Woodin Creek Basin Habitat Assessment Final Report

Prepared for:

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WOODIN CREEK BASIN
HABITAT ASSESSMENT
FINAL REPORT
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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.

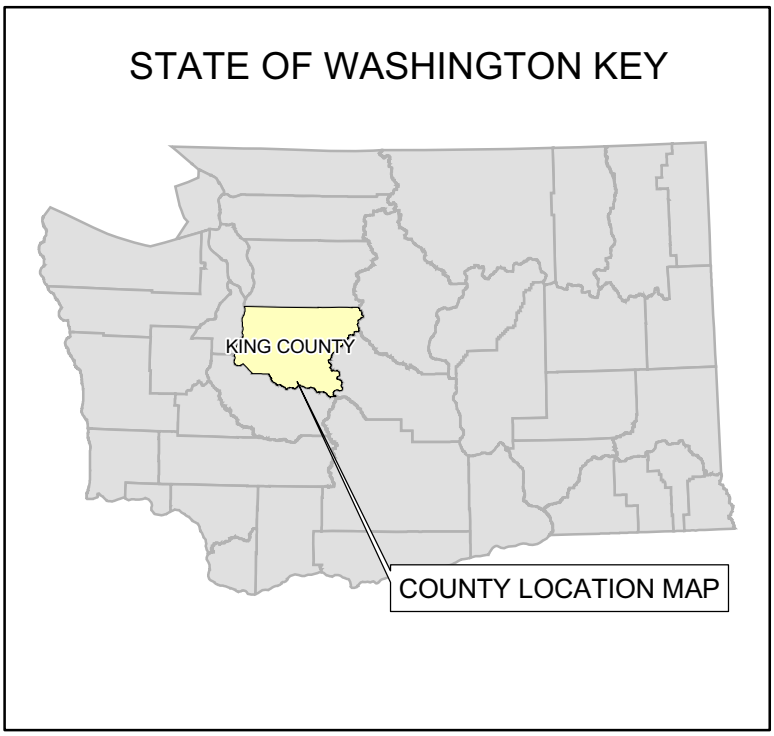
This study also has two secondary goals. The first is to identify potential limiting factors that support City-wide planning efforts aimed at the conservation and restoration of salmonid habitat within the City of Woodinville. The second and related goal is to provide information that may be used by 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.

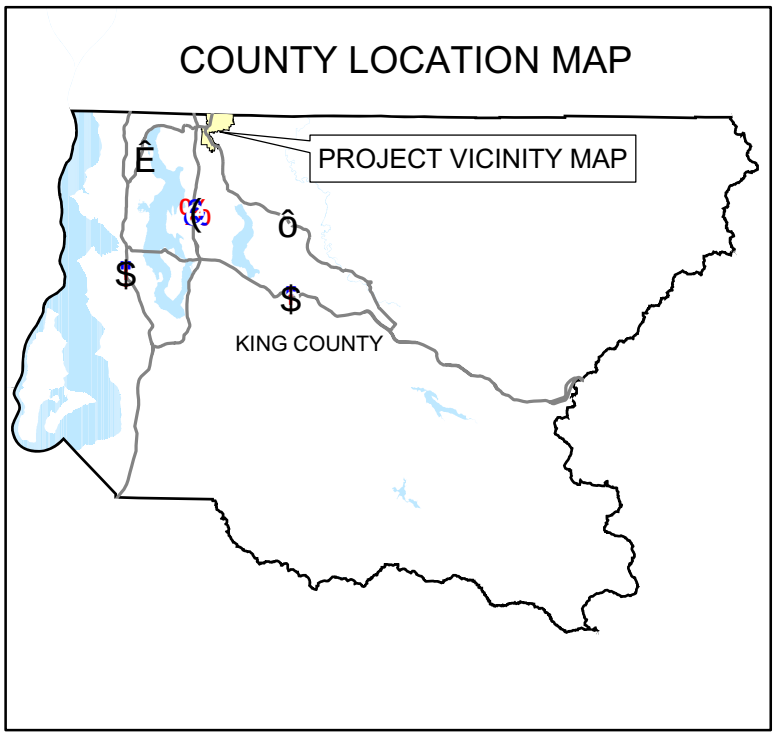
Regulatory Background

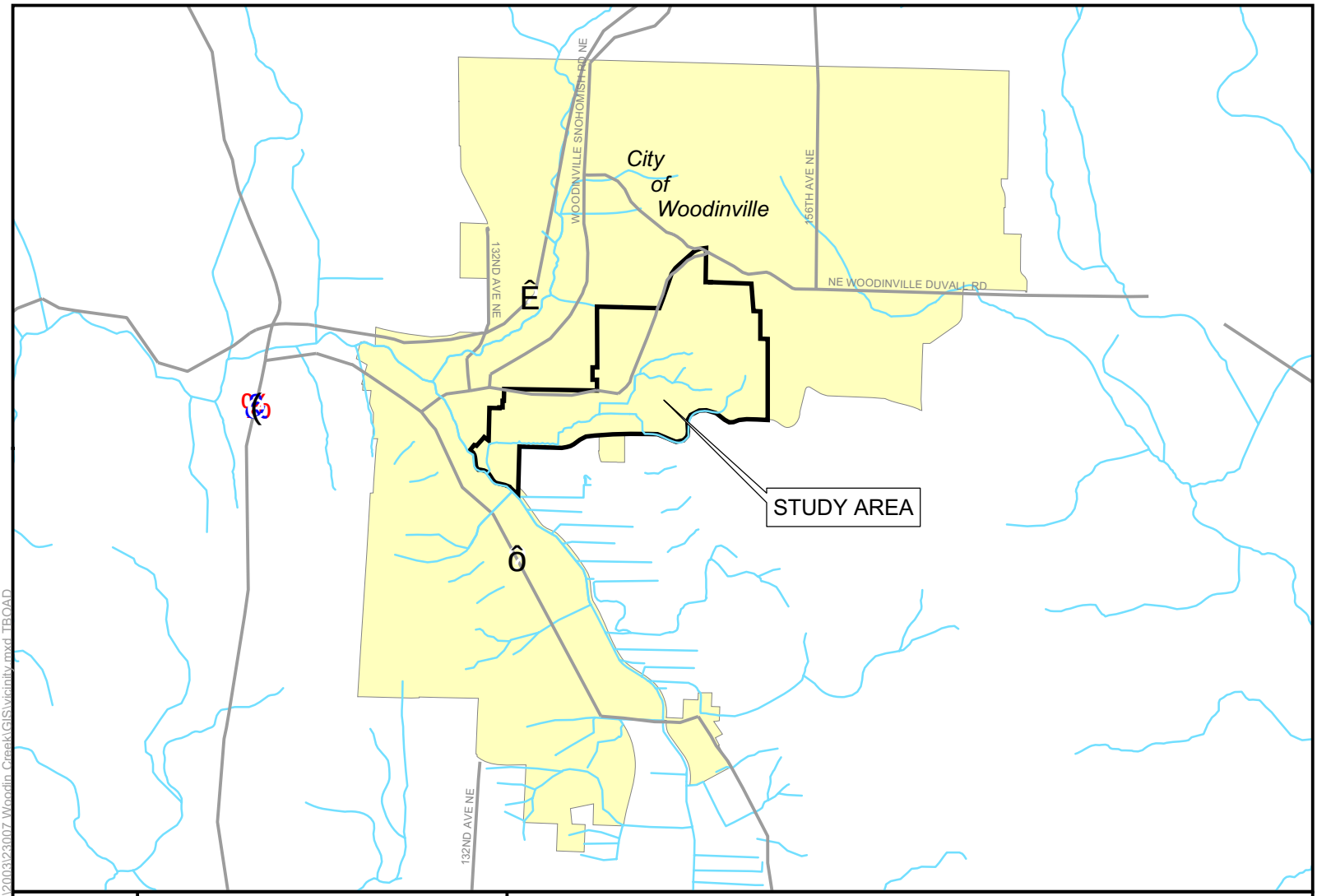
Due to the cultural and economic importance of anadromous fisheries in the Pacific Northwest, fish populations and habitat requirements in many of the regions larger stream systems are well studied. For example, The State of Washington, federal government, tribal governments, and regional water resource 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.

