City of Black Diamond Sensitive Areas Ordinance

Best Available Science Review and Recommendations for Code Update

Summary and Recommendations

Prepared for

City of Black Diamond
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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

BAS	Best Available Science
BDMC	Black Diamond Municipal Code
BMPs	best management practices
CAO	critical areas ordinance
CARAs	critical aquifer recharge areas
CMZ	channel migration zone
CTED	Washington State Office of Community Trade and Economic Development
DNR	Department of Natural Resources
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FEMA	Federal Emergency Management Agency
FWHCAs	fish and wildlife habitat conservation areas
GIS	Geographic Information System
GMA	Growth Management Act
LWD	large woody debris
NMFS	National Marine Fisheries Service
NWI	National Wetlands Inventory
OHWM	ordinary high water mark
PHS	Priority Habitat and Species
SASSI	Washington State salmon and steelhead stock inventory
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SPTH	site-potential tree height
SWPPP	Stormwater Pollution Prevention Plan
TES	threatened, endangered, or sensitive
TIA	total impervious surface
UGAs	Urban Growth Areas
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WHPAs	Wellhead protection areas
WRIA	Water Resource Inventory Area

1. SUMMARY OF FINDINGS

This report summarizes the findings in the City of Black Diamond Sensitive Areas Best Available Science Studies prepared for the City by Parametrix Inc. in September 2008.

The general findings are:

- The City of Black Diamond and its Urban Growth Area (UGA) include most of the Lake Sawyer watershed.
- Lake Sawyer is a particularly sensitive and fragile lake because of its large area and relatively small watershed. In the past, the lake has been adversely impacted by nutrient loading. The lake is vulnerable to degradation as a result of urbanization.
- A landscape analysis of a variety of factors affecting ecological functions has identified the large stream wetland complexes of the Rock Creek, Jones Lake/Jones Creek and Black Diamond Lake/Black Diamond Creek as the areas within the UGA with the most intensive concentration of ecological processes that positively contribute to water quality of Lake Sawyer.
- Other streams and wetlands play an important part in ecological processes, but since most of them flow into the Rock Creek, Jones Lake/Jones Creek and Black Diamond Lake/Black Diamond Creek, their role is subsidiary.
- The Rock Creek, Jones Lake/Jones Creek and Black Diamond Lake/Black Diamond Creek area also provides the most productive aquatic and terrestrial wildlife habitats in the UGA with the most intensive concentration of ecological processes that positively contribute to water quality of Lake Sawyer.
- The City of Black Diamond and its Urban Growth Area (UGA) is a small part of, and a relatively small contributor to the ecological functions and values of the larger Green River watershed and the smaller Soos Creek and Covington Creed subbasins in which it is primarily located.
- Geologically hazardous areas (including coal mine hazards) and critical aquifer recharge areas are a concern, but can largely be addressed on a case-by-case basis.

The recommendations for management of Sensitive Areas in City of Black Diamond and its Urban Growth Area are:

- The City should focus protection on the areas with the most important ecological functions - the “core” stream and wetland complexes of the Rock Creek, Jones Lake/Jones Creek and Black Diamond Lake/Black Diamond Creek and provide those areas with the greatest protection indicated as the “Core” area in Figure 1-1.
- The second priority in preservation should be the wetland complexes at the headwaters of Ginder Creek, Lawson Creek and other tributaries that provide an important water supply to the larger system.
- Other streams and wetlands in the area provide important ecological functions and should be protected.

Some flexibility can be provided in development regulations to areas other than the core stream and wetland complexes of the Rock Creek, Jones Lake/Jones Creek and Black Diamond Lake/Black Diamond Creek. Regulations that allow reduction of buffer areas by transferring buffers to the areas providing a greater complex of ecological functions are especially appropriate.

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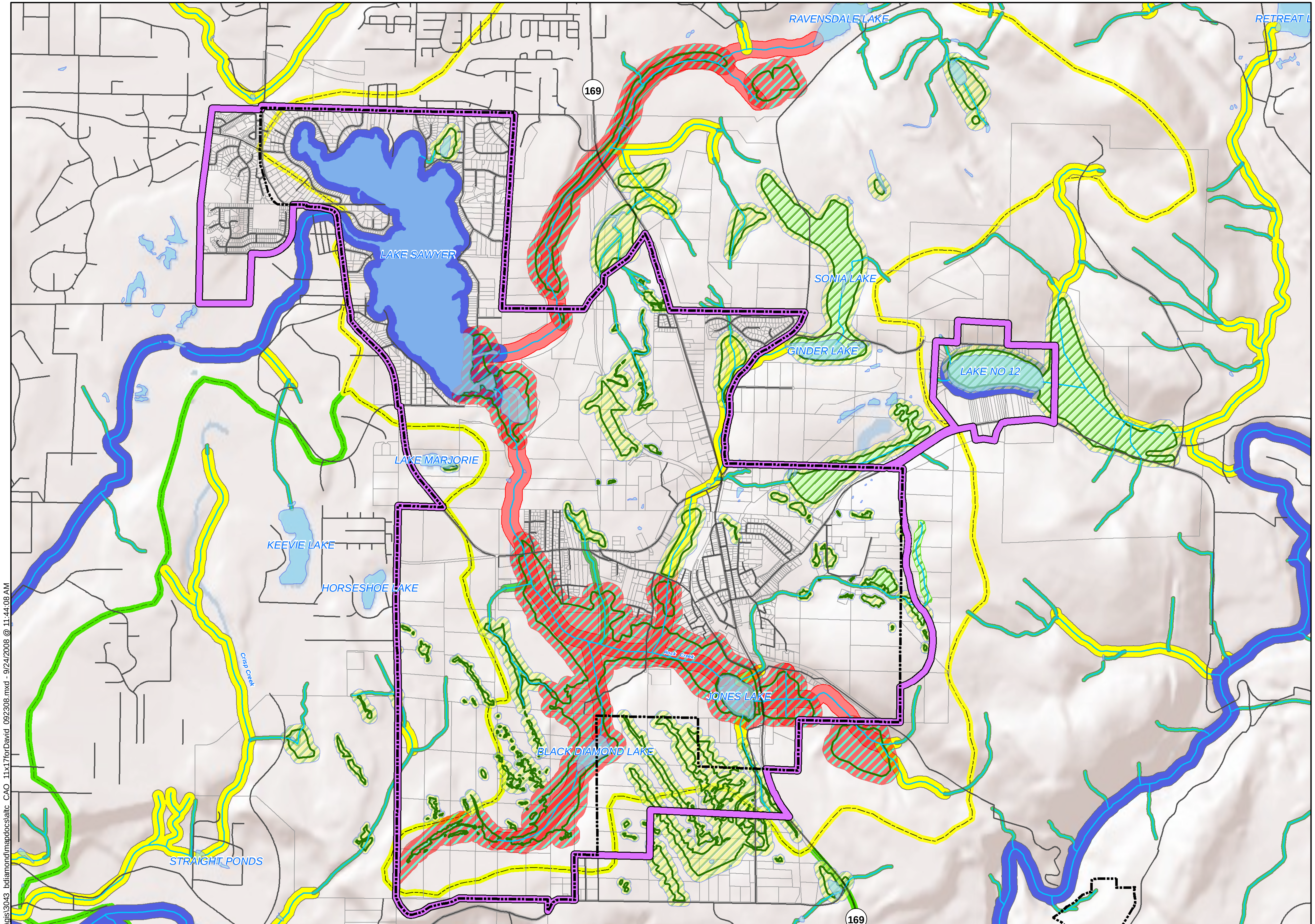

N

0 1,250 2,500
Scale in Feet

Legend
- Black Diamond City Limits
- UGA Boundary
- SR 169
- Road
- Water Body
- WADNR Streams
- CAO Wetland boundaries

Wetland Buffer Alternative C

Category and Buffer Distance
- Headwaters - 225 ft
- CORE - 225 ft
- I - 180 ft
- II - 150 ft
- III - 80 ft
- IV - 50 ft

Stream Buffer Alternative C

Category and Buffer Distance
- CORE - 225 ft
- S - 200 ft
- F - 150 ft
- Np, Ns - 50 - 100 ft

Study Area
- Lake Sawyer Watershed
- Green River Watershed

Data Source: King County GIS, WA DNR

Figure 1-1
Core Area
Most Intensive Processes
Black Diamond UGA

Sensitive Area Ordinance Update
City of Black Diamond, WA

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2. BEST AVAILABLE SCIENCE

2.1 WHAT IS BEST AVAILABLE SCIENCE

As defined in Washington Administrative Code (WAC) 365-195-905, Best Available Science (BAS) means current scientific information derived from research, monitoring, inventory, survey, modeling, assessment, synthesis, and expert opinion that is:

- Logical and reasonable
- Based on quantitative analysis
- Peer reviewed
- Used in the appropriate context
- Based on accepted methods
- Well referenced.

In some instances the GMA and its regulations constrain the choice of science that can be used to designate or protect a particular resource (e.g., local governments are required to use the definition of wetlands found in RCW 36.70A.030.21). In other cases, there may be a range of options that are supported by science (e.g., wetland buffer widths necessary to protect functions).

The State legislature and the Growth Management Hearings Boards have defined critical area "protection" to mean preservation of critical area "structure, function, and value." Local governments are not required to protect all functions and values of all critical areas, but are required to achieve "no net loss" of critical area functions and values across the jurisdictional landscape. Local governments are also required to develop regulations that reduce hazards associated with some types of critical areas, including geologically hazardous areas and frequently flooded areas. The standard of protection is to prevent adverse impacts to critical areas, to mitigate adverse impacts, and/or reduce risks associated with hazard areas.

This document and the Technical Appendixes that accompany it provide a summary of scientific studies related to designating and protecting critical areas, including habitat for anadromous fish species, as defined by the GMA. The information provides a basis for recommended changes and additions to the City of Black Diamond critical areas regulations in Ordinance 474 adopted in 1993 It is not intended to provide an exhaustive summary of all science available for all critical areas. The information reviewed is pertinent to City of Black Diamond, applicable to the types of critical areas present, and is believed to be the best available scientific information.

2.2 HOW IS THIS REPORT ORGANIZED

The analysis of Critical Areas in Black Diamond focused on ecological functions of wetlands, streams, habitat and aquifers and the hazards associated with geologic feature and, abandoned coal mines. The ecological analysis included two levels:

- The planning context, including state statutes and county and local plans
- A Landscape analysis that looked at ecological functions on a sub-watershed scale and addresses two main questions:
    - Which geographic areas are important for key ecological processes?

- What human activities in the important areas have altered or may later the key processes?

- A topical analysis of each of the resources within the Urban Growth Area, including streams, wetlands with their related habitat functions, frequently flooded areas, critical aquifer recharge areas, and geologic hazards, including coal mines. Each topical analysis assesses regulatory options for each resource.

This report summarizes more detailed analysis in Technical Appendixes that address specific resources:

Technical Appendix A, Best Available Science Review and Recommendations for Code Update, Landscape Analysis

Technical Appendix B, Best Available Science Review and Recommendations for Code Update, Fish and Aquatic Species, Terrestrial Habitat, Wetlands, Frequently Flooded Areas

Technical Appendix C, Best Available Science Review and Recommendations for Code Update, Geologically Hazardous Areas, Critical Aquifer Recharge Areas

3. PLANNING CONTEXT

3.1 STATUTORY MANDATE

In 1995, the Washington State legislature amended the Growth Management Act (GMA) to require that local governments include Best Available Science (BAS) in designating and protecting critical areas (RCW § 36.70A.172(1)). In 2000, the state's Office of Community Trade and Economic Development (CTED) adopted procedural criteria to implement these changes to the GMA and provided guidance for identifying BAS (CTED 2004).

This document summarizes BAS for City of Black Diamond sensitive areas and provides recommendations for updating the City's sensitive areas ordinance (CAO).

As directed by RCW 36.70A.050, this document addresses the following critical areas which are referred to in the Black Diamond Code as "sensitive areas":

- Fish and wildlife habitat conservation areas (HCAs).
- Wetlands (both freshwater and estuarine);
- Geologically hazardous areas;
- Frequently flooded areas; and
- Critical aquifer recharge areas (CARAs).

3.2 RELATIONSHIP TO OTHER PLANNING EFFORTS

The recommendations derived from the BAS review will be used as the basis for revising the City's development regulations and Sensitive Areas ordinances. The City is required to integrate sensitive areas protection into zoning regulations, clearing and grading provisions, stormwater management requirements, subdivision regulations and other applicable plans and policies. The City is also required to integrate the CAO provisions with its Shoreline Master Program (SMP). To comply with House Bill 1933, SMP regulations pertaining to critical areas must be as protective or more protective of functions and values as the CAO regulations themselves.

3.3 CITY SETTING

The City of Black Diamond is located in central western Washington State and encompasses approximately 5.9 square miles with a population of 4,120 (Figure 3-1, Vicinity Map). The Green River Valley lines the City to the south and east, and the City of Maple Valley is located to the north. The western edge of the City and UGA south of Lake Sawyer is generally along the alignment of 228th Avenue SE.

The vast majority of the City of Black Diamond's Urban Growth Area (UGA) is located in the Green/Duwamish River watershed (WRIA 9). Within the Green River watershed, the city drains into two distinct sub-basins:

- The Lower Green River/Soos Creek/Covington Creed subbasin, of which the Lake Sawyer sub-basin is part.
- The Middle Green River/Crisp Creek sub-basin.
- With the exception of two small portions of the UGA streams in the City drain to the Lake Sawyer/Covington Creek ("Lake Sawyer") subwatershed. Mapped streams located in the City include Covington Creek, Rock Creek, Ginder Creek, Black Diamond Lake Creek, Lawson Creek, Ravensdale Creek, and Jones Lake Creek. Rock Creek and Ravensdale Creek are the two primary tributaries to Lake Sawyer; Covington Creek, only a small portion of which is located in the City, is the only outlet for the lake. Several of the aforementioned streams support anadromous species.

A small portions of Green River/Crisp Creek sub-basin also is located in the city's UGA. (Figure 3-2). The portions of this basin located in the City do not have mapped streams and do not support anadromous species.

Lake 12 to the northeast of the current city limits is within the UGA and provides the headwaters of a separate stream named Rock Creek which drains into the Cedar River. To prevent confusion, this stream is referred to as the "Cedar River tributary Rock Creek."

Black Diamond is located at the edge of the King County Urban Growth Boundary. The City and King County have an existing agreement (the Black Diamond Urban Growth Area Agreement) that outlines a mutually acceptable Urban Growth Area boundary for the City of Black Diamond and conditions under which these areas may be annexed into the City. The UGA Agreement covers 792 acres of land. Following annexation, 593 of these acres can be developed and 189 acres would be preserved as open space. The area involved in the agreement is also referred to as the Potential Annexation Area (PAA) to distinguish them from the Lake Sawyer and Black Diamond Lake areas, also in the City's UGA (Figure 3-3).

3.4 COMPREHENSIVE PLAN

The City of Black Diamond adopted its current Comprehensive Plan in 1996. The City is currently updating that plan and issued a draft in March 2008 which is expected to be adopted in late 2008 (Figure 3-4 and Figure 3-5).

3.4.1 King County, Countywide Planning Policies

The City's Comprehensive Plan must be consistent with the King County Countywide Planning Policies (CCP) that provide the basis for designating Urban Growth Areas (UGA) throughout the county. King County policies provide specific policies that recognize the particular setting and challenges of rural communities. Specific relevant policies include:

- **King County CCP LU-38**. In recognition that cities in the rural area are generally not contiguous to the countywide Urban Growth Area, and to protect and enhance the options cities in rural areas provide, these cities shall be located within Urban Growth Areas. These Urban Growth Areas generally will be islands separate from the larger Urban Growth Area located in the western portion of the county. Each city in the Rural Area and King County and the Growth Management Planning Council shall work cooperatively to establish an Urban Growth Area for that city.

3.4.2 Black Diamond Urban Growth Area Agreement

In 2005 the City, the County, the Cascade Land Conservancy, and Plum Creek Timber Co. entered into the "Black Diamond Urban Growth Area Agreement" that established urban growth boundaries and specific conditions for annexation to the City to proceed.

The UGA Agreement is guided by four main goals:

- Protect the Rock Creek /Lake Sawyer Watershed and the Rock Creek/Lake 12 Basin
- Protect and maintain the community character
- Provide a healthy jobs-housing mix
- Make efficient development a priority

The Open Space component of the Urban Areas Agreement is shown in Figure 3-3.

3.4.3 Black Diamond Draft Comprehensive Plan

The March 2008 Comprehensive Plan Draft establishes the basis for land use within the city, as shown in Figure 3-4.

