ENVIRONMENTAL ASSESSMENT
SR 520 BRIDGE REPLACEMENT AND HOV PROGRAM

DECEMBER 2009

SR 520, Medina to SR 202: Eastside Transit and HOV Project

Appendix S

Water Resources Discipline Report

Washington State Department of Transportation

U.S. Department of Transportation Federal Highway Administration

SR 520, Medina to SR 202: Eastside Transit and HOV Project Environmental Assessment

Water Resources Discipline Report

Prepared for

Washington State Department of Transportation
Federal Highway Administration

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Acronyms and Abbreviations

ac	acre
BMP	best management practice
CARA	Critical Aquifer Recharge Area
CCDP	concrete containment and disposal plan
cf	cubic feet
CFR	Code of Federal Regulations
cfs	cubic feet per second
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EPM	Environmental Procedures Manual
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GIS	geographic information system
gpm	gallons per minute
HOV	high-occupancy vehicle
HRM	Highway Runoff Manual
mg/L	milligram per liter
NOAA Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
OHWM	ordinary high water mark
PAH	polycyclic aromatic hydrocarbon
PGIS	pollutant-generating impervious surfaces
RCW	Revised Code of Washington

SPCC	spill prevention control and countermeasures
SR	State Route
TDA	Threshold Discharge Area
TESC	temporary erosion and sediment control
TSS	total suspended solids
USC	United States Code
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WRIA	water resource inventory area
WSDOT	Washington State Department of Transportation

Introduction

Why are water resources considered in an Environmental Assessment?

This discipline report uses the phrase "water resources" to refer collectively to surface water bodies (e.g., lakes, rivers, and streams), stormwater, and groundwater. The report is divided into two primary sections:

- Surface water bodies and the project's proposed stormwater treatment facilities
- Groundwater and how the project could affect it

The Clean Water Act (33 United States Code [USC] 1251 et seq.) is the cornerstone of legislation protecting water resources in the United States (U.S. EPA 2004b). Passed in 1972, the Clean Water Act responds to widespread public concern about controlling water pollution and protecting America's water bodies (U.S. EPA 2004a). The goal of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (U.S. EPA 2004b).

The U.S. Environmental Protection Agency (EPA) is the federal agency responsible for implementing and enforcing the Clean Water Act. Regarding the administration of the National Pollutant Discharge Elimination System (NPDES), EPA has delegated its authority and implementation duties to the Washington State Department of Ecology (Ecology). EPA has approved the state Municipal NPDES program, as well as the Pretreatment and General Permits programs. Ecology is responsible for managing and protecting Washington's water resources. In doing so, Ecology has adopted laws that regulate the concentrations of toxic substances allowed in stormwater and surface water bodies. Ecology has also developed manuals detailing approved stormwater treatment and detention procedures.

In addition to the state, the cities and towns in the study area have jurisdiction over water resources, wetlands, and critical areas in the project vicinity. The Washington State Department of Fish and Wildlife; the National Oceanic and Atmospheric Administration, National

What are "water resources"?
As used in this report, the phrase "water resources" refers collectively to surface water bodies (e.g., lakes and streams), stormwater, and groundwater. When the issue under consideration applies to only one element, "surface water body," "stormwater," or "groundwater" is used to identify the specific resource.

Surface water bodies include lakes, streams, ponds, and wetlands.

Stormwater includes storm-water runoff, snowmelt runoff, and surface runoff and drainage [40 Code of Federal Regulations (CFR) 122.26(b)(13)]. Drainage can flow across the ground in open ditches, in pipes, or below the surface as interflow.

Groundwater is water found underground in the saturated zone. The saturated zone is the layer of soil that is soaked or loaded to capacity with water.

Marine Fisheries Service (NOAA Fisheries); and the U.S. Fish and Wildlife Service also have jurisdiction over water quality as it applies to protecting wetlands and fish and wildlife resources.