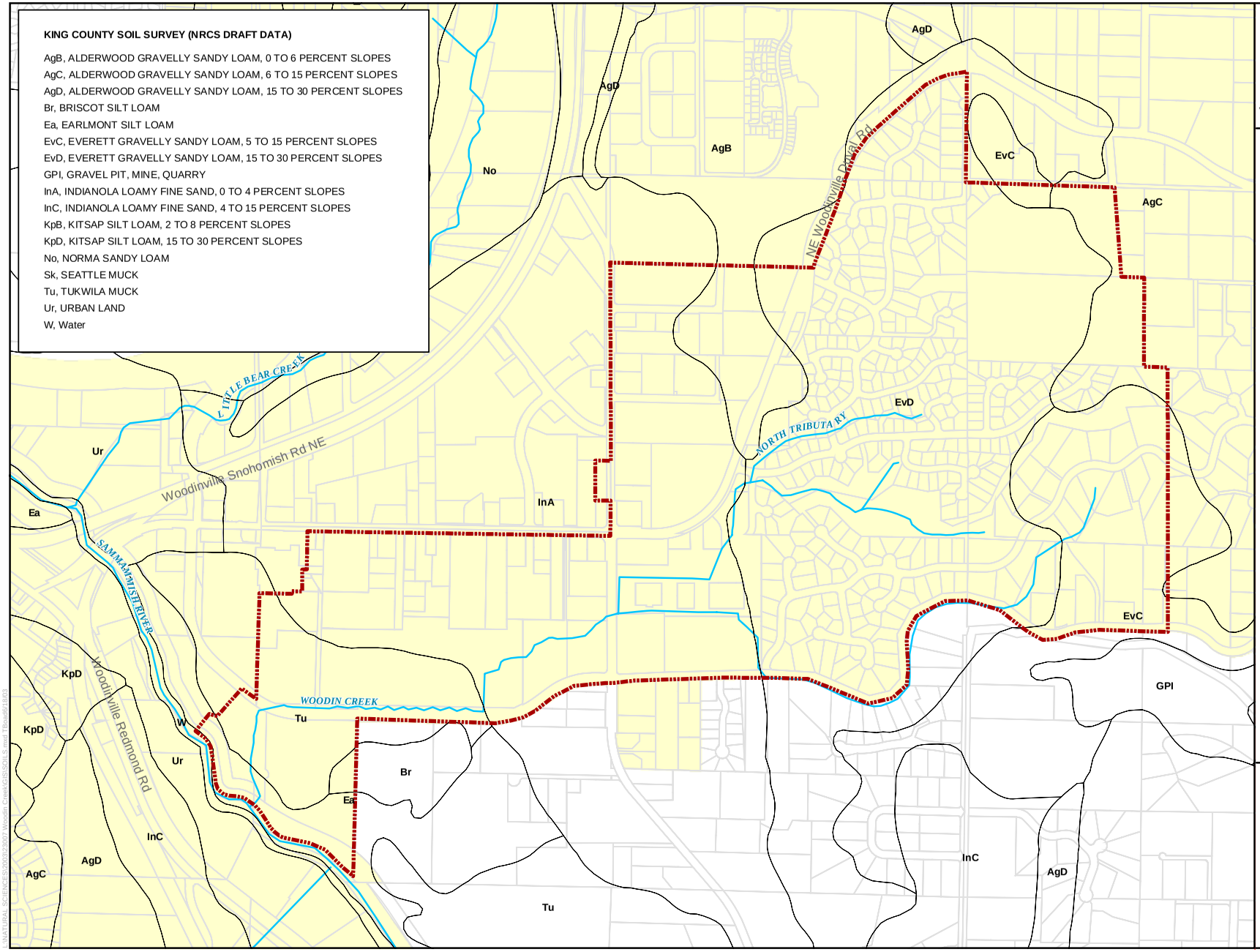
Source: Woodinville GIS 2002; King County GIS 2002; ESRI 2000

NO SCALE

FIGURE 1

VICINITY MAP
WOODIN CREEK BASIN
HABITAT ASSESSMENT
WOODINVILLE, WASHINGTON

\\NATURAL_SCIENCES\2003\23007 Woodin Creek\GIS\vicinity.mxd TBOAD


KING COUNTY SOIL SURVEY (NRCS DRAFT DATA)
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
Br, BRISCOT SILT LOAM
Ea, EARLMONT SILT LOAM
EvC, EVERETT GRAVELLY SANDY LOAM, 5 TO 15 PERCENT SLOPES
EvD, EVERETT GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES
GPI, GRAVEL PIT, MINE, QUARRY
InA, INDIANOLA LOAMY FINE SAND, 0 TO 4 PERCENT SLOPES
InC, INDIANOLA LOAMY FINE SAND, 4 TO 15 PERCENT SLOPES
KpB, KITSAP SILT LOAM, 2 TO 8 PERCENT SLOPES
KpD, KITSAP SILT LOAM, 15 TO 30 PERCENT SLOPES
No, NORMA SANDY LOAM
Sk, SEATTLE MUCK
Tu, TUKWILA MUCK
Ur, URBAN LAND
W, Water
AgD
AgB
AgC
EvC
EvD
No
Ur
Ea
InA
KpD
W
Tu
Br
InC
GPI
LITTLE BEAR CREEK
Woodinville Snohomish Rd NE
SAMMAMISH RIVER
Woodinville Redmond Rd
WOODIN CREEK
NORTH TRIBUTARY
NE Woodinville Duvall Rd
FIGURE 3
SOILS
WOODIN CREEK BASIN
HABITAT ASSESSMENT
WOODINVILLE, WASHINGTON
Study Area
Soils
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; NRCS 2002