The plan has a number of policies relevant to sensitive areas and other ecological functions in the city. The most important of these include:

Critical Areas

UGA Policy NE 6: Naturally occurring processes such as runoff, stream channel migration, should be maintained by designing stream crossings to pass floods and debris, as well as fish.

UGA Policy NE 7: Development of headwater catchments should be limited to protect streams from temperature increases, sediment, and fish habitat degradation.

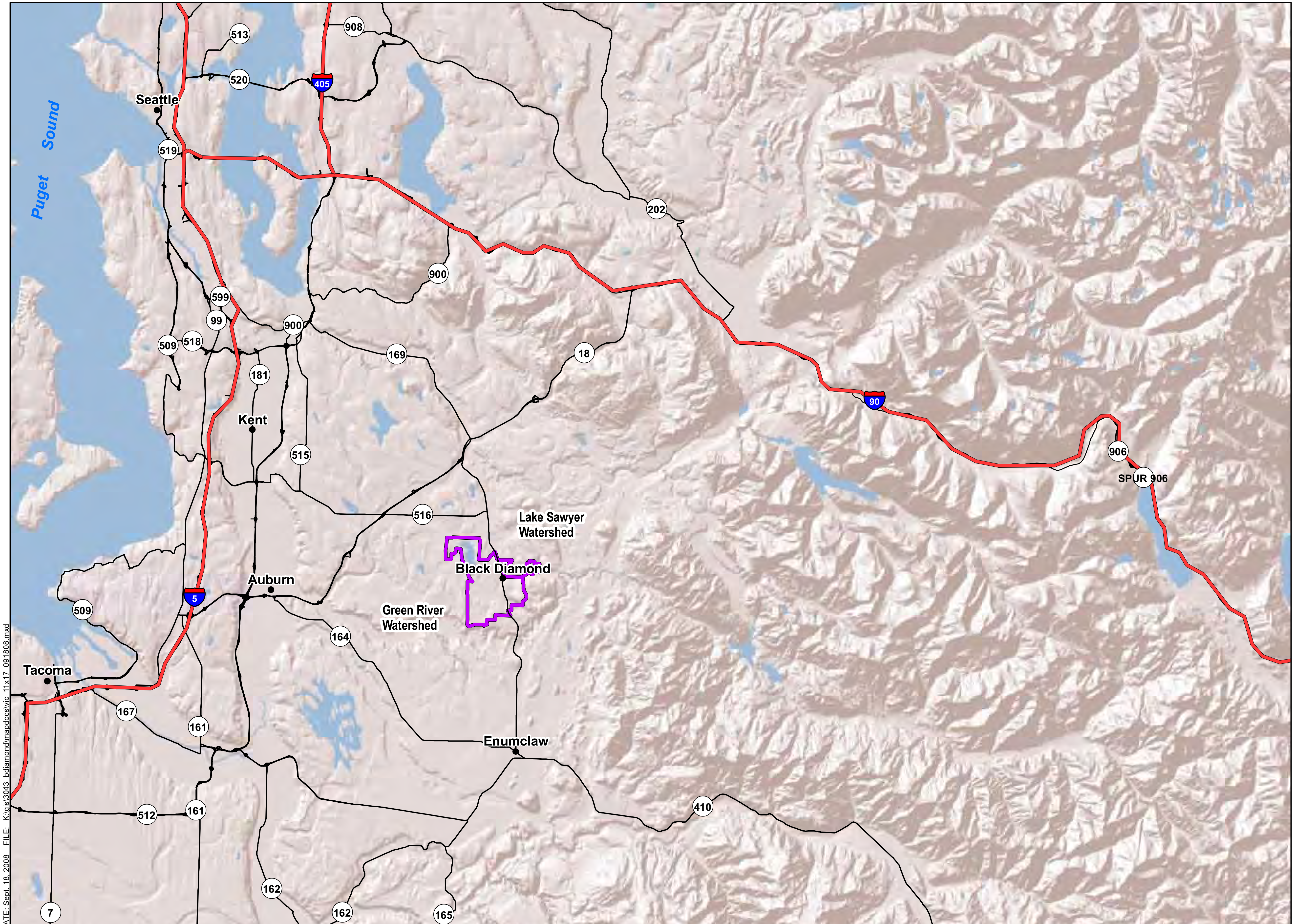
UGA Policy NE 8: Where linkages between habitats have been severed or interrupted, connections should be restored by replacing culverts with bridges, revegetating riparian areas, and improving in stream habitat.

UGA Policy NE 9: Developed portions of all annexation areas, especially in the Lake 12 Annexation Area, should protect the maximum amount of native vegetation to enhance storm water management.

UGA Policy NE 10: New residential development in the Lake 12 Annexation Area should be sited and clustered away from the adjacent rural and resource, or critical areas.

UGA Policy NE 11: Coordinate with King County and the Muckleshoot Indian Tribe to develop management plans that preserve County Open Space identified in the UGA Agreement primarily for its open space values, as opposed to timber values.

UGA Policy NE 12: Mitigation measures identified in the City of Black Diamond Potential Annexation Area Final Environmental Impact Statement and Comprehensive Plan Amendments should be used, with other city requirements, as development standards for the UGA.



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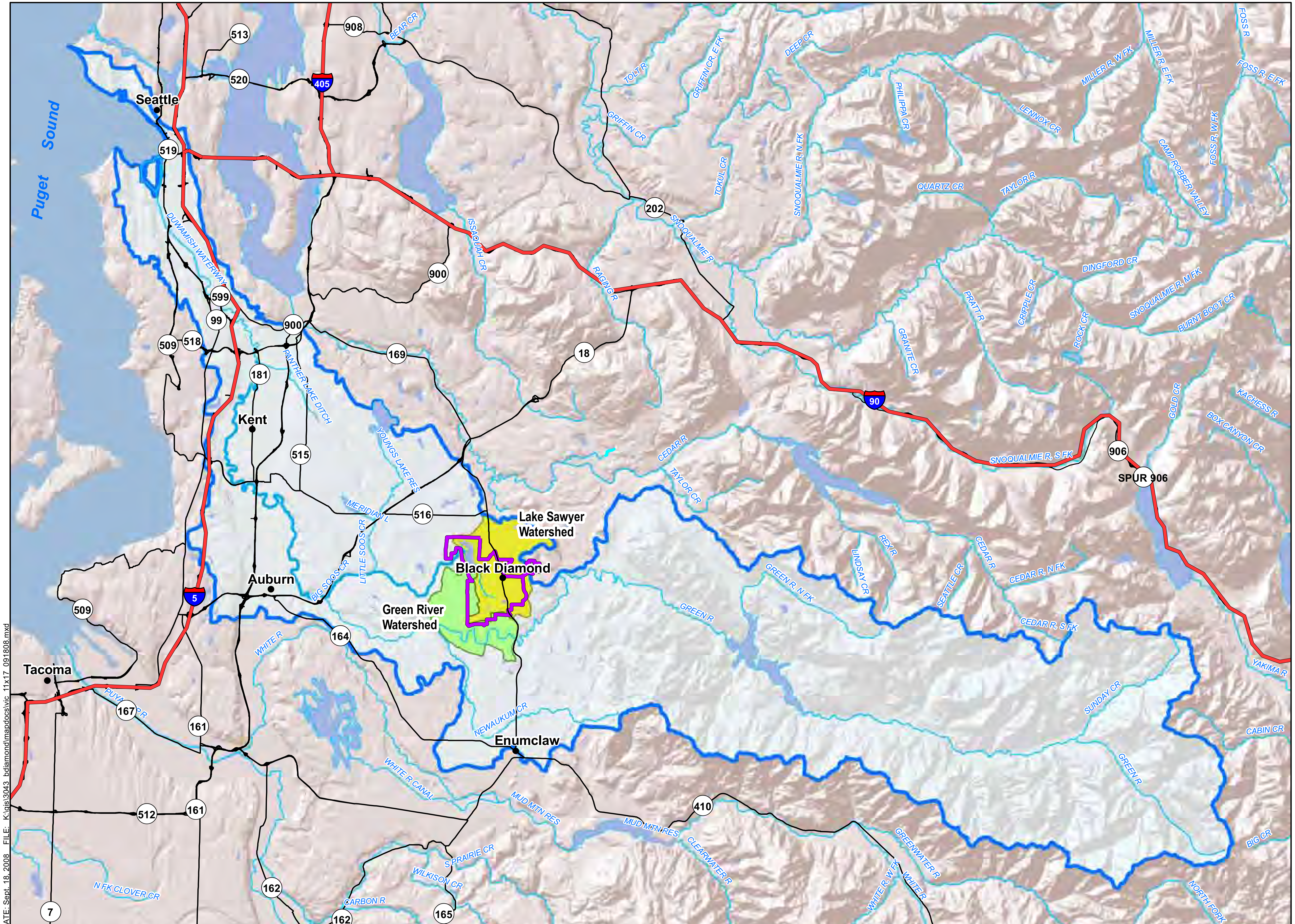
Legend

Black Diamond UGA Boundary

Data Source: King County GIS

Figure 3-1
Vicinity Map

Sensitive Area Ordinance Update
City of Black Diamond, WA



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Parametrix

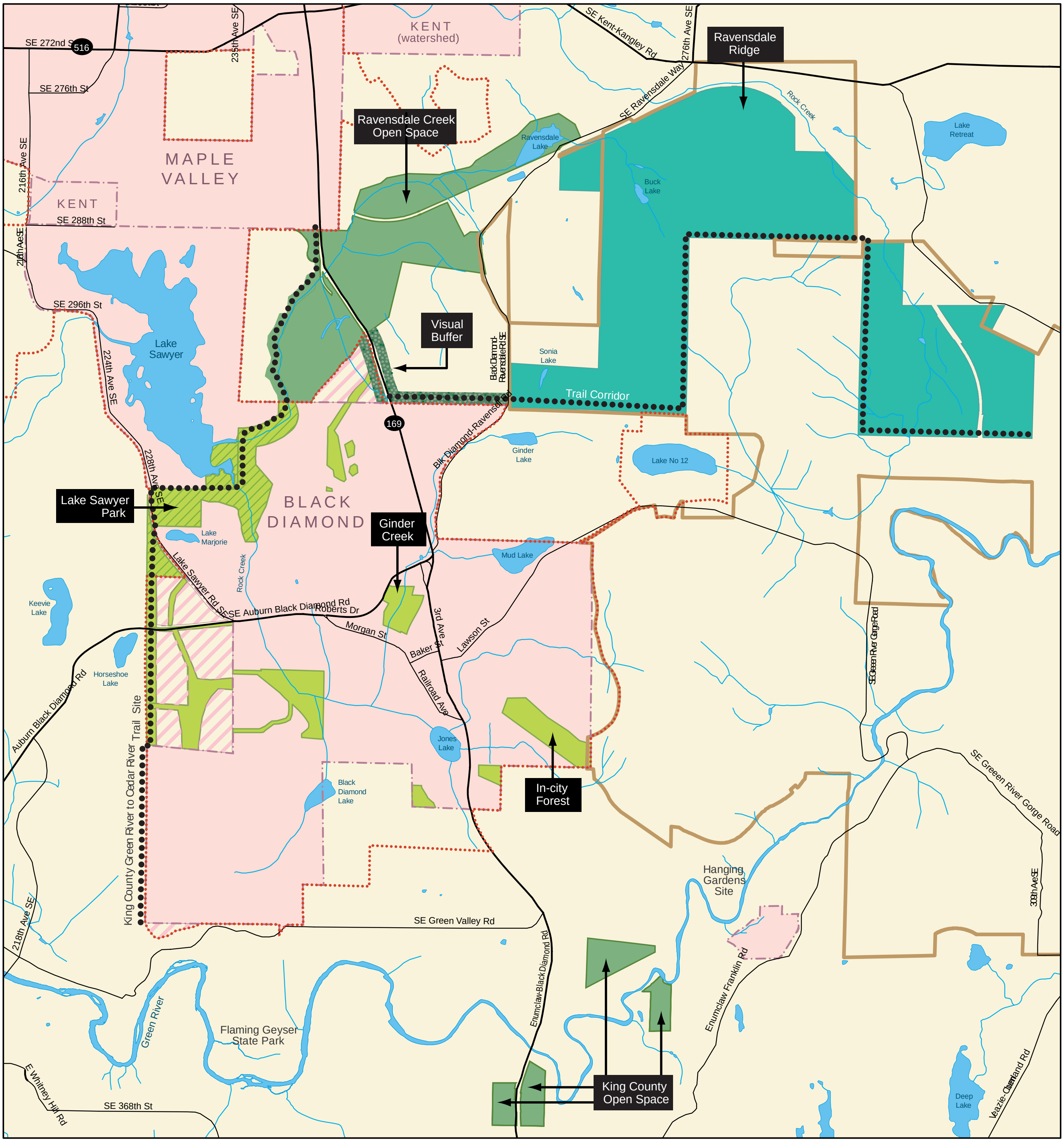
Legend

- Duwamish - Green River Watershed
- Black Diamond UGA Boundary
- Lake Sawyer Watershed
- Green River Watershed

Data Source: King County GIS, WA DNR

Figure 3-2
Vicinity Watersheds

Sensitive Area Ordinance Update
City of Black Diamond, WA



Parametrix 217-3043-004/01(01) 8/08 (B)

- Black Diamond Open Space
- King County Open Space
- Conserved Forest Land
- Visual Buffer
- Lake Sawyer Park
- Streams
- Minor Road
- Major Road
- Future Trail Site
- Lake
- Incorporated Area
- Annexation Area
- Urban Growth Area Line
- Forest Production District Boundary

0 0.5 1

Scale in Miles

N

Data Sources:
Standard King County datasets: lakes, rivers/streams, urban growth area line, forest production district.
Custom King County GIS Center datasets: in-city forest, annexation areas, King County open space, trails.
ESM Consulting Engineers, LLC (2005): In-City Open Space/Forest, Ginder Cr. Open Space, Section 2 Visual Buffer.

Produced by:
DNRP GIS and WLRD Visual Communications and Web Unit

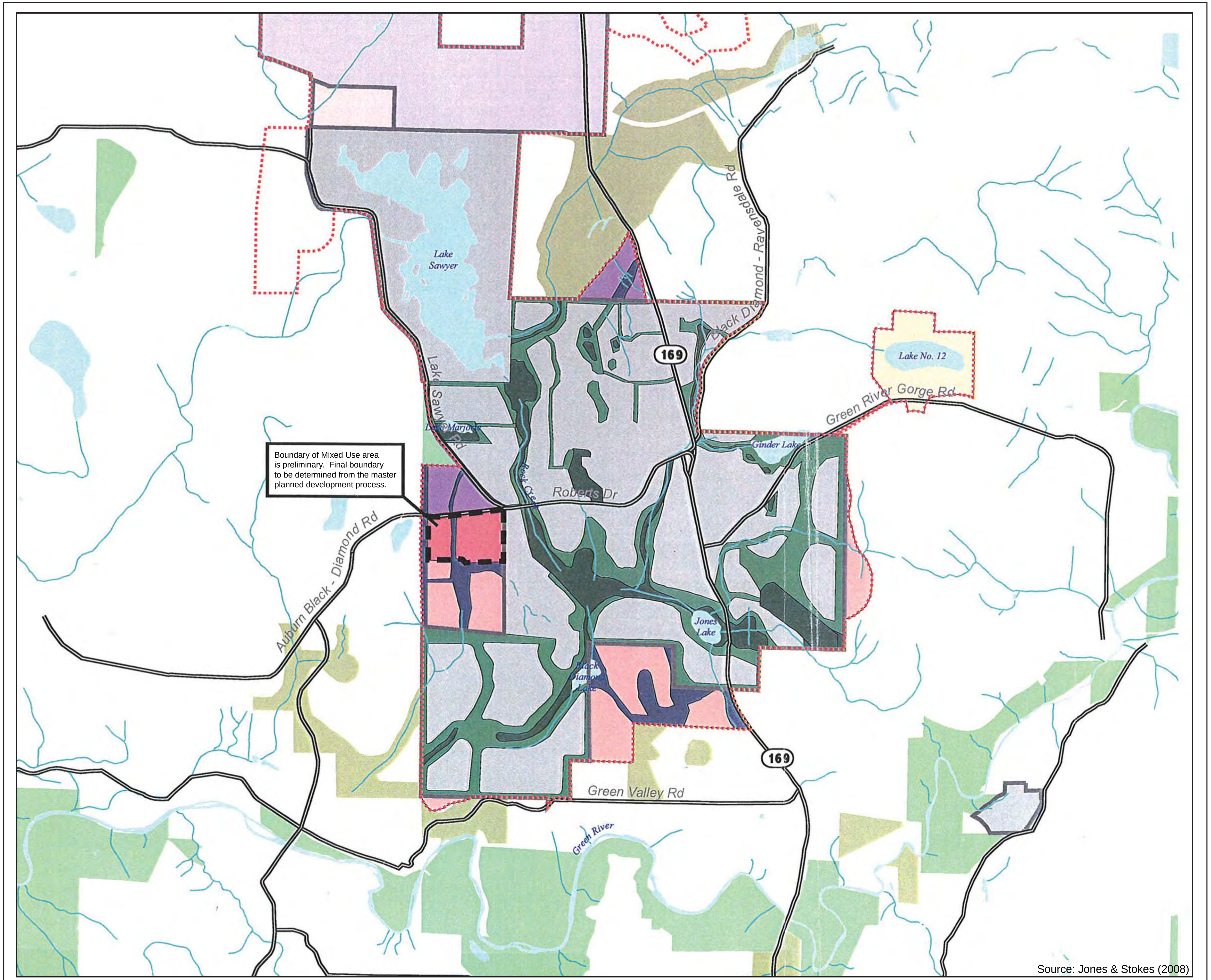
Map File:
WLRNT7/Cart/Finished/...ORRP/0506_BDOSAmapAFLANDS.ai LPRE

GIS Data Files (WLRD GIS Archives):
DNRP1/Projects/WLRD/05065

King County
Department of
Natural Resources and Parks
Water and Land Resources
Division

Figure 3-3 Black Diamond Urban Growth Area Agreement, Open Space

Parametrix 217-3043-004/01(01) 8/08 (B)



Legend

UGA Land Use

- UGA Open Space
- Low Density Residential
- Medium Density Residential
- Mixed Use
- Business Park & Light Industri

In City Open Space

- Primary
- Secondary

- King County Open Space
- UGA County Open Space

City

- Black Diamond
- Kent
- Maple Valley
- Water Body
- UGA Boundary
- Stream
- Arterial

Note: UGA Land Use approved by Black Diamond Ordinance No. 723 on 12/6/2001.

