introduced.
36.	2, 3.	Curly dock	*Rumex crispus*	Introduced.
37.	2, 3.	Bitter dock	*Rumex obtusifolius*	Introduced.
38.	1, 2, 3.	Small-fruited bulrush	*Scirpus microcarpus*	Native.
39.	1, 2, 3.	Bittersweet nightshade	*Solanum dulcamara*	Introduced, invasive.
40.	2, 3.	Hedge nettle	*Stachys cooleyae*	Native.
41.	1	Tansy	*Tanacetum vulgare*	Introduced, invasive.
42.	1	Dandelion	*Taraxacum officinale*	Introduced, invasive.
43.	2, 3.	Piggy-back plant	*Tolmeia menziesii*	Native.
44.	2	White clover	*Trifolium repens*	Introduced.
45.	2, 3.	Stinging nettle	*Urtica dioica*	Introduced.

Ornamentals represent introduced species that were typically planted in private yards or businesses. They are usually not invasive, except for English ivy (*Hedera helix*), which can choke trees. Most do not represent a threat and are unable to naturally propagate. Others such as English holly (*Liex aquifolium*) are distributed by bird droppings, but are not problematic.

Table 15:
Ornamental Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	3	Norway maple	*Acer platanoides*	Introduced.
2.	3	Red maple	*Acer rubrum*	Introduced.
3.	1	Butterfly bush	*Buddleia davidii*	Introduced.
4.	3	Parneyi cotoneaster	*Cotoneaster lacteus*	Introduced.
5.	3	Crocosmia	*Crocosmia* sp.	Introduced.
6.	1	Buning bush	*Euonymus alaalatus*	Introduced.
7.	1, 2	English ivy	*Hedera helix*	Introduced, invasive.
8.	3	Blue star juniper	*Juniperus squamata*	Introduced.
9.	2	English holly	*Liex aquifolium*	Introduced.
10.	1	Apple fruit tree	*Malus* sp.	Introduced.
11.	1	Scotch pine	*Pinus sylvestris*	Introduced.
12.	3	Thundercloud plum tree	*Prunus cerasifera*	Introduced.
13.	1	Otto-luyken laurel	*Prunus laurocerasus*	Introduced.
14.	1	Plum fruit tree	*Prunus* sp.	Introduced.
15.	3	Flowering cherry tree	*Prunus* sp.	Introduced.
16.	1	Rhododendron species	*Rhododendron* sp.	Introduced.
17.	1, 2, 3.	Locust tree	*Robinia* sp.	Introduced.
18.	1	Weeping willow	*Salix babylonica*	Introduced.
19.	2	European mountain ash	*Sorbus acuparia*	Introduced.

The NMFS (1996) indicator for riparian reserves includes several factors that must be assessed in order to determine its existing state. These factors include: adequate shade, large woody debris recruitment, habitat protection, connectivity, and percent similarity of riparian vegetation to the potential natural community/composition. The functionality of the riparian reserve decreases as loss and fragmentation increase, and as the percent similarity of the existing riparian vegetation to the potential natural community/composition drops from >50 percent (*properly functioning*), to 25 percent to 50 percent (*at risk*), and finally <25 percent (*not properly functioning*). The percent "intact" can also be quantified in that >80 percent is considered *properly functioning*, 70 percent to 80 percent is considered *at risk*, and <70 percent is considered *not properly functioning*. Based on the analysis of aerial photographs, ground truthing, and detailed stream survey, the results indicate the riparian reserves vary by reach.

The riparian reserve in Reach 1 is **not properly functioning** due to only 5.11 percent being forested habitat within the 122-meter (400-foot) wide corridor. Furthermore, the limited amount of riparian reserves along Reach 1 are dominated by deciduous trees and introduced invasive species.

The functionality of the riparian reserve in Reach 2 is not as clear as Reach 1. Although the percent forested increased to 21.63 percent, it is also composed of primarily deciduous trees, introduced invasive species are abundant, and shrubs and grasses (46.46 percent) dominate large tracts. The riparian reserve in this reach is also confined between Highway 522 to the west and commercial businesses to the east. Furthermore, the ability of the reserve to provide large woody debris and

adequate shading has been extremely compromised. Therefore, based on these facts, the riparian reserve in Reach 2 is also **not properly functioning**.

The functionality of the riparian reserve in Reach 3 increases as the percent forested habitat increased to 45.76 percent, and overall shading increased (except immediately upstream of NE 195th Street). Although the potential for future large woody debris recruitment is still unacceptably low, and much of the forest has a high deciduous component, conifers become much more prevalent. Because of these factors, the riparian reserve is considered **at risk** in Reach 3.

The overall rating for the riparian reserve in Little Bear Creek as it flows through the City of Woodinville is considered **not properly functioning**. Although conditions improve in the upper reaches, the overall dominance of deciduous trees, poor potential for future large woody debris recruitment and lack of shade in Reaches 1 and 2 indicate that overall the riparian reserve is **not properly functioning**.

4.4.7 Water Quality

The NMFS (1996) considers temperature, sediment, and chemical contamination/nutrients in their Matrix of Diagnostics/Pathways and Indicators criteria. Of these, sediment was previously discussed in Section 4.4.3, Substrate.

Temperature: Water temperature is a key factor controlling the ability of salmonids to survive in a stream. It will also influence species composition in that some species such as bull trout require exceptionally colder water to successfully reproduce. Water temperatures rising above a 7-day average maximum of 7.8°C (46°F) is reported to limit spawning and rearing success of bull trout.

The following temperatures are average 7-day maximums. The NMFS (1996) considers 10 to 13.9°C (50 to 57°F) or less to be *properly functioning*. At risk temperatures depend on time of year or life cycle (spawning or migration and rearing). Water temperature is considered *at risk* for spawning adults when between 13.9 to 15.6°C (57 to 60°F), and for migration and rearing when 13.9 to 17.8°C (57 to 64°F). Stream temperatures above 15.6°C (>60°F) for spawning and above 17.8°C (>64°F) for migration and rearing are considered *not properly functioning*. The Washington State Department of Ecology reported that temperatures from 21 to 22°C (69.8 to 71.6°F) are lethal to chinook salmon while temperatures from 20 to 21°C (68 to 69.8°F) create thermal barriers (Hicks, 2000 as reported by Kerwin, 2001).

DEA biologists monitored two Hobo temperature data loggers in Little Bear Creek between June 16 and October 17, 2001 (4 months). The lowermost data logger was installed near the mouth of Little Bear Creek while the uppermost was installed downstream of NE 205th Street crossing near the King/Snohomish County line. Each data logger was set to collect hourly readings. The City of Woodinville is continuing the monitoring effort beyond the period of analysis documented in this report (Monzaki, personal communication, 2001).

Table 16 below presents the consolidated stream temperature data in the NMFS 7-day average maximum temperature format for Little Bear Creek from June 16 through October 17, 2001. Juvenile

life cycle data is for chinook salmon as defined by Kerwin (2001) as adapted by Myers et al., 1998. The outmigration period lasts from early March through late July, peaking in June. Adult migration and spawning life cycle data was determined by reviewing the WDFW salmon spawning ground survey data from 1952 through 2000. The earliest observation of an adult chinook in Little Bear Creek occurred on September 29 while the latest live sighting occurred on November 5th, peaking in October. Although this analysis is focused on chinook salmon it is important to note that some species such as juvenile coho salmon, resident cutthroat trout, coastrange sculpins, and western brook lampreys are present in Little Bear Creek throughout the year.

Table 16:
7-day Average Maximum Stream Temperatures for Little Bear Creek, Woodinville

Week	Reach 1 Mouth	Reach 3 205th	Chinook Salmon Life Cycle	NMFS Indicator Status
6/16 – 6/22	15.3°C	14.9°C	Peak Juvenile Migration and Rearing	At Risk
6/23 – 6/29	14.8°C	14.5°C	Peak Juvenile Migration and Rearing	At Risk
6/30 – 7/6	16.4°C	16.1°C	Peak Juvenile Migration and Rearing	Not Properly Functioning
7/7 – 7/13	17.0°C	16.6°C	Juvenile Migration and Rearing	Not Properly Functioning
7/14 – 7/20	15.1°C	14.7°C	Juvenile Migration and Rearing – Adults in Lake Wa.	At Risk
7/21 – 7/27	16.1°C	15.6°C	Juvenile Migration and Rearing – Adults in Lake Wa.	Not Properly Functioning
7/28 – 8/3	15.0°C	14.7°C	Juvenile Migration and Rearing – Adults in Lake Wa.	At Risk
8/4 – 8/10	16.8°C	16.3°C	Juvenile Chinook now absent – Adults in Lake Wa.	Not Properly Functioning
8/11 – 8/17	17.2°C	16.5°C	Adults in Lake Washington	Not Properly Functioning
8/18 – 8/24	15.6°C	15.0°C	Adults in Lake Washington	Not Properly Functioning/At Risk
8/25 – 8/31	16.3°C	15.8°C	Adults in Lake Washington	Not Properly Functioning
9/1 – 9/7	14.8°C	14.4°C	Adults in Lake Washington	At Risk
9/8 – 9/14	14.7°C	14.2°C	Adults in Lake Washington	At Risk
9/15 – 9/21	13.7°C	13.3°C	Adults possibly present in Little Bear Creek	High-end of Properly Functioning
9/22 – 9/28	13.7°C	13.1°C	Adult Chinook likely present Little Bear Creek	High-end of Properly Functioning
9/29 – 10/5	12.0°C	11.6°C	Adult Chinook present – spawning in Little Bear Creek	Properly Functioning
10/6 – 10/12	11.1°C	10.6°C	Adult Chinook present – spawning in Little Bear Creek	Properly Functioning
10/13 – 10/17	11.0°C	10.6°C	Adult Chinook present – spawning in Little Bear Creek	Properly Functioning

Notes: *Properly Functioning* = 10 to 13.9° C.
At Risk = 13.9 to 15.6° C for migrating adults, and 13.9 to 17.8° C for migration and rearing.
Not Properly Functioning = >15.6° C for spawning, and >17.8° C for migration and rearing.

Based on the stream temperature data collected by DEA between June 16, through October 17, 2001, this parameter ranges from **at risk** to **not properly functioning** during juvenile migration and rearing, and **properly functioning** during adult migration and spawning. However, between September 15, 2001, through September 28, 2001, temperatures were at the upper end of **properly functioning** and will likely shift to **at risk** during warmer years.

The stream temperature data collected during this study is presented in Appendix P (Reach 1) and Appendix Q (Reach 3). It is interesting to note that daily stream temperatures fluctuated from 0.46 to 4.68 degrees and that on average, Reach 1 was approximately 0.4 degree warmer than Reach 3. The greatest daily fluctuations "typically" occurred on days when the maximum hourly temperature

was higher than average, and as stream temperature decreased so did the degree of fluctuation. Stream temperature was typically the coolest from 0700 to 0900 hours, and warmest from 1600 to 1800 hours. However, these "typical" time periods would shift substantially during cooling events. The highest hourly stream temperature reading occurred in Reach 1 measuring 18.16°C (64.69°F) for a 1-hour period between 1700 and 1800 hours on August 12, 2001.

Stream temperature data collected by Snohomish County Public Works – Surface Water Management (SWM) in the upper reaches of Little Bear Creek reported only one monthly measurement above 16°C (60.8°F) (SWM, 2000). However, these were spot checks during water quality sampling events utilizing hand held thermometers, and likely occurred prior to the daily peak. Snohomish County also reported that mean fecal coliform levels have violated Class AA standards, nitrate levels are some of the highest in the county, and dissolved oxygen levels violated standards about 8 percent of the time (SWM, 2000). Furthermore, the SWM reported that sediment samples collected near the mouth contained chromium, copper, lead, nickel, and zinc, although exact levels were not reported (SWM, 2000). Some of the peak water quality measurements during the year 2000 include 8,600 colonies/100 mL for fecal coliform, 0.00812 mg/L for copper, 0.000624 mg/L for lead, and 0.00691 mg/L for zinc collected on July 12, 2000 near the headwaters of Little Bear Creek (Thornburgh, personal communication, 2001).

Water quality data is collected by King County in Little Bear Creek at Station No. 0478 located in Reach 1 near the mouth. Stream temperature data collected by King County from 1990 through 1993 ranged from a low of 1.0°C (33.8°F) on February 16, 1993, to a high of 16.2°C (61.2°F) on July 20, 1992 (King County, 1994). Dissolved oxygen levels were generally good, with a low of 9.2 mg/L on August 19, 1991, when the stream temperature was 16.0°C (60.8°F), and a high of 14 mg/L on a couple of dates during the winter when stream temperatures were extremely low at 1.0 to 1.5°C (33.8 to 34.7°F). There is an inverse relationship of stream temperature and dissolved oxygen in that as stream temperature increases dissolved oxygen decreases.

Additional parameters analyzed by King County indicate turbidity fluctuates widely from 0.3 to 42 nephelometric turbidity units (NTU). The highest measurements recorded for various parameters were pH = 8.30, turbidity = 42.0 NTUs, suspended solids = 87.00 mg/L, fecal coliform = 1,700 organisms/100mL, nitrate + nitrite = 1.600 mg/L, ortho-phosphorus = 0.190 mg/L, and total phosphorus = 0.570 mg/L. Stormwater metal levels were below detection levels for cadmium, lead, and nickel, but averaged 0.006 mg/L copper, and 0.023 mg/L zinc (King County, 1994). Levels of copper and zinc in Little Bear Creek were higher than in Swamp, North, Bear-Evans, Issaquah, and Tibbetts creeks.

Chemical Contamination/Nutrients: The NMFS (1996) reports that for the chemical contamination/nutrients indicator, a *properly functioning* stream has low levels of chemical contamination from agricultural, industrial, and other sources, no excess nutrients, and no Clean Water Act (CWA) 303d designated reaches. An *at risk* stream has moderate levels of chemical contamination from agricultural, industrial, and other sources, some excess nutrients, and one CWA 303d designated reach. A *not properly functioning* stream contains high levels of chemical contamination, high levels of excess nutrients, and more than one Clean Water Act 303d designated reach. The Washington Department of Ecology has reported that Little Bear Creek does not support designated uses, and contains three 303(d) listed stream reaches due to elevated fecal

coliform levels (Kerwin, 2001). Furthermore, a recent King County small streams toxicity/pesticide study indicates a variety of pesticides are present in Little Bear Creek at levels high enough to be "toxic" to test species (Kerwin, 2001). Based on the data presented by Kerwin (2001), and reports by SWM (2000) and King County (1994), the water quality pathway and associated chemical contamination/nutrients are **not properly functioning** in Little Bear Creek.

Additional Water Quality Data: Water quality data was collected in the field with a Horiba U-10 water quality meter during this survey. The goal was to document change by reach, and compare Little Bear Creek with the Sammamish River utilizing data collected on the same day. Based on this effort, the following data in Table 17 is presented. On September 25, 2001, pH, turbidity, and dissolved oxygen levels were noticeably lower in the Sammamish River, while temperature was elevated (Table 17). Based on the results, water quality is generally better in Little Bear Creek than in the Sammamish River due to lower water temperature and higher dissolved oxygen levels in Little Bear Creek. Within Little Bear Creek, conductivity and turbidity increased, and temperature decreased from Reach 1 to 3. Dissolved oxygen and pH fluctuated little between reaches.

Table 17:
Water Quality Data on 9/25/01 for Little Bear Creek, Woodinville

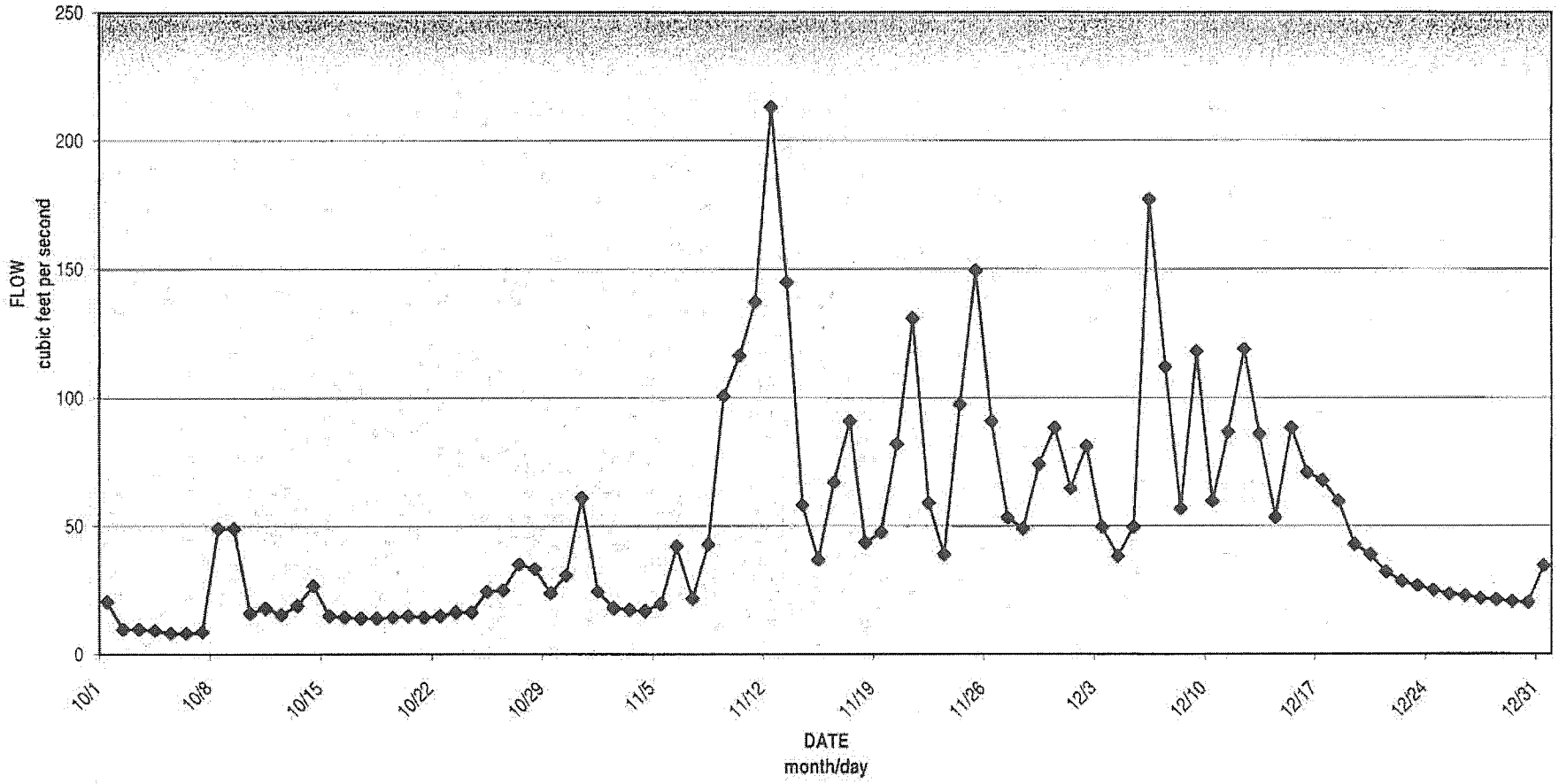
#	Parameter	Sammamish River	Reach 1 Mouth	Reach 2 134th	Reach 3 205th
1.	pH	6.85	7.70	7.89	7.72
2.	Conductivity (mS/cm)	0.145	0.144	0.147	0.148
3.	Temperature (C)	16.0	13.2	13.3	13.0
4.	Turbidity (NTU)	1	7	10	12
5.	Dissolved oxygen (mg/L)	6.90	9.40	8.65	8.95

4.4.8 Flow/Hydrology

The flow/hydrology pathway contains two indicators: change in peak/base flow and increase in drainage network. Increased urbanization results in increased flood frequency and streamflow variability (May et al., 1997). The result is that flow levels change frequently and extreme flow events occur more often. This condition is exasperated by an increase in the drainage network. Elements of the drainage network include ditches, road crossings, and stormwater outfalls. The overall result is that rainwater reaches the stream channel exponentially faster then what would occur naturally.

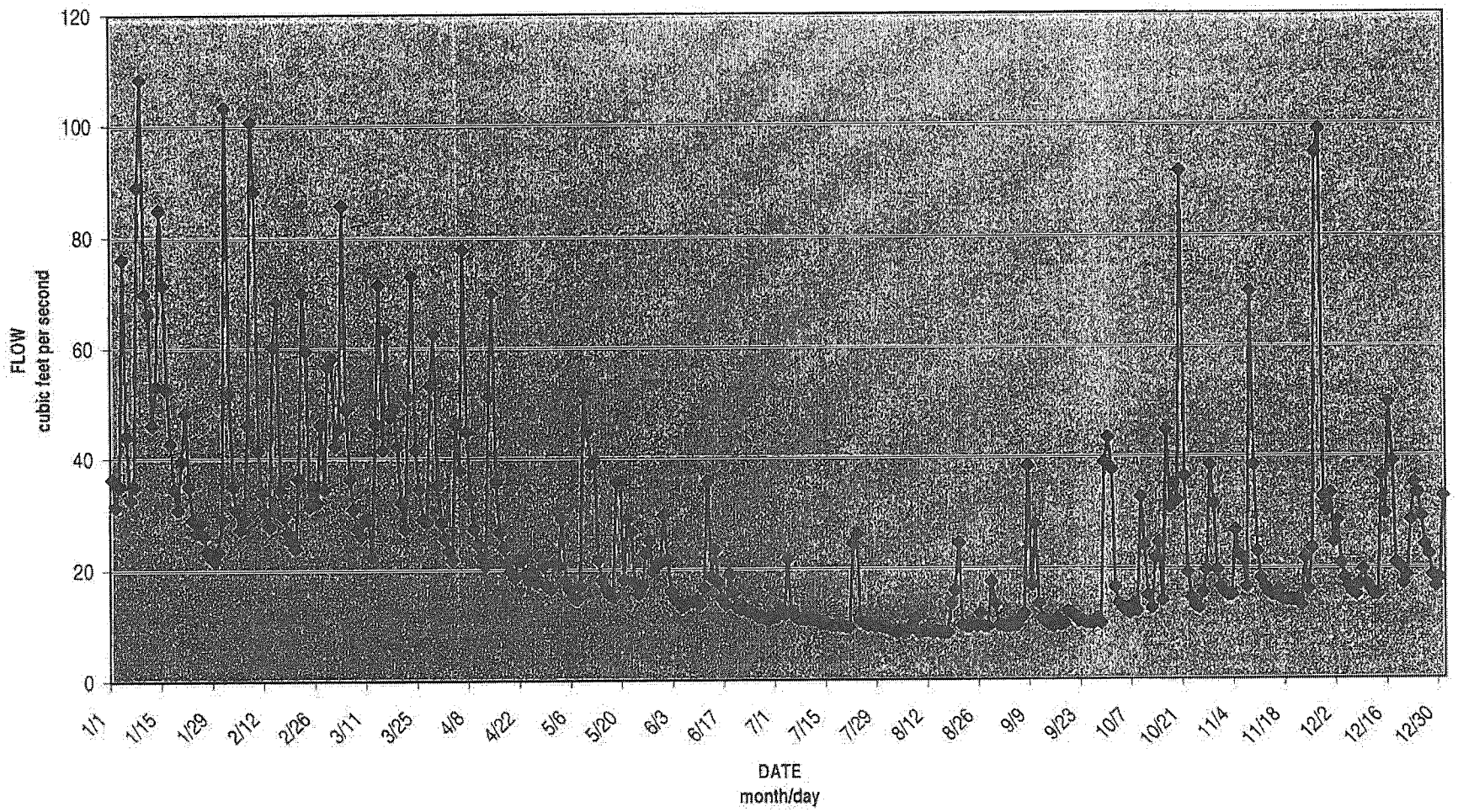
Peak/Base Flow: The NMFS (1996) Matrix of Diagnostics/Pathways and Indicators utilizes watershed hydrographs to document changes in peak/base flow. A *properly functioning* stream's hydrograph would indicate peak, base, and flow timing is comparable to a similar undisturbed watershed. An *at risk* stream shows some evidence of change. A *not properly functioning* stream's hydrograph indicates pronounced change in peak, base, and flow timing. Based on the following hydrographs (Figures 5a through 5c), the peak/base flow indicator is **at risk** due to evidence of change when compared with hydrographs from minimally disturbed watersheds.

Figure 5a: 1999 Hydrograph, October through December
Little Bear Creek



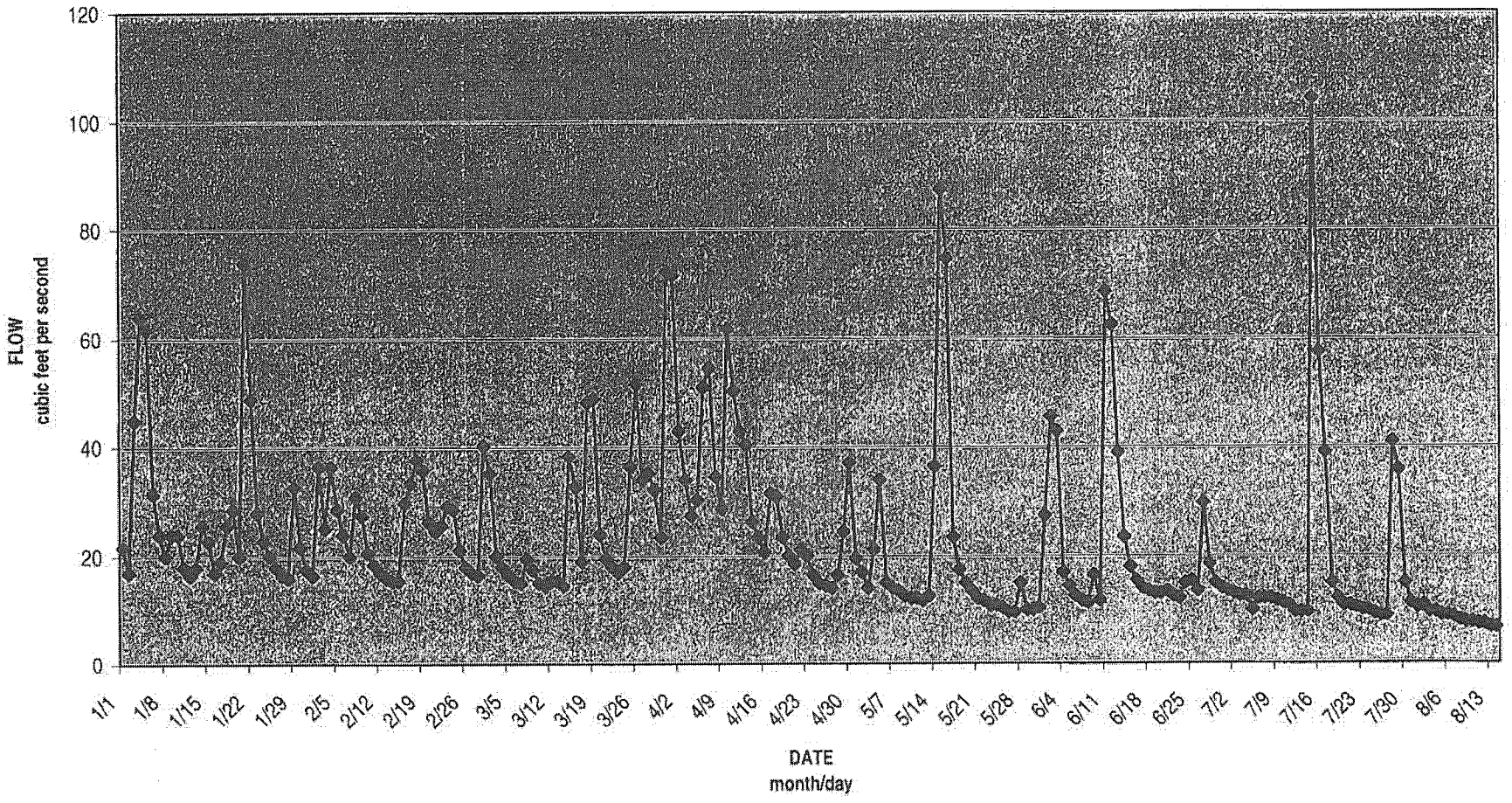
o:/project/w/wood0000-0010/0500 deliverables/Figure 5a 5b 5c.xls/5a, 1999

Figure 5b: 2000 Hydrograph, January through December
Little Bear Creek



o:/project/w/wood0000-0010/0500 deliverables/Figure 5a 5b 5c.xls/5b, 2000

Figure 5c: 2001 Hydrograph, January through August
Little Bear Creek



o:/projectw/wood0000-0010/0500 deliverables/Figure 5a 5b 5c.xls/5c, 2001

Increase in Drainage Network: The NMFS (1996) Matrix of Diagnostics/Pathways and Indicators utilizes an increase in drainage network to document change. A *properly functioning* stream will have zero or minimum increases in drainage network due to roads. An *at risk* stream will have a moderate increase in drainage density due to roads (e.g., 5 percent). A *not properly functioning* stream will have a significant increase in the drainage network due to roads (e.g., 20 to 25 percent).

The percentage of total impervious surface has increased to about 37 percent and road density to 5.9 kilometers per square kilometer (km/km^2) (2.28 mi/mi^2) in the past 12 years (Purser and Simmonds, Snohomish County Surface Water Management, unpublished data as reported by Kerwin, 2001). Based on these changes, the increase in drainage network indicator is **not properly functioning**.

4.4.9 Watershed Conditions

The watershed conditions pathway is gauged by three indicators: road density and location, disturbance history, and riparian reserves. Riparian habitat was documented above in Section 4.4.6 – Riparian Habitat.

Road Density and Location: The NMFS (as modified by the Mt. Baker Snoqualmie National Forest) has quantified parameters to rank the degree of road density and location within their Matrix of Diagnostics/Pathways and Indicators (Appendix L-2). Based on their criteria, a *properly functioning* watershed contains less than 1.61 km/km^2 (<1 mi/mi^2) of roads and no valley bottom roads. An *at risk* watershed contains 1.61 to 3.86 km/km^2 (1 to 2.4 mi/mi^2) of roads with some valley bottom roads. A *not properly functioning* watershed contains >3.86 km/km^2 of roads (>2.4 mi/mi^2), and many valley bottom roads.

May et al. (1997) documented numerous watershed characteristics based on aerial photographs from 1989. At that time, the percent total impervious surface in the Little Bear Creek Basin was 13.8 percent and the road density was 4.9 km/km^2 (1.90 mi/mi^2). They reported that the basin was composed of 43 percent undeveloped forest, 12 percent undeveloped open land, 32 percent rural residential land, 6 percent suburban residential land, 2 percent urban residential land, and 7 percent commercial industrial land. This equates to a total of 57 percent of the land being developed to some degree at that time.

During the past 12 years, the percentage of total impervious surface has increased to about 37 percent and road density to 5.9 km/km^2 (2.28 mi/mi^2) (Purser and Simmonds, Snohomish County Surface Water Management, unpublished data – as reported by Kerwin, 2001). Based on these changes, the NMFS watershed condition indicators for road density is **not properly functioning**. During this period, the amount of undeveloped forest has only dropped to 40 percent. This indicates that the majority of new impervious surface since 1989 has been established in the previously undeveloped open land and rural residential land.

Disturbance History: The NMFS (1996) defines a *properly functioning* watershed as containing <15 percent equivalent clear-cut acres (ECA) within the entire watershed with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian areas. Additional parameters specific for the Northwest Forest Plan do not apply. An *at risk* watershed

also contains <15 percent ECA within the watershed, but disturbance is concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian areas. A *not properly functioning* watershed contains >15 percent ECA and disturbance is concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian areas.

This indicator is difficult to judge based on the NMFS (1996) criteria and may be more applicable to watersheds outside the Puget Sound lowlands due to the extensive amount of development within this region. The ECA concept appears to be applicable in watersheds where logging is the dominant land use. Instead, DEA proposes to utilize the Urban Stream Rehabilitation guideline presented by May (1996) that ranks a stream based on percent total impervious area (percent TIA). This system results in a ranking of natural (percent TIA < 5 percent), impacted (percent TIA 10 to 30 percent), degraded (percent TIA 30 percent to 40 percent), and non-supporting (percent TIA >45 percent). Therefore, DEA equated natural to *properly functioning*, impacted to *at risk*, and degraded and non-supporting to *not properly functioning*. The location of the disturbance can also be factored into the formula.

Since about 37 percent of the watershed is impervious, and much of the riparian zone in the lower reaches has been developed, this watershed appears to be degraded. Therefore, the disturbance history indicator is **not properly functioning**. This is especially apparent when reviewing the rate of increase in new impervious area from 1989 to present.

4.4.10 Habitat Access

The Habitat Access Pathway includes the Physical Barriers Indicator. The NMFS (1996) states that a *properly functioning* stream with man-made barriers allows upstream and downstream fish passage during all flows. An *at risk* stream with man-made barriers does not allow upstream and/or downstream passage at base/low flow. A *not properly functioning* stream with man-made barriers does not allow upstream and/or downstream fish passage during a wide range of flows.

The Adopt-A-Stream Foundation conducted a Washington State Department of Transportation (WSDOT) Level A assessment of 88 culverts that posed potential fish passage barriers throughout the Little Bear Creek watershed (Adopt-A-Stream, unpublished data as reported by Kerwin, 2001). They concluded that only 8 of these culverts were fully passable during winter and spring flow conditions. The remaining 80 culverts posed at least partial barriers during this high flow period. The 8 culverts that were fully passable during high flows could also pose fish passage barriers during lower flows. Although this may seem dire, adult salmon are not usually present during peak flow periods in the early winter and spring time period, and "most" juvenile salmonids are migrating downstream during the spring. Therefore, this condition may primarily impact resident trout and juvenile coho salmon. This conclusion does not negate the need to continue basin wide removal of restrictive culverts, or the conversion of round culverts to larger bottomless culverts and bridges.

Habitat Access is not a major limiting factor along the mainstem of Little Bear Creek as it flows through the City of Woodinville. Potentially restrictive road crossings containing culverts within the City of Woodinville include SR 202, 132nd Avenue NE, 134th Avenue NE, Highway 522, NE 195th Street, and NE 205th Street. The crossing at NE 178th Street is considered passable to all life stages regardless of flow. All crossings within the City of Woodinville are passable to adult salmonids during the late summer and early fall. All of these crossings are also passable to juveniles with the possible exception of NE 205th Street which likely restricts upstream movement

by juveniles. It is likely that during peak flows that occur during the winter and spring, juvenile upstream passage is further restricted by all the aforementioned culverts. The primary issue is shear velocity due to the funneling effect of the culverts along the mainstem, and loss of three tributaries as the result of extensive culverting at their interface with Little Bear Creek in Reach 2 (Figure 3). Based on these conclusions, the physical barrier indicator within the City of Woodinville is **at risk**, but could become **properly functioning** as existing culverts are replaced with bridges, removed, or retrofitted to improve upstream passage for juvenile salmonids.

4.5 WILDLIFE

Biologists recorded bird, mammal, reptile, and amphibian species along Little Bear Creek both during surveys and incidentally during other site visits. Additional species to those observed likely use the area but remain undocumented by this study, as field visits were limited to spring and summer of a single year. A list of additional wildlife species that could potentially be present along the Little Bear Creek corridor but were not documented during these surveys is included in Appendix S.

4.5.1 Bird Observations

Thirty-nine bird species were observed along Little Bear Creek during site visits and surveys (Table 18). The majority of these species likely breed in the area, as most males were observed singing during the breeding season. One species, willow flycatcher (*Empidonax traillii*), is a federally designated species-of-concern. Five singing males were identified on three survey plots. The WDFW Priority Habitat and Species (PHS) program classifies great blue heron rookeries as vulnerable aggregations (Criterion 2) and are protected. Although no rookeries are documented within 2 miles of the corridor (WDFW, 2001b), suitable foraging habitat exists within the creek and adjacent wetlands, and biologists observed one individual during stream surveys.

Table 18:
Bird Observations Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	S Rank	Comment
1.	2, 3	Mallard	*Anas platyrhynchos*	S5B	
2.	2, 3	Great blue heron	*Ardea herodias*	S4S5	
3.	1, 2, 3	Cedar waxwing	*Bombycilla cedrorum*	S4N	NMBS*
4.	1, 2	Canada goose	*Branta canadensis*	S5B	
5.	2, 3	Red-tailed hawk	*Buteo jamaicensis*	S5B	
6.	3	Pine siskin	*Carduelis pinus*	S5B	
7.	1, 2, 3	American goldfinch	*Carduelis tristis*	S5B	
8.	1, 2, 3	House finch	*Carpodacus mexicanus*	S5	
9.	3	Swainson's thrush	*Catharus ustulatus*	S5B	NMBS
10.	1, 2, 3	Belted kingfisher	*Ceryle alcyon*	S5	NMBS
11.	1, 2	Killdeer	*Charadrius vociferus*	S5B	
12.	2, 3	Northern flicker	*Colaptes auratus*	S5	
13.	1, 2, 3	American crow	*Corvus brachyrhynchos*	S5	
14.	2, 3	Steller's jay	*Cyanocitta stelleri*	S5	
15.	2, 3	Willow flycatcher	*Empidonax traillii*	S5B	NMBS; Federal Species of Concern.
16.	3	Brewer's blackbird	*Euphagus cyanocephalus*	S5	
17.	3	Dark-eyed junco	*Junco hyemalis oreganus*	S5B	
18.	1	California gull	*Larus californicus*	S4B	Flying over creek.
19.	1, 2, 3	Song sparrow	*Melospiza melodia*	S5B	

Table 18 continued

#	Reach #	Common Name	Scientific Name	S Rank	Comment
20.	1, 2, 3	Brown-headed cowbird	*Molothrus ater*	S4N	
21.	1	House sparrow	*Passer domesticus*	SE	
22.	2, 3	Black-headed grosbeak	*Pheucticus melanocephalus*	S5B	NMBS
23.	1, 3	Downy woodpecker	*Picoides pubescens*	S5	
24.	3	Hairy woodpecker	*Picoides villosus*	S4S5	
25.	2, 3	Spotted towhee	*Pipilo erythrophthalmus*	S5B	Nest observed in Reach 3.
26.	1, 2, 3	Black-capped chickadee	*Poecile atricapilla*	S5	Nest observed in Reach 2.
27.	2, 3	Chestnut-backed chickadee	*Poecile rufescens*	S5	
28.	1, 2, 3	Bushtit	*Psaltriparus minimus*	S5	Nest observed in Reach 3.
29.	3	Golden-crowned kinglet	*Regulus satrapa*	S5B	NMBS
30.	3	Red-breasted sapsucker	*Sphyrapicus ruber*	S4S5	
31.	1, 2, 3	European starling	*Sturnus vulgaris*	SE	Nest observed in Reach 2.
32.	1, 2, 3	Violet-green swallow	*Tachycineta thalassina*	S5B	NMBS
33.	1, 2, 3	Bewick's wren	*Thryomanes bewickii*	S5	
34.	1, 2, 3	American robin	*Turdus migratorius*	S5B	
35.	3	Warbling vireo	*Vireo gilvus*	S5B	NMBS
36.	3	Hutton's vireo	*Vireo huttoni*	S5	
37.	2, 3	Wilson's warbler	*Wilsonia pusilla*	S5B	NMBS
38.	1	Mourning dove	*Zenaidura macroura*	S5B	NMBS
39.	1, 2, 3	White-crowned sparrow	*Zonotrichia leucophrys*	S5B	NMBS

*NMBS = neotropical migrant bird species

The WDFW PHS program maintains a list of species for which it has occurrence and status information. A global rank (GRank) describes the species' relative rarity or endangerment worldwide, and a state rank (SRank) describes the status within Washington State. Most bird species observed in the study area have a GRank of G5, which signifies that they are demonstrably secure globally. Most species have an SRank of S5 or S4 (Table 18), defining them as "demonstrably secure in state" or "apparently secure, with many occurrences", respectively. SRanks may include the qualifiers "B" and "N", which indicate breeding and nonbreeding status, respectively, of migrant species. The breeding status of these species may differ greatly from their nonbreeding status in the state. SE indicates an established exotic species. Two codes for any one species indicates an intermediate rank.

Eleven of the species recorded along Little Bear Creek are neotropical migrant bird species. Neotropical migrants breed in North America and winter in Mexico, Central America, the Caribbean, and South America. The publication of results from long-term survey programs confirms that populations of many neotropical migrants are declining, in some cases precipitously. Habitat loss and related problems are key issues in the causes of the declines. Therefore, these species may be of interest, particularly if they are breeding in the area. The area could potentially provide breeding habitat for several of these species, including Swainson's thrush, black-headed grosbeak, willow flycatcher, warbling vireo, Wilson's warbler, mourning dove, and white-crowned sparrow (Table 18). In addition, neotropical migrant species not detected during surveys and field visits may use the corridor (Appendix S).

4.5.2 Mammal Observations

Biologists documented ten mammal species in the Little Bear Creek corridor (Table 19). None of the species observed have federal or state special status. Other mammal species that may utilize the corridor include mink (*Mustela vison*), striped skunk (*Mephitis mephitis*), and coyote (*Canis latrans*). Appendix S contains a complete list of mammals that could potentially be present based on habitat types and historic range.

Table 19:
Mammal Observations Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	2	Beaver	*Castor canadensis*	Chewed shrubs and trails.
2.	3	Opossum	*Didelphis marsupialis*	Introduced, dead in stream.
3.	3	River otter	*Lutra canadensis*	Tracks, scat, and eaten salmon.
4.	2	Longtail weasel	*Mustela frenata*	Crossing stream on log.
5.	1, 2, 3	Myotis bat	*Myotis* spp.	
6.	2, 3	Black-tailed deer	*Odocoileus heminonus columbianus*	Tracks along stream bank; pellets.
7.	2, 3	Raccoon	*Procyon lotor*	Tracks along stream bank.
8.	2	Norway rat	*Rattus norvegicus*	Introduced.
9.	2, 3	Eastern gray squirrel	*Sciurus carolinensis*	Introduced.
10.	1, 2	Eastern cottontail	*Sylvilagus floridanus*	Introduced, dead young in nest (Reach 2).

4.5.3 Reptile and Amphibian Observations

Four reptile and amphibian species were observed in and along Little Bear Creek during field visits and surveys (Table 20). None of the species have state or federal special status. Other reptiles and amphibians not documented during this survey that could potentially be present along the Little Bear Creek corridor include: northern alligator lizard (*Elgaria coerulea*), painted turtle (*Chrysemys picta*), red eared slider (*Trachemys scripta*), common garter snake (*Thamnophis sirtalis*), western terrestrial garter snake (*Thamnophis elegans*), long-toed salamander (*Ambystoma macrodactylum*), rough-skinned newt (*Taricha granulosa*), western red-backed salamander (*Plethodon vehiculum*), ensatina (*Ensatina eschscholtzii*), western toad (*Bufo boreas*), and red-legged frog (*Rana aurora*). Both species of turtles were included due to the close proximity of several lakes to the study area.

Table 20:
Amphibian and Reptile Observations Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	3	Pacific Tree frog	*Hyla regilla*	3 in wetland near reach end.
2.	2	Bull frog	*Rana catesbeiana*	Introduced species captured next to stream.
3.	Tributary D	Northwestern salamander	*Ambystoma gracile*	Larva in small tributary.
4.	3	Northwestern garter snake	*Thamnophis ordinoides*	Near barricades at NE 195th.