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[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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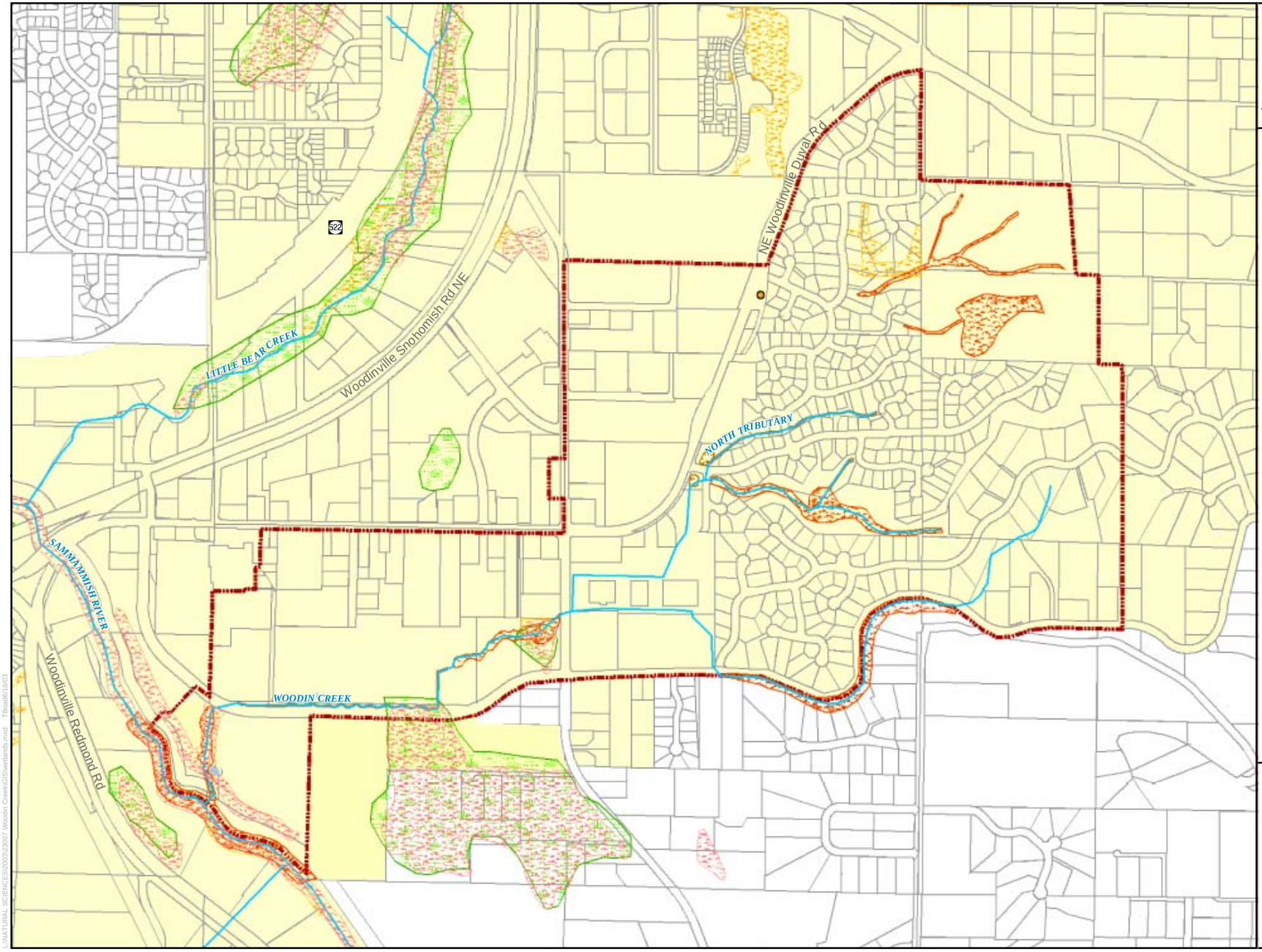

FIGURE 4

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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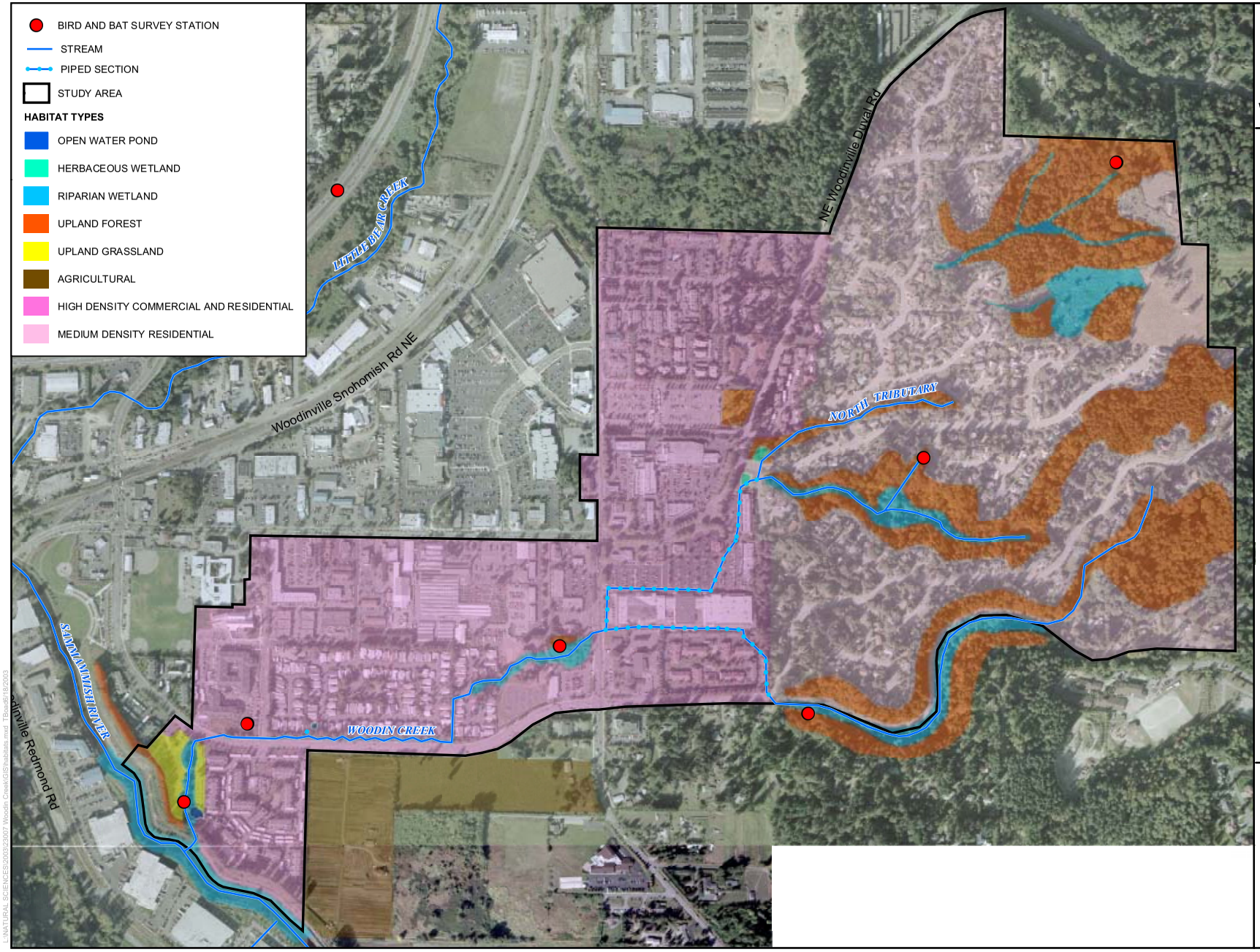

