City of Shoreline

McAleer Creek and Lyon Creek Basins Characterization Report

May2004

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CITY OF SHORELINE

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Prepared for:
City of Shoreline
Shoreline, WA

Prepared by:

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Project #3320005

McAleer Creek and Lyon Creek Basins Characterization Report
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EXECUTIVE SUMMARY

The Washington State Growth Management Act (GMA) requires every county and city in Washington to adopt policies and regulations that designate and protect critical areas, subject to continuing review and evaluation by the jurisdiction that adopted them. Recognizing unique environments and local values, each jurisdiction's policies, regulations and nonregulatory programs should be specific to the community needs and available resources. Counties and cities are required to utilize best available science (BAS) in developing policies and regulations to protect the functions and values of critical areas.

Citizens of the City of Shoreline place high value on environmental resources and open spaces. The first step in developing local policies, regulations and programs to protect critical areas is their identification. The Stream and Wetland Inventory and Assessment, including nine basins characterization reports, is our first step to identify critical areas including streams and wetlands in the City. Tetra Tech/KCM, a local consulting firm, was contracted to conduct this study.

The Stream and Wetland Inventory and Assessment provide extensive up-to date information for the City of Shoreline's streams and wetlands. In order to support preparation of critical area and surface water policies and regulations based on the best available science (BAS) requirements, Tetra Tech/KCM described in various chapters the methodology used to obtain the information regarding the streams and wetland functions.

The Tri-County Urban Stream Baseline Evaluation Method (USBEM) was primarily used in the basin characterization protocol. The basin characterizations are thorough enough for the reader to review methods and results for the stream reaches that were identified within the various basins. It is evident that the basins are complex and that this study was an ambitious undertaking.

It should be noted that the Stream and Wetland Inventory and Assessment are intended to be diagnostic first steps in surface water and watershed basin planning. The information presented in this study will help understand the function and values of streams and wetlands within Shoreline, and provide a solid basis for identifying critical areas. More specific identification of wetlands would be difficult and may only be determined during development review. Completing and constantly updating the study data and analysis will advance the primary intent of this study, which is collecting environmental data to support policy, regulations, and watershed basin plans.

1. INTRODUCTION

This basin characterization report for the McAleer and Lyon Creeks drainage basins was developed as part of the City of Shoreline's Stream and Wetland Inventory and Assessment. Basin characterization reports were developed for all drainage basins in the City as part of the inventory and assessment. These basins include the following:

- Boeing Creek Basin
- Thornton Creek Basin
- McAleer Creek Basin
- Lyon Creek Basin
- Middle Puget Sound Basin North

  Middle Puget Sound Basin South
- Bitter Lake Basin
- West Lake Washington Basin
- Seattle Golf Course Basin.

Characterization of the Lyon Creek Basin is included in the same report with that of the McAleer Creek Basins because of the basins' proximity and because the portion of the Lyon Creek Basin inside Shoreline's City limits is small. Other basins that are being combined into single basin characterization reports are Middle Puget Sound with Bitter Lake and Seattle Golf Course and Thornton Creek with West Lake Washington. The accompanying appendices provide supporting information.

Each characterization report includes a description of streams, wetlands, fish use and habitat in the basin. The work for each basin consists of three phases:

- **Phase I**—Collecting existing information, identifying the stakeholders in the basin and developing a strategy to involve private property owners in the planning process
- **Phase II**—Collecting field data to use in characterizing each basin, including an inventory of streams and wetlands and an assessment of fish presence and habitat condition
- **Phase III**—Characterizing each basin regarding streams, wetlands, fish presence and habitat, fish barriers, riparian habitat and preparing a report summarizing results of the inventory and assessment for the basin.

The information and recommendations presented in this report will be used by the City to develop projects and/or policies to address problem areas identified in the report, to assist the City's overall planning and permitting process, and to assist the City in complying with the Endangered Species and Clean Water Acts.

The citywide inventory and assessment was commissioned by the City of Shoreline and is partially funded by the Ronald Wastewater District and the King Conservation District.

PREVIOUS PLANNING EFFORTS AND STUDIES

Information from relevant documents was reviewed for integration into this basin characterization report. The original sources (listed in the reference list at the end of this report) should be consulted for comprehensive presentations of the overview provided here. A substantial amount of the information summarized in this report is taken from the following sources:

- *McAleer Creek Project.* KCM. 1983.
- *McAleer and Lyon Creek Drainage Basin Study.* HCW-L. 1999.
- *King County Sensitive Areas Map Folio.* 1990.
- *Basin Plan Review: 1981 Lyon Creek Watershed Comprehensive Drainage Plan.* July 1987.
- *Basin Plan Review: 1983 McAleer Creek Project.* June 1987.

PUBLIC INVOLVEMENT

Interested Shoreline residents participated in the development of this report. The City of Shoreline, which is leading the basin planning activities, facilitated mailings and public meetings. The following steps were included in the public participation process:

- Identify stakeholders within the basin, their interest, and their authority.
- Implement educational measures (e.g., newsletters, utility bill mailers, and public meetings).
- Involve residents in characterizing the basin.

The City of Shoreline held four public meetings and open houses to introduce and explain the Stream and Wetland Inventory and Assessment to City residents. One meeting was held for residents in each of the three major drainage basins including Boeing Creek (April 5, 2001), Thornton Creek (April 3, 2001) and McAleer Creek (April 10, 2001); one general meeting was held to explain the project with respect to all City drainage basins (April 11, 2001).

At each meeting, the City and Ronald Wastewater District set up explanatory stations to describe aspects of the Stream and Wetland Inventory and Assessment. Stations were staffed by City staff, Ronald Wastewater District personnel and consulting scientists. Participants were invited to submit their own observations, including wildlife sightings, evidence of significant erosion, flooding, or other problems and issues. Many of their observations were incorporated into the background information for this report. Appendix D contains handouts produced for the basin meetings.

Both the City of Shoreline and Ronald Wastewater District have ongoing programs to increase the environmental awareness of Shoreline residents, including working with elementary and high school students. The City of Shoreline employs a staff person whose primary responsibility is working with residents on environmental education issues.

On March 3, 2003, the City Council received the Draft Stream Basin Characterization Reports for their review. After a public testimony the Council referred this study to the Planning Commission to receive and review any new scientific information and to report to the Council its findings and recommendations.

On March 19, 2003, the Planning Commission Chair received a letter from the Washington Department of Fish and Wildlife (WDFW) that included several observations and raised potential issues regarding the subject reports and specifically two reaches of Thornton Creek including Peverly Pond. On March 20, 2003, Commissioners discussed the WDFW letter and concluded that a thorough review of the issues raised in the letter should be referred to the scientists who wrote the stream report for analysis and response.

The City of Shoreline asked Tetra Tech/KCM, Inc. to review the WDFW letter, examine scientific and other available material addressing Thornton Creek in context of Best Available Science (BAS) requirements, review Washington State Department of Transportation studies referenced in the WDFW letter, conduct additional evaluation of habitat quality in Thornton Creek Reach 8 (TC8), TC2, and Peverly Pond, and recommend to the City any potential need to modify the Stream Basin Characterization Report.

Tetra Tech/KCM, Inc. addressed the issues raised in the WDFW letter, conducted additional research, contacted Eva Wilder, WDFW scientist who raised several issues in the WDFW letter, and, with the support of City staff, conducted a biological evaluation of TC8, TC2, and Peverly Pond. Based on the scientific findings and analysis, they concluded that the information presented in the WDFW March 19 letter to the Planning Commission does not materially change what is contained in the draft Stream Basin Characterization report, specifically the Thornton Creek Basin Report.

The Planning Commission reviewed the additional information from Tetra Tech/KCM on November 20, 2003 and received public testimony. They continued their review on December 4, 2003 and again received additional testimony regarding Thornton Creek Reach 8 (TC8), TC2, and Peverly Pond. Rather than forwarding a recommendation to the City Council, the Commissioners provided staff with direction to remove the distinctions between "artificial open water course" and "open water course" within each of the Characterization Reports and to delineate and map more completely the wetland south of Twin Ponds (Figure 2-3). The City engaged again the services of Tetra Tech/KCM to use the Tri-County Urban Stream Baseline Evaluation Methodology (USBEM) on stream reaches that were classified as "artificial open water courses". Tetra Tech/KCM evaluation of the stream reaches and the maps are included in these reports.

2. STUDY AREA DESCRIPTION

Natural drainage in the City of Shoreline occurs in nine separate drainage basins including the north and south drainages of Middle Puget Sound (see Figure 2-1). The McAleer Creek Basin, the third largest basin in the City, encompasses approximately 1,300 acres. The small (185-acre) portion of the Lyon Creek Basin within the City limits drains into Ballinger Creek, a tributary to Lyon Creek. The basins are in the northeastern part of the City.

PLANNING UNITS

The first step in basin planning is to divide the basin into manageably sized planning units for analysis. The appropriate size of the planning units depends on the types of analyses to be performed. More detailed analyses require a smaller planning unit. The following analyses are included in the characterization report:

- Estimation of existing and future land use and corresponding percentage of impervious surface
- Analysis of land use as it relates to water and habitat quality
- Characterization of in-stream habitat quality
- Stream assessment including water quality, flooding and erosion issues, riparian habitat, and fish passage barriers
- Description of major wetlands

Subbasins

The size of the watershed planning units (subbasins) delineated for the McAleer and Lyon Creek Basins is less than 1 square mile. According to the *Rapid Watershed Planning Handbook* (Center for Watershed Protection 1998), measures to classify and manage streams are appropriate management approaches for this size of planning units. The drainage characteristics for subbasins of this size are strongly influenced by the amount of impervious surface within the basin.

The basin boundaries for McAleer and Lyon Creeks were created using several sources of information:

- **City of Seattle Basin Boundary**: This boundary was generated using topography from a 1993 aerial survey.
- **King County Drainage Map (1984)**: A drainage map created by King County was used to identify drainage based on existing stormwater drainage.
- **City of Shoreline**: Portions of the drainage boundary were field verified by the City of Shoreline.
- **King County Aerial Survey (2001)**: Contour lines generated from a 2001 LIDAR aerial survey were used to verify topographic boundaries.
- **McAleer and Lyon Creek Drainage Basin Study (June 1999)**

- **McAleer Creek Project (May 1983).**
- **Basin Plan Review: 1981 Lyon Creek Watershed Comprehensive Drainage Plan (July 1987).**
- **Basin Plan Review: 1983 McAleer Creek Project (June 1987).**

Topography defines basin and subbasins limits. Subbasins were delineated based on the King County Aerial Survey (2001). The McAleer and Lyon Creek Subbasins are shown in Figure 2-2.

McAleer Creek is the outlet stream from Lake Ballinger in Snohomish County. Its basin boundary for this study includes all the area inside the City of Shoreline that drains to Lake Ballinger as well as the areas draining directly to the creek or its tributaries downstream of the lake. The Lake Ballinger drainage areas in the basin are west of 5th Avenue NE and the areas draining to McAleer Creek and its tributaries are east of 5th Avenue NE. Subbasins have been delineated as follows:

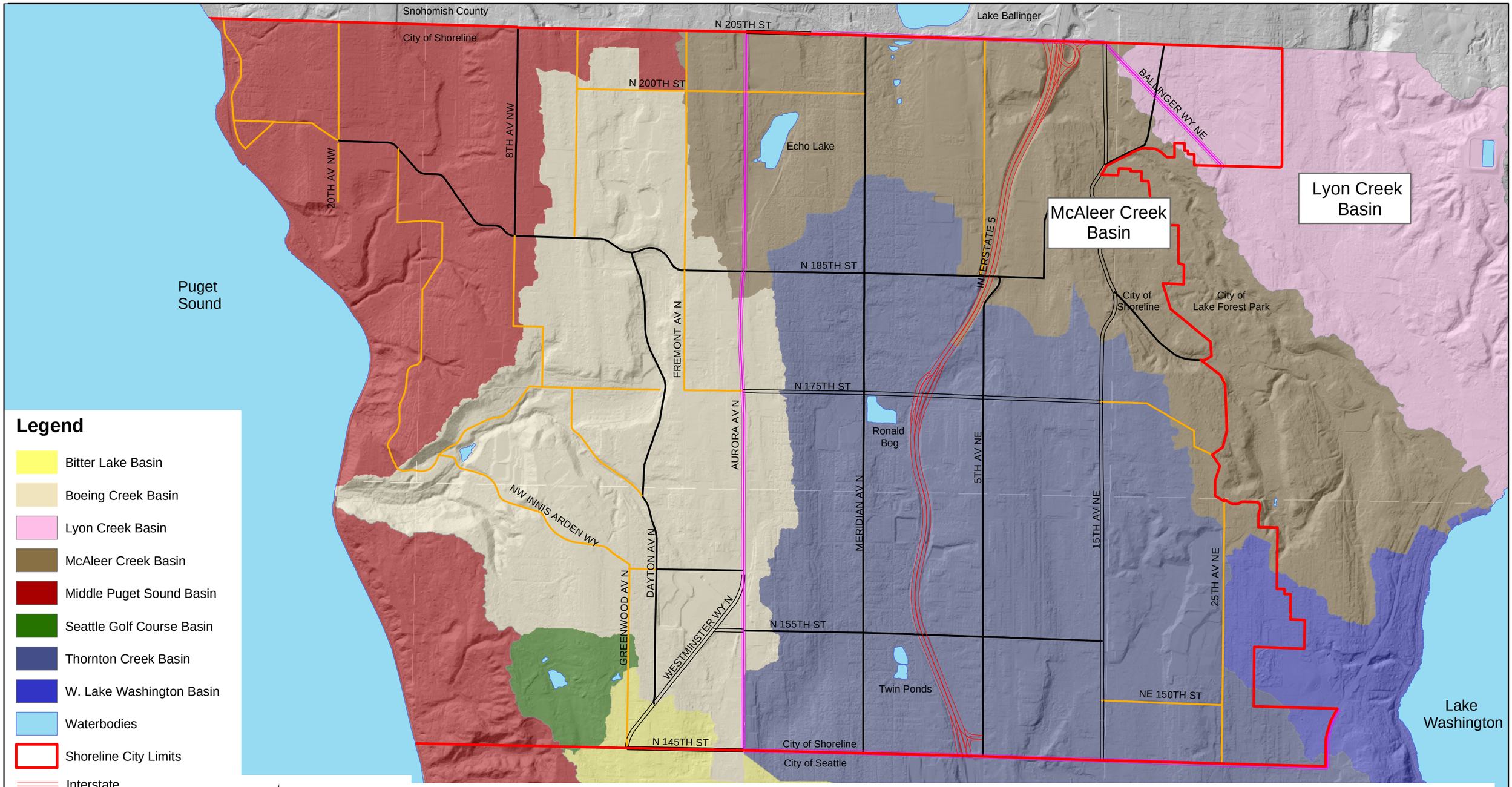
- Subbasins MC-E and MC-G both drain to Lake Ballinger but are treated separately for this study because Subbasin MC-F, the Echo Lake Subbasin, lies between them.
- Subbasin MC-F drains to Echo Lake within the City limits, with drainage ultimately continuing to Lake Ballinger.
- Subbasin MC-D is a closed depression.
- Subbasin MC-C drains north into the portion of McAleer Creek in Snohomish County.
- Subbasin MC-B consists of the area that drains directly into McAleer Creek.
- Subbasin MC-A consists of the area that drains to the Whisper Creek and Brookside Tributaries of McAleer Creek.