4.5.4 Wildlife Habitat

Habitat in the Little Bear Creek corridor consists of wetlands, uplands, and a riparian zone. Vegetative composition in the riparian zone is discussed in detail in Section 4.4.6, Riparian Habitat. Wetland habitats include mixed forest, young deciduous, and scrub/shrub wetlands. Upland

habitats include second- and third-growth mixed forest, young alder, shrub, and open grassy areas. Exotic and invasive plant species occur both as infestations and in small, scattered clusters.

Most of the corridor in Reach 1 is disturbed shrub, dominated by Himalayan blackberry, red alder saplings, and Scotch broom. Approximately 5.1 percent of the corridor along Reach 1 consists of forested riparian habitat. An area of non-native planted species occurs in the developed area between 130th Avenue NE and NE 178th Street. The corridor is relatively narrow along this reach and provides limited wildlife habitat, although the mouth of the creek adjoins more heavily vegetated habitat along the Sammamish River and may be utilized by birds and other wildlife using the Sammamish River corridor. Red alder saplings, red-osier dogwood, and Himalayan blackberry were dominant in Reach 1 sampling plots. No snags, logs, or suitable raptor nesting or perching trees fell within sampling plots. Invasive species are common in all habitat types in the reach. The wildlife community in this reach is most likely made up of species habituated to human disturbance and able to utilize highly fragmented habitat (see Tables 18, 19, and 20 for wildlife species occurrence by reach).

Approximately 22 percent of Reach 2 is composed of young and mature deciduous forest. The remaining area is largely scrub/shrub, much of it disturbed and dominated by invasive weeds. One small area at the southeast junction of Highway 522 and SR 202 that fell within a sampling plot consisted of mature riparian vegetation, including red cedar of 61 to 76 centimeters (24 to 30 inches) DBH and several black cottonwoods and Douglas firs each approximately 61 centimeters (24 inches) DBH. Dominant species in this plot were hazelnut, big leaf maple, and Indian plum. Red alder, black cottonwood, and big-leaf maple dominate the deciduous forest in Reach 2. Common species include Himalayan blackberry, salmonberry, willow, Douglas fir, and giant horsetail. Few mature trees occurred outside of the mature forested sampling plot, although 2 snags were present on another plot. Sampling plots in disturbed riparian habitat, including young forest and scrub/shrub, were dominated by red alder, with infestations of Himalayan blackberry, Scotch broom, reed canarygrass, and other invasive species. Common native species included salmonberry, willow, and bitter cherry. The most extensive tracts of undeveloped land in Reach 2 are highly disturbed, while less disturbed areas tend to be small and highly fragmented. These areas support scattered mature trees, some red cedar along the creek, that may provide limited perching/nesting opportunities for raptors. The reach contains little breeding habitat for neotropical migrant bird species, which generally breed in forest interiors.

Reach 3 contains the highest proportion of mature trees and native species-dominated areas, as well as the most extensive tract of habitat. Deciduous and mixed forest makes up approximately 46 percent of the habitat in this reach, with the remainder in shrub and grass habitats. The reach supports potential raptor and neotropical migrant bird habitat, particularly in the northern region, where habitat is most extensive and large conifers occur more frequently. Sampling plots in Reach 3 fell into three general vegetative communities translated here into habitat types. Douglas fir, western red-cedar, big-leaf maple, and red alder dominated forested sampling plots. Common species were western hemlock, red-osier dogwood, salmonberry, trailing blackberry, willow, vine maple, red elderberry, skunk cabbage, and lady fern. Less frequent species included red huckleberry, piggyback, and Indian plum. DBH averaged approximately 71 centimeters (28 inches) for Douglas fir and western red-cedar, 41 centimeters (16 inches) for big-leaf maple, and 23 centimeters (9 inches) for red alder. Snags, stumps, and logs were more common than in the other reaches, averaging one of each per sampling plot. Young deciduous forest in Reach 3 was dominated by red alder, and western red-cedar, black cottonwood, vine maple, and salmonberry

were common. Invasive species, mainly reed canarygrass and giant horsetail, were encroaching on one sampling plot. Red alders averaged 13 centimeters (5 inches) DBH, and a few larger cottonwoods ranging from 15 to 38 centimeters (6 to 15 inches) DBH were recorded. One stump and little downed wood occurred on two plots. Shrub wetland sampled in Reach 3 consisted of alder saplings, Himalayan blackberry, reed canarygrass, evergreen blackberry, and bracken fern.

5.0 RESTORATION POTENTIAL

The Little Bear Creek watershed has changed significantly since the arrival of European settlers in the late 1800s. Although the Little Bear Creek corridor is still utilized by numerous species of fish and wildlife the quality of instream and riparian habitat has been impacted by changes in land use. Throughout this report the existing status of numerous pathways and indicators as defined by the NMFS (1996) have been documented. The determination of *properly functioning*, *at risk*, and *not properly functioning* for each "indicator" was used as a basis for the prioritization of restoration efforts. Baseline conditions determined to be *not properly functioning* are likely the most limiting conditions for salmonids and are therefore considered the highest priority for restoration followed by the conditions determined to be *at risk*. Table 21 represents a summary of the baseline conditions in Little Bear Creek as they pertain to listed salmonids. Other important considerations in prioritizing possible restoration opportunities are cost, feasibility, and probability of success.

Table 21:
Little Bear Creek Environmental Baseline Condition Summary

PATHWAY	INDICATORS	BASELINE CONDITIONS
Water Quality	Temperature	Juvenile Migration and Rearing = Not Properly Functioning to At Risk Adult Migration and Spawning = Properly Functioning
	Sediment	Not Properly Functioning
	Chemical Contamination & Nutrients	Not Properly Functioning
Habitat Access	Physical Barriers	At Risk
Habitat Elements	Substrate	At Risk
	Large Woody Debris	Not Properly Functioning
	Pool Frequency	Not Properly Functioning
	Pool Quality/Depth	At Risk (not properly functioning in Reach 1)
	Off-Channel Habitat	Not Properly Functioning
	Refugia	Not Properly Functioning
Channel Conditions and Dynamics	Width/Depth Ratio	Reach 1: Not Properly Functioning Reach 2 and 3: At Risk
	Streambank Condition	Not Properly Functioning
	Floodplain Connectivity	Not Properly Functioning
Flow/Hydrology	Change in Peak/Base Flows	At Risk
	Increase in Drainage Network	Not Properly Functioning
Watershed Conditions	Road Density and Location	Not Properly Functioning
	Disturbance History	Not Properly Functioning
	Riparian Reserve/Conservation Areas	Not Properly Functioning (at risk in Reach 3)

The NMFS matrix of pathways and indicators is divided into six major pathways each having several indicators. The following discussion on stream and riparian habitat restoration possibilities and prioritization follows this habitat component approach. Many of these indicators are interwoven in that correcting one will also improve another. An example of this is that large woody debris, riparian reserve, refugia, pool frequency and quality, streambank conditions, and substrate are all related. Another important consideration is that no single action will fully restore Little Bear Creek, and that improving existing conditions will be the result of a multitude of efforts taken over an extended period of time.

The City of Woodinville has already begun undertaking numerous restoration measures along the Little Bear Creek corridor (Appendix R). This includes land acquisition, culvert removal, fish passage improvements, and non-native plant removal. These measures, in addition to those outlined below, will help improve fish and wildlife habitat along the Little Bear Creek corridor.

5.1 WATER QUALITY

Temperature: The temperature indicator ranges from **properly functioning** to **not properly functioning** depending on time of year and life cycle of the species under consideration (see Section 4.4.7 and Table 16). Stream temperature increases as Little Bear Creek flows towards the Sammamish River. Based on the results of data collected from two hobo temperature data loggers installed at the downstream and upstream extremes of Little Bear Creek within the City of Woodinville, stream temperature typically increases by 0.4 degree Celsius within the city.

Additional data documenting the contribution tributaries and ambient air temperature makes to the overall increase of stream temperature would be beneficial in analyzing potential mitigating measures. However, increasing shade by planting conifer trees along the mainstem and tributaries to Little Bear Creek is the primary action the City of Woodinville could undertake to address this issue. The simplistic step of drastically increasing the abundance of conifers along both banks of Little Bear Creek would help increase shade and thereby reduce the rate of increase in stream temperature. Furthermore, planting conifer trees along both banks would help increase bank stability, reduce the abundance of invasive species such as reed canarygrass, provide wildlife habitat, reduce sedimentation, and eventually provide LWD and habitat complexity.

Sediment: The sediment indicator is **not properly functioning** due to a high percentage of fines within the substrate. Primary sources of sediment include stormwater runoff from upland sources such as roads and disturbed areas that directly enter Little Bear Creek or its tributaries, eroding and sloughing banks, and upstream sources. Remedies to reduce the percent of fines within the substrate include best management practices (BMPs) associated with construction projects, bank stabilization efforts, stormwater impact reduction measures, and isolated sediment removal measures from potential spawning areas or introduction of quality spawning gravel (typically not practicable). The most practicable measures the City of Woodinville could undertake to address this issue include bank stabilization efforts utilizing native vegetation, increasing the enforcement and use of BMPs, and working with Snohomish County to address upstream sources.

Chemical Contamination and Nutrients: The chemical contamination and nutrients indicator is **not properly functioning** (Table 21). This determination was based primarily on high fecal

coliform levels (a 1998 303[d] listing), the presence of pesticides, and the presence of metals in sediment samples collected in Reach 1.

The presence of high fecal coliform levels in Little Bear Creek is likely the result of failing septic tanks and runoff from fields with livestock. Both of these potential sources appear to be restricted to the upper portions of Little Bear Creek in Snohomish County and therefore not within the jurisdiction of the City of Woodinville to correct. The source of pesticides in Little Bear Creek may also be the result of actions occurring in the upper watershed.

The presence of metals is likely the result of road runoff entering Little Bear Creek through stormwater runoff in tributaries and direct discharge of stormwater from retention/detention facilities throughout the watershed. However, no existing data on metal concentrations from various potential sources exists. Therefore, identification of priority sites that contribute the highest metal concentrations to Little Bear Creek would need to be initiated prior to the initiation of corrective actions. Junk and construction yards located in Reach 2 and 3, and immediately north of King County may also contribute to the high metal concentrations in Little Bear Creek. An alternative to investing money and time into additional data collection is to insert catch-basin filters in high capacity parking lots that have the highest probability of contributing pollutants. Existing stormwater catch basins can be fitted with filter systems designed to capture priority pollutants such as soluble metals. The overall cost of installing and maintaining catch basin filters depends on the quantity of systems installed. The installation of catch basins would not eliminate existing contamination, but would reduce the rate of future accumulation.

5.2 HABITAT ACCESS

Habitat Access is **at risk**, and therefore not an imminent concern (Table 21). Both the City of Woodinville and Snohomish County are currently addressing habitat access concerns at 132nd Avenue NE and NE 205th Street (Appendix R). The predominance of the culverts identified as potential barriers to fish passage by the Adopt-A-Stream foundation are in Snohomish County and therefore outside of the jurisdiction of the City of Woodinville to correct.

Although the 134th Avenue NE crossing is not currently a fish passage barrier to migrating adult salmonids, they do stack-up immediately downstream of the crossing. The City of Woodinville should investigate the feasibility of purchasing the wrecking yard on the west side of Little Bear Creek serviced by this crossing. If this lot could be purchased several stream enhancement opportunities could occur. The first goals would be to remove soil contaminants within the lot and remove all structures. The second goal would be to use this crossing for enhancement efforts between Little Bear Creek and Highway 522 within Reach 2. Once these actions were completed the crossing could be permanently removed.

5.3 HABITAT ELEMENTS

Four of six indicators of the Habitat Elements pathway are **not properly functioning** (Table 21). Indicators that are **not properly functioning** include LWD, pool frequency, off-channel habitat, and refugia. Although the substrate indicator is **at risk** versus **not properly functioning**, the status of this indicator is also a concern due to its impact on salmonid reproduction.

The lack of LWD plays a major role in decreasing pool frequency and the availability of refugia. The importance of LWD in creating and maintaining pool frequency and refugia is so vital that this may be the single most important habitat element requiring immediate attention in Little Bear Creek. Furthermore, because the riparian zone along Little Bear Creek does not contain adequate numbers of large conifers for LWD recruitment, this indicator will remain **not properly functioning**. The addition of LWD by mechanical means in itself is simplistic and only moderately expensive. However, streamside access and uncertainty in obtaining desired results can create problems. These facts limit the applicability of installing LWD or creating pool habitat. However, some areas with good access are present, and careful design and implementation can increase the probability of success. Sites where access is good include most of Reach 1, within Reach 2 near 132nd Avenue NE and 134th Avenue NE, and within Reach 3 immediately upstream of NE 195th Street. Additional sections of stream could be accessed along Highway 522.

Another important issue is the availability of future recruitment of LWD. Large conifer trees that could potentially add to the presence of instream LWD are lacking along the Little Bear Creek corridor. The only way to address this issue is to plant thousands of conifers along the riparian corridor. Although the time-delay between planting conifer saplings and achieving LWD recruitment would be many decades, this action is necessary for the long-term interest of Little Bear Creek. Because of this time-delay, the planting of conifers is of the highest priority. Additional actions associated with this effort include the removal of non-native and invasive species to facilitate conifer establishment, and long-term monitoring. Additional value is created by this action since planting conifers along the riparian zone will increase bank stability, shade, and wildlife habitat. The entire remaining vegetated corridor along Little Bear Creek is in need of immediate and intensive planting of conifer saplings.

Restoring or improving pool frequency above what would result from the placement of LWD in accessible locations is problematic and costly. Two sites where stream restoration efforts could be undertaken include the lowermost section of Reach 1 and within Reach 3 immediately upstream of NE 195th Street (Appendix G). Both of these sites are fully armored, linear, lack LWD, and consist of low-gradient riffle habitat. Because these sites are degraded, owned by the city, and accessible, they are deemed the best candidates for intensive site specific restoration efforts that could address a multitude of the indicators for the Habitat Elements pathway that are not properly functioning. Primary actions that could occur at these sites include removal of bank armoring, creation of refugia and off-channel habitat, creation of pool habitat, revegetation, and installation of LWD.

Off-channel habitat can also be used as refugia by juvenile salmonids. Off-channel habitat could be created as part of the site specific restoration plan that would be developed for the two stream restoration sites mentioned above. Another simplistic and relatively inexpensive measure that would create additional off-channel habitat and refugia would be to reduce the length of two or three culverts that currently extend into the active stream channel located in Reach 2 (Appendix D – Reach 2 Photos 10, 12, 17, 20, and 21). These culverts drain the unnamed tributaries within the City of Woodinville as shown on Figure 3. The idea here is to cut each culvert back as far as possible into the adjacent uplands for a distance of at least 6 meters (>20 feet) so that new off-channel habitat (and wetlands) is created where culverts and their associated fill material currently exists. The newly exposed area would need to be graded to the stream's

base-flow level and planted with native hydrophytic vegetation. LWD could also be installed at these sites to increase their overall functionality.

5.4 CHANNEL CONDITIONS AND DYNAMICS

Two indicators of the Channel Conditions and Dynamics pathway that are **not properly functioning** include streambank condition and floodplain connectivity. Streambank conditions can be improved by replacing non-native and invasive species with conifers as mentioned previously. Extensive sections of the streambank, especially between Little Bear Creek and Highway 522 could be greatly improved. The removal of armoring in conjunction with revegetation in the lower section of Reach 1 near the mouth and immediately upstream of NE 195th Street will also help to improve streambank conditions.

Floodplain connectivity relates to hydrologic linkage between Little Bear Creek and adjacent off-channel areas, wetlands, riparian vegetation, and succession. No connectivity occurs where stream armoring is present or the stream is abutted by development. No other areas were identified where floodplain connectivity could be increased except as where previously mentioned.

5.5 FLOW/HYDROLOGY

The Flow/Hydrology pathway includes two indicators that were identified as **not properly functioning**. The percent impervious surface within the watershed and abundance of man-made drainage networks are the primary factors influencing this pathway. The two actions that can improve this pathway include reducing the percent of impervious surface, and improving or creating retention/detention facilities within the watershed. The preservation and restoration of existing habitat are critical in protecting against the continued degradation of this pathway. These issues are watershed-wide problems that extend far beyond the Little Bear Creek corridor. Because of the scale of this issue, it is most appropriately dealt with through the implementation of the Growth Management Act (GMA), Shoreline regulations, and city and county codes throughout the Little Bear Creek watershed. However, retrofitting of stormwater retention/detention facilities and elimination of impervious surface should be undertaken whenever the opportunity arises. Actions that reduce the speed at which stormwater travels through existing ditch networks to Little Bear Creek will further reduce the flashy conditions of the existing hydrographs (Figures 5a through 5c).

5.6 WATERSHED CONDITIONS

All indicators for the Watershed Conditions pathway including road density and location, disturbance history, and riparian reserve/conservation areas are **not properly functioning**. With the exception of the riparian reserve/conservation areas indicator (previously addressed), the remaining indicators are influenced primarily by the total amount of impervious surface within the watershed. As was the case with the Flow/Hydrology pathway, this issue is most appropriately dealt with through the implementation of the GMA, Shoreline regulations, and city and county codes throughout the watershed.

Table 22 below summarizes the pathway, indicator, priority, and action for each baseline condition identified as *not properly functioning*. Included in Table 22 are indicators that may have been partially *properly functioning* or *at risk* in one reach or for a specific life history (adult

migration/spawning) but otherwise *not properly functioning*. The priority of each indicator was determined based on time required to achieve desired results, degree of additional benefit, potential for success, and feasibility. Several of the indicators will benefit from the same basic action (e.g. installation of LWD and planting conifers). Although prioritized, the actions required to address these conditions in Little Bear Creek should occur simultaneously.

Table 22:
Not Properly Functioning Baseline Conditions Summary

PATHWAY	INDICATORS	Priority	Basic Action
Water Quality	Temperature	Medium	Plant conifers in riparian zone to increase shading.
	Sediment	Medium	Stabilize problem areas (e.g. LB of Reach 2), stabilize banks, reduce/eliminate upland sources, clean substrate (not practicable).
	Chemical contamination and nutrients	Medium	Identify key sources and implement corrective actions at sources.
Habitat Elements	Large Woody Debris	High	Install LWD and plant conifers for future recruitment.
	Pool Frequency	Medium	Will increase through installation of LWD
	Off-Channel Habitat	High	Create through LWD and retracting culverts
	Refugia	High	Create through LWD and retracting culverts
Channel Conditions and Dynamics	Width/Depth Ratio	Low	Remove armoring and taper back, and address incision resulting from changes in hydrology.
	Streambank Condition	High	Remove non-natives & plant > 10,000 conifers
	Floodplain Connectivity	Medium	Protect and restore corridor
Flow/Hydrology	Increase in Drainage Network	Medium	Reduce ditching and impervious area.
Watershed Conditions	Road Density and Location	Medium	Limit new roads and remove unnecessary ones
	Disturbance History	Medium	Protect and restore corridor
	Riparian Reserve/Conservation Areas	High	Remove non-natives, plant > 10,000 conifers, preserve existing habitat, and acquire more.

In summary, several key actions could potentially improve existing habitat conditions in Little Bear Creek. These recommended actions include:

1. Obtain, preserve, and enhance land along Little Bear Creek to minimize further habitat degradation from continued development along the Little Bear Creek corridor. Undeveloped properties along the corridor with quality riparian habitat should be high priority acquisitions, such as, the properties to the north of the City's "Lumpkin" property (east of 134th Avenue NE crossing). Another area to consider would be the properties to the west of 134th Avenue NE as described in item 7.
2. Immediately initiate a program to reestablish conifers within the riparian zone throughout the Little Bear Creek corridor.
3. Restore hardened rip/rap banks along Little Bear Creek. Include creation of pool habitat, and addition of large woody debris as part of the restoration plan.
4. Retrofit potential pollution-generating sites such as large parking lots and roadways with pollution prevention and storm flow retention facilities where such facilities are presently absent.

5. Reforest upland areas dominated by introduced species such as reed canarygrass and Himalayan blackberry.
6. Create off-channel habitat at each culverted tributary confluence with Little Bear Creek. This can be accomplished by daylighting the maximum extent of culverted tributary possible at each confluence.
7. The City of Woodinville should investigate the feasibility of purchasing the wrecking yard on 134th Avenue NE along the west side of Little Bear Creek. If this lot could be purchased several stream enhancement opportunities could occur. The first goals would be to remove soil contaminants within the lot and remove all structures. The second goal would be to use this crossing for enhancement efforts between Little Bear Creek and Highway 522 within Reach 2. Once these actions were completed the 134th Avenue NE crossing could be permanently removed, or converted to a bridged crossing.
8. The newly purchased city property immediately upstream of NE 195th Street is an ideal site for intensive in-stream, riparian, and upland habitat restoration activities. Actions that would benefit Little Bear Creek at this site include removal of bank armoring, creation of pool habitat, removal of impervious surface (pavement) and non-native vegetation, and installation of large woody debris, riparian vegetation, and upland vegetation.
9. Maintain regular street sweeping, storm drainage system cleaning, and add sediment traps where feasible. This will reduce the amount of sediment entering Little Bear Creek.

5.7 WILDLIFE HABITAT

The Little Bear Creek corridor was originally dominated by large expanses of old-growth forest composed of primarily conifers. These forests were extensively logged throughout the late 1800s and early 1900s and subsequently converted to agricultural land. More recently, agricultural land has rapidly been replaced with an urban landscape. Wetlands adjacent to the Sammamish River were historically extensive but were later filled to reduce flooding and create more developable land. Habitat features such as snags, downed wood, large conifers with a multi-canopy understory, and large wetland complexes are now uncommon or absent along the Little Bear Creek corridor.

Because the existing landscape has been significantly degraded from native conditions, numerous wildlife habitat enhancement opportunities exist. Based on our survey results, five primary actions that would improve wildlife habitat have been identified including:

1. Replacement of existing reed canarygrass, Himalayan blackberry, and scotch broom expanses with native vegetation.
2. Addition of conifers and mast (food) producing shrubs within existing deciduous dominated forest habitat.
3. Addition of downed woody debris to the forest floor.
4. Wetland creation within the corridor.
5. Installation of bird boxes for cavity nesting species.

The first four actions would help create more natural conditions conducive to native wildlife species. These four actions would benefit wildlife by creating suitable habitat, and Little Bear Creek by improving buffer functions. The installation of bird boxes is presented as a temporary measure to provide habitat for cavity nesters until other restoration efforts are able to reestablish suitable cavity nesting sites.

Numerous opportunities for wildlife habitat enhancement exist along the Little Bear Creek corridor in the City of Woodinville. Non-native plant removal opportunities exist along all reaches of the creek. The south end of Reach 1 is highly disturbed and in need of restoration. Little cover exists and non-native plants, which generally provide poor wildlife habitat, are common. The creek in the remainder of Reach 1 is closely bordered by development and would also benefit from restoration, as the existing vegetation provides little cover for wildlife.

The south end of Reach 2 in the vicinity of 132nd Avenue NE also has habitat enhancement opportunities. Shrub habitat on the left bank between 132nd Avenue NE and 134th Avenue NE is heavily infested with Himalayan blackberry, reed canarygrass, and other invasive species and is in need of weed removal and enhancement. Large areas of Himalayan blackberry and Scotch broom exist on the right bank beyond the riparian strip. The area from 134th Avenue NE to the north end of Reach 2 would benefit from the removal of reed canarygrass and other exotics, followed by restoration and enhancement. Although it is highly disturbed, the corridor is relatively wide in the middle stretch of Reach 2 and could potentially provide habitat for birds and mammals. Access to the right bank is difficult because of thick blackberry. The riparian zone becomes very narrow and shade and cover decrease from south to north. The north end of Reach 2 in particular would benefit from habitat restoration, as there is currently only sparse tree cover.

The portion of Reach 3 below NE 195th Street is bordered by private property on the right bank and Highway 522 on the left bank, and accessibility is poor. The area along Highway 522 is densely vegetated with Himalayan blackberry, and intensive clearing would be necessary to access and enhance this area. Private ownership along the left bank (east side) could hinder restoration attempts along this segment.

A shrub area accessed by a gravel lot off of 136th Avenue NE immediately north of NE 195th Street has good access and potential to provide wildlife habitat. The area is adjacent to a stand of mixed forest, which supports scattered large conifers and could provide a corridor for wildlife using the shrub area. Restoration of the gravel lot and adjacent areas would likely provide additional habitat for wildlife using the corridor north of this point.

Wildlife habitat improves with the increase of forest in the northern portion of Reach 3. Abundance of potential nesting and perching trees increases northward, and the corridor increases in width. The middle of Reach 3 is accessible from 136th Avenue NE, and this area provides opportunities for habitat improvement. Weed removal and the addition of native trees and shrubs to upland clearings outside of the riparian zone would enhance habitat in this area. While much of the forested area is young deciduous trees, larger trees increase in number to the north. This area might benefit most from the preservation of large conifers and tracts of forest.

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Woodin Creek Basin Habitat Assessment Final Report

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September 2004

WOODIN CREEK BASIN
HABITAT ASSESSMENT
FINAL REPORT
SEPTEMBER 2004

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EXECUTIVE SUMMARY

The City of Woodinville has retained Adolfson Associates, Inc. (Adolfson) to conduct a habitat assessment of Woodin Creek Basin. The study area for the Woodin Creek Basin Habitat Assessment includes all wetted habitat areas within the City of Woodinville that occur within the Woodin Creek Basin from its headwaters to its mouth at the Sammamish River. The primary purpose of the Woodin Creek Basin Habitat Assessment is to provide baseline information on habitat conditions affecting fish and wildlife in the study area. Other goals of the study are to identify potential limiting factors that support City-wide planning efforts aimed at the conservation and restoration of salmonid habitat within the City of Woodinville and to provide information that may be used by both the City and its citizens to assist in obtaining grants or other outside support to implement habitat conservation and restoration projects within the Woodin Creek Basin.

Methods

The field inventory method used for this study followed King County's stream habitat assessment methodology (King County, 1991). This is a semi-qualitative method used to document channel characteristics, in-water habitat conditions, riparian habitat conditions, substrate, and large woody debris. This study also addresses stream habitat and watershed criteria in relation to a hypothetical "properly functioning" stream system as currently defined by National Oceanic and Atmospheric Administration (NOAA) and United States Department of the Interior Fish and Wildlife Service (USFWS).

Summary of Findings

Watershed Conditions, Flow, and Hydrology

Woodin Creek has a high level of impervious surface. Approximately 41 percent of the total basin area of approximately 400 acres is covered by some type of impervious surface (roads, buildings, parking lots). The highest level of impervious surface within the basin was associated with road rights-of-way. The second highest level of impervious surface was associated with large parking lots for commercial, retail, and multifamily residential development. These two sources account for over half of the total impervious surface with the basin. Roadways and parking lots also impact flow and hydrology in Woodin Creek as a result of culverts. Approximately 20 percent of the total length of stream within the Woodin Creek basin is enclosed in culverts or pipes under roadways and parking lots. The most significant amount of alternation is the piping of the entirety of Reaches 2a and 2b (approximately 3,200 feet). In addition to these pipes, flow and hydrology within the basin are affected by the use of much of Reach 1 for conveyance of stormwater from developed areas. Flow enters the stream through a series of pipes and is conveyed downstream until it reaches a high flow bypass upstream of NE 171st Street where flow re-enters the piped storm conveyance network near station 9+25

Habitat Access

The scope of the Woodin Creek Habitat Assessment included a fall and winter in 2003 survey to identify use by adult salmon and to identify potential migration barriers based on fish-use. One adult Chinook salmon (carcass) was observed during the first day of the fall spawning survey upstream from NE 171st Street. No other adult salmon were observed at any other time during the spawning survey. Local neighborhood groups have reported observations of occasional large fish (unidentified species) within the stream during the fall and winter. King County relocated approximately 250 juvenile cutthroat trout and two sub yearling coho salmon from Reach 1 in November 2003 prior to conducting in-water work in the stream. Juvenile salmonid fish (unidentified species) were observed throughout the entire length of Reach 1 during the summer habitat inventory. Two adult cutthroat trout were observed downstream of NE 171st Street within Reach 1. In addition to salmonid fish, larval lamprey (unidentified species) and sculpin (unidentified species) were also seen in the stream. No adult or juvenile fish of any species were noted in Reaches 3, 4, or 5.

Water Quality

Woodin Creek did not meet all required State of Washington water quality parameters for Class AA waters during the study period. Temperature, dissolved oxygen, and pH are the water quality parameters included in the data provided to Adolfson for this study that were most often exceeded that relate to fish and wildlife habitat support. Temperature and dissolved oxygen values were most limiting during the summer; pH readings were lowest during the fall and winter. Woodin Creek also does not provide "properly functioning" water quality parameters considered necessary to support healthy self-sustaining populations of salmonid fish per NOAA Fisheries and USFWS parameters (NOAA Fisheries, 1996; USFWS, 1998). Summer temperatures recorded in Woodin Creek indicate that the primary concern is in relation to supporting rearing and migration habitat for salmonid fish.

Habitat Elements and Channel Conditions and Dynamics

Woodin Creek is limited in relation to the following habitat elements: Substrate, Large Woody Debris, Pool Frequency, Pool Quality, Off-Channel Rearing Habitat, and Refugia. Small gravel was the dominant substrate type in Reaches 1, 3, and 4. The only reach where cobble or large gravel was a significant component of the substrate was in Reach 5. Substrates in Reach 1 where fish are present were small gravel or finer (sand, silt, or organic materials). No naturally occurring large woody debris was observed in Reach 1. The large woody debris that was observed was associated with constructed log weirs or root wads installed and secured to the streambed and/or bank with cables. Pool frequency within Reach 1 was approximately a third of that which NOAA Fisheries (1996) and USFWS (1998) identify as "properly functioning." Pool quantity was generally low or moderate. There were few deep pools (over 3 feet deep) and dense woody cover was generally lacking in association with pools.

Riparian habitat widths in Reach 1 were commonly 100 feet or less and few habitats were adjacent to riparian areas that had a mature forest component. The narrow riparian area constrained by roads and development limits the abundance of off-channel rearing opportunities and significant areas for refugia. The few off-channel wetlands or side channels that are present have largely been impacted by conversion to landscape amenities (ponds).

Wildlife Habitat

Seven habitat types occur in the study area. These include in order of abundance: High Density Commercial and Residential; Medium Density Residential; Upland Forest; Riparian-Wetlands; Upland Grassland; Herbaceous Wetland; and Open Water Pond. In addition, Agricultural areas occur in King County just south of the study area.

Songbirds were the most abundant wildlife identified by the study both in numbers of individuals and numbers of species. The most abundant species of birds were those generally adapted to habitats located within urban environments. The study attempted to identify species that might not be commonly observed by residents, as a result night surveys were conducted and identified the presence of significant numbers of bats and one group of western screech owls. Bats and owls were observed in the forested areas of the watershed, generally adjacent to Reaches 3, 4, and 5. Other wildlife observations recorded during the habitat surveys included waterfowl (mallard), pileated woodpecker excavations, eastern gray squirrel, Pacific chorus frog, mole tunnels, and Virginia opossum.

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INTRODUCTION

The City of Woodinville has retained Adolfson Associates, Inc. (Adolfson) to conduct a habitat assessment of Woodin Creek Basin. This work will encompass all of 2003 and was designed to occur in two phases. The first phase included the gathering of existing baseline information regarding Woodin Creek and the completion of a reconnaissance-level review of habitat conditions within the basin. The second phase included site-specific field studies to document fish and wildlife use and habitat conditions in the basin. This report discusses the findings of the second phase of the Woodin Creek Basin Habitat Assessment.

Study Area and Purpose

The mouth of Woodin Creek is located on the left bank of the Sammamish River south of the center of the City of Woodinville, Washington (Figure 1). The Woodin Creek Basin drains a significant portion of the City of Woodinville east of the Sammamish River. Woodin Creek originates from groundwater seeps in residential areas in the eastern portion of the City and then flows generally west through the heavily developed floor of the Sammamish River Valley within the City (Figure 2). One tributary with two distinct branches originates from groundwater seeps and enters Woodin Creek from the north (Figure 2).

The study area for the Woodin Creek Basin Habitat Assessment includes all areas within the City of Woodinville that occur within the Woodin Creek Basin from its headwaters to its mouth at the Sammamish River (Photos 1 and 2). For the purpose of this study, the Woodin Creek Basin is defined as all parcels that contribute flow, either directly or indirectly to Woodin Creek (Figure 2).

The primary purpose of the Woodin Creek Basin Habitat Assessment is to provide baseline information on habitat conditions affecting fish and wildlife in the study area. This included identifying and summarizing existing sources of information to determine the applicability of existing resources in regard to Woodin Creek. These data will support the City of Woodinville's efforts to develop regulations and policies to comply with the GMA and implement their CIP program. Because of the emphasis on fisheries in both GMA guidelines and the ESA listings, much of this report focuses on habitat in the context of supporting anadromous fisheries, including Chinook salmon and bull trout; however, information on wildlife habitat conditions are also included in this report to address other regulatory and policy needs.

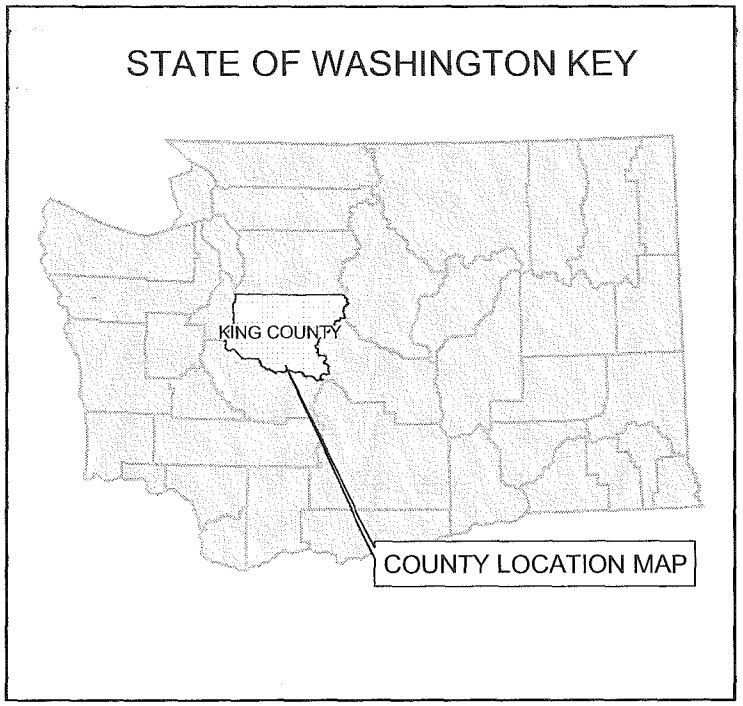
This study also has two secondary goals. The first is to identify potential limiting factors that support City-wide planning efforts aimed at the conservation and restoration of salmonid habitat within the City of Woodinville. The second and related goal is to provide information that may be used by both the City and its citizens to assist in obtaining grants or other outside support to implement habitat conservation and restoration projects within the Woodin Creek Basin.

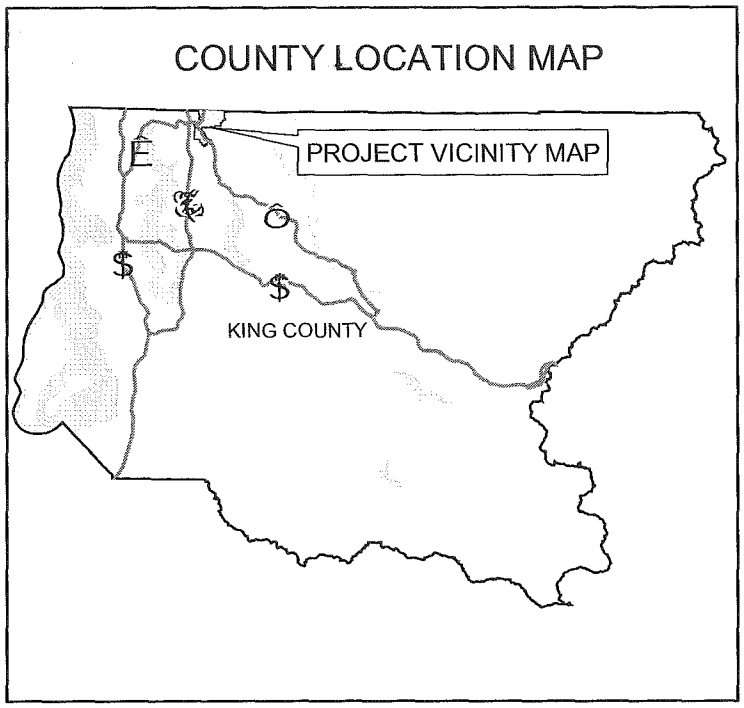
Regulatory Background

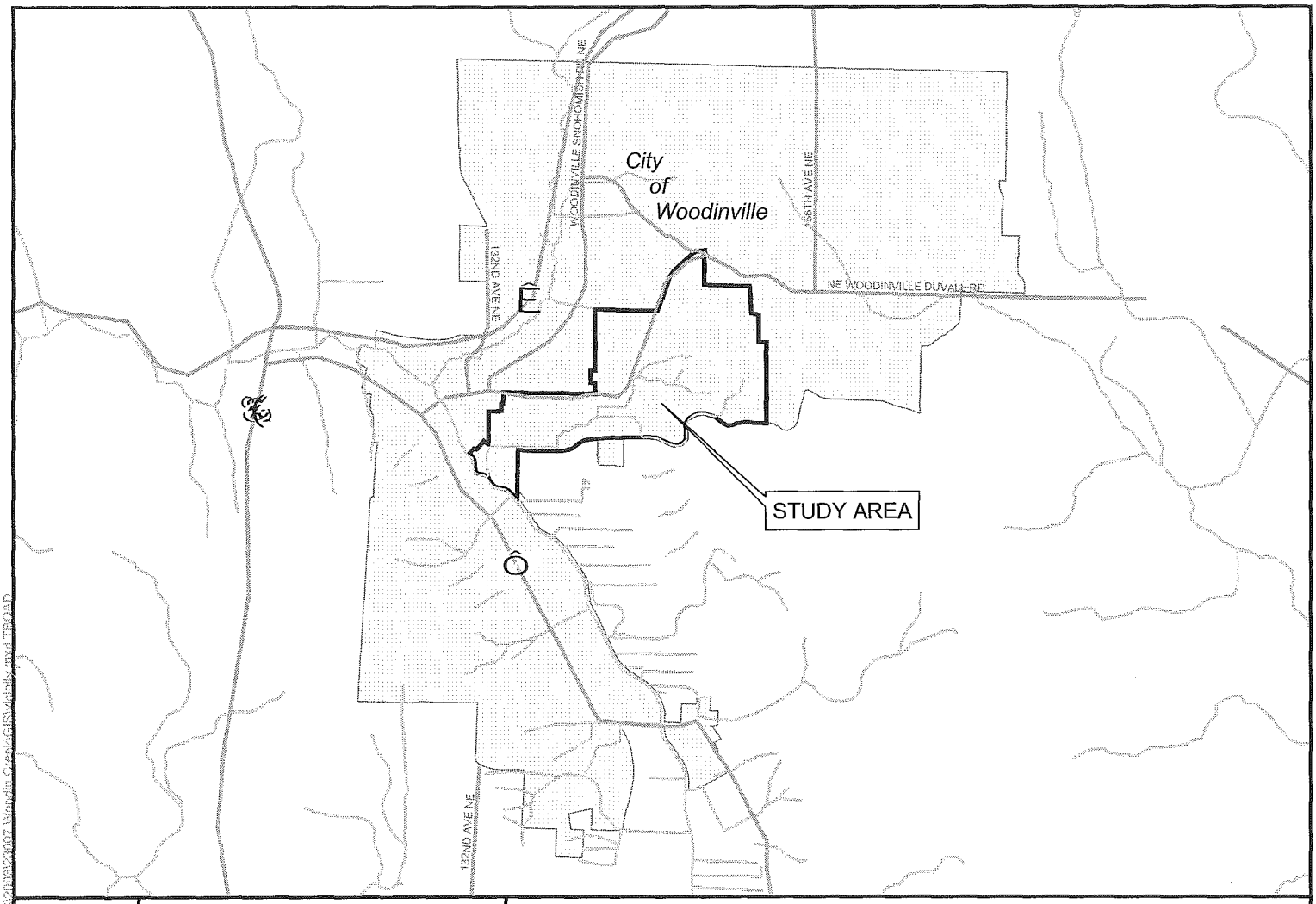
Due to the cultural and economic importance of anadromous fisheries in the Pacific Northwest, fish populations and habitat requirements in many of the regions larger stream systems are well studied. For example, The State of Washington, federal government, tribal governments, and regional water resource agencies such as METRO (now part of King County) all have been involved in the study of the regions rivers and streams over the past half century. Ideally, reliable scientific information would be known for all of the region's watercourses; however, most work has occurred to determine habitat requirements and species presence and abundance in the regions larger rivers and streams. It is only since the late 1990's that smaller urban tributaries became more of a research priority. This has been driven, in large part, by the requirements of the state's Growth Management Act (GMA) and the listings of Chinook salmon and bull trout under the federal Endangered Species Act (ESA).

The Washington State's legislature added a new section to the state's GMA in 1995 to ensure that cities consider reliable scientific information when adopting policies and regulations to designate and manage critical areas (RCW 36.70A.172). In 2002, the state adopted procedural criteria to implement these regulations. The regulations require that cities consider "best available science" in developing land use management policies and codes and that these policies and regulations give special consideration to the preservation or enhancement of anadromous fisheries. Although the state has specifically emphasized fisheries resources, the regulations also mandate that policies and land use decisions regarding other critical areas, including wetlands and wildlife habitat areas, similarly are based on the best scientific information available.

The National Marine Fisheries Service, a branch of the National Oceanic and Atmospheric Administration (NOAA Fisheries) proposed the Puget Sound Chinook salmon as "threatened" under the ESA in 1998. The following year, the US Fish and Wildlife Service (USFWS) listed Costal/Puget Sound bull trout stocks as "threatened." These listings brought with them the requirement that all projects that have a federal nexus (most commonly federal funding or the requirement for a federal permit) must comply with section 7(c) of the ESA. Many of the City's planned and proposed Capital Improvement Projects (CIPs) in the Woodin Creek Basin are anticipated to have a federal nexus, either as a result of a federal grant or as the result of the need to acquire a federal permit. A Corps of Engineers Section 404 permit is required for most work affecting in wetlands and streams and is one of the more common federal permit required by CIPs. The Section 7(c) consultation process administered by both NOAA Fisheries and USFWS require the evaluation of habitat conditions in relation to their ability to support populations of these listed fish species







Map data shown are the property of the sources listed below. Inaccuracies may exist, and Adolfson Associates, Inc. implies no warranties or guarantees regarding any aspect of data depiction.

