

# **Chapter 4 The Natural Environment – Effects on Ecosystems and Natural Resources**

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## **What is addressed in this chapter?**

This chapter describes the community's existing natural environment and how the alternatives may impact those resources. This chapter specifically addresses the following elements:

- Earth
- Hazardous Materials
- Water
- Plants and Animals
- Climate Change

Several exhibits within this chapter identify the locations and/or conditions of natural resources. The mapping information used to create these exhibits came from a variety of sources, are intended only as general depictions, and may not be accurate to the parcel level. During the MPD process, natural resources will be analyzed at a parcel level.

# Water

## Surface Water Resources

### 1 What surface water resources are present in the study area?

The Lawson Hills study area is located within the Duwamish-Green River Drainage Basin (Water Resource Inventory Area [WRIA] 09). All surface water runoff within the study area drains to Rock Creek and Lake Sawyer and then on to Covington Creek and Big Soos Creek. Big Soos Creek flows into the Green River. The Green River becomes known as the Duwamish River Waterway at River Mile 11 and flows into Elliot Bay and the Puget Sound in Seattle.

In the study area, there is a large concentration of natural features that affect ecological function and the health of the watershed. These features include Jones Lake, Mud Lake, Mud Lake Creek, Ginder Creek, Rock Creek, and a large wetland complex. They provide flood desynchronization, water storage, and a variety of nutrient control functions. These features also provide important fish and wildlife habitat areas. The Lawson Hills Main Property interacts with these features through five drainage basins:

- Basin A: The central portion of the Main Property, consisting of about 71 acres, drains from Lawson Creek to Jones Lake, which then flows to Rock Creek and Lake Sawyer;
- Basin B: An area of about 38 acres south of Lawson Street which drains to Mud Lake which in turn drains to Ginder Creek then Rock Creek;
- Basin C: The southerly portion of the Main Property, consisting of about 38 acres, which drains to the south by subsurface flow or via sheet flow through numerous small ravines and slopes to recharge groundwater and Jones Lake Creek on the east side of SR 169; and

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#### Appendix M

Additional information regarding water is available in Appendix M.

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#### What is analyzed in the “Water” Section?

- Surface Water: Streams, lakes
  - Groundwater: Hydrology between water bodies, aquifers
  - Stormwater: Water quality
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#### What is flood desynchronization?

Flood desynchronization is the ability of wetlands to store flood waters and later discharge those waters at a non-simultaneous rate reducing the height and rate of flows that would otherwise be associated with flooding.

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- Basin D: An area of about 46 acres between Lawson Street and SR 169 that drains into the confluence of Mud Lake Creek and Ginder Creek and then to Rock Creek.
- North Triangle: This area is about 54 acres in size. The southeasterly portion of the site ranges in elevation from 670 to 640 feet, and drains into a wetland and stream complex that traverses a steeply sloping area, infiltrating into groundwater in the lower flat portion of the site. Groundwater is presumed to flow to Ravensdale Creek to the north through a wetland complex along Cranberry Creek. See Exhibit 4-9 for a detailed overview of the existing drainage basin.

Note: In some water quality reports and correspondence regarding the Lawson Hills project area, a sixth basin, Basin E, is also discussed. Basin E is a small parcel that exists to the south of Basin C. It is not under consideration for development and is therefore not discussed in this EIS.

**Jones Lake** measures less than 20 acres and is characterized by relatively high concentrations of naturally occurring acidic organic materials. The majority of the lake shoreline is undeveloped and surrounded by a mature coniferous forest. The majority of the land draining to Jones Lake is relatively undeveloped. Exceptions include historical mining activities, low-density residential development in lower Lawson Creek and SR 169.

Jones Lake has moderate to high primary productivity with good to fair water quality, although temperatures reach as high as 25 degrees Celsius (77 degrees Fahrenheit) during summer. Only coho salmon are currently reported in Jones Lake. Despite relatively low direct use of the lake by fish species, it constitutes the headwaters of Rock Creek, a stream that provides valuable habitat for steelhead, cutthroat trout, and coho salmon. Consequently, the Jones Lake watershed provides process-intensive functions that are critical for fisheries downstream in Rock Creek and Lake Sawyer.

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**What is nutrient control?**

Wetlands play a very crucial role in storing and providing a source of nutrients to organisms in the surrounding environment. More information regarding nutrient control and water quality is available in the Water Quality Technical Report in Appendix M.