The Lyon Creek Basin occupies only 0.3 square miles within the City limits. This is smaller than the area identified by the *Rapid Watershed Planning Handbook* as appropriate for subbasin planning, so the Shoreline portion of the Lyon Creek Basin was not further divided.

Stream Reach Planning Units

Dividing a stream into reaches provides a structure for recording stream habitat information and for prioritizing improvement projects. Preliminary stream reaches were defined in the office using topographic and hydrographic data from the City of Shoreline Geographic Information System (GIS). Uniform hydraulic characteristics such as channel gradient and alignment were used to develop the preliminary reaches, since stream reaches with uniform hydraulic characteristics generally have uniform fish habitat features.

The stream reaches mapped based on GIS data were refined using information gathered in a stream reconnaissance. During the reconnaissance, the preliminary stream reaches were verified for predominantly homogenous characteristics. Each stream segment, referred to as "open water course" in the map legend, was designated as a reach. This includes sections



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For regulatory purposes, segments within a reach are classified on a site-specific basis. The mapping in this document provides a general guide to classification.

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Figure 2-1
Drainage Basins

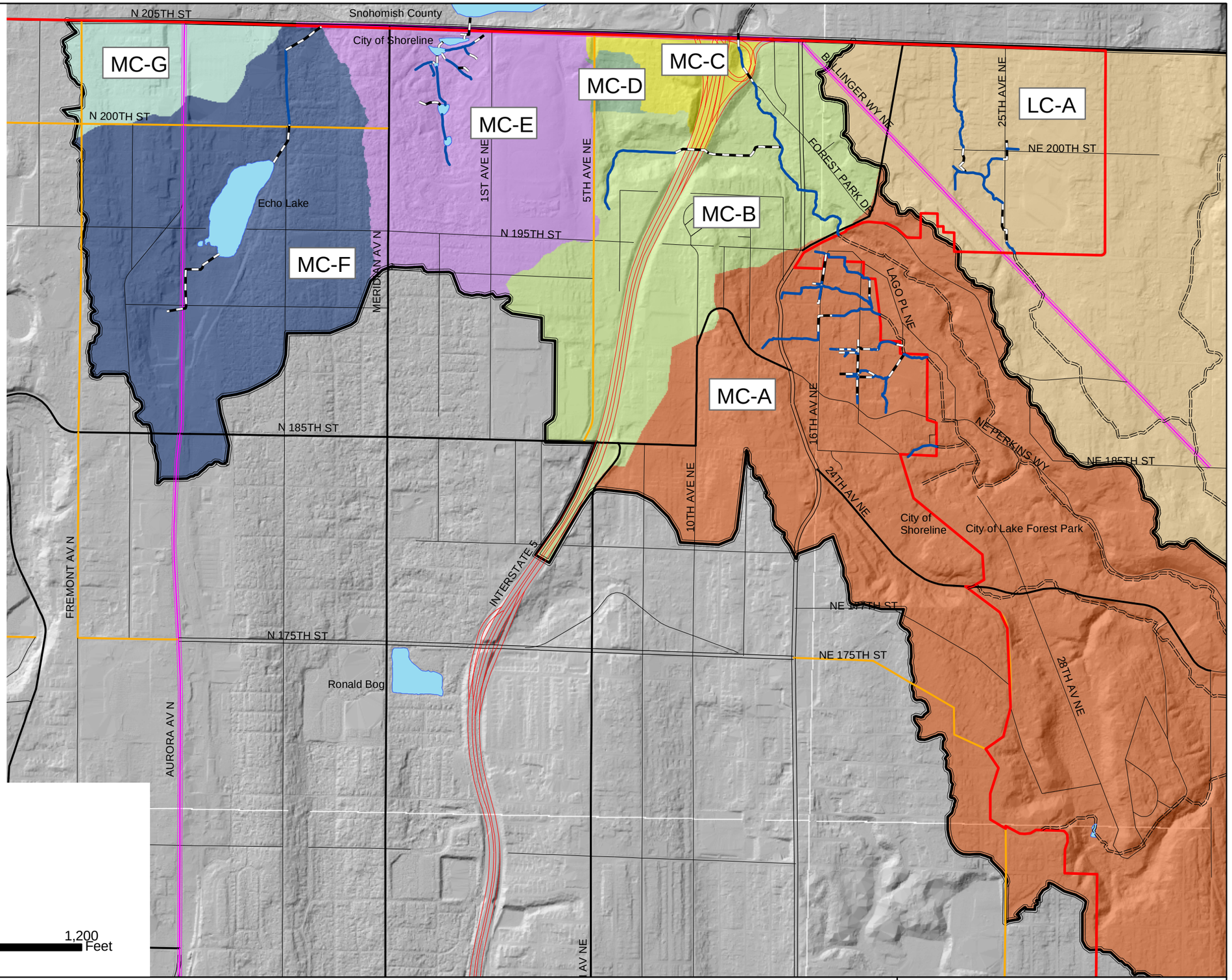
Legend

McAleer Subbasins

- Subbasin MC-A
- Subbasin MC-B
- Subbasin MC-C
- Subbasin MC-D
- Subbasin MC-E
- Subbasin MC-F
- Subbasin MC-G

Lyon Creek Subbasin

- Subbasin LC-A
- Basin Boundary
- Open Water Course
- Piped Water Course
- Stream Outside City
- Waterbodies
- Shoreline City Limits
- Interstate
- State Route
- Principal Arterial
- Minor Arterial
- Collector Arterial
- Residential Street



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N

1,200 600 0 1,200 Feet

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Figure 2-2
Subbasins

that are obviously ditched or channelized. Some reaches were not entirely homogenous; a reach designated as an open water course, for example, may have small sections that are piped (piped water course). Reaches which were a combination of open water course and piped mapped based on the predominant characteristic within their reach boundaries.

The inventory conducted as part of the stream reconnaissance included a field survey of significant points such as fish passage barriers, stream alignment changes, flow branch and flow confluence locations, and selected stormwater catchbasins. A Leica GS50 global positioning system (GPS) receiver was used to record the locations of the surveyed features. The GPS database has been provided to the City of Shoreline. The results of the reconnaissance and survey were incorporated into the development of the planning units. The stream reaches for McAleer and Ballinger Creeks are shown in Figure 2-3.

HISTORICAL ASSESSMENT

Over the years, natural water courses have been modified into ditches or placed into pipes as the City of Shoreline experienced residential and commercial development and construction of its road network. *A Salmon Guide to Lake Forest Park* (LFPSF 2001) cites an early resident of the area constructing a wooden flume within McAleer Creek and its ravine to carry logs from Lake Ballinger (previously know as McAleer Lake) to Lake Washington. Apparently the flume was only used for several years while his company was clearing the original town site of Edmonds.

LAND USE

Existing Land Use

Current land use in the McAleer Creek Basin is predominantly residential, although there is a moderately large commercial/industrial section along the Aurora Avenue corridor. There are small areas of schools, parks, open space, the cemetery, and Echo Lake. Roads make up the largest impervious area in the basin. Figure 2-4 shows the existing land use patterns in the basin.

In the Lyon Creek Basin, the most common land use is single- and multi-family residential, but there is a mix of all other land uses in the area. The commercial uses are clustered along NE Ballinger Way north of 19th Avenue NE. Multi-family is also found along NE Ballinger Way, mostly south of 19th Avenue NE. A large school complex is at the intersection of 25th Avenue NE and NE 200th Street. Bruggers Bog and Ballinger Park are located along 25th and 24th Avenues NE, respectively (KCM 1997).

Estimates of existing land use in 1997 documented that 54 percent of the basin was developed as either single-family or multi-family residential. Roads and transportation corridors also dominated the basin, accounting for 21 percent of the land use. Parks, vacant land and open space accounted for 4 percent of the existing land use, and 12 percent of the land use was classified as lake/pond/wetland areas. The remainder of the basin was estimated to be a mix of schools, offices, businesses and cemeteries.

Impervious Surface Area Percentage

Human alteration of the landscape, including clearing, grading, paving, building and landscaping changes the physical features that affect hydrologic and biological processes. Soil compaction and paving reduce the infiltration and storage capacity of soils, which in turn lessens groundwater recharge and base flows in streams. These high flow rates can cause flooding and destroy aquatic and riparian habitat by eroding banks, removing riparian vegetation, filling stream riffles and pools and creating debris jams. Heavy rains can lead to a runoff process called Horton overland flow, whereby the rainfall rate exceeds the infiltration rate, and the excess precipitation flows downhill over the surface. This type of flow results in water rapidly reaching a stream or built conveyance system, causing more frequent and much higher peak flow rates than would occur with the natural landscape. These flows increase the erosive force in the creeks and can result in bank failure and channel incision. Development not only increases peak flow rates, but also changes annual and seasonal runoff volumes. By quantifying the percentage of the basin that is covered with impervious surface, the rainfall-runoff relationship in the basin can be described, and appropriate mitigating measures can be implemented.

For this report, impervious area is expressed as total impervious area (TIA), which is defined as the amount of actual impervious area. Features included in TIA include roofs, roads, driveways, and any other surface that prevents water from infiltrating into the ground. This area is calculated by adding up or estimating all of the area of impervious surfaces within a basin. TIA is expressed as a percentage of the total surface area.

The TIA was computed for each subbasin using the ArcView GIS software program. Table 2-1 shows the estimated TIA for general land use types as defined by the City. Knowing the amount of each existing land use type, and knowing the percent impervious value for each land use type, it was possible to directly compute the average TIA for each subbasin, as shown in Table 2-2.

For this analysis, City of Shoreline staff obtained impervious surface data from a variety of sources. King County provided data for properties whose owners pay the surface water management utility fee. These properties encompass the commercial, multi-family residential, public facilities, parks/cemeteries, and institution land use categories. The County tallies the amount of impervious surface for commercial and institutional parcels to determine the utility fee.

For the single-family residential land use, City of Shoreline staff sampled six lot-size categories ranging from less than 5,000 square feet to larger than 43,560 square feet (1 acre). Staff analyzed 1999 aerial photos to determine the percentage of impervious surface for each of 130 residential parcels. From this analysis, staff calculated and applied a percent impervious factor for six residential lot sizes. These percentages were applied to the actual area of each single family lot in the basin to determine total impervious area for the single family land use type. For transportation, staff chose to use a percent impervious value of 70 percent, based on analysis by the Snohomish County Surface Water Management Division.

Legend

- Open Water Course
- Piped Water Course
- Stream Outside City Limits
- Wetlands
- WL-S Wetland ID
- MC1 Reach ID
- Reach Start Point
- Fish Passage Barrier
- Detention Pond
- Parks
- Lyon Creek Basin
- McAleer Creek Basin
- Waterbodies
- Shoreline City Limits
- Interstate
- State Route
- Principal Arterial
- Minor Arterial
- Collector Arterial
- Residential Street

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N

1,200 600 0 1,200 Feet

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Figure 2-3
Stream Reaches, Wetlands and Fish Passage Barriers

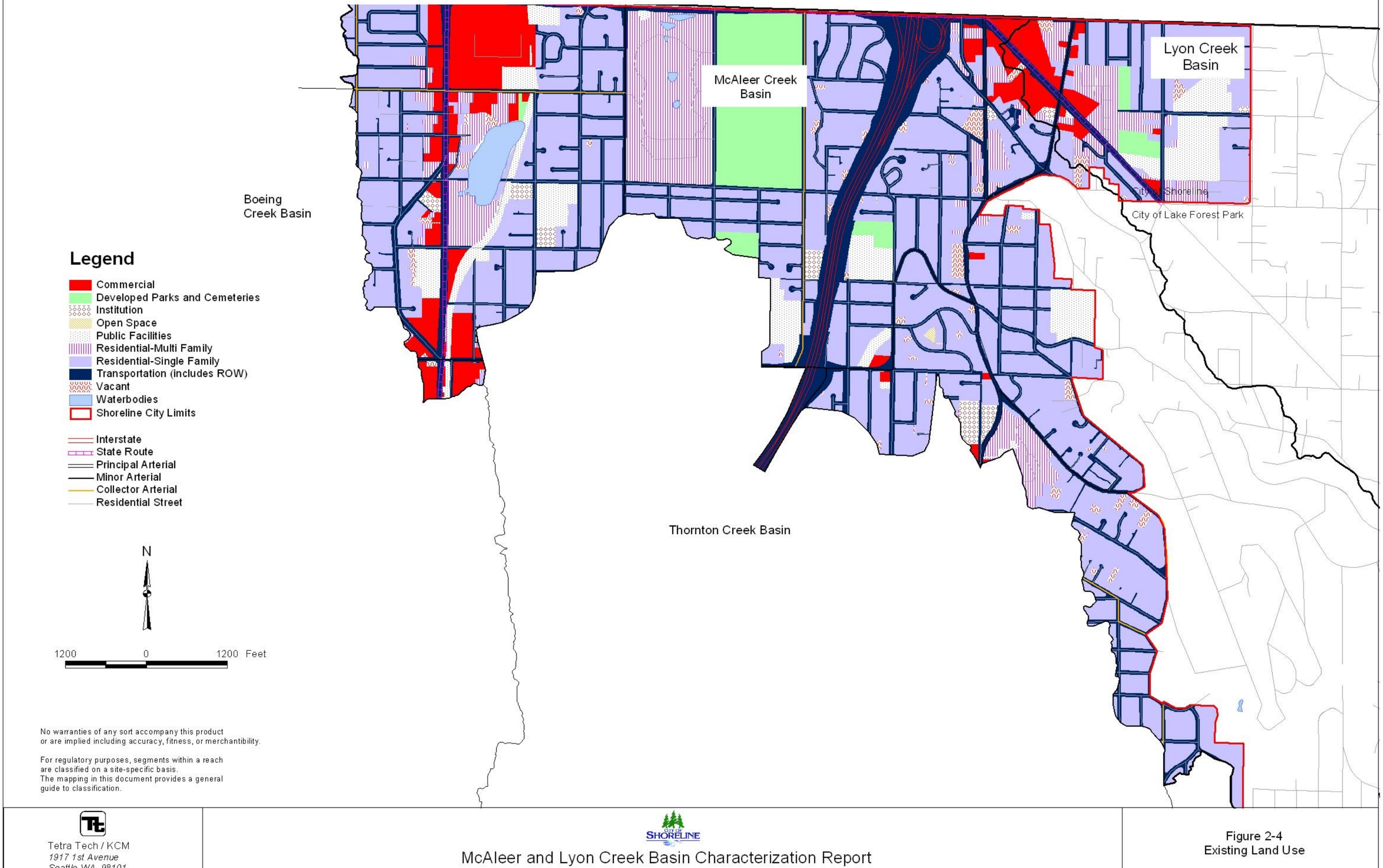

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Figure 2-4
Existing Land Use

TABLE 2-1.
GENERAL LAND USE CATEGORIES AND ASSOCIATED PERCENT IMPERVIOUS VALUES

Land Use	Percent Impervious
Commercial	87
Residential/Multi-Family	73
Public Facilities	55
Institution	57
Transportation	70
Open Space	0
Parks/Cemetery	12
Residential (Lots Less Than 5,000 SF)	57
Residential (Lots 5,000 to 7,199 SF)	40
Residential (Lots 7,200 to 10,890 SF)	36
Residential (Lots 10,891 to 21,780 SF)	28
Residential (Lots 21,781 to 43,560 SF)	19
Residential (Lots More Than 43,560 SF)	17

Source: City of Shoreline

TABLE 2-2.
EXISTING PERCENT IMPERVIOUS VALUES FOR McALEER AND LYON CREEKS SUBBASINS

Subbasin Identification	Percent Impervious
MC-A	42
MC-B	49
MC-C	58
MC-D	46
MC-E	29
MC-F	56
MC-G	65
LC-A	47

The weighted averages of the existing percent impervious values computed for the McAleer and Lyon Basins are 46 percent and 47 percent, respectively. The weighting includes a factor for the subbasin area. The only subbasin with a TIA less than 30 percent is Subbasin MC-E with a TIA of 29 percent. The subbasins with the highest concentration of TIA are Subbasins MC-C (58 percent), MC-F (56 percent), and MC-G (65 percent). Subbasins MC-F and MC-G both drain into Lake Ballinger and the lake's large storage volume may provide some mitigation of the effects on McAleer Creek of impervious surface in these subbasins. Impervious area in Subbasin MC-C, which drains directly to McAleer Creek, would have a greater impact on the creek.