Source: Woodinville GIS 2002; King County GIS 2002; ESRI 2000

NO SCALE

FIGURE 1
VICINITY MAP
WOODIN CREEK BASIN
HABITAT ASSESSMENT
WOODINVILLE, WASHINGTON

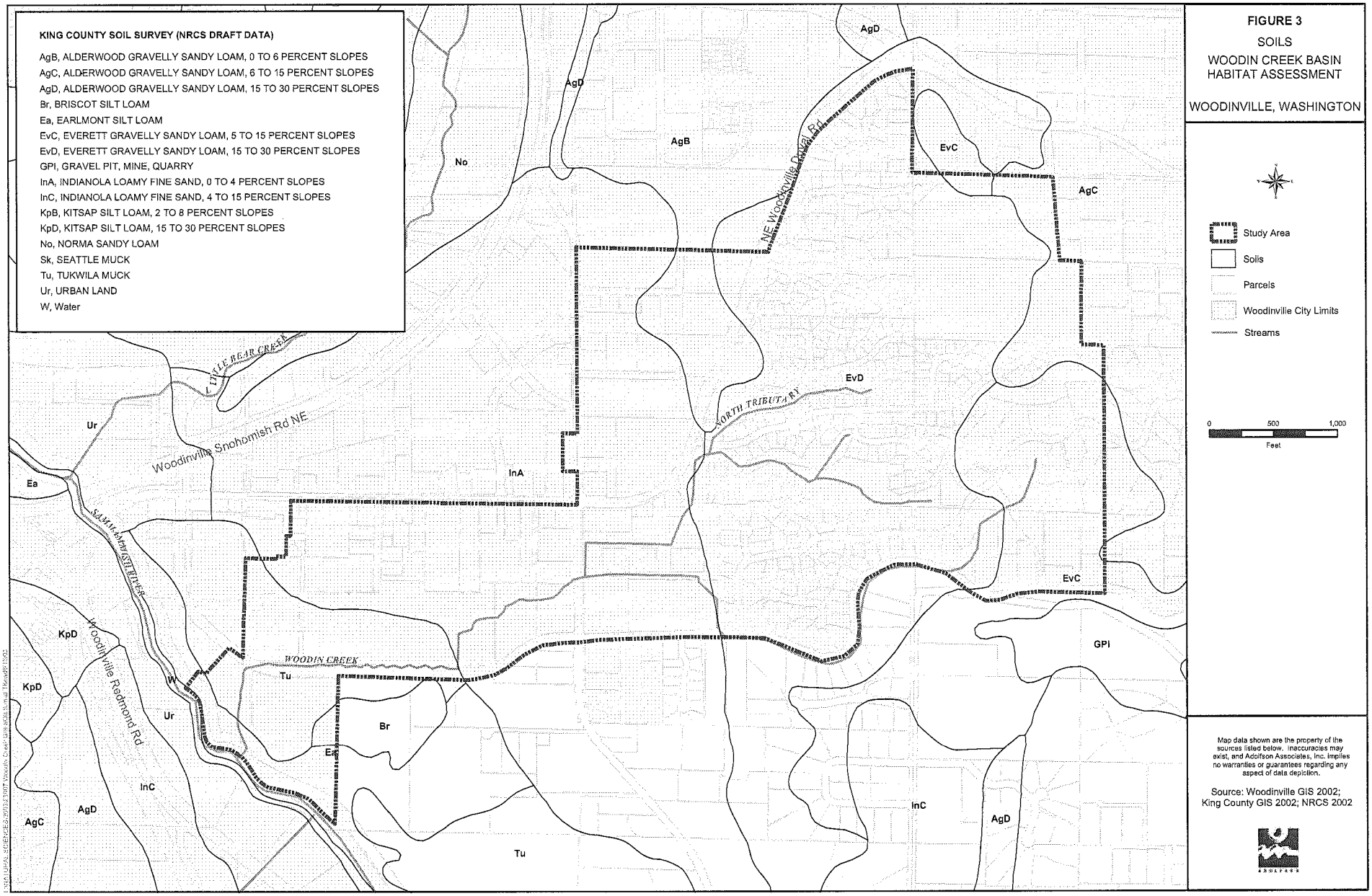


FIGURE 3

SOILS

WOODIN CREEK BASIN HABITAT ASSESSMENT

WOODINVILLE, WASHINGTON

METHODOLOGY

The reconnaissance-level investigation included a review of existing background information to determine the type and relevancy of habitat data available for Woodin Creek and a general qualitative field review of the basin as observable from public rights-of-way and publicly owned properties. To assist with the assessment of fish habitat, Woodin Creek and its tributaries were divided into five primary reaches. These include:

- Reach 1: Mouth to 140th Avenue NE
- Reach 2: 140th Avenue NE to Woodinville City limits (includes Reach 2A and 2B)
- Reach 2A: Piped section under Woodinville Plaza connects to Reach 3 at NE 171st Street/143rd Place NE
- Reach 2B: Piped section under north end of Woodinville Plaza connects to Reach 4 and 5 at NE 178th Street/143rd Avenue NE
- Reach 3: Woodinville City Limits at 143rd Place NE to headwaters
- Reach 4: North Tributary Branch A 143rd Avenue NE to 151st Way NE
- Reach 5: North Tributary Branch B 143rd Avenue NE to 148th Avenue NE

These reaches are identified in Figure 2.

Impervious Surface Area

The approximate area of impervious surface was calculated using GIS information to characterize the Woodin Creek basin. GIS data provided street right-of-way (ROW) from the parcel data and building footprints along with aerial photos of Woodinville (City of Woodinville GIS data, 2003). This data was clipped to the study area (Woodin Creek Basin).

The acreage of the building footprints in low density residential (R-1, R-4, and R-6) was subtracted from the total acreage. A parcel sample of approximately 10 % (or at least 10, whichever was greater) was taken from each of the previously mentioned residential areas. On those sample parcels, additional impervious areas were measured (driveways, other buildings, etc) to the extent that the aerials would visually allow, excluding street ROW. This measurement was added to the building footprint acreage and an average for the total impervious area was taken for each of the sample sets. This was then multiplied by the number of existing parcels in each of the low residential zoning groups to derive the approximate impervious area for R-1, R-4 and R-6.

The parking lots and other visible impervious areas were then measured in the commercial and higher density residential areas. Street ROW area was calculated. The combination of these numbers gave us an approximate existing impervious surface area for the study area.

Water Quality and Hydrology

Existing water quality data for Woodin Creek was obtained from the City of Woodinville. Water quality parameters including: conductivity, dissolved oxygen, oxidation/reduction potential, pH,

salinity, total dissolved solids (TDS), temperature, and turbidity were measured by the City of Woodinville at two sites within Woodin Creek from January 2003 to October 2003. Additional water quality monitoring was performed by the City of Woodinville to assess contaminant levels within Woodin Creek at Woodin Park (Reach 1) from October 2000 to July 2003. Samples were collected and analyzed for fecal coliforms, metals, nitrate/nitrite, total phosphorous, total suspended solids (TSS), and other parameters. (See Table 6.)

Adolfson collected limited water quality data from four sites (Figure 2) within Woodin Creek. Portable water quality meters were used to document temperature, pH, conductivity, and turbidity. Samples were also collected and analyzed for dissolved oxygen (DO) at North Creek Laboratories in Bothell, Washington.

In addition, Adolfson collected stream temperature data from four sites using HOBO temperature data loggers that were placed directly in the stream. One temperature logger also monitored ambient air temperatures. Data was recorded at a rate of one reading every five minutes from June 6, 2003 to August 27, 2003. Site 1 was located approximately 200 feet upstream of the mouth in Reach 1. Site 2 was located immediately west of 140th Avenue NE (end of Reach 1). Site 3 was located at the NE Woodinville-Duvall Road/178th Way NE intersection (Reach 4). Site 4 was located at the NE 171st Street/143rd Place NE intersection (Reach 3).

Fish Habitat Assessment

The assessment of stream habitat generally followed the King County stream habitat assessment, General Site Survey methodology (King County, 1991). The General Site Survey is a qualitative review of stream characteristics, habitat conditions, riparian habitat, and fish use. There are 11 primary habitat elements evaluated during the General Site Survey (Table 1). The King County 1991 protocol is based on the methods defined in the *USDA Forest Service Stream Habitat Classification and Inventory Procedures for Northern California* (McCain et al., 1990). Habitat units are defined as one of 23 habitat types listed in Table 2 below.

Table 1. Elements of the General Site Survey

ID	Description
1	Natural drainage system configuration and stream classification
2	Riparian soils, channel morphology, and bank stability
3	Substrate composition
4	Riparian zone land uses
5	Riparian vegetation
6	Description of adjacent wetlands
7	Large woody debris and pool quality
8	Animal habitat and utilization
9	Benthos
10	Fish habitat and utilization
11	Photographs of stream features

Source: King County, 1991

While the inventory methods followed King County General Site Survey protocols, the

assessment of those inventory elements has been expanded to consider ESA evaluation guidelines. NOAA Fisheries and USFWS guidance for conducting ESA reviews requires that habitat assessments used in support of section 7(c) consultations define the biological requirements of a listed fish species in terms of properly functioning conditions (PFC) (NOAA Fisheries, 1996; USFWS, 1998). PFC is the sustained presence of natural habitat-forming processes necessary for the long-term survival of the species through the full range of environmental variation. Indicators of PFC vary between different landscapes based on unique physiographic and geologic features. Since aquatic habitats are inherently dynamic, PFC is defined by the persistence of natural processes that maintain habitat productivity at a level sufficient to ensure long-term survival (NOAA Fisheries, 1996). An overview of these elements is included below in Table 2.

Table 2. Stream Habitat Types

ID	Description	ID	Description
1.	Low-gradient riffle	12.	Lateral scour pool-bedrock formed
2.	High gradient riffle	13.	Damned pool
3.	Cascade	14.	Glide
4.	Secondary channel pool	15.	Run
5.	Backwater pool-boulder formed	16.	Step run
6.	Backwater pool-rootwad formed	17.	Mid-channel pool
7.	Backwater pool-log formed	18.	Edgewater
8.	Trench/Chute	19.	Channel confluence pool
9.	Plunge pool	20.	Lateral scour pool-boulder formed
10.	Lateral scour pool-log formed	21.	Pocket water
11.	Lateral scour pool-rootwad formed	22.	Corner pool
		23.	Culvert

Source: McCain et al., 1990

A hip chain was used to measure habitat lengths and create station numbers. The hip chain was zeroed at the lowermost starting point for each habitat reach, and used to document the location of specific features including: seeps, erosion areas, and other actions taken along each reach. Habitats were limited to the actual wetted width of the stream channel at the time of the survey. Habitat widths and depths were measured using a six-foot staff graduated in inches. Adolfson biologists defined "left bank" (LB) and "right bank" (RB) as when facing upstream.

Stream Stationing

To assist with the identification of the location of habitats and the approximate location of features described in the text, Adolfson calculated stream stationing for features based on the measurements taken with a hip chain as stated above. Stationing as is stated in this report is the cumulative total of the habitat lengths for each habitat type. Stationing starts at 0+00 at the downstream limit of each reach. The station for the habitat type is identified as the last station within that habitat type. It should be noted that stream stationing as identified in this report is approximate in nature and is for the purpose of aiding discussion in relation to this study. The location of features as described in this study should be verified by a civil survey prior to any engineering design, permitting, or other quantitative analysis. The approximate station of each

habitat area is identified on the summary tables in Appendix B prior to the field data collected for each reach.

Fish Use

During the preliminary investigation, information pertaining to fish-use in Woodin Creek is based on existing data, where available, and incidental observations of fish use occurring during the reconnaissance-level habitat assessment from May 13, 2003 to July 8, 2003. More detailed analysis of fish use, including adult salmon spawning surveys were conducted in the fall of 2003 during the second phase of the study.

The adult salmon spawning surveys were conducted from September 23, 2003 through November 24, 2003. Since Woodin Creek is a small stream and typical spawner surveys require wading the stream, several observation points and 200-foot reaches were observed from the bank to prevent the disturbance of spawning substrates. Survey locations are shown in Figure 2. Observation points and reaches were observed for adult salmon spawners, salmon carcasses, and redds.

Wildlife

Habitat Evaluation

Wildlife habitat was evaluated in the field from public rights-of-way, on public land, and on private land with permission from the City. Field surveys also included observations of opportunities for improving habitat. Habitat assessment methods described in *Wildlife–Habitat Relationships in Oregon and Washington* (Johnson and O'Neil, 2001) were used to describe and evaluate common habitat types in the City. These methods were developed by the WDFW with input from a panel of regional wildlife experts and with information collected from more than 12,000 pertinent publications. Using this methodology, habitats were assessed at three levels of detail: wildlife habitat types, structural conditions, and habitat elements. Opportunities for habitat protection and restoration were also explored.

The term "wildlife habitat type" as referred to in this inventory and in Johnson and O'Neil (2001) generally describes vegetation cover types or land use/land cover types. Geographic distribution and physical setting-- including climate, elevation, soils, hydrology, geology, and topography-- determine vegetation cover types. Human activities determine other land use cover types such as urban and agricultural habitat types. Habitat types can also include areas of disturbance where grasses, forbs, shrubs, or tree saplings are the primary vegetation cover type. Wildlife habitat types, in turn, are directly related to wildlife species abundance and distribution.

The habitat types in this report do not use the exact naming conventions found in Johnson and O'Neil (2001). Rather they are modified to further define habitat structural conditions and land cover conditions. Specific references to regional habitat types are not needed for this study that occurs only within Western Washington. Westside lowland conifer-hardwood forest as described by Johnson and O'Neil (2001) is divided into upland forest and grassland habitat types, and urban and mixed environs is divided into high density commercial and residential and medium density residential to further define habitat structural types on project maps and in this report.

Structural conditions refer to vegetation structure and are based on the characteristics of trees and shrubs including tree size, number of canopy layers, and canopy closure. Structural conditions in urban areas are shaped by land use cover type as indicated by variables such as the percent impervious surface in a watershed.

Habitat elements are described on a site-specific basis and include biological, physical, and anthropogenic features that influence wildlife species distribution, abundance, fitness, and viability. Common habitat elements in the Woodin Creek basin include downed wood, tree snags, moss, leaf litter, trails, hedgerows, street trees, ornamental landscaping, and roads. Habitat elements can have positive or negative effects on wildlife species.

Opportunities can include the protection and conservation of a particular habitat, removal of invasive or non-native vegetation or wildlife species, or the reduction of noise and encroachment from surrounding developments. The presence of non-native vegetation and wildlife is identified in the Findings section.

Bird and Mammal Surveys

Two types of wildlife survey were conducted in each daylighted reach of Woodin Creek: general observations, and specific studies. The specific studies included early morning bird surveys and evening bat and owl surveys. Bird and other wildlife observations were also made in the basin during general habitat and stream surveys in 2003.

Six survey stations within the Woodin Creek basin, mostly in riparian areas, were established for the specific studies using aerial photographs and field reconnaissance. The six stations were located in order to represent different habitat types within the different stream reaches. The bird surveys were conducted on April 29, May 23, and June 12, 2003. The bat and owl surveys were conducted on July 7 and 17, 2003. The locations of the survey stations are shown on Figure 5. Table 17 identifies the location of each survey station within different areas of the basin and habitat types found in these areas.

Early morning bird surveys were conducted once per month from April through June, and evening bird and mammal surveys were conducted in June and July. Bird and other wildlife observations were also made throughout the Woodin Creek basin during general habitat and stream surveys from March through June. A total of six survey stations ranging from near the mouth of Woodin Creek to the upper portion of the basin were established for these surveys. For the early morning surveys, birds were observed (by direct visual observation and by their calls) during a 15-minute period at each station. These surveys were conducted during the two hours following sunrise (approximately). Methodology for the bird survey protocols was taken from *Monitoring Wetlands* (Miller et al., 1996).

Evening surveys were conducted during the two hours following sunset at each of the six survey stations. A Peterson D-100 bat detector was used at each station to detect high-frequency bat calls (10 to 120 Hz) for the first five minutes of the survey and later during the owl surveys. The bat survey documented only presence or absence of bats.

After five minutes of bat and other general observations, a tape of owl calls was used to attract and detect owls in the vicinity. Owl calls were played for one minute per species, followed by a one-minute silent break for listening. Owl species calls were played in order of bird size, from smallest to largest, and call type. This was done because large owls are known to prey on

smaller owl species (i.e., the calls of the large owls may scare away small owls before they can be surveyed). The owl species included northern saw-whet owl, western screech owl, barn owl, barred owl, and great horned owl. The five owl species surveyed were chosen because they may occur in the City. Owl survey techniques from *How to Spot an Owl* (Sutton, 1994) and recommendations from members of the Seattle Audubon Society were used to develop protocols for owl surveys.

PROPERLY FUNCTIONING CONDITIONS

Ideally, reliable scientific information would exist for all populations of listed species that would allow the effects of an action to be quantified in terms of population impacts (NOAA Fisheries, 1999). As stated in the Habitat Approach, an August 1999 supplement to the NOAA Fisheries guidance document: Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale, in the absence of population-specific information, an assessment must define the biological requirements of a listed fish species in terms of PFC. PFC elements are typically identified as being either:

1. "Properly functioning" meaning that the element can support healthy populations of fish;
2. "At risk," meaning that functionality is maintained but there is a likelihood that further degradation would result in a negative response by fish populations; or
3. "Not properly functioning," meaning that there are known limitations to those parameters necessary to support healthy salmonid populations.

NOAA (1996) and USFWS (1998) have developed guidelines to assist in conducting a limiting factors analysis in relation to several specific PFC elements using a matrix approach following specific environmental pathways to evaluate indicators of habitat quality (Table 3). The King County stream habitat assessment methodology used for this inventory does not include all of the same parameters used by NOAA Fisheries and USFWS relative to a "properly functioning" stream system. Because of this, it is necessary to consider indirect factors related to the overall condition of the drainage basin in combination with best professional opinion and make judgments on whether or not Woodin Creek meets "properly functioning" criteria. The following describes the habitat quality indicators used to assess PFC. Actual PFC for Woodin Creek are discussed further in the "Findings" section of this document.

Water Quality

Temperature

In-stream water temperatures are important indicators of stream health. Smaller streams such as Woodin Creek, usually have much lower temperatures than larger mainstem streams, such as the Sammamish River, unless adversely affected by development. Small cooler tributaries can provide higher quality rearing habitat and/or refuge from higher temperatures and may be important to maintaining healthy fish populations throughout the basin. However, elevated water temperatures in smaller tributaries such as Woodin Creek reduce the area of usable rearing habitat during the summer and can render these small streams, potentially some of the most productive and structurally complex habitats, unusable (NOAA Fisheries, 1996).

NOAA Fisheries (1996) considers temperatures ranging from 10 to 13°C (50 to 57°F) or less to be a properly functioning conditions. Temperatures from 13°C to 15°C (57 to 60°F) are considered an at risk condition for adult spawning salmonids and temperatures ranging from 10 to 17°C (57 to 64°F) are considered an at risk condition for migrating and rearing salmonids. Temperatures above 15°C are considered not properly functioning for spawning salmonids and temperatures above 17°C are not properly functioning for migration and rearing salmonids (Table 3).

Sediment/Turbidity

Salmonid habitat is produced and maintained by substrate recruited from upstream streambanks and deposited in downstream reaches of the river. This natural process can be affected by development so that sediment inputs and turbidity exceed norms anticipated under natural conditions. Excessive sedimentation, caused by landslides, dam construction, the conversion of historic forests to urban environments, or bank erosion, can cause fish habitat degradation (Kerwin, 2001). The rearing capacity of salmon habitat is decreased as embeddedness, the degree to which fine sediments surround coarse substrates on the surface of a streambed (Stylte and Fischenich, 2002), levels increase in spawning substrates. Along with habitat degradation, increased fine sediment entombs incubating salmon in redds, reduces egg survival by reducing oxygen flow, alters the food web, reduces pool volumes for adult and juvenile salmon, and reduces the availability of rearing space for juveniles rendering them more susceptible to predation (NOAA Fisheries, 1996).

Table 3. Matrix of Pathways and Indicators

PATHWAY	INDICATORS	PROPERLY FUNCTIONING	AT RISK	NOT PROPERLY FUNCTIONING
Water Quality:	Temperature	50-57°F[1]	57-60° (spawning) 57-64° (migration & rearing)[2]	>60° (spawning) >64° (migration & rearing)[2]
	Sediment/Turbidity	<12% fines (<0.85 mm) in gravel, turbidity low	12-17% (westside)[3] 12-20% (eastside)[2] turbidity moderate	>17% (westside)[3] >20% (eastside)[2] fines at surface or depth in spawning habitat[2], turbidity high
	Chemical Contamination/Nutrients	Low levels of chemical contamination from agricultural, industrial and other sources, no excess nutrients, no CWA 303d designated reaches[5]	Moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one CWA 303d designated reach[5]	high levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one CWA 303d designated reach[5]
Habitat Access:	Physical Barriers	Any man-made barriers present in watershed allow upstream and downstream fish passage at all flows	Any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at base/low flows	Any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows
Habit Elements:	Substrate	Dominant substrate is gravel or cobble (interstitial spaces clear), or embeddedness <20%[3]	Gravel and cobble is subdominant, or if dominant, embeddedness 20-30%[3]	Bedrock, sand, silt or small gravel dominant, or if gravel and cobble dominant embeddedness >30%[2]
	Large Woody Debris	>80 pieces/mile >24" diameter >50 ft. length[4]; >20 pieces/mile >12" diameter >35 ft. length[2]; and adequate sources of woody debris recruitment in riparian areas.	Currently meets standards for properly functioning, but lacks potential sources from riparian areas of woody debris recruitment to maintain that standard	Does not meet standards for properly functioning and lacks potential large woody debris recruitment

Table 3. Matrix of Pathways and Indicators (cont.)

PATHWAY	INDICATORS	PROPERLY FUNCTIONING	AT RISK	NOT PROPERLY FUNCTIONING
Habit **Elements** (cont.):	Pool Frequency Channel width / # pools/mile[6] 5 feet 184 10 feet 96 15 feet 70 20 feet 56 25 feet 47 50 feet 26 75 feet 23 100 feet 18	Meets pool frequency standards (left) and large woody debris recruitment standards for properly functioning habitat (above)	Meets pool frequency standards but large woody debris recruitment inadequate to maintain pools over time	Does not meet pool frequency standards
	Pool Quality	Pools >1 meter deep (holding pools) with good cover and cool water[3], minor reduction of pool volume by fine sediment	Few deeper pools (>1 meter) present or inadequate cover/temperature[3], moderate reduction of pool volume by fine sediment	No deep pools (>1 meter) and inadequate cover/temperature[3], major reduction of pool volume by fine sediment
	Off channel Habitat	Backwaters with cover, and low energy off channel areas (ponds, oxbows, etc.)[3]	Some backwaters and high energy side channels[3]	Few or no backwaters, no off-channel ponds[3]
	Refugia (important remnant habitat for sensitive aquatic species)	Habitat refugia exist and are adequately buffered (e.g., by intact riparian reserves); existing refugia are sufficient in size, number and connectivity to maintain viable populations or sub-populations[7]	Habitat refugia exist but are not adequately buffered (e.g., by intact riparian reserves); existing refugia are insufficient in size, number and connectivity to maintain viable populations or sub-populations[7]	Adequate habitat refugia do not exist[7]
Channel **Condition** & Dynamics:	Width/Depth Ratio	<10[2,4]	10-12 (we are unaware of any criteria to reference)	>12 (we are unaware of any criteria to reference

Table 3. Matrix of Pathways and Indicators (cont.)

PATHWAY	INDICATORS	PROPERLY FUNCTIONING	AT RISK	NOT PROPERLY FUNCTIONING
Channel Condition & Dynamics: (cont.)	Streambank Condition	>90% stable; i.e. on average, less than 10% of banks are actively eroding[2]	80-90% stable	<80% stable
Channel Dynamics (cont.):	Floodplain Connectivity	Off channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly
Flow/Hydrology:	Change in Peak/Base Flows	Watershed hydrograph indicates peak flow, base flow and how timing characteristics comparable to any undisturbed watershed of similar size, geology and geography	Some evidence of altered peak flow, baseflow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	Pronounced changes in peak flow, baseflow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography
	Increase in Drainage Network	Zero or minimum increases in drainage network density due to roads [8,9]	Moderate increases in drainage network density due to roads (e.g., ~5%)[8,9]	Significant increases in drainage network density due to roads (e.g., ~20-25%)[8,9]
Watershed Conditions: (AMA-ECA-LSOG-Late Successional and Old Growth NWFP-NW Forest Plan) AMA: Adaptive Management Area ECA: Equivalent Clearcut Area	Road Density & Location	<2 ml/ml[2,11], no valley bottom roads	2-3 ml/ml[2], some valley bottom roads	>3 ml/ml[2], many valley bottom roads
	Disturbance History	<15% ECA (entire watershed) with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area (except AMAs), ≥15% retention of LSOG in watershed[10]	<15% ECA (entire watershed) but disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area (except AMAs), ≥15% retention of LSOG in watershed[10]	>15% ECA (entire watershed) and disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; does not meet NWFP standard for LSOG retention

Table 3. Matrix of Pathways and Indicators (cont.)

PATHWAY	INDICATORS	PROPERLY FUNCTIONING	AT RISK	NOT PROPERLY FUNCTIONING
Watershed Conditions (cont.):	Riparian Reserves	The riparian reserve system provides adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subwatershed, and buffers or includes known refugia for sensitive aquatic species (>80% intact), and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/composition >50%[12]	Moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian reserve system, or incomplete protection of habitats and refugia for sensitive aquatic species (~70-80% intact), and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/composition 25-50% or better[12]	Riparian reserve system is fragmented, poorly connected, or provides inadequate protection of habitats and refugia for sensitive aquatic species (<70% intact), and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/composition <25%[12]

1 Bjornn, T.C. and D.W. Reiser, 1991. Habitat Requirements of Salmonids in Streams. American Fisheries Society Special Publication 19:83-138. Meehan, W.R., ed.

2 Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995

3 Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee, 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

4 Biological Opinion on Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). National Marine Fisheries Service, Northwest Region, January 23, 1995.

5 A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

6 USDA Forest Service. 1994. Section 7 Fish Habitat Monitoring Protocol for the Upper Columbia River Basin.

7 Frissell, C.A., Liss, W.J., and David Bayles. 1993. An Integrated Biophysical Strategy for Ecological Restoration of Large Watersheds. Proceedings from the Symposium on changing roles in Water Resources Management and Policy, June 27-30, 1993 (American Water Resources Association), p. 449-456.

8 Wemple, B.C. 1994. Hydrologic Integration of Forest Roads with Stream Networks in Two Basins, Western Cascades, Oregon. M.S. Thesis, Geosciences Department, Oregon State University.

9 E.g., see Elk River Watershed Analysis Report, 1995. Siskiyou National Forest, Oregon.

10 Northwest forest Plan. 1994. Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern spotted Owl. USDA Forest Service and USDI Bureau of land Management.

11 USDA Forest Service. 1993. Determining the Risk of Cumulative Watershed Effects Resulting from Multiple Activities.

12 Winward, A.H. 1989. Ecology Status of Vegetation as a base for Multiple Produce Management. Abstracts 42nd annual meeting, society for Range Management, Billings MT, Denver Co; Society for Range Management, p. 277.

NOAA Fisheries (1996) has determined that water quality within western Washington streams becomes not properly functioning when sediment fines have greater than 17 percent of coverage. Streams on the west-side have at risk water quality conditions when sediment fines are at a level of 12-17 percent and turbidity within the stream is moderate. Properly functioning conditions exist when sediment fines are less than 12 percent in the gravel substrate and turbidity is low (NOAA Fisheries, 1996) (Table 3).

Chemical Contamination

Urbanization of salmonid streams can have multiple impacts. Urbanized streams generally have elevated levels of many contaminants; however, the most consistent problems include oxygen demand, conductivity, suspended solids, ammonium, hydrocarbons, and metals. These increases may be attributed to both point and non-point sources (Paul and Meyer, 2001). The increase of impervious surface area within a stream basin creates higher volumes of non-point source pollution from runoff. Because of restrictions placed on the direct discharge of materials into tributary streams under state water quality regulations, non-point pollution often contributes the highest level of chemical contamination found in small urban streams such as Woodin Creek.

In addition to runoff from roads and other impervious surfaces, chemical contaminants widely used within urbanized areas may affect fish both directly and indirectly. Some pesticides are capable of killing salmon directly and within a short period of time. Indirect effects of pesticides on salmon include interfering with their food supply or altering the aquatic habitat (Lind, 2002). Some studies have suggested that suppressed immune systems in young salmon from chemical contamination could make the fish more susceptible to disease as they move further into the marine environment (Arkoosh, 1991,1998 as seen in Kerwin, 2001).

NOAA Fisheries (1996) considers properly functioning conditions to be present for the chemical contamination indicator when there are low levels of chemical contamination from agricultural, industrial, and other sources. An at risk stream contains moderate levels of chemical contamination from agricultural, industrial, and other sources. If there are some excess nutrients and the stream contains one Clean Water Act (CWA) designated reach the stream is also considered at risk. A not properly functioning stream contains high levels of chemical contamination from agricultural, industrial, and other sources and has high levels of excess nutrients and more than one CWA 303(d) designated reach (Table 3).

The CWA requires Washington State to prepare a list of all surface waters that serve beneficial uses such as drinking water, recreation, aquatic habitat, and industrial use, and that are impaired by pollutants. A 303(d) listed reach would be a portion of a stream that falls short of state surface water quality standards and is not expected to improve over the next two years following listing. Waters that are placed on the 303(d) list require the preparation of Total Maximum Daily Loads (TMDL's), which will identify the total allowable maximum amount of pollutant to be released so as not to impair the waterbody. The Washington State Department of Ecology assessment of which waters are to be placed on the list is guided by federal laws, state surface water quality standards, and 303(d) policy. Pollutants and water quality standards that are of primary concern include temperature, fecal coliform, toxic substances, excess nutrients, organic waste, and erosion (DOE, 2004)

Habitat Access

Physical Barriers

Physical barriers are defined as natural or anthropogenic features, features made by people or resulting from human activities, that prevent or inhibit the movement of salmon and steelhead, these include: falls, cascades, dikes/levees, ditches, culverts, weirs, flood/tide gates, dams, or other human structures (WDFW, 1999). Culvert blockage appears to be the main physical barrier within Woodin Creek. Washington Department of Fish and Wildlife (WDFW) (1999) identifies five common conditions at culverts that create migration barriers:

- Excess drop at culvert outlet;
- High velocity within culvert barrel;
- Inadequate depth within culvert barrel;
- Turbulence within the culvert; and
- Debris accumulation at culvert inlet.

Adequate migration corridors are vital to maintaining anadromous fish populations. Physical barriers may reduce the quantity of available habitat that can be utilized by anadromous fish for spawning and rearing. Even where adult fish can bypass a potential barrier and gain access to spawning areas, habitat barriers can result in impacts to anadromous fish populations. Studies have shown that the majority of salmonid movement is upstream even during fry stages (Kahler and Quinn, 1998). Any type of physical barrier to this upstream movement precludes the use of vital upstream habitat for migration, spawning, and rearing life stages.

NOAA Fisheries (1996) considers streams with any man-made barriers present in the watershed that allow upstream and downstream fish passage at all flows is considered to be "properly functioning" for habitat access. A stream is at risk when any man-made barriers are present in the watershed and do not allow upstream and/or downstream fish passage at base/low flows. Not properly functioning conditions exist when any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows (Table 3).

Habitat Elements

Instream Habitat (Pool Frequency and Pool Quality)

Riffles and pools are often the dominant habitats in smaller tributary streams. Pools are created by erosion processes in the channel and below in-stream obstructions. Riffles are associated with straight, often higher-gradient, areas and are characterized by shallow, faster flow. The spacing between pools and riffles is indicative of the slope and condition of the stream channel. Pool habitat is important for all stages of salmonid development. Adult salmon need deep pools for resting and for shelter from predators (Kerwin, 2001). Pools are important rearing habitat for juvenile salmonids.

NOAA Fisheries' (1996) indicators for pool habitat are divided into pool frequency and pool quality. Habitat elements are properly functioning for pool indicators when pool frequency standards of 184 pools per mile are present within a stream with five foot of width and large woody debris recruitment standards are properly functioning. Pools also must be greater than

one meter deep with good cover and cool water, along with minor reduction of pool volume by fine sediment (NOAA Fisheries, 1996) (Table 3).

Substrate

Substrate is vitally important to most salmonid fish, particularly the trout and salmon species that occur in the Pacific Northwest. Studies have shown that in a healthy stream young salmon and trout hide in the interstitial spaces between cobbles and boulders to avoid predation (Mendocino website, 2002). Suitably sized substrate is also required for most species of salmon and trout to successfully spawn.

NOAA Fisheries has determined that properly functioning conditions for the substrate indicator exist when dominant substrate is gravel or cobble with clear interstitial spaces in between and embeddedness is less than 20 percent. If gravel and cobble is subdominant or is dominant and contains an embeddedness of 20 to 30 percent then the habitat element is at risk. Not properly functioning conditions exist when bedrock, sand, silt or small gravel is the dominant substrate, or if gravel and cobble are dominant, embeddedness is greater than 30 percent (NOAA Fisheries, 1996) (Table 3).

Large Woody Debris

Large woody debris (LWD) is an important part of functioning stream habitat and plays many roles in a healthy stream environment. Large woody debris is defined as large woody material, usually at least 20 inches in diameter, which has fallen to the ground or into a stream (Kerwin, 2001). Large woody debris helps to contribute nutrients to instream habitat through invertebrates, vegetated material, and indirectly by holding salmon carcasses. Structurally, LWD provides potential roosting, nesting, refuge, and foraging opportunities for wildlife; foraging, refuge, and spawning substrate for fishes; and foraging, refuge, spawning, and attachment substrate for aquatic invertebrates and plants (Brennan and Culverwell in prep, as seen in Kerwin, 2001).

NOAA Fisheries' (1996) standards for properly functioning LWD within western Washington streams are greater than 80 pieces of LWD per mile with diameters of greater than 24 inches and greater than 50–feet in length. Habitat elements at risk meet standards for properly functioning, but lack potential sources from riparian areas of woody debris recruitment to maintain that standard. Not properly functioning conditions do not meet standards for properly functioning and lack potential large woody debris recruitment (Table 3).

Off Channel Habitat

Off channel habitat such as ponds, connected wetland areas, side channel stream, and backwater pools are important habitat areas for juvenile salmonids. These off channel areas not only provide refuge areas for juvenile salmonids during high stream flows, but also provide protection from predators. In small tributary systems such as Woodin Creek, off channel habitat may not be common even under natural conditions; however, these streams themselves provide necessary off channel habitat and refuge for fish when associated with larger mainstem waterbodies such as the Sammamish River.

NOAA Fisheries (1996) standards for off channel habitat describe properly functioning conditions containing backwaters with cover, and low energy off channel areas (such as ponds, and oxbows etc). Conditions are at risk when the habitat contains some backwaters and high-

energy side channels. Not properly functioning habitat exists when few or no backwaters and no off channel ponds exist (Table 3).

Channel Condition and Dynamics

Width/Depth Ratio

Comparisons of bankfull width to depth ratios can indicate shifts in channel stability in response to disturbance (Rosgen, 1996 as seen in Kerwin, 2001). Increased discharge increases erosion rates of the streambanks and causes channel widening and increased width to depth ratios (Kerwin, 2001). NOAA Fisheries (1996) describes properly functioning conditions existing when the bankfull width to depth ratio is 10. At risk conditions exist when the width to depth ratio is 10 to 12. A not properly functioning condition occurs when the ratio is above 12 (Table 3).

Streambank Condition

Streambanks provide important sources of gravel recruitment necessary to maintain natural stream functions; however, where banks become unstable due to the lack of vegetation or increased scour within the channel, the input of sediment may exceed the system's natural capacity. As a result, some habitats can be impacted by excessive bed load scour while others can be lost to sedimentation.

NOAA Fisheries (1996) describes properly functioning conditions as having greater than 90 percent stable banks or on average less than 10 percent of streambanks are actively eroding. Conditions are at risk when streambanks are 80 to 90 percent stable. A not properly functioning condition exists when less than 80 percent of the streambanks are eroding (Table 3).

Floodplain Connectivity

Natural floodplains provide an area for dissipation of energy during flood events. Many natural streams and rivers floodplains are connected directly to the river at many points, allowing the floodplains to store flood water and later discharge this storage back to the river during lower flows. NOAA Fisheries (1996) describes properly functioning conditions existing when off channel areas are frequently linked hydrologically to the mainstream channel, overbank flows occur and maintain wetland functions, riparian vegetation, and succession. Conditions become at risk when linkage of wetland, floodplains, and riparian areas to the mainstream channel are reduced. This causes overbank flows to be reduced relative to historic frequency, as evidenced by a moderate degradation of wetland function, riparian vegetation, and riparian succession. Not properly functioning conditions exist when hydrologic connectivity between off channel, wetland, floodplain, and riparian areas are severely reduced. During not properly functioning conditions, the wetland extent is drastically reduced and riparian vegetation/succession is altered significantly (Table 3).

Flow/ Hydrology

Change in Peak/Base Flows

The change in peak/base flows is linked to a number of human activities such as changes in land cover, including the clearing of forests and the creation of impervious surfaces. The combination of activities increase storm flows and reduces base flows (Kerwin, 2001). Flood impacts may be

exacerbated by human activities that lead to increased sediment loads, point and non-point source pollutants, and the removal of instream LWD. However, floods can also be beneficial as they also produce and maintain habitats where they provide the necessary energy to scour deep pools, connect off channel habitats, and create side channels (Kerwin, 2001). Low flows typically limit salmon production for stocks that rear during summer within the stream (Kerwin, 2001).

NOAA Fisheries (1996) describes properly functioning conditions as having conditions indicated for change in peak/base flows by watershed hydrographs that indicate peak flow, base flow, and comparable timing characteristics to any undisturbed watershed of similar size, geology, and geography. At risk conditions are indicated by the evidence of altered peak flow, baseflows, and/or flow timing is relative to an undisturbed watershed of similar size, geology, and geography. Not properly functioning conditions exist when there are pronounced changes in peak flow, baseflow, and/or flow timing is shown relative to an undisturbed watershed of similar size, geology, and geography (Table 3).

Increase in Drainage Network

All the tributaries of Lake Washington and Lake Sammamish utilized by salmonid species have been intensively urbanized with a myriad of human-caused habitat impacts, which for the most part mask the natural population limiting factors of low summer stream flows and poor spawning gravel quality.

NOAA Fisheries (1996) describe properly functioning conditions for flow/hydrology drainage network indicator existing when zero or minimum increases in the drainage network density due to roads are present. Conditions are at risk when moderate increases in drainage network density due to roads exist, for example, approximately 5 percent increase. Not properly functioning conditions exist when there are significant increases in drainage network density due to roads, for example, an increase of 20 to 25 percent (Table 3).

Watershed Condition and Dynamics

Road Density and Location

NOAA Fisheries (1996) describe properly functioning conditions existing within a watershed environment when the watershed contains no valley bottom roads and has less than two miles of roads. Conditions are at risk when some valley bottom roads exist and there are 2 to 3 miles of road per square mile within the watershed. Not properly functioning conditions exist when there are many valley bottom roads with greater than 3 miles of roadway within the watershed (Table 3).

Disturbance History

NOAA Fisheries (1996) describes disturbance history within a watershed based upon conditions that exist in a forested environment and not an urban environment and thus is not applicable as criteria for Woodin Creek. Much work has been done in the urban environment in relation to disturbance history (Booth et al., 2001; Horner and May, 2000; May et al., 1997), and much of the disturbance history is correlated with increases in impervious surface area. Studies in Puget Sound lowland streams show that alteration can occur in basins with as little as 10 percent total impervious surface. However, dramatic effects can be seen relative to discharge in basins where

impervious surface exceeds 40 percent (May et al., 1997). The amount of impervious surface area within the Woodin Creek basin will be used to assess the disturbance history.

Riparian Zone and Vegetation

Riparian zones are transitional areas between aquatic and upland habitats. These usually lie within an area between 100 or 200 feet from the water's edge (Raedeke, 1988 in Johnson and Ryba, 1992). A number of wildlife species depend heavily on the functions of riparian zones including the life history of Pacific Northwest fish (Johnson and Ryba, 1992). This habitat assessment will concentrate on the influences of riparian systems on salmonids that include:

- The contribution of organic matter (leaves, needles, cones, twigs, wood, and bark) and many terrestrial insects vital to the diet of juvenile salmonids.
- The contribution of large woody debris, logs and branches, that shape channel morphology, retain organic matter, and provide essential cover for juvenile salmonids.
- The stabilization of streambanks with roots that also contribute to the formation of juvenile salmonid habitat.
- Protective cover from overhanging vegetation that helps maintain cool stream temperatures in small stream systems during the summer (Johnson and Ryba, 1992).

If a riparian buffer is to be able to meet all of these functions, it must have a properly functioning riparian reserve. A properly functioning riparian reserve provides adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subbasins, and buffers or includes known refugia for sensitive aquatic species (greater than 80 percent intact) (NOAA Fisheries, 1996) (Table 3).

FINDINGS

Review of Existing Background Data

A primary goal of this study was to identify and summarize existing sources of information to determine the applicability of existing resources in regard to Woodin Creek. Background sources used specifically in this assessment include:

- *Salmon and Steelhead Habitat Limiting Factors* Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8) (Kerwin, 2001)
- 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI) Appendix One: North Puget Sound Volume (WDFW and WWTIT, 1994)
- 1998 Washington Salmonid Stock Inventory Bull Trout and Dolly Varden Appendix (WDFW, 1998)
- *Catalog of Washington Streams and Salmon Utilization*, Washington State Department of Fisheries (Williams et al., 1975)
- Draft Coastal Cutthroat SASSI Data (Unpublished)
- *Tributary 87 Biological Resources Inventory* (Unpublished)
- *Sensitive Areas Map Folio*, King County, Washington (King County, 1990)
- *Soil Survey of King County Area, Washington* (Natural Resource Conservation Service, 1973)
- *US Geological Survey (USGS) Water Resources for Washington State: Historical Data* (USGS, 2001).

Existing resources indicate that little information specific to Woodin Creek is available. Woodin Creek is only specifically identified in one of these resources (*Salmon and Steelhead Habitat Limiting Factors* Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8) and is not even shown on many of the existing inventories. Although there was limited information specific to Woodin Creek in these sources, they do provide overview information on general fish-use and basin-wide characteristics that can be applied generally to Woodin Creek and other tributaries in the Sammamish River drainage (Figures 3 and 4).

Properly Functioning Conditions

Site-specific habitat data is provided for each of the five identified reaches in the following section and is based upon information gathered during the stream habitat assessment (Summer 2003), and water quality data collected by Adolfson and the City of Woodinville. This section describes the findings of the site-specific and reconnaissance-level investigations and discusses general conditions at the basin-level. Table 4 summarizes the PFC conditions for Woodin Creek.