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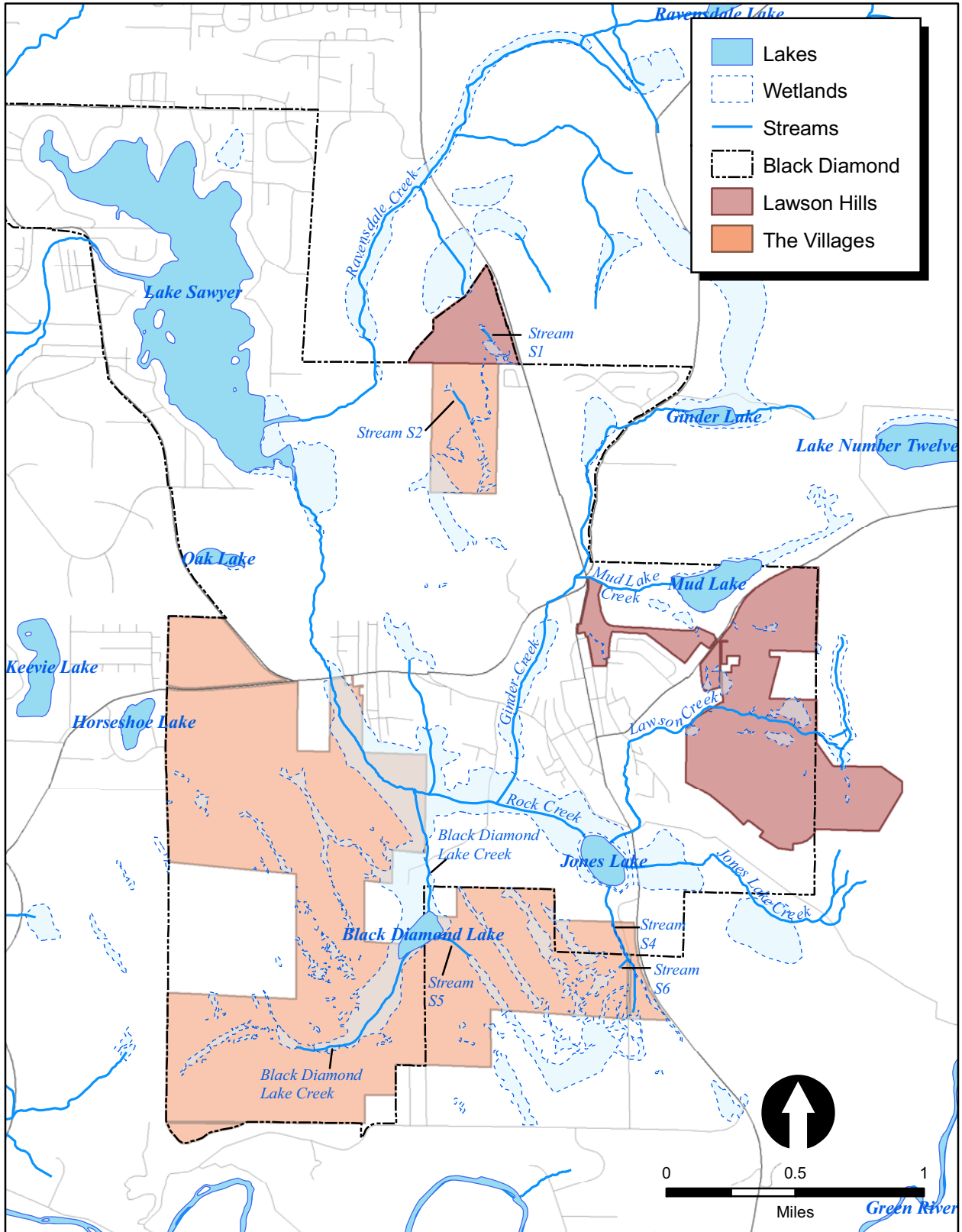
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**What is primary productivity?**

Primary productivity is the production of organic compounds from carbon dioxide in the atmosphere or in the water. This is primarily accomplished by photosynthesis by plants and some types of microorganisms.

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**Exhibit 4-9  
Existing Drainage Basins**



Exhibits in this EIS are intended to provide a general graphical depiction of built and natural environment conditions and may not be accurate to the parcel level.

**Mud Lake** is a former wetland that was dredged and mined for coal as part of the John Henry Mine. It is now a relatively deep 32-acre lake. The area is surrounded by highly disturbed soils and possesses little native vegetation. Additionally, the habitat quality of Mud Lake is unknown.

**Mud Lake Creek** is a roughly 3/4-mile long stream that originates in Mud Lake. The majority of Mud Lake Creek drainage is undeveloped but was previously disturbed by mining activity. Water temperature in the creek was measured at 15 degrees Celsius (59 degrees Fahrenheit). Primarily because of its small size, salmonids are not reported in Mud Lake Creek. Despite the relatively low direct use of the creek by salmonids, the creek provides low temperature water in the summer months to the Lake Sawyer/Rock Creek sub-watershed and to Ginder Creek, which is important to water quality of those fisheries.

**Ravensdale Creek** drains all water from the North Triangle. With the exception of the SR 169 crossing, the lower portion of the basin is relatively undisturbed. Extensive wetlands (both forested and emergent) flank this portion of Ravensdale Creek. Riparian canopy closure is good, and canopy closure appears to meet the 89 percent target required to maintain Class A water quality temperature standards.

Much of the watershed is part of the Lake Sawyer Regional Park, which was transferred to public ownership as part of the Black Diamond Area Open Space Agreement.

Water quality data indicates that Ravensdale Creek has excellent water quality with respect to moderately low hardness, low dissolved metals, and low total phosphorous concentrations. However, it is 303(d) listed for temperature. During all or portions of the year, Ravensdale Creek likely supports many of the fish species found in Lake Sawyer.

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**How will a 303(d) listing affect the alternatives?**

Section 303(d) of the CWA requires states to develop a list of waters not meeting water quality standards or not supporting their designated uses. Ravensdale Creek's 303(d) listing for temperature means that it has exceeded standards for temperature. Waters placed on the 303(d) list require preparation of a plan to limit pollutants. Because Ravensdale Creek is listed, it will likely receive more intense scrutiny for any activities that might result in further temperature exceedances.

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## 2 What regulations apply to surface water quantity and quality?

Surface water quality is regulated at the federal, state, and local levels. From a regulatory standpoint, most water quality issues are regulated under the umbrella of the Clean Water Act (CWA). The National Pollutant Discharge Elimination System (NPDES) is a federally mandated program enacted in accordance with the CWA with the goal of regulating point source discharges. The NPDES program sets limits on the amount of pollutants that can be discharged into receiving water bodies.

The United States Environmental Protection Agency (EPA) is the federal agency charged with enforcing the CWA and the NPDES program. In the state of Washington, EPA has delegated the operation of the NPDES program to the Washington Department of Ecology (Ecology). The State of Washington has adopted rules based upon the CWA. These rules are largely covered under various chapters of Title 173 of the Washington Administrative Code (WAC).

In the State of Washington, water quantity resources are governed primarily under the authority of the Water Resources Act (WRA) of 1970. Section 173-509 of the WAC regulates water quantity for WRIA 09, which encompasses the Lawson Hills site, including current and future water rights. Moreover, WAC 173-509-040 dictates limits on withdrawals from specific streams/water bodies in WRIA 09.

## 3 What regulations apply to development near streams or other water bodies?

The State Shoreline Management Act (SMA) of 1971 regulates development activities in Lake Sawyer, which is the sole water body in Black Diamond regulated as a shoreline of the state. The City's SAO regulates development and redevelopment activities that might impact water quality in streams, wetlands, and smaller lakes, through the use of buffer zones and specific development standards.