N

0 3,000

Scale in Feet

Figure 3-4
Black Diamond Comprehensive Plan, Land Use and Open Space

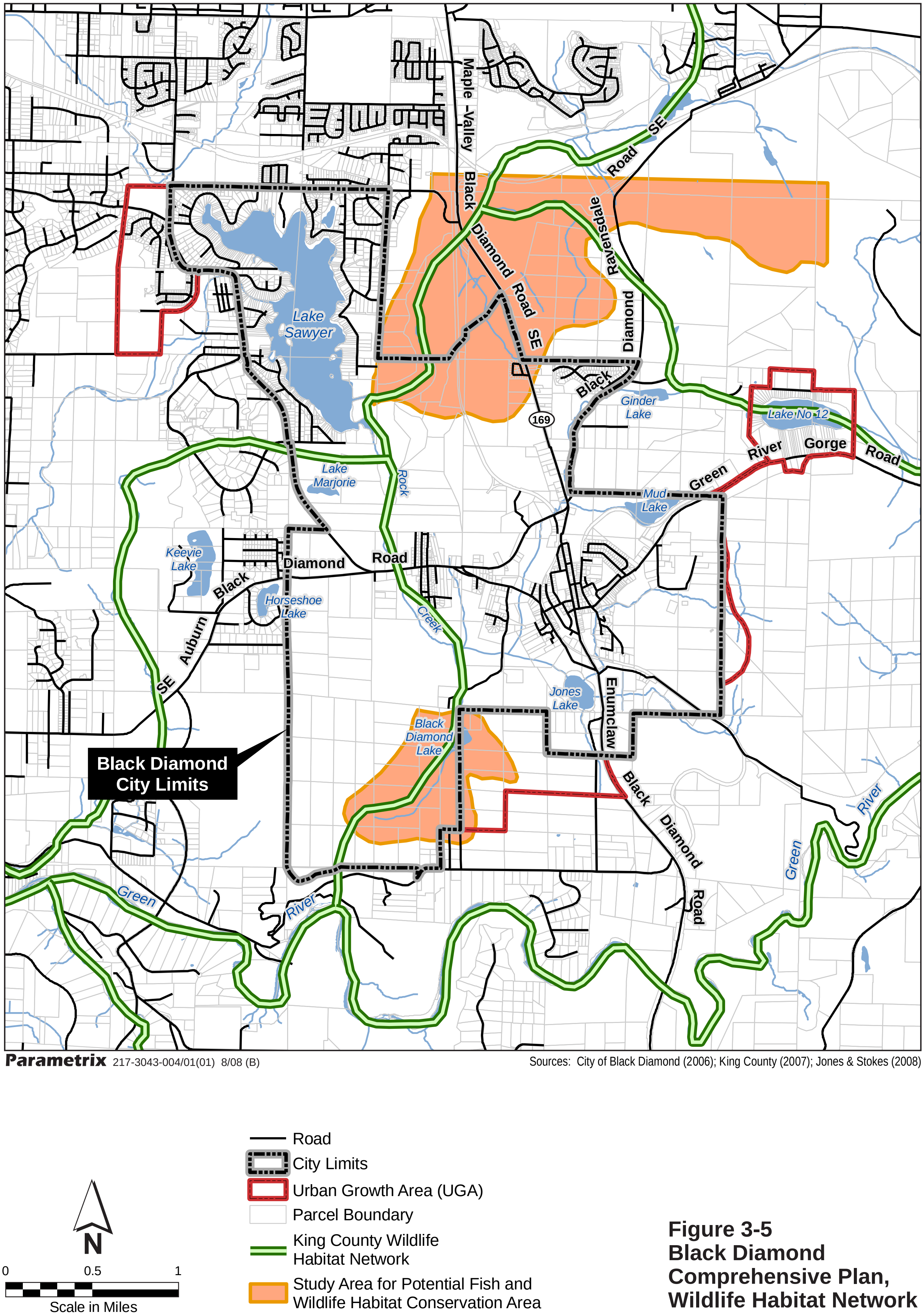


Figure 3-5
Black Diamond Comprehensive Plan, Wildlife Habitat Network

Land Use

UGA Objective LU 1: Accommodate projected growth, protect the critical drainage areas from inappropriate development, protect and retain the community character, and efficiently provide urban services within UGA lands.

UGA Objective LU 2: Ensure that the site development process for the UGA provides flexibility in locating uses, a unified development plan for each site, and adequate opportunities for public involvement.

UGA Objective LU 3: Phase development of the UGA to minimize impacts on environmental quality and disruption of the social and business climate in the existing city.

Open Space

UGA Policy LU 5: Establish a Transfer of Development Credits (TDC) Program prior to annexing any portion of the UGA.

UGA Policy LU 6: The TDC Program should transfer development credits from the priority open space areas identified in the City Open Space Program for use in the UGA.

UGA Policy LU 7: Prior to annexation of any portion of the Pits landowners will Confirm to the City that the PAA and County open space areas have been permanently protected under the City and County open space programs, as appropriate.

UGA Policy LU 8: Approval of the annexation of the Lake 12 Annexation Area should include permanent public access to the lake. (Note: The Washington Department of Fish and Wildlife maintains a public boat launch on the south side of the lake, However, parking, is limited there and the site does not have restroom picnic facilities)

UGA Policy LU 9: Approval of the annexation of the East Annexation Area should include provision of permanent public access to the In-City Forest.

Habitat areas are indicated in Figure 3-4.

3.5 BALANCING WITH OTHER GMA GOALS

Protection of Critical areas is mandated in the Growth Management Act (GMA) as one of many goals and directives in that statute. Critical areas protection however must be balanced with other competing goals.

The importance of balancing the range of GMA goals and polices is reflected in a Court of Appeals case *HEAL v. Hearings Board*, 96 Wn.App 522 (1999) in which the court made several important points in relation to critical areas:

> “The GMA requires balancing of more than a dozen goals and several specific. directives in implementing those goals. The Legislature passed RCW 36.70A.172(1) five years after the GMA was adopted. It knew of the other factor, but neither made best available science the sole factor, the factor above all other factors nor made it purely procedural. Instead, the Legislature left the cities and counties with the authority and obligation to take scientific evidence and to balance that evidence among the many goals and factors to fashion locally appropriate regulations based on the evidence not on speculation and surmise.”

> “While the balancing of the many factors and goals could mean the scientific evidence does not play a major role in the final policy in some GMA contexts, it is hard to imagine in the context of critical areas. The policies at issue here deal with critical areas, which are deemed "critical" because they may be more susceptible to damage from development. The nature and extent of this susceptibility is a uniquely scientific inquiry.

> It is one in which the best available science is essential to an accurate decision about what policies and regulations are necessary to mitigate and will in fact mitigate the environmental effects of new development."

This approach is reflected in Growth Management Hearings Board cases:

> GMA, the practicality of the science and the fiscal impact must be balanced by a local government in determining how to designate and protect CAs. The scientific evidence must be contained within the record but also must be practical and economically feasible. CCNRC v. Clark County 96-2-0017 (Final Decision and Order, 12-6-96)

4. LANDSCAPE–SCALE ANALYSIS

This section summarizes the results of the landscape-scale analysis found in Technical Appendix A. The study based generally on the approach in "Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes" developed by the Washington State Department of Ecology (Stanley et al. 2005). The approach addresses two main questions:

- Which geographic areas are important for key landscape processes?
- Have human activities in the important areas altered the key processes?

The landscape-scale analysis helps integrate ecosystem processes into sensitive areas assessment and planning (Hruby et al. 2005). The analysis also considers aquatic processes and functions at multiple scales when developing plans for protecting or restoring sensitive areas. (Gove et al. 2001).

4.1 CONTRIBUTING AREA

The contributing area is the portion of land where surface water, groundwater, and water-borne materials flow into the streams , lakes, or other aquatic resources within the subwatershed, and where key processes influence aquatic functions (Stanley et al. 2005). For this study, we defined the contributing area on several scales:

- The Green River/Soos Creek/Covington Creek basin
- The Lake Sawyer sub-basin
- The Middle Green River/Crisp Creek sub-basin
- The Rock Creek/Cedar River sub-basin

These contributing areas are shown in Figure 3-2. Watersheds are primarily oriented to surface water. As discussed below, local groundwater movement cuts across surface water basins and generally flows in a westerly direction.

4.1.1 Green River Basin

All of the Black Diamond Urban Growth Area (UGA) is in the Green River Basin. The UGA is located within in the middle portion of the Green/Duwamish River watershed and is in two sub-basins as shown in Figure 4-1:

- The Covington Creek sub-basin flows into the Soos Creek sub-basin, which then flows into the Green River at about river mile 33.

- The Crisp Creek sub-basin flows into the Green River within the Middle Green River sub-basin. It drains an area of roughly 3,200 acres.

The Green/Duwamish River watershed is the largest freshwater component of Water Resources Inventory Area (WRIA) 9. Historically the White, Green and Cedar (via the Black) Rivers flowed into the Duwamish River and the system drained an area of over 1,600 miles. Because of the diversion in the White River in 1911 and the Cedar River in 1916, the Green/Duwamish drainage area has been reduced to 556 square miles (KC DNR 2000).

The Green/Duwamish River is the most hydrologically and habitat altered large river system in the Puget Sound area. Bank hardening and levee projects began in the mid to late 1800’s. The river system has been impacted by water diversions, alterations to the channel and estuary (such as filling and deepening), and development has disconnected its floodplains.

The middle portion of the Green River is primarily composed of residential development (50 percent), commercial forestry (27 percent), and agriculture (12 percent). Most of the upper basin is composed of rural residential, commercial forestry, and agriculture while cities and unincorporated urban areas dominate the lower portion of the basin. (King County 2000)

Riparian conditions in the Middle Green River subwatershed vary widely based on channel type and surrounding land use. According to NMFS criteria for riparian function, most riparian zones in the middle portion of the Green River (with the exception of the undeveloped Green River gorge) currently are not functioning properly because either they are too narrow and/or support non-native vegetation (King County 2000).

4.1.2 Soos Creek/Covington Creek

Covington Creek originates in the northwest portion of the City of Black Diamond at the outfall of Lake Sawyer. It is part of the Soos Creek subbasin, which drains an area of approximately 70 square miles and contains approximately 25 identified tributary streams totaling over 60 linear miles. Covington Creek is one of three major tributaries in the Soos Creek subbasin. It flows 6.33 miles generally southwest before entering Big Soos Creek near Wynaco. (King Co DNR 2000).

4.1.3 Lake Sawyer

The Lake Sawyer sub-basin is 13 square miles, of which 6.59 miles is located in the UGA (Figure 3-1). Its primary tributaries are Rock Creek and Ravensdale Creek. Rock Creek is located largely within the city limits and UGA. The majority of Ravensdale Creek is outside the UGA in an area zoned for resource forestry use.

Lake Sawyer is the fourth largest lake in King County with a surface area of 286.1 acres. The lakeshore is primarily developed as single family lots which accounts for about 85 percent of the shoreline. The lake is used extensively for boating, water skiing, swimming and fishing. Public access is provided at county parks on the northwest side and southern parts of the lake. The City of Black Diamond annexed the lake and surrounding homes in 1998.

Lake Sawyer has had historical water quality problems related to the discharge of wastewater from a failed wetland treatment system. The wastewater was diverted to the sanitary sewer in 1992. A draft lake management plan was developed in 1996 by King County to address the long-term water quality protection of the lake and watershed. The management approach for Lake Sawyer and its watershed as stated in the Draft Management Plan is to address the nutrient loading form the watershed to maintain its existing conditions.

4.1.4 Middle Green River Creek/Crisp Creek

The Crisp Creek watershed is tributary to the Middle Green River and drains roughly 3,200 acres. The creek originates from several groundwater springs, including Keta Creek Springs and a 20-acre bog northwest of Kievee Lake (Kerwin and Nelson, 2000; Muckleshoot Indian Tribe, March 1992). The creek is about 3 miles long and enters the Green River at about River Mile 40. Two lakes, Horseshoe Lake and Keevie Lake, are located within the Crisp Creek basin. Approximately 17 percent of the drainage area is within the Black Diamond UGA.

The land use and land cover in the upper Crisp Creek watershed are characterized by second growth commercial forest lands. Downstream of the commercial timberlands the riparian area becomes wider with mostly deciduous trees. The lower reach of the creek includes several farms and a few single-family homes.

Crisp Creek provides spawning and rearing habitat for coho, chinook, chum and winter steelhead (Kerwin and Nelson, 2000) and serves as the water supply for the Keta Creek Hatchery, operated by the Muckleshoot Indian Tribe. The hatchery rears and releases chum, coho, chinook, and winter steelhead (released off-station).

4.1.5 Rock Creek Tributary to the Cedar River

The Rock Creek watershed originates at Lake 12 is tributary to the Cedar River and drains roughly 32 square miles. The 9.5 mile long Rock Creek has been identified as the highest quality remaining tributary habitat in the lower Cedar River (King County 1997). The stream supports chinook, coho, sockeye and steelhead salmon, as well as cutthroat trout and a variety of other species. The near natural conditions of the creek provide spawning habitat and a variety of lifecycle habitats for a wide range of species, largely due to the intact riparian forests. (King County 1993) A large portion of the water basin has been protected by the Black Diamond Area Open Space Protection Agreement. The only portion of the sub-basin in the Black Diamond UGA is Lake 12.

4.2 KEY LANDSCAPE PROCESSES

Landscape (or ecosystem) processes and functions are complex, interrelated, and work on multiple temporal and spatial scales.

Watershed physical processes deliver, transport, store, and remove materials from the ecosystem thereby affecting the structure and biological functions of river and lake shorelines. The movement of water, sediment, chemicals, and organic material occur throughout the landscape, but these processes occur at varying intensities depending on local geologic and climate conditions. The following section describes ecosystem processes, the mechanisms through which and identifies areas most important for supporting those processes. This section summarizes conditions broadly across the entire study area.