Table 4. Summary of Woodin Creek Baseline Conditions

Pathways: Indicators	Environmental Baseline	Comments
Water Quality		
Temperature	"at risk" to "not properly functioning"	During summer months only.
Sediment	"at risk"	TSS levels low, however erosive nature of soils in upper reaches likely contribute to high turbidity during storm events.
Chemical	"not properly functioning"	Reach 1 does not meet state surface water quality standards for fecal coliform on a regular basis, elevated nitrtates/nitrites, pH low in winter months, DO low in summer months, elevated stream temperatures during summer months.
Habitat Access		
Physical Barriers	"not properly functioning"	Culverted Reach 2 acts as a complete fish passage barrier to upstream Reaches 3, 4, and 5. Other barriers exist during high and low flow conditions.
Habitat Elements		
Substrate	"not properly functioning"	High degree of embedment of spawning substrates in Reach 1, which is the only accessible spawning reach.
LWD	"not properly functioning"	LWD is absent from much of Reach 1, all of Reach 2, and is limited in the upper reaches as well.
Pool Frequency	"not properly functioning"	27 pools per mile of stream.
Pool Quality	"not properly functioning"	Pools that do exist lack adequate cover and depth.
Refugia	"not properly functioning"	
Off-Channel Habitat	"not properly functioning"	Reaches 3, 4, and 5 are high gradient, Reach 2 is culverted, and Reach 1 is primarily channelized and offers no off-channel habitat.
Channel Condition and Dynamics		
Width/Depth Ratio	"properly functioning"	Overall width/depth ratios are <10.
Streambank Condition	"at risk"	Conditions in Reach 1 are fairly stable due to armoring and low bank height and Reaches 3, 4, and 5 contain steeper gradients and more erosive soils and are less stable.
Floodplain Connectivity	"not properly functioning"	Development of valley floor, diking of Sammamish River, channelization, armoring, and culverting have all severely reduced floodplain connectivity.
Flow/Hydrology		
Peak/ Base Flows	"not properly functioning"	Over 40% impervious surface within the basin.
Drainage Network	"not properly functioning"	Over 30% of impervious surface within the basin is within road rights-of-way.
Watershed Conditions		
Road density and location	"not properly functioning"	Many roads cross Woodin Creek and almost all of Reach 1 is confined to roadside conveyance ditches.
Disturbance History	"not properly functioning"	Highly disturbed by urban development.
Riparian reserves	"not properly functioning"	Reaches 1 and 2 have been significantly modified and much of the riparian vegetation is gone. Upper Reaches are intact to some extent, but are fragmented.

Impervious Surface Area

The Woodin Creek basin is approximately 408 acres in size. The total impervious area within the basin was calculated at 168.37 acres or 41.3% of the Woodin Creek Basin. Table 5 summarizes the impervious area within the basin. Stream degradation has been associated with the quantity of impervious surface in a basin (Booth, 2000; May et al., 1997; Horner and May, 2000). Urbanization changes the volume, rate, and timing of water flowing through stream systems, which can impact the physical characteristics of the stream channel (Booth, 1991). Dramatic effects can be seen relative to discharge in basins where impervious surface exceeds 40 percent (May et al., 1997). The percent impervious surface area within the Woodin Creek basin suggests that it has a large impact on the overall degradation of stream conditions and likely has a negative impact upon salmonid populations within the basin.

Table 5. Summary of Impervious Surface Area in The Woodin Creek Basin

Measured Parameters	Acres	% of Study Area	% of Total Impervious Area
Street ROW	53.50	13.1%	31.8%
Commercial/Multi-family Building footprints	37.70	9.2%	22.4%
SFR R-1, R-4, R-6	25.99	6.4%	15.4%
Large visible parking lots	51.18	12.5%	30.4%
SUM Impervious	168.37	41.3%	100.0%
Study Area	408.00	100.0%	

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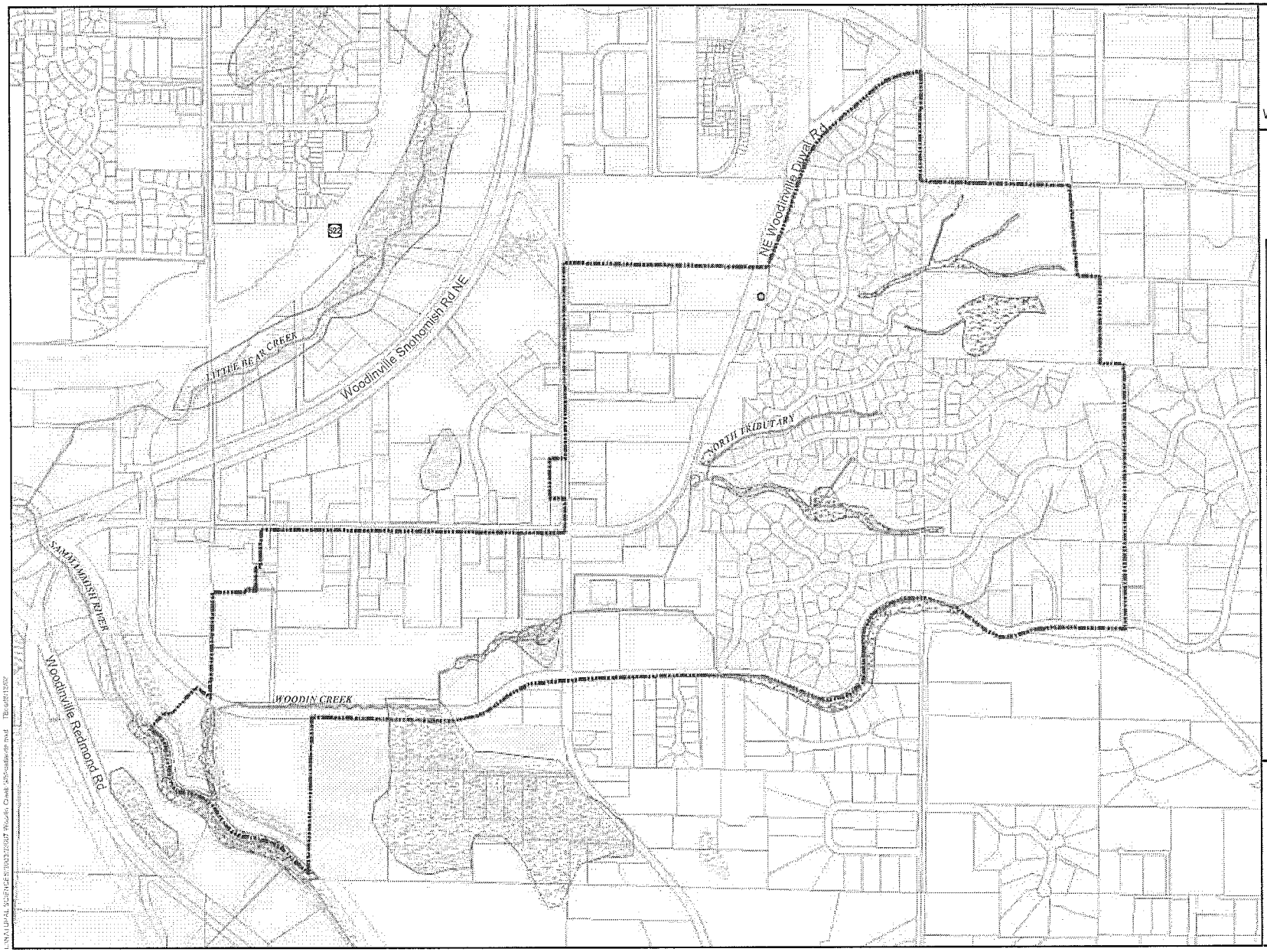

FIGURE 4

WETLANDS

WOODIN CREEK BASIN
HABITAT ASSESSMENT

WOODINVILLE, WASHINGTON

N

- NWI Wetlands
- NWI Wetlands
- King County Wetlands

Habitat Types

- Agricultural
- Upland Grassland
- Open Water Pond
- Riparian Wetland
- Herbaceous Wetland
- NWI Modified
- Study Area
- Parcels
- Woodinville City Limits
- Streams

0 500 1,000
Feet

Map data shown are the property of the sources listed below. Inaccuracies may exist, and Adolfson Associates, Inc. implies no warranties or guarantees regarding any aspect of data depiction.

Source: Woodinville GIS 2002; King County GIS 2002; NWI 1987

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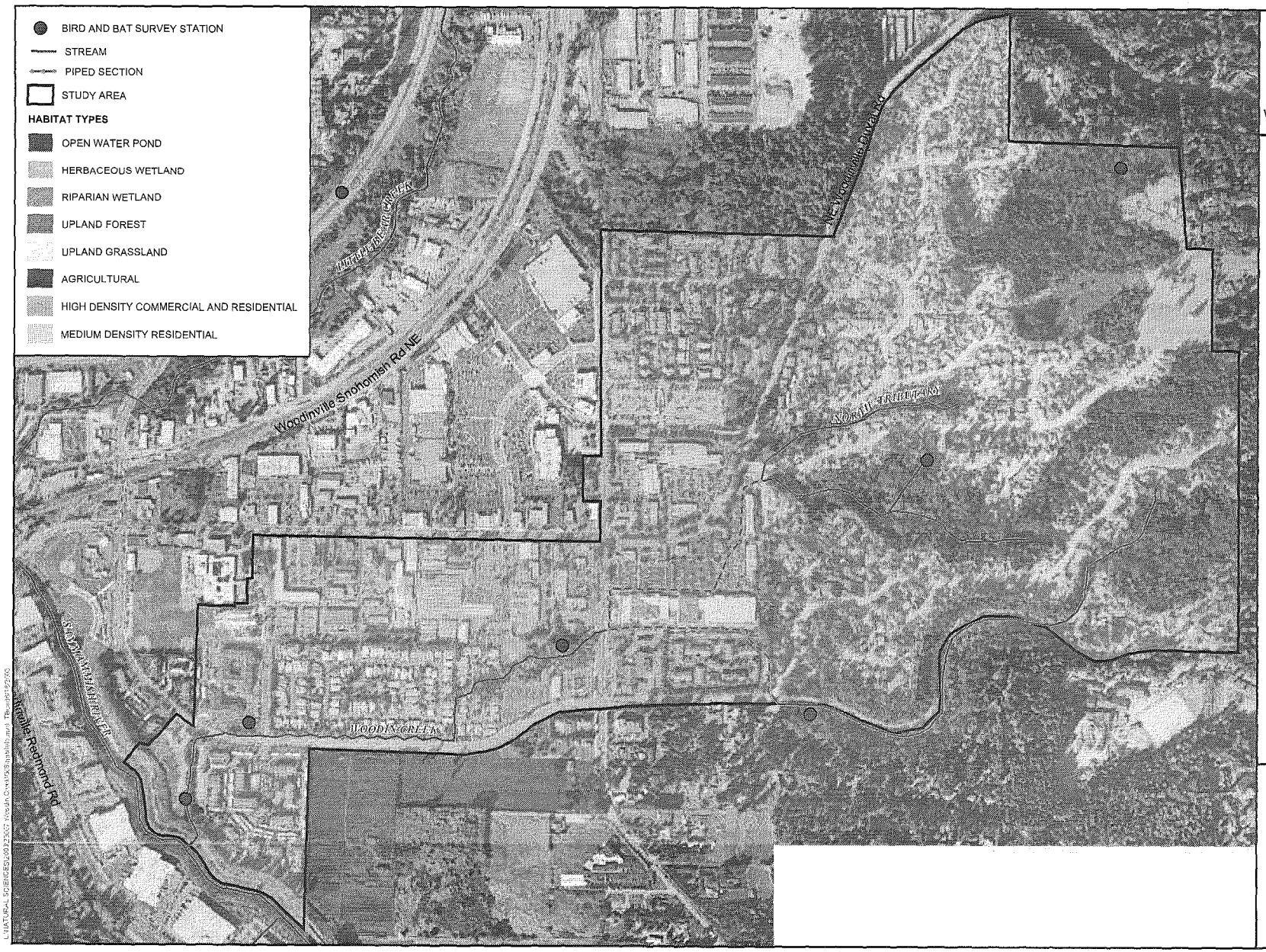

FIGURE 5

HABITATS

WOODIN CREEK BASIN
HABITAT ASSESSMENT

WOODINVILLE, WASHINGTON

Map data shown are the property of the sources listed below. Inaccuracies may exist, and Adolfson Associates, Inc. implies no warranties or guarantees regarding any aspect of data depiction.

Source: Woodinville GIS 2002;
King County GIS 2002

Water Quality

Table 6 shows the range in which the measured parameters occurred. Appendix A contains the water quality data collected by both Adolfson and the City of Woodinville. Figure 2 shows the Adolfson's sample site locations. The pH standards set by the State of Washington Department of Ecology in the Washington Administrative Code (WAC) 173-201A for class "AA" waters including all waters in the Lake Washington and Sammamish Basins states that pH shall be within the range of 6.5 to 8.5. The pH data collected by Adolfson only accounted for three days in 2003, but the City's data was more comprehensive and was used to assess the pH of Woodin Creek (Table 6 and Appendix A). Approximately 71 percent of samples collected by the City at the upstream site (171st Place) were below a pH of 6.5. Approximately 10.5 percent of the downstream samples in Reach 1 (Woodin Park) were below a pH of 6.5. According to State water quality standards Woodin Creek exceeded pH criteria standards on several occasions.

Table 6. Range of Water Quality Parameters Measured Within Woodin Creek

Sample Site	Parameter	Maximum	Minimum
NE 171st Place	pH	7.53 (5/8/03)	5.00 (2/13/03)
Woodin Park		7.63 (5/1/03)	5.80 (1/16/03)
Site 1		7.40 (8/29/03)	7.20 (5/30/03)
Site 2		7.10 (5/30/03)	6.90 (8/29/03)
Site 3		7.10 (*)	7.10
Site 4		7.20 (10/31/03)	7.10 (5/30/03)
NE 171st Place	***Conductivity***	**21.7 (8/14/03)	**5.7 (3/13/03)
Woodin Park	(uOhms)**	**20.4 (9/27/03)	**6.3 (3/6/03)
Site 1	uS	298 (5/30/03)	228 (10/31/03)
Site 2		277 (10/31/03)	235 (5/30/03)
Site 3		241 (5/30/03)	255 (10/31/03)
Site 4		302 (8/29/03)	219 (10/31/03)
NE 171st Place	***Turbidity***	372 (9/11/03)	31.8 (3/6/03)
Woodin Park	(NTU)	272 (8/21/03)	20.7 (1/23/03)
Site 1		3.35 (8/29/03)	1.5 (5/30/03)
Site 2		4.34 (8/29/03)	2.32 (5/30/03)
Site 3		5.42 (8/29/03)	2.64 (10/31/03)
Site 4		4.93 (8/29/03)	2.98 (5/30/03)
NE 171st Place	***Dissolved Oxy.***	7.3 (10/16/03)	9.9
Woodin Park	(mg/L)	7.7 (10/16/03)	6.7
Site 1		12.04 (10/31/03)	5.91 (8/29/03)
Site 2		11.72 (10/31/03)	4.97 (8/29/03)
Site 3		11.88 (10/31/03)	5.51 (8/29/03)
Site 4		12.06 (10/31/03)	9.58 (8/29/03)

Temperature

Temperature data was collected by Adolfson and the City of Woodinville to assess Woodin Creeks ability to support aquatic life and in particular those of salmonids. Data collected by the City of Woodinville from two sites (Woodin Park and at NE 171st Place) within Woodin Creek from January 2003 to October 2003 indicates that temperatures at the park in lower Reach 1 ranged from 6.0 °C (43 °F) in February to 18 °C (64 °F) in July. Temperatures in the upper section (Reach 3) ranged from 4.7 °C (40.5 °F) in February to 21.3 °C (70.3 °F) in June.

Table 7 shows the average weekly daytime temperatures collected by Adolfson for each water quality monitoring site, which were those temperatures recorded between 6:00 A.M. to 7:00 P.M. over the seven day period, as well as the highest and lowest temperature recorded at each site. Temperatures within Woodin Creek appear to be "not properly functioning" for the lower reach (Sites 1 and 2) and "at risk" for the upper reaches (Sites 3 and 4) based on NOAA Fisheries standards. Temperature standards set by the State of Washington Department of Ecology in the Washington Administrative Code (WAC) 173-201A for class "AA" waters including all waters in the Lake Washington and Sammamish Basins states that temperatures shall not exceed 16 °C (60.8 °F). According to State water quality standards Woodin Creek exceeds criteria standards during the summer months.

Dissolved oxygen (DO) levels were also measured in Woodin Creek (Table 6). DO levels ranged from poor to good, with a minimum of 4.97 mg/L recorded in Reach 1 on August 29, 2003, when the stream temperature was 15° C (59 °F), and a maximum of 12.06 mg/L in Reach 3 on October 31, 2003, when the stream temperature was 6.5° C (43.7 °F). There is an inverse relationship between stream temperature and DO in that as stream temperature increases, the DO decreases. DO standards set by the State of Washington Department of Ecology in the Washington Administrative Code (WAC) 173-201A for class "AA" waters including all waters in the Lake Washington and Sammamish Basins states that DO levels shall exceed 9.5 mg/L. It appears that DO levels in Woodin Creek do not meet State standards during the summer months.

Table 7. Summary of Temperature Data for Woodin Creek.

	Weekly Average Daytime Temperatures (°C)				
Week	Air	Site1	Site 2	Site 3	Site 4
6/6/03-6/12/03	17.8	15.1	14.3	13.3	13.6
6/13/03-6/19/03	16.7	14.5	14.1	13.5	12.9
6/20/03-6/26/03	15.1	13.9	13.7	12.9	11.9
6/27/03-7/3/03	18.4	15.2	14.7	15.1	13.3
7/4/03-7/10/03	18.9	15.8	15.0	15.6	13.4
7/11/03-7/17/03	20.0	16.8	15.8	13.8	14.4
7/18/03-7/24/03	21.1	17.6	15.6	14.0	14.8
7/25/03-7/31/03	21.6	17.8	16.7	14.3	15.2
8/1/03-8/6/03	19.3	16.7	16.4	13.6	14.7
8/7/03-8/13/03	18.9	16.7	16.5	13.5	14.5
8/14/03-8/20/03	20.5	18.1	16.6	13.8	14.9
8/21/03-8/27/03	15.1	13.3	13.5	10.9	11.9
Minimum	7.6	11.7	12.6	9.5	11.0
Maximum	32.8	21.5	19.9	22.4	17

Sediment/Turbidity

Turbidity data was collected by both Adolfson and the City of Woodinville (See Table 3 and Appendix A). Turbidity measurements within Woodin Creek ranged from 1.5 NTU's to 372 NTU's. The USFWS recommends a maximum TSS level of 80 mg/L to protect salmonids (Kuttel, 2001). The highest reported TSS level for Woodin Creek was 63 mg/L in November 2000 (Table 8 and Appendix A). TSS data provided by the City was fairly low and appears to be protective of salmonids; however, certain turbidity levels measured by the City were much higher.

To a large degree, sediment and turbidity are related to the erosive character of the adjacent streambanks and surrounding soils types (Figure 3). Most of the erosion and sediment deposition in Reach 1 can be attributed to the soils and slopes that exist within the upper reaches of Woodin Creek (Reaches 3, 4, and 5). Soils in Reaches 4 and 5 and the upper most portion of Reach 3 consist of Everett Gravelly Sandy Loam with 15-30 percent slopes. The lower portion of Reach 3 is Everett Gravelly Sandy Loam with 5-15 percent slopes. However, these conditions result in sediment deposition within the lower reaches of Woodin Creek. The grain size is sufficient enough to cause the sediments to drop out of the water column quickly once they reach the lower gradient portions of the stream. This limits the amount of total suspended solids within the system. It appears that Woodin Creek is "at risk" based upon NOAA Fisheries standards for this element.

Chemical Contamination/Nutrients

Woodin Creek is not specifically listed on the state's CWA 303(d) list; however, the list does not often include small tributaries such as Woodin Creek. Data collected to date indicate higher than normal level of some contaminants within Woodin Creek. Data collected by the City over a three year period (Appendix A) has shown high amounts of fecal coliform organisms along with high amounts of nitrate/nitrite, particularly within Reach 1. Reach 1 was the only site analyzed for contaminants.

Fecal Coliform standards set by the State of Washington Department of Ecology in the Washington Administrative Code (WAC) 173-201A for class "AA" waters including all waters in the Lake Washington and Sammamish Basins states that fecal coliform levels shall not exceed a geometric mean value of 50 colonies/100ml and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100ml. The geometric mean for all samples collected by the City (Appendix A) is 403 colonies/100ml with 66.7 percent of the samples exceeding 100 colonies/100ml. Reach 1 does not meet current State water quality standards.

Table 8 shows the contaminants that were measured by the City and the range of concentrations reported over the three-year period. Due to elevated stream temperatures and higher than normal contaminants, it is likely that Woodin Creek is "not properly functioning" based on NOAA Fisheries standards for this element.

Table 8. Reported Concentration Ranges for Analyses Assessed

Sample Site	Parameter	Maximum	Minimum
Woodin Park	Fecal Coliforms (organisms/100ml)	2800 (June 01)	0.5 (Jan. 01)
Woodin Park	Nitrate/Nitrite (µg/l)	1460 (March 02)	0.731 (July 03)
Woodin Park	Total Phosphorous (mg/l)	0.1450 (Aug. 01)	0.0025 (Nov. 00)
Woodin Park	Total Suspended Solids (mg/l)	63 (Nov. 00)	2 (Jan. 01)
Woodin Park	Lead (mg/l)	0.00295 (Nov. 00)	0.00050 (Jan. 01)
Woodin Park	Zinc (mg/l)	0.0712 (Jan. 01)	0.0050 (Feb. 01)
Woodin Park	Copper (mg/l)	0.06460 (March 01)	0.00050 (Sept. 01)

Source: City of Woodinville, unpublished data (Appendix A)

Habitat Access

Physical Barriers

Physical barriers to fish passage were noted in the field and described below.

Reach 1. The culvert at NE 171st Street appears to be a fish barrier during high flow events (Figure 2). Sedimentation has reduced the volume of the culvert and may result in increased velocities that could preclude fish use during some times of the year. No other man-made barriers were noted within Reach 1 that would prohibit the access of salmonids to the upstream reaches, although the stream is crossed by several roads via culverts. Many of these appear to be newer culverts and were designed with fish passage as a consideration or allowed fish passage as a result of the need to provide adequate conveyance.

Reach 2. From 140th Avenue NE to NE 174th Street, Woodin Creek is culverted (Figure 2). The length of culvert is approximately 1,350 feet. This length of culvert is a blockage to upstream fish passage to Reach 3 and Reaches 4 and 5.

Reach 3. There are no known man-made habitat blockages within Reach 3. The culvert under 146th Place NE is likely a fish passage barrier during low-flow periods (Figure 2).

Reach 4. Much of the lower section of the North Tributary is culverted under the same development as Reach 2. This length of culvert is a blockage to upstream fish passage and likely precludes anadromous fish from upstream sections of this reach and from Reach 5.

Reach 5. There are two culverts crossings under roads within Reach 5. One culvert is under NE 178th Street and one is under 146th Avenue NE. The culvert under 178th Street has a grate covering the culvert and is a barrier to upstream fish passage. The culvert at 146th Avenue NE is elevated several feet above the streambed and is a barrier to upstream migration.

It is evident that the Woodin Creek Basin is not properly functioning for this habitat element. The long expanses of culverts in Reaches 2 and 4 preclude anadromous or migratory resident fish from accessing available upstream habitats.

Habitat Elements

Substrate

Sand and silts substrates were most evident within Reach 1 of Woodin Creek (Photos 3 and 4, Appendix C). Sand flows from Reaches 3, 4, and 5 and is deposited in Reach 1 due to lower stream gradients. The majority of sediment deposition from erosion areas in Reaches 4 and 5 collect at the stormwater facilities at NE 178th Street/NE Woodinville-Duvall Road. Catch basins along the culverted Reach 2A collect sediment as well. Erosion areas for Reach 3 generally included areas in the vicinity of stations 49+00 to 51+00. Erosion areas were common in Reach 4 and included areas in the vicinity of stations: 1+00 to 11+00. Erosion areas in Reach 5 occurred in the vicinity of stations 1+00 to3+30. In some areas, small gravel is present, but where it occurs it is highly embedded. Substrates were not evaluated in Reach 2 and lower sections of Reach 4 because these areas are culverted. Upstream of these piped segments, substrates in Reaches 3 and 4 are dominated by small gravel (Photo 5, Appendix C). Cobble was the dominant substrate in Reach 5. Subdominant substrates range from large gravels (Reaches 3 and 5) in areas with higher sloped streambeds to organic matter where the stream crosses areas of riparian wetlands (Figure 4). Sand was a subdominant substrate in Reaches 1 and 4. Table 9 documents substrate composition in Reaches 1, 2, 4, and 5.

Although sand was not a dominant substrate based on surface area coverage, the overall dominant coverage was 25 percent with a subdominant coverage of 52 percent. This causes a high degree of imbedment for the larger grained substrates such as gravels and cobble, and ultimately reduces stream velocities necessary to flush fine sediments from spawning substrates. Substrates within Woodin Creek are "not properly functioning" due to the high levels of sedimentation in Reach 1 and the loss of habitat area in Reach 2 due to culverts.

Large Woody Debris

Large woody debris does not appear to meet the requirements for properly functioning conditions throughout the entire basin. Large woody debris is largely absent from Reach 1. The only large woody debris that was observed occurred in one location where it appears to have been placed during restoration efforts (Photo 6, Appendix C). Potential for LWD recruitment in Reach 1 is lacking due to the lack of available mature trees in the riparian areas older trees. No large woody debris occurs in Reach 2 because that section is culverted.

Large woody debris pieces are present, but do not meet the standards for properly functioning due to the size and lack of number of pieces available within the streambed. Large woody debris within Reaches 3, 4, and 5 is generally small, approximately 10-inch to 20-inch in diameter and is short (less than 20 feet). The total number of LWD pieces, that meet standards for properly functioning, was 20 pieces for the 7,469 feet of stream surveyed. This equates to 14.1 pieces of LWD per mile of stream. Woodin Creek is "not properly functioning" for the LWD element. Appendix B contains stream survey data sheets, which document LWD within Woodin Creek.

Table 9. Substrate Summary

Substrate	Dominant Coverage (ft)	Secondary Coverage (ft)	Dominant Coverage (%)	Sub-dominant Coverage (%)
		Reach 1		
Silt/Organic	40	18	1%	1%
Sand	1,019	2,023	29%	57%
Small Gravel	2,048	846	58%	24%
Large Gravel	96	300	3%	9%
Cobble	80	96	2%	3%
Totals	3,283	3,283	93%	93%
		Reach 3		
Silt/Organic	6	6	0%	0%
Sand	718	577	37%	30%
Small Gravel	769	575	39%	29%
Large Gravel	460	787	24%	40%
Cobble	-	8	-	0%
Totals	1,953	1,953	100%	100%
		Reach 4		
Sand	131	1,173	10%	88%
Small Gravel	1,200	131	90%	10%
Large Gravel	-	27	-	2%
Totals	1,331	1,331	100%	100%
		Reach 5		
Silt/Organic	75	-	11%	-
Sand	-	75	-	11%
Small Gravel	-	20	-	3%
Large Gravel	-	481	-	72%
Cobble	310	-	47%	-
Boulder	191	-	29%	-
Totals	576	576	86%	86%
		Summary for Reaches 1, 3, 4, and 5		
Silt/Organic	121	24	2%	0%
Sand	1,868	3,848	25%	52%
Small Gravel	4,017	1,572	54%	21%
Large Gravel	556	1,595	7%	21%
Cobble	390	104	5%	1%
Boulder	191	-	3%	-
Totals	7,143	7,143	96%	96%

Instream Habitat Types (Pool Frequency and Pool Quality)

Woodin Creek contains 113 habitat types in the portions surveyed of which 55 are riffle habitats and 39 are pool habitats. This number excludes habitat within culverts. Tables 10 through 13 summarize the habitat data collected in the field (Appendix B) for each Reach. Table 14 summarizes habitat data for the entire portion of stream surveyed. Instream habitat within Reach 1 consists of low-gradient riffle and glide habitat. Pools within Reach 1 are few and are largely limited to those created by stream enhancement activities including the construction of log weirs

across the stream and root wads (Photos 7 and 8, Appendix C). Most of Reach 1 is contained within roadside conveyance ditches and/or has been channelized and straightened by past development activities. Instream habitat in Reach 2 and lower sections of Reach 4 is absent as a result of culverting. Instream habitat within open channel portions of Reaches 3, 4, and 5 are dominated by riffles with few pools (Photo 9, Appendix C). Cascades are present in areas with high streambed gradients. This occurs primarily within the Northern Tributary (Reaches 4 and 5). Woodin Creek contains a total of 39 pools in the 1.4 miles surveyed (Appendix B). This translates into 27 pools per mile of stream. Woodin Creek contains no pools with depths greater than three feet and lacks the large woody debris necessary for creating quality pool habitat. Woodin Creek is not properly functioning based on NOAA Fisheries standards for pool frequency and pool quality (Table 3).

Off Channel Habitat

Off channel habitat throughout the Woodin Creek system has been degraded by the channelization of Reach 1 and the culverting of Reach 2 and parts of Reach 4. Off stream habitat is limited in Reaches 3, 4, and 5 due to higher streambed gradients and residential development. The most significant area of off-channel habitat is associated with a small pond in Reach 1 approximately 250 feet upstream of the stream mouth (Figure 2; Photo 10, Appendix C); however, this pond is elevated above Woodin Creek and is not accessible as off channel habitat and only receives flow during storm events. A second open water pond is located adjacent to Woodin Creek north of NE 171st Street within the Canterbury Estates community (Figure 2). This pond is elevated above Woodin Creek and is not accessible as off channel habitat. Woodin Creek is likely to be "not properly functioning" based on NOAA Fisheries standards for off channel habitat.

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Table 10. Habitat Summary for Reach 1

Habitat	Frequency	Total Length (feet)	Average Width (feet)	Average Depth (inches)	Average Length (feet)	Total Area (feet^2)	Percent of Total Reach (Area)	Percent of Total Reach (Length)
Low Gradient Riffle	26	1,808	4.5	2.9	69.5	8,066.5	49.5%	51.4%
High Gradient Riffle	2	80	5.0	3.0	40.0	400.0	2.5%	2.3%
Plunge Pool	6	72	6.8	10.0	12.0	492.0	3.0%	2.0%
Glide	14	946	4.1	5.6	67.6	3,919.1	24.1%	26.9%
Step Run	1	32	6.0	5.0	32.0	192.0	1.2%	0.9%
Mid-Channel Pool	7	140	7.0	9.3	20.0	980.0	6.0%	4.0%
Corner Pool	12	176	6.2	8.9	14.7	1,085.3	6.7%	5.0%
Culverted Reach	5	236	4.2		47.2	991.2	6.1%	6.7%
Other	2	29	5.5	9.0	14.5	159.5	1.0%	0.8%
Totals	75	3,519				16,285.6	100%	100%

Table 11. Habitat Summary for Reach 3

Habitat	Frequency	Total Length (feet)	Average Width (feet)	Average Depth (inches)	Average Length (feet)	Total Area (feet^2)	Percent of Total Reach (Area)	Percent of Total Reach (Length)
Low Gradient Riffle	19	1,839	3.7	1.2	96.8	6,872.1	94.0%	94.2%
High Gradient Riffle	1	50	3.0	1.0	50.0	150.0	2.1%	2.6%
Cascade	1	10	4.0	1.0	10.0	40.0	0.5%	0.5%
Backwater Pool - Log Formed	2	7	5.5	3.0	3.5	38.5	0.5%	0.4%
Plunge Pool	6	28	4.0	4.8	4.7	112.0	1.5%	1.4%
Dammed Pool	4	17	5.3	4.8	4.3	89.3	1.2%	0.9%
Mid-Channel Pool	1	2	4.0	8.0	2.0	8.0	0.1%	0.1%
Totals	34	1,953				7,309.8	100%	100%

Table 12. Habitat Summary for Reach 4

Habitat	Frequency	Total Length (feet)	Average Width (feet)	Average Depth (inches)	Average Length (feet)	Total Area (feet^2)	Percent of Total Reach (Area)	Percent of Total Reach (Length)
Low Gradient Riffle	3	1,298	4.7	2.0	432.7	6,057.3	98.5%	97.5%
High Gradient Riffle	1	27	3.0	1.0	27.0	81.0	1.3%	2.0%
Plunge Pool	1	6	2.0	3.0	6.0	12.0	0.2%	0.5%
Totals	5	1,331				6,150.3	100%	100%

Table 13. Habitat Summary for Reach 5

Habitat	Frequency	Total Length (feet)	Average Width (feet)	Average Depth (inches)	Average Length (feet)	Total Area (feet^2)	Percent of Total Reach (Area)	Percent of Total Reach (Length)
Low Gradient Riffle	3	556	2.7	2.3	185.3	1,482.7	86.1%	83.5%
Cascade	1	20	3.0	2.0	20.0	60.0	3.5%	3.0%
Culverted Reach	1	90	2.0		45.0	180.0	10.4%	13.5%
Totals	5	666				1,722.7	100%	100%

Table 14. Overall Habitat Summary for Woodin Creek

Habitat	Frequency	Total Length (feet)	Average Width (feet)	Average Depth (inches)	Average Length (feet)	Total Area (feet^2)	Percent of Total Reach (Area)	Percent of Total Reach (Length)
Low Gradient Riffle	51	5,501	4.1	2.2	107.9	22,543.3	71.6%	73.7%
High Gradient Riffle	4	157	4.0	2.0	39.3	628.0	2.0%	2.1%
Cascade	2	30	3.5	1.5	15.0	105.0	0.3%	0.4%
Backwater Pool - Log Formed	2	7	5.5	3.0	3.5	38.5	0.1%	0.1%
Plunge Pool	13	106	5.2	7.1	8.2	546.3	1.7%	1.4%
Dammed Pool	4	17	5.3	4.8	4.3	89.3	0.3%	0.2%
Glide	14	946	4.1	5.6	67.6	3,919.1	12.4%	12.7%
Step Run	1	32	6.0	5.0	32.0	192.0	0.6%	0.4%
Mid-Channel Pool	8	142	6.6	9.1	17.8	940.8	3.0%	1.9%
Corner Pool	12	176	6.2	8.9	14.7	1,085.3	3.4%	2.4%
Culverted Reach	6	326	3.8		54.3	1,249.7	4.0%	4.4%
Other	2	29	5.5	9.0	14.5	159.5	0.5%	0.4%
Totals	119	7,469				31,496.8	100%	100%

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Refugia

Refugia throughout the entire Woodin Creek basin has been degraded by development that has either resulted in the loss of mainstream habitat or riparian vegetation. This degradation has reduced the amount of vegetation and appropriate substrate and other remnant habitat available for refugia. Although some refugia does occur along the stream, primarily as a result of off channel wetlands in Reach 1, these areas are relatively small and have been impacted by adjacent land uses. In several instances, off channel wetlands have been converted into landscape amenities as decorative ponds that do not provide as high a level of refugia function as would undisturbed riparian wetlands. Woodin Creek is likely to be "not properly functioning" based on NOAA Fisheries standards for refugia.

Channel Condition and Dynamics

Width/Depth Ratio

Width/Depth ratios were calculated using channel width and depth data (Appendix B) collected during stream surveys. Data shows that values ranged widely between reaches with Reaches 1 and 3 showing the widest variability. Reach 1 values ranged from 1.3:1 to 32:1. Reach 3 values ranged from 1.4:1 to 40:1. Reach 4 values ranged from 1.5:1 to 8:1. Reach 5 values ranged from 3:1 to 8:1. Average width/depth ratios for all reaches are less than 10:1, which would indicate that Woodin Creek is "properly functioning" for this element. Low width/depth ratios are typical for incised channels such as those encountered in Woodin Creek.

Streambank Condition

Streambank conditions within Reach 1 of Woodin Creek are generally stable due to the lack of bank height and armoring within the reach. Armoring stationing areas include the angular rip-rap beneath the footbridge (0+18). Bank stability is compromised to some degree in Reaches 3, 4, and 5 because of the erosive nature of soils and the slope of streambanks in these reaches. Reaches 4 and 5 are the most susceptible to erosion due to 15-30 percent slopes. Reach 3 contains some 15-30 percent slopes in the uppermost section, but the majority is 5-15 percent slopes. Reaches 3-5 all contain erosion problem areas and much of this sediment is deposited in the lower gradient Reach 1. Streambank conditions within Woodin Creek appear to be "at risk" based on NOAA Fisheries standards.

Floodplain Connectivity

Floodplain connectivity within Woodin Creek has been affected by past channelization, culverting, and bank armoring. The overall floodplain area has been severely degraded by diking of the Sammamish River and development of the valley floor. It is evident that Woodin Creek is not properly functioning for floodplain connectivity based on NOAA Fisheries standards.

Flow/Hydrology

Change in Peak/Base Flows

Much of the basin is comprised of impervious surfaces (Figure 2). Runoffs from impervious surfaces appear to have altered peak and base flows within the basin. The stream appears to commonly breach the streambanks along the main channel of Reach 1. The level of development within the basin and the documented problems with sedimentation support this

assessment. It is evident that the Woodin Creek Basin is not properly functioning for flow/hydrology based on NOAA Fisheries standards.

Drainage Network

Approximately 31 percent of the impervious surface within the Woodin Creek basin occurs in road rights-of-way. Many roads have drainage networks that predate current water quality detention and treatment standards. The Woodin Creek Basin is not properly functioning for flow/hydrology based on NOAA Fisheries standards.

Watershed Conditions

Road Density and Location

Many roadways cross Woodin Creek. Most of Reach 1 is confined to roadside conveyance ditches. It is evident that the Woodin Creek Basin is not properly functioning for road density and location based on NOAA Fisheries standards.

Disturbance History

The Woodin Creek Basin is 41.3% impervious surface area. The valley floor is heavily developed and the original stream channel in this area has been historically altered to allow for development. Best available science indicates that basins with greater than 40 percent impervious surface area are known to severely degrade streams in the Lowland Puget Sound region (May et al., 1997). Based upon this information, it is likely that Woodin Creek is not properly functioning for this element.

Riparian Zone and Vegetation

The width of the vegetated riparian zone within the basin varies considerably by location. In Reach 1, the riparian zone varies from approximately 100-feet along the east banks to five feet or less as it parallels NE 171st Street. The riparian zone is completely lacking in Reach 2 and lower sections of Reach 4. In Reaches 3 and 5, and in Reach 4 upstream of 143rd Avenue NE, the riparian corridor is more consistent and ranges from 50 to 100 feet in width. Steep slopes and development under more current land use guidelines appear to have allowed riparian conditions in these areas to be maintained to a higher degree than in other portions of the basin. Although riparian areas have been maintained in some areas, the significant modification in Reaches 1 and 2 and the fragmentation of other riparian areas indicates that the Woodin Creek basin is not properly functioning for riparian reserve based on NOAA Fisheries standards.

Fish Use in the Woodin Creek Basin

Woodin Creek is a small tributary to the Sammamish River. Limited site-specific data was found that describes fish use in Woodin Creek. The Washington Department of Fish and Wildlife Priority Habitat and Species map does not identify Woodin Creek or identify fish presence within Woodin Creek. On the other hand, King County Water Resources Inventory Area 8 data contains some information on fish presence within Woodin Creek. The King County Salmon Watcher's Program evaluated Woodin Creek in 1999 and 2002 and did not identify any spawning salmonids within Woodin Creek during those years. There is also

sufficient data available related to the larger Sammamish River Basin that allows information on fish use within the area, or potential fish use, within Woodin Creek to be assessed. In addition, Adolfson performed spawner surveys within Woodin Creek. Surveys were performed from September 2003 through November 2003 (Figure 2). Table 15 shows the dates the surveys took place and the number of spawning adults, carcasses, and redds observed for the indicated sites.

Table 15. Spawner Survey Results for Woodin Creek

Date	Number and Species of Spawning Adults, Carcasses, and Redds Observed							
	*OP-1	OP-2	OP-3	OP-4	**OR-1	OR-2	OR-3	OR-4
9/23/03	None	1 Chinook Carcass	None	None	None	None	None	None
10/6/03	None	None	None	None	None	None	None	None
10/15/03	None	None	None	None	None	None	None	None
10/23/03	None	None	None	None	None	None	None	None
10/31/03	None	None	None	None	None	None	None	None
11/14/03	None	None	None	None	None	None	None	None
11/24/03	None	None	None	None	None	None	None	None

*OP = Observation Point **OR = Observation Reach

ESA-listed and Candidate Fish Species

Chinook Salmon and Bull Trout

Under ESA-enabling legislation, two anadromous fish species have been listed as threatened in Puget Sound: Chinook salmon and bull trout. In the Lake Washington Basin, Chinook salmon spawn mainly in the Cedar River and Bear Creek in Redmond. Chinook spawning in north Lake Washington tributaries utilize North, Swamp, Bear, Little Bear, Thornton, McAleer, and Cottage Lake Creeks as well as the Sammamish River. Spawning occurs from September through October with the spawning peak occurring in October (WDFW and WWTIT, 1994). Smaller tributaries have some documented Chinook spawning activity although it is not known if these streams represent reproducing runs of Chinook or if spawners are mainly strays from other basins. One Chinook carcass (Photo 11, Appendix C) was discovered during the September 2003 spawner survey at the upstream end of the culvert beneath NE 171st Street in Reach 1. The carcass was out of the stream and approximately five feet up the left bank in a patch of reed canarygrass. Water levels at the time were extremely low in this lower reach, and the Chinook was likely stranded and removed by a streamside predator (raccoon). No other Chinook were observed during the spawner surveys.

Less than a dozen bull trout have been reported in the Lake Washington Basin; these individuals are thought to be strays from other Puget Sound basins. Although native char (bull trout and/or Dolly Varden trout) have been documented in the Snohomish River basin to the north and in Chester Morse Lake (headwaters of the Cedar River) (Snohomish County, 2000), no reproducing populations are known or thought to exist in the Sammamish River Basin. All known successful bull trout spawning in the region occurs below the winter snow line (ranges from 1,500 feet to 2,500 feet in the Western Cascades). It is unlikely that bull trout occur within Woodin Creek. No bull trout were observed during the stream or spawner surveys.

Coho Salmon

Puget Sound/Strait of Georgia coho salmon are currently candidates for listing under the ESA. Coho salmon utilize small streams for spawning and are found in virtually all of the accessible

reaches of smaller Lake Washington tributaries. Based on declining escapement numbers, however, Lake Washington coho runs are considered "depressed." Coho spawn timing occurs from late October to mid-December and is very similar to hatchery coho spawn timing (WDFW and WWTIT, 1994) (Table 16). Spawning surveys in 1996 identified adult coho salmon spawning activity within the lower reaches of Woodin Creek (King County, 2001). Juvenile salmonid fish, likely to be coho fry, were observed by Adolfson biologists during site visits in February 2003. In addition, King County personnel electrofished and dewatered a portion of lower Reach 1, prior to sediment blockage removal activities in early November 2003. Two subyearling coho were removed and released upstream of removal activities. No spawning coho were observed during surveys conducted from September through the end of November.

Table 16. Life History of Lake Washington Chinook and Coho Salmon (WDFW, 1994)

Month	J	F	M	A	M	J	J	A	S	O	N	D
adult spawning –Chinook												
adults spawning –coho												
intragravel development – Chinook												
intragravel development –coho												
rearing –Chinook												
rearing –coho												
smolting & migration – Chinook												
smolting & migration –coho												

Other Salmonids

Sockeye Salmon

Sockeye salmon stocks have been recognized as three distinct stocks according to the Washington State Salmon and Steelhead Stock Inventory or SASSI (WDFW and WWTIT 1994): (1) Cedar River; (2) tributary streams to Lakes Washington and the Sammamish River; and (3) Lake Washington beach spawners. These stocks are distinguished from other Puget Sound sockeye stocks by geographic and reproductive separation. Genetic studies suggest the current stocks in the Cedar River and Issaquah Creek are similar to the Baker River stock transferred from the Birdsview Hatchery and first released in 1935 into Lake Washington. Electrophoretic genetic analysis of fish taken from North Lake Washington tributaries indicates they are genetically different from the introduced stocks. As such, these fish may be of native origin (Kerwin, 2001). Lake Washington sockeye stocks are the largest sockeye run in the state (Kerwin, 2001). Spawn timing for Lake Washington sockeye occurs from early September through November with Cedar River and beach spawners spawning into January (WDFW and WWIT, 1994). Sockeye salmon have been observed spawning in the lower reaches of Woodin Creek in 1996 (King County, 2001). No Sockeye were observed spawning in Woodin Creek by Adolfson during the September through November 2003 spawner surveys.