FIGURE 5

HABITATS

WOODIN CREEK BASIN
HABITAT ASSESSMENT

WOODINVILLE, WASHINGTON

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

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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 ºC (43 ºF) in February to 18 ºC (64 ºF) in July. Temperatures in the upper section (Reach 3) ranged from 4.7 ºC (40.5 ºF) in February to 21.3 ºC (70.3 ºF) 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 ºC (60.8 ºF). 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 15º C (59 ºF), and a maximum of 12.06 mg/L in Reach 3 on October 31, 2003, when the stream temperature was 6.5º C (43.7 ºF). 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 (ºC)					
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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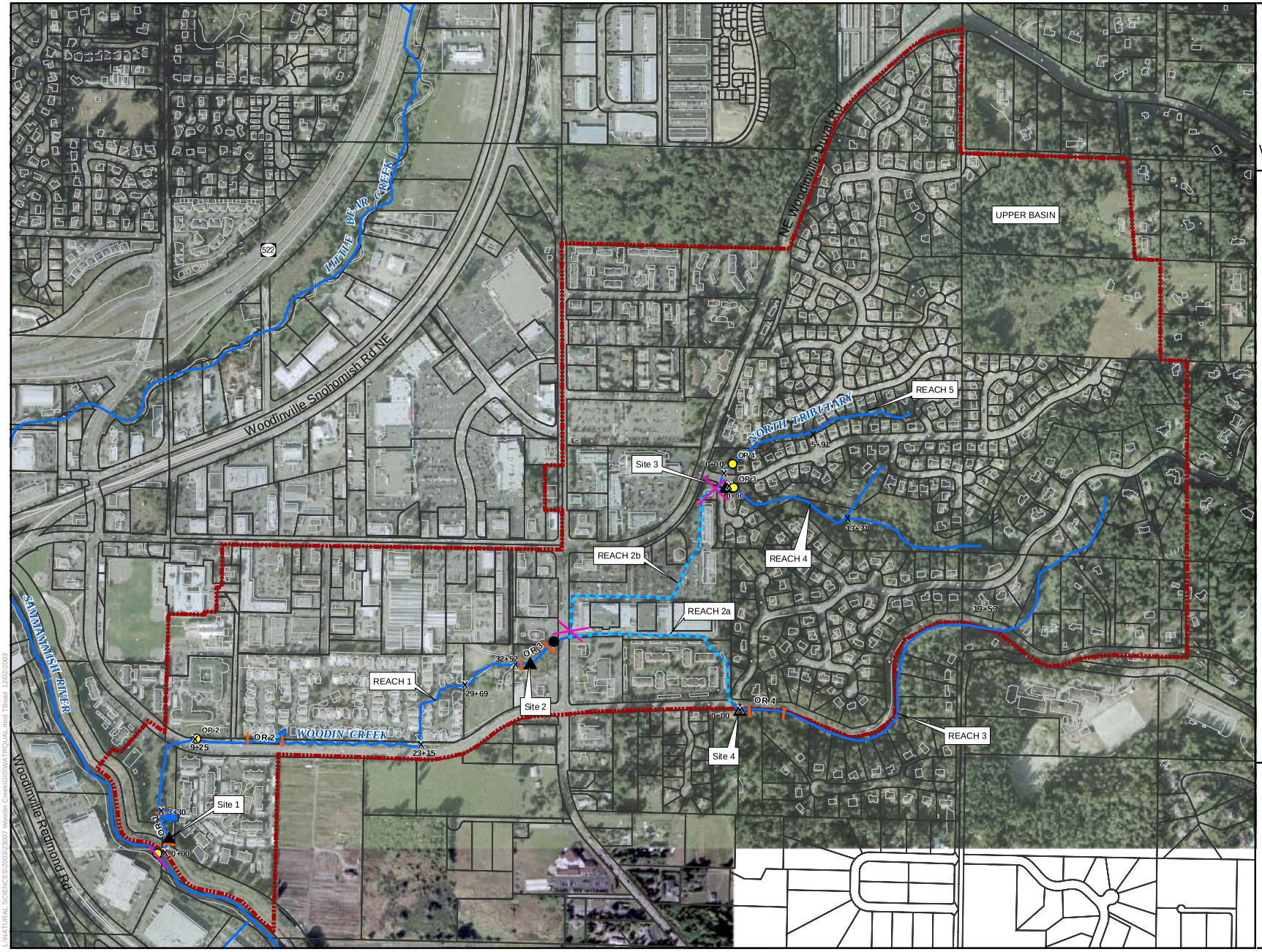

FIGURE 2

WATER QUALITY & SPAWNER SURVEY LOCATIONS

WOODIN CREEK BASIN HABITAT ASSESSMENT

WOODINVILLE, WASHINGTON

N
W E
S

- 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

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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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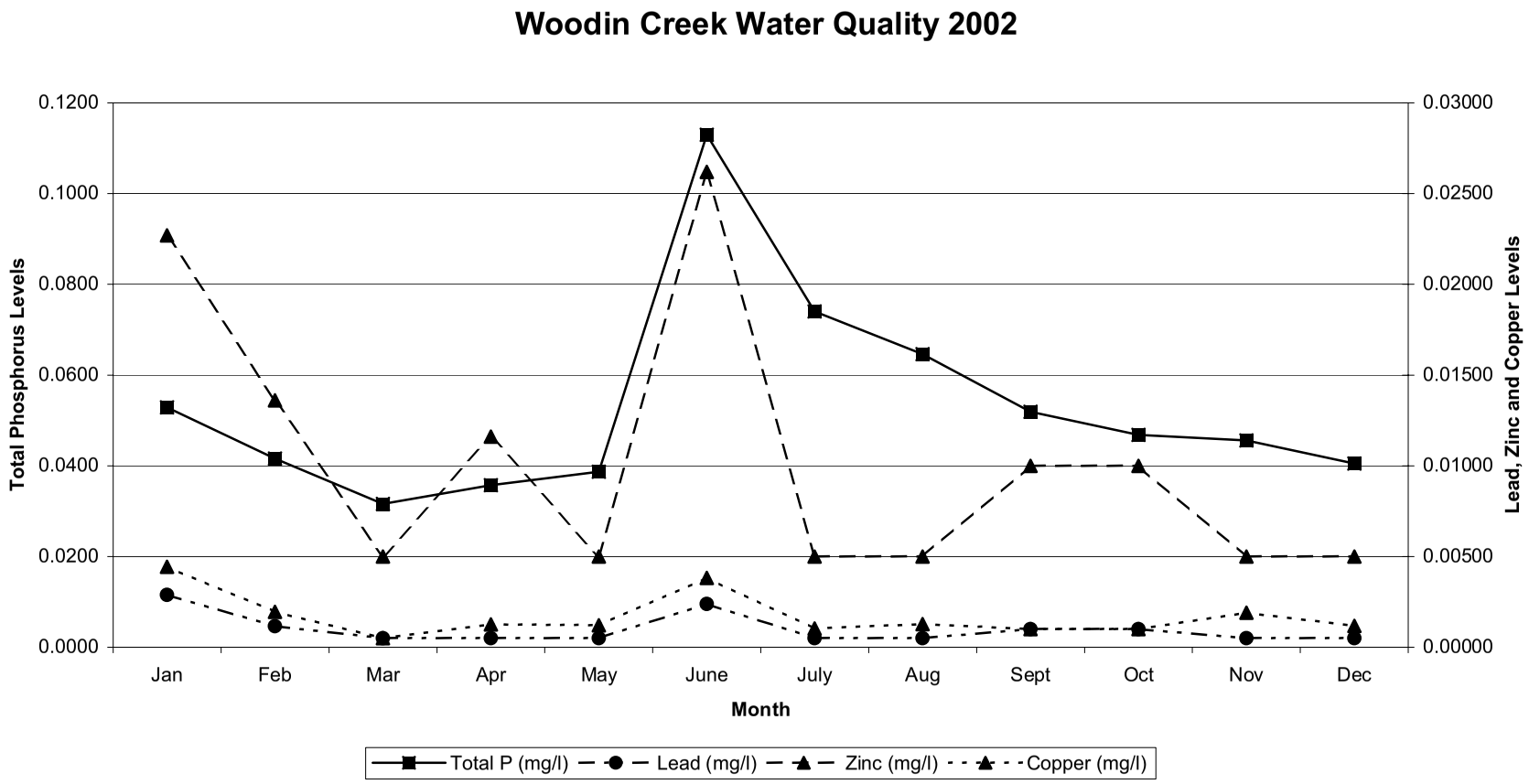
City of Woodinville

