Section 2—Characterization of the Study Area

Service Area

Drainages within the City

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

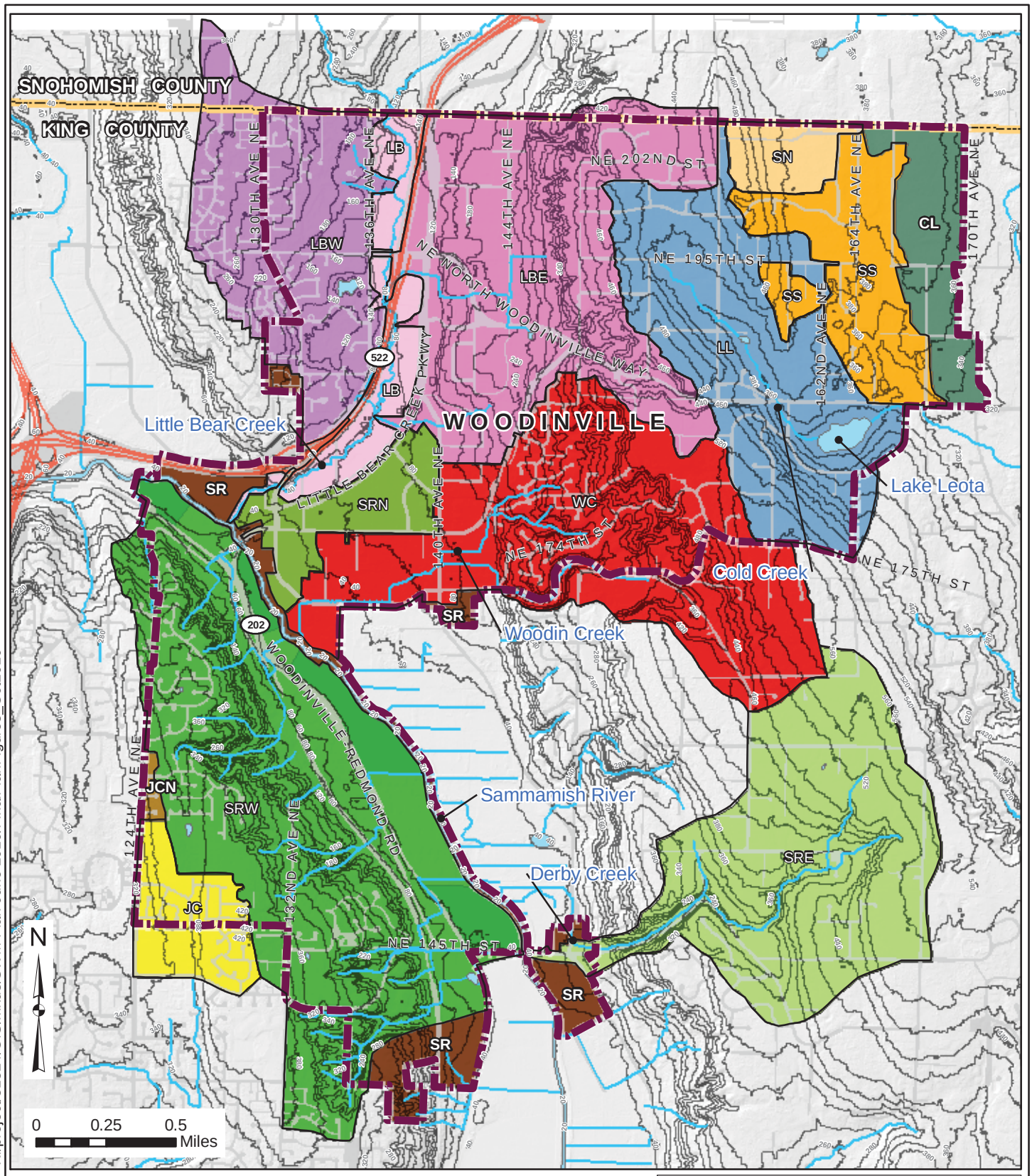
Major watersheds are provided in Table 2-1 which lists the total drainage basin areas that contribute runoff within the City.