Key processes important for maintaining aquatic resources such as streams, lakes, and wetlands are (Beechie et al. 2003):

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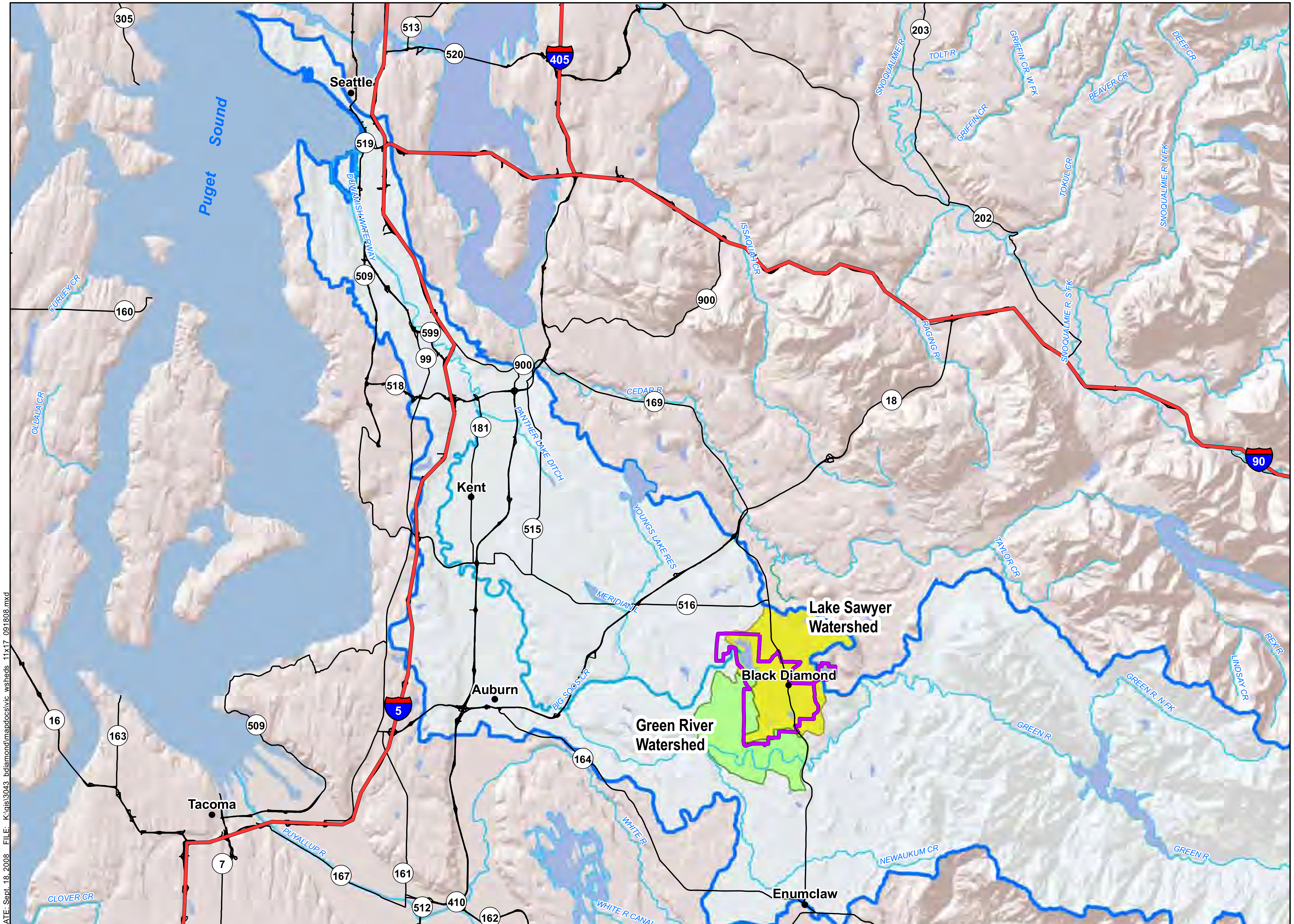

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Miles

Legend

- Duwamish - Green River Watershed
- Black Diamond UGA Boundary
- Lake Sawyer Watershed
- Green River Watershed
- Rock Creek Tributary to Cedar River

Data Source: King County GIS, WA DNR

Figure 4-1
Vicinity Watersheds

Sensitive Area Ordinance Update
City of Black Diamond, WA

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- **Hydrology** (surface and ground water) The cycling of water through the ecosystem is dependent on geologic and climate controls such as slope, elevation, precipitation type and amount, soil permeability, and storage potential on the surface (landform) and underground (soil porosity).
- **Sediment** The cycling of sediment through the ecosystem is dependent on geologic and climate controls such as slope, land cover, soil cohesion, precipitation duration and intensity, and storage potential determined by landform. Also important are interactions with the hydrologic process which is a vehicle for both sediment delivery and transport. Therefore, many of the alterations to the hydrologic process also directly and indirectly affect the sediment process. Important areas for sediment storage are the same as those described for water. Depressional areas such as lakes, wetlands, and floodplains allow for the precipitation of suspended sediment in slack water.

Water Quality The delivery and elements and compounds in water bodies is highly dependent on water and sediment processes that provide a vehicle for dissolved and adsorbed materials to be transported. These mechanisms for delivery result in s balance in natural systems that are often disturbed by human activity. Storage of materials that affect water quality is similar to those for sediment, where adsorbed compounds such as phosphorus, nitrogen, and toxins can be deposited and potentially removed via biotic uptake. In addition, wetlands with minerals soils are important areas where dissolved phosphorus can undergo adsorption and storage.

- **Organic Matter** Organic materials include living organisms and the carbon-based material they leave behind after dying, including coarse woody debris, finer woody debris, and detritus. These elements are important for the cycling of energy and nutrients in aquatic ecosystems, including storage, transport, and chemical transformation (Naiman 2001). In addition, downed trees play a significant role in the aquatic ecosystems of the Pacific Northwest. Large woody debris (LWD) significantly influences the geomorphic form and ecological functioning of streams. In a natural system, LWD provides organic material to aquatic ecosystems and is considered a principal factor in forming stream structure and associated habitat characteristics (e.g., pools and riffles). Riparian vegetation is the key source of LWD.
- **Other Processes** Other secondary processes have less widespread but important influences on overall ecological function in shorelines, including heat/light inputs, biotic interactions, and habitat connectivity.

Each landscape process influences and may impair ecological functions. For example, erosion and mass wasting determine sediment inputs to aquatic systems, while other mechanisms act to store or transport the delivered sediment through the system. These mechanisms are associated with specific areas (referred to as important areas) on the landscape that exhibit certain characteristics (geology, vegetation, and land use). The relationship between processes, mechanisms, and important areas is summarized in Table 4-1.

Table 4-1. Mechanisms and Important Areas for Landscape Processes

Process	Mechanism	Important Areas
Hydrology	Infiltration/recharge	Permeable soils, riparian areas, floodplains
	Surface water storage	Depressional wetlands, lakes, floodplains,
	Peak flows	Impervious surfaces, rain-on-snow (ROS) zone, forest cover
	Groundwater movement (baseflow)	Permeable deposits, fissured bedrock
Sediment Supply	Erosion	Erodible soils, especially on steep slopes, Channel Migration Zones (CMZs)
	Mass wasting	Slopes prone to landslides
Water Quality	Physical properties (temperature, turbidity)	Forest cover, riparian zones
	Chemical properties (pH, nutrient levels)	Depressional wetlands, wetlands with organic soils, riparian zones, hyporheic zones, floodplains
	Contaminants (toxins, pathogens)	Depressional wetlands, riparian zones, hyporheic zones, floodplains
Organic Inputs/LWD	Riparian vegetation	Riparian zones, forested CMZs
	LWD recruitment	Riparian zones, forested CMZs, landslide hazard areas

The geographic location of these specific features (e.g., depressional wetlands, permeable surficial deposits, or steep gradients) is used to identify process-intensive areas. Because of their inherent characteristics, areas that are identified as process-intensive have greater influence on aquatic resource structure and function than other areas, and therefore may be more important for protection and/or restoration (Stanley et al. 2005).

4.2.1 Hydrology

Hydrology is the study of the movement of water through the landscape. For purposes of this report, hydrologic mechanisms include infiltration and recharge, surface water storage, peak flows, and groundwater flow. Two other important hydrologic mechanisms, interception and evapotranspiration, are not considered in this landscape analysis, but their alteration is inferred from changes in land cover. A graphic depiction of the hydrologic cycle under natural conditions and with human alteration is shown in Figure 4-2.

Well-drained soils, floodplains, depressional wetlands, and lakes are all areas of importance for the hydrology (distribution of water) over the landscape. As water contacts the ground surface, typically in the form of precipitation, infiltration is the first mechanism that determines how water moves through the landscape. Infiltration is important as the source of water (recharge) for lateral subsurface movement (interflow) or baseflow (groundwater), which in turn is important for aquifer recharge and stream discharge. Depressional wetlands, floodplains, and lakes/ponds all have the potential to store water, particularly during peak flow events (Sheldon et al. 2003; Hruby et al. 2000). This surface water storage releases runoff over time a longer duration, and reduces peak flows from storm events. Sources of runoff include direct precipitation onto surface waters, overland flow, interflow, and groundwater discharge. The rate, distance, and volume of water movement across the landscape vary for each of these water sources, and this variability desynchronizes flows.

The local watersheds that feed the Lake Sawyer sub-basin are primarily dependent on rain and groundwater interflow. The area is too low in elevation to receive a substantial component of snow. Rains come primarily in the winter, and summers tend to be dry. On a seasonal basis, approximately 50 percent of the annual precipitation falls in the four month period October through January, and about seventy-five percent in the six months between October and March (King Co 2002).

General conclusions about the hydrology of the Black Diamond UGA include:

- Most of the streams in the UGAs are smaller, headwater systems. The majority of the mechanisms that affect their use by aquatic species, including anadromous fish, are related to processes within the UGA.
- Large portions of the UGA currently are undeveloped and therefore have relatively intact hydrologic processes.
- Urban land use (namely the addition of impervious surfaces and clearing of native vegetation) has the greatest potential to alter watershed hydrology. Therefore increasing urbanized areas, construction activities, road networks, and land clearing within the City and UGA would negatively alter watershed hydrology and directly impact usage of study area streams by aquatic species, including anadromous fish.
- An important feature of all the streams in the area is that they either originate in large wetland complexes or have substantial wetlands along the watercourse. These wetland complexes are an essential element of the hydrology, particularly for low flow periods. The local sources of recharge to these wetlands is fundamental in maintaining their functions and warrants both Sensitive Area regulations and stormwater controls, including Low Impact Development. The importance of these factors is discussed in the following sections.

4.2.2 Vegetation

The plant cover over a landscape or on a site influences the interaction of water and surficial geology. Plants perform a number of important functions that control the distribution of water, including:

- Intercepting precipitation, which decreases water’s available energy for sediment transport;
- Recirculating water through transpiration, which may, in turn, influence local climatic conditions;
- Providing shade, which moderates temperatures and humidity near the ground’s surface;
- Stabilizing soil structure with their roots; and
- Providing organic input, nutrient enrichment, and habitat structure.

Vegetation has a crucial role in the hydrologic cycle by affecting the rate at which water reaches the surface by providing a physical barrier that reduces the force of raindrops hitting the surface and also by intercepting, storing and releasing water at a reduced rate.

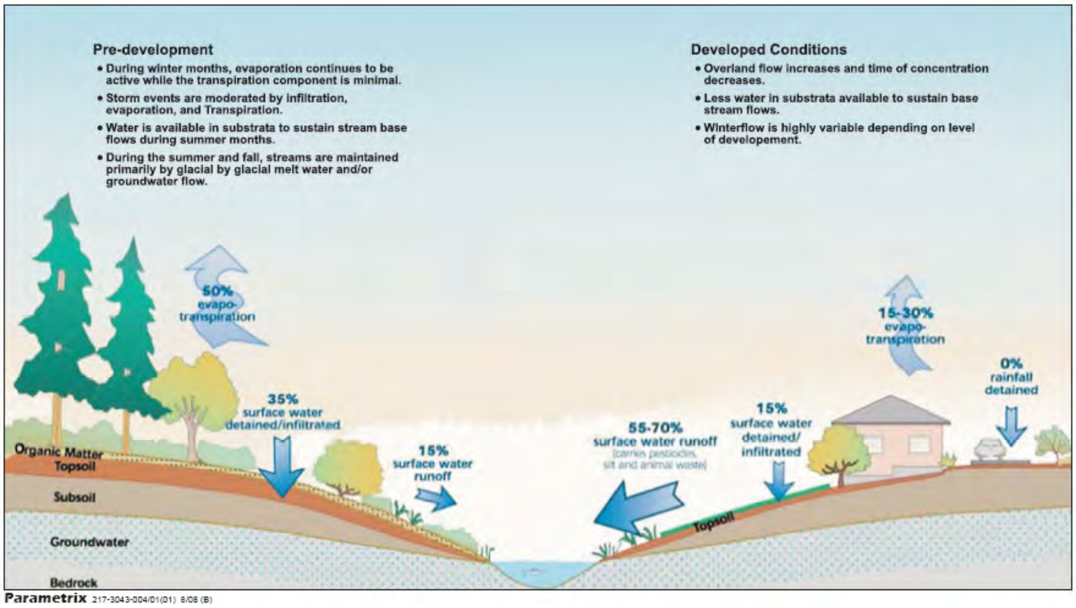


Figure 4-2. Hydrologic Cycle

Unlike geology and climate, human activities can easily alter vegetation. The type and extent of vegetation on a site, or within a region, can vary dramatically over a short time-interval as a result of human actions (i.e., burning, clearing, irrigation). Thus, it is a proximate control that can be managed.

Changes in vegetation cover associated with urban development are discussed in conjunction with land use, below.

4.2.3 Sediment Supply

Sediment is moved from hillslopes to aquatic systems by water and gravity. Hillslope sediment transport is accomplished primarily through surface erosion, mass wasting, and slope creep; therefore areas of erodible soil and landslide-pone hillslopes are important areas for sediment supply processes. Clearing vegetation, exposing erodible soils, or increasing the amount of impermeable surface may affect the pattern and timing of water distribution, which may, in turn, accelerate erosion and slope failures.

As with the hydrologic component, the majority of the mechanisms that affect use of streams in the Lake Sawyer watershed are within the UGA. Large portions of the study area within the City and UGA currently are undeveloped and are unlikely to contribute significant sediment to study area streams. Urban land use, construction, forestry, and instream erosion have the greatest potential to produce substantial inputs of sediment within the Green/Duwamish River basin. Therefore increasing urbanized areas, construction activities, and road networks within the City and UGA would increase sediment delivery to its streams and directly impact their use by aquatic species, including anadromous fish. This would have the most direct impact to the Lake Sawyer subwatershed.

4.2.4 Organic Matter and LWD Inputs

Organic matter, often in the form of leaf litter and other plant detritus, is the basis of the food web and largely determines productivity in aquatic and terrestrial systems. Riparian areas are important areas for organic and heat/light processes. Organic inputs provide nutrients and structure to the substrate and are an important food source for microbes, invertebrates, vertebrates, and plants (Sheldon et al. 2003). If abundant enough, organic matter may be the principal component of organic soils (peat, muck). Originating as plant and animal matter, organics may be imported to an aquatic site by surface waters or may originate in-situ. Land Cover and Land Use are shown in Figures 4-3 and 4-4.

Most stream reaches (and associated riparian areas) within the study area are important sources of organic matter and LWD. These include all streams in the Lake Sawyer subwatershed except Ginder Creek, whose riparian area is heavily developed. The mainstems of Rock Creek and Ravensdale Creek, as well as their tributaries (except Ginder Creek), are particularly important for the delivery of organic matter and LWD to portions of the system that support anadromous fish, including the mainstems of Rock and Ravensdale Creeks as well as Lake Sawyer, Covington Creek, and Jones Lake.

In summary, as with water quality, the majority of the mechanisms (including delivery of organic material and LWD) that affect the use of Lake Sawyer subwatershed streams for aquatic species, including anadromous fish, are related to processes within the City and its UGA. In contrast, the majority of the mechanisms that affect the use of streams within the Green River subwatershed are located outside of the City and its UGA limits, with the exception of any processes related to Horseshoe Lake and possibly Keevie Lake.

4.2.5 Water Quality

Important areas for water quality processes are:

- depressional wetlands,
- floodplains, and
- hyporheic zones.

Wetlands, floodplains and hyporheic zones affect nutrient cycling (nitrogen and phosphorous), oxygen, pH, temperature and turbidity as well as pathogens and toxins (metals, hydrocarbons, pesticides). Wetlands store surface water, which traps sediment and facilitates phosphorus removal and contaminant absorption, uptake and storage. Denitrification and adsorption occurs in wetlands, particularly those with alternating reducing and oxidizing conditions or organic or clay soils. Wetlands can also be important phosphorous sinks because they trap and store sediment (Sheldon et al. 2003); particularly depressional wetlands with constructed outlets are conductive to standing water. Areas important for sediment storage such as floodplains and lakes are also important phosphorus sinks.

Figure 4-5 indicates the floodplains within the study area. Figure 4-6 indicates mapped wetlands,

These figures and data indicate that the wetland areas crucial to water quality functions include

- The large riparian wetland complexes located along Rock, Ravensdale, Ginder, and Black Diamond Lake Creeks, particularly those along Rock and Ravensdale Creeks.

- Additionally, the undeveloped, mature forests and wetlands in the upper reaches of Cranberry Slough, Black Diamond Lake Creek, and Lawson Creek provide important water quality functions for their respective basins. The upper portions of Lawson Creek and Cranberry Slough are of particular importance as they drain to water-quality limited lakes that provide habitat for anadromous fish..