Kokanee

Kokanee salmon is the freshwater resident form of sockeye salmon. The Lake Washington Basin is thought to support two distinct kokanee populations and a population of residualized sockeye that are managed as kokanee. A summer (early) and presumed native run that returns in August primarily to Issaquah Creek, and a native stock returning to East Lake Sammamish Tributaries in November through January. A third stock, that was recently determined to be more closely linked genetically to sockeye, is found in North, Little Bear, and Big Bear Creeks. In March 2000, the summer run kokanee stock that returns to Issaquah Creek was petitioned for listing as Endangered under the Endangered Species Act (Kerwin, 2001). Adult kokanee have been identified spawning within Reach 1 of Woodin Creek (King County, 2001). No kokanee were observed by Adolfson spawning in Woodin Creek during the September through November 2003 spawner surveys.

Cutthroat Trout

Coastal cutthroat trout, a subspecies of cutthroat trout are known to occur throughout the Lake Washington Basin (Kerwin, 2001). In 1997 juvenile cutthroat trout were identified within Woodin Creek by the Muckleshoot Indian Tribe Fisheries Department (King County, 2001). Adolfson also documented cutthroat trout use of Woodin Creek during spawner and stream habitat surveys in Reach 1. No cutthroats were documented using the upper reaches of Woodin Creek (Reaches 3-5). This is likely due to the culverted section (Reach 2 and lower portion of Reach 4) that acts as a fish passage barrier.

In addition, King County personnel electrofished and dewatered a portion of lower Reach 1, prior to sediment blockage removal activities in early November 2003. Approximately 250 cutthroat trout were removed and released upstream of the work area.

Steelhead Trout

Wild winter steelhead are present within the Lake Washington system and are a distinct native stock. No summer steelhead stock have been identified. Spawn timing for winter steelhead within the Lake Washington system is generally from early March to mid-June (WDFW and WWIT, 1994). While it is unlikely that adult steelhead spawn in Woodin Creek, juvenile steelhead may enter the system to rear. No spawner survey was performed by Adolfson during peak steelhead spawning, so no assessment can be made as to their presence or absence from the stream.

Other Fish

Along with salmonids, other species in Woodin Creek are typical of Lake Washington tributaries and include sculpins, three-spine stickleback, western brook lamprey, red-sided shiner, large-scale sucker, peamouth, small mouth bass, long nose dace, and speckled dace (Wydoski and Whitney, 1979). In addition King County personnel electrofished and dewatered a portion of lower Reach 1, prior to sediment blockage removal activities, in early November 2003. Lampreys (*Lampetra sp.*) and sculpin (*Cottus sp.*) were removed and released upstream of work area.

Aquatic Species

Aquatic species such as insects, leeches, slugs, and other species typical of Lake Washington tributaries are also present within Woodin Creek. During preliminary studies stonefly larvae, cadis fly larvae, and adult mayflies were observed by Adolfson staff during site surveys.

Wildlife Habitat

Woodin Creek basin habitat and wildlife surveys were conducted within five main stream reaches and the upper basin area. Habitat type descriptions and opportunities for habitat improvements are summarized in Table 17. Plant species observed in the stream reach areas are listed in Table 17. Bird survey findings are provided in Table 18.

Habitat Types

Eight primary habitat associations are identified in the basin and mapped on an aerial photograph. Seven habitat types occur in the study area. These include in order of abundance: High Density Commercial and Residential; Medium Density Residential; Upland Forest; Riparian-Wetlands; Upland Grassland; Herbaceous Wetland; and Open Water Pond. In addition, Agricultural areas occur in King County just south of the study area (Figure 5).

High Density Commercial and Residential

The dominant habitat type of the basin along Reaches 1 and 2 is high density commercial and residential (Photo 12). These areas consist of nearly 100 percent impervious surfaces. Native vegetation communities are lacking, and invasive, non-native plants and animals such as lawn grasses, Himalayan blackberry, European starling, house sparrow, house mouse, and raccoon are abundant.

Medium Density Residential

The dominant habitat type of the basin along Reaches 3, 4, and 5 is medium density residential (Photo 13). Single-family housing is located within 100 feet (horizontal distance) of the stream. This habitat type is covered by 30 to 59 percent impervious surfaces. Vegetation is mainly lawn grasses and ornamental trees and shrubs, with some remaining patches of native forest. A few native and non-native wildlife species are abundant in these areas including American robin, black-capped chickadee, house finch, domestic cat, and the species listed above for high density commercial and residential.

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Table 17. Summary of Terrestrial Habitats in Different Stream Reaches

Stream Reach	Survey Station	Habitat Types	Structural Conditions	Habitat Elements	Opportunities
Reach 1	1, 2, 4	Riparian-wetland, open water wetland, herbaceous wetland, upland grassland, high density commercial and residential	Shrub-sapling along stream with scattered small trees, maintained grass in park, windbreak poplars in rows	Sammamish River, dense shrub thickets along stream, large woody debris in stream, fruits and seeds, nest boxes	Conifers could be planted near stream to provide future structure and woody debris. Park maintenance activities could be reduced, especially near the stream. Invasive plant species could be removed/managed and native shrubs and trees could be planted in riparian and adjacent upland areas. Limit development near stream.
Reach 2a and 2b	Piped stream	High density commercial	No forested component is present.	Commercial buildings, dumpsters with food garbage	None
Reach 3	3	Riparian-wetland, upland forest, medium density residential	Medium trees (15-19" dbh) – single story – closed (>70% canopy cover), and smaller patches of large tree (20-29" dbh) – multi-story – closed (>70% canopy cover)	Small, deciduous snags, conifer trees, multiple-trunked maple trees, forested and scrub-shrub wetlands, mosses, large woody debris, leaf litter, herbaceous ground cover, fruits, seeds, and nuts, shrub thickets	Continue protection of existing riparian-wetland areas and native forest. Protect large trees and snags for nesting, roosting, and foraging habitat.
Reach 4 and 5	5	Riparian-wetland, upland forest, medium density residential, herbaceous wetland	Small and medium trees (10-19" dbh) – single story – moderate (40-69% canopy cover) in upland forest and riparian	Wetlands where the base of ravines widen, conifer trees, invasive vines with fruits (Himalayan blackberry and English ivy), leaf litter, herbaceous ground cover, fruits, seeds, and nuts, shrub thickets	Reduce the dumping of yard debris and garbage into forested ravines. Remove invasive vines and replant with native understory herbs and shrubs. Increase development set-backs from forested ravines. Encourage neighborhood wildlife watch programs to increase resident's awareness of the native forest environment.
Upper basin	6	Upland forest, agricultural	Small and medium tree (15-19" dbh) – single story – closed (>70% canopy cover)	Understory shrubs, moss, large woody debris, leaf litter, conifer trees, fruits, seeds, and nuts	Retain native forest areas to prevent downstream flooding from new impervious surfaces, prevent erosion on steep slopes, and provide wildlife habitat. Ensure that any new developments in the upper basin provide adequate stormwater treatment and detention.

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Upland Forest

The largest areas of upland forest are found in the upper basin and in steep ravines bordering Reaches 3, 4, and 5. Dominant trees in upland forest areas include red alder, black cottonwood, Douglas fir, big leaf maple, and western red cedar (Photo 14). Common understory shrubs and herbs include trailing blackberry, salmonberry, Indian plum, red elderberry, hazelnut, sword fern. Non-native, invasive vines including Himalayan blackberry and English ivy are prevalent in some areas, especially near developed areas. Most forest areas consist of small and medium trees (10 to 19" dbh) with one tree canopy layer. The canopy layer is moderate (40 to 69 percent cover) near Reaches 4 and 5, and closed (more than 70 percent cover) in Reach 3 and the upper basin. Scattered large Douglas fir, big leaf maple and black cottonwood (20 to 36 inches diameter at breast height [dbh]) are found near Reach 3. Habitat elements include herbaceous ground cover, shrub thickets, fruits, seeds, nuts, leaf litter, moss, and small deciduous snags. Wildlife species observed in this habitat type include a number of bird, mammal, and amphibian species as described in the wildlife survey sections below.

Riparian Wetlands

Riparian wetland habitats are found along all of the reaches except for Reaches 2a and 2b that are piped and in the upper basin. This habitat type is dominated by shrubs in Reach 1 and by shrubs and trees in Reaches 3, 4, 5 and the upper basin. Dominant shrubs include willow species and salmonberry, dominant trees include red alder, black cottonwood, and western red cedar. In Reach 3, herbaceous cover includes skunk cabbage and youth-on-age (Photo 15). Structural forest conditions are mostly small tree (10 to 14 inches dbh) with moderate canopy (40 to 69 percent cover). One tree canopy layer is present, with dense shrub thickets present between the stream and upland forest in some places. Habitat elements include those listed above for upland forest and stream and herbaceous wetland habitats. Wildlife species observed in this habitat type include Pacific chorus frog, song sparrow, American robin, common yellowthroat, white-crowned sparrow, black-capped chickadee, myotis bats, and pileated woodpecker excavations in snags.

Upland Grassland

Most of the upland grassland habitat is maintained on a regular basis by mowing and is found in Woodin Creek Park along Reach 1 and in the upper basin in agricultural fields. Maintained grassland also includes residential lawns, too small to identify on the habitat map, in Reaches 4 and 5. Structures are limited to utility poles, buildings, and scattered trees. Wildlife species in this habitat type include mostly American robin, European starling, and house sparrow.

Herbaceous Wetland

Herbaceous wetland habitat occurs adjacent to the stream and associated ponds along Reach 1 and in storm drainage retention facilities at the downstream end of Reaches 4 and 5 (Photo 16). Dominant plants include reed canarygrass, bentgrass, creeping buttercup, and water cress. Willows and red alders provide woody structure in adjacent riparian-wetland areas. Habitat elements include seasonal and permanent open water, dense herbaceous cover, and adjacent shrubs and trees. Wildlife species observed in this habitat type include common yellowthroat, red-tailed hawk, marsh wren, and song sparrow.

Open Water Pond

Permanent open water ponds occur mainly in Reach 1 (Photo 17), while seasonally ponded areas occur throughout the riparian-wetland area of Reach 3. Ponds are situated adjacent to herbaceous wetland and riparian-wetland habitats and habitat structure and elements are similar to those listed for herbaceous wetland. Wildlife species observed in the study area and expected

use open water areas include gadwall, mallard, red-winged blackbird, violet-green swallow, marsh wren, Pacific chorus frog, and others.

Wildlife Surveys

Results of the early morning bird surveys are provided in Table 18. The most common species observed at most stations included American crow, American robin, Bewick's wren, black-capped chickadee, song sparrow, spotted towhee, and white-crowned sparrow. These species are generally adapted to vegetated habitats located within an urban matrix. Species closely associated with herbaceous wetland and open water wetland habitats were observed only at Station 1, and include red-winged blackbird, common yellowthroat, marsh wren, and gadwall.

During bat and owl surveys conducted in July, bat echolocations were detected at Stations 3, 5, and 6, and a family of western screech owls were observed perching and flying between trees and by their call at Station 5. It is interesting to note that bats and owls were only detected at the stations that were located near medium to large conifer trees. The owls were observed flying between conifer trees, between residential properties and the ravine. Structure for bat roosting could be limited where conifer trees or other large trees are not present. Smaller deciduous trees usually lack peeling bark and fissures that characterize medium to large conifer trees. Peeling bark and fissures provide potential roost sites for bats.

Other wildlife observations recorded during the habitat surveys included ruby-crowned kinglet, dark-eyed junco, mallard, pileated woodpecker excavations, eastern gray squirrel, Pacific chorus frog, mole and mountain beaver tunnels, raccoon, and Virginia opossum.

Special Status Species

Special status wildlife species include species designated by federal or state government agencies (USFWS, NMFS, and WDFW) as endangered, threatened, proposed, candidate, sensitive, and monitor species. The USFWS also designates species of concern. Habitat for several special status wildlife species occurs in the Woodin Creek basin. The foraging sign, excavations in live and dead trees, of pileated woodpecker, a state candidate species, was observed during habitat surveys in Reach 3. Foraging habitat for this species is especially prevalent in this reach. Potential nest sites for status species such as bald eagle, pileated woodpecker, and great blue heron are limited in the basin due to the lack of large trees within remaining forest habitats. However, foraging habitat is present for bald eagle and great blue heron, mostly along the Sammamish River. Olive-sided flycatcher, a federal species of concern, was heard in the distance at Station 6 during an early morning bird survey.

Table 18. Early Morning Bird Survey Results.

Bird Species	29-Apr-03						23-May-03						12-Jun-03					
	Stations						Stations						Stations					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
American crow	x	x	x	x	x			x	x				x	x	x	x	x	
American robin	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
Bewick's wren				x	x	x				x	x				x	x	x	x
Black-capped chickadee	x	x				x						x	x	x		x	x	x
Bullock's oriole													x					
California quail												x						
Canada goose							x											
Cedar waxwing								x										
Chestnut-backed chickadee			x			x					x						x	
Common yellowthroat	x						x						x					
European starling							x						x	x			x	x
Gadwall							x											
Gull				x						x								
House finch	x												x			x		
House sparrow								x		x				x				
Marsh wren	x						x											
Northern Flicker							x										x	
Olive-sided flycatcher																		x
Red-breasted nuthatch			x		x													
Red-winged blackbird	x						x						x					
Song Sparrow	x	x	x		x	x	x	x	x	x			x	x	x	x	x	
Spotted towhee	x					x			x	x	x	x	x	x	x	x	x	x
Stellar's jay			x	x				x			x				x		x	x
Swainson's thrush																	x	
Violet-green swallow														x				
White-crowned sparrow	x	x	x	x		x							x	x		x		

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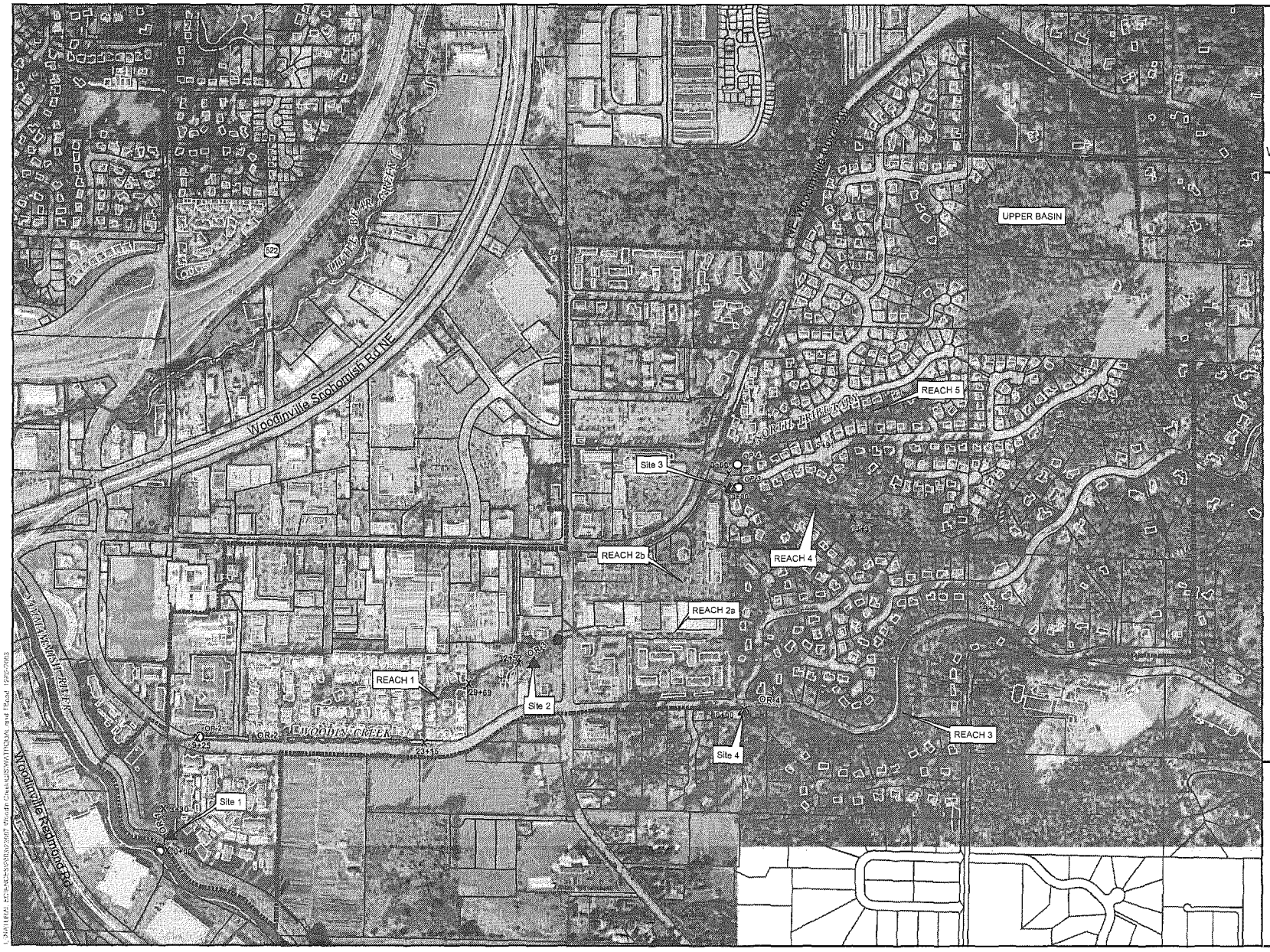

FIGURE 2

WATER QUALITY & SPAWNER SURVEY LOCATIONS

WOODIN CREEK BASIN HABITAT ASSESSMENT

WOODINVILLE, WASHINGTON

- Study Area
- Parcels
- Locations of Ponds
- Streams
- Piped Sections
- Spawning Survey Observation Reaches
- Water Quality Monitoring Sites
- Spawner Survey Observation Points
- OP Observation Point
- OR Observation Reach
- Fish Barriers / Culverts
- X Stations
- Start of Reach

0 500 1,000 Feet

0 500 Feet

Map data shown are the property of the sources listed below. Inaccuracies may exist, and Adolfson Associates, Inc. implies no warranties or guarantees regarding any aspect of data depiction.

Source: Woodinville GIS 2003; King County GIS 2002

LIMITATIONS

All rights-of-entry for the purpose of conducting this study was granted by the City of Woodinville. The boundaries of the study area were established based on maps provided by the City. It should be recognized that stream surveys are inexact sciences; fisheries professionals may disagree on the characterization of habitat types, the relative value of certain habitat features, and stream classifications. The final determination of stream classifications is the responsibility of the resource agencies that regulate activities in and around streams. Accordingly, all stream evaluations performed for this study, as well as the conclusions drawn in this report, should be reviewed by the appropriate regulatory agencies prior to any detailed site planning or construction activities. Further, streams are dynamic systems; habitat types and riparian vegetation may change with time.

Within the limitations of schedule, budget, and scope-of-work, we warrant that this study was conducted in accordance with generally accepted environmental science practices, including the technical guidelines and criteria in effect at the time this study was performed, as outlined in the Methods section. The results and conclusions of this report represent the authors' best professional judgment, based upon information provided by the project proponent in addition to that obtained during the course of this study. No other warranty, expressed or implied, is made.

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APPENDIX A: WATER QUALITY DATA

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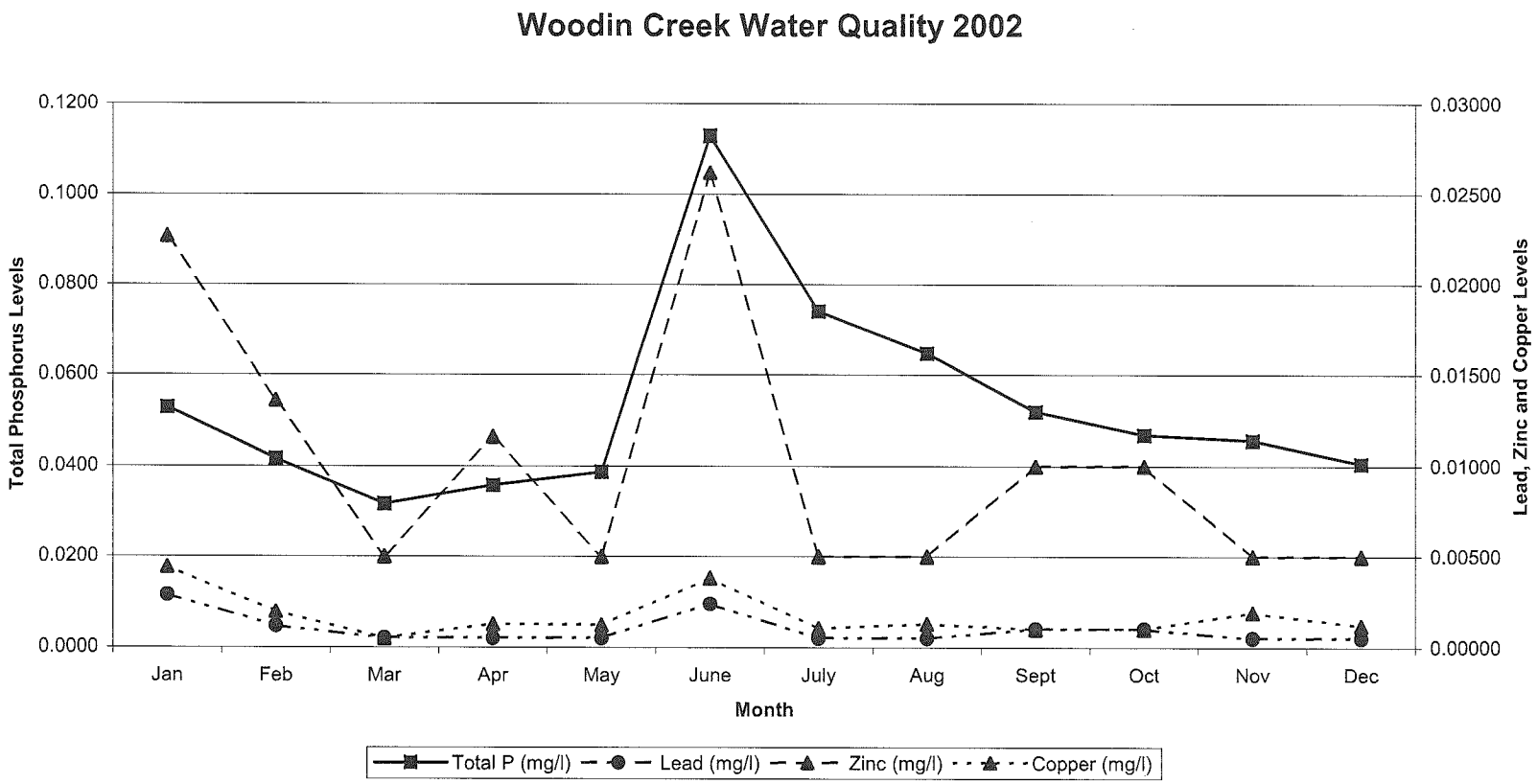
City of Woodinville

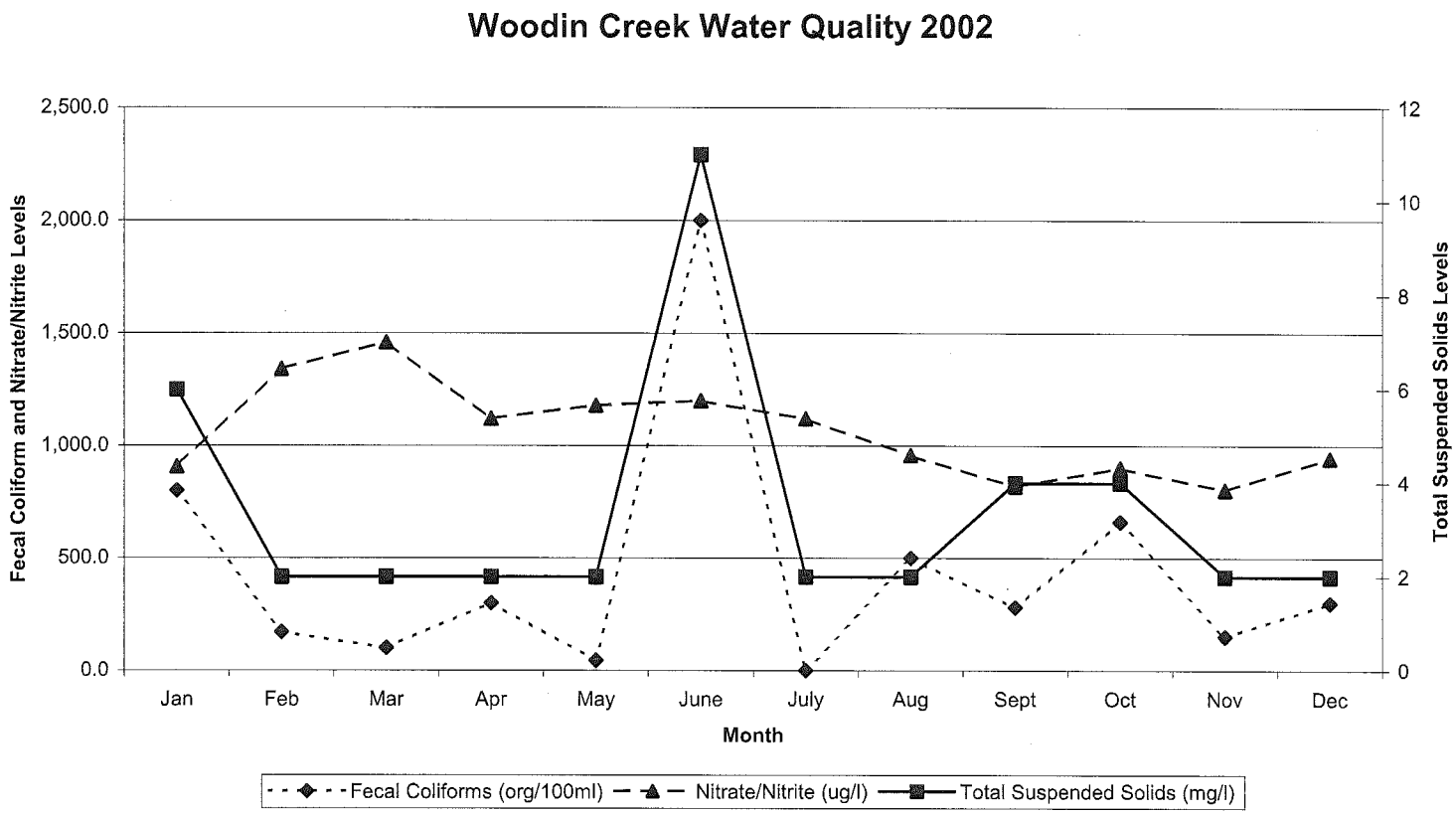
Woodin Creek Water Quality Data

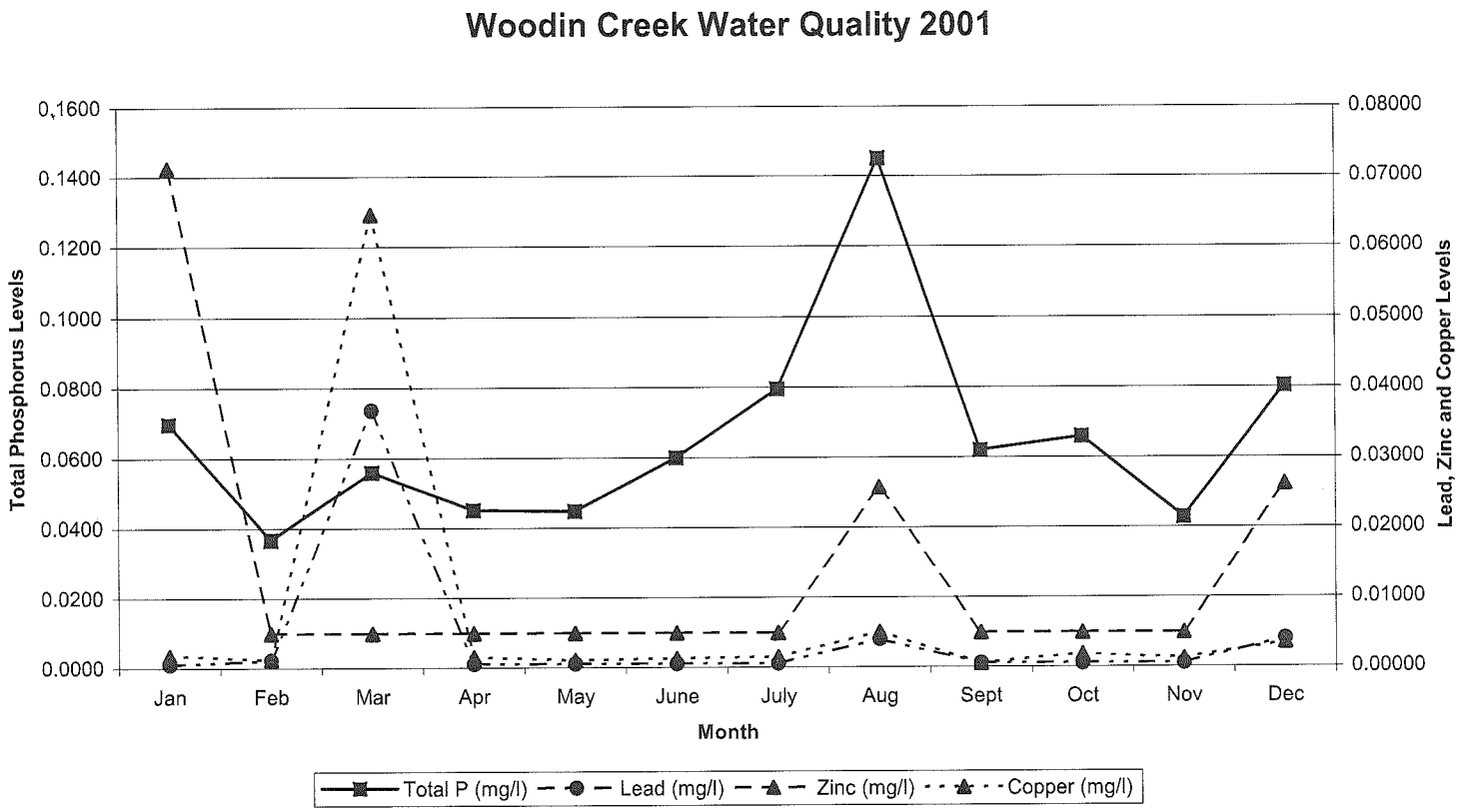
Collected by the City of Woodinville

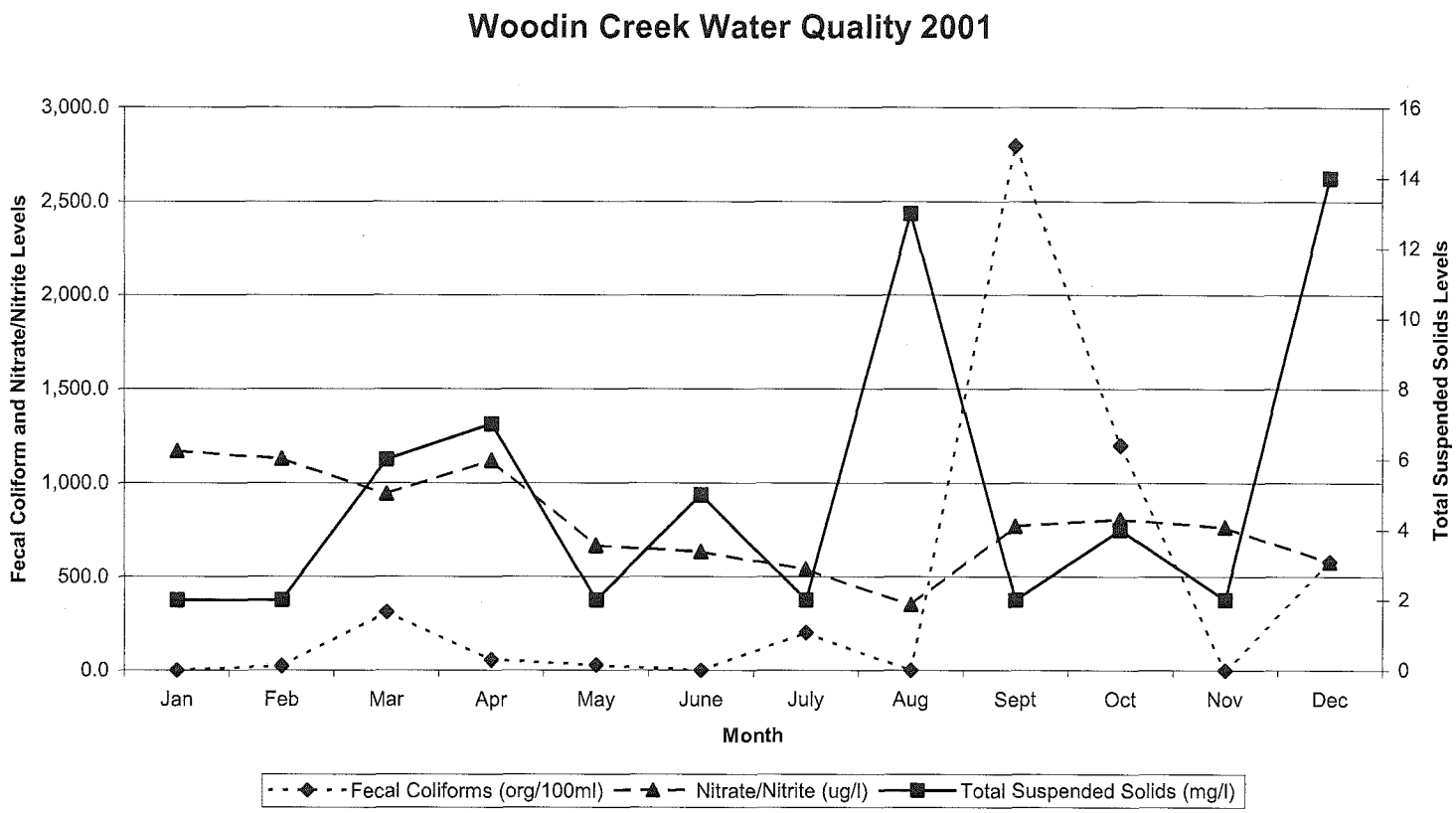
Date	Fecal Coliforms (org/100ml)	Nitrate/Nitrite (ug/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)
Year 2000							
Oct	780.0	852	0.0849	19	0.00189	0.0158	0.00274
Nov	580.0	975	0.0025	63	0.00295	0.0230	0.00497
Year 2001							
Jan	0.5	1,170	0.0697	2	0.00050	0.0712	0.00176
Feb	23.0	1,130	0.0367	2	0.00108	0.0050	0.00120
Mar	310.0	941	0.0559	6	0.03680	0.0050	0.06460
Apr	55.0	1,120	0.0450	7	0.00050	0.0050	0.00151
May	27.0	668	0.0447	2	0.00050	0.0050	0.00106
June	0.5	634	0.0600	5	0.00050	0.0050	0.00124
July	200.0	540	0.0795	2	0.00050	0.0050	0.00149
Aug	0.5	351	0.1450	13	0.00402	0.0257	0.00512
Sept	2,800.0	769	0.0620	2	0.00050	0.0050	0.00050
Oct	1,200.0	807	0.0660	4	0.00050	0.0050	0.00184
Nov	0.5	764	0.0428	2	0.00050	0.0050	0.00120
Dec	580.0	578	0.0803	14	0.00405	0.0262	0.00356
Year 2002							
Jan	800.0	906	0.0529	6	0.00288	0.0227	0.00443
Feb	170.0	1,340	0.0416	2	0.00116	0.0136	0.00195
Mar	100.0	1,460	0.0316	2	0.00050	0.0050	0.00050
Apr	300.0	1,120	0.0357	2	0.00050	0.0116	0.00126
May	45.0	1,180	0.0387	2	0.00050	0.0050	0.00121
June	2,000.0	1,200	0.1130	11	0.00239	0.0262	0.00382
July	0.5	1,120	0.0740	2	0.00050	0.0050	0.00103
Aug	500.0	957	0.0646	2	0.00050	0.0050	0.00128
Sept	280.0	818	0.0519	4	0.00100	0.0100	0.00100
Oct	660.0	900	0.0468	4	0.00100	0.0100	0.00100
Nov	150.0	802	0.0456	2	0.00050	0.0050	0.00190
Dec	300.0	943	0.0405	2	0.00050	0.0050	0.00118

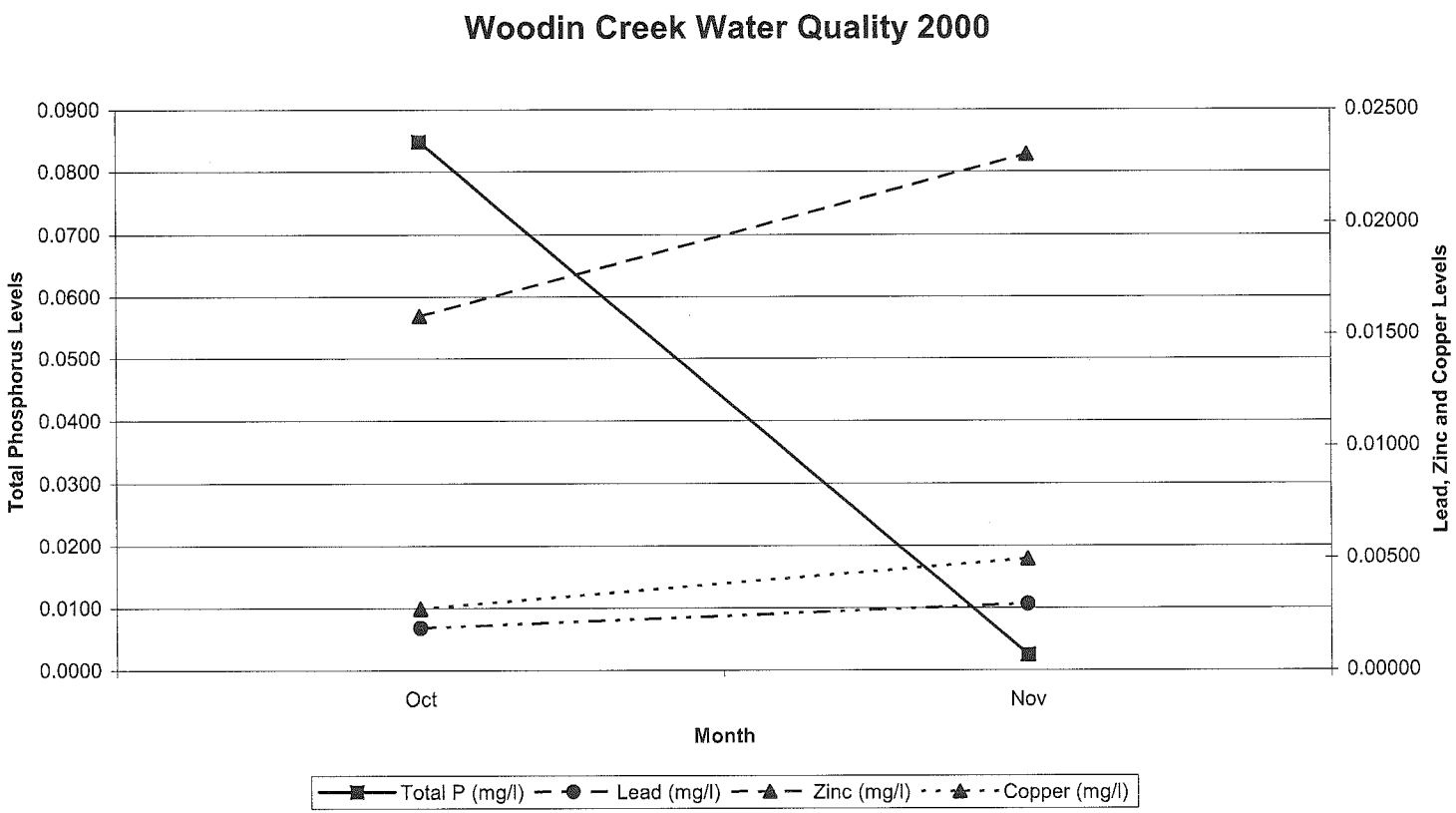
Year 2003							
Jan	430.0	1,230	0.0378	2	0.00050	0.0050	0.00050
Feb	160.0	1,130	0.0345	2	0.00050	0.0050	0.00050
Mar	55.0	1,160	0.0327	2	0.00050	0.0050	0.00050
Apr	140.0	879	0.0381	2	0.00050	0.0108	0.00200
May	91.0	922	0.0472	2	0.00050	0.0050	0.00050
June	350.0	0.926	0.0698	2	0.00050	0.0102	0.00050
July	220.0	0.731	0.1090	2	0.00050	0.0162	0.00160

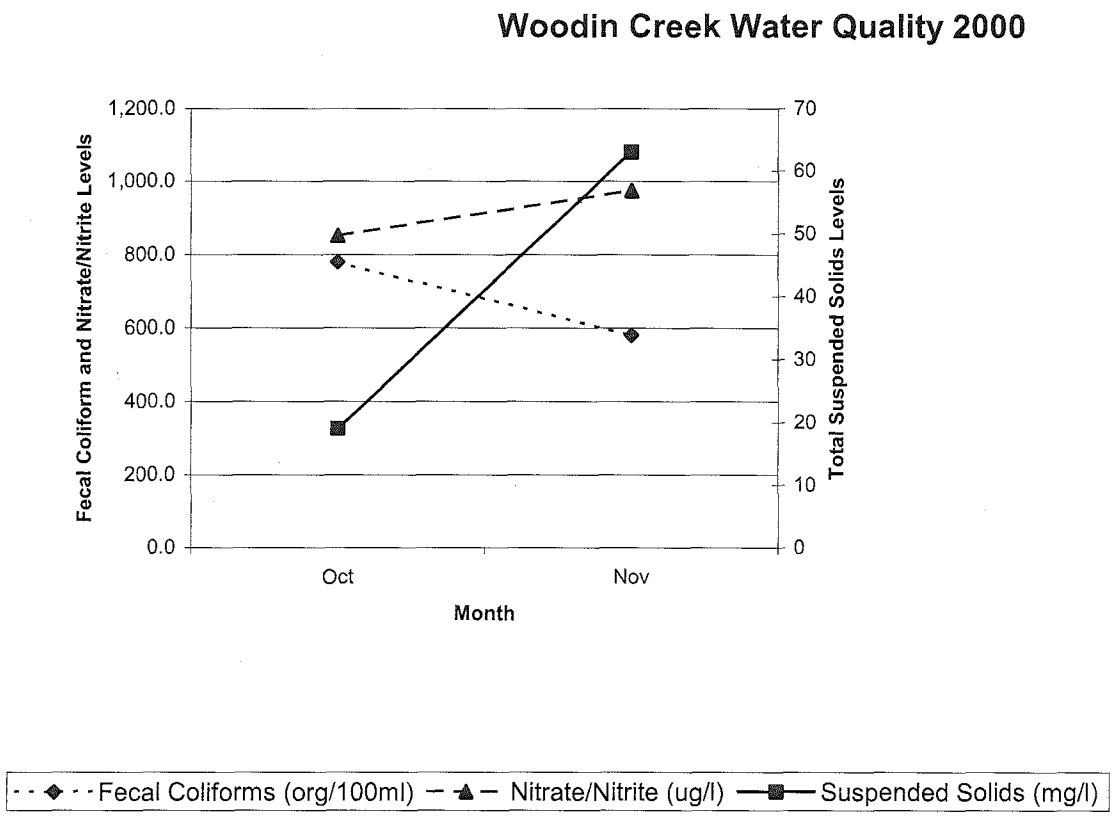

Woodin Creek Water Quality 2002
Total Phosphorus Levels
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
Lead, Zinc and Copper Levels
0.03000
0.02500
0.02000
0.01500
0.01000
0.00500
0.00000
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
Total P (mg/l)
Lead (mg/l)
Zinc (mg/l)
Copper (mg/l)