Exhibit 1 lists the agencies responsible for protecting surface water resources, describes the policies and regulations these agencies follow, and explains the purpose of the policies. Groundwater regulations are discussed in the *Groundwater* section of this report.

Exhibit 1. **Agencies that Regulate and Manage Surface Water in the Study Area and Their Policies**

Agency/ Organization	Policies/Regulations	Purpose/Intent
Ecology	Clean Water Act (33 USC 1251 et seq.)	Establishes the basic structure for regulating discharges of pollutants to receiving waters.
	Water Quality Standards for Surface Waters of the State of Washington (Washington Administrative Code [WAC] 173-201a-240)	Sets goals for a water body by designating beneficial uses and assigning water quality criteria to protect those uses.
	Stormwater Management Manual for Western Washington (Ecology 2005)	Provides technical standards and guidance on storm-water management measures to control quantity and quality of stormwater produced by new development and redevelopment.
Washington State Department of Transportation (WSDOT)	Puget Sound Highway Runoff Program (WAC 173-270)	Establishes procedures and water quality criteria for WSDOT's highway runoff program.
	Highway Runoff Manual (WSDOT 2008a)	Directs the planning and design of storm-water management facilities for new and redeveloped Washington state highways and other facilities. Directs the planning and design of storm-water control measures during construction. WSDOT's *Highway Runoff Manual* is considered equivalent to Ecology's *Stormwater Management Manual for Western Washington*.
	Environmental Procedures Manual (WSDOT 2008b)	Provides guidelines for complying with federal and state environmental laws and regulations for all phases of project delivery.
Medina, Hunts Point, Clyde Hill, Yarrow Point, Kirkland, and Bellevue	City and county critical or sensitive area ordinances that establish allowed uses, mitigation standards, and buffers for streams and lakes	Establishes policies and development guidelines to protect the functions and values of critical areas. All cities and counties in Washington are required by the Growth Management Act to adopt critical area regulations (Revised Code of Washington [RCW] 36.70A.060).
Medina, Hunts Point, Clyde Hill, Yarrow Point, Kirkland, and Bellevue	City and county shoreline management programs that establish allowed uses and buffer/setback requirements for regulated waterways	Establishes policies and development guidelines to protect the functions and values of shoreline areas. All cities and counties in Washington are required by the Shoreline Management Act to enact shoreline management programs (Revised Code of Washington [RCW] 90.58).

What is the project?

The Washington State Department of Transportation (WSDOT) is proposing to construct the SR 520, Medina to SR 202: Eastside Transit and HOV Project to reduce transit and high-occupancy vehicle (HOV) travel times and to enhance travel time reliability, mobility, access, and safety for transit and HOVs in rapidly growing areas along the State Route (SR) 520 corridor east of Lake Washington. Exhibit 2 shows the project vicinity. Some of the improvements included in this project were originally part of the SR 520 Bridge and HOV Project. On June 18, 2008, the Federal Highway Administration (FHWA) authorized WSDOT to develop the SR 520, Medina to SR 202: Eastside Transit and HOV Project as an independent project. The project includes building a complete HOV system between Lake Washington and 108th Avenue NE and restriping the existing HOV lanes from the outside lanes to the inside lanes between the 108th Avenue NE interchange and SR 202 in Redmond.

The portion of the project between Evergreen Point Road and 108th Avenue NE was previously part of the SR 520 Bridge Replacement and HOV Project. The SR 520, Medina to SR 202: Eastside Transit and HOV Project has been an independent project to address needs specific to the portion of SR 520 east of Lake Washington. The project limits extend approximately 8.8 miles along SR 520 from the east shore of Lake Washington (vicinity of Evergreen Point Road) to the interchange with SR 202 in Redmond.