The other basins that drain directly to the creek or its tributaries, Subbasins MC-A and MC-B, also have high TIA values: 42 percent and 49 percent, respectively. The McAleer

Creek Regional Detention Pond, located at the outlet of Subbasin MC-B, likely mitigates some of the Subbasin MC-B and MC-C impacts downstream of the detention pond.

Future Land Use

The City's zoning plan specifies the current potential for future land use within the basin. Under current zoning, as shown in Figure 2-5, low-density residential zoning (R-4 and R-6) makes up the largest area in the basin. Commercial areas are largely limited to the existing commercial corridors along Aurora Avenue North and NE Ballinger Way. Multi-family zoning is located along a significant portion of the 15th Avenue NE corridor.

With the exception of parks and open space, which are typically zoned residential but will not be developed in the future for that use, the City's current zoning plan was used to estimate the maximum potential increase in the amount of impervious surface. The zoning plan was chosen over the City's Comprehensive Plan to estimate future land use because it is consistent with the Comprehensive Plan Future Land Use Map but, unlike the Comprehensive Plan, is based on specific standards for maximum impervious surface area defined in the Shoreline Municipal Code. Table 2-3 lists the zoning categories and their associated maximum percent impervious values, as defined in Section 20.50.020 of the Shoreline Development Code. The future TIA analysis assumed that the basin would be fully built-out according to the maximum allowed impervious area as specified in the City's Development Code.

TABLE 2-3.
ZONING CATEGORIES AND ASSOCIATED
PERCENT IMPERVIOUS VALUES

Land Use	Percent Impervious
Developed Parks and Cemeteries	15
Open Space	0
Residential, 4 units/acre	45
Residential, 6 units/acre	50
Residential, 8 units/acre	65
Residential, 12 units/acre	75
Residential, 18 units/acre	85
Residential, 24 units/acre	85
Residential, 48 units/acre	90
Neighborhood Business	85
Office	85
Community Business	85
Regional Business	95
Industrial	95
Transportation ROW	70
North City Business District	95
Contract Zone	85

Source: City of Shoreline

Boeing
Creek Basin

Thornton
Creek Basin

McAleer Creek
Basin

Lyon Creek
Basin

City of Shoreline

City of Lake Forest Park

Legend

Future Land Use

- R-4; Residential, 4 units/acre
- R-6; Residential, 6 units/acre
- R-8; Residential, 8 units/acre
- R-12; Residential, 12 units/acre
- R-18; Residential, 18 units/acre
- R-24; Residential, 24 units/acre
- R-48; Residential, 48 units/acre
- O; Office
- NB; Neighborhood Business
- CB; Community Business
- NCBD; North City Business District
- RB; Regional Business
- I; Industrial
- CZ; Contract Zone
- Waterbodies
- Shoreline City Limits

- Interstate
- State Route
- Principal Arterial
- Minor Arterial
- Collector Arterial
- Residential Street

N

1200 0 1200 Feet

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Representation of official zoning map adopted by
City Ordinance No. 292. This map shows
amendments through November 13, 2001.

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Figure 2-5
Future Land Use
Based on 2001 Zoning

The future percent impervious values for the subbasins in the McAleer and Lyon Creek Basins were computed using the ArcView GIS software program. Future impervious surface area was calculated for each parcel in the basins based on the maximum allowed impervious surface percentage for that parcel's zone in the Shoreline Development Code, multiplied by the area of the parcel.

City parks and open space were given a future percent impervious value based on studies done in other jurisdictions and the professional opinion of staff. It was assumed that developed parks would see additional development of impervious surfaces to accommodate new park facilities and appurtenances, while open space areas would remain natural and free from new development. Table 2-4 lists the percent impervious in each subbasin for full build-out conditions using these assumptions.

TABLE 2-4.
FUTURE PERCENT IMPERVIOUS VALUES
FOR McALEER AND LYON CREEKS SUBBASINS
AT BUILDOUT

Subbasin Identification	Percent Impervious
MC-A	56
MC-B	59
MC-C	63
MC-D	55
MC-E	40
MC-F	68
MC-G	72
LC-A	64

The weighted averages of the future percent impervious values for the McAleer and Lyon Creek Basins are 58 and 64 percent, respectively. Subbasin MC-E, which contains the 73-acre Holyrood Cemetery, would have the lowest percent impervious in the two basins under buildout conditions. The McAleer subbasin with the largest increase from existing conditions is MC-A, which has a potential TIA increase of 14 percent.

Subbasins MC-C and MC-G have only the lowest potential increase from existing to future conditions, indicating that they have nearly reached their full buildout condition. Subbasins MC-C and MC-G are very densely developed commercial and multi-family residential areas. Subbasin MC-F also is a densely developed commercial area, but it has more potential for additional development and increased impervious area.

The percent impervious for the Lyon Creek Basin is projected to increase by approximately 17 percent. Runoff from this basin affects a significant portion of both Ballinger Creek and Lyon Creek. Therefore, without mitigation, the full buildout scenario could have significant impact on both creeks.

CLIMATE

The characteristic weather of the McAleer and Lyon Creek watersheds is typical of the mild, mid-latitude coastal climate of the Pacific Northwest, moderated by marine air from the Pacific Ocean. In the summer, temperature ranges from the 70s to the 90s during the day and drops to the 60s at night. In the winter, temperatures average in the 40s during the day and 30s at night, with occasional cold spells and temperatures in the low 20s.

Precipitation in the study area is influenced by the moist marine air, which, when lifted and cooled by the mountains as it moves inland, causes persistent cloudiness and precipitation, resulting in an average of about 40 inches of precipitation annually. Snowstorms occur rarely, often followed by warming temperatures and rain. The frozen ground is unable to absorb the snowmelt and rainfall, which can cause severe flooding, as during the 1996 holiday storm. Most of the rain falls during the wet season, approximately October to May, usually with low intensity but long duration. While the prevailing winds come from the southwest, there are occasional severe storms from the north.

GEOLOGY AND SOILS

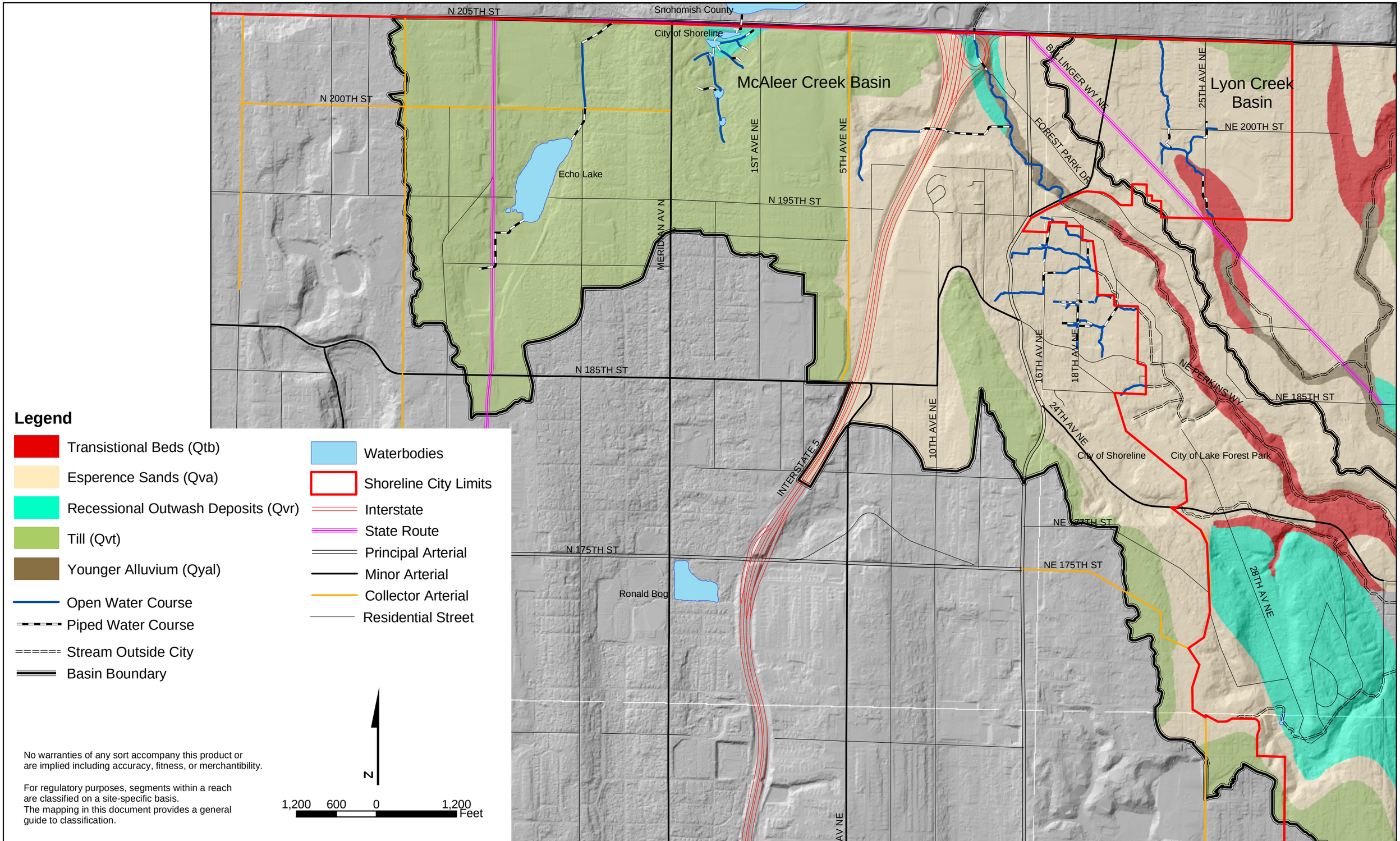
Surveys of both surficial geology and soils were examined for this report. Surficial geology develops from geologic activity (glacial advance and retreat for example), while soils develop as the geologic units in the area weather. Since the soil layer in an area can be very thin in areas of erosion, the geologic layer is often found at the ground surface, and is often incorrectly referred to as a soil layer. Since the geologic layer often dominates the infiltration and seepage characteristics of an area, as well as its tendency for erosion, a more complete description is provided below. Figure 2-6 shows the geologic units of the McAleer and Lyon Creek Basins.

Geology

Surveys of surficial geology and soils were examined for this report. Surficial geology develops from geologic activity such as glacial advance and retreat. Soils develop from weathering of geologic units. The soil layer can be very thin in areas of erosion, so the geologic layer is often found at the ground surface. The geologic layer often dominates the infiltration and seepage characteristics of an area, as well as its tendency for erosion.

Basin topography for McAleer and Lyon Creeks results from sedimentation, folding, volcanic activity and glacial advances and retreats. Glacial activity from 2.5 million to 11,000 years ago caused glacial scour, till and outwash. Till, often referred to as hardpan, is an impermeable layer formed by glacial compression that contains clay and fine sediment and is associated with higher runoff rates. Outwash consists of rocks and soil deposited by advancing and retreating glaciers.

Till is resistant to infiltration and provides the best locations for retention/detention mitigation projects. The sand and gravel layers have high infiltration rates and are best suited as locations for infiltration ponds. Caution should be used in locating infiltration ponds; surcharging the groundwater table in areas prone to slides can accelerate the erosion process or lead to a catastrophic landslide.



Legend

- Transistional Beds (Qtb)
- Esperence Sands (Qva)
- Recessional Outwash Deposits (Qvr)
- Till (Qvt)
- Younger Alluvium (Qyal)
- Open Water Course
- Piped Water Course
- Stream Outside City
- Basin Boundary
- Waterbodies
- Shoreline City Limits
- Interstate
- State Route
- Principal Arterial
- Minor Arterial
- Collector Arterial
- Residential Street

No warranties of any sort accompany this product or are implied including accuracy, fitness, or merchantibility.

For regulatory purposes, segments within a reach are classified on a site-specific basis. The mapping in this document provides a general guide to classification.

N

1,200 600 0 1,200 Feet

Tetra Tech / KCM
1917 1st Avenue
Seattle WA, 98101

McAleer and Lyon Creek Basin Characterization Report

Figure 2-6

Surficial Geology

The McAleer and Lyon Creek Basins are generally underlain by soils deposited during the last glaciation. The old soils are Lawton clay and undifferentiated pre-Vashon silt and clay. Esperance sand overlies the Lawton clay. The Esperance sand and Lawton clay were deposited by lake and stream waters preceding the advance of the last glacier to invade the Puget Sound lowland from the north. As the ice overrode the area, it locally scoured these advance deposits and is responsible for the north/south-trending ridges on both sides of the McAleer Creek corridor. During the time that ice occupied the Seattle area, it deposited Vashon till, a non-sorted, non-stratified deposit of silt, sand and gravel. Most of the glacial till is very dense as a result of having been deposited under the weight of several thousand feet of glacial ice. The McAleer Creek ravine was formed by glacial meltwater during the period of ice retreat. It consists of Vashon recessional soils, which include sand, silt, and some gravel deposited by meltwater. McAleer Creek has eroded its valley into the recessional deposits and locally into the underlying silt and clay.

Soils

Soil types in the McAleer Creek Basin were summarized from the soil survey compiled in 1952 by the U.S. Soil Conservation Service. The McAleer Creek Basin's soils are about 71 percent Alderwood gravelly sandy loam. There is approximately 16 percent of Everett gravelly sandy loam and a diverse amount of other soils amounting to 3 percent or less of the basin: Everett gravelly loamy sand, Indianola fine sandy loam, Carbondale muck, Norma fine sandy loam, Rifle peat, and Greenwood peat. The muck and peat soils are hydric soils frequently supporting wetlands.

Lyon Creek Basin within the City limits has a diverse group of soils. There are three main types: Everett gravelly sandy loam, which comprises 37 percent of area, Everett gravelly loamy sand (20 percent), and Alderwood gravelly sandy loam (30 percent). Soils found in smaller amounts include Kitsap silt loam (6 percent), Rifle peat shallow (5 percent), and Rifle peat (2 percent). The last two types are hydric soils frequently supporting wetlands.

3. DRAINAGE CHARACTERISTICS

Within the City of Shoreline, the McAleer Creek Basin includes the area tributary to Echo Lake (which drains into Lake Ballinger), the area that drains directly into Lake Ballinger, and the area tributary to McAleer Creek itself. Five drainage courses make up the McAleer Creek drainage within the City of Shoreline:

- Main Stem of McAleer Creek
- West Tributary
- Brookside Creek
- Whisper Creek
- Echo Lake.

Ballinger Creek, tributary to Lyon Creek, is the primary drainage course in the Shoreline portion of the Lyon Creek Basin. The stream system and the constructed stormwater features for each drainage course are described in more detail below.