Land use and the proportion of the built environment within a watershed can directly impact water quality in a given basin, including groundwater. Generally, the more developed a basin, the greater the proportion of impervious surface and potential for increased input of sediment, pollutants such as hydrocarbons, and nutrients to a water body. Storm events can enhance the movement of pesticides and metals bound to loose organic matter (Minton 2002), and increased sediment loads created by erosion can accumulate adsorptive pollutants (EPA 2001).

4.2.6 Land Use

Land use activities related to agriculture, forestry, and residential/commercial development, can alter vegetation and, to a lesser extent, surficial geology, which can affect landscape processes. Land use acts as a stressor on natural processes disrupting the:

- interception and uptake of precipitation and nutrients;
- microclimate;
- the type and amount of nutrient and pollutant inputs;
- infiltration and recharge; and
- proportion of water distributed via surface and subsurface flows.

Changes in land use and resulting impacts would likely be exhibited in changes to Lake Sawyer, the most sensitive features in the watershed. Likely effects would be most apparent in an increase in nutrients and resulting reduction in water quality and associated features such as algae blooms. Land Cover and Land Use are shown in Figures 4-3 and 4-4.

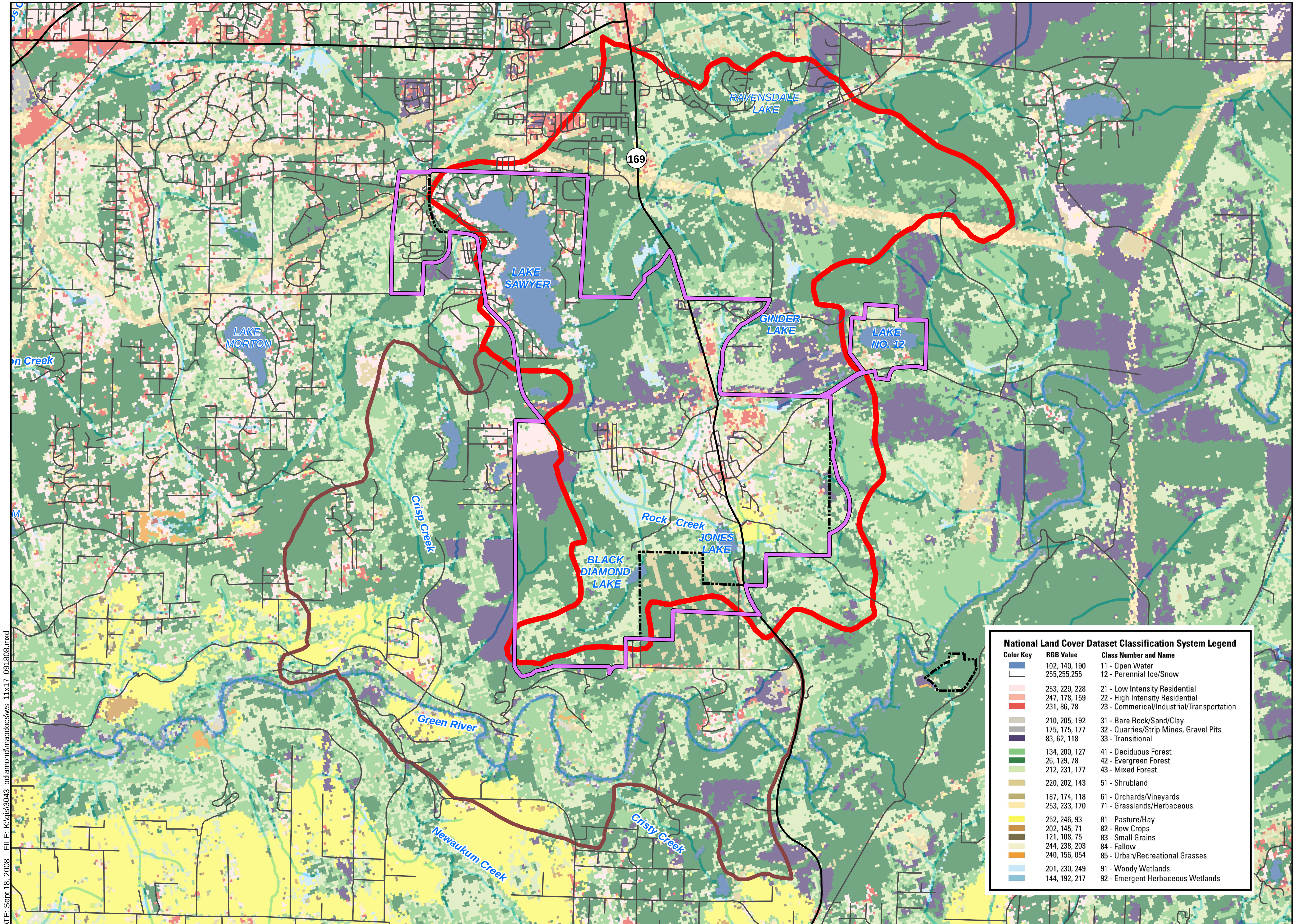
Constrinat on Land use in Black Diamond area relate to wetlands and streams as well as topographic features such as sleep slopes, shown on Figure 4-7. Another major constrain on land use are abandon coal mines shown in Figure 4-8.

4.2.7 Landscape Analysis Findings

The vast majority of Black Diamond and its UGA are located in the Lake Sawyer subwatershed. These areas include several streams and lakes that are important to anadromous fish and other priority species. Many of these resources have relatively intact riparian areas, extensive wetlands, and relatively good water quality and instream habitat. Additionally, many of these areas provide numerous process-intensive functions that contribute to the overall productivity of the subwatershed. The maintenance of these functions throughout the UGA will be critical to maintaining ecological functions and values within Lake Sawyer. The lake has a relatively small watershed and will be extremely sensitive to changes brought on by urbanization.

The processes that occur within the City and its UGA have a relatively smaller impact on the larger Green River/Soos Creek/Covington Creek watershed simply because it is a small contributing area.

Parametrix



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N

0 2,000 4,000

Scale in Feet

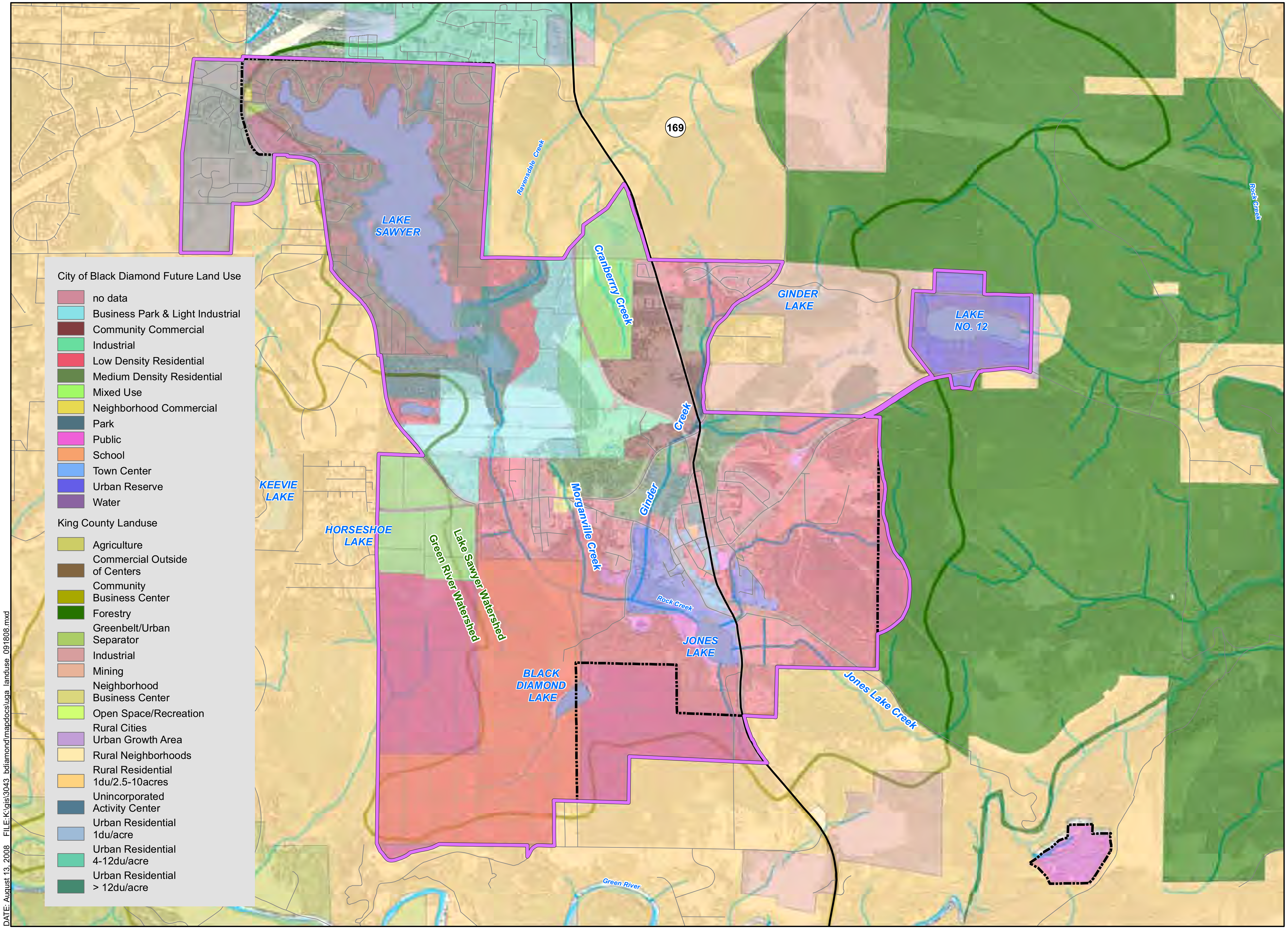
Legend

- Black Diamond
- UGA Boundary
- Lake Sawyer Watershed
- Green River/Crisp Creek Watershed
- State Highway
- Road
- Water Body
- Stream

Data Sources: King County GIS, WA DNR
Landcover data is 1999 NCLD

Figure 4-3
Land Cover

Sensitive Area Ordinance Update
City of Black Diamond, WA



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0 1,250 2,500

Scale in Feet

Legend

Black Diamond

UGA Boundary

Green River/Crisp Creek Watershed

Lake Sawyer Watershed

State Highway

Road

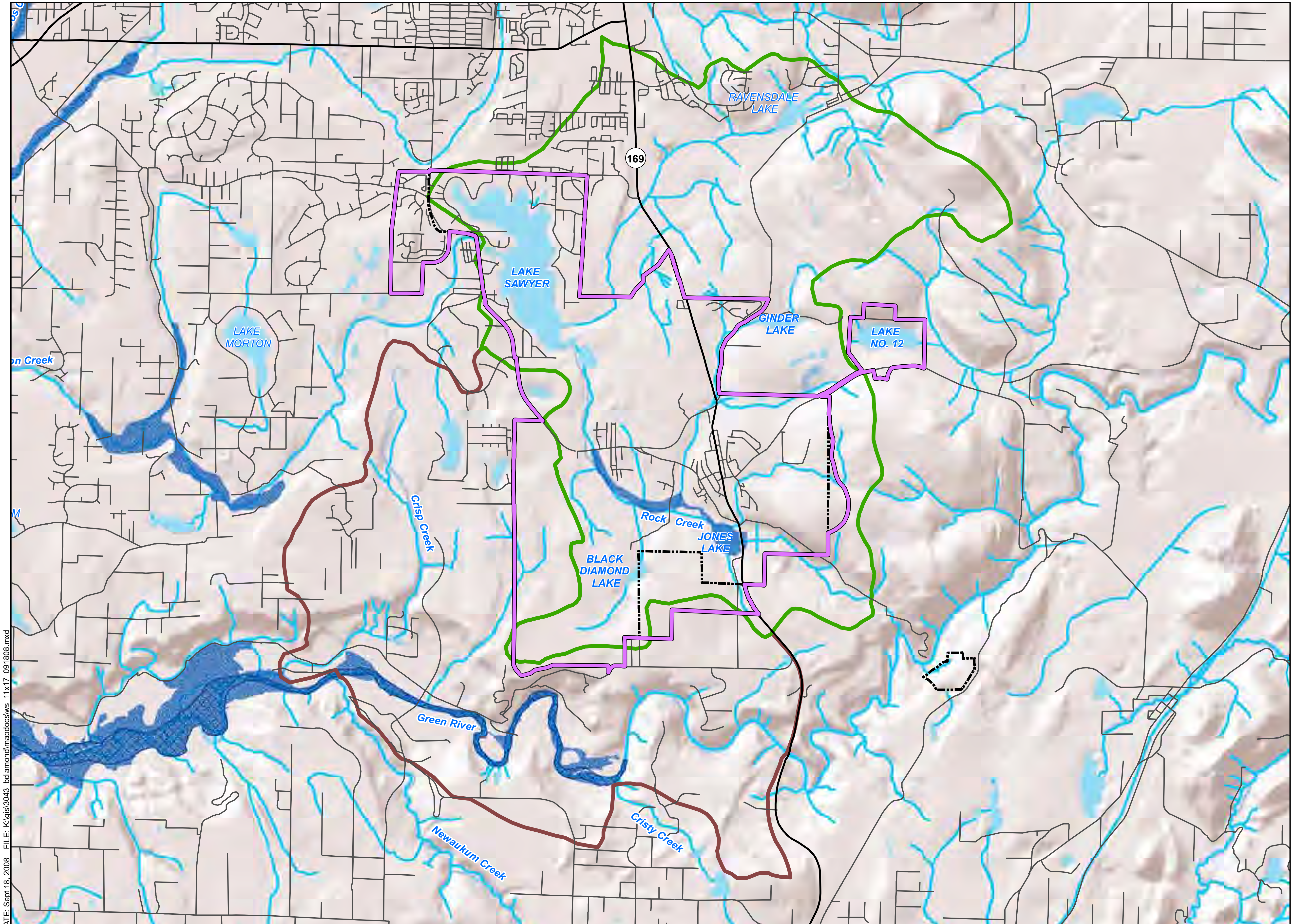
Water Body

Stream

Data Source: King County GIS, WA DNR, Triad

Figure 4-4
Land Use
Black Diamond UGA

Sensitive Area Ordinance Update
City of Black Diamond, WA



Parametrix

N
0 2,000 4,000
Scale in Feet

Legend
- Black Diamond
- UGA Boundary
- Lake Sawyer Watershed
- Green River/Crisp Creek Watershed
- State Highway
- Road
- Water Body
- Stream
- 100 Year Floodplain
- Floodway

Data Source: King County GIS

Figure 4-5
FEMA Floodplain

Sensitive Area Ordinance Update
City of Black Diamond, WA

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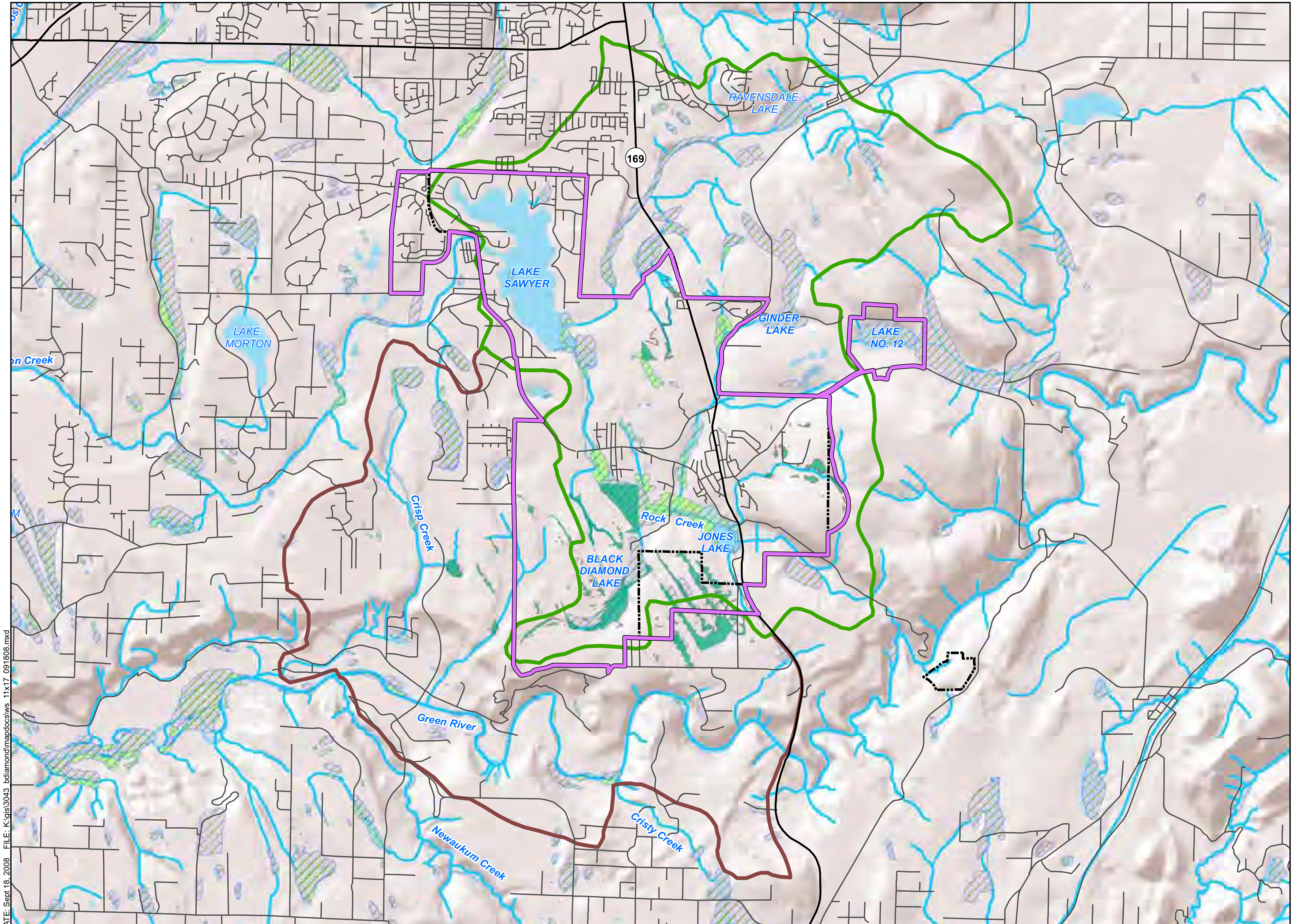
Parametrix