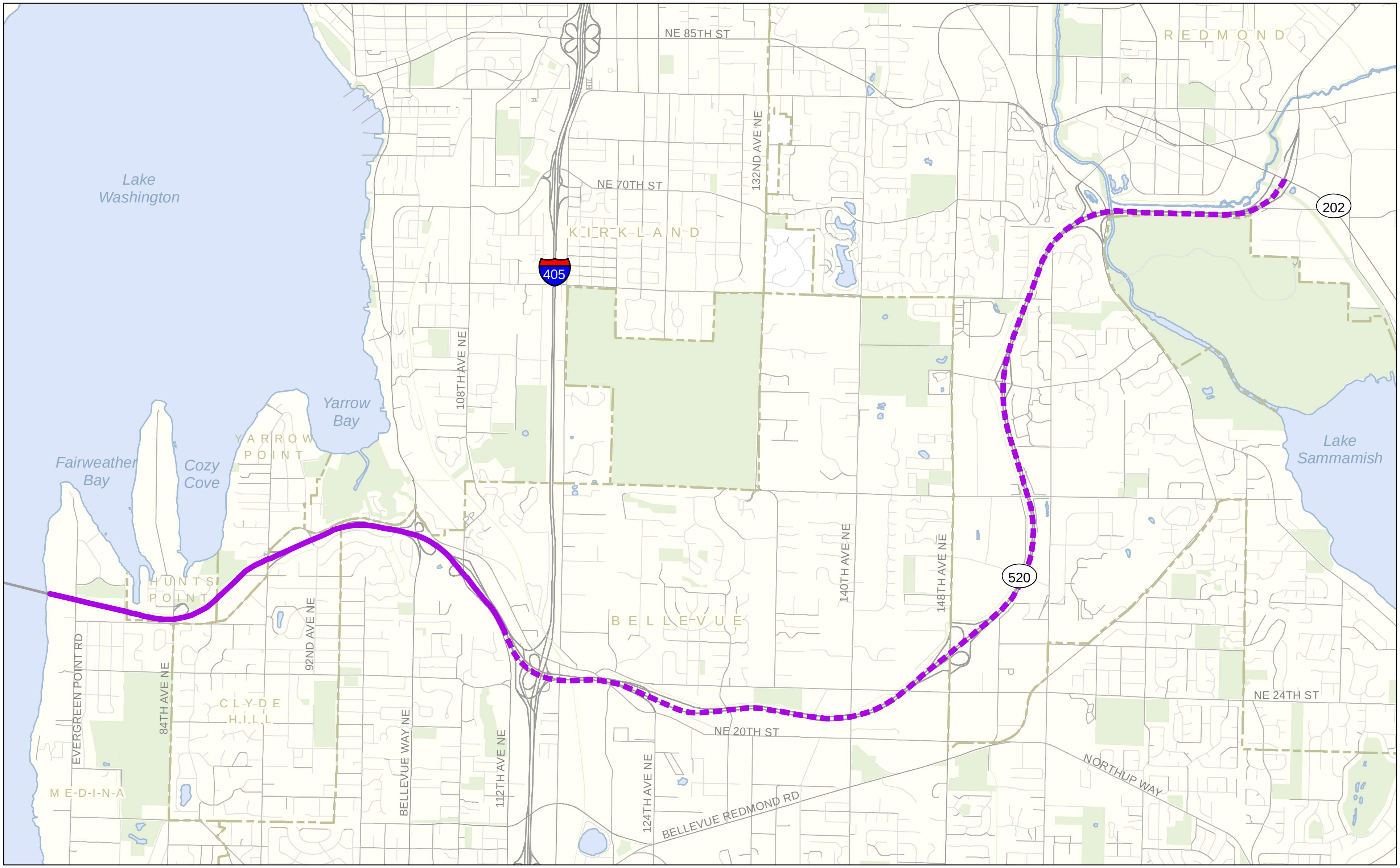
WSDOT is considering two alternatives for the project: the Build Alternative and the No Build Alternative.

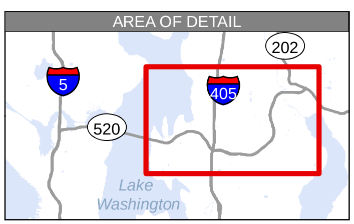
Build Alternative

Under the Build Alternative, the proposed project would include the improvements described below.