Woodin Creek Water Quality 2002
Fecal Coliform and Nitrate/Nitrite Levels
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
Total Suspended Solids Levels
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
Fecal Coliforms (org/100ml)
Nitrate/Nitrite (ug/l)
Total Suspended Solids (mg/l)


Woodin Creek Water Quality 2001
Total Phosphorus Levels
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
Lead, Zinc and Copper Levels
0.08000
0.07000
0.06000
0.05000
0.04000
0.03000
0.02000
0.01000
0.00000
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
Total P (mg/l)
Lead (mg/l)
Zinc (mg/l)
Copper (mg/l)


Woodin Creek Water Quality 2001
Fecal Coliform and Nitrate/Nitrite Levels
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
Total Suspended Solids Levels
16
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
Fecal Coliforms (org/100ml)
Nitrate/Nitrite (ug/l)
Total Suspended Solids (mg/l)


Woodin Creek Water Quality 2000
Total Phosphorus Levels
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
Lead, Zinc and Copper Levels
0.02500
0.02000
0.01500
0.01000
0.00500
0.00000
Oct
Nov
Month
Total P (mg/l)
Lead (mg/l)
Zinc (mg/l)
Copper (mg/l)


Woodin Creek Water Quality 2000
Fecal Coliform and Nitrate/Nitrite Levels
1,200.0
1,000.0
800.0
600.0
400.0
200.0
0.0
Total Suspended Solids Levels
70
60
50
40
30
20
10
0
Oct
Nov
Month
Fecal Coliforms (org/100ml)
Nitrate/Nitrite (ug/l)
Suspended Solids (mg/l)

City of Woodinville
Woodin Creek at NE 171st Pl Water Quality Data

Collected by the City of Woodinville

Date	Time	pH	Conductivity	Turbidity	DO	Temp. (*C)	Salinity	Total Dissolved Solids (mg/l)	Specific Gravity	Oxidation Reduction Potential	Weather Conditions	Comments
1/30/03	11:10 AM	6.50	16.1	41.7		8.6	0	0.10	0	182		
2/6/03	3:45 PM	5.30	18.0	116.0		4.9	0	0.12	0	198	overcast, dry	
2/13/03	3:10 PM	5.00	23.0	108.0		4.7	0	0.10	0	167	sunny, dry	
2/20/03	1:00 PM	5.60	15.6	135.0		7.6	0	0.10	0	299	gray, drizzly	
2/27/03	8:50 AM	5.40	18.7	45.6		4.8	0	0.12	0	364	sunny, dry	
3/6/03	11:45 AM	6.40	18.7	31.8		6.5	0	0.12	0	306	sunny, dry	
3/13/03	7:55 AM	5.35	5.7	334.0		9.5	0	0.04	0	364	gray, rainy	
3/20/03	2:17 PM	5.33	15.3	56.6		10.7	0	0.10	0	348	slightly cloudy, dry	
3/27/03	1:31 PM	5.82	16.4	60.1		9.6	0	0.11	0	345	sunny, dry, cloud patches	
4/3/03	10:10 AM	5.65	14.9	137.0		7.2	0	0.1	0	339	sunny, wet, cloud patches	
4/10/03	10:07 AM	5.82	16.9	173.0		9.0	0	0.11	0	331	gray overcast, damp	
4/17/03	7:49 AM	5.66	17.9	97.2		9.3	0	0.12	0	400	light overcast, dry	
4/24/03	1:30 PM	5.63	10.5	190.0		8.9	0	0.07	0	392	overcast, damp	
5/1/03	12:46 PM	5.89	18.9	103.0		12.1	0	0.12	0	355	sunny, clear	
5/8/03	2:30 PM	7.53	18.9	170.0		9.8	0	0.12	0	205	slightly cloudy, dry	
5/15/03	8:45 AM	6.55	18.5	133.0		8.9	0	0.12	0	313	light overcast, dry	
5/22/03	8:15 AM	6.06	19.6	71.1		11.9	0	0.13	0	353	light overcast, dry	
5/31/03	1:33 PM	6.48	19.6	124.0		12.6	0	0.13	0	339	sunny, dry	
6/5/03	12:46 PM	6.44	19.8	157.0		14.3	0	0.13	0	275	sunny, dry	
6/12/03	2:08 PM	6.93	20.9	40.1		21.3	0	0.14	0	225	sunny, dry	
6/20/03	7:19 AM	6.39	19.0	133.0		11.1	0	0.12	0	185	light overcast, drizzly	
6/26/03	8:05 AM	6.35	20.4	121.0		12.4	0	0.13	0	295	sunny, dry	
7/3/03	7:43 AM	6.03	20.7	113.0		11.4	0	0.13	0	307	sunny, dry	
7/11/03	9:31 AM	7.48	20.8	115.0		14.2	0	0.13	0	226	sunny, dry	
7/17/03	11:07 AM	7.23	20.7	128.0		14.3	0	0.13	0	251	sunny, dry	
7/25/03	1:54 PM	6.83	21.1	109.0		15.4	0	0.14	0	278	sunny, dry	
8/4/03	9:21 AM	6.86	21.4	114.0		14.0	0	0.14	0	290	sunny, dry	
8/7/03	9:47 AM	6.43	21.3	166.0		14.1	0	0.14	0	336	sunny, dry	
8/14/03	8:36 AM	6.51	21.7	174.0		13.3	0	0.14	0	146	sunny, dry	

City of Woodinville
Woodin Creek at NE 171st Pl Water Quality Data

Date	Time	pH	Conductivity	Turbidity	DO	Temp. (*C)	Salinity	Total Dissolved Solids (mg/l)	Specific Gravity	Oxidation Reduction Potential	Weather Conditions	Comments
8/21/03	1:19 PM	6.41	21.7	185.0		15.7	0	0.14	0	315	sunny, dry	
8/29/03	9:15 AM	6.97	21.7	166.0		13.6	0	0.14	0	307	sunny, dry	
9/4/03	11:39 AM	5.27	21.6	84.5	9.9	15.9	0	0.14	0	285	sunny, dry	
9/11/03	1:35 PM	6.12	19.7	372.0	7.9	14.2	0	0.13	0	321	gray, light rain	
9/19/03	11:34 AM	5.93	19.5	120.0	9.4	13.1	0	0.13	0	376	sunny, dry	
9/26/03	10:58 PM	6.24	21.1	89.1	8.1	12.8	0	0.14	0	357	sunny, dry	
10/2/03	3:22 PM	5.85	21.4	85.8	7.6	13.2	0	0.14	0	354	slight overcast, low light, dry	
10/16/03	3:39 PM	5.73	17.0	101.0	7.3	12.0	0	0.11	0	335	slight overcast, low light, dry	heavy sedimentation
10/30/03	4:08 PM	6.50	20.2	148.0	7.7	8.2	0	0.13	0	402	slight overcast, low light, dry	

City of Woodinville
Woodin Creek at Park Water Quality Data

Date	Time	pH	Conductivity	Turbidity	DO	Temp. (*C)	Salinity	Total Dissolved Solids (mg/l)	Specific Gravity	Oxidation Reduction Potential	Weather Conditions	Comments
1/16/03	2:45 PM	5.8	18.4	64.6		7.4	0	1.20	0	232		
1/23/03		6.7	15.0	20.7		8.8	0	0.10	0	180		
1/30/03	12:00 PM	7.0	17.3	22.8		9.3	0	0.11	0	165		
2/6/03	12:20 PM	6.7	18.5	48.6		6.0	0	0.12	0	169	overcast, dry	
2/13/03	11:15 AM	7.2	18.3	22.3		6.1	0	0.12	0	148	sunny, dry	
2/20/03	2:55 PM	6.6	9.8	46.8		8.5	0	0.06	0	186	gray, drizzly	
2/27/03	1:16 PM	7.4	18.2	57.9		8.4	0	0.12	0	245	sunny, dry	
3/6/03	11:19 AM	6.1	18.3	91.9		7.2	0	0.12	0	308	sunny, dry	
3/13/03	9:27 AM	6.63	6.3	37.5		9.6	0	0.04	0	190	gray, rainy	
3/20/03	3:40 PM	7.53	15.0	42.4		11.4	0	0.10	0	216	slightly cloudy, dry	
3/27/03	3:01 PM	7.61	17.0	54.0		11.9	0	0.11	0	202	sunny, dry, cloud patches	
4/3/03	12:10 PM	7.04	15.1	54.5		9.4	0	0.10	0	208	sunny, damp, cloud patches	
4/10/03	11:38 AM	7.17	17.1	49.4		10.2	0	0.11	0	184	overcast, damp	
4/17/03	9:20 AM	6.76	17.7	60.8		10.1	0	0.12	0	195	light overcast, dry	
4/24/03	3:17 PM	6.44	9.9	108.0		10.0	0	0.06	0	236	overcast, damp	
5/1/03	2:21 PM	7.63	18.3	98.1		14.2	0	0.12	0	164	sunny, clear	
5/8/03	11:24 AM	7.41	18.4	53.4		10.4	0	0.12	0	180	light overcast, dry	
5/15/03	10:09 AM	7.17	16.6	74.9		10.7	0	0.11	0	166	light overcast, dry	
5/22/03	10:02 AM	6.98	18.5	55.3		12.5	0	0.12	0	215	light overcast, dry	
5/31/03	3:50 PM	7.34	18.7	107.0		15.3	0	0.12	0	190	sunny, dry	
6/5/03	2:45 PM	7.33	19.3	93.1		16.7	0	0.13	0	179	sunny, dry	
6/12/03	2:15 PM	7.46	19.0	60.1		14.6	0	0.12	0	240	sunny, dry	
6/20/03	8:50 AM	6.89	12.4	91.4		13.3	0	0.08	0	281	light overcast, drizzly	
6/26/03	12:18 PM	6.86	19.5	91.8		15.6	0	0.13	0	288	sunny, dry	
7/3/03	9:00 AM	7.08	16.7	92.4		15.1	0	0.11	0	191	sunny, dry	
7/11/03	9:21 AM	7.37	19.4	61.5		15.8	0	0.13	0	225	sunny, dry	
7/17/03	10:49 AM	7.23	19.3	142.0		15.3	0	0.13	0	246	sunny, dry	
7/25/03	3:47 PM	7.37	19.4	106.0		18.0	0	0.13	0	248	sunny, dry	
8/4/03	10:45 AM	7.09	19.5	96.0		15.9	0	0.13	0	302	sunny, dry	

City of Woodinville
Woodin Creek at Park Water Quality Data

Date	Time	pH	Conductivity	Turbidity	DO	Temp. (*C)	Salinity	Total Dissolved Solids (mg/l)	Specific Gravity	Oxidation Reduction Potential	Weather Conditions	Comments
8/7/03	12:47 PM	6.97	19.8	137.0		16.8	0	0.13	0	273	sunny, dry	
8/14/03	10:10 AM	7.37	19.7	168.0		15.4	0	0.13	0	270	sunny, dry	
8/21/03	3:01 PM	7.00	19.5	272.0		17.7	0	0.13	0	279	sunny, dry	
8/29/03	11:06 AM	7.12	19.6	190.0		15.9	0	0.13	0	283	sunny, dry	
9/4/03	1:26 PM	6.28	19.7	127.0	7.3	17.7	0	0.13	0	248	sunny, dry	
9/11/03	3:33 PM	6.61	17.7	103.0	7.4	14.5	0	0.12	0	278	sunny, dry	
9/22/03	10:07 AM	6.73	20.4	109.0	6.9	13.0	0	0.13	0	298	sunny, dry	
9/27/03	2:05 PM	6.87	20.4	168.0	7.3	15.7	0	0.13	0	284	sunny, dry	
10/2/03	5:16 PM	6.68	20.2	48.0	6.7	14.7	0	0.13	0	312	slight overcast, dark, dry	
10/16/03	5:36 PM	6.14	13.6	69.8	7.7	13.5	0	0.09	0	319	slight overcast, dark, dry	Sedimentation on stream
10/30/03	5:34 PM	7.00	19.5	51.9	7.7	10.0	0	0.13	0	319	slight overcast, dark, dry	bottom with light debris strewn along stream bottom

Project: **Woodin Creek Water Quality Monitoring (Project #23007)**

Monitor: **Deron Lozano; Adolfson Associates, Inc.**

Date: **May 30, 2003**

Weather: **Sunny with scattered clouds**

Table 1. Woodin Creek Water Quality Monitoring Results

Site / Location	Sample Time	Water Quality Parameters				
		Dissolved Oxygen (mg/l)	Turbidity (Nephelometric Turbidity Units (NTUs))	pH	Conductivity (µS/cm)	Temp. (°C)*
Site 1 Sammamish River Regional Park	9:53 a.m.	10.52	1.50	7.2	298	13.5
Site 2 Immediately west of 140th Ave. NE	10:30 a.m.	10.33	2.32	7.1	235	13
Site 3 NE Woodinville-Duvall Rd/178th Way NE intersection	10:58 a.m.	10.93	4.65	7.1	255	12
Site 4 NE 171st St./143rd Pl NE intersection	11:28 a.m.	10.80	2.98	7.1	286	13.5

*Temperature loggers were placed at each of the four sampling sites during the May 30 site visit. Data was retrieved from the temperature loggers on June 6, 2003. A graphical representation of the temperature in Woodin Creek and presented in the attached table.

Project: Woodin **Creek Water Quality Monitoring (Project #23007)**

Monitor: Deron Lozano; Adolfson Associates, Inc.

Date: August 29, **2003**

Weather: Sunny / **Clear**

Table 1. Woodin Creek Water Quality Monitoring Results

Site / Location	Sample Time	Water Quality Parameters				
		Dissolved Oxygen (mg/l)	Turbidity (Nephelometric Turbidity Units (NTUs))	pH	Conductivity (µS/cm)	Temp. (°C)*
Site 1 Sammamish River Regional Park	8:53 a.m.	5.91	3.35	7.4	269	15
Site 2 Immediately west of 140th Ave. NE	9:17 a.m.	4.97	4.34	6.9	277	15
Site 3 NE Woodinville-Duvall Rd/178th Way NE intersection	9:32 a.m.	5.51	5.42	7.1	244	12.5
Site 4 NE 171st St./143rd Pl NE intersection	9:49 a.m.	9.58	4.93	7.1	302	13.5

*Temperature data was retrieved from the temperature loggers placed within the stream sites June 6, 2003 and is included in the attached table.

Project: **Woodin Creek Water Quality Monitoring (Project #23007)**

Monitor: **Deron Lozano; Adolfson Associates, Inc.**

Date: **October 31, 2003**

Weather: **Sunny / Clear**

Table 1. Woodin Creek Water Quality Monitoring Results

Site / Location	Sample Time	Water Quality Parameters				
		Dissolved Oxygen (mg/l)	Turbidity (Nephelometric Turbidity Units (NTUs))	pH	Conductivity (µS/cm)	Temp. (°C)
Site 1 Sammamish River Regional Park	11:04 a.m.	12.04	3.30	7.2	228	6.5
Site 2 Immediately west of 140th Ave. NE	11:43 a.m.	11.72	3.52	7.1	277	8
Site 3 NE Woodinville-Duvall Rd/178th Way NE intersection	12:15 p.m.	11.88	2.64	7.1	241	6.5
Site 4 NE 171st St./143rd Pl NE intersection	12:00 p.m.	12.06	3.05	7.2	219	6.5

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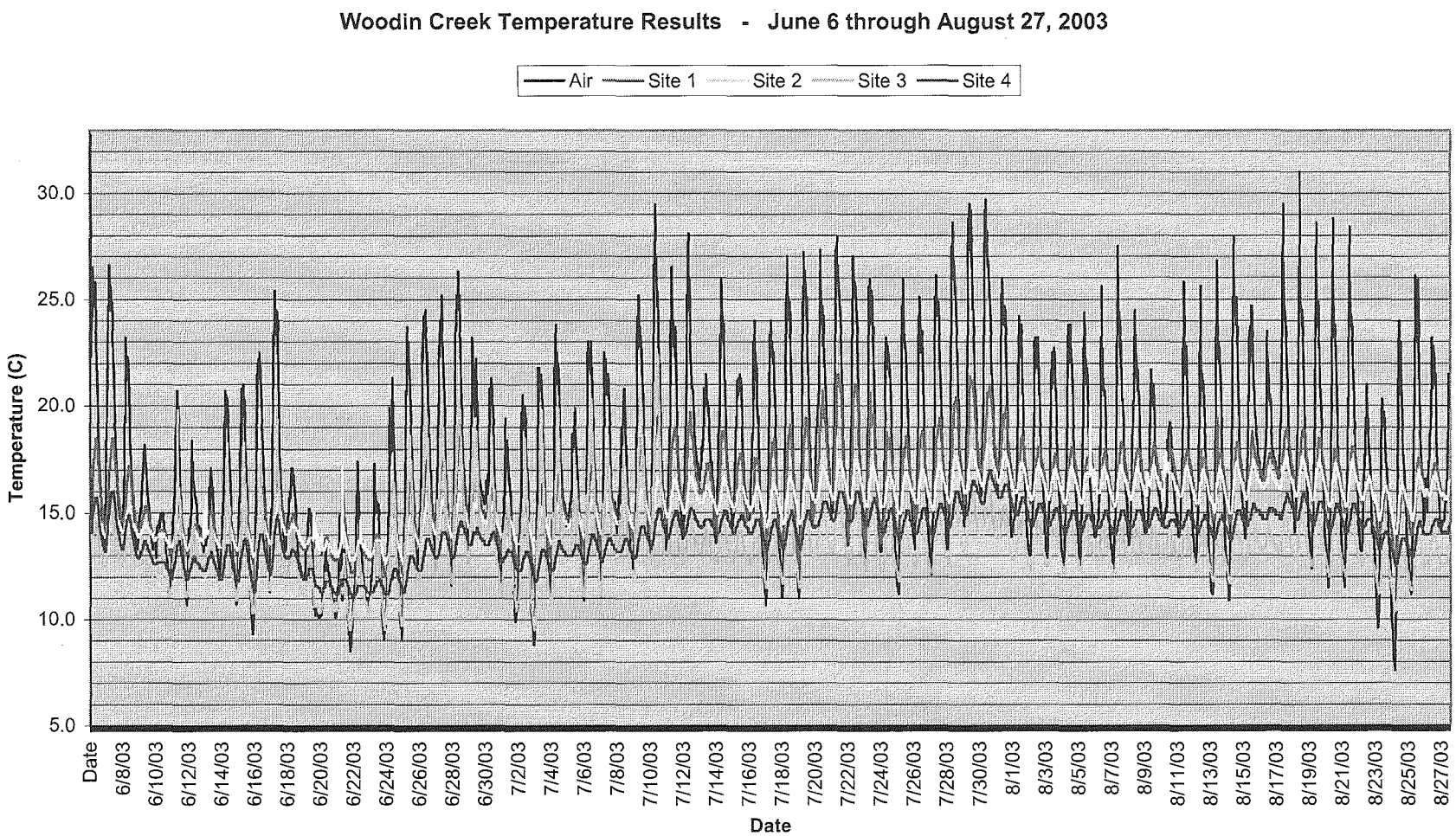
Woodin Creek Temperature Results - June 6 through August 27, 2003
Air
Site 1
Site 2
Site 3
Site 4
Temperature (C)
30.0
25.0
20.0
15.0
10.0
5.0
Date
6/8/03
6/10/03
6/12/03
6/14/03
6/16/03
6/18/03
6/20/03
6/22/03
6/24/03
6/26/03
6/28/03
6/30/03
7/2/03
7/4/03
7/6/03
7/8/03
7/10/03
7/12/03
7/14/03
7/16/03
7/18/03
7/20/03
7/22/03
7/24/03
7/26/03
7/28/03
7/30/03
8/1/03
8/3/03
8/5/03
8/7/03
8/9/03
8/11/03
8/13/03
8/15/03
8/17/03
8/19/03
8/21/03
8/23/03
8/25/03
8/27/03
Date

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APPENDIX B: STREAM SURVEY DATA SHEETS

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Habiat Inventory Summary

Woodin Creek - Reach 1

Reference Number (RF)	Stream Stationing	Habitat (HT)	Width (W)	Depth (D)	Length (L)	Channel Width (CW)	Channel Depth (CD)	Primary Substrate (SBST)	Secondary Substrate (SBST)
1	00+18	22	10	10	18	12	22	3	6
2	00+41	2	6	3	23	6	15	6	3
3	00+59	24	6	8	18	8	20	3	2
4	00+99	14	7	10	40	8	28	2	3
5	01+31	16	6	5	32	8	23	4	3
6	01+51	22	8	12	20	8	3	3	6
7	01+72	22	10	15	21	12	27	5	3
8	01+91	1	4	2	19	7	14	4	3
9	02+15	17	12	13	24	15	25	3	6
10	03+30	1	4	2	115	8	23	4	3
11	04+03	14	4	8	73	6	32	3	4
12	04+55	1	4	3	52	4	27	4	3
13	04+90	14	4	6	35	4	30	4	3
14	05+20	17	15	8	30	20	32	3	4
15	07+79	14	5	3	259	8	21	3	3
16	08+64	23	5		85				
17	09+25	1	5	4	61	6	19	3	4
18	09+61	14	5	5	36	6	26	3	4
19	09+75	17	5	8	14	10	26	3	4
20	10+00	1	4	2	25	6	14	4	3
21	10+16	17	4	6	16	6	21	4	3
22	10+32	1	4	3	16	6	15	4	3
23	10+60	22	6	8	28	8	23	4	3
24	10+91	1	4	3	31	6	27	3	3
25	11+36	23	5		45				
26	11+46	9	5	4	10	10	12	4	5
27	13+04	1	3	6	158	4	30	4	3
28	13+65	14	3	6	61	5	30	4	3
29	14+88	1	3	6	123	4	30	4	3
30	15+07	22	3	8	19	4	30	4	3
31	15+17	9	4	6	10	4	30	3	4
32	15+70	1	5	3	53	7	15	3	3
33	15+91	17	3	10	21	4	21	3	3
34	16+39	14	3	6	48	4	20	3	4
35	16+62	1	4	2	23	6	14	4	3
36	16+77	9	9	12	15	12	24	3	6
37	16+83	9	10	14	6	10	26	3	6
38	16+94	24	5	10	11	6	22	3	3
39	17+34	1	6	3	40	7	15	4	3
40	18+57	14	3	4	123	4	12	4	3
41	18+65	9	7	6	8	7	21	4	3
42	18+76	22	4	6	11	4	21	4	3
43	19+18	1	4	3	42	5	18	4	3
44	19+70	14	4	5	52	4	20	4	3
45	19+93	1	4	2	23	5	14	4	3
46	20+01	22	5	8	8	5	20	4	3
47	20−31	14	3	6	30	4	21	4	3
48	20−39	22	5	12	8	7	27	3	4

Woodin Creek - Reach 1

Reference Number (RF)	Stream Stationing	Habitat (HT)	Width (W)	Depth (D)	Length (L)	Channel Width (CW)	Channel Depth (CD)	Primary Substrate (SBST)	Secondary Substrate (SBST)
53	21+54	17	4	12	10	5	24	4	3
54	21+76	1	3	1	22	8	15	4	3
55	21+89	22	6	8	13	6	20	4	6
56	22+47	14	4	6	58	5	18	3	4
57	23+15	1	6	2	68	10	12	3	4
58	23+78	14	5	4	63	7	14	3	4
59	25+43	1	6	2	165	8	14	4	3
60	25+82	23	3		39				
61	26+80	1	4	2	98	6	14	4	5
62	27+22	23	3		42				
63	27+79	2	4	3	57	5	27	6	4
64	28+02	9	6	18	23	6	54	3	4
65	28+39	14	4	4	37	5	19	4	3
66	29+04	1	4	3	65	5	18	4	4
67	29+69	1	4	3	65	5	15	4	4
68	29+80	22	8	6	11	12	24	3	4
69	30+33	1	5	2	53	7	17	4	3
70	30+58	17	6	8	25	9	23	4	3
71	32+27	1	6	8	169	9	23	4	3
72	32+52	23	5		25				
73	33+17	1	6	2	65	12	14	5	4
74	33+27	22	5	6	10	12	18	5	4
75	35+19	1	5	2	192	10	14	4	5
76		23							

WOODIN CREEK

WRIA Basin # 8 Basin # Reach 1 Date 05/13/03 Time 10:00 am

Stream # Stream Order: Survey Length (RM) to 2:30 pm

Weather Conditions Sunny

Investigators Beau Burke, Alex Gittell

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
Restor. Identify	1	22	10'	21" max 10" Avg	18'	12"	22"	3	25	M	3	25	M	3/6		NONE					
	75 Acmon Parr/P-Mouth/Stk																				
	2	22	6'	3"	23'	6"	15"	3	25	M	3	25	M	Ang. Riprap							
	Sculpin													6/3							
	Redd under Footbridge Remove Ang/Riprap																				
	3	24	6'	8"	18'	8'	20"	3	25	M	3	50	M	3/2		None					
				13" max Depth																	
	4	14	7'	10"	40'	8'	28"	3	25	M	3	50	M	2/3		NO					
*	5	16	6'	5"	32'	8'	23"	3	25	M	3	50	M	4/3		30' Installed	18"	A	C	O/R	L
																12'	15"	A	C	O	W/F
																12'	10"	A	C	O/R	L
	6	22	18'	12" 21" max	20'	8'	3	3	25	M	3	50	M	3/6	High	10'	18"	A	C	O	B/P
	Juv. Cutthroat															8'	15"	A	C	O	B/P
																10'	15"	A	C	O	B/P
																4'	15"	A	C	O	L
	7	22	10'	15" 24"	21'	12'	27'	3	25	M	3	50	M	5/3	High						
	P-MT H/MIN/Coho Juv ?																				
	CP (Corner Pool) include small gravel tailout										up to 10(+)					10'	10"	A	C	O	L
																10'	15"	A	C	O	B/P
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM
CD=Avg Channel Depth from OHWM L=Length of Habitat Type *(All Depths <> 5 measurements)*

SS=Streamside Structure *Options:* 0=No Riparian (Note Lawn, Road, Building, etc.) 1=Mature Complex Forest
2=Immature/Even-aged/Disturbed Forest 3=Shrub Dominated (Less than 20') 4=Grassland/Meadow/Pasture 5= Wetland
LB=Left Bank RB=Right Bank W=Width TY=Riparian Type *Options:* C=Coniferous D=Deciduous M=Mixed

SBST=Substrate (Dominant/Subdominant) *Options:* 1=Bedrock 2=Silt/Organic 3=Sand 4=Small Gravel (<25 mm)
5=Large Gravel (25 mm-100 mm) 6=Cobble (100mm-256mm) 7=Boulder (*Note Dominant and Subdominant* [Dom/Sub])

PQI=Pool Quality Index Value *(For all Pools, Record Maximum Depth and Cover)*

LWD=Large Woody Debris LE=Length DI=Mean Diameter ST=Stability *Options:* A=Anchored U=Unancored ?=Unknown
V=Variety *Options:* C=Coniferous D=Deciduous ?=Uncertain
CN=Conditions *Options:* S=Solid [Subtype (R)ecent/(O)ld] M=Moderate [Subtype (R)ecent/(O)ld]
R=Rotted [Subtype (R)ecent/(O)ld] TY=Type *Options:* J=Log Jam F=Floating Log S=Stranded Log
B=Bridge Log [Subtype (C)ollapsed/(P)artial] L= Lateral Log W=Weir [Subtype (F)ull/(P)artial]

* HABITAT RESTORATION AREA

WRIA Basin # 8 WOOLUM CREEK Basin # Reach 1 Date 5/13/03 Time 10:00am

Stream # Stream Order: Survey Length (RM) to 2:30pm

Weather Conditions SUNNY

Investigators Ben Burke & ALEX BITTAY

CH6 50' RP DANKS TO OTHER CREW

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
*	8	1	4'	2"	19'	7'	14"	3	25	M	3	50	M	4/3		8'	12"	A	C	S/O	W
*	9	17	12'	13"	24'	15'	25"	3	25	M	3	25	M	3/6		18'	24"	A	C	S/O	B/C
			MAX 21"											(ANG) rock							
	10	1	4'	2"		8'	23"	3	100'	M	3	50	M	4/3							
								ROND-													
								1	NO OUTLET		TO CRK										
	11	14	4'	8"		6'	32"	3	100'	D	3	25	D	3/4							
	12	11	4'	3"	52	4'	27"	3	100'	D	3	25	D	4/3							
	13	14	4'	6"	35	4'	38	3	100'	D	3	30	D	4/3							
	14	19	15'	8"	30'	20'	32"	3	100'	D	3	25	D	3/4	1'6"						
			MAX 18"																		
	TOP OF HABITAT OLD Beaver Dam/Beaver blockage under															LOW FLOW					
	TRAPPING SUBSTRATE/SAND															75%					
	15	14	5'	3"	259'	8'	21"	3	25	D	3	25	D	3/3							
	8" Cut & 5" Cut										(PARK/LAWN										
	Juvenile Cut Hight																				
	16	23			85'																
	DIAMETER 60" Pipe ARCH - PASSABLE - Stewed ANGLE															under					
	17	1	5'	4"	61	6'	19'	D-ROAD			3	100	D	3/4							
											Restoration										
	18	14	5'	5"	56'	6'	20"	3	10	D	3	75	D	3/4							
	19	17	5'	8"	14'	10'	26"	3	10	D'	3	100'	D	3/4	LOW						
			MAX 13"																		
	20	1	4'	2"	25'	6'	14"	3	<25	D	3	>100	D	4/3							
	21	17	4'	6"	16'	6'	21"	3	<25	D	3	>100	D	4/3							
			MAX 9"																		
	22	1	4'	3"	16'	6'	15"	3	<25	D	3	>100	D	4/3							
	23	22	6'	8"	38'	8'	23'	O-ROAD			3	100	D	4/3	1'6"	30'	18"	A	C	S/O	L
			MAX 21"																		
	24	1	4'	3"	31'	6'	27"	O-ROAD			3	100	D	3/3		(Juvenile Cutthroat)					
	25	23	- Get Length from CAD & WIDTH													12'	12"	A	C	S/O	W
	26	9	5'	4"	10'	10'	12"	O-ROAD			3	100	D	4/5							
			MAX 10"																		
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM
CD=Avg Channel Depth from OHWM L=Length of Habitat Type *(All Depths <> 5 measurements)*

SS=Streamside Structure *Options:* 0=No Riparian (Note Lawn, Road, Building, etc.) 1=Mature Complex Forest
2=Immature/Even-aged/Disturbed Forest 3=Shrub Dominated (Less than 20') 4=Grassland/Meadow/Pasture 5= Wetland
LB=Left Bank RB=Right Bank W=Width TY=Riparian Type *Options:* C=Coniferous D=Deciduous M=Mixed

SBST=Substrate (Dominant/Subdominant) *Options:* 1=Bedrock 2=Silt/Organic 3=Sand 4=Small Gravel (<25 mm)
5=Large Gravel (25 mm-100 mm) 6=Cobble (100mm-256mm) 7=Boulder *(Note Dominant and Subdominant (Dom/Sub))*

PQI=Pool Quality Index Value *(For all Pools, Record Maximum Depth and Cover)*

LWD=Large Woody Debris LE=Length DI=Mean Diameter ST=Stability *Options:* A=Anchored U=Unancored ?=Unknown
V=Variety *Options:* C=Coniferous D=Deciduous ?=Uncertain
CN=Conditions *Options:* S=Solid [Subtype (R)ecent/(O)ld] M=Moderate [Subtype (R)ecent/(O)ld]
R=Rotted [Subtype (R)ecent/(O)ld] TY=Type *Options:* J=Log Jam F=Floating Log S=Stranded Log
B=Bridge Log [Subtype (C)ollapsed/(P)artial] L= Lateral Log W=Weir [Subtype (F)ull/(P)artial]

WRIA Basin # 8 Basin # Reach 1 Date 5/13/03 Time _____

Stream # Stream Order: Survey Length (RM) - to ____

Weather Conditions Sunny

Investigators Ben Burke & Alex Otley

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
1	27	1	3'	6"	158'	4'	30"	0-ROAD			3	25	D	4/3		4'	18"	A	C	S/O	W
2			Juvenile Cut																		
3	28	14	3'	6"	161'	5'	30"	0-ROAD			3	30	D	4/3							
4			Juvenile Cut																		
5	29	11	3'	6"	123'	4'	30"	3	25	M	3	25	M	4/3		30'	10"	A	C	S/O	L
6	30	22	3'	8"	19'	4'	30"	0-ROAD						4/3	HIGH						
7				15" MAX																	
8	31	9	4'	6"	10'	4'	30"	3	15	M	3	30	M	3/4	HIGH	8	20"	A	C	S/O	W
9				MAX 12"																	
10	32	11	5'	3"	53'	7'	15"	3	20	M	3	25	M	3/3							
11	33	17	3'	10"	21'	4'	21"	0-ROAD						3/3	MOD						
12				MAX 18"																	
13	34	14	3'	6"	48'	4'	20"	0-ROAD			3	10	M	3/4							
14	35	11	4'	2"	23'	6'	14"	3	10	M	3	10	M	4/3							
15	36	9	9'	12"		12'	24"	3	10	M	3	25	M	3/6	MOD	6'	18"	A	C	S/O	W
16		LAMPREY/Juvenile CUT														12'	20"	A	C	S/O	W
17				MAX 21"												~~12'~~	~~20"~~	~~A~~	~~C~~	~~S/O~~	~~W~~
18	37	9	10'	14"	6'	10'	26"	3	5	M	3	50	M	3/6	MOD						
19				MAX 20"																	
20	38	24	5'	10"	11'	6'	22"	0-ROAD			3	50	M	3/3	LOW						
21				MAX 14"																	
22	39	11	6'	3"	40'	7'	15"	55	5	M	3	50	M	4/3							
23	40	14	3'	4"	123'	4'	22"	55	3	M	3	25	M	4/3		ROOT WAD/ANCHORED					
24																					
25																					
26																					
27																					
28																					
29																					
30																					
31																					
32																					
33																					
34																					
35																					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM
CD=Avg Channel Depth from OHWM L=Length of Habitat Type *(All Depths <> 5 measurements)*

SS=Streamside Structure *Options:* 0=No Riparian (Note Lawn, Road, Building, etc.) 1=Mature Complex Forest
2=Immature/Even-aged/Disturbed Forest 3=Shrub Dominated (Less than 20') 4=Grassland/Meadow/Pasture 5= Wetland
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LWD=Large Woody Debris LE=Length DI=Mean Diameter ST=Stability *Options:* A=Anchored U=Unancored ?=Unknown
V=Variety *Options:* C=Coniferous D=Deciduous ?=Uncertain
CN=Conditions *Options:* S=Solid [Subtype (R)ecent/(O)ld] M=Moderate [Subtype (R)ecent/(O)ld]
R=Rotted [Subtype (R)ecent/(O)ld] TY=Type *Options:* J=Log Jam F=Floating Log S=Stranded Log
B=Bridge Log [Subtype (C)ollapsed/(P)artial] L= Lateral Log W=Weir [Subtype (F)ull/(P)artial]

Sheet 2

WRIA Basin # 8 Basin # Reach 1 Date 5/29/03 Time 8:45 am

Stream # Stream Order: Survey Length (RM) to 11:00 am

Weather Conditions Sunny

Investigators ALEX & BENN

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
1	41	9	7'	6" 18"	8	7	21"	0	25	M	3	25	M	4/3	MOD	8'	20"	A	C	S/D	W/F
2	SMALL JUV. SALMONIDS										3				COVER						
3	42	22	4	6"	11	4	+15"	0	25	M	3	25	M	4/3	LOW						
4				9"										4	COVER						
5	43	1	4'	3"	42'	5'	+15"	0	5	M	3	25	M	4/3							
6	44	14	4'	5"	52'	4'	+15"	0	25	M	3	40	M	4/3							
7	45	1	4'	2"	23'	5'	+12"	3	10	M	3	50	M	4/3							
8	46	22	5'	8"	8	5	+12"	0		M	3	50	M	4/3	HIGH						
9				15"											COVER						
10	47	14	3'	6"	30'	4'	+15"	0		M	3	50	M	4/3							
11	48	22	5'	12"	8'	7'	+15"	0		M	3	50	M	3/4	MOD						
12				18"											COVER						
13	49	14	4'	6'	31'	5'	+15"	0		M	3	30	D	3/4							
14	50	1	3'	3'	41'	6	+12"	0		M	3	25	M	4/3							
15	Number of small JUV. SALMONIDS																				
16	51	22	4'	8"	9'	5'	+15"	0		M	3	60	M	3/4	LOW						
17				15"				Next to							COVER						
18								sidewalk													
19	52	1	6'	1"	24'	8'	+12"	3	5	M	3	75	M	4/3							
20	JUV. SALMONIDS																				
21	53	17	4"	12"	9'	5'	+12"	3	10	M	3	60	M	4/3	LOW						+
22				15"											COVER						
23	54	1	3	1	22'	8	+12	3	25	M	3	25	M	4/3							
24	JUV SALMONIDS																				
25	55	28	6	8	13'	6	+12							4/6	LOW	JUV. SALMONIDS					
26				10										AVG RB	COVER						
27	56	14	4	6	58	5	+12	3	5	M	0			3/4							
28	JUV SALMONIDS & COHO IDENTIFIED																				
29	57	1	6	2"	68	10	+10"	9	15	M	0			3/4							
30	POND ENTERS @ secondary channel / PHOTO @ 68 FT 2/3 PHOTOS																				
31	58	14	5'	4"	63	7	+10"	0			0			3/4	ENTERED MOBILE HOME AREA						
32	59	1	6	2"	165	8	+12	0			0			4/3							
33	60	23			39																
34	61	1	4	2	98	6	+12	0			0			4/5							
35	JUV SALMONIDS SPOTTED																				
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

8 14 10 58

PHOTOS

HGTGS BENN

10 PHOTOS

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM

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CN=Conditions *Options:* S=Solid [Subtype (R)ecent/(O)ld] M=Moderate [Subtype (R)ecent/(O)ld] R=Rotted [Subtype (R)ecent/(O)ld] TY=Type *Options:* J=Log Jam F=Floating Log S=Stranded Log B=Bridge Log [Subtype (C)ollapsed/(P)artial] L=Lateral Log W=Weir [Subtype (F)ull/(P)artial]

WATER ENTERS POND FROM unknown origin culvert @ 63 of 58

WRIA Basin # 8 Basin # Reach 1 Date 5/29/03 Time 8:45

Stream # Stream Order: Survey Length (RM) to 1.108

Weather Conditions SUNNY & CLEAR

Investigators ALEX OTTLEY & BENN BURKE

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
+10 1	62	23			42'			0			0					NEW					
32 2	63	2	4	3	57'	5	+24"	3	-25	m	3	.25	M	6/4							
3	6							LANDSCAPED						AND RR							
4	64	9	6	18"	23	6	+36"	0			0			3/4							
5				27"	MANY	JUVEN		ILE	&	ADULT											
6	Rock	@	base	of	Plunge			which	may	be	fish	passage		barrier	/ PHOTO						
7	65	14	4	4	37'	5	+15	0			0			4/3							
8	66	1	4	3	65'	5	+15	0			0			4/4	STOPPED	@	FENCE				
9	67	1	4	3	65'	5	+15	3	50	D	3	50	D	4/4							
10	68	22	81	6"	11	12'	+18	3	50	D	3	35	D	3/4	MODERATE						
11				10"	LOTS	OF	JUV.	SALMONIDS							COVER						
12	69	1	5	2"	53	7	+15	3	50	D	3	50	D	4/3							
13	70	17	6	8"	25	9		3	50	D	3	50	D	4/3	HIGH						
14				15"											COVER						
15	71	1	6	8	169	9	+15	3	50	D	3	50	D	4/3							
16	72	23			25				CULVERT		under	McDONALD'S		DRIVE							
17	73	1	6	2	65	12	+12	3	50	D	3	100	D	5/4							
18	ADJACENT			70	MCDONALD'S			[illegible]		D	—		D								
19	74	22	5	6	10	12	+12	3	50	D	3	100	D	5/4	MODERATE						
20				12																	
145 21	75	1	5	2	192	10	+12	3	100	D	3	75	D	4/5							
22	76	23		PIPED	SECTION			UNDER			WOODINVILLE			MALL							
23																					
24																					
25																					
26																					
27																					
28																					
29																					
30																					
31																					
32																					
33																					
34																					
35																					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

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Habiat Inventory Summary

Woodin Creek - Reach 3

Reference Number (RF)	Stream Stationing	Habitat (HT)	Width (W)	Depth (D)	Length (L)	Channel Width (CW)	Channel Depth (CD)	Primary Substrate (SBST)	Secondary Substrate (SBST)
78	00+08	1	4	2	8	4	24	4	6
79	00+12	7	6	2	4	9	36	3	4
80	00+34	1	3	3	22	6	24	4	3
81	00+40	9	7	2	6	7	48	3	3
82	01+58	1	3	1	118	10	60	3	4
83	01+61	7	5	4	3	9	72	3	3
84	01+97	1	7	1	36	7	48	3	4
85	02+02	9	5	10	5	7	60	3	3
86	02+82	1	4	1	80	15	48	4	3
87	03+32	2	3	1	50	10	48	4	3
88	04+27	1	3	1	95	18	60	5	3
89	04+32	9	2	2	5	18	72	3	3
90	05+97	1	4	2	165	20	84	5	3
91	06+27	1	7	1	30	30	84	3	4
92	06+65	1	3	1	38	10	12	5	3
93	06+68	9	4	3	3	20	24	3	3
94	08+24	1	3	1	156	15	36	3	4
95	08+26	17	4	8	2	15	36	3	3
96	09+96	1	3	1	170	10	36	3	5
97	09+99	9	3	2	3	6	24	3	4
98	13+49	1	3	1	350	10	48	4	5
99	13+75	1	3	1	26	20	6	5	4
100	13+78	13	4	5	3	10	8	3	4
101	14+21	1	3	1	43	6	16	5	4
102	14+25	13	3	4	4	5	10	3	5
103	15+58	1	3	1	133	10	10	3	4
104	15+68	3	4	1	10	4	24	3	3
105	15+85	1	4	1	17	6	24	3	4
106	15+91	9	3	10	6	5	26	3	4
107	16+84	1	4	1	93	4	20	5	3
108	16+88	13	6	6	4	6	26	3	5
109	17+15	1	4	1	27	5	12	4	5
110	17+21	13	8	4	6	8	18	2	2
111	19+53	1	3	1	232	5	28	4	5