Table 2-1
Drainage Basin Areas Within City Limits

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

Adjacent and Downstream Drainages

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



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LEGEND

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

Basin Boundary

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

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

STORMWATER MANAGEMENT PLAN

FIGURE 2-1

MAJOR WATERSHEDS AND DRAINAGE BASINS

CITY OF WOODINVILLE

OCTOBER 2010

Hydrologic Characteristics

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

Climate

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

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

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

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

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

Soils

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

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

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

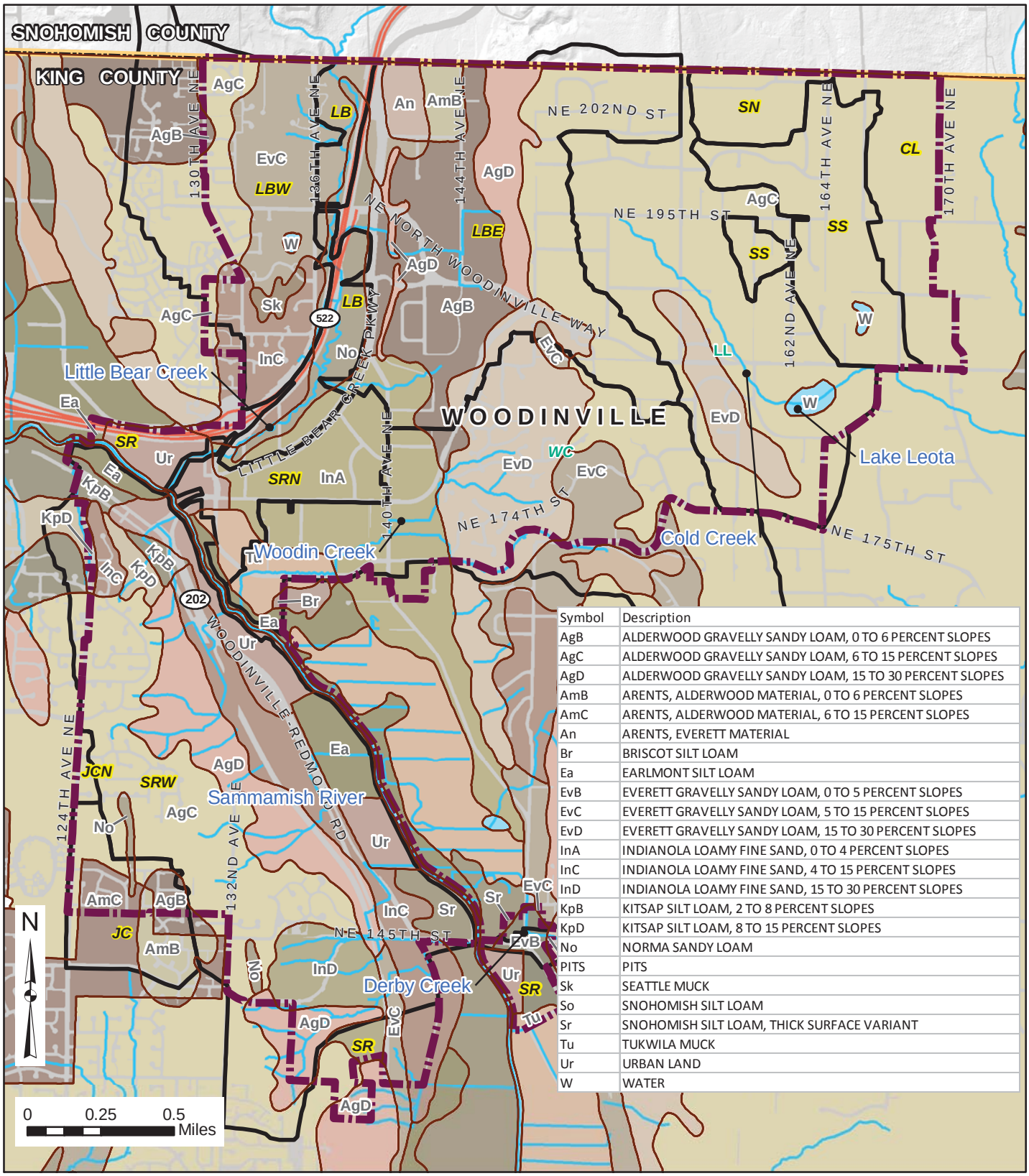
The thirteen different soil types within the City are classified by NRCS as Alderwood, Arents-Alderwood, Arents-Everett, Briscot, Earlmont, Everett, Indianola, Kitsap, Norma, Seattle, Snohomish, Tukwila and Urban. The hydrologic soil groups (HSGs) were identified using the 2005 Ecology Manual. The HSG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