SR 520 Improvements from Lake Washington to I-405

The proposed project would reconstruct SR 520 from just west of Evergreen Point Road to just east of 108th Avenue NE. Elements constructed as part of this section include the following:





Construction Extent

Restriping Extent

Park

City Limits

N

0 0.5 1 Miles

Source: King County (2008) GIS Data (Streams, Streets, Water Bodies), CH2M HILL (2008) GIS Data (Parks). Horizontal datum for all layers is NAD83(91), vertical datum for layers is NAVD88.

Exhibit 2. **Project Vicinity**

Medina to SR 202: Eastside Transit and HOV Project

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- Construct a new eastbound HOV lane from Lake Washington to the existing eastbound HOV lane west of the I-405 interchange. This improvement would complete the currently discontinuous HOV network on the Eastside and improve travel time reliability for buses and carpools.
- Relocate the existing westbound HOV lane from the outside lane to the inside lane from Lake Washington to I-405. This change would enhance safety by eliminating the need for merging vehicles to weave across the faster-moving HOV lanes to reach the general-purpose lanes.
- Construct a lid with inside transit stop over SR 520 at Evergreen Point Road.
- Construct a new lid and modify the existing half-diamond interchange at 84th Avenue NE.
- Construct a new lid with inside transit stop over SR 520 at 92nd Avenue NE and modify the existing interchange.
- Reconfigure the existing interchange at Bellevue Way NE.
- Construct new HOV direct access ramps at 108th Avenue NE. This improvement would create a more efficient connection for transit and HOV from SR 520 to the South Kirkland Park-and-Ride via local streets.
- Add a bike/pedestrian path from Lake Washington to approximately 108th Avenue NE. This improvement would facilitate nonmotorized use of SR 520, provide transit connections for bikes and pedestrians, and complement the existing nonmotorized transportation network on the Eastside.

What is a lid?

The term "lid" is short for "lidded highway". Lids are long bridges that cover a length of highway. Lid surface areas can carry paths and trails to connect communities across the highway, landscaping to create open space and places for passive recreation, and items such as pergolas, seating, and transit waiting areas.

SR 520 Improvements from I-405 to SR 202

- Restripe existing eastbound and westbound HOV lanes from the outside to the inside lane. This change would enhance safety by eliminating the need for merging vehicles to weave across the faster-moving HOV lanes to reach the general-purpose lanes.

Other Improvements

- Provide noise walls between Evergreen Point Road and Bellevue Way NE.

- Provide retaining walls and stormwater management system improvements.
- Improve stream habitat by realigning portions of the Yarrow Creek channel and shortening some culverts.
- Improve fish passage culvert crossings to restore fish passage and open up habitat that was previously inaccessible to salmon and other fish species.
- Mitigate the project's effects on wetlands and streams at a site or sites as determined through future negotiations with permitting agencies.

No Build Alternative

Under the No Build Alternative, the project would not be built. Only routine maintenance, repair, and minor safety improvements would take place on SR 520 in the study area over the next 20 years. The No Build Alternative would not improve transit reliability and transit and HOV travel times on SR 520. Also included in the No Build Alternative for traffic modeling purposes is the assumption that the SR 520, Bridge Replacement and HOV Project would not be built until this project is complete.

WSDOT is evaluating the No Build Alternative to provide a reference point for comparing the effects, both positive and negative, associated with the proposed project.

What are the key points of this report?

When State Route (SR) 520 was constructed stormwater treatment and flow was not required. As a result, most of the stormwater from SR 520 today is not discharged. Stormwater would continue to be discharged without treatment or flow control under the No Build Alternative. Conversely, stormwater would be treated and flows controlled (as required) for the Build Alternative.

The No Build Alternative would maintain existing conditions. Untreated pollutants carried in stormwater from SR 520 pavement would continue to be discharged to surface water bodies.