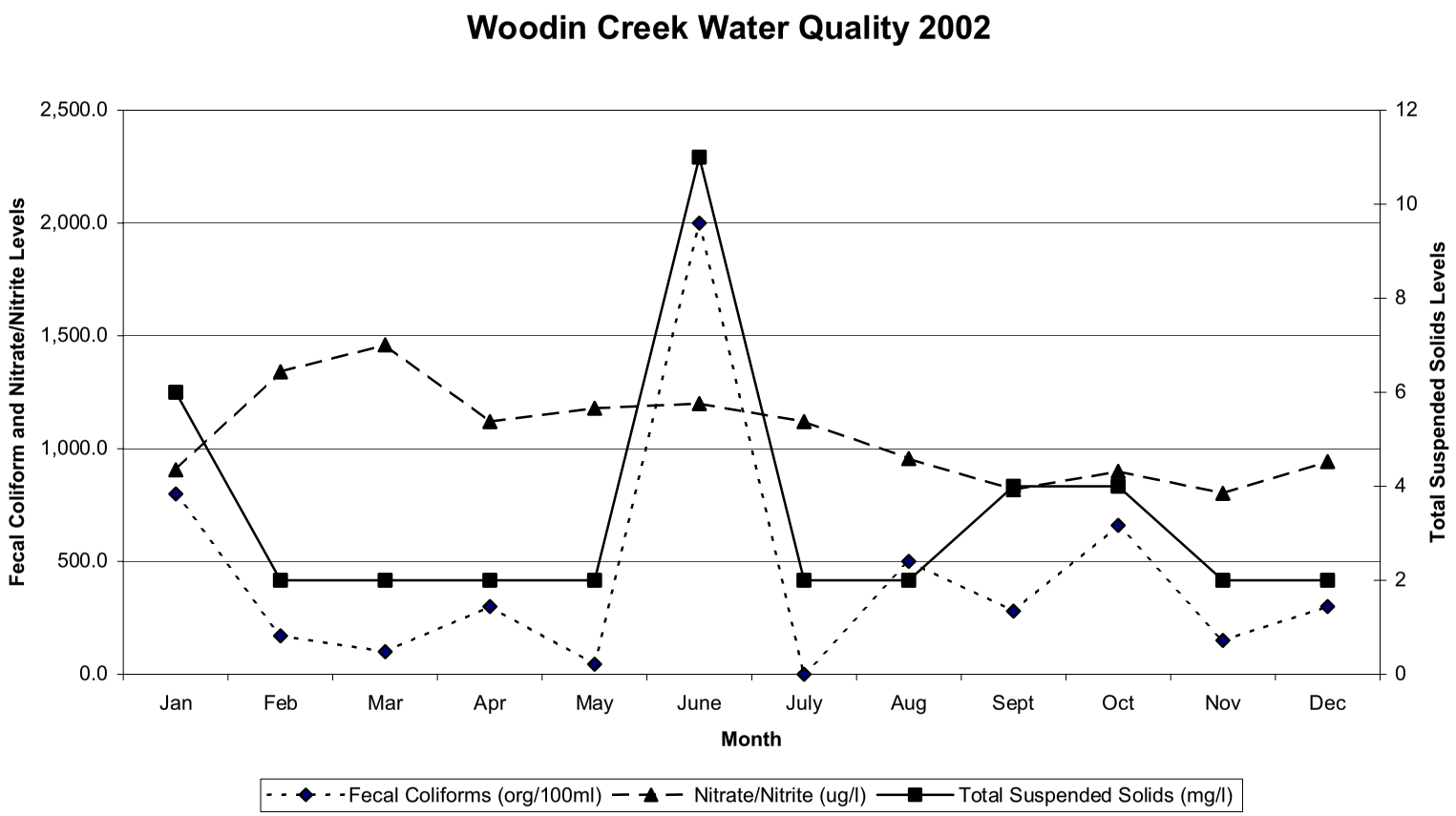
Woodin Creek Water Quality Data

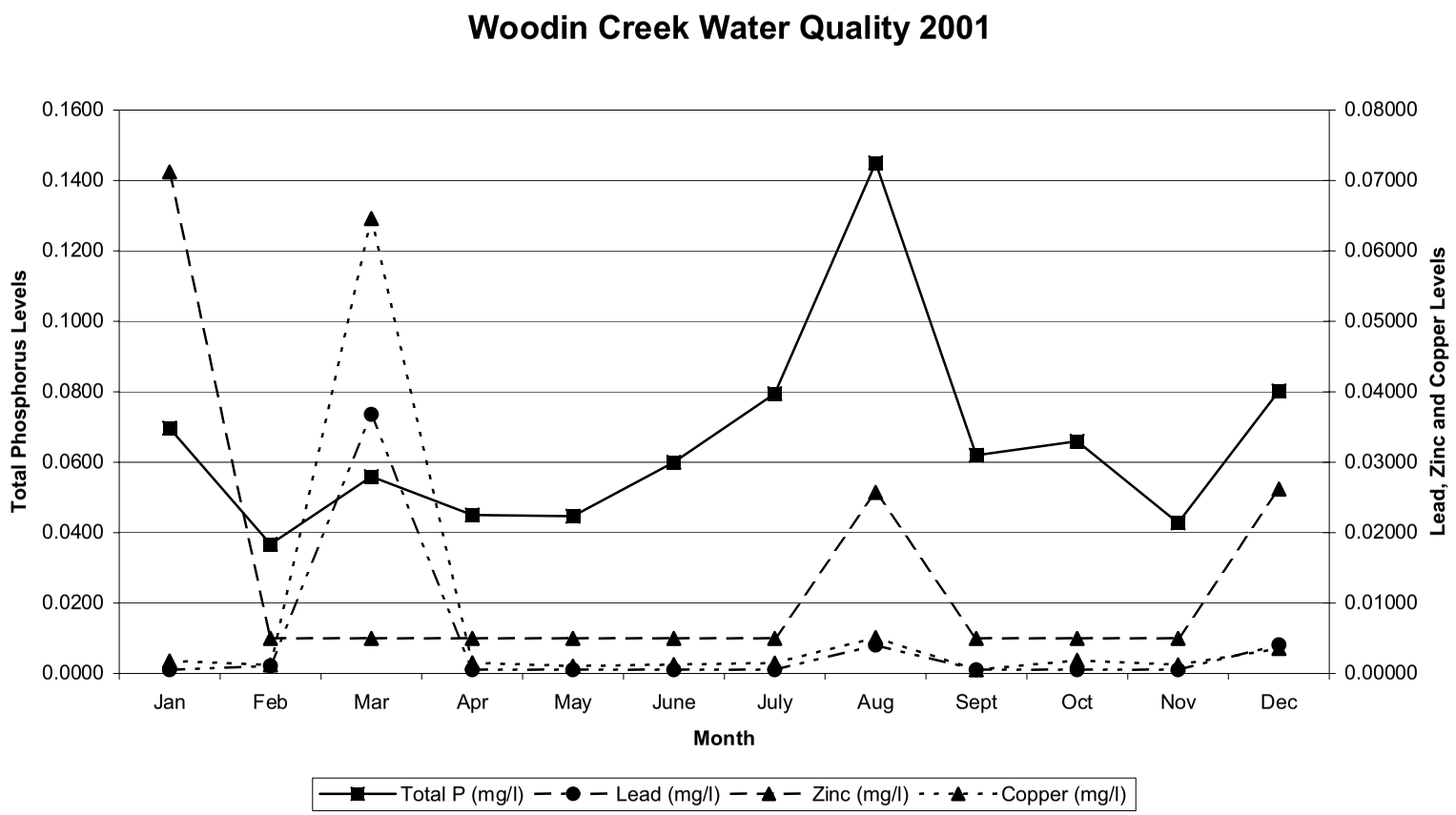
Collected by the City of Woodinville

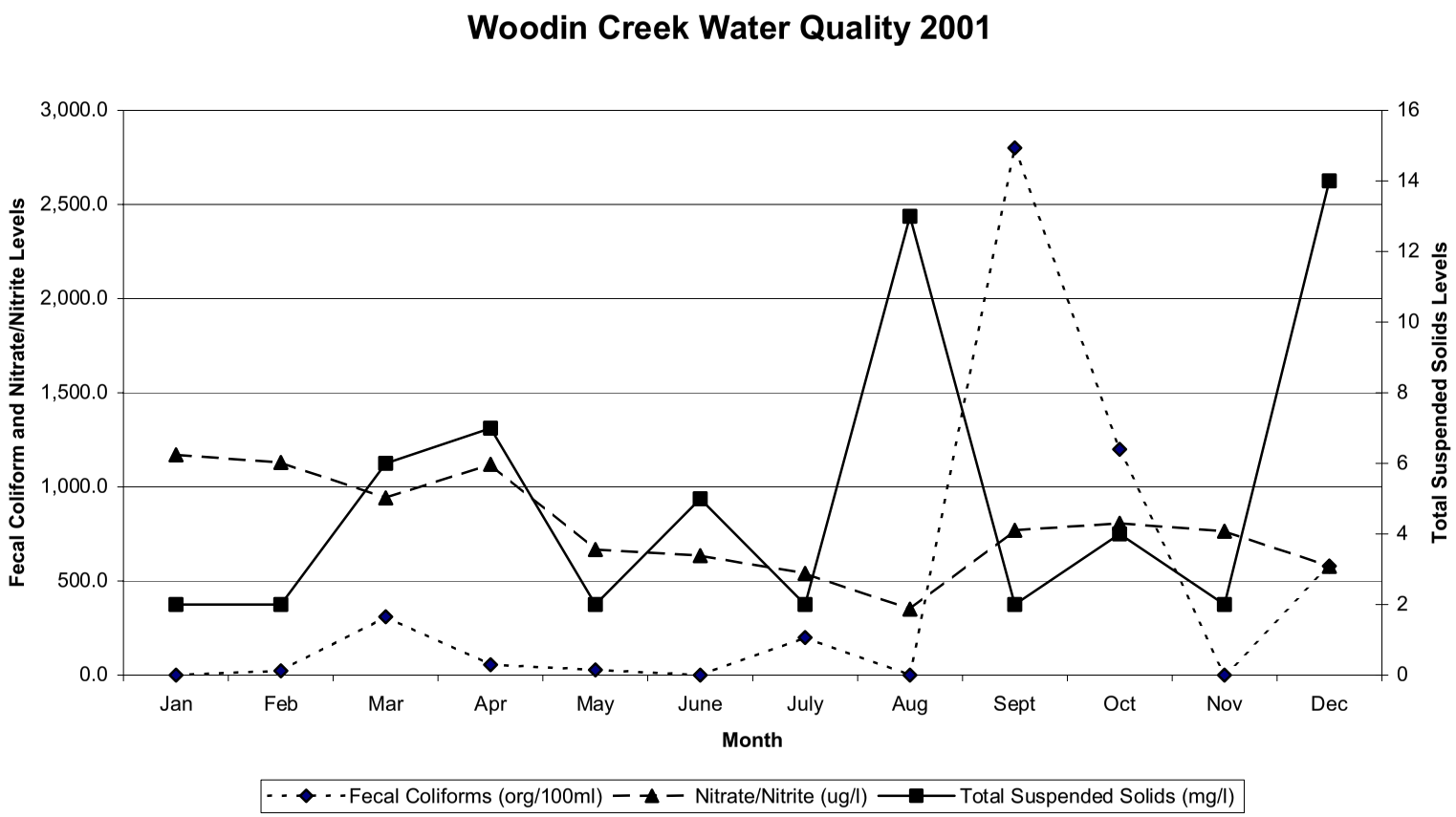
Date	Fecal Coliforms (org/100ml)	Nitrate/Nitrite (ug/l)	Total P (mg/l)	Total Suspended Solids (mg/l)	Lead (mg/l)	Zinc (mg/l)	Copper (mg/l)
Year 2000							
Oct	780.0	852	0.0849	19	0.00189	0.0158	0.00274
Nov	580.0	975	0.0025	63	0.00295	0.0230	0.00497
Year 2001							