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0 2,000 4,000

Scale in Feet

Legend

- Black Diamond
- UGA Boundary
- Lake Sawyer Watershed
- Green River/Crisp Creek Watershed
- State Highway
- Road
- Water Body
- Stream
- King County CAO Wetland
- NWI Freshwater Emergent Wetland
- NWI Freshwater Forested/Shrub Wetland
- Triad Surveyed Wetlands

Data Sources: King County GIS, WA DNR, Triad

Figure 4-6
Wetlands

Sensitive Area Ordinance Update
City of Black Diamond, WA

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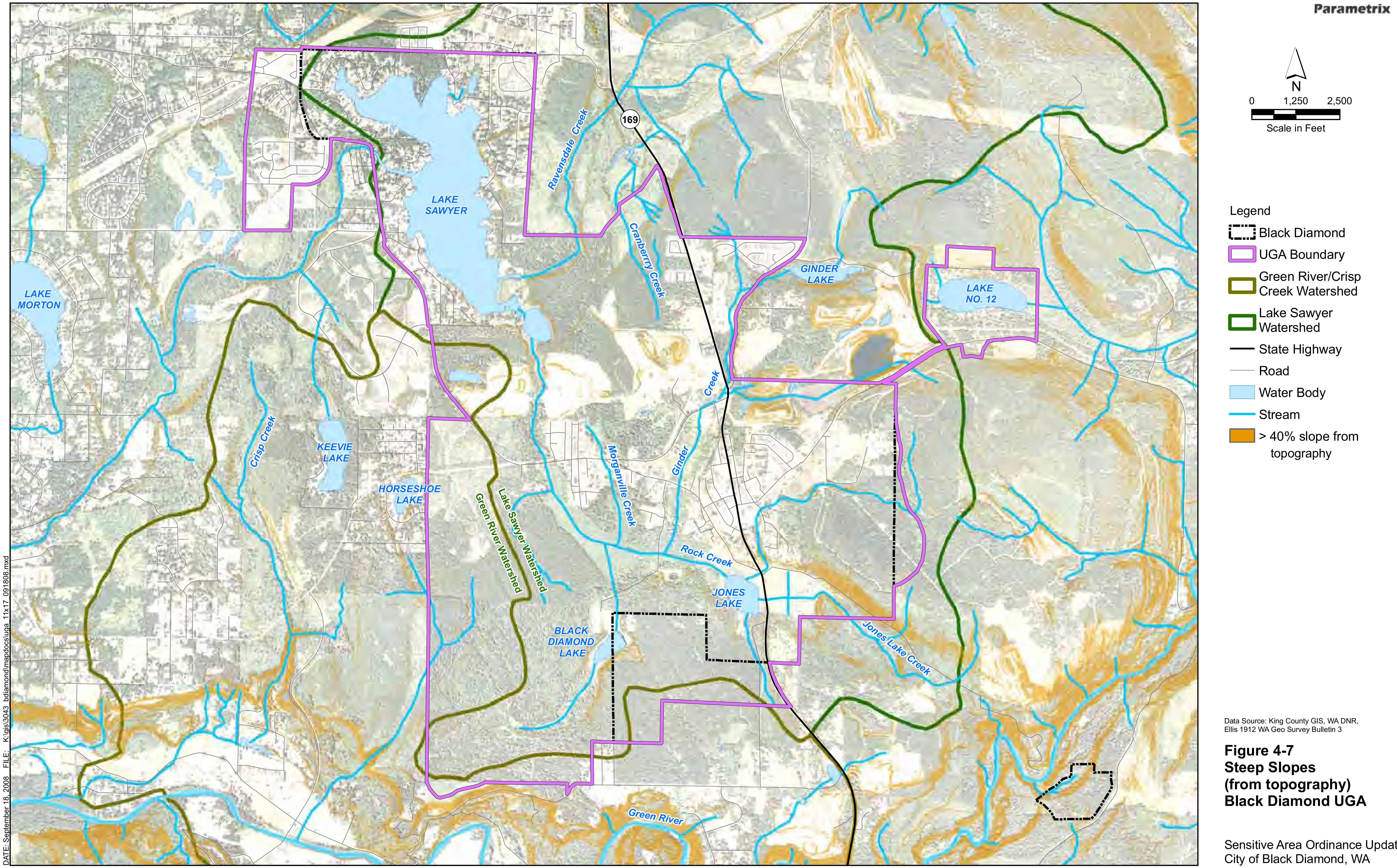
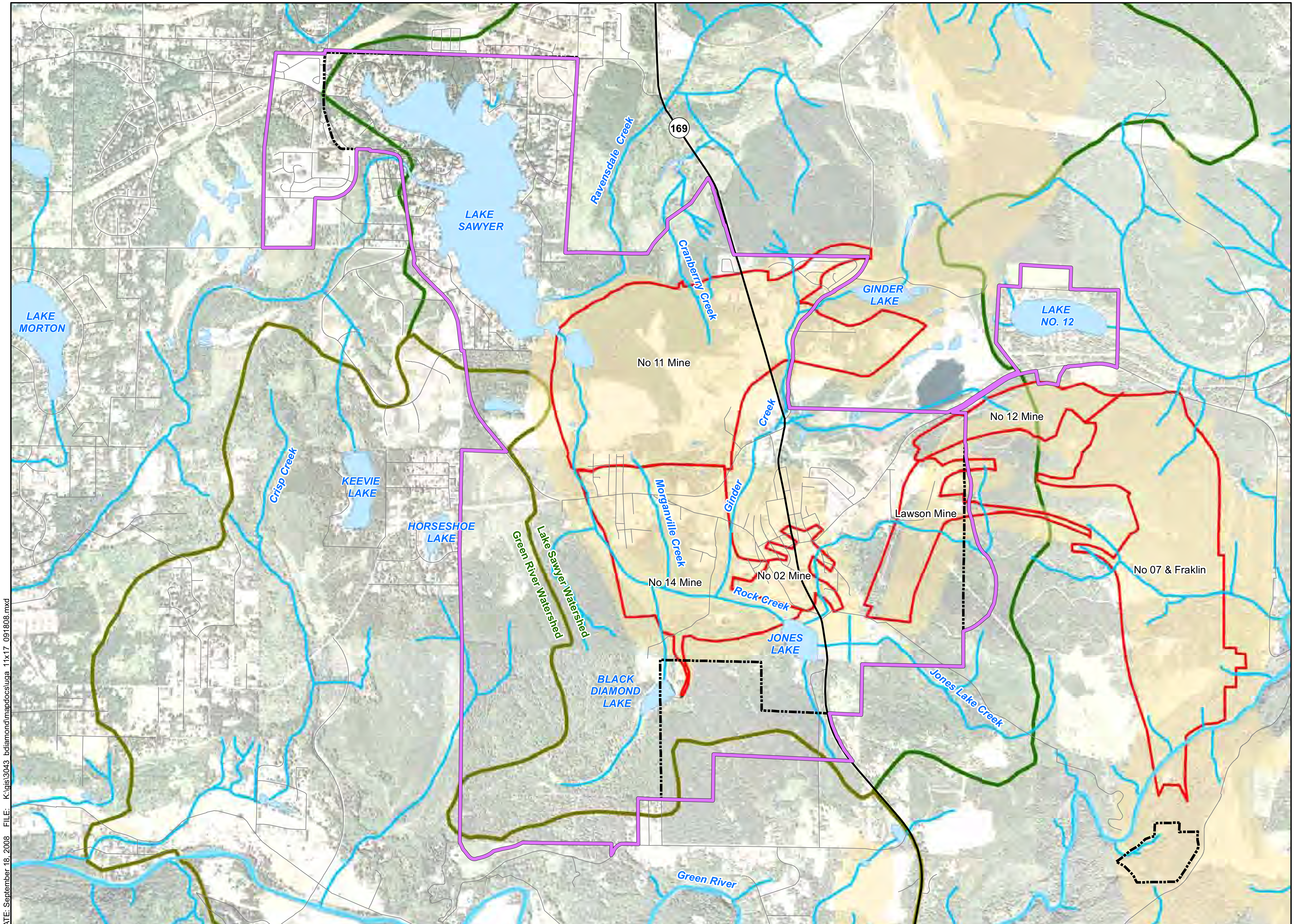


Data Source: King County GIS, WA DNR, Ellis 1912 WA Geo Survey Bulletin 3

Figure 4-7
Steep Slopes (from topography)
Black Diamond UGA

Sensitive Area Ordinance Update
City of Black Diamond, WA



Parametrix

N

0 1,250 2,500

Scale in Feet

Legend

- Black Diamond
- UGA Boundary
- Green River/Crisp Creek Watershed
- Lake Sawyer Watershed
- State Highway
- Road
- Water Body
- Stream
- Coal Mine Hazard Area

Mapped Mine Hazards

- Mine Boundary

Data Source: King County GIS, WA DNR, Ellis 1912 WA Geo Survey Bulletin 3

Figure 4-8
Abandoned Coal Mine Hazard Areas
Black Diamond UGA

Sensitive Area Ordinance Update
City of Black Diamond, WA

DATE: September 18, 2008 FILE: K:\gis\3043_bdiamond\mapdocs\uga_11x17_091808.mxd

The processes that occur in the portion of the UGA in the Middle Green River/Crisp Creek watershed primarily are related to groundwater recharge. The City and its UGA provide fewer process-intensive functions contributing to the overall productivity of that subwatershed, but may be critical to processes that occur in the nearby Horseshoe Lake and possibly Keevie Lake.

The analysis above of the areas associated with the important functions related to hydrology, vegetation, sediment balance, and water quality indicates that:

- The Rock Creek/Jones Lake/Jones Creek corridor has the largest concentration of critical features that affect landscape function, including a large complex of wetlands that provides flood desynchronization, water storage, and a variety of nutrient control functions critical to the health of the watershed. This corridor provides the most important aquatic and terrestrial habitat areas.
- Black Diamond Lake and the associated stream has a large and important concentration of similar features, including a large wetland complex, but is less important currently due to the smaller tributary watershed.
- Large wetland complexes that provide the headwaters of many streams are important for water storage and maintaining year-round stream flows and temperature moderation. Such wetland complexes for the headwaters of Ginder Creek, Lawson Creek, and Jones Creek are present in many smaller tributaries in the area.
- Tributary streams in the area have a variety of gradients and flow conditions, as well as varying degrees of human alteration. Generally, they are less important in providing aquatic and wildlife habitat, but they are critical to providing inputs of high quality low temperature water to the systems with the greater concentrations of landscape functions.

Regulatory implications of these findings lead to a recommendation that the City of Black Diamond can take an approach that provides a high level of protection for the most important areas of the city that contribute the most to current ecological functions. This would be accompanied by a lower level of protection for those specific critical area resources in specific contexts where they contribute less to key functions. By this focused approach, the City is likely to be successful in preserving key ecological functions while accommodating growth goals.

5. SPECIFIC CRITICAL AREAS

5.1 WETLANDS

Wetlands occur throughout the City of Black Diamond and its UGA and are primarily associated with bodies of water (lakes and streams) but also occur separately. Brief summaries of the functions of these wetland complexes are outlined below. It is unknown whether freshwater wetlands were displaced by past residential, commercial, and forestry uses. Any wetlands that may have existed in developed portions of the City have been displaced.

- <u>Rock Creek Wetlands</u> Wetlands associated with Rock Creek are mapped by the NWI as scrub/shrub and forested wetlands. This wetland complex was given a preliminary Category I rating under the Ecology wetland rating system.

- Jones Lake/Creek Wetlands Jones Lake is a dystrophic lake, characterized by relatively high concentrations of acidic organic materials in solution. Such lakes generally form in conjunction with associated wetlands, particularly bogs and peat deposits that provide a unique ecological environment in which the acidity of the water retards the processes of bacterial breakdown that would otherwise recycle nutrients. This results in a departure from the normal eutrophic life cycle of lakes and wetlands. Jones Lake and Creek wetlands can be considered an extension of the larger system along Rock Creek to the west.

- Black Diamond Lake/Creek Wetlands Wetlands associated with Black Diamond Lake and Black Diamond Creek are characterized as a forested wetland, and more particularly as a bog. The King County Wetland Inventory identifies the wetlands associated with Black Diamond Lake and the upstream and downstream reaches of Black Diamond Creek as unique/outstanding. The Black Diamond Lake and its associated world-class bog have been extensively researched by the Nature Conservancy and represent a valuable natural asset for the City The low elevation riparian wetland associated with Black Diamond Lake is also considered a high quality wetland ecosystem.

- Ginder Lake, Ginder Creek, and Lake Sonia Wetlands Wetlands associated with Ginder Lake and Ginder Creek are mapped by the NWI as emergent and forested wetlands. Wetlands surrounding the lake (possibly the lake itself) and associated with the creek were given a preliminary Category II rating under the Ecology wetland rating system (City of Black Diamond 2008).

  Wetlands associated with Lake Sonia are mapped by the NWI as emergent and scrub/shrub wetlands. These wetlands are located outside of the City of Black Diamond UGA; it is unknown whether they were preliminarily rated using the Ecology wetland rating system as part of the City's preliminary wetland and stream inventory conducted in 1991. The King County Wetland Inventory identifies the wetlands around Lake Sonia as unique/outstanding.

- Ravensdale Lake/Creek Wetlands Wetlands associated with Ravensdale Lake and Ravensdale Creek are important to the function of the stream and Lake Sawyer. These wetlands are predominantly located outside of the City of Black Diamond UGA and are mapped by the NWI as emergent, forested, and scrub/shrub wetlands. Ravensdale Creek has a disproportionately high discharge-to-drainage area ratio, likely due to a high level of groundwater recharge. Although its drainage area is about half that of Rock Creek's drainage area, Ravensdale Creek has an estimated summer low-flow season discharge about 3 times greater than that of Rock Creek. Phosphorus concentrations during the low flow season in Ravensdale Creek are relatively high due to naturally occurring phosphorus-rich groundwater.

- Lake 12 Wetlands associated with Lake 12 are mapped by the NWI as forested and scrub/shrub wetlands. These wetlands are predominantly located outside of the City of Black Diamond limits but within the UGA. The wetland complex extends about a mile downstream of Lake 12 and provides important habitat, as well as flood desynchronization and water quality functions., the functions of the wetlands related to water quality are likely to become more important in the future. Wetlands associated with the lake shoreline also have the potential to provide shoreline protection functions.

5.2 AQUATIC RESOURCES

Aquatic resources within the study area include Green River, Covington Creek, and their tributaries; floodplain, depressional, and slope wetlands; lakes; and groundwater. Historically, these aquatic resources provided important functions such as peak flow storage, groundwater recharge, water quality maintenance, and fish and wildlife habitat.