McALEER CREEK BASIN

Stream System

Main Stem

The headwaters of McAleer Creek begin in the Hall's Creek and Echo Lake watersheds, both of which drain into Lake Ballinger. McAleer Creek begins at Lake Ballinger's outlet, at an elevation of 277 feet, and flows through the City of Mountlake Terrace, the City of Shoreline, and the City of Lake Forest Park. The main stem of McAleer Creek enters the City of Shoreline in the area enclosed by the south cloverleaf off-ramp for Interstate 5 at NE 205th Street (Reach MC3) and exits the City just downstream of NE 196th Street (Reach MC1).

The creek passes beneath NE 205th Street through a 4-by-6-foot box culvert. The creek flows approximately 300 feet in a channelized open water course before entering a culvert beneath the south cloverleaf off-ramp for Interstate 5. Downstream of the south cloverleaf, the stream flows 24 feet before entering a 72-inch diameter culvert beneath Forest Park Drive NE.

Downstream of Forest Park Drive NE, the stream gently meanders approximately 1,500 feet to a 4-by-4-foot box culvert beneath 15th Avenue NE. The west tributary (Reach MC2) flows into the main stem upstream of 15th Avenue NE. From there, the creek continues its meander to a 12-by-8-foot box culvert under NE 196th Street, where it leaves the City of Shoreline and enters the City of Lake Forest Park. The channel section in this area (Reach MC1) transitions gradually from a manicured residential channel to a natural ravine.

Unmapped tributaries include the following:

- Two small tributaries and a 24-inch-diameter storm drain outfall enter the main stem from the west between 15th Avenue NE and NE 196th Street.
- A small tributary drains into the main stem from the west on the outside of a large bend between NE 196th Street and 15th Avenue NE.
- A 42-inch-diameter storm drain and a small sediment-laden tributary enter from the west on the 12th Avenue right-of-way.

The main stem of McAleer Creek empties into Lake Washington at an elevation of 25 feet, in the City of Lake Forest Park. The overall channel gradient averages 1 percent, with a gradient of 0.25 percent between Lake Ballinger and the first culvert under Interstate 5.

West Tributary

The West Tributary (Reach MC2) drains the Interstate 5 corridor and west basin south of NE 205th Street. The west tributary follows along the west side of winding 6th Avenue NE as a channelized open water course. It remains open, running east along NE 200th Street, until it enters a culvert just west of Interstate 5. The tributary remains piped for approximately 1,500 feet and daylights just before its confluence with the main stem. The West Tributary drainage enters the main stem in an open channel upstream of 15th Avenue NE.

Brookside Creek

Brookside Creek drains into McAleer Creek just downstream of NE 178th Street in the City of Lake Forest Park. At the Brookside Elementary School, the tributary divides into west (Hillside Creek) and south (Brookside Creek) forks. It is not evident in the field whether either fork extends into the City of Shoreline. The south fork drains approximately 95 acres and the west fork drains 130 acres of wooded and residential area. The west fork of Brookside Creek exits from an 800-foot-long culvert under the school's playground. Upstream of the culvert, the stream is in a ravine bordered by East 178th Street.

The south fork of the tributary exhibits a low gradient and is heavily sedimented in its lower reaches. In its upper reaches, the south fork divides into two branches, one to the south (Sheridan Creek) and one to the west, both in characteristic deep ravines (KCM 1983).

Whisper Creek

Whisper Creek enters McAleer Creek from the west out of a ravine approximately 200 feet downstream of Perkins Way near NE 185th Street. The segments of the creek inside Shoreline's City limits include Reaches MT1 and MT5. Whisper Creek originates just west of the intersection of NE 195th Street and 16th Avenue NE. The total length of the segments in the City is approximately 1,300 feet.

Predominantly spring-fed from five major sources (Reaches MT2, MT3, MT4, MT6 and MT7) within the City limits, the tributary potentially offers, for its size, the best continuous

clean water source, cover and substrate in the basin, and contributes to good water quality in the lower main stem of McAleer Creek. The spring-fed sources are as follows:

- Reach MT2 originates north of the intersection of NE 192nd Street and 15th Avenue NE. The length of this tributary within the City is approximately 1,500 feet.
- Reach MT3 originates west of the intersection of NE 190th Street and 15th Avenue NE. The length of this tributary within the City is approximately 1,800 feet.
- Reach MT4 is a short reach (400 feet) originating from springs in the backyards of local residences between the Cedarbrook School playfield and 20th Avenue NE and Lago Place NE.
- MT6, known as Sarah's Creek, is only in the City for 400 feet, flowing through residential yards along 23rd Avenue NE.
- MT7, known as Cedarbrook Creek flows south from NE Perkins Way along the west side of Cedarbrook School.

Echo Lake Drainage

Echo Lake is in the western portion of the McAleer Creek Basin. Echo Lake has a year-round open water area of approximately 13 acres. The outlet stream from the lake, beginning at the lake's north end, flows north to Lake Ballinger, whose outlet stream is McAleer Creek. The outlet of the lake is piped until passing beneath North 200th Street. North of the street crossing, the drainage is highly confined as it flows through a channelized open water course surrounded by a commercial development to the west and residential neighborhood to the east (Reach EL1). The primary inlet to the lake is a pipe entering at the south end (Reach EL2) that drains an area extending west of Aurora Avenue North.

Constructed Stormwater Features

The McAleer Creek Regional Detention Pond is the most significant constructed stormwater feature in the City of Shoreline portion of the McAleer Creek Basin. The pond is on the north side of NE 196th Street and is approximately 500 feet east of 15th Avenue NE. It is designed to store approximately 4.6 acre-feet of water, to a maximum depth of 12 feet, for a 100-year 24-hour duration storm. Control is through a sluice gate at the upstream portion of the dam. The pond's maximum surface area is 1 acre and it extends 550 feet upstream of NE 196th Street in a natural ravine on McAleer Creek. The pond reduces peak flows into Lake Washington by approximately 24 percent for high frequency (1-5 year) storms and 20 percent for lower frequency (10-25 year) storms.

LYON CREEK BASIN

The Lyon Creek Basin extends through Snohomish County as well as the Cities of Shoreline, Lake Forest Park, Mountlake Terrace, and Brier. The size of the basin within Shoreline's City limits is approximately 184 acres. The only drainage course within Shoreline is a portion of Ballinger Creek and its associated tributaries, all of which are in the northeast corner of the City.

Stream System

Ballinger Creek, a tributary to Lyon Creek, originates north of the City in Snohomish County. It flows south between 21st and 22nd Avenue NE and enters the Ballinger Creek Condominiums, where it flows alternately through buried culverts and channelized open water courses. The creek daylights in Bruggers Bog and flows to the southeast. As it enters Bruggers Bog Park it meets with an unnamed stream flowing from the west. Just upstream of its confluence with Ballinger Creek, this unnamed tributary forks into a north and a south branch. These contributing tributaries were not mapped in their entirety for this report.

Ballinger Creek flows southeast across Bruggers Bog and picks up flow from two unnamed tributaries flowing in from the east. These tributaries were not surveyed for this report. At the southeast corner of Bruggers Bog Park, Ballinger Creek enters a network of pipes at 25th Avenue NE. The creek daylights on the southeast side of 25th Avenue NE and flows in a channelized open water course prior to leaving the City and flowing under NE Ballinger Way into the City of Lake Forest Park. In the City of Lake Forest Park, the creek flows roughly parallel to NE Ballinger Way and enters Lyon Creek outside the City limits near the intersection of NE Ballinger Way and 35th Avenue NE.

Constructed Stormwater Features

Constructed stormwater features of note on Ballinger Creek include the City owned trash-rack just north of the Ballinger Creek Condominiums and the piped portion of the stream on the condominium property. There are no flow control orifices associated with these stormwater structures. The trash rack is an in-line structure, within the stream channel, and is maintained by the City on an annual basis. Maintenance includes removal of sediment accumulations and debris caught in the trash-rack.

Another maintenance issue with the system through the condominium property occurs within the stormwater pipe, about 40 feet downstream of the point where the pipe enters the property. At this location, the pipe makes a sharp bend. Based on City staff observation, this bend appears to slow the velocity of the water, causing sediments to be deposited. The accumulation of sediment at this point can block the pipe entrance as well as the culvert between the trash rack and the condominiums.

4. HABITAT CHARACTERISTICS

This chapter addresses habitat characteristics in the McAleer and Lyon Creek Basins. Streams are described by individual reach. In addition, fishery habitat is addressed, including definite and potential barriers to fish access. Significant wetlands are described. Riparian and terrestrial habitat are also addressed, as well as species of concern under state and federal regulations.

STREAM HABITAT

A stream reconnaissance in the spring and summer of 2001 evaluated aquatic habitat in the McAleer and Lyon Creek Basins. The Tri-County Urban Stream Baseline Evaluation Method (USBEM; R2 Resource Consultants 2000) was adapted for the stream reconnaissance. The USBEM provides a protocol for determining a stream's suitability as habitat for a selected salmonid species. Time and cost precluded utilizing the full protocol. The report and data of this assessment are provided in full in Appendix A. A summary of the aquatic habitat conditions within each reach is provided below.

Stream Channel Modifications

Most of the stream reaches are modified with a variety of structures, such as weirs, bank armoring, culverts, and bridges. Figure 2-3 shows the locations of definite fish passage barriers. In many reaches, most of the native riparian vegetation has been removed for landscaping with ornamentals and grass or for home gardens. The level of channel and watershed alteration is high for the basins as a whole, and for all the reaches.

Benthic Invertebrate Analysis

Two benthic invertebrate samples were collected: one each on McAleer Creek and Ballinger Creek. The results of the sampling are presented in Table 4-1. Each sample had a density of less than 150 organisms per square meter, made up of only 3 to 5 taxa or orders of invertebrates, most of which were tolerant to environmental stress and unstable habitats. The dominant taxon in the sample made up at least 40 percent of the total number of organisms, indicating poor diversity. Each sample was rated poor relative to biointegrity based on the low diversity of species and dominance by more tolerant species.

TABLE 4-1.
DATA SUMMARY FOR BENTHIC INVERTEBRATE SAMPLING

Reach	Total No. of Organisms	Total No. of Taxa	EPT No.[a]	Benthic Invertebrate Bioassessment[b]
MC1	101	4	1	39
BA2	32	3	1	36

a. Number of taxa present in sample that are in the orders of Ephemeroptera, Plecoptera, and Tricoptera, or preferred salmon prey species.
b. Biomonitoring protocol for assessing benthic invertebrate communities developed by Aquatic Biology Associates, Inc. (March 1996). Rankings are as follows:
   - 90-100 Very High—Very high habitat complexity, biotic integrity, taxa richness, percent of cool adapted fauna, number of more specific microhabitat related taxa; low number of tolerant taxa
   - 80-89 High—High as above, low number of tolerant taxa
   - 60-79 Moderate—Moderate as above, some habitat limitations
   - 40-59 Low—Low as above, significant habitat and water quality limitations
   - <40 Severe—Severe departure from ideal conditions.

The benthic invertebrate bioassessment revealed that each sample (with index numbers less than 40) contained an invertebrate community composed of a very low diversity of species. The species present in the greatest numbers were those that typically are tolerant of toxic conditions. BA2 had a very sandy, unstable substrate and a severely stressed habitat as a result of riprap and channeling. MC1 showed better potential habitat, but still scored low. It is likely that stream conditions, including streambed instability, prevent a diverse and rich benthic invertebrate community from becoming established.

Given the community structure observed, it is possible that other limiting factors could be present, such as significant levels of pollutants, which would greatly diminish the ability of Ephemeroptera, Plecoptera, and Tricoptera to survive. This species diversity could also be an indication that, although habitat conditions are not completely suitable for diverse benthic invertebrates, they have the potential to become suitable with proper enhancement and protection, including primarily peak flow reduction. However, Lyon Creek has elevated levels of diazinon, which could severely impact aquatic invertebrates.

Definite conclusions cannot be made from this single sampling event. The City has an ongoing water quality monitoring program to accumulate more data regarding the health of City streams.

Reach Habitat Descriptions

Figure 2-3 shows the reaches of the McAleer and Lyon Creek system and indicates whether they are an open water course or piped water course. The stream habitat condition found in each reach during the stream reconnaissance, using a customized version of the Tri-County Urban Stream Baseline Evaluations Method (R2 Resource Consultants 2000), is described below and in more detail in Appendix A.

McAleer Creek Reach 1

McAleer Creek Reach 1 (MC1) extends from NE 196th Street to Forest Park Drive NE. Portions of this reach were lined with a mixture of native and non-native vegetation of unsuitable size to provide shade, cover or large wood (LW) recruitment. However, there were sections with vegetated banks, and considerable riparian cover remains in this reach especially in the area associated with wetland (WL-V). Approximately 58 percent of the 50-foot riparian corridor is forested. Pools were only present as step pools formed by weirs. The channel provided poorly defined pool-riffle complexes. Many private landowners had lined the creek with riprap or other bank hardening materials. In the developed areas of the stream, bank hardening has constricted the stream and resulted in a scoured and incised channel.

Within the channel, gravel or cobble was subdominant; however, it was heavily cemented with sediment. Embeddedness was rated low. Embeddedness can be quantitative and qualitative. For this report, embeddedness is a qualitative measure of the amount of fine material clogging stream gravels, which reduces spawning suitability. This reach had an overall average score close to fair, but more criteria were given poor ratings. For this reason, the overall rating is poor.

The McAleer Creek Regional Detention Pond is on the north side of NE 196th Street approximately 500 feet east of 15th Avenue NE. The detention facility is controlled by a sluice gate that is typically left open and passable to fish. A large box culvert with a graveled bottom enables the stream to flow under NE 196th Street.

A 48-inch box culvert crossing beneath 15th Avenue NE has no drop but may be a velocity barrier to juvenile fish. KCM (1983) reported that this culvert may be a low-flow barrier for fish passage. A 72-inch diameter culvert beneath Forest Park Drive NE is not likely to be a fish passage barrier. The upstream end of the culvert was not accessible. Daley (2004) found a temporary passage barrier due to improper maintenance. Replacement of the 15th Avenue NE culvert may open access to juvenile salmonids for an additional 2,000 feet upstream.

Upstream of Forest Park Drive NE the creek is open for only 24 feet before it enters a 66-inch culvert under the south cloverleaf on-ramp for Interstate 5. Within the south cloverleaf, the stream exhibits a scoured trapezoidal form. The average width of the creek in this reach is approximately 10 feet.

McAleer Creek Reach 2

McAleer Creek Reach 2 (MC2) follows along the west side of 6th Avenue NE and turns east along NE 200th Street before passing under Interstate 5. This channelized open water course portion is alternately piped and ditched along roadways. The piped portion runs beneath Interstate 5 and continues east to discharge into MC1 through a 42-inch concrete culvert with wing walls near a wastewater pumping station. This reach did not contain water and had no LW or pools. The open channel is concrete for most of the length with quarry spawl comprising a portion of the channel.

McAleer Creek Reach 3

McAleer Creek Reach 3 (MC3) is a combined piped and channelized open water course reach that passes through the south off-ramp of Interstate 5 at NE 205th Street. The 300-foot open water course portion is a grassy swale in the cloverleaf.

McAleer Creek Tributary Reaches 1 and 2

McAleer Creek Tributary Reach 1 (MT1), a segment of Whisper Creek, is almost entirely on private property between NE 195th and 16th Avenue NE just west of Lago Place NE. MT2 is just south of Reach MT1, running from 15th Avenue NE to Whisper Creek at the City boundary. Localized springs are the major sources of flow in these reaches.