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### What are point source discharges?

A point source discharge is a discrete location from which pollutants may be discharged. Examples include pipes and ditches.

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*North tip of Black Diamond Lake.*

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At the local level, the City of Black Diamond regulates surface water through stormwater management standards (see the Stormwater section in Chapter 3 of this EIS for more information on these local standards).

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#### **4 What stormwater regulations apply to runoff?**

Stormwater runoff is regulated in accordance with the CWA and the NPDES program. In Washington, the Department of Ecology is responsible for stormwater regulations in accordance with Chapter 90.48 of the RCW.

As a city with a population less than 100,000, all stormwater-related activities are regulated under the Black Diamond’s Western Washington NPDES Phase II Permit (Phase II Permit). Among other requirements, the Phase II Permit requires the City to have programs that directly deal with operation and maintenance of existing stormwater collection, treatment, and discharge systems; pollution prevention from sites of development, redevelopment, commercial, industrial, residential, and municipal activities; and an Illicit Discharge Detection and Elimination (IDDE) program to identify, isolate, and terminate illicit discharges to the City’s storm sewer.

Additionally, for site disturbances of more than 1 acre, or for sites smaller than 1 acre which are part of a larger common plan of development, a Construction Stormwater General Permit must be obtained from Ecology. The Construction Stormwater General Permit details specifically what the permittee must do to prevent and mitigate water quality impacts due to construction activities.

#### **5 What are some considerations to be made for managing stormwater at the Lawson Hills site?**

There are two components of a stormwater management program – flow management and water quality treatment. Flow management refers to limiting the frequency and duration of a development’s stormwater discharges to the levels occurring prior to development. *Peak Standard* flow management seeks to maintain the volume of peak discharges at their predevelopment levels. *Duration Standard* flow management seeks to maintain the length of time that a variety of peak discharges occur.

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#### **Stormwater**

There is additional information about stormwater provided in Chapter 3.

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In managing water quality, a variety of treatment facilities are used to remove pollutants from stormwater prior to the stormwater entering a water body. These pollutants include sand, silt, and other suspended solids; metals such as copper, lead, and zinc; nutrients (for example, nitrogen and phosphorous); certain bacteria and viruses; and organics such as petroleum hydrocarbons and pesticides.

Methods of pollutant removal include sedimentation/settling, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Floatable pollutants such as oil, debris, and scum are usually removed from the stormwater through the use of separator structures, devices which trap floatable pollutants and discharge clean water.

Different types of facilities are required to address different water quality issues. The initial step in choosing a stormwater quality treatment approach is to determine the water quality requirements of the receiving water bodies. Receiving waters in the Lake Sawyer system require “phosphorus treatment,” and in some basins “enhanced treatment,” because of the sensitivity of Lake Sawyer and other water bodies to nutrients and eutrophication (see the *Stormwater* section in Chapter 3 of this EIS for more information on stormwater treatment facilities).

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**What is eutrophication?**

Eutrophication is a term that refers to the addition of nutrients to a water body. Although eutrophication can be a natural process, water pollution can greatly exacerbate and speed up this process. Eutrophication can lead to massive algae blooms in lakes and fish kills.

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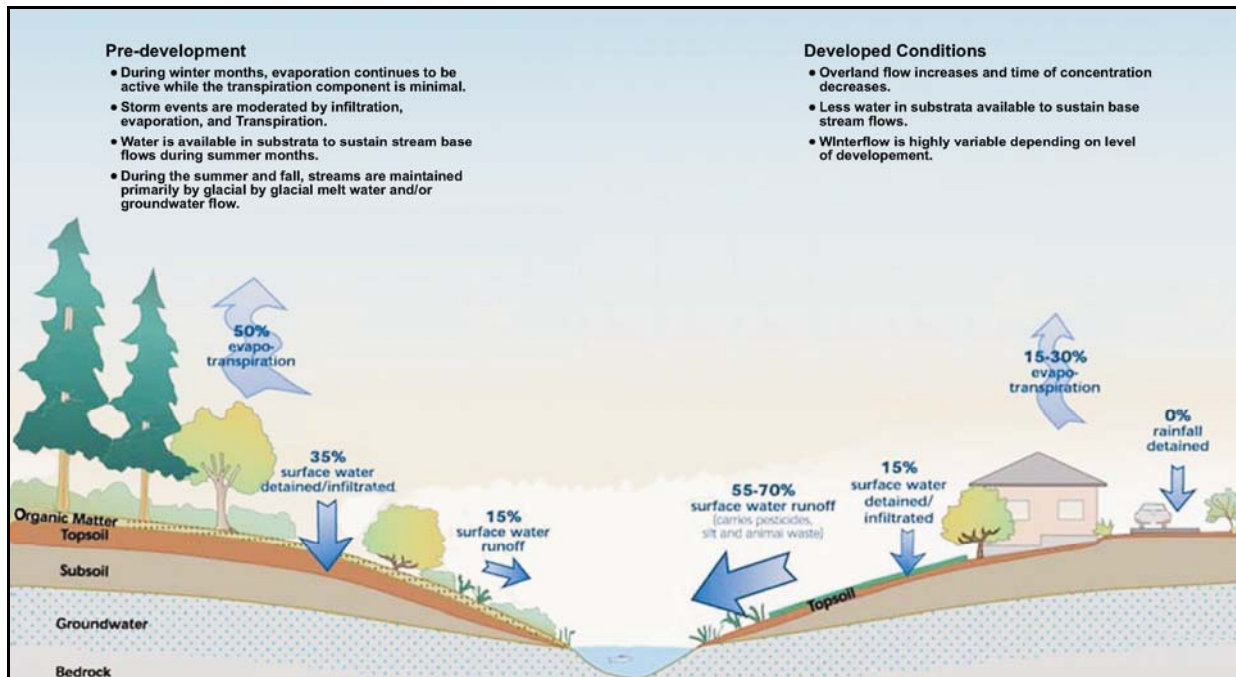
## **6 How would the alternatives affect surface water resources?**

In order to understand how the alternatives would affect surface water resources, it is important to understand how development in general affects the hydrologic cycle.