Principal fisheries species present within the study area include (Jeanes 2004):

- Chinook Salmon (*Oncorhynchus tschawytscha*): The principal stock of Chinook salmon present in the Green/Duwamish River watershed is summer/fall ocean type Chinook. WRIA data report Chinook salmon occurring in Covington Creek up to the outlet of Lake Sawyer as well as Crisp Creek and the portion of the Green River located in the study area (King County 2000).
- Coho salmon (*O. kisutch*): The Green/Duwamish River watershed supports one run of coho salmon, which is a mixed stock with composite production (WDFW 2002). Green/Duwamish River coho salmon are considered part of the Puget Sound/Strait of Georgia ESU. Lake Sawyer and Jones Lake as well as Covington, Ravensdale, Ginder, Rock, and Lawson Creeks are reported as providing spawning and/or rearing habitat for coho salmon. These sources also report rearing habitat within and spawning and rearing habitat within Crisp Creek and the portion of the Green River located within the study area.
- Steelhead *(O. mykiss)*: Winter run steelhead within the Covington Creek basin are in the Puget Sound ESU, which is listed as threatened under the ESA. Covington Creek, Ravensdale Creek, Rock Creek, Lake Sawyer, Crisp Creek, and the portion of the Green River located in the study area are reported as providing spawning and/or rearing habitat for winter steelhead.

  Cutthroat trout *(O. clarki)*: Cutthroat trout exhibit both resident and anadromous life histories. Cutthroat trout found within the study area are part of the Puget Sound ESU, which does not warrant listing under ESA at this time as populations have been relatively stable over the past 10-15 years. The presence of cutthroat trout is reported in Covington, Ravensdale, Ginder, Rock, Lawson, Crisp, and Black Diamond Lake Creeks as well as Lake Sawyer and the portion of the Green River located in the study area. Most cutthroat trout in the study area likely exhibit resident life histories.
- Bull trout *(Salvelinus confluentus)*: Puget Sound bull trout exhibit four distinct life histories: resident, adfluvial, fluvial, and anadromous.. All bull trout found within the study area are part of the Puget Sound DPS, which is listed as threatened under the ESA.
- Other Anadromous Species: The portion of the Green/Duwamish River basin located in the study area does not support pink salmon (*O. gorbuscha*); however, it does provide migration habitat for sockeye salmon (*O. nerka*), as well as spawning and rearing habitat for chum salmon (*O. keta*) (StreamNet 2008).
- Other Resident Species: Limited information is available on resident fish in the Lake Sawyer and Middle Green River subwatersheds. Native resident species likely to be present include sculpins (*Cottus spp.*), speckled dace (*Rhinichthys osculus*), and three-spine stickleback (*Gasterosteus aculeatus*). Relatively few non-native fish species are reported in the Green/Duwamish River. Species observed primarily include warm water game fish that are found in several of the basin's lakes. These include black crappie (*Pomoxis nigromaculatus*), brown bullhead (*Ameiurus*

nebulosus), smallmouth bass (*Micropterus dolomieui*), and largemouth bass (*Micropterus salmoides*).

As stated previously, most streams within the Black Diamond UGA drain to either the Lake Sawyer subwatershed or Middle Green River subwatershed. However, only a small portion of Covington Creek (the outlet for Lake Sawyer) is located within the City and UGA limits, i.e., the vast majority of this creek falls outside of the study area. Additionally, a portion of the UGA provides infiltration and groundwater recharge to the Middle Green River and Crisp Creek.

For these reasons, general descriptions of the character of Covington Creek and the Green River are presented in this landscape-scale analysis section. Detailed descriptions of aquatic resources located within the City and/or UGA are presented in Technical Appendix A of this report.

5.3 TERRESTRIAL HABITAT

The undeveloped areas within the Black Diamond UGA provide a variety of habitat types for the full range of species that inhabit the Puget Sound Lowland. Urbanization will convert much of this area for human activities. These areas will generally be lost as productive habitat for most species.

Habitat corridors are an approach that land managers and regulatory agencies have implemented to address impacts on wildlife habitats and species within human-influenced environments. Habitat corridors are contiguous, vegetated, conduits that connect habitat patches to other patches or larger landscape habitat components and prevent isolation of habitat. Corridor establishment attempts to mimic in a managed landscape some of the biologic processes that occur in animal movement in natural landscapes.

The functions of corridors may be as conduits to provide movement or may provide habitat functions, if wide enough and vegetated (Rosenberg et. al. 1997). The functions generally provided by corridors include:

- Providing a conduit for animals to move between one habitat patch and another on a daily or seasonal basis, without providing substantial habitat functions. Such habitats may be relatively narrower than habitat patches;
- Reducing species extinction rates by ensuring that populations or individuals are not isolated from others in the landscape as well as redoing detrimental genetic effects of isolated populations such as inbreeding and random genetic drift;
- Providing increased foraging habitat for a variety of species, if large enough;
- Providing an avenue for vegetative communities to maintain reproduction viability and colonize new areas particularly species carried in animal feces;

King County has designated Wildlife Habitat Networks that are designed to link wildlife habitat found within sensitive areas, their buffers, priority habitats, trails, parks or open space. The network is designed to provide for wildlife movement and alleviate the effects of habitat fragmentation. The county specifies hat the corridor should be 300 feet wide, although it may be reduced to 150 feet where necessary. The city has designated the King County Habitat Network as well as a “Study Area for Potential Fish and Wildlife Habitat Conservation Area” in its Comprehensive Plan, as shown in Figure 3-5.

Combining habitat corridors with the core area for water and wetland functions including the entire Lake Sawyer/Rock Creeks /Jones Lake and Jones Lake Creek corridor as well as the corridor extending to the west to the Crisp Creek watershed along the Black Diamond Lake and stream corridor is the most effective means of providing productive terrestrial habitat in the area as it urbanizes.

5.4 GEOLOGICAL HAZARDS

As indicated in Figures 4-7 and 4-8 steep slopes and mine hazards are the major geologic hazards within the city. Hazards related to slopes include slope stability and landslide hazards. Erosion is an additional concern for all sloped areas, especially those close to water bodies. In most cases, landslide hazards and erosion hazards can be assessed on a site-by-site basis.

Hazards associated with abandoned coal mines are directly related to mine collapse and land subsidence as well as methane gas generation and the risk of fire. The potential for coal mine collapse and land subsidence is influenced primarily by:

- the height of the mine void,
- the depth and the strength of the rock roof, and
- the type and amount of roof support within the mine (Crowell 2001).

There are two types of subsidence:

- sinkhole, also called pit or pothole; and
- sag or trough.

5.5 CRITICAL AQUIFER RECHARGE AREAS

Three factors generally dominate determination of aquifer susceptibility (Cook 2000):

- Overall permeability of the unsaturated zone (soil and underlying geologic strata);
- Thickness of the unsaturated zone (depth to groundwater in unconfined aquifers); and
- Amount of available recharge.

Evaluation of soils in the Black Diamond UGA indicate that most areas have a slight to moderate susceptibility to contamination. There are a number of wells providing public and private water supplies that should be protected as part of the city’s regulatory system.

6. OPTIONS FOR PROTECTION OF SENSITIVE AREAS

6.1 CONTROL OF USE AND ALTERATION

The most common approach to protection of sensitive areas in Washington State that has been developed since the adoption of the Growth Management Act (GMA) in 1994 includes the elements of:

- Designation and classification of critical areas
- Restriction on land use and alteration within the resource area and buffers

This approach tends to focus on individual occurrences of features such as streams, wetlands and geologically hazardous areas. The management and protection mechanisms tend to be related to a rating system that attempts to characterize the ecological functions and values provided by each discrete resource occurrence A similar approach tends to focus on individual occurrences and the case-by-assessment of hazard and risk in the case of geological hazards, frequently flooded areas and aquifer recharge areas.

This approach that looks at discreet occurrences contrasts somewhat with the interpretation of the statutory mandate to "protect" these areas. Several Growth Management Hearings Board and court cases have provided clarification that is succinctly described as follows:

The Act's requirement to protect critical areas, particularly wetlands and fish and wildlife habitat conservation areas means that the values and functions of such ecosystems must be maintained. While local governments have the discretion to adopt development regulations that may result in localized impacts upon, or even the loss of, some critical areas, such flexibility must be wielded sparingly and carefully for good cause, and in no case result in a net loss of the value and functions of such ecosystems within a watershed or other functional catchment area [Tulalip Tribes of Washington (Tulalip I) v. Snohomish County, CPSGMHB Case No. 96-3-0029)].

The "landscape analysis" approach outlined in Section 4, above, is one approach to analyze fish and wildlife habitat and wetlands on a watershed or catchment basis that provides a more integrated view of the inter-relationships between these resources.

6.1.1 Restrictions on use and alteration

Natural systems, such as wetlands and streams typically cannot provide an inter-related web of ecological functions if human intervention displaces or alters key features of the system. The most obvious human alteration is displacement. Filling a wetland eliminates virtually all functions and values provided. Culverting or piping a stream may have similar effects, although upstream and downstream portions of the stream may retain important functions.

Alteration that is less complete than displacement may interrupt important functions. For example, the removal and modification of riparian and aquatic vegetation, placement of the bulkhead structure and associated fill and removal of woody debris have the following effects:

- Increases flow velocities and change in the natural stream dynamics that produce substrate and other conditions for fish spawning and rearing;
- Increases in flow that increase band erosion and downstream deposition that alters the substrate and other conditions for fish spawning and rearing;
- changes in wave action on lakes that alters substrate and other processes;
- loss of organic input (e.g., tree litter, LWD, insects) within the a stream or lake's littoral zone;
- loss of shade and temperature attenuation provided by large vegetation;
- displacement of physical aquatic and terrestrial habitat;

Generally, regulations for wetland, streams and lakes seek to prohibit most human alterations. Activities generally allowed are limited and commonly include:

- Utilities that can cross streams or wetlands either overhead or in buried (or bored) pipelines that produce minimal disturbance of ecological functions during operation.
- Essential public facilities, such as roads, that sometimes must cross water bodies to connect two points.

- Recreational uses such as fishing, hunting, bird watching and interpretation of natural features.
- Continued use and maintenance of existing features such as dams, water diversions; and existing or ongoing uses such as forestry or agriculture.
- Docks and boat launch ramps on water bodies that provide access for public recreation use;

It also should be recognized that water bodies, especially navigable waters, provide a variety of opportunities for commerce that are integral to our economic system. The state Shoreline Management Act passed in 1971 includes several key goals (RCW 90.58.020 and WAC 173-26-176(3)):

(a) The utilization of shorelines for economically productive uses that are particularly dependent on shoreline location or use.

(b) The utilization of shorelines and the waters they encompass for public access and recreation.

(c) Protection and restoration of the ecological functions of shoreline natural resources.

Generally, critical area codes must allow for use of shorelines of the state for:

- Water dependent uses: Those uses that "cannot exist in any other location and are dependent on the water by intrinsic nature of its operation".
- Water-related uses: Those uses that are not intrinsically dependent on a waterfront location but whose operation cannot occur economically without a shoreline location.
- Water enjoyment uses provide the opportunity for a significant number of people to enjoy the shoreline.

6.1.2 Buffers

Buffers are often thought of as areas that are outside of sensitive areas such as wetlands and water bodies that separate environmentally sensitive areas for areas of human activity and reduce the adverse impacts of human disturbance. (Norman 1996) This narrow definition however reflects a narrow classification-based view of such features and not an ecosystem perspective. The continued use of the term buffer is somewhat unfortunate, but likely will continue as a familiar concept.

It is important to note that the Growth Management Act requires the protection of "areas *and ecosystems*" (emphasis added) relating to wetlands, fish and wildlife habitat conservation areas and frequently flooded areas. The protection of an ecosystem must go beyond the areas that can be identified by discreet criteria, such as a wetland, or a specific stream reach to include ecosystem processes that occur outside those features.

6.1.3 Buffer Ecological Functions

A variety of functions occur in wetland and aquatic habitats that have essential links with upland areas, including:

- Providing for continued hydrological processes, that provide surface and ground water critical to maintaining wetland aquatic resources;

- Maintaining natural functions related to water quality, including removing sediment generated by natural processes and removing nutrients such as phosphorous and nitrogen;
- Maintaining the microclimate in upland areas, that influence the functions of wetlands and aquatic habitats, as well as the vegetation complexity of upland habitat;
- Maintaining adjacent habitat and wetland functions that are essential to certain stages of populations (such as the need for amphibians to spend part of their lifecycle in water);
- Maintaining an area sufficient for populations to be maintained in all their lifestages;

A scientific literature review indicates that the buffer width necessary to protect a given habitat function or group of functions depends upon numerous site-specific factors. These factors include the plant community (i.e., type of plant species present, density of plants, and age of vegetation community), aspect, slope, and soil type, as well as adjacent land use. The body of science indicates that the appropriate buffer width for a given ecological function is specific to the environmental setting and functions to be achieved by that buffer (Castelle and Johnson 2000).

A summary of specific functions provided in buffer areas for aquatic and wetland ecological functions are provided in the tables below

Table 6-1. Generalized Comparison of Functions of Riparian Buffer Widths Aquatic Ecological Functions

	Buffer Width				
Stream Function	**15 Feet[1]**	**50 Feet**	**150 Feet**	**300 Feet**	**600 Feet**
Microclimate	X	X	N	P	F
Wildlife Habitat	X	N	P	P	F
LWD Recruitment	X	N	P	F	F
Pollutant Removal	N	N	P	P	F
Sediment Filtration	X	N	P	F	F
Water Temperature	X	N	F	F	F
Organic Litter	X	P	F	F	F
Bank Stability	X	F	F	F	F

KEY
F = Buffer width fully supports/maintains stream function
P = Buffer width partially supports/maintains stream function
N = Buffer width nominally supports/maintains stream function
X = Buffer does not adequately support/maintain stream function

Table 6-2. Generalization of Various Wetland Buffer Widths on Functions Provided

Buffer Functions Provided	Range of Buffer Widths					
	25-50 ft.	**50-100 ft.**	**100-150 ft.**	**150-200 ft.**	**200-250 ft.**	**250-300 ft.**
Habitat:	L	L/M	M	M/H	M/H	H
Habitat connectivity						
Amphibians:						

Table 6-2. Generalization of Various Wetland Buffer Widths on Functions Provided (Continued)

Buffer Functions Provided	Range of Buffer Widths					
	25-50 ft.	50-100 ft.	100-150 ft.	150-200 ft.	200-250 ft.	250-300 ft.
Sensitive	L	L	L	L	L	L
Urban	L/M	L/M	M	M	M/H	H
Birds:						
waterfowl	L	L	M	M/H	M/H	M/H
urban adapted	H	H	M/H	M/L	L	L
edge spp.	M/H	M/H	M/H	M/H	M/H	M
interior [2]	L	L	L	L	L	L
Mammals:						
Small	L	L/M	M	M	M/H	M/H
Large	L	L	L	L	L/M	M
Removing Sediment						
Grassy slope less than 5%	M/H	H	H	H	H	H
60-90% removal grassy	L/M	H	H	H	H	H
Steep slope	L	L	L/M	M/H	H	H
Particle Size:						
Sands	H	H	H	H	H	H
Silts	M	M/H	H	H	H	H
Clay	L	L	L	L	L	L
Removing excess nutrients						
60% removal	H	H	H	H	H	H
80% removal	L/M	H	H	H	H	H
Bacterial	L	L/M	H	H	H	H

6.1.4 Buffer from Human Activities

Human activities can produce a variety of changes to ecological processes and proximity impacts can affect wetlands, aquatic and terrestrial wildlife habitat and other ecological processes.

There are basically two types of impacts that occur from human activities:

- Changes in inputs to ecological processes that affect the hydrologic cycle or other elements of the ecosystem. Buffers are generally not effective for these impacts, unless large enough to provide sufficient area for the processes to remain. Even in those cases, impacts from outside the buffer are usually larger in scope and require other mitigation.

- Proximity impacts such as noise and light can disrupt feeding, breeding, and sleeping habits of wildlife and introduce predation from pets.

The table below summarizes the major impacts of human activities and the extent to which they can be addressed by buffers of other mitigating measures.