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

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

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

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



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

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LEGEND

City Limits
County Boundary
Basin Boundary
Highway
Streams

Soil Type as Classified by NRCS

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

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

STORMWATER MANAGEMENT PLAN

FIGURE 2-2

DRAINAGE BASINS WITH SOILS
(AS CLASSIFIED BY NRCS)

CITY OF WOODINVILLE

OCTOBER 2010

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

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

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

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

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

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

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

Erosion Hazard Rating Hydric Rating (Source NRCS)

According to NRCS:

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

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

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

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

Hydric Rating (Source NRCS)

According to the NRCS

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

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

Drainage Class (Source NRCS)

According to NRCS

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

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

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

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

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

Suitability for Roads (Natural Surface) (Source NRCS)

According to NRCS

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

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

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

Topography

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

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

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

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

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

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

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

Treatment Swale near Woodinville-Duvall

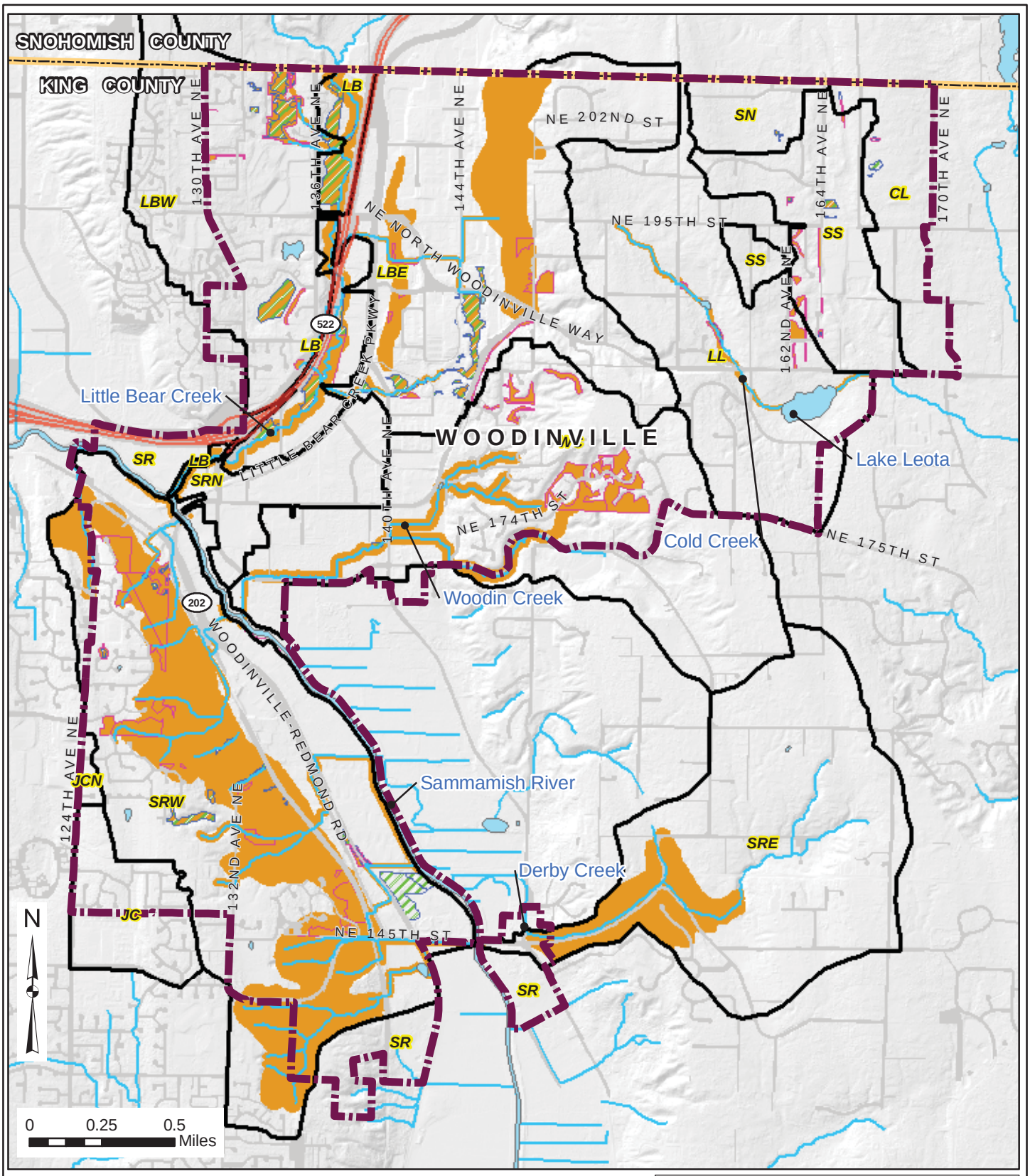
Sensitive Areas

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

Steep Slopes

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

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



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LEGEND

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

Sensitive and Critical Areas

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

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

STORMWATER MANAGEMENT PLAN

FIGURE 2-3

SENSITIVE AND CRITICAL AREAS

CITY OF WOODINVILLE

OCTOBER 2010

Wetlands

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

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

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

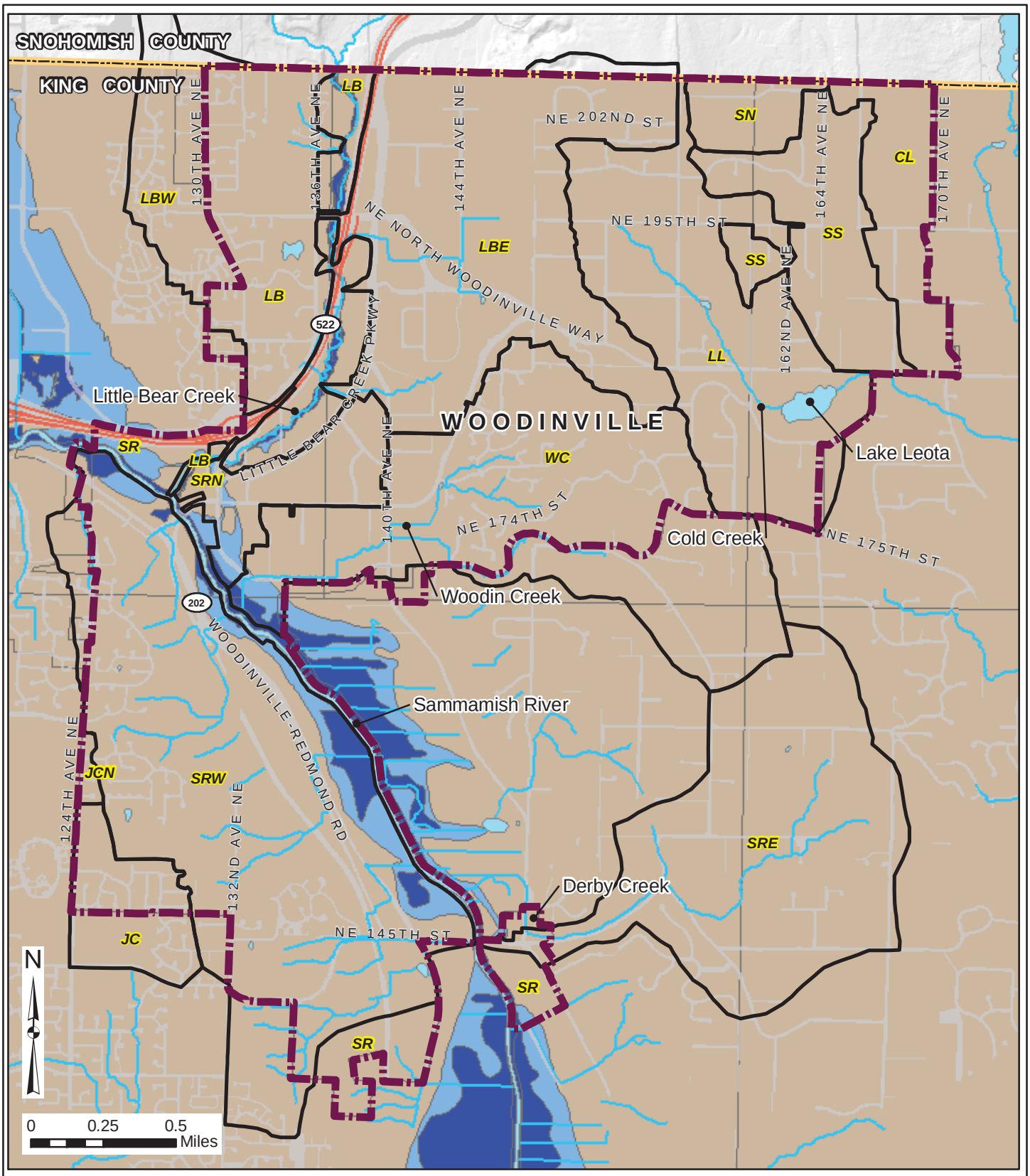
See Appendix H for a copy of the City's habitat assessment reports for Woodin Creek and Little Bear Creek.

Floodplains

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

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

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



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LEGEND

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

FEMA Flood Zone Designations

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

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

STORMWATER MANAGEMENT PLAN

FIGURE 2-4

FEMA FLOODWAY MAP

CITY OF WOODINVILLE

OCTOBER 2010

Drainage Basins and Streams

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

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

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

Table 2-5
Watershed Areas within the City of Woodinville

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

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

Sammamish River

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

Sammamish River as it flows through Woodinville

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

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

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

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

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

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

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

Little Bear Creek

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

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

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

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

This habitat assessment included some of the following selected recommendations:

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

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

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

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

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

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

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

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

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

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

Woodin Creek

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

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

Stewardship Sign for Woodin Creek

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

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

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

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

Roadway cross culvert on Woodin Creek

Lake Leota

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

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

Juanita Creek

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

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

Derby Creek

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

School Creek

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

Zoning and Impervious Areas

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

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

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

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

Existing Zoning

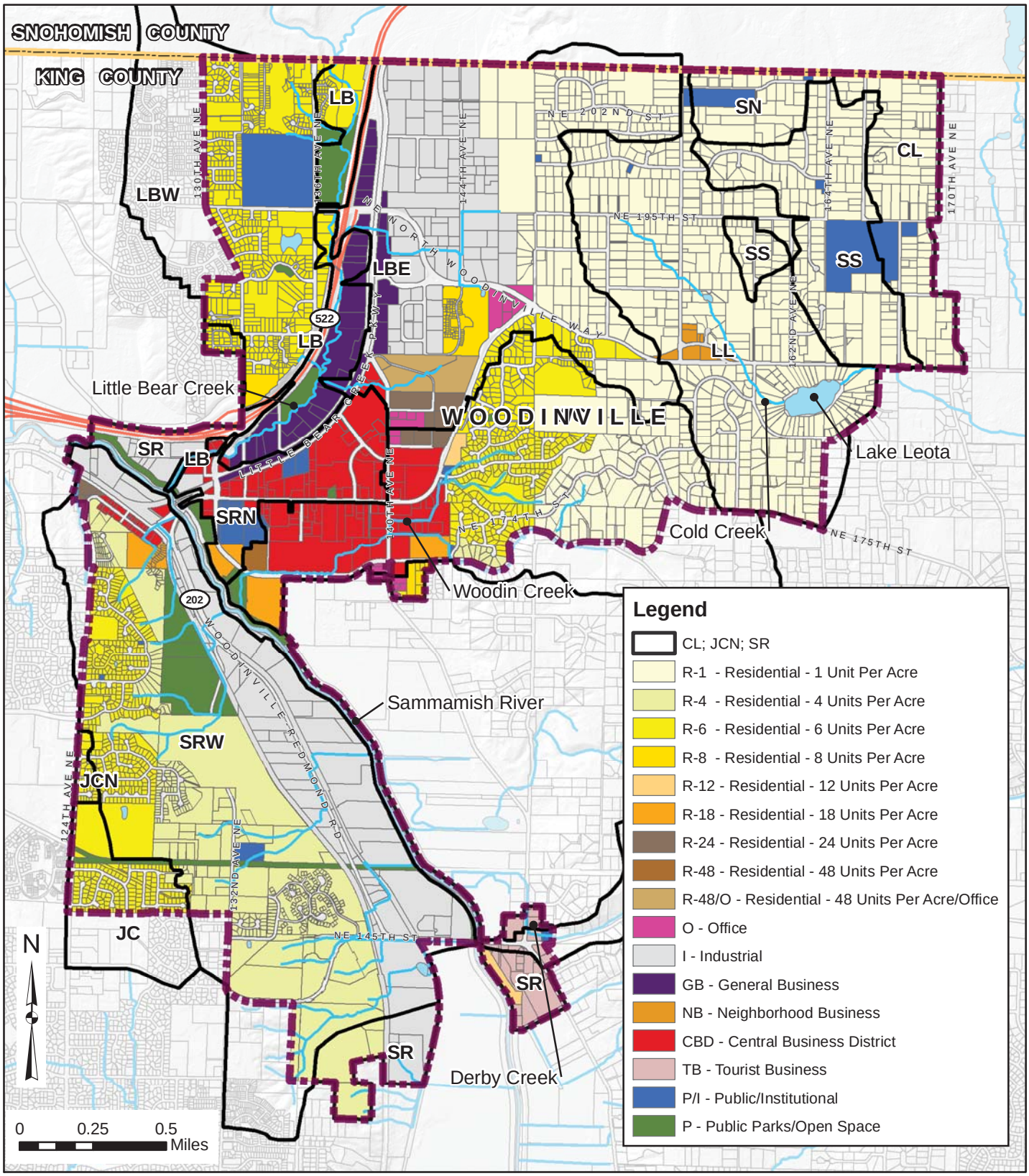
Figure 2-5 shows the City's existing zoning map last updated in April 2010, as presented in the City's Comprehensive Plan. The existing zoning areas within the City are summarized in Table 2-6.