The Build Alternative would increase the amount of land covered by pollutant-generating impervious surface (PGIS) in the study area.

However, by applying storm-water treatment and flow control in this design, the Build Alternative would meet state and federal water quality regulations. In general, the Build Alternative would either not change existing pollutant loads or would reduce them compared with existing levels because stormwater would be treated prior to discharge. Although pollutant loading would be reduced overall in the study area, the Build Alternative would increase loadings of some kinds of pollutants (e.g., total suspended solids [TSS], total and dissolved metals, and hydrocarbons) in specific subbasins compared with the No Build Alternative.

The Build Alternative would also affect storm-water discharge rates. Flow control would be included in storm-water treatment facilities discharging to project streams. Examples of flow control in this project would be the use of constructed wetlands. Reducing discharge flow rates should minimize the effect of the Build Alternative on the physical characteristics of study area streams. Temporary water quality effects during construction of the Build Alternative would be avoided or minimized through the development and implementation of required erosion control plans, spill control plans, and permit conditions. These plans and permits regulate construction activities on land and in the water to prevent or limit water quality effects.

Effects on groundwater during project operation would be negligible. The Build Alternative would increase PGIS in the study area; however, this increase would not cause a detectable change to groundwater recharge. The increased impervious surface associated with the Build Alternative would have minimal or no effect on groundwater recharge because increases would be small (much less than 1 percent) relative to the entire drainage area's pervious surface's contribution to groundwater recharge.

Additionally, effects on groundwater used for drinking water purposes would be negligible because use of groundwater for drinking water is very limited in the study area. There is one small well that is used by four households for drinking water. It is located within 500 feet and upgradient of the study area. In addition, 23 wells are listed within 1 mile of the study area. The current condition, uses, or existence of these wells are unknown. If these wells still exist, they are most likely not used for drinking water because they are located in areas served by municipal drinking water systems.

Groundwater levels might need to be temporarily lowered in some areas during construction so that some structures could be built in dry conditions. This dewatering could temporarily alter the groundwater flow direction or the volume of groundwater discharge to surface water; however, these effects would be temporary and localized. Water generated during dewatering would be stored either in temporary treatment ponds or in portable steel tanks. Water would be stored for a sufficient amount of time to allow particles to settle, or chemical flocculants could be used to reduce suspended particles before the water was discharged to the storm-water system. Additionally, temporary effects to groundwater used for drinking water purposes in the study area would be negligible because use of groundwater for drinking water is very limited in the study area. However, some homeowners along Fairweather Bay appear to have water rights and withdraw water from the lake for irrigation and perhaps other purposes.

There would be no need to further mitigate or compensate for long-term project effects because all regulatory requirements to address negative effects would be included in the design of the Build Alternative. Construction effects would be avoided or minimized by implementing erosion control plans and spill control plans, and by meeting established permit conditions.

Affected Environment

How was the information collected?

The water resources analysts identified surface water resources in the study area by collecting and reviewing maps and government reports. They combined several maps using geographic information system (GIS) software to create a single project base map that incorporated the following data:

- Streams
- Lakes
- Wetlands
- Wetland buffers

- Soil types
- Floodplains
- Floodways
- Culverts
- Subbasin and watershed boundaries

The analysts also consulted with various state and local agencies to obtain other important information about study area surface water resources and stormwater. Local agencies identified existing flooding problems in the study area. Water quality information came from Ecology's 303(d) list and Washington's Water Quality Assessment Report (also called the 305[b] Report).

WSDOT provided information about the existing storm-water system on SR 520. The water resources analysts consulted with project team members, WSDOT, and other agencies to obtain information about hazardous materials, edges of existing pavement lines, and the quantity and quality of treated stormwater from the existing highway within the study area.

What is the Ecology 303(d) list?

The 303(d) list identifies surface water body segments (lakes, streams, and ponds) with degraded water quality. Ecology assembles available water quality data and publishes this list, as required under Section 303(d) of the federal Clean Water Act (40 CFR 130.7, as revised July 1, 2003).