Both reaches have several road crossings, including 16th and 18th Avenues NE, and are primarily modified natural channels with piped water course sections. Flows may contribute significantly to McAleer Creek during the winter. The channels are highly modified, with few natural in-stream formations of pools and riffles. No LW pieces were observed; the majority of riparian species were non-native. Bank condition was rated poor due to extensive bank hardening through private property and piped portions. Gravel was a subdominant substrate, but sand and silt were present in large amounts. Overall, both reaches are rated poor.

Low to no flows and piped and culverted sections may be barriers to fish passage. Culverts are present at the 16th and 18th Avenues NE road crossings. Velocities could not be recorded due to extremely low flows and it is not known whether the culverts pose fish passage problems at higher flows.

McAleer Creek Tributary Reach 3

McAleer Creek Tributary Reach 3 (MT3) begins west of 15th Avenue NE and generally flows east and joins Whisper Creek just south of MT2. Localized springs are the major source of this reach, which flows primarily through residential yards.

This tributary is very narrow, with a gravel substrate intermixed with a large amount of sand and silt. Riparian vegetation is minimal over most of this reach. Frequently, lawns were mowed to the stream's edge. Other than artificial pools, streambed structure was poor and extensive glide habitat was present, consisting of smoothly flowing water.

McAleer Creek Tributary Reach 4

McAleer Creek Tributary Reach 4 (MT4) originates from springs and flows into Whisper Creek. The northern portion of MT8 discharges to MT4 east of 18th Avenue NE. The reach has a dense growth of riparian vegetation, including alder and willow, which supplies LW and structure to the reach. Substrate is primarily gravel, with a substantial sand component. Bank condition is fair with no apparent hardening.

McAleer Creek Tributary Reach 5

McAleer Creek Tributary Reach 5 (MT5), a reach of Whisper Creek west of Lago Place NE, has a dense but narrow riparian corridor providing shade and LW. Channel width is approximately 5 feet. Substrate consists of gravel with a mix of sand and mud.

McAleer Creek Tributary Reach 6

McAleer Creek Tributary Reach 6 (MT6) is locally referred to as Sarah's Creek and flows through the City along 23rd Avenue NE for only about 400 feet before discharging to Whisper Creek in the City of Lake Forest Park. Significant riparian vegetation is lacking. The stream bed possesses a good assortment of gravels and little embededness. Portions of the banks are hardened.

McAleer Creek Tributary Reach 7

McAleer Creek Tributary Reach 7 (MT7), known as Cedarbrook Creek, drains the area around Cedarbrook School and NE Perkins Way. One channelized open water course segment from the south part of Reach MT8 joins with MT7 at the Cedarbrook School playfield, where they are piped to Whisper Creek. MT 7, a perennial open water course, lies along the west side of the school, flowing through thickets of primarily blackberries and laurel that provide dense cover. There are alder and cedar trees scattered along the reach. The substrate is primarily sand and mud with little LW evident. Fishery habitat is poor because of the small size of this stream, no channel complexity and lack of native riparian vegetation.

McAleer Creek Tributary Reach 8

McAleer Creek Tributary Reach 8 (MT8) is a matrix of piped and channelized open water course segments, most of which occur along roadways between 16th Avenue NE and Lago Place NE and NE 190th and NE 186th Streets. The northern part of the system discharges to MT4; the southern part discharges to Whisper Creek (MT5) through the pipeline under Cedarbrook School.

Echo Lake Creek Reach 1

Echo Lake Creek Reach 1 (EL1) extends from Echo Lake to Lake Ballinger in Snohomish County. It flows through a channelized open water course without natural substrate between North 203rd Street and North 200th Street. The remainder of the reach is piped. No flow was observed during surveys. Riparian vegetation was narrow on both banks and consisted of mixed hardwoods and conifers. The open channel area is approximately 5 feet wide and riprap-lined with silt substrate and dominated by non-native species such as blackberries, ivy and grasses. Fish passage is limited by low or intermittent flows, rock-lined portions and extensive piped sections.

Echo Lake Reach 2

The downstream end of Echo Lake Creek Reach 2 (EL2) is the inlet to Echo Lake. This piped reach extends from the lake to the intersection of North 192nd Street and Aurora. It is piped for its entire length.

Ballinger Creek Reach 1

Ballinger Creek Reach 1 (BA1) begins near the City of Shoreline boundary at NE 195th Street and continues to the southeast corner of Bruggers Bog Park. This reach is primarily piped, with a small segment of a channelized open water course at its southern end. Piping beneath 25th Avenue NE does not appear to be a fish passage barrier, but it might hinder access at extremely low flows.

Ballinger Creek Reach 2

Ballinger Creek Reach 2 (BA2) passes through Bruggers Bog Park. Based on the numerous old western red cedar stumps with platform notches and the damp soil, it is likely that much of the park was once a wetland that since has been drained and/or filled. All ratings for this reach, except for fish passage, were poor. The riparian area consisted primarily of grass that is regularly mowed and no LW pieces were present. Silt and sand were dominant substrates and embeddedness levels were high. Few pools were present. Much of the private portions had artificially hardened banks. A few areas may be suitable for coho or cutthroat spawning, but the large amount of fines in the reach likely would inhibit this activity. This reach is hydraulically connected with the adjacent wetland (WL-T) as it leaves the park.

Ballinger Creek enters the north end of Bruggers Bog Park via three concrete culverts each less than 2 feet in diameter at the downstream end of BA4. The jumping height from the water surface to the bottom edge of these culverts is a minimum of 30 inches, presenting a fish passage constraint. A channelized open water course (BA3) with very low flow drains into BA2 at this point.

The creek runs alongside a parking lot for more than 100 feet. Support material for the fill under the parking lot, which appears to be a crib wall of concrete ecology blocks, constitutes the left bank for long portions of this reach. Two culverts, which drain a parking lot, discharge stormwater into the creek and a small spring-fed tributary enters Ballinger Creek from the left bank. Beyond the parking lot, the creek passes through another culvert (27 inches in diameter) under the access road for Bruggers Bog Park. This culvert has a small jumping height (4 inches) and flow velocities of less than 0.8 feet per second, which is passable for fish.

Ballinger Creek Reach 3

Ballinger Creek Reach 3 (BA3) carries drainage from the adjacent hillside and park to the main channel of Ballinger Creek at the northwest corner of Bruggers Bog Park; it flows along the west edge of the park and immediately east of a King County maintenance yard. There is probably a hydraulic connection with the wetland (WL-T) along the south edge of the park, although there was no apparent surface connection. The substrate was organic, and native vegetation such as cattail and water parsley grew in several areas. Standing water exhibited an oil sheen. This reach had probably been dug many years ago to help drain the wetland and receive runoff from the hillside to the west.

Ballinger Creek Reach 4

Ballinger Creek Reach 4 (BA4) begins at the northwest corner of Bruggers Bog Park and continues to the north City limit at NE 205th Street. The stream is piped through the Ballinger Creek Condominiums except for a few short sections of open channel through manicured landscaping; the channel is open from the trash rack at NE 200th Street upstream to the City limit. As addressed under BA2, the three concrete culverts at the downstream end of this reach present an upstream barrier to fish. A small tributary flows from east to west along the north side of NE 200th Street and enters BA4 near the trash rack. City staff noted flow in the summer of 2001 and a wetland fringe adjacent to the stream.

Riparian vegetation consisted mostly of Himalayan blackberries and a few 20- to 30-year-old alders; bank condition was stable. The width of riparian vegetation was approximately 50 feet on both sides near NE 200th Street, but it rapidly decreased upstream, and at NE 203rd Street it was less than 10 feet. Sand and gravel were co-dominant, but embeddedness was high and riprap was present upstream of NE 200th Street. The reach has no natural meanders and runs between residential homes and beneath road crossings at NE 200th Street and NE 203rd Street.

Ballinger Creek Reach 5

Ballinger Creek Reach 5 (BA5) is primarily piped and running south along 25th Avenue NE then turning west as a channelized open water course south of NE 200th Street and discharging into Reach BA2.

FISHERIES

The following discussion summarizes the *Fish Utilization in City of Shoreline Streams* report (Appendix C) as it relates to McAleer and Lyon/Ballinger Creeks.

Stream walks were conducted on the streams in February, April, May, August and October of 2001 to assess fish utilization. The fisheries assessment focused on the presence of salmonids (resident cutthroat trout and anadromous salmon) within the basins. Figure 4-1 summarizes life cycle timing for fish in the McAleer and Lyon/Ballinger systems and when certain species are in residence. Coho salmon and searun cutthroat trout spend their first year rearing in creeks prior to outmigration. Resident cutthroat trout reside in the stream throughout their life cycle. Chinook salmon fry usually remain in the streams for three months after emerging from the gravels and migrate seaward from early March through early July.

Inspection of McAleer Creek downstream of Interstate 5 revealed a temporary barrier to fish passage in the culvert under Forest Park Drive NE immediately south of Northeast 205th. The barrier is temporary and due to improper culvert maintenance; both adult and juvenile fish could navigate this culvert with proper maintenance.

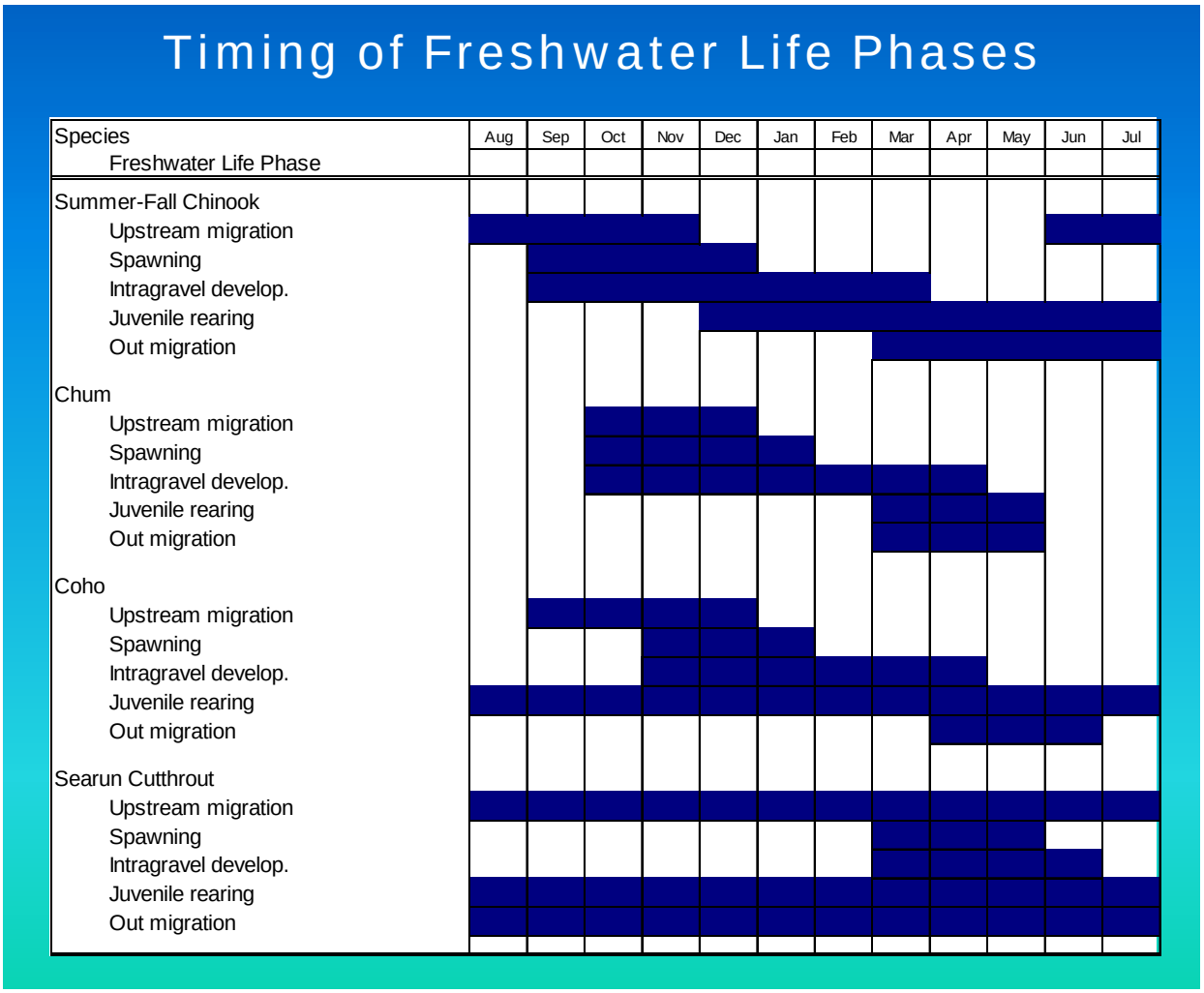


Figure 4-1. Life Cycle Timing for Fish in McAleer and Lyon Creek Basins (Adapted from Williams 1995)

McAleer Creek supports anadromous fish as far upstream as Lake Ballinger. LFPSF (2001) notes that chinook salmon have been found as far upstream as the flood control system and fish ladder at NE 196th Street between Forest Park Drive NE and 15th Avenue NE. Field observations in May 2001 and observations by Mr. Ed Barnes (personal communication, September 2001) confirm cutthroat trout and coho salmon using this system. Ned Orr, who lives adjacent to Reach MT2 on 16th Avenue NE, cites cutthroat trout and coho in this reach (personal communication, March 2001). Sockeye have been reported in the lower reaches of this system outside the Shoreline City limits (SPU November 2000). LFPSF (2001) documents that a steelhead trout carcass was found in Lyon Creek in 1998 and also cites stream use by coho and cutthroat trout. The Reconnaissance Assessment for WRIA 8 (GLWTC 2001) notes that chinook, both sockeye and kokanee, coho salmon; and steelhead, rainbow and coastal cutthroat trout have been observed in McAleer Creek. City staff found a steelhead and 3 adult cutthroat trout spawning in MC1 just south of the Interstate 5 cloverleaf on March 11, 2004. Sockeye and coho salmon and cutthroat and rainbow trout have been observed in Lyon Creek (GLWTC 2001).

KCM (1983) evaluated fish habitat in McAleer Creek and associated tributaries. The report documented remnant populations of salmon (sockeye/kokanie, chinook and coho) and trout (cutthroat and steelhead/rainbow) in the creek. Cutthroat trout were the most common in the stream system and more resistant to the detrimental impacts of development than anadromous species. Reasons for this resistance could include the following:

- Trout require smaller gravel size for spawning.
- Trout spawn later in winter and are less exposed to winter floods.
- With a reduced population of salmon, the available supply of food, shelter and spawning and rearing habitat would be increased.

The report summarizes the creek as follows:

> "The predominant characteristic of the mainstem of McAleer Creek is that of cemented gravel substrate, a condition indicative of a heavy long-term sediment load and reduced potential for successful spawning."

The Echo Lake drainage, which is part of the headwaters of McAleer Creek, flows north into Lake Ballinger. A culvert at the Echo Lake outlet has created a definite impassable barrier to movement of adult and juvenile fish between the two lakes. Prior to this system being piped, there may have been a natural vertical barrier. Echo Lake has supported a population of rainbow trout (Wolcott 1965) and supports resident cutthroat trout, large mouth bass and sunfish populations. It is likely that urban development and the associated stormwater runoff into the lake have significantly lowered the water quality of the lake with increased temperatures and chemical contamination.