Table 2-6
Existing Zoning

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

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

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



LEGEND

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

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

STORMWATER MANAGEMENT PLAN

FIGURE 2.5

EXISTING ZONING

CITY OF WOODINVILLE

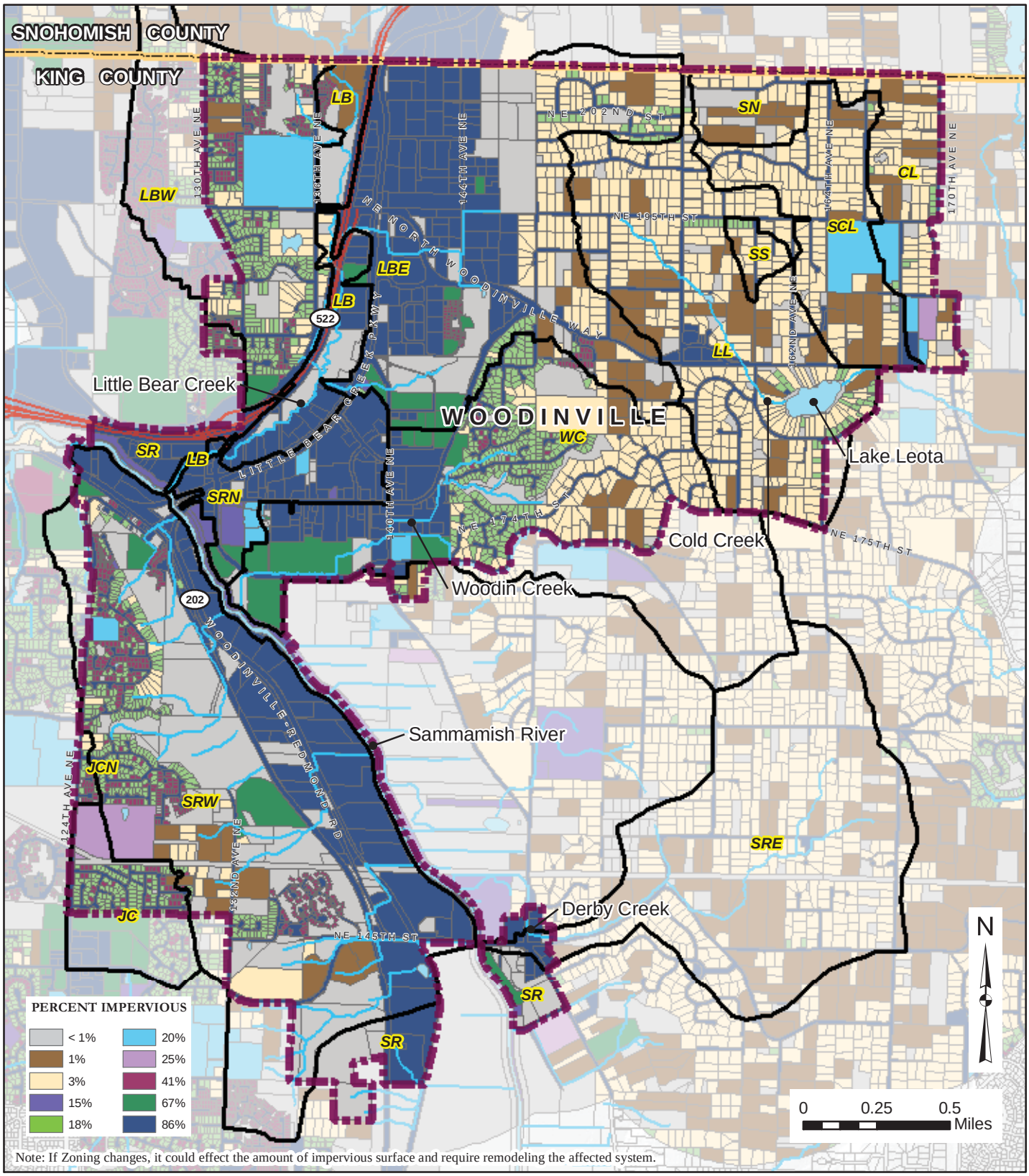
JUNE 2010

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

Future Impervious Percent Area

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

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



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

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LEGEND