All of the alternatives will bring about replacement of natural vegetation with impervious surfaces and landscaping, and as a result, the alternatives will change the natural patterns of water movement (known as the hydrologic cycle). As shown in Exhibit 4-10, the replacement of natural vegetation with roads, parking lots, buildings, and turf and ornamental plants can result in dramatic increases in the amount of surface water runoff. Because the alternatives differ in amount and placement of development, the extent to which increased runoff impacts the hydrologic cycle varies.

Exhibit 4-10

**Overview of the Hydrologic Cycle in Predeveloped and Developed Conditions**



The degree to which stormwater infiltrates or forms runoff depends a great deal on soil structure. The Main Property is composed mainly of Alderwood and Beausite series soils that are moderately well-drained soils formed on weathered till. The Main Property soils are not suitable for infiltration of stormwater due to relatively thin top soil underlain by dense to very dense, low permeability till.

The North Triangle is underlain by Alderwood soils on the southerly upland area of the North Triangle. The lowland areas are composed of Everett soils that are derived from glacial outwash and are excessively drained. Virtually all precipitation that falls on the North Triangle runs off to the outwash soils and infiltrates.

In general, the physical and biological health of creeks and streams declines as development increases within a watershed. Physical changes include flow and temperature alterations, channel incision, bank erosion, stream widening, and

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**Where can I find more information about soils?**

A detailed description of soil types found in the Black Diamond area is located at the beginning of this chapter under the Earth section.

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sedimentation, all of which can impact the ability of a creek or stream to support fish and wildlife. Studies have shown that there are two development thresholds that, once reached, usually result in noticeable impacts on the biological health of streams: approximately 10 percent of the sub-basin is covered in impervious surface; or when the amount of forested cover drops below 65 percent.

Development can also result in reduced water volumes within these creeks and streams and increased water temperatures.

### **Displacement of Flows**

When a system of pipes and detention facilities is used to manage stormwater in place of infiltration, stream sections above detention facilities tend to dry up while downstream sections experience increased water flows. In addition, alterations in hydrology from flow displacement can substantially affect wetlands.

### **Peak Flows and Geomorphic Instability**

Even when complying with the *Stormwater Management Manual's* peak and duration stormwater management standards, runoff is likely to increase, resulting in adverse impacts on receiving streams. This is because the total volume of runoff will increase when vegetation is replaced by development, and this larger volume of water cannot be stored as long as runoff was stored under predevelopment conditions. However, duration standards will be established in order to keep the increased stormwater volumes and decreased retention duration from negatively impacting creeks and streams. These duration standards will be accomplished through the use of stormwater detention ponds and in accordance with the stormwater treatment methods outlined in the various alternatives in this EIS. Typically a rate of about 50 percent of the predevelopment 2-year storm flow discharge is used for planning stormwater facilities.

A qualitative evaluation of existing stream conditions in the study area led to a conclusion that most of the stream sections appear stable. The evaluation also looked at stream power,

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#### **What is a duration standard?**

A duration standard seeks to maintain the postdevelopment duration of all stormwater discharges at predevelopment levels.

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#### **What does the term “2-year storm” mean with regard to stormwater flow?**

Storm events of a magnitude which are expected to be equaled or exceeded in a given time period are a commonly used component of designing stormwater facilities. A 2-year storm event has a 50% chance of being equaled or exceeded during any given year. Storms up to this magnitude are the dominant storms that determine the size and shape of receiving streams. Therefore, these types of storms are a commonly used component for designing stormwater facilities.

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which is a function of flow and gradient and provides information regarding thresholds for erosion potential. The methodology, modeling results, and qualitative assessment used in the evaluation did not analyze changes to duration of stream flow. Final design of storm ponds will have to consider flow duration as required by the 2005 *Ecology Stormwater Manual*. This is critical for streams like Lawson Creek with higher gradient sections where longer flow durations may result in increased bed movements.

### **Low Flows**

Decreases in stormwater infiltration would likely lead to decreased summer water flows in local streams. The greatest potential impact is on Lawson Creek that passes through the Main Property. Lawson Creek currently dries up in the summer. The development of a piped stormwater management system may result in drying of the stream earlier in the season.

The study area represents about 15 percent of Jones Lake’s watershed. Reductions in infiltration may have adverse impacts on Jones Lake, especially when associated with temperature increases. In addition, the study area represents about 28 percent of Mud Lake Creek watershed, and the low summer temperatures in Mud Lake Creek indicate a substantial amount of groundwater entering the stream. However, as the watershed basin has already been altered, it is difficult to predict what affect a loss of groundwater will have on Mud Lake Creek and its receiving water bodies.

### **Temperature**

Development impacts on the hydrologic cycle may result in significant increases in the temperature of water discharged by streams in the summer, when receiving waters are most temperature sensitive. Pavement absorbs large amounts of solar radiation, particularly in the summer, and can be heated to temperatures in excess of 60 degrees Celsius (140 degrees Fahrenheit). Removal of shade and decreased evapotranspiration due to reductions in vegetation contribute substantially towards elevated temperatures of roadways, sidewalks, and other surfaces. During a storm event, runoff

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#### **What is evapotranspiration?**

Evapotranspiration is a term that refers to water loss from an area due to the cumulative effects of both evaporation and transpiration by plants. Transpiration is the loss of water by plants as water vapor as part of their natural metabolic processes.

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flowing over heated pavement can absorb this heat, raising the temperatures of the receiving water bodies.

Recent studies have confirmed that conventional stormwater detention ponds can significantly increase the temperatures of streams (due to solar heating) if stormwater is discharged directly into them, especially for streams at full capacity or those experiencing back-to-back storms. The use of open detention ponds with large surface areas presents the greatest risk of increased temperature, as water within these ponds can also gain heat from solar heating.