Many reaches of open water courses support fish such as sculpin, dace and stickleback and also cutthroat trout, even though some of these reaches have poor to fair fish habitat. Cutthroat have evolved in the Northwest to occupy a variety of habitats including saltwater, lakes and streams. The City has not intensively sampled fish distribution within its boundaries or within McAleer and Lyon Creeks. Based on the KCM (1983) study and other urban sampling programs, it is likely cutthroat trout occur in many, if not most, of the open water course reaches especially those that have developed in-stream and near-bank vegetation and have dense riparian vegetation.

Fish Passage Barriers

Fish passage barriers prevent the movement of fish within a creek. Barriers can be man-made, such as the perched culvert at the outlet of Echo Lake, or natural, such as a stream segment with a long and steep gradient. No such natural barriers exist between Lake Washington and Lake Ballinger, since anadromous fish occur at least to this point.

Some barriers primarily impede upstream access; others impede upstream and downstream access equally. In Shoreline, upstream impediments generally don't impede downstream access. Barriers can be seasonal, affected by the level of flow in a reach. They can also be species and age-class specific. Adult coho and steelhead are more adept at accessing reaches with shallow water depths or swift flow than adult chum or chinook. Adult fish in general can navigate blockages more effectively than juvenile fish. Adult chinook salmon have been found in McAleer Creek as far as the flood control system at NE 196th Street. Barriers can

impede up and downstream migration of anadromous species such as salmon, but can also block access to additional stream reaches for resident cutthroat trout and other non-salmonid species of fish such as sculpin and dace.

The Washington Department of Fish and Wildlife (1998) has a protocol for determining whether an impediment in a stream is a barrier to fish migration. This protocol involves measuring current velocity, grade, distance and depth of water over and immediately downstream of the impediment. Unless the structure is an obvious barrier such as a dam, observations without using the protocol are judgment calls; experts can disagree as to accessibility. This study did not use the WDFW protocols in assessing whether a reach is accessible. A comprehensive barrier assessment would require a full year of flow measurements. This study used best professional judgment when assessing whether a barrier presented an impediment to fish passage. Definite barriers are present on Reaches BA4 and EL1. Potential barriers have been identified at a number of locations within the McAleer and Lyon Creeks Basins. Table 4-2 summarizes definite and potential fish passage barriers identified in the McAleer and Lyon Creek Basins. More detail is provided in the individual reach descriptions. Figure 2-3 shows the location of definite fish passage barriers.

WETLAND HABITAT

Wetlands are an essential part of a properly functioning watershed, benefiting both human and wildlife populations. Wetlands provide fish and wildlife with refuge and cover for nesting, mating, rearing, and foraging. They are also valuable to the surrounding human community for flood mitigation, storm abatement, sediment retention, aquifer recharge, water quality improvement and aesthetic qualities (Mitsch and Gosselink 1986). Shoreline's critical areas code establishes an overall goal of maintaining no net loss of the function, value and acreage of wetlands within the City.

Historically, wetlands were not viewed as having important value. When early settlers moved into the heavily wooded Puget Sound upland, arable land was at a premium in many areas. As home sites became more scarce, especially around urban areas, early residents were forced into less desirable locations. As a consequence, farmers diked and drained extensive expanses of wetlands throughout the Puget Sound area. Early residents and business owners began filling and draining wetlands for home and business sites. In some areas, it was necessary to pipe the water to prevent it from accumulating and discharge it to a local stream or ravine.

TABLE 4-2.
FISH PASSAGE BARRIERS
MCALEER AND LYON CREEKS

Reach	Barrier	Description
Definite Barriers		
BA4	Culverts	Three concrete culverts upstream of Bruggers Bog have minimum jumping heights of 30 inches.
EL1	Culvert	Perched culvert at Echo Lake outlet is too high for access.
Potential Barriers		
MC1	Culvert	Culvert under Forest Park Drive at NE 205th Street may prevent fish passage.
MC1	Culvert	Culvert beneath 15th Avenue NW may prevent fish passage.
MT1	Culvert	Culverts under 16th and 18th Avenues NE may prevent fish passage.
MT2	Culvert	Culverts under 16th and 18th Avenues NE may prevent fish passage.
MT3	Culvert	Culverts under 16th and 18th Avenues may prevent fish passage.
MT5	Pipe	The long pipe under the Cedarbrook School playfield may prevent fish passage.

It is likely a number of structures and facilities around Shoreline have been constructed on filled wetlands, including portions of the King County maintenance yard next to Bruggers Bog, Bruggers Bog Park, Cedarbrook School playfields and the Park and Ride at NE 192nd Street and Aurora Avenue North.

As these wetlands became filled and more construction occurred in the City, rainfall had a much smaller area to infiltrate into the soil or to flow to wetlands for storage. Previously, accumulated rainfall would have percolated down through the soil or been slowly released by the wetland to provide a base flow for local streams. This is important for fish and the aquatic ecosystem during the dry summer months. High peak flows now common in most Shoreline streams are in large part due to the filling of wetlands.

A wetland inventory was conducted in October and November of 2001 to identify significant unmapped wetlands within the City boundaries. This wetland inventory was not exhaustive, but addressed wetlands that were known from the City's GIS wetland layer (primarily wetlands identified from the National Wetland Inventory), wetlands that were subjects of development reports supplied by the City and wetlands readily identified from aerial photography. Each of these areas was visited and ground-truthed to determine whether it qualifies as a wetland. The report describing the wetland identification of major wetlands and those wetlands for which the City had development reports is presented in Appendix B. The wetlands found within the McAleer and Lyon Creek Basins are summarized below. Figure 2-3 shows the wetland locations.

Wetland Classification

The wetlands within the City were classified according to the U.S. Fish and Wildlife Service Classification System. This classification system, which has no regulatory status, is described below.

U.S. Fish and Wildlife Service Classification System

The U.S. Fish and Wildlife Service classification (Cowardin et. al 1979) places the wetland into a system category first, and then subcategorizes the wetland into a class based on the vegetation present. All wetlands that were identified in this study fall under the system category, "palustrine," which is defined as follows:

- Water regime not influenced by oceanic tides
- Persistent emergents, trees, shrubs, or emergent mosses covering 30 percent or more of the area.

Identified Shoreline wetlands were classified in the following classes based on vegetation:

- Aquatic Bed: Vegetation composed predominantly of plants that grow principally on or below the surface of the water for most of the growing season in most years
- Emergent Wetland: Vegetation composed predominantly of emergent, vascular species
- Forested Wetland: Vegetation composed predominantly of trees or shrubs that are 20 feet or taller
- Scrub-Shrub Wetland: Vegetation composed predominantly of trees or shrubs than are less than 20 feet tall.

Wetland Description

Only one area was identified as a potential unmapped wetland in the basins. Field verification determined that the area was not a wetland. Two previously mapped wetland areas were verified for size and location. The majority of wetlands in the City are palustrine wetlands under the federal classification, since they have 30 percent or greater vegetation cover and are not influenced by oceanic tides. A description of each wetland assessed within the McAleer and Lyon Creek Basins and its classification under the federal system is presented below and summarized in Table 4-3.

Wetland S, Echo Lake

Previous mapping indicating wetlands along the southwest fringe of Echo Lake appears to be accurate and the boundaries have not changed. Wetland fringe consists of three wetland classes: aquatic bed, emergent, and scrub-shrub. Aquatic bed wetlands were present where yellow pond-lily has become established. Reeds were dominant in emergent wetlands, and willows and Douglas spirea dominated the scrub-shrub wetlands. The total area of this wetland is estimated to be 0.2 acres. Echo Lake covers approximately 13 acres.

TABLE 4-3.
WETLAND CLASSIFICATIONS

Site	Location	Size (acres)	Wetland Classes Present (Cowardin, et al. 1979)
S	Echo Lake	0.2	Palustrine Scrub-Shrub Palustrine Emergent Palustrine Aquatic Bed
T	Bruggers Bog	<0.5	Palustrine Scrub-Shrub Palustrine Emergent
U	McAleer Creek Reach 1	1	Palustrine Forested Palustrine Scrub-Shrub

Wetland T, Bruggers Bog

Bruggers Bog historically was a bog with acidic soils. Plants that survive under these conditions include spaghnum moss, cranberry and Labrador tea. Such plants are not currently present in Bruggers Bog. Surface waters accumulate from single- and multi-family residences in the surrounding area, flow southeast and contribute to Ballinger Creek, which runs through Bruggers Bog Park. Wetland T is a narrow and linear wetland on the south edge of the park adjacent to a King County Maintenance Facility and a small remnant of the original wetland. Vegetation includes small willow trees and shrubs, cottonwoods, and red alders, along with cattails, sedge and water parsley in the very wet areas. The reach description of BA2 gives an additional description of Bruggers Bog.

Wetland U, McAleer Creek Reach 1

Wetland U is associated with and adjacent to McAleer Creek, west of 15th Avenue NE. This wetland extends linearly south of NE 200th Court and on both the east and west sides of McAleer Creek. It was originally delineated for an apartment complex bordering the wetland on the northeast (Land-Tek Wetland Services 2001). The size within the parcel was calculated to be 0.68 acres, however it extends off-site both north and south and is estimated to be approximately 1 acre or more. It is one of the few surviving forested/scrub-shrub wetlands in the City. Approximately 20 large cedar trees (20- to 30-inch in diameter) provide cover for this wetland.

RIPARIAN INFLUENCE AREAS

Riparian influence areas for this report include the areas bordering open water courses out to a distance of 300 feet from the upper bank. Spence (1996) identifies these areas as having the most effect on essential habitat functions for streams. This distance may vary depending on channel forming process affecting individual stream segments. Riparian trees and shrubs include western red cedar, red alder, willow, elderberry, vine maple, salmonberry and devil's club. Skunk cabbage, buttercup, youth-on-age, fringecup, reed canarygrass and other herbaceous species comprise the ground cover.

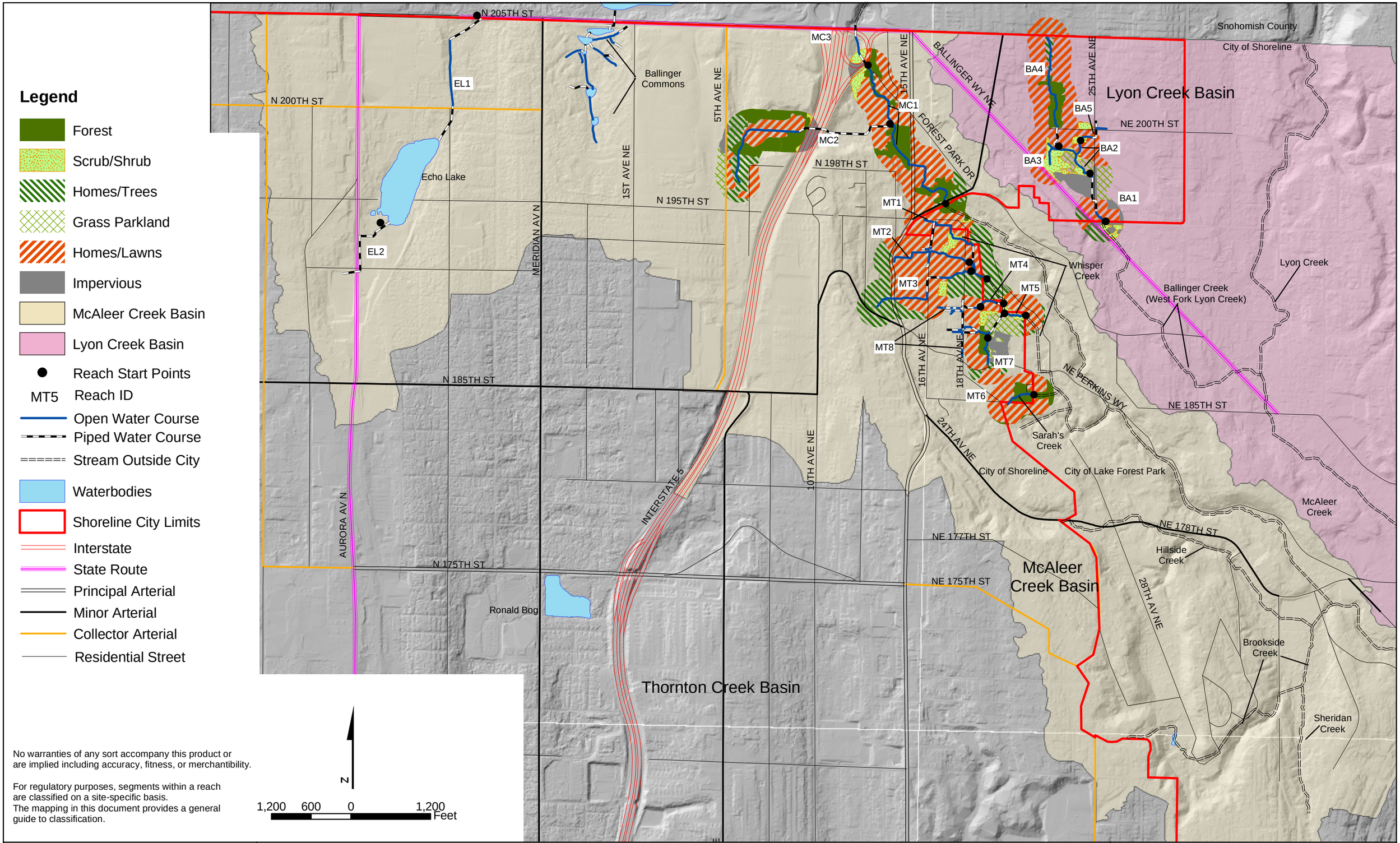
Riparian areas vegetated with trees and shrubs provide essential benefits to the environment such as protecting water quality by filtering sediment out of stormwater

runoff, retaining and controlling flood waters, stabilizing stream banks, and providing wildlife habitat, corridors and migratory pathways. In addition, vegetated riparian areas enhance fish habitat by shading streams, providing large wood, and contributing insects and nutrients to the system.

Riparian influence areas were mapped for open water courses in the basin. Aerial photographs were used to identify existing land use within the 300-foot corridor. The riparian area for the McAleer and Lyon Creek Basins is illustrated in Figure 4-2. The land use categories used for the mapping are as follows:

- Forest: More than 65 percent canopy closure; no impervious surface other than roads.
- Scrub/Shrub: More than 65 percent scrub-shrub habitat.
- Grass Parkland: Parks or large grassy areas with less than 10 percent total impervious or other land use type.
- Homes/Lawns: Sparse to no tree canopy and may be dominated by lawns and driveways
- Homes/Trees: Moderate to significant tree canopy; impervious surfaces include homes, driveways and roads.
- Impervious: Large parking lots, roads and roof tops. Contains less than 5 percent vegetation. This would include Interstate 5, school buildings, and large commercial and industrial buildings.
- Surface Water: Lakes and ponds within the corridor around the streams.

Since the riparian analysis was conducted adjacent to the open water courses, the proportion of the riparian area delineated to the total area around each reach varies with the length of the water course in the reach. For example, the predominantly piped reach BA1 has a small percentage of riparian habitat since the reach has only a small section that is an open water course. Table 4-4 lists the total corridor area associated with each reach, the area and percentage of riparian area within the reach and the predominant channel type. Table 4-5 lists the total length of each reach along with the total length of open water course within that reach. Tables 4-6 to 4-9 list the percentage of riparian land use for 50-, 100-, 200-, and 300-foot corridors along each reach.



No warranties of any sort accompany this product or are implied including accuracy, fitness, or merchantibility.