What is the Ecology 305(b) Report?

Ecology prepares the Section 305(b) Report to inform the U.S. Congress and the public about the current condition of the state's waters. This report describes the status of *all* waters in the state, while the 303(d) list reports only the *impaired* waters in the state.

What surface water bodies are present in the study area?

Surface water bodies in the study area include the following:

- Lake Washington
- Fairweather Creek
- Cozy Cove Creek
- Yarrow Creek (including the east and west tributaries)

These water bodies are located in developed suburban areas where impervious surfaces cover 30 to 33 percent of the stream basins. Water flows through the study area via several pathways (Exhibit 3):

- In surface water bodies such as streams, ponds, wetlands, and lakes.
- Across the surface as storm-water runoff, where it flows directly to surface water bodies, or is conveyed to surface

How does impervious surface affect surface water resources?

Impervious surfaces such as rooftops, sidewalks, roads, parking lots, and compacted urban soils prevent rain from infiltrating soils as it would naturally. These barriers shift more water into creeks and lakes, and can increase the transport of pollutants from land to adjoining surface waters.

How do state agencies regulate increases in impervious surface?

Current state regulations require new and redeveloping construction projects to treat stormwater and sometimes control the flow of stormwater from existing and new impervious surfaces.

water bodies in open ditches or drainage pipes, or infiltrates and enters the groundwater table.

- Below ground in soil and/or in the groundwater.

Although surface water bodies, stormwater, and groundwater are typically managed and regulated independently, they are interconnected and interdependent. Exhibit 3 shows how stormwater can move between surface water bodies, how runoff can percolate into soil and become groundwater, and how groundwater can move between surface water bodies.

While the entire project site includes sections of SR 520 east of Bellevue Way NE, the water bodies adjacent to this section of the roadway were not included in the study area. There would be no change to water quality effects between the No Build and Build Alternatives because the only project action in this section of the project site would be the restriping of existing roadway surfaces, and there would be no increase of impervious surface.