Jan	0.5	1,170	0.0697	2	0.00050	0.0712	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

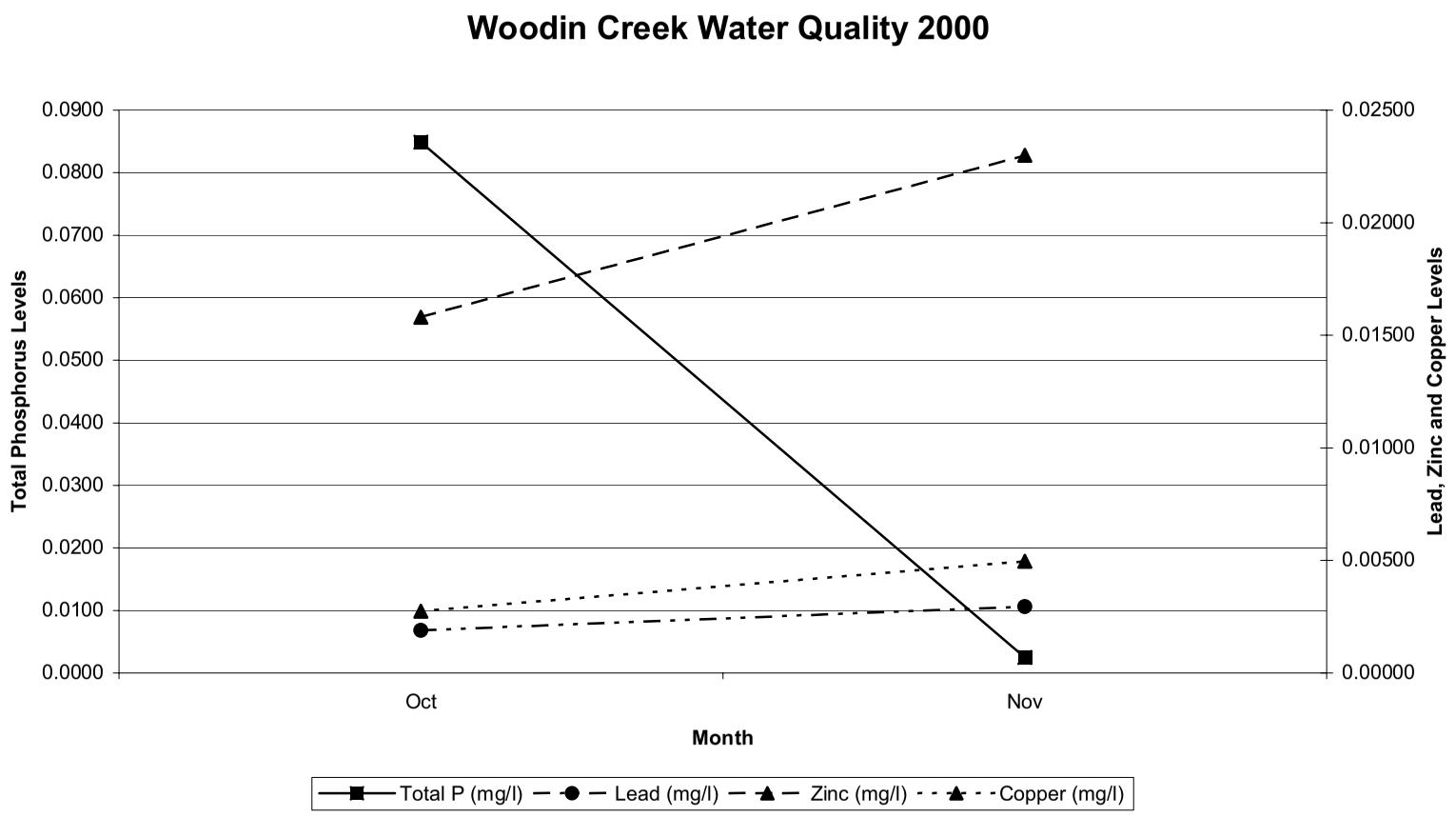
Year 2003							
Jan	430.0	1,230	0.0378	2	0.00050	0.0050	0.00050
Feb	160.0	1,130	0.0345	2	0.00050	0.0050	0.00050
Mar	55.0	1,160	0.0327	2	0.00050	0.0050	0.00050
Apr	140.0	879	0.0381	2	0.00050	0.0108	0.00200
May	91.0	922	0.0472	2	0.00050	0.0050	0.00050
June	350.0	0.926	0.0698	2	0.00050	0.0102	0.00050
July	220.0	0.731	0.1090	2	0.00050	0.0162	0.00160