For regulatory purposes, segments within a reach are classified on a site-specific basis. The mapping in this document provides a general guide to classification.

Tetra Tech / KCM
1917 1st Avenue
Seattle WA, 98101

McAleer and Lyon Creek Basin Characterization Report

Figure 4-2
Riparian Influence
Area Characterization

TABLE 4-4.
RIPARIAN INFLUENCE AREA WITHIN 300-FOOT CORRIDOR FOR McALEER AND LYON CREEK BASINS

Reach ID	Total Area Within 300-Foot Corridor (acres)	Reach Riparian Area (acres)	Riparian Area as Percentage of Total (%)	Predominant Channel Type
MC1	42	42	100	Open Water Course
MC2	48	28	58	Open Water Course
MC3	16	0	0	Piped Water Course
MT1	21	18	86	Open Water Course
MT2	30	30	100	Open Water Course
MT3	26	26	100	Open Water Course
MT4	10	10	100	Open Water Course
MT5	11	11	100	Open Water Course
MT6	12	12	100	Open Water Course
MT7	13	13	100	Open Water Course
MT8	29	0	0	Piped Water Course
EL1	35	19	56	Piped Water Course
EL2	23	0	0	Piped Water Course
BA1	16	9	56	Piped Water Course
BA2	18	18	100	Open Water Course
BA3	12	12	100	Open Water Course
BA4	29	25	86	Open Water Course
BA5	14	0	0	Piped Water Course

TABLE 4-5.
LENGTH OF OPEN WATER COURSE PER REACH

Reach ID	Total Length of Reach (feet)	Length of Open Water Course (Feet)	Open Water Course as Percentage of Total (%)	Predominant Channel Type
MC1	2941	2841	100	Open Water Course
MC2	3003	1526	51	Open Water Course
MC3	710	283	40	Piped Water Course
MT1	1285	1067	83	Open Water Course
MT2	1538	1538	100	Open Water Course
MT3	1815	1435	79	Open Water Course
MT4	408	408	100	Open Water Course
MT5	334	334	100	Open Water Course
MT6	432	432	100	Open Water Course
MT7	466	466	100	Open Water Course
MT8	3123	1047	34	Piped Water Course
EL1	2059	948	46	Piped Water Course
EL2	1271	0	0	Piped Water Course
BA1	737	180	24	Piped Water Course
BA2	978	978	100	Open Water Course
BA3	338	338	100	Open Water Course
BA4	1681	250	15	Open Water Course

BA5	522	227	43	Piped Water Course

TABLE 4-6.
RIPARIAN LAND USE BY PERCENT; 0- TO 50-FOOT CORRIDOR

Reach	Forest	Scrub-Shrub	Homes-Trees	Grassy Open Space	Homes-Lawns	Impervious	Surface Water
MC1	58.5	0.0	1.1	0.0	40.4	0.0	0.0
MC2	19.3	0.0	33.2	0.0	47.5	0.0	0.0
MC3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT1	0.0	18.4	4.4	0.0	77.2	0.0	0.0
MT2	0.0	0.0	28.6	0.0	71.4	0.0	0.0
MT3	0.0	6.7	33.9	0.0	59.4	0.0	0.0
MT4	0.0	0.0	17.2	0.0	82.8	0.0	0.0
MT5	0.0	69.2	0.0	13.0	17.8	0.0	0.0
MT6	70.4	0.0	0.0	0.0	29.6	0.0	0.0
MT7	52.9	0.0	5.4	15.3	16.0	10.4	0.0
MT8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EL1	54.5	0.0	0.0	0.0	38.7	6.8	0.0
EL2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA1	0.0	0.3	0.0	0.0	84.0	15.7	0.0
BA2	0.0	55.1	0.0	15.5	21.9	7.5	0.0
BA3	0.0	85.4	0.0	0.0	14.6	0.0	0.0
BA4	51.9	0.0	25.9	0.0	22.2	0.0	0.0
BA5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4-7.
RIPARIAN LAND USE BY PERCENT; 51- TO 100-FOOT CORRIDOR

Reach	Forest	Scrub-Shrub	Homes-Trees	Grassy Open Space	Homes-Lawns	Impervious	Surface Water
MC1	41.2	1.2	2.2	0.0	55.5	0.0	0.0
MC2	19.6	0.0	32.8	0.0	47.6	0.0	0.0
MC3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT1	0.0	7.1	8.6	0.0	84.2	0.0	0.0
MT2	0.0	0.9	33.9	0.0	65.2	0.0	0.0
MT3	0.0	5.2	32.8	0.0	61.9	0.0	0.0
MT4	0.0	8.8	28.3	0.0	62.9	0.0	0.0
MT5	0.0	13.0	5.3	31.5	50.2	0.0	0.0
MT6	43.5	0.0	0.0	0.0	56.5	0.0	0.0
MT7	24.9	0.0	8.9	20.5	20.7	25.1	0.0
MT8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EL1	16.4	0.0	0.0	0.0	46.2	37.4	0.0
EL2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA1	0.0	11.2	2.8	0.0	68.3	17.7	0.0
BA2	0.0	26.5	0.0	29.3	27.4	16.8	0.0
BA3	0.0	52.9	0.0	0.2	46.9	0.0	0.0
BA4	36.3	0.0	3.5	0.0	60.2	0.0	0.0

BA5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4-8.
RIPARIAN LAND USE BY PERCENT; 101- TO 200-FOOT CORRIDOR

Reach	Forest	Scrub-Shrub	Homes-Trees	Grassy Open Space	Homes-Lawns	Impervious	Surface Water
MC1	21.2	3.7	3.4	0.0	69.2	2.5	0.0
MC2	29.0	0.0	21.2	1.4	39.9	8.6	0.0
MC3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT1	3.9	4.5	16.2	0.0	75.4	0.0	0.0
MT2	0.0	4.2	46.5	0.0	49.2	0.0	0.0
MT3	2.0	3.6	39.6	0.0	54.8	0.0	0.0
MT4	0.0	22.4	32.7	6.7	38.2	0.0	0.0
MT5	0.0	6.4	6.8	28.6	58.2	0.0	0.0
MT6	15.9	0.0	0.0	0.0	84.1	0.0	0.0
MT7	4.7	3.3	6.5	18.8	46.3	20.4	0.0
MT8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EL1	4.0	0.0	0.7	1.9	44.2	49.3	0.0
EL2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA1	0.0	6.0	24.6	0.1	54.6	14.7	0.0
BA2	0.0	19.9	0.0	21.8	40.7	17.6	0.0
BA3	0.0	19.8	0.0	8.9	68.5	2.7	0.0
BA4	5.7	0.0	0.0	0.0	94.3	0.0	0.0
BA5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4-9.
RIPARIAN LAND USE BY PERCENT; 201- TO 300-FOOT CORRIDOR

Reach	Forest	Scrub-Shrub	Homes-Trees	Grassy Open Space	Homes-Lawns	Impervious	Surface Water
MC1	6.6	7.8	0.0	0.0	81.7	3.9	0.0
MC2	35.0	1.8	16.1	11.9	15.7	19.5	0.0
MC3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT1	13.7	2.4	23.2	0.0	60.7	0.0	0.0
MT2	0.0	0.8	59.4	0.0	39.9	0.0	0.0
MT3	9.0	3.6	42.7	0.0	44.6	0.0	0.0
MT4	1.4	7.1	34.4	17.1	40.0	0.0	0.0
MT5	0.0	5.0	20.2	24.3	48.3	2.2	0.0
MT6	15.2	0.0	0.0	0.0	84.8	0.0	0.0
MT7	0.0	6.9	15.0	16.8	46.5	14.8	0.0
MT8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EL1	4.2	0.0	4.7	2.7	39.8	48.6	0.0
EL2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA1	0.0	9.2	31.6	8.8	24.3	26.1	0.0
BA2	0.0	16.9	0.0	15.7	47.9	19.5	0.0
BA3	3.7	14.3	0.0	7.2	69.5	5.4	0.0

BA4	0.0	2.4	0.0	0.0	97.6	0.0	0.0
BA5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The riparian area surrounding McAleer and Lyon Creeks and their tributaries is dominated by moderate-density single-family residential neighborhoods. Reach MC1 has the largest amount of high quality riparian habitat (forest and/or scrub-shrub) in the McAleer Creek Basin with 58 percent of the riparian area classified as forested within 50 feet of the creek. In the Lyon Creek Basin, the area around Bruggers Bog (Reaches BA2 and BA3) contains a large amount of high quality riparian habitat. Approximately 55 and 85 percent of the riparian area within 50 feet of the creek along Reaches BA2 and BA3, respectively, is classified as forested and/or scrub-shrub. However, field visits indicated that much of the scrub-shrub classified in these reaches, using aerial photos, may in fact be grassy open space. Reach BA4 also has a sizeable amount of high quality habitat within the 50-foot corridor surrounding the creek with over 50 percent of the habitat classified as forested.

Reaches MT1 through MT3 are dominated by residential development. The classifications of Homes-Trees, Homes-Lawns, and Grass-Open Space consistently represent 80 percent or more of the riparian habitat along these reaches. Reaches MT4 and MT5 are also dominated by residential development. Residential and commercial development also encroach on the Echo Lake outlet stream (Reach EL1). Impervious area from a commercial parking lot and a residential development make up over 80 percent of the riparian area beyond the first 50-foot corridor. Reaches MT6 and MT7 have a fairly high percentage of high quality habitat near the stream, but residential development tends to dominate farther from the stream.

In general, the amount of high quality riparian habitat along the reaches declines with distance from the stream. For example, 58 percent of the riparian habitat within 50 feet of Reach MC1 is high quality. At a distance between 200 to 300 feet, the percentage of high quality habitat decreases to approximately 15 percent, with the remainder of the habitat containing residential development. This trend also occurs along Ballinger Creek. For example, 85 percent of the riparian habitat within 50 feet of Reach BA3 is classified as scrub-shrub. At a distance between 200 and 300 feet, the percentage of high quality habitat decreases to approximately 17 percent, with the remainder of the habitat containing residential development.

TERRESTRIAL HABITAT

The biota and ecology of the McAleer and Lyon Creek Basins are influenced by such factors as the wet and moderate maritime climate, soil type and human activities. European descendants have been logging, mining, farming, fishing, shellfishing, industrializing and residing in and around the area since the middle of the 19th century. Native Americans lived in the Puget Sound area for thousands of years before their arrival.

The study area encompasses mainly coniferous forest within the western hemlock (*Tsuga Heterophylla*) forest zone. Also referred to as the Coastal Forest Zone, this area possesses climax vegetation of western hemlock and western red cedar. Historically, these trees probably covered much of the City of Shoreline and were the dominant vegetative type.

These stands of trees were logged and cleared by early and present-day residents. Stands of this timber were replaced by Douglas fir, which characterizes the sub-climax vegetative type in this zone and frequently occurs as the dominant tree over the large areas. Although these forests might be termed "secondary growth," the trees frequently attain ages of several hundred years. Eventually, if these stands were left to nature, the Douglas fir, which requires much sunlight for growth and reproduction, would shade itself out of its dominant role. Absent logging, the shade-tolerant cedar and hemlock grow to crowd out Douglas fir over hundreds of years.

Presently, the McAleer and Lyon Creek Basins possess mixed native and non-native vegetation in a fragmented state, with no large forested areas. The upland vegetative communities have been highly altered with residential development and small commercial strips such as the Ballinger Way Shopping Mall. Most of the forested areas are characterized by a conifer-deciduous upper canopy including western red cedar, Pacific madrone, Douglas fir, red alder and big leaf maple.

Understory in these basins has been heavily disturbed with large scale removal of native vegetation and subsequent replacement with impervious surfaces and non-native vegetation including English ivy and Himalayan blackberry. However a full complement of native plants populate the less disturbed portions, including sword fern, huckleberry, hazelnut, vine maple, Oregon-grape, ocean spray and salal.

Based on input from local residents, a variety of wildlife inhabits the McAleer and Lyon Creek Basins. Pileated woodpecker, black-crowned night heron, kingfisher, band-tailed pigeon and a variety of raptors, including bald eagle, red-tailed hawk, goshawk and merlin, have been observed in the basin (personal communication, Cynthia Wilson, Shoreline Resident, April 10, 2001). The LFPSF (2001) documents a family of Cooper's hawks fledging in the McAleer ravine. Appendix E contains a list of birds seen in the Shoreview Park area in Boeing Creek Basin. Many of these same birds could be expected in the more wooded areas of McAleer and Lyon Creek Basins, especially along the riparian areas and uplands bordering the creeks.

FEDERAL AND STATE REGULATED SPECIES

Table 4-10 includes the federally listed and candidate species that the U.S. Fish and Wildlife Service and National Marine Fisheries Service require to be addressed for Endangered Species Act (ESA) compliance. Table 4-11 summarizes state priority species that could occur in the McAleer and Lyon Creek Basins. Priority species have no federal or state regulatory status. Appendix I includes listed Washington State endangered, threatened and candidate species in addition to species of concern. Candidate species are species under review for possible listing as endangered or threatened and are protected as state sensitive species. Appendix J lists Washington State priority habitats and species.

Chinook and coho salmon and bald eagle have been documented in the McAleer Creek Basin. Because chinook have been found up to the flood control system and fish ladder at NE 196th Street, the area from this location downstream to the mouth was considered "designated critical habitat" for chinook salmon. Critical habitat for the Puget Sound chinook salmon includes all marine, estuarine and river reaches accessible to chinook salmon in Puget Sound (US Federal Register 7764). Based on a legal suit filed by the

National Association of Homebuilders, this designation has been withdrawn for Puget Sound Chinook pending reassessment by the National Marine Fisheries Service (NMFS) (personal communication, Brian Gorman, NMFS, January 30, 2003).

Of the state priority species, great blue herons and cutthroat trout are quite common in open water courses and some wetlands in the City of Shoreline. As noted earlier, City staff documented a steelhead in MC1. Band-tailed pigeon and the pileated woodpecker are Washington State Priority Species. Pileated woodpecker is also a state candidate species.

TABLE 4-10.
FEDERALLY LISTED AND CANDIDATE SPECIES WITHIN THE CITY OF SHORELINE

Species	Federal and State Status
Fish Species	
Bull trout (*Salvelinus confluentus*), Coastal-Puget Sound distinct population segment (DPS)	FT/SC
Chinook salmon (*Oncorhynchus tshawytscha*), Puget Sound evolutionary significant unit (ESU)	FT/SC
Coho salmon (*Oncorhynchus kisutch*), Puget Sound/Strait of Georgia ESU	FC
Species	Federal and State Status
Bald eagle (*Haliaeetus leucocephalus*)	FT/ST
Marbled murrelet (*Brachyramphus marmoratus*)	FT/ST

Notes: FT = Federally listed threatened; ST = Washington State listed threatened
FC = Federal candidate; SC = Washington State candidate

TABLE 4-11.
STATE PRIORITY SPECIES—CITY OF SHORELINE

Amphibians/Reptiles	Birds
• Western Toad	• Brandt's Cormorant
• Western Pond Turtle	• Common Loon
Mammals	• Marbled Murrelet
• Myotis species	• Great Blue Heron
• Townsend's Big-Eared Bat	• Brant
Fish	• Bald Eagle
• Bull Trout	• Merlin
• Chinook Salmon	• Northern Goshawk
• Chum Salmon	• Peregrine Falcon
• Resident/Searun Cutthroat	• Pileated Woodpecker
• Sockeye Salmon	• Purple Martin
• Coho Salmon	• Band-Tailed Pigeon
• Steelhead Trout	

Priority Habitat and Species (PHS) data collected by the Department of Fish and Wildlife were also examined for this report. PHS species are not necessarily listed as endangered, threatened or candidate species under the federal or state ESA. The PHS data include categories for resident fish species, streams where anadromous fish are present as well as

their spawning and rearing areas, fish barriers, and the wildlife heritage database that identifies locations where wildlife species of concern have been observed. For the McAleer and Lyon Creek Basins, Reach MC1 was the only reach identified as priority habitat containing resident fish. In addition to being identified as a priority habitat, Reach MC1 was identified as an anadromous spawning and rearing stream.