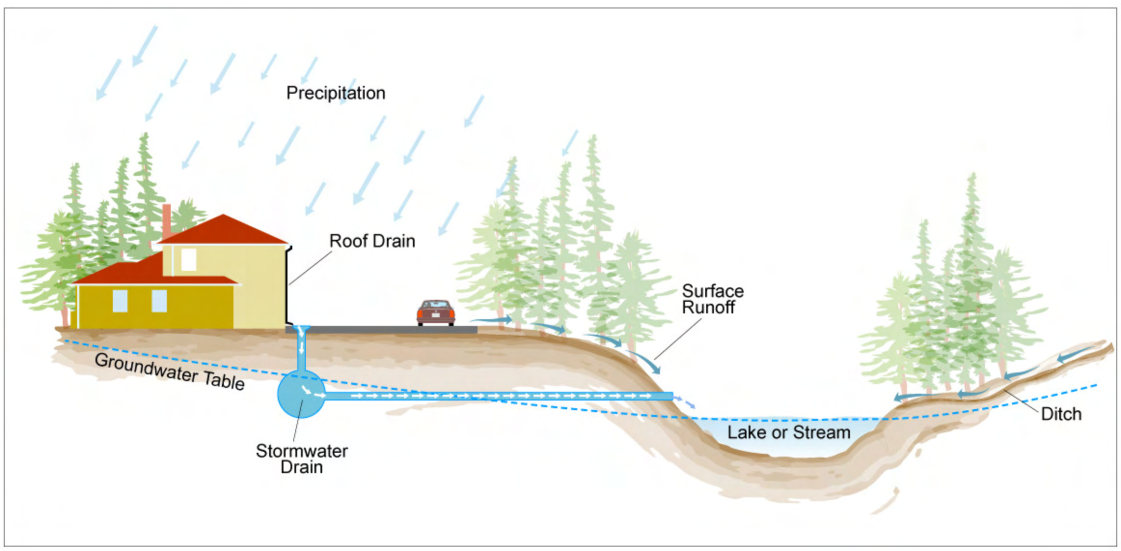


Exhibit 3. **Pathways for Water Moving through the Study Area**

General Background Information

The study area is located entirely in water resource inventory area 8 (WRIA 8) (Exhibit 4), the most heavily developed of the 15 WRIAs directly bordering Puget Sound. As shown in Exhibit 4, WRIA 8 is divided into two watersheds: (1) Lake Washington/Cedar and (2) Sammamish. The study area lies within the Lake Washington/Cedar watershed, the more highly developed of the two watersheds. These two watersheds are further divided into a number of smaller basins (see Exhibit 4).

The study area contains both urbanized and suburban areas. Exhibit 5 shows the developed and undeveloped areas located within WRIA 8. Urbanization overlays the natural landscape with impervious surfaces made up of sidewalks, streets, parking lots, and buildings. These impervious surfaces prevent rain from percolating into the ground and altering the distribution and movement of surface water and groundwater.

Urbanization and its associated impervious surfaces alter water flows in a watershed by:

- Lowering stream summer minimum flows (known as base flows)
- Raising stream winter maximum flows (known as peak flows)
- Lowering groundwater levels

Urbanization can also lead to more rapid increases and decreases (termed "flashiness") in stream flow rates and the frequency and extent of flooding when it rains. Researchers have documented a decline in the quality of aquatic habitat in urban streams. Degraded aquatic habitats have been associated with a decline in the numbers and types of fish and invertebrates in these streams (Booth 1989; Booth and Jackson 1997; Karr and Chu 1999; Kleindl 1995). When the flow of water is modified by increases in impervious surface, the results are as follows:

- Changed streamside conditions (such as increased stream bank erosion and loss of riparian vegetation, which shades streams and helps to filter out storm-water pollutants)
- Reduced structural complexity and stability of stream channels

New impervious surface can further affect water resources by accumulating and retaining pollutants, which can then be transported by storm-water runoff to surface water bodies and to groundwater. Various pollutants and sources are present in both urban and suburban areas, such as sediments from development and new construction; oil, grease, and chemicals from vehicles; nutrients and pesticides from turf management and gardening; viruses and bacteria from failing septic systems; road salts; and heavy metals from automobile tire and brake wear (U.S. EPA

Pollutant-Generating Impervious Surfaces (PGIS) are impervious surfaces that are a source of pollutants in storm-water runoff. Study area PGIS includes roadways that receive direct rainfall or the run-on or blow-in of rainfall.

While the study area includes a minor amount of existing driveways and small parking lots, only high traffic PGIS was evaluated in the water quality analyses reported here.

2004d). Sediments and solids constitute the largest volume of pollutant loads to receiving waters in urban areas. Impervious surfaces that accumulate and retain pollutants are called PGIS. PGIS can adversely affect the quality of water resources because of the following:

- Increased fertilizer amounts that lower dissolved oxygen levels in water bodies
- Increased turbidity that limits algal productivity and harms fish and aquatic insects
- Increased levels of metals, pesticides, and oil and greases that harm fish, aquatic insects, and algae
- Increased sickness in people who swim and boat in these areas, due to increased levels of bacteria and viruses