The potential for higher temperature discharges to Jones Lake in the summer months could further degrade this system which already has high summer water temperatures. Increased water temperatures in Jones Lake could adversely affect the downstream Rock Creek stream/wetland system, and possibly to Lake Sawyer, depending on the cumulative effects of urban runoff from other sources.

Discharging higher temperature waters into Mud Lake Creek, which currently has low summer temperatures, could substantially elevate temperatures in this stream and in the receiving waters of Ginder Creek and the Rock Creek Stream/wetland system.

A study by A.C. Kindig and Company (see Appendix M) in Sammamish, Washington, showed that in the hottest months, July to September, the natural process of evaporation prevented stormwater discharges from occurring. Based on this study, the potential for high temperature discharges to receiving streams may be lower than in other regions given Western Washington's climate. However, the City or applicant may want to perform limited temperature analyses post-construction if it is noted that stormwater discharges are occurring during periods of warm weather.

### **Water Quality**

Transitioning from a natural hydrologic cycle to one dominated by urban runoff increases potential for bacterial and chemical pollutants entering water bodies. In natural environments, pollutant discharges to storm water are minimal. Additionally, pollutant levels in stormwater are naturally filtered through vegetation and infiltration into soils. With urbanization, impervious surfaces replace vegetation, disrupting this natural filtration system and increasing bacterial and chemical pollutant concentrations in stormwater runoff.

The major sources of bacterial contamination are residential pets and wildlife that deposit feces on lawns and impervious surfaces that are then washed into the stormwater system by storms. Fecal bacteria densities generally increase with greater housing density, increased impervious surfaces, and domestic animal density.

Chemicals of concern include heavy metals such as lead, zinc, and copper, which are largely deposited on road surfaces as a result of vehicle use where they then enter the stormwater management system. Lead is largely in the form of particulates and results from wear of moving vehicle parts. Copper results from wear from brakes, alternators, and radiators and is extremely toxic to aquatic life. Zinc results largely from tire wear. Lesser amounts of zinc originate from brake linings and exhaust emissions, as well as from galvanized metal in structures.

Oil and grease in urban stormwater are largely from automotive spills and leaks; including lubricants, antifreeze, and hydraulic fluids; and can leach out of asphalt road surfaces.

Nutrients of concern in stormwater consist largely of nitrogen and phosphorus and often originate from fertilizers used on lawn and landscaping, and from exterior use of detergents. Nitrogen and phosphorous can also enter waterbodies from erosion during construction and from bed movement in streams. Lake Sawyer currently has a 303(d) listing for phosphorus, based on past water quality problems. Jones Lake is not currently listed, but is a likely candidate for potential eutrophication from increased inputs of nutrients as the watershed transitions from primarily undeveloped land.

The existing forested land cover in the Main Property and North Triangle likely has little or no discharge of pollutants. With regard to phosphorous in particular, measurements taken at Lawson Creek in 2007 during a storm measured 0.030 mg/L and during one baseflow event measured 0.014 mg/L, for an average of 0.022 mg/L of total phosphorous. To see what effects development may have on phosphorous concentrations at the Lawson Hills site, this phosphorous measurement in an “undeveloped” state is compared in Exhibit 4-11 to some phosphorous measurements taken in urbanized areas.

**Exhibit 4-11**

**Comparison of Undeveloped Lawson Creek Phosphorous Concentrations to Various Urban Watersheds**

<b>Watershed</b>	<b>Development Status</b>	<b>Total Phosphorous (mg/L)</b>
Lawson Creek	Undeveloped	0.022
Lakemont, Bellevue, WA	Urban	0.14
Lake Garrett, White Center, WA	Urban	0.13
Seattle Urban Watersheds	Urban	0.14–1.62
EPA – Various	Urban	0.3–300

*Note: Above developments were prior to 2005 Ecology manual.*

Based on the above examples, the increase in phosphorus in urban runoff may be several times greater than that of previously forested conditions. Specific to this site, quantified analysis indicates that total phosphorous concentrations could increase in Lawson Creek by a factor of 1.3 to 2.0 under treated conditions. Additionally, these measurements do not include phosphorus bound to sediments which may reenter the water column at a later date; this mechanism is especially pertinent in low oxygen environments such as Jones Lake. The combined impact of phosphorus in runoff and phosphorus bound to sediments may contribute substantially to the risk of eutrophication of receiving waters.

## **7 How do the alternatives compare in terms of stormwater impacts?**

### **Alternative 1**

Development under Alternative 1 is assumed to occur in conformance with the *Stormwater Management Manual*, and would meet detention and water quality treatment requirements. It would not have a specific requirement for open space or retention of native vegetation and therefore would not have the benefits to maintaining natural hydrologic cycle processes dominated by evaporation, evapotranspiration, and infiltration. The City's SAO would preserve wetlands and streams.

Calculations based on land use show that Alternative 1 would result in more impervious surface creation than Alternative 2 (140 acres versus 131 acres, respectively). Alternative 1 would also replace more native forest with lawns and ornamental vegetation further reducing evaporation, evapotranspiration, and infiltration. With more impervious surface, less water would be available for groundwater recharge.

The development of multiple smaller detention/treatment facilities under Alternative 1 may result in less displacement of water flows since there would be multiple points of discharge to surface water. Stream scouring and erosion from greater duration of flows and water quality impacts likely would be similar to Alternative 2.

### **Alternative 2**

This Alternative differs from Alternative 1 primarily in:

- Commercial development in the North Triangle and Main Property
- Higher density residential development
- Mixed use development

The preservation of open space under Alternative 2 would tend to preserve the natural hydrologic cycle to the extent where portions of the site remain native forest. While all of the alternatives retain approximately 102 acres of native vegetation

in the form of sensitive areas and their buffers, Alternative 2 provides an additional 36 acres of open space. Some of this open space will likely be forested and may add additional hydrological benefits.

The greatest potential impact of Alternative 2 is on Ravensdale Creek from the North Triangle, where the majority of the site would be developed in commercial use with a high proportion of impervious surface. Depending on the type and location of stormwater facilities placed at the North Triangle, hydrology could be affected in multiple ways.