WOODIN CREEK - UPPER REACH

WRIA Basin # _____ Basin # Reach 3 Date 6/5/03 Time 8:25

Stream # Stream Order: Survey Length (RM) to 10.30

Weather Conditions Sunny & Clear

Investigators ALEX O & LINDA K

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
1	77	23																			
2	78	1	4'	2"	8'	4'	2'	4	10	-	4	10	-	4/6	-						
3	79	7	6'	2"	4'	9'	3'	2	20	D	3	15	D	3/4	low	small log jam - limbs - longest piece 3'					
4			max- 5"					12" dbh alder													
5	80	1	3	3	22'	6	2	2	20	D	2	25	D	4/3							
6	81	9	7	2"	6'	7'	4'	2	30	D	2	25	D	3/3	mod	7<	6"	A	C	SO	W
7			max 5"					2			2										
8	82	1	3	1"	118'	10'	5'	2	200+	D	2	100	D	3/4		35"	12"	U	C	SO	S
9																8'	10"	U	C	SO	S
10																6'	12"	U	C	SO	S
11																5.5'	12"	U	C	SO	S
12																5'	12"	A	C	SO	S
13	83	7	5'	4"	3'	9'	6"	2	200+	D	2	75'	D	3/3	low	7'	12"	A	C	SO	J
14			max	8"												6'	12"	A	C	SO	J
15	84	1	7	1"	36"	7'	4'	2	300+	D	2	50'	D	3/4							
16	85	9	5'	18"	5'	7'	5'	2	300	D	2	50'	D	3/3	mod	7'	12"	A	C	SO	W
17			max	12"																	
18	86	1	4	1"	80'	15'	4'	2	300'+	D	2	75'	D	4/3		14'	24"	A	C	SO	W
19																	plus smaller debris combined				
20	87	2	3'	1"	50'	10'	4'	2	300'	D	2	75'	D	4/3		6'	12"	U	D	SO	S
21	88	1	3'	1"	95'	18'	5'	2	300'+	D	2	25'	D	5/3		10'	4'	U	C	RO	S
22																14'	10"	A	C	SO	W
23																150'	12"	U	D	SO	S
24																3'	18"	U	C	SO	S
25	89	9	2'	2"	5'	18'	6'	2	300'	D	2	30'	D	3/3	low						
26			max	8"																	
27	90	1	4'	2"	165'	20'	7'	2	300+	D	2	50'	D	5/3		150'	10"	U	D	SR	B
28																6'	16"	U	D	SO	S
29																20'	10"	U	D	RO	C
30	91	1	7'	1"	30'	30'	7'	2	300	D	2	75'	D	3/4		10'	22"	U	U	RO	S
31																16'	24"	U	U	RO	S
32	92	1	3'	1"	38'	10'	12"	2	300'	D	2	75'	D	5/3		Large cedar root - stump					
33																200'	26"	A	D	RO	B old growth
34	93	9	4'	3"	31'	20'	2'	2	300	D	2	80'	D	3/3	mod	150'	10"	A	U	RO	U
35			max	8"																	
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

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B=Bridge Log [Subtype (C)ollapsed/(P)artial] L= Lateral Log W=Weir [Subtype (F)ull/(P)artial]

hedge w/ road

same tree

three footbridges

WOODEN [illegible]

WRIA Basin # _____ Basin # Reach 4/3 Date 6-5-03 Time 10:30

Stream # Stream Order: Survey Length (RM) to ____

Weather Conditions 70°F, sunny

Investigators LK, AO

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
1	94	1	3'	1"	156'	15'	3'	2	300'	D	2	60'	D	3/4		150'	10"	U	U	SR	B
2									open canopy							11'	22"	U	U	SO	B
3																10'	12"	U	U	RO	S
4																100'	26"	U	U		S
5	95	17	4'	8"	2'	15'	3'	2	300+	D	2	80'	D	3/3	mod	4'	14"	A	U	RO	T
6			max	12"												100'	24"	A	U	RO	B
7	96	1	3'	1"	170'	10'	3'	2	300	D	2	50'	D	3/5		150'	36"	U	C	SR	B
8																20'	30"	U	U	SO	B
9																200	32"	A	C	SR	B
10																20'	36"	A	U	SO	B
11	97	9	3'	2"	3'	6'	2'	2	300'	D	2	70'	D	3/4		4'	12"	A	C	SO	W
12			max	4"												200'	36"	U	C	SO	S
13	98	1	3	<1"	350'	10'	4'	2	300'	D	2	56'	D	4/5		20'	18"	U	U	RO	S
14																75'	24"	A	U	SO	B
15																300'	14"	A	U	RO	L
16																8'	14"	A	C	SO	U
17																8'	12"	A	U	RO	L
18																200+	38"	A	D	SO	B
19																90'	18"	A	U	RO	L
20																7'	12"	U	U	RO	S
21	99	1	3'	<1"	26'	20	6"	2	200'	D	2	50	D	5/4		6'	16"	A	U	RO	L
22	100	13	4'	5"	3'	10'	8"	2	200'	D	2	50'	D	3/4	Low	1'	12"	A	U	RO	Root
23	101	1	3'	max 21"	43'	6'	16"	2	200'	D	2	50	D	5/4		90'	16"	A	U	RO	Root
24	WEI = GPS coordinate; RB Groundwater seep erosion - photo w/stake # 180															40'	10"	A	D	RO	B
25	WEI = GPS coordinate for photo 1204															12'	12"	?	U	RO	L
26	102	13	3'	4'	4'	5'	10"	2	300'	D	2	75'	D	3/5		13'	12"	U	D	RO	L
27	103	1	3'	max 10" 21"	133	10'	10"	2	300'	D	2	56'	D	3/4		10'	18"	U	U	RO	L
28																15'	10"	U	D	RO	B
29																30'	20"	A	C	RO	L
30																50'	18"	A	D	RO	B
31																30'	30"	A	C	RO	B
32																100'	25"	A	C	SR	B
33																150'	30"	A	D	SR	B
34																75'	8"	A	D	SR	B
35																75'	10"	A	D	SR	B
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

knotweed coming in

other gnarly stumps, snags

clearly incised

6/18/03

erosion pt. photo of creek

cowy undercut bank (RB)

log jam

undercut by 2½'

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM

SS=Streamside Structure *Options:* 0=No Riparian (Note Lawn, Road, Building, etc.) 1=Mature Complex Forest 2=Immature/Even-aged/Disturbed Forest 3=Shrub Dominated (Less than 20') 4=Grassland/Meadow/Pasture 5= Wetland

LB=Left Bank RB=Right Bank W=Width TY=Riparian Type *Options:* C=Coniferous D=Deciduous M=Mixed

SBST=Substrate (Dominant/Subdominant) *Options:* 1=Bedrock 2=Silt/Organic 3=Sand 4=Small Gravel (<25 mm) 5=Large Gravel (25 mm-100 mm) 6=Cobble (100mm-256mm) 7=Boulder (*Note Dominant and Subdominant* [Dom/Sub])

PQI=Pool Quality Index Value *(For all Pools, Record Maximum Depth and Cover)*

LWD=Large Woody Debris LE=Length DI=Mean Diameter ST=Stability *Options:* A=Anchored U=Unancored ?=Unknown

V=Variety *Options:* C=Coniferous D=Deciduous ?=Uncertain

CN=Conditions *Options:* S=Solid [Subtype (R)ecent/(O)ld] M=Moderate [Subtype (R)ecent/(O)ld]

R=Rotted [Subtype (R)ecent/(O)ld] TY=Type *Options:* J=Log Jam F=Floating Log S=Stranded Log

B=Bridge Log [Subtype (C)ollapsed/(P)artial] L= Lateral Log W=Weir [Subtype (F)ull/(P)artial]

WRIA Basin # 8 Basin # Reach 3 Date 6/18 Time 10:00

Stream # WOODIN CREEK Stream Order: Survey Length (RM) to

Weather Conditions Overcast 64°

Investigators Steve Krueger & Alex Ottley

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
1	103 cont															100'	10"	A	D	SR	B
2																100'	16"	A	D	SR	B
3																50'	24"	A	C	RO	B
4																30'	12"	A	C	RO	B
5 root system substrate	104	3	4'	<1"	10'	4'	24"	2	300'	D	2	50'	D	3		—	—	—	—	—	—
6	105	1	4'	<1"	17'	1'	24"	2	300'	D	2	50									
7	Left Bank & RB erosion																				
8	106	9	3'	10"	10'	5'	36	2	300'	D	2	75	D	3/4							
9	107	1	4'	max 18" 27"	99'	4'	30"	2	300'	D	2	100	D	5/3		40'	18	A	D	SR	B
10	3' undercut on LB @ 46'															80'	30"	A	D	SR	B
11																10'	12"	A	C	RO	B
12																10'	10"	A	U	RO	B
13																10'	10"	A	U	RO	B
14	108	13	6'	6"	4'	6'	36"	2	300'	D	2	100'	D	3/5	WOD	—	—	—	—	—	—
15	109	1	4' max	11"	27'	5'	12"	2	300'	D	2	200'	D	4/5		50'	8"	A	U	RO	L
16	Island @ 21'					—		—		—	—		—	—	—	50'	30"	A	D	SR	B
17	110	13	8'	4"	10'	8'	18"	2	300	D	2	200	D	2							
18				max 10"																	
19	111	1	3'	<1" to 0	232'	5'	28"	2	300	D	2	50	D	4/5		10'	12"	A	U	RO	L
20	NO Flow up above 110'															50'	8"	A	U	RO	B
21																6'	18"	A	U	RO	W
22	Headwaters																				
23																					
24 Reach 4	Start Reach 4																				
25	112	1	41	2"	135'	4'	24"	2	25'	m	2	100'	m	(3)/4		5'	12"	A	D	MR	W
26	RB erosion problem @ 11' (15 ft)															50'	10"	A	D	SR	B
27	LB Erosion problem @ 43' (20 ft)																				
28	Undercut bank (RB) ~ 3' @ 100', ~10" @ 121'																				
29	113	2	3	1"	27'	3'	24"	2	50'	D	2	150'	D	4/5							
30	LB seep																				
31	GPS Coord for seep R45																				
32	114	1	6'	2"	692'	8'	24"	1	200	M	2	200'	M	4/3		20'	10"	A	U	RO	L
33																5'	10"	A	U	RO	W
34																7'	14"	U	U	RO	F
35															(2)	6'	18	U	U	RO	F
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM

SS=Streamside Structure *Options:* 0=No Riparian (Note Lawn, Road, Building, etc.) 1=Mature Complex Forest 2=Immature/Even-aged/Disturbed Forest 3=Shrub Dominated (Less than 20') 4=Grassland/Meadow/Pasture 5= Wetland

LB=Left Bank RB=Right Bank W=Width TY=Riparian Type *Options:* C=Coniferous D=Deciduous M=Mixed

SBST=Substrate (Dominant/Subdominant) *Options:* 1=Bedrock 2=Silt/Organic 3=Sand 4=Small Gravel (<25 mm) 5=Large Gravel (25 mm-100 mm) 6=Cobble (100mm-256mm) 7=Boulder (*Note Dominant and Subdominant* [Dom/Sub])

PQI=Pool Quality Index Value *(For all Pools, Record Maximum Depth and Cover)*

LWD=Large Woody Debris LE=Length DI=Mean Diameter ST=Stability *Options:* A=Anchored U=Unancored ?=Unknown

V=Variety *Options:* C=Coniferous D=Deciduous ?=Uncertain

CN=Conditions *Options:* S=Solid [Subtype (R)ecent/(O)ld] M=Moderate [Subtype (R)ecent/(O)ld]

R=Rotted [Subtype (R)ecent/(O)ld] TY=Type *Options:* J=Log Jam F=Floating Log S=Stranded Log

B=Bridge Log [Subtype (C)ollapsed/(P)artial] L=Lateral Log W=Weir [Subtype (F)ull/(P)artial]

Habiat Inventory Summary

Woodin Creek - Reach 4

Reference Number (RF)	Stream Stationing	Habitat (HT)	Width (W)	Depth (D)	Length (L)	Channel Width (CW)	Channel Depth (CD)	Primary Substrate (SBST)	Secondary Substrate (SBST)
112	01+25	1	4	2	125	4	24	3	4
113	01+52	2	3	1	27	3	24	4	5
114	08+44	1	6	2	692	8	24	4	3
115	08+50	9	2	3	6	4	6	3	4
116	13+31	1	4	2	481	5	14	4	3

WOODIN CREEK INVENTORY

WRIA Basin # ____ Basin # 8 Date 6/18/03 Time 11:30

Stream # REACH 4 Stream Order: Survey Length (RM) to ____

Weather Conditions Overcast 64°

Investigators Steve Leutzke + Alex Ottley

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
1	114 (cont)	Braided Channel 148'-168'														30'	14"	U	D	MO	F
2		RB Erosion starts @ 428'-443' or (15')														60'	10"	U	D	mo	B
3		LB seep @ 501'; GPS COORD: N452														75'	6"	A	D	RO	B
4																75'	10"	A	D	RO	B
5																5'	10"	A			B Root Wad
6		RB Erosion problem 562'-578 or (16')														100	30"	A	C	mo	B
7		LB seep small @ 595' (NO GPS)														22"	30"	U	U	RO	S
8		LB seep @ 634" (No GPS)														10'	30"	U	U	RO	S
9	115	9	2'	3"	6'	4"	6"	2	200	m	2	200	m	3/4	LOW	5'	10"	A	U	RO	D
10			Max 6"																		
11	116	1	4'	2"	481'	5'	14"	2	200	D	2	200	D	2/3							
12				Caddis Fly & Stonefly larvae observed												100'	10"	A	D	JR	B
13				mayfly adults observed												25"	10"	A	D	Living	B
14																40'	10"	A	D	RO	D
15				seep @ 80' on LB												8'	11"	A	U	RO	B
16				seep @ 101' on LB												60'	28"	A	C	RO	B
17			RB Erosion problem (slide) @ 135'-142' (R4E1 GPS coord)													75'	18"	A	C	RO	B
18			LB " " @ 152'-190' or (38')													75'	24"	A	C	RO	B
19																100'	24"	U	MO	RO	B
20																20'	24	U	C	RO	B
21																50'	36"	A	C	RO	B
22																100'	30"	A	C	RO	B
23																100'	20'	A	C	RO	B
24																20'	24"	A	U	RO	W
25																75'	38"	A	C	RO	B
26																5'	10"	A	U	RO	B
27																8'	12"	U	U	RO	S
28			RB seep @ 251'-292' (41')													100'	36"	A	C	RO	B
29		LB &	RB erosion problem GPS Coord R4E2													50'	30"	A	D	MO	B
30																35'	8"	A	D	RO	B
31																10'	16"	A	U	RO	B
32																25'	12"	A	U	RO	B
33																40'	10"	A	D	MO	B
34														Heavy Undergrowth		60'	10"	A	D	RO	B
35	LB	seep @ 481'; Stop Point GPS coord: Windfalls														20'	20"	A	U	RO	L
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	POI	LE	DI	ST	V	CN	TY

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM

SS=Streamside Structure *Options:* 0=No Riparian (Note Lawn, Road, Building, etc.) 1=Mature Complex Forest 2=Immature/Even-aged/Disturbed Forest 3=Shrub Dominated (Less than 20') 4=Grassland/Meadow/Pasture 5= Wetland

LB=Left Bank RB=Right Bank W=Width TY=Riparian Type *Options:* C=Coniferous D=Deciduous M=Mixed

SBST=Substrate (Dominant/Subdominant) *Options:* 1=Bedrock 2=Silt/Organic 3=Sand 4=Small Gravel (<25 mm) 5=Large Gravel (25 mm-100 mm) 6=Cobble (100mm-256mm) 7=Boulder (*Note Dominant and Subdominant* [Dom/Sub])

POI=Pool Quality Index Value *(For all Pools, Record Maximum Depth and Cover)*

LWD=Large Woody Debris LE=Length DI=Mean Diameter ST=Stability *Options:* A=Anchored U=Unancored ?=Unknown

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CN=Conditions *Options:* S=Solid [Subtype (R)ecent/(O)ld] M=Moderate [Subtype (R)ecent/(O)ld] R=Rotted [Subtype (R)ecent/(O)ld] TY=Type *Options:* J=Log Jam F=Floating Log S=Stranded Log B=Bridge Log [Subtype (C)ollapsed/(P)artial] L= Lateral Log W=Weir [Subtype (F)ull/(P)artial]

Habiat Inventory Summary

Woodin Creek - Reach 5

Reference Number (RF)	Stream Stationing	Habitat (HT)	Width (W)	Depth (D)	Length (L)	Channel Width (CW)	Channel Depth (CD)	Primary Substrate (SBST)	Secondary Substrate (SBST)
05_1		23	2						
05_2	03+10	1	4	4	310	7	12	6	5
05_3	03+30	3	3	2	20	6	24	7	4
05_4	05+01	1	2	2	171	4	6	7	5
05_5	05+91	23	2		90				
05_6	06+66	1	2	1	75	2	6	2	3

WRIA Basin # 8 Basin # Reach 5 Date 7/8/03 Time 1200 pm

Stream # Stream Order: Survey Length (RM) to ____

Weather Conditions Overcast 64°

5-1 Investigators STEVE KRUEGER & Alex Ottley

	Habitat Characteristics							Riparian - RB			Riparian - LB					LWD					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY
1	5-1	Culvert														4'	10"	U	D	RO	S
2	5-2	1	4'	4"	310'	7'	12"	2	75'	D	2	75'	D	6/5	–	9'	10"	U	D	RR	S
3		– Debris blockage @ 37' Photo #002													–	4"	12"	U	D	RO	S
4		– LB culvert 12" galvanized @ 127' – Photo #003													–	75'	14"	A	D	SR	S
5		– undercut bank (RB) 195' – 228 (8-10")													–	8'	12"	U	D	RO	S
6		– Feeder creek (LB) @ 240' Photo #004													–						
7		Debris blockage @ 240-250'													–	12'	14"	U	D	RO	S
8		– 3 or 4 French drains observed in stretch from residential areas																			
9		– RB Erosion problem @ 275' Photo #005													–						
10		– Seep w/ Eroding Deposits @ 301' (RB)													–						
11	05-3	3	3'	2"	26'	6'	24"	2	75'	D	2	75'	D	7/4	–	50'	14"	A	C	SR	B
12		– Photos 006 & 007 – Cascade																			
13		– LB & RB Erosion 310' – 320'																			
14	05-4	1	2'	2"	171'	4'	6"	2	30'	D	2	40'	D	7/5	–	–	–	–	–	–	–
15	05-5	Culvert		–	90'																
16		Passes under 146th Ave NE																			
17	05-6	1	2'	1"	75'	2'	6"	2	16'	D	2	10'	D	2/3		–	–	–	–	–	–
18		STREAM END'S – dry up above –																			
19																					
20																					
21																					
22																					
23																					
24																					
25																					
26																					
27																					
28																					
29																					
30																					
31																					
32																					
33																					
34																					
35																					
	RF	HT	W	D	L	CW	CD	SS	W	TY	SS	W	TY	SBST	PQI	LE	DI	ST	V	CN	TY

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LB=Left Bank RB=Right Bank W=Width TY=Riparian Type *Options:* C=Coniferous D=Deciduous M=Mixed

SBST=Substrate (Dominant/Subdominant) *Options:* 1=Bedrock 2=Silt/Organic 3=Sand 4=Small Gravel (<25 mm) 5=Large Gravel (25 mm-100 mm) 6=Cobble (100mm-256mm) 7=Boulder (*Note Dominant and Subdominant* [Dom/Sub])

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B=Bridge Log [Subtype (C)ollapsed/(P)artial] L= Lateral Log W=Weir [Subtype (F)ull/(P)artial]

APPENDIX C: PHOTOS

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Photo 1. Mouth of Woodin Creek at the Sammamish River beginning of Reach 1 (0+00).

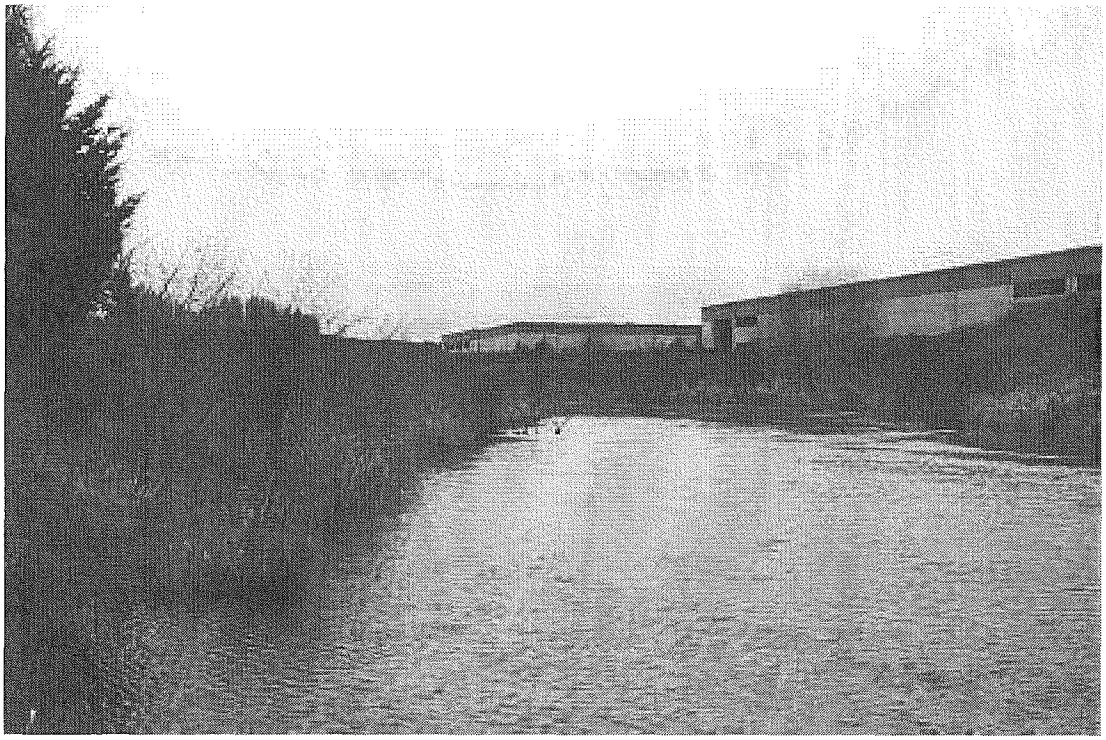

Photo 2. Sammamish River downstream of Woodin Creek below the beginning of Reach 1.

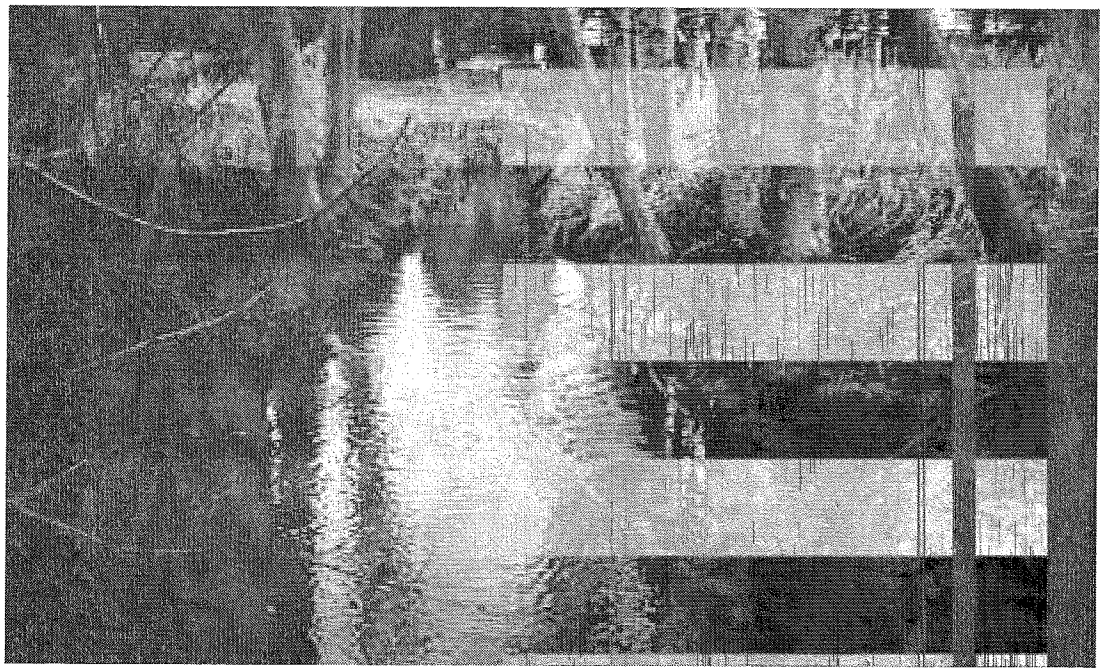

Photo 3. Sand substrate within the mainstem of Reach 1 of Woodin Creek below NE 171st Street adjacent to Woodin Creek Park (~7+00).

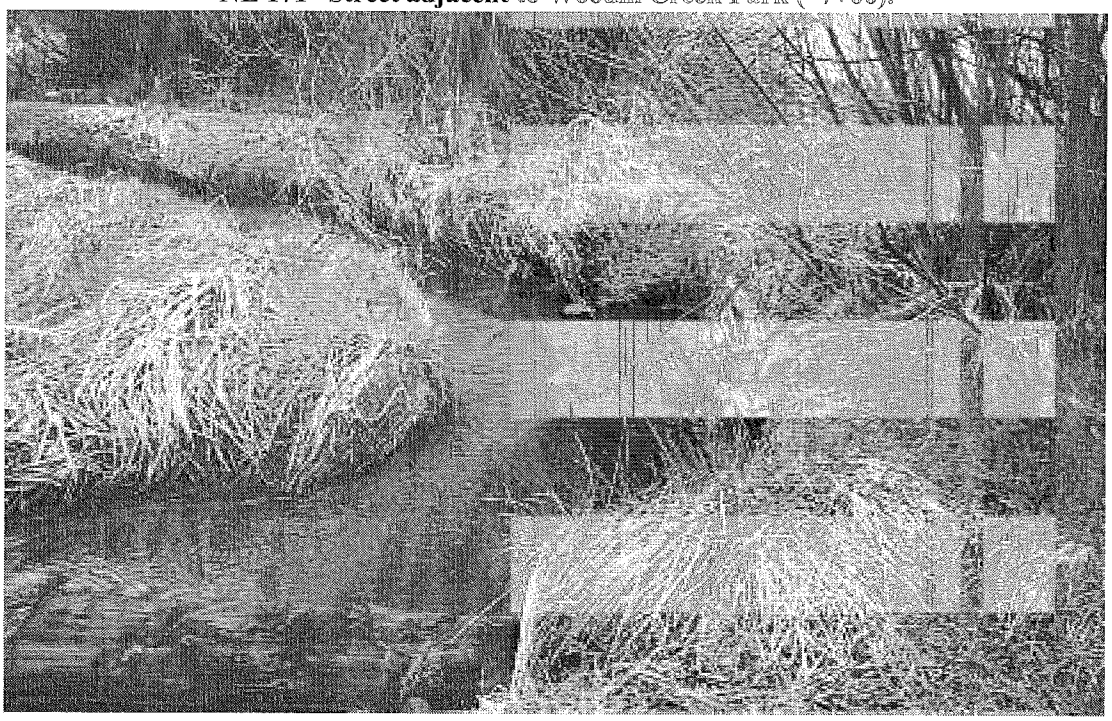

Photo 4. Sand substrate and visible sediment at depth within Reach 1 of Woodin Creek along the north side of NE 171st Street and south of Canterbury Square (~9+50).

Photo 5. Stream channel Reach 3 of Woodin Creek upstream from the culvert on NE 171st Street (~2+50).

Photo 6. Large woody debris within Reach 1 upstream from the mouth of Woodin Creek (~2+00).

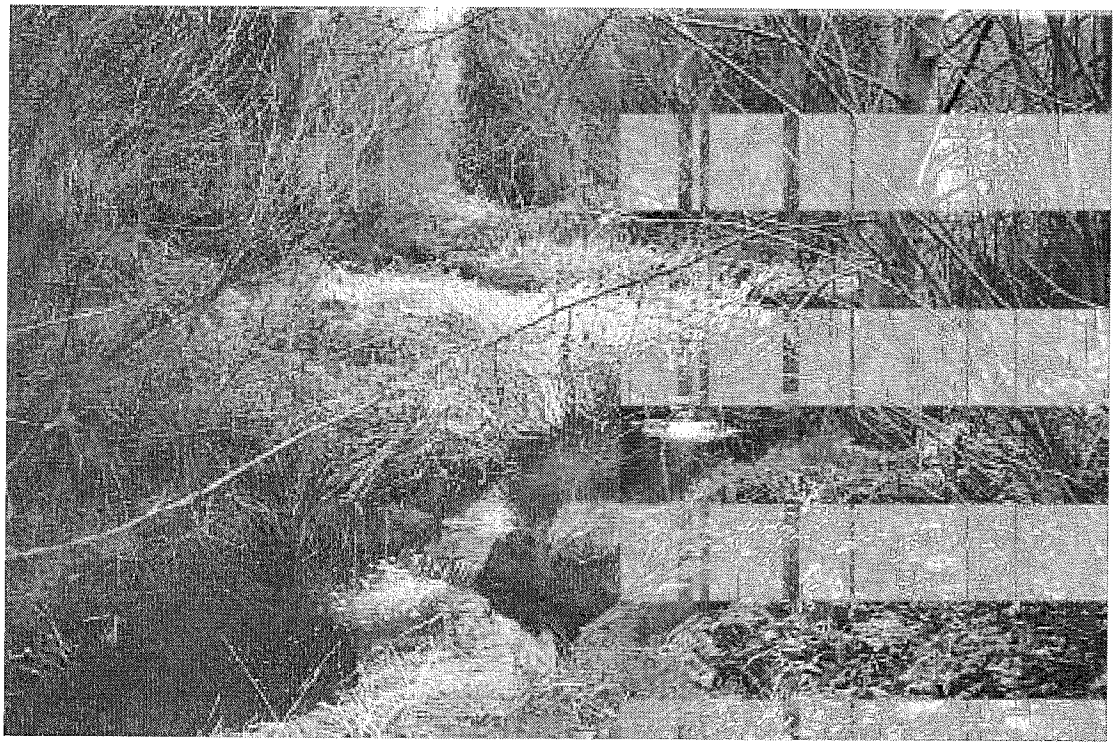

Photo 7. Pools within Reach 1 of Woodin Creek created by log weirs (~16+50).

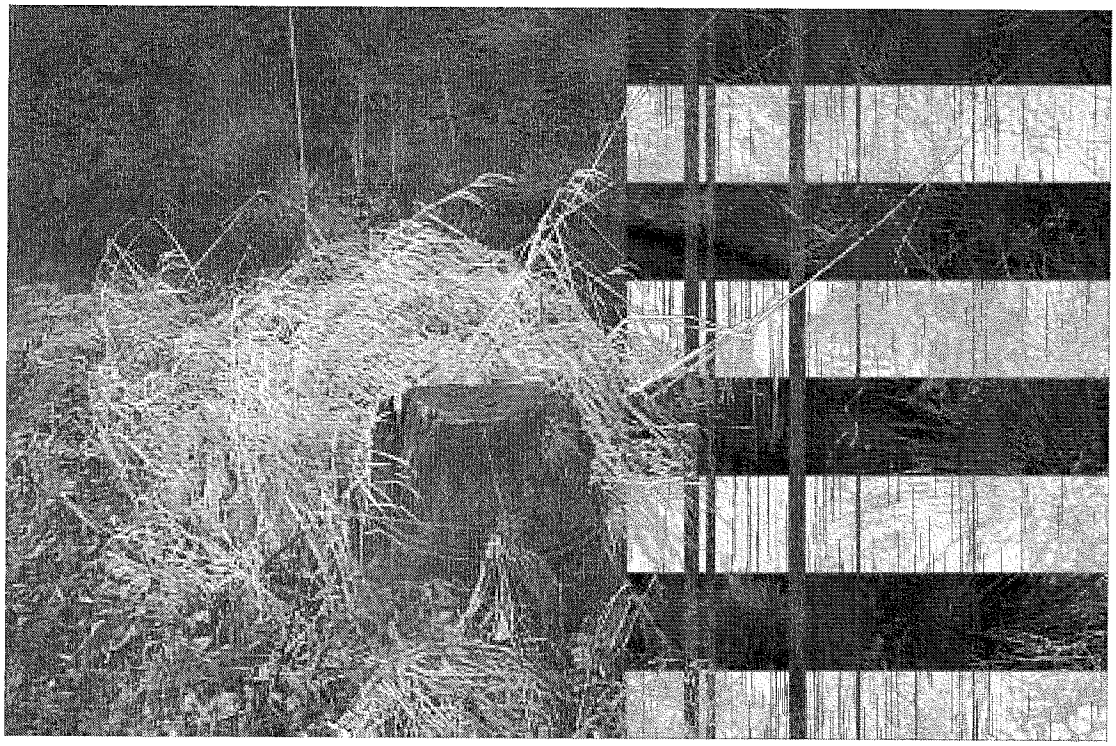

Photo 8. Root wad secured on the left bank of Reach 1 of Woodin Creek (~18+57).

Photo 9. Riffle habitats in Reach 3 (~5+97).

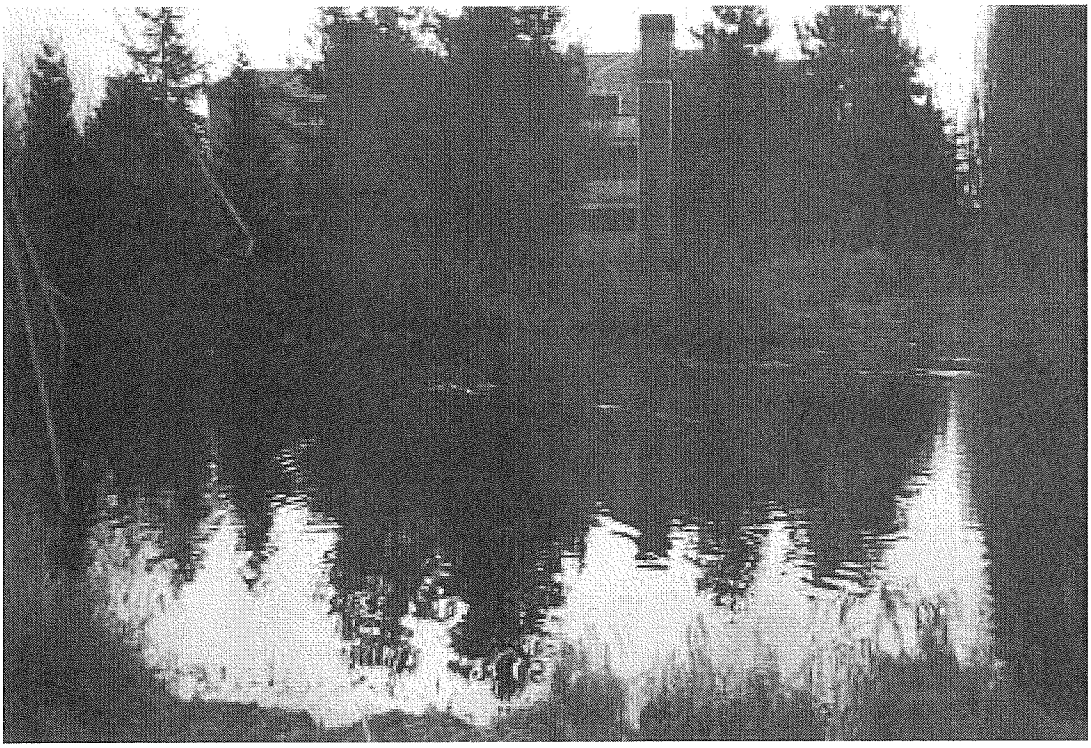

Photo 10. Off Channel Pond in Reach 1 (3+30).

Photo 11. Chinook Carcass on LB of Woodin Creek (9/23/03) (~9+50)

Photo 12. High density residential land use adjacent to Reach 1 (March 21, 2003).

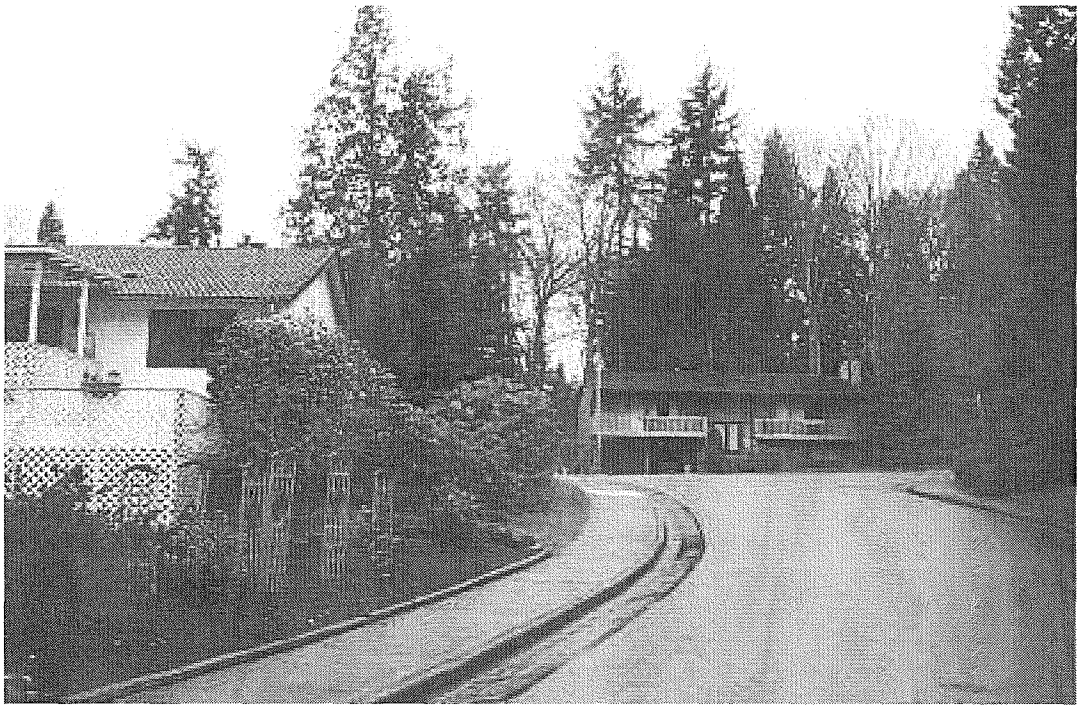

Photo 13. Medium density residential land use between Reaches 4 and 5 (March 21, 2003).

Photo 14. Upland forest in Reach 5 (March 21, 2003).

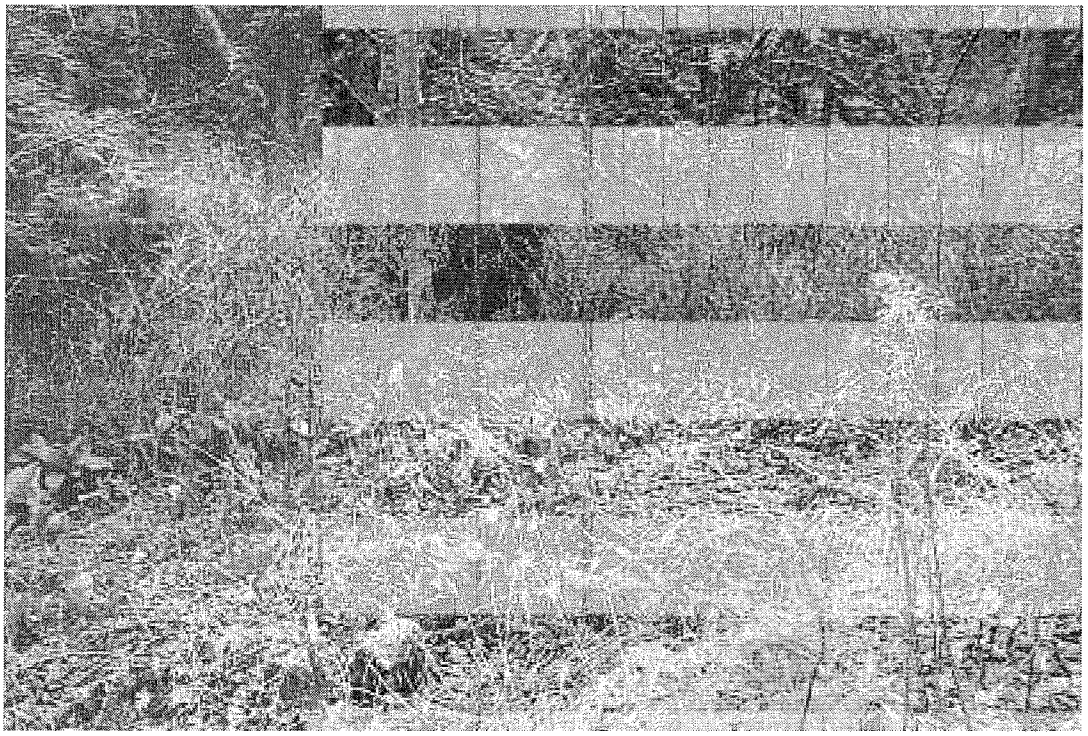

Photo 15. Riparian-wetland forest in Reach 3 (March 21, 2003).

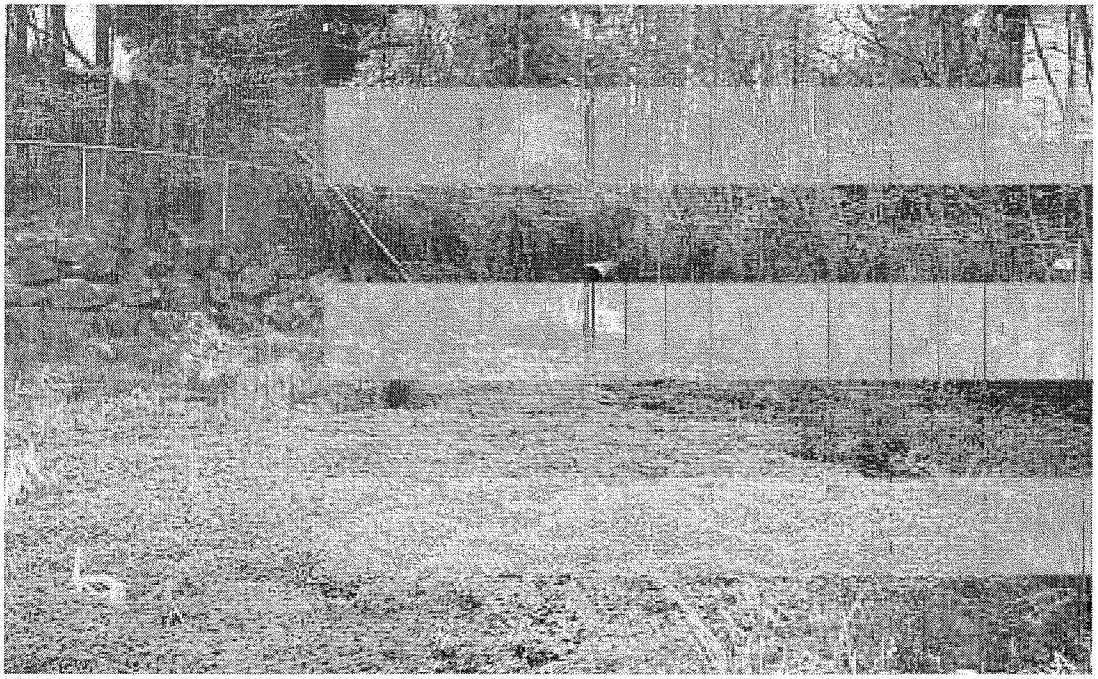

Photo 16. Herbaceous wetland habitat in a storm drainage retention area at the downstream end of Reaches 4 and 5 (~0+00) (March 21, 2003).