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

Basin Name and Abbreviation

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

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

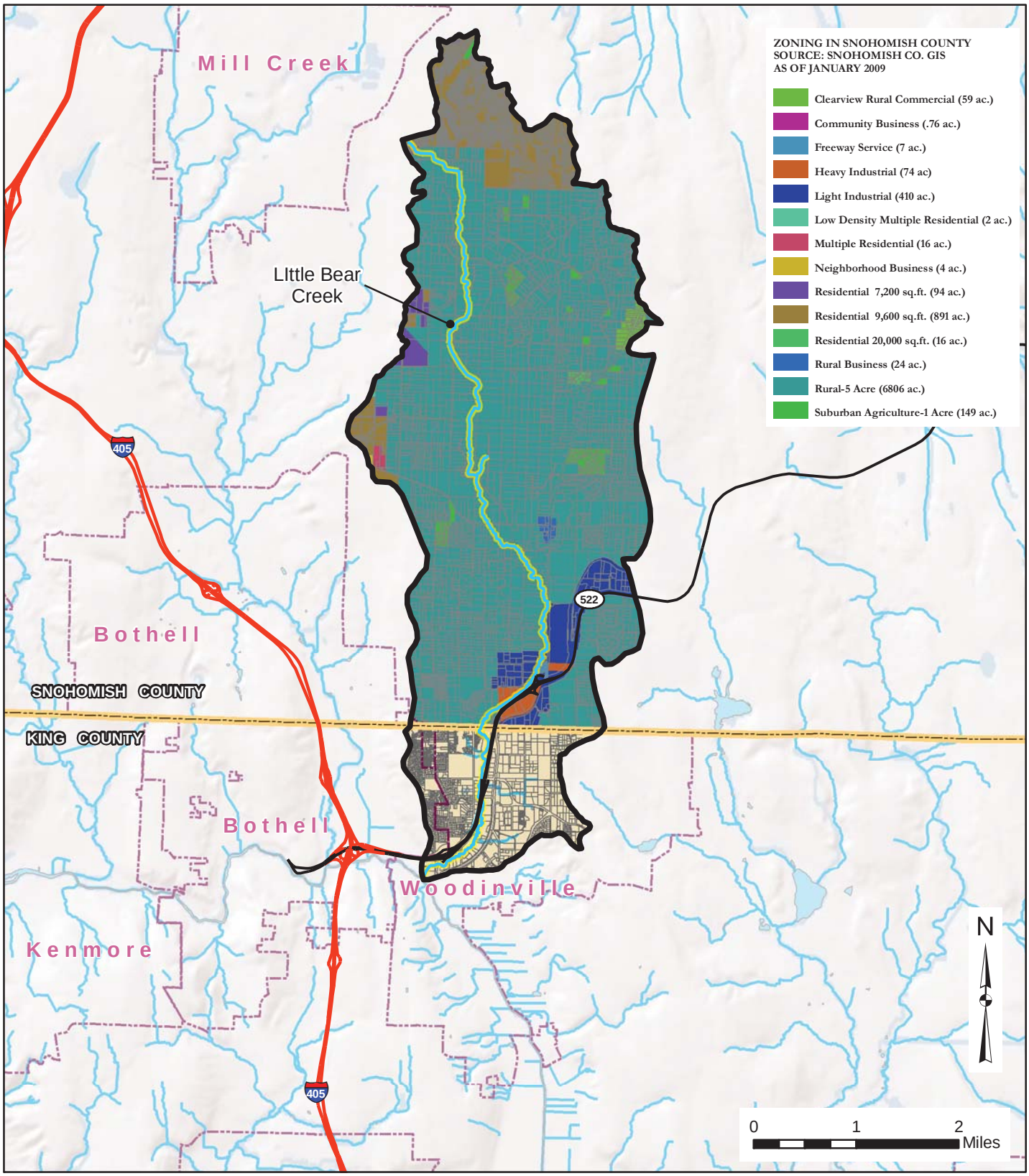
STORMWATER MANAGEMENT PLAN

FIGURE 2.6

FUTURE IMPERVIOUS PERCENT AREA

CITY OF WOODINVILLE

OCTOBER 2010



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LEGEND

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

LITTLE BEAR CREEK WATERSHED

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

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

STORMWATER MANAGEMENT PLAN

FIGURE 2.7

ZONING IN LITTLE BEAR CREEK SUBBASIN

CITY OF WOODINVILLE

OCTOBER 2010