If discharge of stormwater is routed through the wetlands on the southerly upland portion of the North Triangle, this would cause a substantial change in the wetlands' hydroperiods. The small stream that feeds the wetlands runs through a deeply incised ravine, and would likely be adversely affected by scour from increased flows. If all runoff were routed to infiltration facilities in the lower portion of the site, the wetlands in the upper area likely would be adversely affected by reduction in recharge. Ravensdale Creek would then be impacted by receiving recharge of a greater amount of water than exists at present.

In addition, an infiltration system could inject water at a faster rate and store less water for summer low flows than the dispersed interflow that would occur under natural conditions. This may affect low water-table periods in the summer for wetlands near the North Triangle. However, overall impacts on Ravensdale Creek likely would be small given the small proportion of the overall watershed and contributory flow represented by the North Triangle.

For Alternative 2, stormwater is currently proposed to be infiltrated in the lower portion of the North Triangle. These infiltration facilities will need to be designed adequately to protect the hydrology of both Ravensdale Creek and the wetland systems in the North Triangle.

Impacts to the Lawson Creek drainage basin would be similar under Alternatives 1 and 2.

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**What are level spreaders and how are they used?**

Level spreaders are a variety of structures used to spread the release of stormwater over a larger area. When appropriately designed and maintained, level spreaders can reduce the flow impacts of stormwater to riparian areas. However, level spreaders are prone to failure if not designed in accordance with site conditions and should not be used on steep slopes.

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Alternative 2 calls for medium- and high-density residential with small amounts of open space in the portions of the Main Property that drain to Jones Lake Creek, and are located on a steep slope above the creek. Development in this area is likely to have greater impacts on water resources than low density residential development which would occur under Alternative 1.

The lack of a clear surface water connection to Jones Lake Creek may result in substantial erosion if measures such as level spreaders on moderate slopes are employed. Level spreaders are subject to frequent design failures. Even if the level spreader functions as designed, concentrated discharge is often generated at the spreader's low point. In addition, topographic conditions downslope also can result in concentration into gullies and other low-lying areas. Such concentrated flow usually results in severe erosion downslope of the discharge. This not only results in damage to areas adjacent to level spreaders, but it can lead to sediment deposition and related damage to aquatic habitat farther downstream.

Alternative 2 will likely have greater impacts to Mud Lake Creek than Alternative 1, because the open space that drains to the lake will largely be devoted to schools or is at the bottom of the slope near SR 169. The additional impervious surfaces from mixed-use, the presence of large buildings like schools, and the presence of large turf areas likely will increase both runoff volumes and adverse water quality. Additionally, because Alternative 2 proposes the use of large stormwater ponds, special consideration should be given to temperature elevation in these ponds due to solar heating and the potential impacts to Mud Lake Creek, which currently maintains relatively cool ambient water conditions during the summer months. Post-construction monitoring, as previously discussed, could be performed.

**Alternative 3**

Alternative 3 represents a mitigated version of Alternative 2 and therefore concentrates development away from sensitive areas and would also incorporate low impact techniques.

Potential impacts to Ravensdale Creek would be less in Alternative 3 given that there will be 15 less acres of commercial/office use. Additionally, overall impacts from new impervious surface would be less for Alternative 3 because it would create approximately 90 acres of impervious surface versus approximately 130 acres in Alternative 2. Alternative 3 also will include 186 acres of total open space, providing significantly more opportunities than the other alternatives for mitigating some of the hydrological changes resulting from development of the project area.

**Alternative 4**

Alternative 4 is similar to Alternatives 2 and 3 and was not further studied in this section.

**8 What measures may reduce the effects of the alternatives on surface water resources?**

There are several general strategies available to reduce or mitigate the effects of urbanization on surface water resources:

- Preserving natural hydrologic functions to the extent possible;
- Providing facilities that mimic or enhance natural hydrologic functions of evapotranspiration and infiltration; and
- Providing for stormwater detention and treatment.

All of these strategies can be applied to stormwater management and are often known collectively as Low Impact Development (LID) or are outcomes of using LID best management practices.

### **Preserving Natural Hydrologic Functions**

Preserving native forest vegetation and soils intact is the most effective means of preserving natural hydrologic functions. In general, surface hydrologic functions continue to operate well when 65 percent of native vegetation and soils are retained. However, the affects of development on hydrologic function will vary by soil type, underlying geology, topography, and placement in the watershed.

In Alternatives 2 and 3, it is estimated that native vegetation will be preserved in three basic areas: along the high mine hazard area parallel to and about 800 feet west of Lawson Street, along the Lawson Creek wetland complex through the central part of the site, and in the Section 12 mine reclamation area at the north end of the site (proposed for a school site). In order to most effectively preserve native open space for hydrologic functions, the areas preserved should:

- Be located on soils and topography best suited to infiltration;
- Be characterized by dense native vegetation; and
- Be located in the headwaters of streams or in conjunction with other natural features such as wetlands that provide year-round water sources to streams.

The most beneficial areas for vegetation retention are the moderately sloped areas along Lawson Road, the relatively flat area along the Lawson Creek Wetland Complex, and the wetland complex along the Jones Lake tributary in the easterly portion of the site. In Alternative 2, these areas are partially in proposed open space and are partially designated for intensive mixed-use and residential development.

The most effective means of preserving native vegetation would be to more tightly cluster development to provide the same number of units in a smaller area, or as proposed in Alternative 3, construct less dwelling units thereby creating a smaller footprint of developed area. In addition, native vegetation can be preserved by fitting infrastructure and buildings to the site through methods such as stepping building

foundations and foregoing the creation of flat yard areas on sloping sites. In residential areas, reducing driveway lengths through shallow lot frontages and reducing road widths and turnaround areas can also help preserve vegetation and soils.