These data correspond to the other data and observations collected as part of this report. However, the PHS data does not include all of the data that have been identified for this report. For example, cutthroat trout have been identified in Echo Lake. Therefore, while the PHS database can be used as a tool in identifying priority habitat species, it should not be considered a comprehensive resource.

The Heritage Wildlife Database, which is part of the Priority Habitat and Species database maintained by the Department of Fish and Wildlife, was consulted to determine the location of observed wildlife species in the McAleer Creek and Lyon Creek Basins. No priority species were documented in either basin within the City limits.

5. REFERENCES

Adolfson and Associates. February 1999. Final Environmental Impact Statement Volume 1: Shoreview Park Capital Project. Prepared for the City of Shoreline.

Adolfson and Associates. February 1999. Final Environmental Impact Statement Volume 2: Shoreview Park Capital Project. Prepared for the City of Shoreline.

Aquatic Biology Associates, Inc. 1996. Benthic Invertebrate Biomonitoring and Bioassessment in Western Montana Streams. March 1996 Version. Corvallis, OR.

Associated Earth Sciences, Inc. 2001. Limited Wetland Delineation Survey for 19620 14th Avenue Northwest. Project No. KB01297A. AES, Inc., Kirkland, Washington.

Associated Earth Sciences, Inc. 2000. Stream and Wetland Delineation Survey for 12th Avenue Northwest Site, Shoreline, Washington. Project No. KB99579A. Prepared for Royal Property Management. AES, Inc., Kirkland, Washington.

Behnke, R.J. 1992. Native trout of western North America. Am. Fish. Soc. Monog. No. 6. American Fish. Soc., Bethesda, Maryland. 275pp.

Brennan, J. 2001. Reconnaissance Assessment of the State of the Nearshore Ecosystem: Eastern Shore of Central Puget Sound. King County Department of Natural Resources. Seattle, Washington.

Brown and Caldwell. 1979. Storm Water Drainage Study of Boeing Creek for the King County Department of Public Works Division of Hydraulics, Task A-1 Interim Report. Brown and Caldwell Consulting Engineers, Seattle, WA. August 1979.

Brown and Caldwell. 1980. Storm Water Drainage Study of Boeing Creek for the King County Department of Public Works Division of Hydraulics, Task C Final Report. Brown and Caldwell Consulting Engineers, Seattle, WA. August 1980.

Burgner, R.L. 1991. Life history of sockeye salmon *Oncorhynchus nerka*. Pages 3-117. In: C. Groot and L. Margolis (eds.). Pacific salmon life histories. Univ. British Columbia Press, Vancouver, British Columbia, Canada.

Cederholm, C.J., D.H. Johnson, R.E. Bilby, L.G. Dominguez, A.M. Garrett, W.H. Graeber, E.L. Greda, M.D. Kunze, B.G. Marcot, J.F. Palmisano, R.W. Plotnikoff, W.G. Pearcy, C.A. Simenstad, and P.C. Trotter. 2000. Pacific Salmon and Wildlife – Ecological Contexts, Relationships, and Implications for Management. Special Edition Technical Report, Prepared for D.H. Johnson and T.A. O'Neil (Manag. Dirs.), Wildlife-Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia.

Center For Watershed Protection. 1998. Rapid Watershed Planning Handbook.

CH2MHill. February 2001. Aurora Avenue North Multimodal Corridor Project. Prepared for the City of Shoreline.

Chapman, D.W. and T.C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. Pages 153-176. In: T.G. Northcote (ed.). Symposium on salmon and trout in streams. H.R. McMillan Lectures in Fisheries. Institute of Fisheries, Univ. of British Columbia, Vancouver, British Columbia. 388pp.

City of Shoreline. February 1999. Final Environmental Impact Statement Volume 1 Shoreview Park Capital Project. Tetra Tech/KCM

City of Shoreline. February 1999. Final Environmental Impact Statement Volume 2: Shoreview Park Capital Project. Tetra Tech/KCM

City of Shoreline. January 1999. Owner's Manual – Your Guide to Services and Citizen Participation in the City of Shoreline.

City of Shoreline November 17, 1997. Draft Environmental Impact Statement Comprehensive Plan Alternatives A, B & C/D.

City of Shoreline. November 17, 1997. Draft Environmental Statement Appendices.

City of Shoreline Municipal Code SMC 20.80.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Prepared for: Office of Biological Services, Fish and Wildlife Service. Report FWS/OBS-79/31.

Daley, W. 2004. Fish Utilization in City of Shoreline Streams.

Entranco. 2001. Revised Draft Basinwide Flow Control Plan – Thornton Creek. Prepared for City of Seattle.

Greater Lake Washington Technical Committee (GLWTC). March 19, 2001. Draft Reconnaissance Assessment – Habitat Factors that Contribute to the Decline of Salmonids, Greater Lake Washington Watershed Water Recourse Inventory Area 8.

Groot, C and L. Margolis (eds.). 1991. Pacific salmon life histories. Univ. British Columbia, Vancouver, British Columbia, Canada. 564pp.

Groot, C., L. Margolis, and W.C. Clarke. 1995. Physiological ecology of Pacific salmon. Univ. British Columbia Press. Univ. British Columbia, Vancouver, British Columbia.

Hammond, Collier & Wade-Livingstone Associates, Inc. June 1999. McAleer and Lyon Creeks Drainage Basin Study. Prepared for the City of Lake Forest Park.

Hartley, James, 1995. Letter report addressing Innis Arden Salmonids. King County SWM.

Healey, M.C. 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-393. In: C. Groot and L. Margolis (eds.). Pacific salmon life histories. Univ. British Columbia Press, Vancouver, British Columbia. Canada.

Hennick, Doug. 1999. Letter report addressing wetland violation on Storm Creek. WDFW.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle.

Jones & Stokes Associates, Inc. 1990. Wetland Report for 2125 North 179th Street, King County, Washington. Jones & Stokes Associates, Inc., Bellevue, Washington.

KCM, Inc. May 1983. McAleer Creek Project. Prepared for King County Surface Water Management, City of Lake Forest Park, City of Mountlake Terrace, WA.

KCM, Inc. February 1993. McAleer Creek Drainage Improvement Project Final Environmental Impact Statement. Prepared for King County Surface Water Management Division, Seattle, WA.

KCM, Inc. September 1997. City of Shoreline – Stormwater Study for GMA Comprehensive Plan/EIS. Prepared for the City of Shoreline.

KCM, Inc. November 1998. Final Environmental Impact statement Draft Comprehensive Plan. Prepared for the City of Shoreline. KCM, Inc., Seattle, WA.

King County. 1987. Reconnaissance Report No. 21-Middle Puget Sound Basin. KCSWM.

King County. June 1987. Basin Plan Review: 1983 McAleer Creek Project. Natural Resources and Parks Division and Surface Water Management Division.

King County. July 1987. Basin Plan Review: 1981 Lyon Creek Watershed Comprehensive Drainage Plan. Natural Resources and Parks Division and Surface Water Management Division.

King County. 1990. King County Sensitive Areas Map Folio.

King County. 1994. Boeing Creek Tributary 0019 Special Study. King County Department of Public Works Surface Water Management Division. November 7, 1994.

King County. September 1998. Surface Water Design Manual. King County Department of Natural Resources Division.

King County. November 1998. Boeing Creek Hidden Lake Restoration Operation and Maintenance Manual Addendum.

King County. 2001. Aerial Survey. King County, Washington.

Lake Forest Park Stewardship Foundation (LFPSF). 2001. A Salmon's Guide to Lake Forest Park.

Land-Tek Wetland Services. 2001. Metcalf Townhome Project Wetland and Stream Report. Land Tek, Olympia, Washington.

May, C. R. Horner, J. Karr, B. Mar, and E. Welch. 1997. Effects of Urbanization on Small Streams In the Puget Sound Lowland Ecoregion. *Watershed Protection Techniques*, 2(4): 483-494.

Mitsch, W.J. and J.G. Grosselink. 1986. Wetlands. Van Nostrand Reinhold, New york.

Mongillo, P. E. 1993. The distribution and status of bull trout/Dolly Varden in Washington State. June 1992. Washington Department of Wildlife, Fisheries Management Division Report 93-22. Olympia.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Mainwright, W.S. Grant, F.K. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443 pp.

Ostergaard, E. 1994. Wetland Delineation Report for the Hidden Lake Restoration Project, King County, Washington CIP# 0A1755. Prepared for King County Surface Water Management and Submitted to King County Department of Development and Environmental Services. KCSWM, Seattle, Washington.

Otak. February 2000. Final Channel Erosion Study on Shorewood Hills Ravine. Prepared for the City of Shoreline.

Otak. July 2000 3rd Avenue NW Drainage Study Volume II: Appendices. Prepared for the City of Shoreline.

Otak. October 2000. Pan Terra Regional Stormwater Detention Pond.

Otak. December 2000. 3rd Avenue NW Drainage Study Volume I: Report. Prepared for the City of Shoreline.

Otak. January 2001. Preliminary Study of Flooding Problem at 14849 12th Avenue NE. Prepared for the City of Shoreline.

Otak. December 2001. Thornton Creek Tributary Flood Reduction Study. Preliminary Draft. Prepared for the City of Shoreline.

Pierce County Water Programs. April 2000. Guidance for Basin Planning.

Puget Sound Salmon Stock Review Group. 1992. Assessment of the status of five stocks of Puget Sound chinook and coho as required under PFMC definition of overfishing. Summary report for Pacific Management Council, Portland, Oregon. 113pp.

Puget Sound Water Quality Action Team. 2000. Puget Sound Water Quality Management Plan.

Rasmussen and Huse, Consulting Engineers, Inc. 1987. Stormwater Drainage Analysis of Ronald Bog. Prepared for King County Department of Public Works Surface Water Management Division.

R2 Resource Consultants. 1999 and 2000. USBEM Tri-County Urban Stream Baseline Evaluation Method developed by R2 Resource Consultants.

R2 Resource Consultants, CH2M Hill, and Shapiro & Associates. 2000. Tri-County Urban Issues ESA Study: Guidance Document. February 2000. Prepared for the Tri-County Urban Issues Advisory Committee, Bellevue, WA.

Seattle Public Utilities. September 1999. Thornton Creek Riparian Corridor Maps.

Seattle Public Utilities. November 2000. Thornton Creek Watershed Characterization Report.

Shannon and Wilson. 1995. Geotechnical Engineering Report for the Hidden Lake Restoration Project and Riparian Corridor Maps.

Sheldon & Associates, Inc. February 2002. Hidden Lake Routine Dredging Maintenance Project. Biological Evaluation for: Puget Sound ESU Chinook Salmon, Coastal ESU Bull Trout, Puget Sound/Strait of Georgia ESU Coho Salmon, Bald Eagle. Prepared for the City of Shoreline.

Spence, B., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4510-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR.

Stream Net. 2001. Northwest Aquatic Information Network homepage. www.streamnet.org.

Stormwater Manager's Resource Center. 2001. www.stormwatercenter.net

Tetra Tech/KCM. June 2001. Kim Wetland Improvements. Letter Report to City of Shoreline.

United States Department of Fish and Wildlife. 1987. National Wetlands Inventory, Edmonds East quadrangle.

United States Geologic Survey. 1981. 1:24,000 Topographic Map, Edmonds East Quadrangle.

United States Soil Conservation Service. 1952. Soil Survey – King County Area.

Vanderhoof, J., E. Ostergaard, D.M. Gleisner. 2000. 1997 Volunteer Salmon Watcher Program in the Lake Washington Watershed. King County Department of Natural Resources, Water and Land Resources Division.

Walcott, E.E. 1965. Lakes of Washington. State of Washington

Washington Forest Practices Board. October 1993. Version 2.0. Standard Methodology for Conducting Watershed Analysis.

Washington State Department of Ecology. August 1993. Washington State Wetlands Rating System – Western Washington. Publication No. 93-74.

Washington State Department of Ecology. March 1997. Washington State Wetlands Identification and Delineation Manual. Publication No. 96-94.

Washington State Department of Ecology. 1998. The 1998 Section 303(d) List. www.ecy.wa.gov.

Washington State Department of Ecology. October 1999. Estimated Baseflow Characteristics of Selected Washington Rivers and Streams (Water Supply Bulletin No. 60).

Washington State Department of Ecology. August 2000. 2000 Washington State Water Quality Assessment. Section 305 (b) Report. Publication No. 00-10-058.

Washington State Department of Ecology. August 2001. Stormwater Management Manual for Western Washington. Publication Numbers 99-11 through 99-15.

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes (WDF et al 1993). 1992 Washington State salmon and steelhead stock inventory (SASSI): summary report. Washington Department of Fisheries, Olympia. 212 pp.

Washington Department of Fish and Wildlife. 1995. Priority Habitats and Species Database. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). and Western Washington Treaty Indian Tribes (WWTIT) 1994. 1992 Washington State salmon and steelhead stock inventory (SASSI). Washington Dept. Fish and Wildlife, Olympia, Washington. 212pp.

Washington Department of Fish and Wildlife. 1998. Fish Passage Barrier and Assessment and Prioritization Manual. Washington Department of Fish and Wildlife. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1998. Salmonid Stock Inventory, Appendix Bull Trout and Dolly Varden. U.S. Fish and Wildlife Service, Sportfish Restoration Program Contracts F-114-R-1, F-114-R-2, and F-115-R-1. Washington Dept. Fish and Wildlife, Olympia, Washington. 437pp.

Wetland Resources, Inc. 2000. Critical Area Study and Wetland Mitigation Plan for Aegis Assisted Living, Project # 98284. Prepared for Aegis Assisted Living. Wetland Resources, Inc., Everett, Washington.

Weitkamp, D.E., G. Ruggerone. 2000. Factors Affecting Chinook Populations. City of Seattle.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region. Washington State Department of Fisheries, Olympia, Washington.

Wolman, M.G. 1954. A method of sampling coarse river-bed material. Transactions of the American Geophysical Union 35(6):951-956.

PERSONAL COMMUNICATION

Barnes, Ed. Shoreline Resident. September 2001.

Bear, William. Shoreline Resident. April 9, 2001.

Blaylock, Bill. Middle Puget Sound North Basin Resident. 19 March 2002.

Dettlaff, Yvonne. U.S. Fish and Wildlife Service. December 3, 2001

Gorman, Brian. National Marine Fisheries Service. January 30, 2003.

Longenbaugh, Matthew. National Marine Fisheries Service. November 8, 2001.

Moren, Sylvia. Shoreline Resident. April 2, 2001.

Orr, Ned. Shoreline Resident. March 25, 2002.

Pelley, Ray. Shoreline Resident. April 2, 2001.

Stiles, Victoria. Shoreline Historical Museum Director. November 26, 2001.

Way, Janet. Shoreline Resident. April 9, 2001.

Wilson, Cynthia. Shoreline Resident. April 10, 2001.