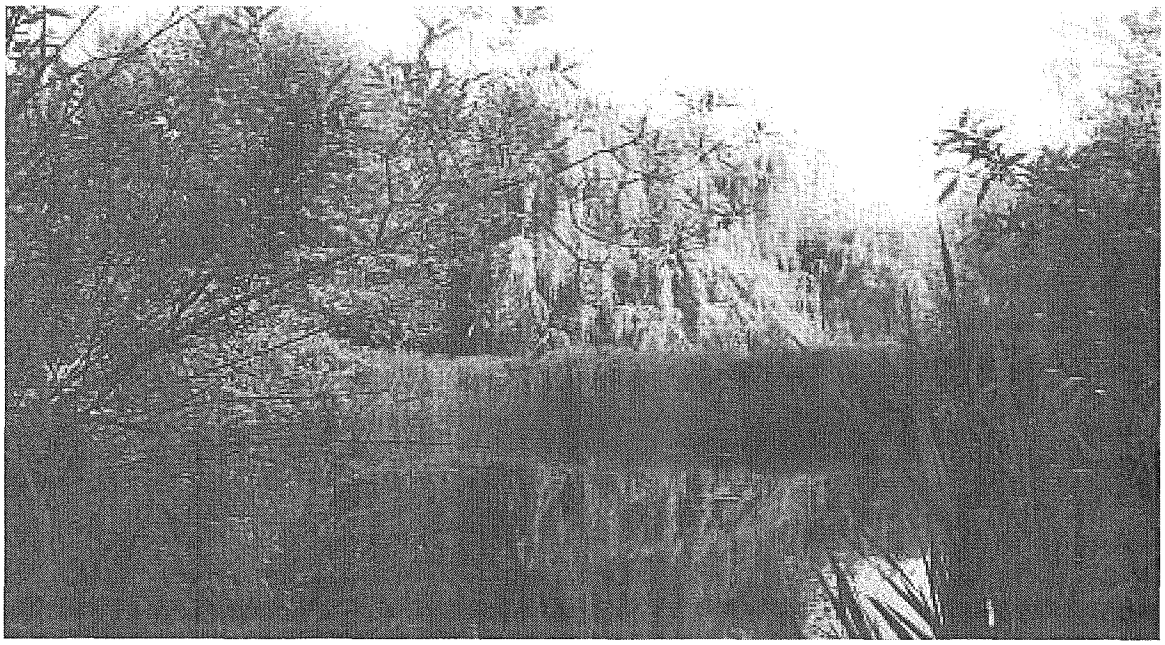

Photo 17. Open water pond habitat adjacent to Reach 1 and Woodin Creek Park (May 23, 2003) (~3+30).

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APPENDIX D: WOODIN CREEK HABITAT ASSESSMENT SUMMARY DISCUSSION, AND RECOMMENDATIONS

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MEMORANDUM

ADOLFSON

Environmental Solutions

DATE: April 12, 2004

TO: Yoshihiro Monzaki, P.E.

FROM: Benn Burke

RE: Woodin Creek Habitat Assessment
Summary of Results, Discussion, and Recommendations

The discussion of the results, conclusions, and recommendations of the Woodin Creek Habitat Assessment (the study) prepared by Adolfson Associates, Inc. are summarized in the following technical memorandum. Specific results and findings are presented detail in the main body of the report.

RELATIONSHIP TO BEST AVAILABLE SCIENCE CRITERIA

Washington State has state adopted procedural criteria to assist with the implementation of the State's Growth Management Act (GMA). The State requires that cities consider "best available science" in developing land use management policies. As described in the study, the primary purpose of the Woodin Creek Basin Habitat Assessment is to provide baseline information on fish and wildlife habitat conditions and identify factors that may be limiting to fish and wildlife, with particular attention provided to anadromous fisheries as directed by the State criteria. These data could be used to support the City of Woodinville's efforts to develop regulations and policies to comply with the GMA as well as provide a baseline for ongoing management activities within the basin.

There are three levels of assessment presented in the study relative to "best available science." The first level of information is data collected in the field that is specific to Woodin Creek in 2003. The study followed King County's stream habitat assessment methodology (King County, 1991). This is a semi-qualitative method used to document channel characteristics, in-water habitat conditions, riparian habitat conditions, substrate, and large woody debris. The second level of evaluation discussed in the study is related to assessing the general condition of Woodin Creek by comparing it to a hypothetical "properly functioning" stream system as currently defined by National Oceanic and Atmospheric Administration (NOAA) Fisheries in the document titled: *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NOAA Fisheries, 1996) and United States Department of the Interior Fish and Wildlife Service (USFWS) in a parallel document titled: *A Framework to Assist in the Making of Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulations Watershed Scale (Draft)* (USFWS, 1998). This level of assessment is comparable to what would be required in support of a Biological Assessment that might be prepared as part of a permit application or in support of a federal grant for a capital project. The King County stream habitat assessment methodology used for this inventory does not include all of the same parameters used by NOAA Fisheries and USFWS relative to a "properly functioning" stream system. Because of this, it is necessary to consider indirect factors related to the overall condition of the drainage basin in combination with best professional opinion and make judgments on whether or not Woodin Creek meets "properly functioning" criteria.

The third level of assessment is a discussion of the findings in an attempt to step beyond the empirical data and provide forward-looking observations and offer hypothesis for why a particular condition occurs in Woodin Creek. Where hypothesis serves as the basis for the discussion, we have recommended potential future studies or monitoring so that better information may become available.

It should be recognized that stream surveys are inexact sciences and fisheries professionals may interpret the conclusions and recommendations differently based on the same data. Therefore, the second and third levels of assessment are less objective than the simple reporting of results. To assist with the delineation between data types related to "best available science" the following summaries of these report findings are delineated into Summary of Findings and Discussion. These sections are followed by two sets of recommendations: 1) recommendations for continued or future monitoring and study and 2) recommendations for potential projects or programs to further assess or attempt to mitigate for a known or assumed limiting factor.

WATERSHED CONDITIONS AND FLOW AND HYDROLOGY

NOAA Fisheries (1996) and USFWS (1998) discuss Watershed Conditions and Flow and Hydrology as the last two factors relative to their parameters for a properly functioning stream. This is largely because these assessment methods were developed for watersheds within forests areas proposed for timber harvest. Following harvest these areas would generally be replanted and would continue to be used for forest production. Neither agency had developed assessment criteria at the time of the study that reflects urban stream conditions. Many authors that study urban systems argue that watershed conditions that affect flow and hydrology should be the primary factor considered when assessing the health of urban systems. As a result, these parameters are discussed first here because watershed conditions and flow and hydrology within the Woodin Creek basin appear to be closely related to many other parameters.

Summary of Findings

The study included an indirect assessment of conditions and past actions that have occurred in the basin that affect flow and hydrology. During the study, biologists reviewed drainage maps provided by the City and conducted an assessment of the level of impervious surface associated with the various land uses within the basin. These assessments found that Woodin Creek has a high level of impervious surface. Approximately 41 percent of the total basin area of approximately 400 acres is covered by some type of impervious surface (roads, buildings, parking lots). The highest level of impervious surface within the basin was associated with road rights-of-way. The second highest level of impervious surface was associated with large parking lots for commercial, retail, and multifamily residential development. These two sources account for over half of the total impervious surface with the basin. Roadways and parking lots also impact flow and hydrology in Woodin Creek as a result of culverts. Approximately 20 percent of the total length of stream within the Woodin Creek basin is enclosed in culverts or pipes under roadways and parking lots. The most significant amount of alternation is the piping of the entirety of Reaches 2a and 2b (approximately 3,200 feet). In addition to these pipes, flow and hydrology within the basin are affected by the use of much of Reach 1 for conveyance of stormwater from developed areas. Flow enters the stream through a series of pipes and is conveyed downstream until it reaches a high flow bypass upstream of NE 171st Street where flow re-enters the piped storm conveyance network near station 9+25.

Discussion

Impervious surface in urban stream basins is a concern for three primary reasons: 1) It can increase the quantity of water that flows into a stream by decreasing the amount of water absorbed and/or retained by the landscape; 2) It can decrease the quality of runoff as a result of oil, grease, metals, nutrients, and particulate material (and other items) that are deposited on roadways and parking areas, and 3) It decreases groundwater infiltration that might reduce the recharge of springs, wetlands, and seeps that provide base flows to the stream during the summer. In addition piping and culverts cause constrictions in the channel, that and

Photo 1: New culvert under 133rd Avenue NE

affect flow rates and discharge, particularly if a culvert is undersized.

There are five road culverts within Reach 1: 131st Avenue NE, 133rd Avenue NE, a private road at approximately station 25+82, a private road at approximately 27+22, and a private driveway at approximately 32+52 near Molbaks. Based on field observations, two culverts, the one at 131st Avenue NE and the one at approximately 32+52 appear to be undersized. This observation is based on the fact that they both appear to create large sediment deposits above the inlet and scour was observed below the outlet as might be expected if water was constructed by the culvert and a head developed that increased water velocities within downstream reaches. This appears to occur to the extent that water velocities may be creating scour in downstream habitats. The culvert at 133rd Avenue NE appears to be new and constructed to current standards (Photo 1). The two private road culverts appear to have been recently upgraded.

Open channel portions of Woodin Creek within Reach 1 and Reach 3 are also constrained by roadways. Approximately 1,500 feet of Reach 1 and 2,000 feet of Reach 3 parallels NE 171st Street. The portion of stream in Reach 1 north of NE 171st Street appears to have been relocated during the reconstruction and widening of the road. As a result, the stream corridor is artificially straight and confined relative to its position in the watershed. Given the location of this stream along the valley floor, a stream with a wide channel and broad meanders would be expected to be present under natural conditions.

Based on the high level of impervious surface within the basin, the fact that roads and parking areas account for over half of the impervious surface, and the fact that extensive portions of Woodin Creek are piped and/or are used to provide stormwater conveyance above normally expected base flows, the basin is "not properly functioning" for both watershed conditions and flow and hydrology criteria.

Recommendations

Study and Monitoring

The study calculated a gross area of impervious surface within the basin; however, the study did not separate out what amount of this is "effective impervious surface," meaning what amount is not effectively treated by stormwater detention and water quality treatment facilities. To better ascertain the degree of impact from impervious surface, a study could be conducted that identifies those parcels or road segments that have stormwater control facilities and, if they do, what level of treatment they provide. It is likely that even those parcels that have stormwater facilities do not provide completely effective treatment based on current standards.

The City might consider a study to identify potential areas to retrofit existing development or roadways with stormwater management facilities. A priority could be those parcels that currently have no stormwater detention or treatment and that discharge directly to the stream. Other studies may be appropriate to address issues with the location and configuration of the channel. These are described below under the Habitat Elements and Channel Condition and Dynamics section.

Projects for Consideration

At this time, there does not appear to be sufficient information available to recommend a specific project that would result in significant improvements within the basin related to watershed condition or flow and hydrology issues. But as a general recommendation there appears to be opportunity for improvement through redevelopment in the basin. Based on the City's comprehensive planning efforts, many of the properties along Woodin Creek adjacent to Reaches 1, 2a, and 2b are planned for redevelopment or could be redeveloped in the future. The redevelopment of parcels adjacent to Reaches 1, 2a, and 2b, should be viewed as significant opportunities to restore a measure of functionality to the stream corridor through the reduction of effective impervious surface and the removal or upgrade of piped streams and culverts. Specifically the culverts at 131st Avenue NE and the one at approximately 32+52 should be priorities for replacement.

HABITAT ACCESS

Summary of Findings

The scope of the Woodin Creek Habitat Assessment included a fall and winter survey to identify use by adult salmon and to identify potential migration barriers based on fish-use. One adult Chinook salmon (carcass) was observed during the first day of the fall spawning survey upstream from NE 171st Street. No other adult salmon were observed at any other time during the spawning survey. Local neighborhood groups have reported observations of occasional large fish (unidentified species) within the stream during the fall and winter. The study did not include sampling for fish use during other times of the year. King County relocated approximately 250 juvenile cutthroat trout and two sub yearling coho salmon from Reach 1 in November 2003 prior to conducting in-water work in the stream. Juvenile salmonid fish (unidentified species) were observed throughout the entire length of Reach 1 during the summer habitat inventory. Two adult cutthroat trout were observed downstream of NE 171st Street within Reach 1. In addition to salmonid fish, larval lamprey (unidentified species) and sculpin (unidentified species) were also seen in the stream. No adult or juvenile fish of any species were noted in Reaches 3, 4, or 5.

Discussion

It appears that the piping and modifications within Reaches 2a and 2b have resulted in the elimination of fish use from the upper sections of the stream (Reaches 3, 4, and 5). Based on the length of pipe within Reach 2a and 2B, it is assumed that fish are precluded from migrating up past Reaches 2a or 2b. Fish were only observed within Reach 1.

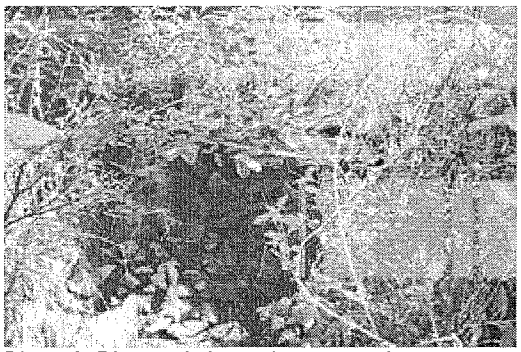
Photo 2: Ripraped channel near mouth.

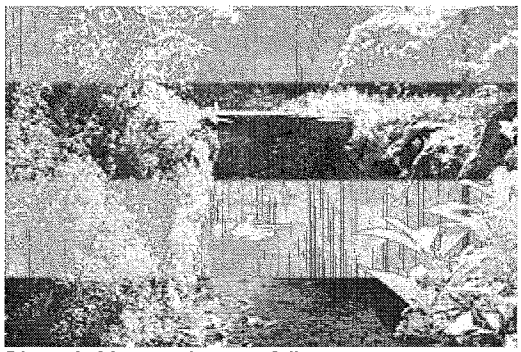
Photo 3: Man-made waterfall.

In addition to the culverts discussed above, there were three habitat features in Reach 1 that biologists identified as potential partial blockages. These included a riprap section of channel underneath the Sammamish River Trail bridge immediately upstream of the mouth (Photo 2) that may block adult salmon during periods of low base flows. A debris jam within Woodin Creek Park near station 3+50 and a waterfall that is part of a stream beautification feature within the mobile home park at approximately station 28+02 (Photo 3) may also be barriers.

Based on the abundant numbers of juvenile fish throughout Reach 1 and the observed presence of juvenile and adult salmon within this reach, it does not appear that there are any absolute migration barriers within Reach 1; however, it does appear that one or more of these features could represent a migration barrier during certain flow levels. As a result Woodin Creek system is not likely "properly functioning" based on the stated criteria.

The assessment of potential barriers within the Woodin Creek system are based on incidental observations of juvenile fish during the habitat inventory, one adult salmon carcass observed during one spawning season, one fish salvage operation in Reach 1 by King County in November of 2003, and anecdotal observations of large unidentified fish in the stream by neighbors. This is not a definitive set of data. It is possible that a few other adult fish did access Woodin Creek but were not

observed. It is possible that because 2003 was a dry year and fall rains were delayed, the riprap below the Sammamish River Trail bridge (approximately station 0+18) was a more significant blockage than it would be under more normal circumstances. The few carcasses that have been observed in the stream could be a result of being drug up from the Sammamish River by a raccoon or other animal. The level of juvenile fish observed in the channel could be supported by resident cutthroat and/or could be a result of juvenile coho salmon out plants from local school groups, sportsman groups, or tribes.

Recommendations

Study and Monitoring

Because of the significant number of unknowns related to fish passage within the system, two courses of study and monitoring are recommended. The first is to augment the data set related to adult and juvenile salmon use. The City might choose to repeat the spawner surveys in a year with more normal rainfall patterns. The City is currently involved in the King County Salmon Waters Program. An alternate to a formal study would be coordinate with the King County program to additional training and organizational support for neighborhood groups to the extent that observations are conducted regularly and that any fish that are observed can be identified with a high degree of certainty. The City might also consider commissioning a study to attempt to trap out-migrating salmon smolts from various locations within Reach 1. Such a study would have to be closely coordinated to insure that the results were not compromised by juvenile out planting by third party groups. The second course of study could be to conduct specific evaluations of the potential habitat barriers identified herein based on State fish passage criteria.

Projects for Consideration

Assessment and potential correction of the passage barriers under the Sammamish River Trail bridge, the debris jam in Woodin Park, and the man-made waterfall within the mobile home community are all potential projects that could benefit fisheries within the basin. Even if these features are not absolute barriers, they could all impede migration of some fish under normal base flow conditions.

Several of the culverts within the basin appear to have been recently replaced or enlarged to improve water flow and improve fish passage. Culverts that should be considered priorities to assess as potential fish barriers include the culvert under 131st Avenue NE upstream of Woodin Creek Park and the culvert at the upstream extent of the Molbaks parcel at approximately station 32+52 (Photo 4). The capacity of the culvert at 131st Avenue NE appears have been decreased by sediment. Although this culvert appeared to be passable during the study, but additional decrease in capacity could create problems. The culvert at Molbaks appears to be undersized based on observations of sediment deposition upstream and scour downstream of the culvert. These conditions could result in high velocities within the culvert during high flows that could limit fish passibility.

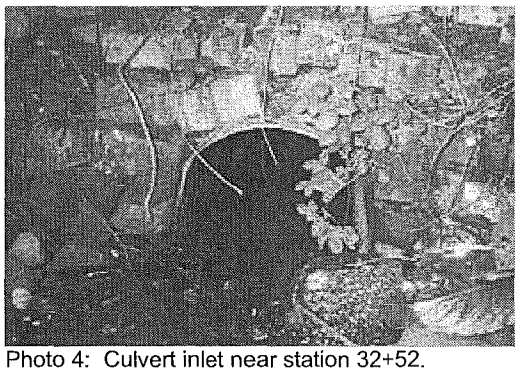

Photo 4: Culvert inlet near station 32+52.

WATER QUALITY

Summary of Findings

Woodin Creek did not meet all required State of Washington water quality parameters for Class AA waters during the study period. Woodin Creek is characterized as a Class AA water per WAC 173-201A. Temperature, dissolved oxygen, and pH are the water quality parameters included in the data

provided to Adolfson for this study that were most often exceeded that relate to fish and wildlife habitat support. Temperature and dissolved oxygen values were most limiting during the summer; pH readings were lowest during the fall and winter. Woodin Creek also does not provide "properly functioning" water quality parameters considered necessary to support healthy self-sustaining populations of salmonid fish per NOAA Fisheries and USFWS parameters (NOAA Fisheries, 1996; USFWS, 1998). Summer temperatures recorded in Woodin Creek indicate that the primary concern is in relation to supporting rearing and migration habitat for salmonid fish.

Discussion

Woodin Creek is limited for many water quality parameters based on the current State water typing criteria; however, it should be noted that State water quality standards are not specifically intended to measure the ability of a water to support healthy populations of fish and wildlife. Water quality exceedances, while common, do not appear to preclude rearing for some salmonids, particular cutthroat trout. It is unknown if high temperatures result in an underutilization of some habitats or if temperatures result in limitations to other species of salmonids. None of the levels observed in the stream appear to indicate the presence of lethal conditions to fish. Low pH values during winter exceed state water quality standards, but further study would be needed to determine if this was a result of a particular point source or is a natural condition. Based on the level of wildlife use with the basin, water quality does not appear to limit many types of wildlife, particularly birds and small mammals habituated to urban environments. It is unknown if water quality is particularly limiting on other wildlife, such as reptiles or amphibians since the wildlife inventory did not specifically target those species.

Recommendations

Study and Monitoring

Ongoing water quality monitoring is recommended to insure that long-term deleterious conditions do not develop. It would be particularly beneficial to continue monitoring those parameters that might attribute to low dissolved oxygen levels (temperature, nutrients, and BOD). Although dissolved oxygen levels can often times be interpolated from temperature data (lowest during the day when temperatures are highest), night dissolved oxygen levels might be a concern for Woodin Creek because of occasional high levels of nutrients in the stream. High nutrient levels might increase the use of oxygen used by algae and bacteria during the night. The addition of occasional night sampling of dissolved oxygen levels could help determine the extreme lows of dissolved oxygen within the within the system. The lowest levels of dissolved oxygen commonly occur just before dawn in late summer.

The scope of the study did not include a statistical assessment of the City's water quality data. Further analysis of the data could show relationships to help pinpoint potential problems. For example, a leaking sanitary sewer might be indicated by a correlation between nutrients (nitrite and nitrate) and fecal levels. A high correlation between nutrients and metals could indicate that runoff from parking lots or roads are a concern.

Low levels of pH have been known to affect spawning success for some salmonid species. If continued monitoring indicates that pH levels continue to be low (6.5 or less), as observed in 2003, additional examination of the data could be warranted to determine if the condition were natural or a result of a specific source. Natural sources of low pH may be runoff from decomposing forest litter or discharge from some types of wetlands. In addition, basin soils may have low buffering capacity. If additional analysis of the data does not identify a situation that can be explained by a natural condition, the current sampling program could be extended to include additional stations or monitoring at outfalls to determine if there is a specific man-made source of the low pH values.

Water quality monitoring provides a quick assessment of potential acute issues with a stream's water. An alternative to extensive water quality monitoring could be to incorporate an evaluation of benthic macroinvertebrate into the sampling program. The addition of benthic monitoring would help identify if there were chronic water quality problems within a stream that might be missed by traditional event sampling.

Projects for Consideration

Temperature (and indirectly dissolved oxygen) has been identified as a potential limiting factor in Woodin Creek. Forested riparian areas with closed canopies provide shade to the stream that limit the potential increase in temperature as a result of direct sunlight. In natural systems, a dense, multilayered, riparian forest may create a cool, high humidity microclimate around the stream that reduces evaporation and might have an actual cool effect on the stream. The establishment of these conditions is likely to require significantly more riparian forest than is possible in Woodin Creek given the high levels of development and limited riparian corridor adjacent to the stream.

Although the establishment of a natural, functioning riparian forest adjacent to Woodin Creek is unlikely due to constraints of the landscape, riparian enhancement is a viable opportunity in the basin. Riparian plantings would benefit many habitats within Reach 1 and lower portions of Reaches 4 and 5. Even areas that are presently forested could be under-planted to help establish as much of a multi-layered forest canopy as possible.

Areas that would specifically benefit from riparian enhancement to provide shade include the reach from station 29+57 to station 32+52 adjacent to Molbaks (Photo 5) and areas within Woodin Creek Park between stations 4+03 and 7+79. In both these areas stream bank vegetation is primarily non-native invasive species (blackberry) and/or immature deciduous forest. Opportunities for shading could also be considered in lower portions of Reaches 4 and 5 adjacent to the existing stormwater facilities and in Reach 1 between station 9+25 and 23+15 where the stream parallels the roadway and there are many south-facing exposures and open canopies (Photo 6).

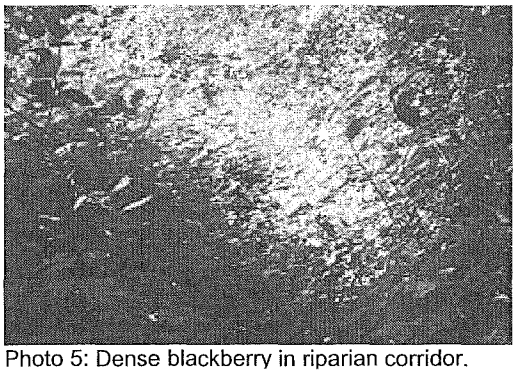

Photo 5: Dense blackberry in riparian corridor.

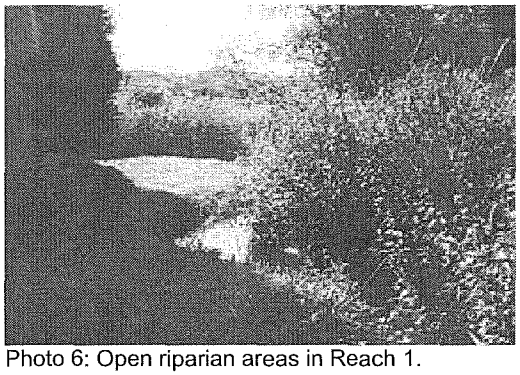

Photo 6: Open riparian areas in Reach 1.

HABITAT ELEMENTS AND CHANNEL CONDITION AND DYNAMICS

These parameters can be discussed separately, however habitat elements and channel condition and dynamics within Woodin Creek appear to be closely related so they are described here as a single topic.

Summary of Findings

Woodin Creek is limited in relation to the following habitat elements: Substrate, Large Woody Debris, Pool Frequency, Pool Quality, Off-Channel Rearing Habitat, and Refugia. Small gravel was the dominant substrate type in Reaches 1, 3, and 4. The only reach where cobble or large gravel were a significant component of the substrate was in Reach 5. Substrates in Reach 1 where fish are present were small gravel or finer (sand, silt, or organic materials). No naturally occurring large woody debris was observed in Reach 1. The large woody debris that was observed was associated with constructed log weirs or root wads installed and secured to the streambed and/or bank with cables. Pool frequency within Reach 1 was approximately a third of that which NOAA Fisheries (1996) and USFWS (1998) identify as "properly functioning." Pool quantity was generally low or moderate. There

were few deep pools (over 3 feet deep) and dense woody cover was generally lacking in association with pools.

Riparian habitat widths in Reach 1 were commonly 100 feet or less and few habitats were adjacent to riparian areas that had a mature forest component. The narrow riparian area constrained by roads and development limits the abundance of off-channel rearing opportunities and significant areas for refugia. The few off-channel wetlands or side channels that are present have largely been impacted by conversion to landscape amenities (ponds)(Photos 7 and 8).

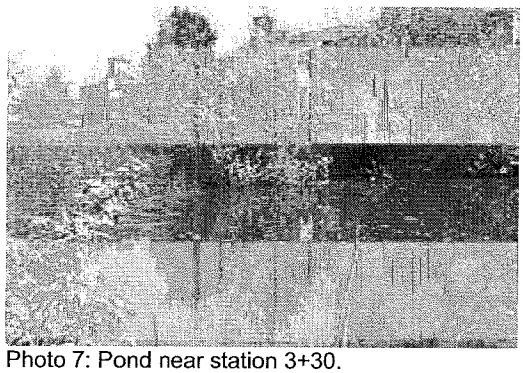

Photo 7: Pond near station 3+30.

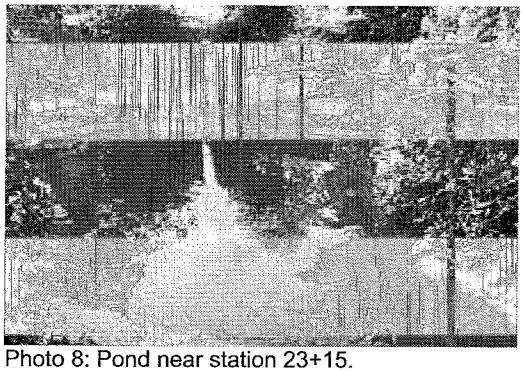

Photo 8: Pond near station 23+15.

Discussion

Bank erosion, scour, and sedimentation are natural and necessary process in streams. These processes provide a continuous supply of spawning gravel and create habitat diversity, particularly when combined with the presence of large woody debris. However, when these processes are unbalanced the opposite can occur: spawning substrate and habitat diversity are degraded or lost entirely. The latter appears to be the current situation in Woodin Creek. The data collected during the study documents that most of Woodin Creek, and the entirety of fish accessible reaches, are dominated by deposits of small gravels or finer particles. Sand is largely a dominant substrate type in lower habitats of Reach 1 downstream of 131st Avenue NE to the extent that sand appears to have filled in most pools between stations 0+18 and 7+79 resulting in monotypic glide habitat.

The study did not identify one specific cause for these substrate conditions (such as a landslide, massive bank failure, or a man-made source). As a result, the data and observations point to a series of factors that may be contributing to excessive sedimentation in the lower reach of stream. The first factor is the geography of the basin with steep upper reaches draining valley slopes and a flat lower reach that flows through a remnant floodplain. The second factor is the erosive soil type along the valley slopes. The third factor is the extensive alteration of Reaches 2a and 2b and the creation of high levels of impervious surface within the basin. The fourth factor is that the reconstructed stream channel of Reach 1 relocated by the construction of NE 171st Street did not appear to be sufficient to accommodate the current sediment load. And the fifth factor is the high flow bypass with its inlet upstream of 131st Avenue NE at approximately station 9+25.

The most exacerbating factor appears to be the historic modification of Reaches 2a and 2b and the high level of impervious surface within the basin. Much of the development surrounding Woodin Creek and the piping of surface flows through Reaches 2a and 2b occurs at a location in the landscape where an active alluvial fan would normally occur. Sediments that would typically be deposited in the alluvial fan appear to be collected in man-made sediment traps or transported downstream into the lower, flatter Reach 1. The sediment traps appear to keep most of the larger gravels and cobble from migrating down the basin, but they do not appear to retain all the small gravel and sand. As a result of an artificially narrow and constrained stream channel and increased flow velocities and discharge from impervious surface, these finer materials appear to be carried downstream where they appear to settle out as flow velocities diminish. This appears to be particularly significant downstream of the high flow bypass at NE 171st Street. The deposition of

sediments decreases the conveyance capacity within the artificially narrow stream channel, resulting in flooding and degradation of in-stream habitats.

Similar factors appear to affect large woody debris within the basin. In natural streams of a similar configuration, upslope forests provide a source of debris for reaches lower in the basin. Large woody debris recruitment potential is limited from Reach 1 as a result of past development and the piping in Reaches 2a and 2b combined with other channel constrictions like culverts. Both the high sediment load and the lack of woody debris appear to be reflected in the quality of pools. A preponderance of the pools studied within Reach 1 appear to be a result of habitat enhancement features installed within the stream. Where installed habitat features are absent, the stream was primarily glide or low gradient riffle habitat. While the installation of these features appears to have increased level of habitat diversity, it does not appear to be a self-sustaining condition. Several of the log weirs appear to be failing and the liner used to construct the weirs was exposed in many areas.

Recommendations

Study and Monitoring

The current habitat conditions relative to substrate, large woody debris presence and recruitment, and pool frequency are largely a result of the level of historic modifications of both the channel of Woodin Creek and wider scale development within the basin.

These problems will not be easily solved; however, there does appear to be significant opportunities within the basin to correct or significantly improve these conditions. These opportunities include: The relatively undeveloped nature of the area south of NE 171st Street compared to areas north of the road within the City, the potential high cost and liability of managing flooding within the basin under the status quo, and the extent of planned redevelopment within the basin.

The most appropriate recommendation for additional study for this basin would be an assessment of the feasibility of reconstructing all or parts of Reaches 1, 2a, and 2b for the purpose of creating new stream habitats, improving sediment transport, addressing fish passage issues, and correcting or improving the condition of limited riparian corridor width. This study could include a wide range of alternatives ranging from an evaluation of the status quo to the full reconstruction of the stream channel downstream of Reach 3. Additional alternatives should also be evaluated to guide potential redevelopment in the event that the larger-scale solution is not feasible.

Projects for Consideration

The purpose of the level of study recommended in the previous section is to identify potential long-term solutions for known problems within the Woodin Creek basin. There are, however, several interim measures that should be considered that would build on past stream restoration actions or leverage existing features within the present land use setting of the basin to provide for more opportunities for off-channel rearing habitat and refugia. A measure for consideration would be to continue sediment removal from existing sediment ponds in Reaches 1, 4 and 5. In addition, a sediment trap might be considered for Reach 3. Although it would be more beneficial to return the system to balance related to sediment deposition and transport, the current condition of Reach 2 likely necessitates ongoing and future sediment management to retain balance in the system until longer-term solutions can be implemented.

There are four areas that appear to be good opportunities for this type of targeted enhancement. The first is the existing pond located at approximately station 3+30 in Reach 1. A similar off-channel pond occurs in Reach 1 at approximately station 15+25. Both of these ponds are currently adjacent to the stream, but both occur above the elevation of the stream channel and neither appears to have a fish passable connection to the stream. The potential may exist to provide fish access to these ponds for additional rearing. This should only be done with advanced planning and input from the Washington State Department of Fish and Wildlife who can provide technical expertise to accomplish this while minimizing potential negative effects from stranding or predation. A third off-channel pond is located at approximately station 23+15. This pond is currently accessible to fish but lacks significant cover to provide quality refugia or off channel rearing potential. Plantings of native vegetation and/or in water

enhancement thought the addition of woody debris might increase the functionality of this feature. The forth opportunity area is the segment of Woodin Creek within Woodin Creek Park. The proximity to the Sammamish River and quantity of available open space north and west of the stream channel between stations 3+30 and 7+79 make this an attractive area to create additional off-channel habitat refugia in addition to, or in conjunction with, opportunities related to the pond on the east side of the stream at station 3+30.

WILDLIFE HABITAT

Management of upland wildlife habitat is not a specifically mandated element for inclusion within a basin habitat assessment; however, the City desired to include an inventory of wildlife habitat and wildlife usage within the basin as part of this assessment to better understand the broad range of habitat conditions associated with Woodin Creek.

Summary of Findings

Seven habitat types occur in the study area. These include in order of abundance: High Density Commercial and Residential; Medium Density Residential; Upland Forest; Riparian-Wetlands; Upland Grassland; Herbaceous Wetland; and Open Water Pond. In addition, Agricultural areas occur in King County just south of the study area.

Songbirds were the most abundant wildlife identified by the study both in numbers of individuals and numbers of species. The most abundant species of birds were those generally adapted to habitats located within urban environments. The study attempted to identify species that might not be commonly observed by residents, as a result night surveys were conducted and identified the presence of significant numbers of bats and one group of western screech owls. Bats and owls were observed in the forested areas of the watershed, generally adjacent to Reaches 3, 4, and 5. Other wildlife observations recorded during the habitat surveys included waterfowl (mallard), pileated woodpecker excavations, eastern gray squirrel, Pacific chorus frog, mole tunnels, and Virginia opossum.

Discussion

It is interesting to note that bats and owls were only detected at the stations that were located near medium to large conifer trees. Structure for bat roosting could be limited to where conifer trees are present. Peeling bark and fissures provide potential roost sites for bats. Smaller deciduous trees usually lack peeling bark and fissures that characterize medium to large conifer trees. Songbirds were common throughout the basin. It should be noted that nocturnal mammals and amphibians may be under represented by the study methods. It is likely that additional species of amphibians and mammals occur within the Woodin Creek basin.

Recommendations

Study and Monitoring

If wildlife habitat management is determined to be a priority, additional studies could be conducted that target both amphibians and nocturnal mammals. Studies that target these animals would provide a more complete data set relative to which animals live in the Woodin Creek basin. Such studies could also include the location and mapping of specific, high valued wildlife habitat such as snags or stands of mature conifers.

Projects for Consideration

The area of Woodin Creek Park actively maintained as lawn could be reduced to provide additional upland habitat for wildlife adjacent to Reach 1. Enforcement and/or education related to maintaining native growth protection areas adjacent to Reaches 4 and 5 could be considered. There were observations of yard waste and litter being disposed of in these areas. In addition, control and removal of invasive/non-native/obnoxious riparian species along the stream, and planting of riparian native species, as described in the Stream Habitat Elements section, would also benefit wildlife.

Appendix I
Maintenance Standards
(From 2005 Department of Ecology Stormwater Management Manual for Western Washington)

Volume V
Minimum Technical Requirements and Site Planning

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4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table 4.5 – Maintenance Standards

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	~~No contaminants or pollutants present.~~
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	

No. 2 – Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

No. 3 – Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks In Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See "Catch Basins" (No. 5)	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

No. 4 – Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).
Catch Basin	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

No. 7 – Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

No. 8 – Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

No. 9 – Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See "Detention Ponds" (No. 1).	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

No. 10 – Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance Is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

No. 11 – Wetponds

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per 1000-SF of pond area.	Trash and debris removed from pond.
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

No. 12 – Wetvaults

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

No. 13 – Sand Filters (above ground/open)

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Above Ground (open sand filter)	Sediment Accumulation on top layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/ Debris in Clean-Outs	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Short Circuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

No. 14 –Sand Filters (below ground/enclosed)

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.

No. 14 –Sand Filters (below ground/enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

No. 15 – Stormfilter™ (leaf compost filter)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accumulation on Media.	Sediment depth exceeds 0.25-inches.	No sediment deposits which would impede permeability of the compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Compost Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

No. 16 – Baffle Oil/Water Separators (API Type)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See "Catch Basins" (No. 5)	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

No. 17 – Coalescing Plate Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

No. 18 – Catchbasin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Normal Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Appendix J
Woodinville Municipal Code Chapter 1.07

WMC Chapter 1.07
CIVIL VIOLATIONS

Sections:

1.07.010 Definitions.
1.07.020 Purpose.
1.07.030 Violations.
1.07.040 Nuisance section.
1.07.050 Severability.

1.07.010 Definitions.
Definitions are set forth in Chapter 1.05 WMC. (Ord. 350 § 4, 2003)

1.07.020 Purpose.
The purpose of this chapter is to preserve the public health and the character and safety of the City's neighborhoods, rendering certain conduct unlawful. The violations set forth in this chapter may be enforced using any of the means set forth in this title. (Ord. 350 § 4, 2003)

1.07.030 Violations.
(1) It is unlawful to violate any applicable provision of the Woodinville Municipal Code.

(2) It is unlawful for any person to initiate, maintain or cause to be initiated or maintained the use of any structure, land or property within the City without first obtaining any and all permits or authorizations required for its use by the applicable provisions of the Woodinville Municipal Code and/or the City's Shoreline Master Program.

(3) It is unlawful for any person to use, construct, erect, enlarge, alter, repair, move, improve, convert, equip, occupy, maintain, locate, demolish or cause to be used, constructed, located, or demolished, any structure, land or property within the City in any manner that is not permitted by the terms of any permit or authorization issued pursuant to the applicable provisions of the Woodinville Municipal Code and/or the City's Shoreline Master Program.

(4) It is unlawful to:

(a) Remove or deface any sign, notice, complaint or order required by or posted in accordance with this chapter;

(b) Materially misrepresent any fact or information in any application, plan or other document submitted to obtain any permit or other authorization from the City;

(c) Fail to comply with any of the requirements of a stop work order or emergency order issued under this chapter;

(d) Fail to conform to the terms of a shoreline substantial development permit, conditional use permit, variance or other permit issued pursuant to the City's Shoreline Master Program, or undertake a development or use on shorelines of the State without first obtaining the necessary shoreline permits or approvals, or fail to comply with a cease and desist order issued pursuant to the City's Shoreline Master Program.

(5) Subdivision Violations. Any person or any agent of any person who violates any provision of Chapter 58.17 RCW or WMC Title 20, which relates to the sale, offer for sale, lease, or transfer of any lot, tract, or parcel of land, shall be subject to prosecution under this chapter for a gross misdemeanor. Each sale, offer for sale, lease or transfer of each separate lot, tract, or parcel of land in violation of any provision of Chapter 58.17 RCW or WMC Title 20 shall be deemed a separate and distinct offense.

(6) Shoreline Master Program Violations.

(a) Pursuant to RCW 90.58.210, the City may impose penalties for Shoreline Master Program violations in an amount not to exceed $1,000 for each violation. Each day of violation shall constitute a separate violation.

(b) Any person who, through an act of commission or omission, aids or abets in a violation shall be considered to have committed a violation for the purposes of the civil penalty.

(c) When a penalty is imposed jointly by the Department of Ecology and the City, it may be mitigated only upon such terms as both the Department and the City agree.

(7) It is unlawful for any person to discharge or allow to be discharged any contaminants into surface and storm water or ground water. Contaminants include, but are not limited to, the following:

(a) Trash or debris;

(b) Construction materials;

(c) Petroleum products including but not limited to oil, gasoline, grease, fuel oil, heating oil;

(d) Antifreeze and other automotive products;

(e) Metals in either particulate or dissolved form;

(f) Flammable or explosive materials;

(g) Radioactive material;

(h) Batteries;

(i) Acids, alkalis, or bases;

(j) Paints, stains, resins, lacquers, or varnishes;

(k) Degreasers and/or solvents;

(l) Drain cleaners;

(m) Pesticides, herbicides, or fertilizers;

(n) Steam-cleaning wastes;

(o) Soaps, detergents, or ammonia;

(p) Swimming pool backwash;

(q) Chlorine, bromine, and other disinfectants;

(r) Heated water;

(s) Domestic animal wastes;

(t) Sewage;

(u) Recreational vehicle waste;

(v) Animal carcasses;

(w) Food wastes;

(x) Bark and other fibrous materials;

(y) Collected lawn clippings, leaves, or branches;

(z) Silt, sediment, or gravel;

(aa) Chemicals not normally found in uncontaminated water;

(bb) Any other hazardous material or waste not listed above.

(8) It is unlawful to:

(a) Fail to maintain Erosion and Sedimentation Control (ESC) measures in a proper manner;

(b) Park any vehicle in the front yard, side yard or rear yard areas, except upon legally established driveways. (Ord. 350 § 4, 2003)

1.07.040 Nuisance section.

The following activities and conditions are unlawful:

(1) Owning, leasing, renting, occupying or having charge or possession of any property in the city, including vacant lots, except as may be allowed by any other city ordinance upon which exists any of the following:

(a) Junk, trash, garbage, litter, discarded lumber and/or salvage materials in front yard, side yard, rear yard or vacant lot, which is visible from the public right-of-way or other private property;

(b) Attractive nuisances dangerous to children including but not limited to the following items when located in any front yard, side yard, rear yard or vacant lot:

(i) Abandoned, broken or neglected equipment;

(ii) Potentially dangerous machinery;

(iii) Refrigerators and freezers and other appliances;

(iv) Excavations, wells or shafts that are not properly fenced or covered;

(c) Broken or discarded furniture or household equipment, in any front yard, side yard or vacant lot, which is visible from the public right-of-way or other private property;

(d) Graffiti on the exterior of any building, fence or other structure in any front yard, side yard, rear yard or on any object in a vacant lot, which is visible from the public right-of-way or other private property;

(e) Vehicle parts or other articles of personal property which are discarded or left in a state of disrepair in any front yard, side yard, rear yard or vacant lot, which is visible from the public right-of-way or other private property;

(f) Distribute or possess for the purpose of sale, exhibition or display, in any place of business from which minors are not excluded, any devices, contrivances, instruments, or paraphernalia which are primarily designed for or intended to be used for smoking, ingestion, or consumption of marijuana, hashish, PCP, or any controlled substance other than prescription drugs and devices. (Ord. 350 § 4, 2003)

1.07.050 Severability.

Should any section, subsection, paragraph, sentence, definition, clause or phrase of this title be declared unconstitutional or invalid for any reason, such decision shall not affect the validity of the remaining portion of this title. (Ord. 350 § 4, 2003)