### **Mimicking or Enhancing Natural Hydrologic Functions**

Facilities that mimic or enhance natural hydrologic functions of evapotranspiration and infiltration are collectively included in LID techniques. There are several options for mimicking or enhancing natural hydrologic functions. One method is to increase the retention time of water in soils resulting in greater potential for infiltration. This can be accomplished by amending soils with compost in lawns, parks, greenbelts, and parking strips. This decreases runoff by increasing the potential for on-site infiltration and evapotranspiration.

Another option is utilizing roof runoff as a source of flow. Roof runoff has lower concentrations of pollutants and can be diverted to adjacent native vegetation or amended soils in both residential and commercial developments, thereby reducing the size of stormwater detention ponds and treatment facilities.

Various facilities are available to provide concentration of runoff in areas with deep soils, or connections to suitable soils for infiltration, or to store water during rainy periods to allow evaporation during warm periods. Typical facilities include bio-retention swales along streets and in parking areas, and small rain gardens on or adjacent to residential lots. Though bio-retention facilities are of limited effectiveness in late winter when all soils are saturated, they can be very beneficial for summer and autumn discharge and can be used to address temperature concerns related to stormwater runoff.

Vegetated roofs (green roofs) are another option that fulfills the function of retaining water and increasing loss by evaporation and evapotranspiration. They do not, however, facilitate infiltration and are among the most costly options.

Finally, storage of runoff in small tanks on parcels can be used for irrigation in warm weather and larger detention facilities can be designed to provide metered release to infiltration facilities, as well as to streams and other water bodies.

However, it should be noted that, except for the North Triangle, the soils on Lawson are very dense, underlain by bedrock, and do not infiltrate.

### **Stormwater Detention and Treatment**

Stormwater detention and treatment is an essential element in dense urban developments where the natural hydrologic cycle cannot be maintained. The key to well functioning detention and treatment systems are appropriate design goals, and effective management, including adaptive management. As it pertains to the *Stormwater Management Manual*, the design goal is matching pre-existing forested conditions to the extent possible. Methods that can help detention facilities achieve this goal include:

- ***Design to accommodate large storm events:*** In addition to managing the duration of flow generated by the average storm event, detention facilities can be designed to accommodate storms that substantially exceed average conditions.
- ***Dispersed or multiple discharges:*** This may better mimic natural conditions by discharging stormwater into numerous headwaters versus a large point discharge at an outfall. This approach may require multiple detention facilities that generally have a higher development and maintenance cost.
- ***Groundwater recharge:*** Stormwater discharged into a groundwater system can provide benefits, such as reductions in stormwater temperature, before the water enters surface water bodies.

The initial step in designing a water quality treatment approach is determining the requirements of the receiving waters.

Equally important is to select a treatment system based on meeting the requirements over a long period, and if necessary, one that is susceptible to retrofitting if monitoring shows the

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#### **What is Adaptive Stormwater Management?**

Adaptive stormwater management involves monitoring stormwater facilities over time, and adjusting the facilities and/or their management as needed, to ensure they continue to meet their design goals.

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treatment methods are not meeting standards. Though important, adaptive management is difficult because the land area and monetary resources needed to modify facilities often are not available until years in the future after development is completed.

Design concepts that can help reduce specific impacts of the alternatives are described below:

- Displacement of Flows;
- Peak Flows and Geomorphic Instability;
- Low Flows;
- Temperature; and
- Water Quality.

#### **Displacement of Flows**

Routing drainage through a piped system to a large downstream detention facility bypasses, and therefore dries up, streams and wetlands above those systems. This problem can be addressed by building multiple smaller systems with several discharges that more closely mimic natural hydrologic conditions. This strategy can be implemented in conjunction with LID measures that emphasize infiltration and groundwater input prior to detention, as well as infiltration from the detention facilities. Though this approach may not be appropriate for higher elevation portions of the Main Property, appropriate sites are available adjacent to the Lawson Creek wetlands and Jones Lake tributaries. Alternative 2 is currently proposed to discharge a portion of stormwater from Basin A directly to Lawson Creek and to pipe the remaining portion around the upper reaches of Lawson Creek to discharge it equally to the lower reaches of Lawson Creek and to Jones Lake Creek. This could help to alleviate flow displacement and, if used in conjunction with other LID techniques as proposed for Alternative 3, will accomplish much to mitigate the alteration of the area's existing hydrology.

### **Peak Flows and Geomorphic Instability**

The impacts of high volume and long duration stormwater events on receiving streams can be minimized by piping peak runoff to receiving waters that are less sensitive. Ideally, such a strategy would be implemented with dispersed facilities designed to discharge low flows into a variety of infiltration systems and streams.

### **Low Flows**

Infiltration systems used in place of detention facilities, as well as detention facilities that allow for infiltration, limit the tendency of development to reduce summertime stream flows.

### **Temperature**

A variety of methods can be used to reduce the temperature of stormwater runoff, including landscaping and shading of parking areas and streets, employment of infiltration facilities ranging from pervious pavement to biofiltration swales, providing smaller detention ponds with tree shading, providing detention vaults for areas of extensive pavement, and infiltrating runoff both before and after detention. These techniques should especially be considered for stormwater facilities if it is found that stormwater discharges with elevated water temperatures are occurring at the project site post-construction.

### **Water Quality**

Water quality impacts of nutrients can be most effectively addressed by using native plant species in landscaping and/or limiting the use of fertilizers and other chemicals that can become concentrated in runoff. LID practices that infiltrate nutrients into soil encourage uptake of these nutrients by plants and can result in reduction through natural soil processes. For water treatment facilities, proper design and maintenance are essential, as well as adaptive management, to ensure that water quality deficiencies can be identified and corrected. These methods bear special consideration for stormwater discharges to existing eutrophied water bodies like Jones Lake.

## Groundwater Resources

### 1 What groundwater resources are present in the study area?

Two groundwater flow systems are present in the area. The first system is a shallow flow system. It sits atop bedrock and flows through overlying glacially derived materials, generally following the topography of the land surface. This system discharges to Lawson Creek and nearby wetlands and springs. The second groundwater flow system is located within deeper coal seams, underground mines, and fractured bedrock. Infiltration of water into the mines recharges the deeper groundwater flow system. The deeper system discharges at the Lawson Mine drainage spring which is located to the south of the study area. Water from the spring creates a channel that discharges to Jones Lake Creek which flows west to Jones Lake.