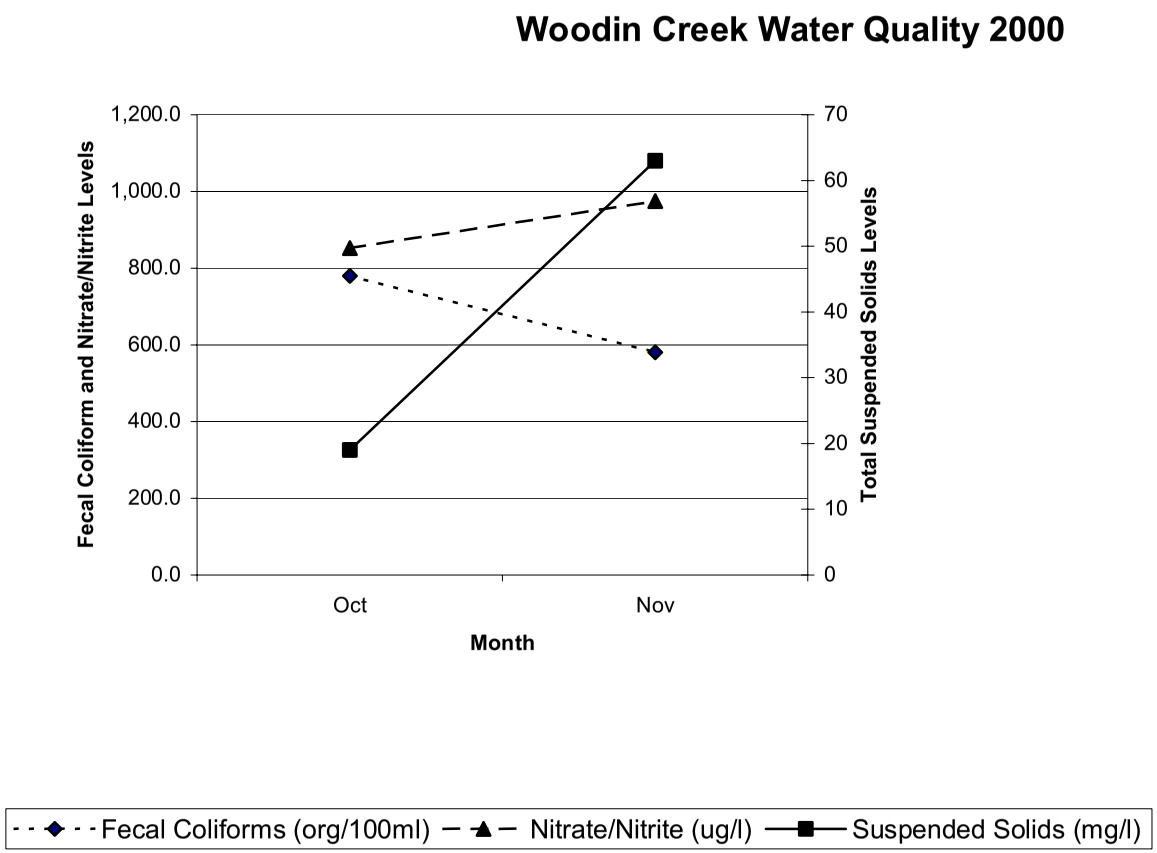

Woodin Creek Water Quality 2002
Total Phosphorus Levels
Lead, Zinc and Copper Levels
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
0.03000
0.02500
0.02000
0.01500
0.01000
0.00500
0.00000
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
Total P (mg/l)
Lead (mg/l)
Zinc (mg/l)
Copper (mg/l)


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
Lead, Zinc and Copper Levels
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
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
Total Suspended Solids Levels
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
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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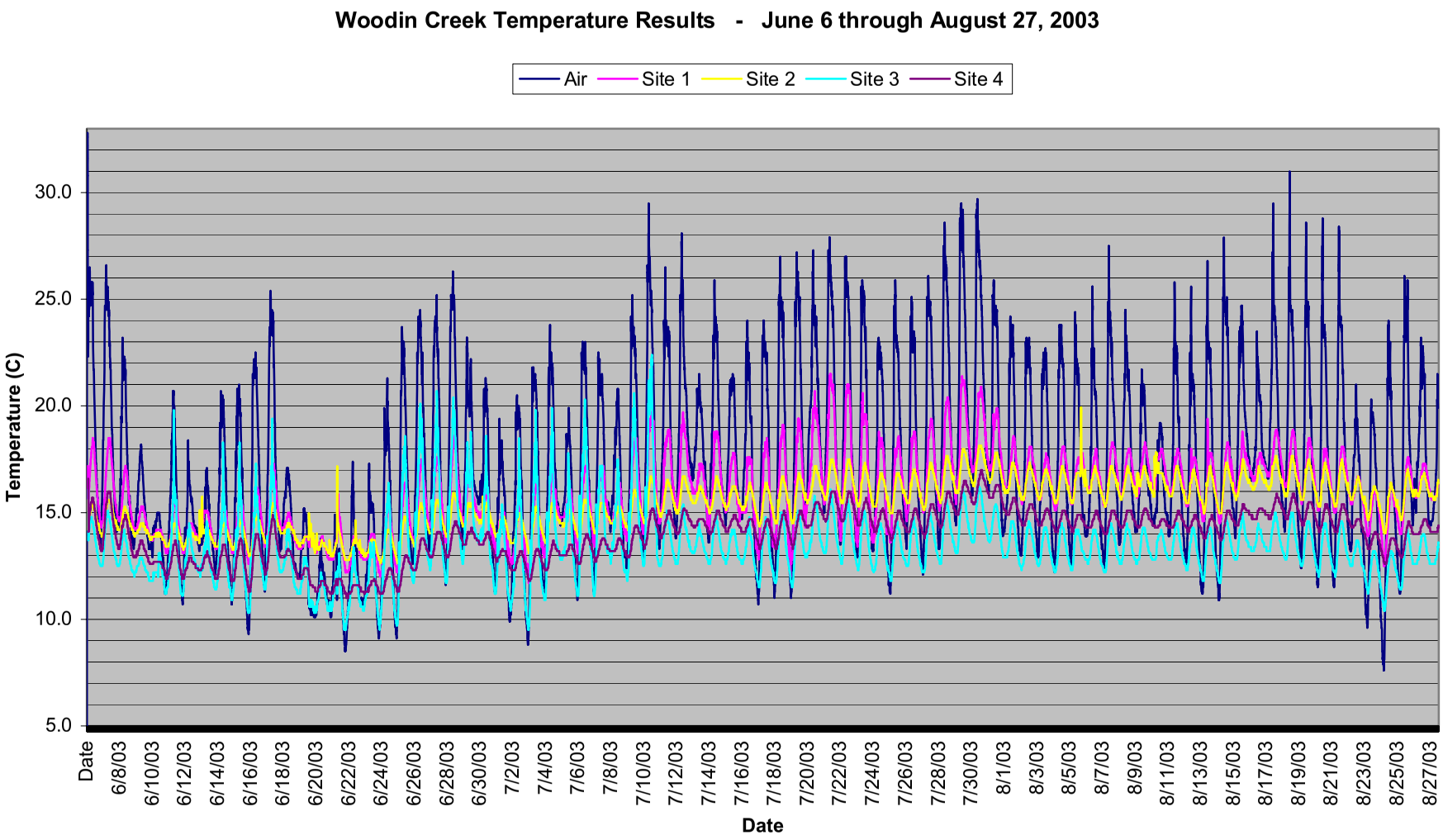
Woodin Creek Temperature Results - June 6 through August 27, 2003
Air
Site 1
Site 2
Site 3
Site 4
Temperature (C)
30.0
25.0
20.0
15.0
10.0
5.0
Date
6/8/03
6/10/03
6/12/03
6/14/03
6/16/03
6/18/03
6/20/03
6/22/03
6/24/03
6/26/03
6/28/03
6/30/03
7/2/03
7/4/03
7/6/03
7/8/03
7/10/03
7/12/03
7/14/03
7/16/03
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 to 2:30 pm

Stream # Stream Order: Survey Length (RM)