Table 6-3. Examples of Impacts to from Adjacent Human Use

Examples of Disturbance	Activities and Uses that Cause Disturbances	Examples of Measures to Minimize Impacts
Hydrologic Impacts • Impervious surfaces • Increased runoff • Decreased infiltration • Stream erosion • Change in hydroperiod	• Impervious surfaces o Parking lots o Roads o Building roofs • Vegetation alteration o Lawns o Landscaping	• Buffers can provide an area in which there processes continue, their effectiveness depends on total area • Provide vegetated open space in development to retain functions • Infiltrate runoff • Provide stormwater detention and treatment for roads and existing adjacent development. • Prevent channelized flow from areas that directly enters the resource or buffer.
Toxic runoff*	• Impervious surfaces o Parking lots o Roads o Building roofs • Lawns and Landscaping o Fertilizers o Herbicides & pesticides	• Buffers can provide filtering • Buffers can provide treatment, depending on width and vegetation • Route all new, untreated runoff away from resource • Limit use of chemicals for vegetation/native plants/integrated pest management.
Lights	• Parking lots • Street lights • Building lights • Car lights	• Buffers can interrupt and reduce, if adequate width and vegetation cover • Direct lights away from resource
Noise	• Roads • Residential areas • Parks • Commercial and Public areas • Manufacturing processes	• Buffers can interrupt and reduce, if adequate width and vegetation cover • Locate activity that generates noise away from resource
Predation from pets	• Residential areas	• Buffers are effective only if they are large enough to provide refuge and reduce the predator to prey interactions • Buffers can provide habitat for predators like coyotes that reduce domestic animal intrusion • Fence buffers and resources • Fence or otherwise limit pet access to resources and buffers
Dust	• Construction sites	• Buffers can interrupt and reduce, if adequate width and vegetation cover • Use best management practices to control dust.

In an urban setting, the range of activities adjacent to a resource may affect the size or character of a buffer. Higher intensity uses generally have greater impacts, although design can make a substantial difference in impacts. For example, large warehouse or industrial buildings adjacent to buffers with wall density sufficient to be a barrier to noise and no windows or exterior lighting may have less of an impact than residential use. Open space uses can vary greatly in proximity impacts. Active sports fields, for example can introduce high levels of noise and light as well as impacts from chemical fertilizers, herbicides and pesticides. Predation of wildlife by domestic animals is difficult to address by buffer size, no matter how extensive. Buffers also may become habitat for ferial domestic animals. In such a case, controls on domestic animals, such as fencing may be needed in addition to buffers.

The character of buffer vegetation is also a key element of ecological functions and attenuation of proximity impacts of human use. The edge vegetation of native forests at a boundary such as a meadow, or an area cleared by humans typically reaches the full length of threes. This contrasts markedly with the interior of a stand of native evergreens that typically have lost most of their lower branches due to shading. A cleared native forest buffer has very little vegetation near the ground and provides little effect on proximity impacts from adjacent development such as light or the view of adjacent development that may deter use by wildlife. An example of the difference between a natural forest edge and a recently cleared second-growth forest are provided in Figures 6-1 and 6-2.

It is important to acknowledge that buffers cannot mitigate all effects of human land uses, on a landscape level. A range of human uses alter the movement and storage of surface water and groundwater within a wetland's contributing basin. Stormwater management programs are essential to control the amount of surface water runoff as well as to assure high water quality.

Figure 6-1. Natural Forest Edge

Figure 6-2. Forest Edge of Cleared Forest

6.2 "NO HARM" REGULATORY SYSTEM

This type of regulatory system is best known in Washington State in its application to agricultural use in Skagit County. The approach was endorsed in challenges heard by the Growth Management Hearings Board for Western Washington and the Washington State Supreme Court (Swinomish v Skagit 2006) The "no harm" approach may be regarded as an "adaptive management" approach to protecting critical areas. As provided in the GMA regulations, in this approach critical areas regulations are "treated as experiments that are purposefully monitored and evaluated to determine whether they are effective and, if not, how they should be improved to increase their effectiveness." (WAC 365-195-920(2).

In determining that the requirement under the GMA to "protect" critical areas is met when local governments prevent new harm to critical areas in reference to protecting fish habitat in agricultural areas the Growth Management Hearings Board and the court both agreed that elements essential to such a program include adequate monitoring, benchmarks, and the ability to require changes to the program if benchmarks are not achieved. In assessing the difference between a prescriptive approach such as buffers and a "no harm" approach, the court held that local governments must either be certain that their critical areas certain that their critical areas regulations will prevent harm or be prepared to recognize and respond effectively to any unforeseen harm that arises.

Implementation of a "no harm" approach in undeveloped portions of the Black Diamond Urban Growth Area (UGA) are not likely to be effective in allowing future development. It would be difficult to meet a "no harm" standard in the conversion of second growth forests to a variety of urban uses. The application of a "no harm" standard to existing uses and land use patterns is more practical. Such an approach has been included in regulations recently adopted by the City of Black Diamond. Such programs also may include provisions to provide for enhancement of functions in future redevelopment of existing uses as is provided for in RCW 36.70A.020(10), RCW 36.70A.172 and RCW 36.70A.020(8).

A “no harm” system also is likely to be much more difficult and expensive to implement, especially the monitoring component, and provides little certainty to applicants of the standards likely to be imposed on their development.

6.3 GEOLOGICAL HAZARDS

The options for regulating geological hazards vary primarily in the degree of specificity of regulation. In general, the greater the specificity the more likely risk will be avoided or reduced.

Each option addresses the following criteria:

- Designating and classifying the hazard areas.
- The information needed to assess risk on a specific site.
- The range of options for avoiding risk.
- Allowing individuals to determine the risk they are willing to accept.
- Specifying restrictions on the types of developments; largely aimed at reducing exposure to uses involving risk to human life, especially large groups in uses such as schools or assembly facilities. The most successful and ultimately least costly protection from geologic hazards is often avoidance of known hazardous areas. This includes activities on adjacent areas that may result in an increased failure hazard that moves off site, down slope, or downstream.
- Reducing the exposure of occupied buildings through requirements for building setbacks, buffers, and vegetation management, as well as adherence to building codes; and development of monitoring and warning systems, evacuation plans, and recovery plans.
- Reducing secondary effects to other resources, such as fish, through limiting activities that result in discharge of materials into water bodies or other effects that may damage habitat.

6.4 FREQUENTLY FLOODED AREAS

Only Rock Creek upstream of Roberts Road (Auburn Black Diamond Road) has been designated a floodplain in studies prepared by the Federal Emergency Management Agency (FEMA). Flooding of this area is affected to some extent by the capacity of the existing Roberts Road Bridge. The floodplain area is largely contained within the wetland and proposed buffer area associated with Rock Creek and does not warrant separate protection.

6.5 CRITICAL AQUIFER RECHARGE AREAS

Three factors generally dominate determination of aquifer susceptibility (Cook 2000):

- Overall permeability of the unsaturated zone (soil and underlying geologic strata);
- Thickness of the unsaturated zone (depth to groundwater in unconfined aquifers); and
- Amount of available recharge.

Data already compiled and described above appear sufficient to support determination of aquifer susceptibility and vulnerability in the City of Black Diamond. Aquifer recharge areas may be identified largely by surficial soils and categorized for sensitivity based on "DRASTIC - A Standardized System for Evaluated Groundwater Pollution Potential Using Hydrogeologic Settings" (Aller et al. June 1987, US Environmental Protection Agency, Publication Number 600287035).

Wellhead protection areas (WHPAs) designated by water purveyors (as required by WAC 246-290-145) and mapped by Ecology (2006) should be added to the City's aquifer recharge area map, showing the 10-year ground-water travel-time area to each well or well field. Superposition of all designated WHPAs illustrates where aquifers are currently used for water supply. The mapping should be updated periodically to allow for additions and deletions of specific water wells. These data should be checked with State of Washington Department of Health and King County Health Department records.

7. SUMMARY

7.1 FINDINGS

The following findings summarize the discussion above and in the more detailed analysis in the Technical Appendixes on individual resources:

1. The majority of Black Diamond and its Urban Growth Area (UGA) are located in the Lake Sawyer subwatershed. Lake Sawyer is an extremely sensitive resource due to its large water area and small tributary watershed. It is especially sensitive to eutrophication from additional nutrients.
2. The streams and lakes in the area provide important habitat for anadromous fish, resident fish, other aquatic species and a range of terrestrial species.
3. Due to the largely undeveloped status of the UGA, many of these resources have relatively intact riparian areas, extensive wetlands, and relatively good water quality and instream habitat. Additionally, many of these areas provide numerous process-intensive functions that contribute to the overall productivity of the subwatershed. The maintenance of these functions throughout the UGA will be essential to maintaining ecological functions and values within Lake Sawyer. The lake has a relatively small watershed and will be extremely sensitive to changes brought on by urbanization.
4. The processes that occur within the City and its UGA have a relatively smaller impact on the larger Green River/Soos Creek/Covington Creek watershed simply because it is a small contributing area.
5. The processes that occur in the portion of the UGA in the Middle Green River/Crisp Creek watershed primarily are related to groundwater recharge. The City and its Urban Growth Area provide fewer process-intensive functions contributing to the overall productivity of that subwatershed, but may be important to processes that occur in the nearby Horseshoe Lake and possibly Keevie Lake.
6. The Rock Creek/Jones Lake/Jones Creek corridor has the largest concentration of sensitive features that affect landscape function, including a large complex of wetlands that provides flood desynchronization, water storage, and a variety of nutrient control functions essential to the health of the watershed and provide the most important aquatic and terrestrial habitat areas. This area has the potential to provide the greatest

beneficial effects on Lake Sawyer water quality, in addition to control of nutrients at the source.

7. Black Diamond Lake and the associated stream has a large and important concentration of similar features, including a large wetland complex, but is currently somewhat less important currently due to the smaller tributary watershed. As the area urbanizes, it will be increasingly important in providing water storage, and a variety of nutrient control functions essential to the health of the Lake Sawyer watershed.
8. Large wetland complexes that provide the headwaters of many streams are important in water storage and maintaining year round stream flows and temperature moderation. Such wetland complexes are present in the headwaters of Ginder Creek, Lawson Creek, Jones Creek, and Mud Creekn as well as the Rock Creek tributary to the Cedar River.
9. Tributary streams in the area have a variety of gradients and flow conditions as well as varying degrees of human alteration. Generally they are less important in providing aquatic and wildlife habitat, but they are important in providing inputs of high quality low temperature water to the systems with the greater concentrations of landscape functions.
10. Terrestrial habitat in the Black Diamond UGA is extensive due to the largely undeveloped character of the area. Preservation of wildlife habitat and corridors can be accomplished in concert with preservation of the Rock Creek/Jones Lake/Jones Creek and Black Diamond Lake/Stream areas with extension of the corridors to the north to Ravensdale Creek and to the east and west UGA boundaries. Wildlife corridors will be enhanced by providing passage under major roads by enhancing crossings of water bodies to provide bridges with additional height and width for animal movement.
11. Frequently flooded areas in the Black Diamond UGA are contained within the recommended stream and wetland buffer areas of the core Rock Creek/Jones Lake/Jones Creek corridor and do not warrant separate regulation.
12. Geologic hazards of landslides, erosion hazards and seismic hazards are relatively limited in scope and can be addressed on a case-by-case basis.
13. Geologic hazards related to abandoned coal mines are of concern in Black Diamond due to its history of coal mining. Coal mine hazards relate primarily to depth of workings and the presence of openings. Generally deeper workings have the least hazard with shallow workings posing the greatest risk. Coal mine hazards can generally be addressed by site specific studies and mitigating measures.
14. Critical aquifer recharge areas are generally in the moderate risk range based on analysis of soil and geologic conditions and can be addressed by regulation of activities most likely to discharge hazardous materials and through protection of wellhead areas.

7.2 RECOMMENDATIONS

Regulatory implications of these findings leads to a recommendation that the City of Black Diamond take an approach that provides the highest level of protection for the most important areas of the city that contribute the most to current ecological functions. This would be accompanied by a lower level of protection for those specific sensitive area resources in specific contexts where they contribute less to key functions. By this focused approach, the city is likely to be successful in preserving key ecological functions while accommodating growth goals.

Key elements of this approach include:

1. The Rock Creek/Jones Lake/Jones Creek corridor and the Black Diamond Lake/Stream corridors and the associated wetland complexes should be recognized as a core area that provides a variety of water supply, water quality, and habitat functions. These functions are essential to the preservation of water quality in Lake Sawyer, and to continue to provide the rich ecological functions of these systems. To function as wildlife corridors, they should extend to Ravensdale Creek to the north and the UGA boundaries to the east and west. They should be preserved with a minimum buffer width of 225 feet and requirements for adjacent uses to incorporate measures to reduce proximity impacts from noise, light and glare, stormwater and predation from pets. These corridors also should extend to the boundaries of adjacent steep slopes and may be widened where possible through a transfer of a portion of the buffer area from lower priority stream complexes.

2. Large wetland complexes at the headwaters of Ginder Creek Lawson Creek, Mud Creek and the Rock Creek tributary to the Cedar River that provide important inputs of water to the core through surface and groundwater should be preserved with buffers of 225 feet.

3. Wetlands outside of the core wetland complexes and the headwaters of Ginder Creek and Lawson Creek provide important hydrologic functions. Their ability to provide productive wildlife habitat for a variety of species will be limited by future urbanization. It is appropriate for the city to recognize tradeoffs between Urban Growth area goals of providing for housing and economic development by lower standards of protection. In recognition of their lower productivity, opportunities for transfer of buffer area to the core wetland system also are appropriate to provide the greatest variety of functions in that central location.

   Recommended buffers are found in Table 7-1:

Table 7-1. Recommened Wetland Buffers

Wetland Category	CORE and Headland	Standard Buffer	Minimum Buffer with Transfer to Core Wetland Complex
Category IV	225 feet	50 feet	30 feet
Category III	225 feet	80 feet	50 feet
Category II	225 feet	150 feet	100 feet
Category I	225 feet	180 feet	125 feet

These buffer reductions, however, should be considered only when adjacent lands and adjacent development have appropriate natural and built features to protect wetland functions. These should include:

(a) The buffer must have topographic and vegetation characteristics that ensure adequate function, including intact soils, limited topographic slope and dense native vegetation, including understory.

(b) Adjacent land use should not include high intensity uses such as commercial, industrial or high intensity multi-family and also should avoid high intensity recreational uses such as sports fields that have considerable loadings of fertilizers and other chemicals and also bring large groups of people into close proximity to the resource.

(c) Adjacent development should control impacts on the resource that will not be addressed by buffer width, including:

- Runoff control generally should not include discharge to or across the buffer. Infiltration or other low impact development mechanisms should be employed.
- Setbacks of buildings, parking areas, road and driveways from the buffer should be employed to provide additional areas for distance attenuation of proximity impacts that may be devoted to low intensity uses such a yards.
- Noise and light and glare should be limited by building placement and design, including avoidance of windows facing the buffer, avoidance of outdoor and security lighting, placement of mechanical and ventilating equipment away from the buffer and planting a dense vegetative screen at the margins of the buffer.
- The buffer should be fenced to limit intrusion of domestic animals and disturbance from informal human use and to also to attenuate noise and light and glare intrusion.

4. Small isolated wetlands often provide few functions when surrounded by urban development. Such wetland should be considered for displacement, if mitigation includes improving functions of wetlands and buffers in the core wetland/stream corridor.

5. Streams outside the core complex should be protected to continue to provide high quality water and fish habitat, where available.

   Recommended buffers for streams and lakes outside the core complex are shown in Table 7-2:

Table 7-2. Recommended Stream and Lake Buffers

Type	Standard Buffer	Minimum Buffer with Transfer to Core Wetland Complex
Type S- all waters, as inventoried as "shorelines of the state" under the jurisdiction of the Shoreline Management Act, except associated wetlands,	200 feet	150 feet
Type F - segments of natural waters other than Type S Waters, which are greater than 10 feet in width	150 feet	100 feet
Type Np - segments of natural waters that are perennial non-fish habitat streams. - 75 feet	100 feet	50 feet
Type Ns - segments of natural waters within defined channels that are seasonal, non-fish habitat streams	50 feet	30 feet

Buffer reductions, however, should be considered only when adjacent lands and adjacent development have appropriate natural and built features to protect wetland functions. The elements outlined above for buffer reduction for wetlands should also be implemented for these buffer reductions.

7. Geological hazards should be recognized and addressed on a case by case basis. Where feasible, slopes adjacent to wetlands and streams should be incorporated into buffers to provide a more effective overall buffer system.

8. Coal mine hazards should be recognized. High risk areas should be left undeveloped, unless mitigation can assure the reduction of risk to acceptable levels. Public facilities generally should avoid high risk areas. Lower risk areas should be assessed to assure that risks are mitigated, including risks to buildings from settlement.

9. Critical aquifer recharge areas are generally in the moderate risk range and can be effectively addressed by regulation of activities most likely to discharge hazardous materials and through protection of wellhead areas.

10. To recognize existing lots that cannot comply with the recommended buffers. Provisions are made for:

    - Allocation of a certain amount of disturbance as a “reasonable use” for existing residential lots
    - A broader “reasonable use” provision reviewed on a case-by-case basis for other uses
    - A sliding scale based on lot depth for buffers
    - Provision for enhancement of setbacks and buffers to reduce impacts to adjacent resources. As properties are re-developed, provisions should be included to enhance buffers.

8. REFERENCES

References are found in the accompanying Technical Appendixes to this summary.