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#### Groundwater Analysis

More detailed information on Groundwater Resources can be found in the Golder Associates (2008) report in Technical Appendix D.

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### 2 What policies and regulations apply to groundwater quantity or quality?

At the Federal level, groundwater quality is protected by the Safe Drinking Water Act (SDWA). In the State of Washington, groundwater quality standards have been promulgated from the SDWA and are codified in Chapter 173-200 WAC. The groundwater quality standards set maximum contaminant levels (MCLs) for primary and secondary contaminants for a wide-range of organic, synthetic, mineral, metallic, and radionuclide compounds.

Water rights for the State of Washington are covered under Chapter 173-152 WAC. Rules regarding protection of withdrawal facilities associated with groundwater rights are codified in Chapter 173-150 WAC. Water Conservancy Boards have been established in Washington to deal with water rights issues. These Boards are operated in accordance with Chapter 173-153 WAC. Rules for protection of groundwater in upper aquifer zones, which are primarily used for domestic water sources and light agricultural uses, are found in Chapter 173-154 WAC. Finally, requirements for measuring and reporting the amount of water used in conjunction with allotted water rights are found in Chapter 173-173 WAC.

### **3 How would groundwater resources be affected by the alternatives?**

Any increases in impermeable surfaces (for example, roads, sidewalks, and buildings) will increase runoff from the area and cause a decrease in infiltration and groundwater recharge. All four alternatives involve development in the Lawson Hills area, and, unless mitigated, will increase net surface runoff and decrease groundwater recharge.

#### **Alternative 1**

Alternative 1 includes assumes development of approximately 269 acres of the 371 acre study area by 2025. Because development would occur on individual properties over time, it is not known what the ultimate composition of the buildable land would look like with regard to impervious surfaces created. Therefore, a quantitative calculation of impacts to groundwater recharge is not possible. However, it is possible to make a qualitative assumption regarding groundwater resource impacts.

Given that most of the Lawson Hills study area is currently undeveloped, the development of the Main and North Triangle properties represents a large increase in impervious surface creation and will impact recharge of groundwater resources. As discussed in the Surface Water section, calculations based on land use show that Alternative 1 would create more impervious surface than Alternative 2 (140 acres versus 131 acres, respectively). Since Alternative 1 does not include an open space provision, build out of the study area in accordance with this alternative would likely have greater impacts to the existing hydrological cycle and groundwater flows.

With regard to potential water quality impacts from residential use, the use of fertilizer, pesticides, herbicides, and vehicle parking have the potential to negatively impact groundwater. These impacts can be reduced through on-site stormwater facilities and homeowner best management practices.

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#### **How are groundwater impacts related to the hydrologic cycle?**

Groundwater and surface water are connected via the hydrologic cycle. Impacts to surface water sources could ultimately impact groundwater sources and vice versa. For more information on effects of the alternatives, see Surface Water Sources, Question 6. For more information regarding project impacts to the hydrologic cycle, see Question 7.

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**Alternative 2**

Alternative 2 includes a mix of residential, retail/commercial, office, educational, recreational, and open space uses. This represents a combined development of 233 acres. As discussed in the Surface Water section, the provision of open space in Alternative 2 would preserve much of the existing hydrological cycle in areas that remain forested and would therefore have less impact on groundwater.

The greatest potential for impact to groundwater is in the North Triangle, where the majority of the site will be commercial in nature. Currently, stormwater from the North Triangle flows to the northwest and infiltrates in outwash soils in the northwest corner. If this infiltration is reduced by development, impacts to groundwater and to Ravensdale Creek will occur.

Additionally, the commercial nature of the proposed development includes potential impacts to stormwater from pollution due to automobile parking and from materials used in commercial activities. Treatment and infiltration as described in Appendix M, and in the MPD application, would mitigate these potential impacts.

Another potential source of impact to groundwater in the North Triangle is from the stormwater flows draining from the proposed North Connector. The North Connector will be built along the northwestern edge of the North Triangle. Roadways are potential sources of pollution due to automobile usage and the potential for spillage of hydrocarbons and other materials from vehicle accidents. Stormwater facilities will have to be utilized to limit the potential for impacts from these commercial and transportation activities.

Potential impacts to groundwater quality in the residential portions (the majority of the Main Property) of the Lawson Hills are likely to be similar to those in Alternative 1. However, some LID techniques are proposed that would mitigate for some of this impact. See Chapter 3 for a discussion of what stormwater facilities may be used in the Lawson Hills study area.

### **Alternative 3**

Alternative 3 would result in fewer impacts than either Alternatives 1 and 2, representing a combined development of 185 acres. Alternative 3 will present more opportunities to preserve existing hydrological functions in areas that remain forested, resulting in less impact on groundwater than either Alternatives 1 or 2. The use of LID techniques will further mitigate impacts of development upon the existing hydrological cycle.

### **Alternative 4**

Alternative 4 was created to represent a fiscally balanced scenario, and was not analyzed in detail for impacts to water resources.

## **4 What measures may reduce the effects on groundwater resources?**

Measures to reduce the effects of the proposal on groundwater resources are very similar to those presented in the Surface Water section. A combination of LID technologies provides a good strategy for minimizing and mitigating the effects of development in the area. These include:

### **Preserving Natural Hydrologic Functions**

The LID discussion in the Surface Water section for preserving natural hydrologic functions is entirely applicable to groundwater. Please see that section for details.

### **Mimicking or Enhancing Natural Hydrologic Functions**

Facilities that mimic or enhance natural hydrologic functions of evapotranspiration and infiltration are collectively included in LID techniques.

### **Stormwater Detention and Treatment**

Building multiple smaller detention systems with multiple discharges, using infiltration systems in place of detention facilities and using native species in landscaping will all reduce impacts.