Weather Conditions Sunny

Investigators Ben 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. Alkatrys	1	22	10'	20" 21" max 10" Avg	18'	12"	22"	3	25	M	3	25	M	3/6		NONE					
	75 Chinook Parr/P-Mouth/Stk																				
	2	12	16'	3"	23'	6"	15"	3	25	m	3	25	m	NO RIPRAP							
	Sculpin													6/3							
	Redd under footbridge Remove Avg/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'	18"	A	C	O/R	L
																Installed					
																12'	15"	A	C	O	W/F
																12'	10"	A	C	O/R	L
	6	22	8'	12"	20'	8'	3	3	25	m	3	50	m	3/6	High	10'	18"	A	C	O	B/P
				21" max																	
	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"	21'	12'	27'	3	25	m	3	50	m	5/3	High						
				24"																	
	P-mth/min/Coho Juv?																				
	CP (Corner Pool) include small gravel tailout										up to 10 ft					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 | Basin # WOOLIN CREEK Reach 1 | Date 5/13/03 | Time 10:00am to 2:30pm

Stream # | Stream Order: | Survey Length (RM)

Weather Conditions SUNNY

Investigators Ben Burke & ALEX GITTAY

CH6 50' R.P. DARKS TO OTHER SIDE

	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/D	W
*	9	17	12'	13"	24'	15'	25"	3	25	M	3	25	M	3/6		18'	24"	A	C	S/D	B/C
			MAX 21"																		
														ANG/ROCK							
	10	1	4'	2"		8'	23"	3	100'	M	3	50	M	4/3							
								POND-													
								1	NO OUTLET		TO CRK										
	11	14	4'	8"		6'	32"	3	100'	D	3	25	D	3/4							
	12	1	4'	3"	52	4'	27"	3	100'	D	3	25	D	4/3							
	13	14	4'	6"	35	4'	28"	3	100'	D	3	30	D	4/3							
	14	17	15'	8"	30'	20'	32"	3	100'	D	3	25	D	3/4	HIGH						
			MAX 18"																		
	TOP OF HABITAT OLD Beaver Dam/Debris, blockage under 71 STATE															LOW FLOW					
	TRAPPING SUBSTRATE/SAND																				
	15	14	5'	3"	259'	8'	21"	3	25	D	3	25	D	3/3							
	8" Cut 15" Cut										CPARK/LAWN										
	Juvenile Cut Hgh #																				
	16	23			85'																
	DIAMETER 60" PIPE ARCH - PASSABLE - Stewed ANG CC															under					
	17	1	5'	4"	61	6'	19'	D-ROAD			3	100	D	3/4							
											Restoration										
	18	14	5'	5"	36'	6'	20"	3	10	D	3	75	D	3/4							
	19	17	5'	9"	14'	10'	28"	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	HIGH	30'	18"	A	C	S/D	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'	8.5"	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

49 + 47 19

17 — 36

ul- culvert

ADD AS CCX W FORD CROSSING

ARCH STONE

33RP DIAM PARALL

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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5=Large Gravel (25 mm-100 mm) 6=Cobble (100mm-256mm) 7=Boulder (*Note Dominant and Subdominant* [Dom/Sub])

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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]
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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 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	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	20	D	4/3							
4		Juvenile Cut																			
5	29	1	3'	6"	123'	4'	30"	3	25	M	3	25	M	4/3							
6	30	22	3'	8"	19'	4'	30"	0-ROAD						4/3	HIGH	30'	10"	A	C	S/O	L
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	1	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							
12				MAX 18"											MOD						
13	34	14	3'	6"	48'	4'	20"	0-ROAD			3	10	M	3/4							
14	35	1	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	1	6'	3"	40'	7'	15"	55	5	M	3	50	M	4/3							
23	40	14	3'	4"	123'	4'	22"	SS	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

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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 5/29/03 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														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	22	6	8	13'	6	+12							4/6	LOW	JUV. SALMONIDS					
26				10										ANG RR	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"	3	15	M	0			3/4							
30	POND ENTERS @ secondary channel / PHOTO @ 68 FT 2/3 PHOTOS																				
31	58	14	5'	4"	63	7	+18"	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

PHOTO 53 NOTES BENN

PHOTOS

RF=Reference # HT=Habitat Type W=Avg. Habitat Width D=Avg Habitat Depth CW=Avg Channel Width at OHWM

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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 11.08

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	SALMOND													
6	Rock	on	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	8'	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			3	50	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 6/5/07 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'	10"	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																10'	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	L
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'	25"	A	D	RO	B
34	93	9	4'	3"	3'	20'	2'	2	300	D	2	40'	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

Notes: 77 23 — Log W road; 81 — max 5"; 82 — same tree; 83 — max 8"; 84 — max 12"; 85 — these lot placed; 86 — max 8"; 87 — max 8"; 89 — max 8"; 90 — max 8"; 92 — old growth

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WOODEN [illegible]

WRIA Basin # _____ Basin # Reach 43 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							114'	22"	U	U	SO	B
3																18'	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	47'	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																250	32"	A	C	SR	B
10																30'	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	200'	D	2	~50'	D	4/5		20'	18"	U	U	RO	S
14																75'	24"	A	U	SO	B
15																200'	14"	A	U	RO	L
16																8'	14"	A	C	SO	L, L
17																8'	12"	A	U	RO	L
18																200+	38"	A	D	SO	B
19																80'	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	1.1	12"	A	U	RO	Root wad
23	101	1	3'	max 8"	43'	6'	16"	2	200'	D	2	50	D	5/4		30'	16"	A	U	RO	RW
24	WE1 = GPS coordinate; KS Groundwater seep erosion - photo w/stake # 1804															40'	10"	A	D	RO	B
25	WE2 = GPS coordinate for photo 1804															12'	12"	?	U	RO	L
26	102	13	3'	4'	4'	5'	10"	2	2m'	D	2	75'	D	3/5		13'	12"	U	D	RO	L
27	103	1	3'	max 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

Shot weed coming in

Another old growth stump.

Springs here

deep, incised

6/18/05

Erosion pt → photo of erosion

Log jam

Log under erosion bank (RB)

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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'	6'	24"	2	300'	D	2	50									
7	Left Bank & RB erosion																				
8	106	9	3'	10"	10'	5'	26	2	300	D	2	75	D	3/4							
9	107	1	4'	2" max 18"	93'	4'	20"	2	200'	D	2	100	D	5/3		40'	18	A	D	SR	B
10	2' 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'	26"	2	200'	D	2	100'	D	3/5	MOD	—	—	—	—	—	—
15	109	1	<1" max	1"	27'	5'	12"	2	200'	D	2	200'	D	4/5		50'	8"	A	U	RO	L
16	Island @ 21'					—		—	—		—	—		3	—	50'	30"	A	D	SR	B
17	110	13	8'	4" max 10"	10'	8'	18"	2	200	D	2	250	D	2							
18																					
19	111	1	3'	<1" to 0	232'	5'	28"	2	200	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	4'	2"	125'	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"	2	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'	12	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

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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 TRIBUTARY

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 Kruegger + Alex Otteby

	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: R452													75'	6"	A	D	RO	B
4																75'	10"	A	D	RO	B
5																5'	10"	A			B Root Stator
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	LOD	5'	10"	A	U	RO	D
10			Max 6"																		
11	116	1	4'	2"	481'	5'	14"	2	300	D	2	300	D	2/3							
12			Caddis fly & stonefly larvae observed													100'	10"	A	D	SR	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	D
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	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

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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 1:00 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/ Eroded Deposits @ 301' (RB)													–						
11	05-3	3	3'	1"	20'	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	10'	D	2	10'	D	2/3		–	–	–	–	–	–
18		STREAM ENDS - dry up above –																			
19																					
20																					
21																					
22																					
23																					
24																					
25																					
26																					
27																					
28																					
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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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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]

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.