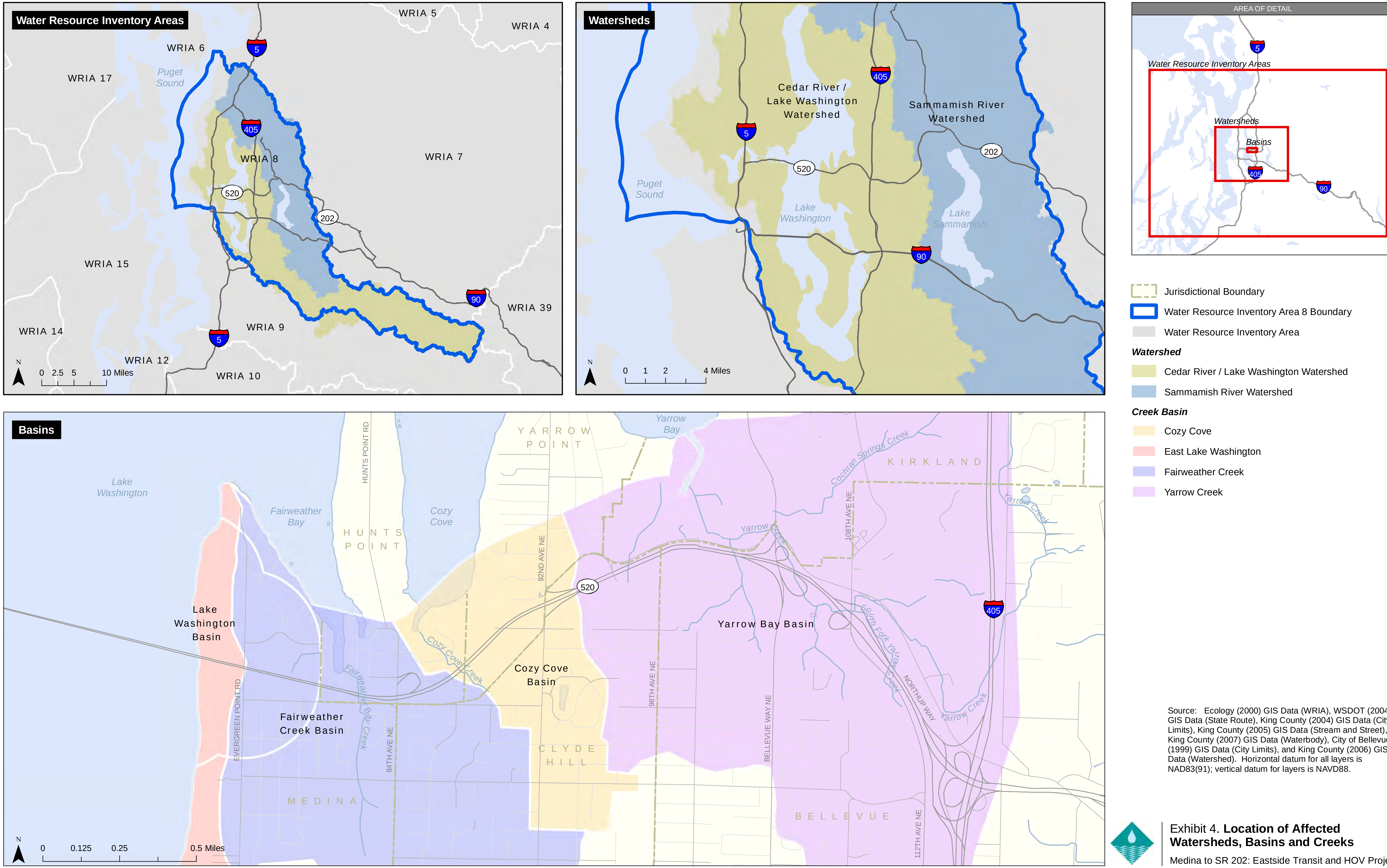
Automobile, truck, and bus traffic traveling on SR 520 impervious surfaces would likely generate only a small subset of this list of potential storm-water constituents. Vehicles are sources of metal (e.g., copper, zinc, and cadmium from brake and tire wear), hydrocarbons (e.g., oil and grease from leaky engines and polycyclic aromatic hydrocarbons [PAHs] from engine exhaust), and TSS (from dirt on car exteriors and tires, and brake and tire wear particles).

Project Surface Water Bodies

Project surface water bodies potentially affected by the project include the shoreline of Lake Washington under the east high rise, Fairweather Bay (part of Lake Washington), and the following streams (Exhibit 4):

- Fairweather Creek
- Cozy Cove Creek
- Yarrow Creek (includes West and East Tributaries of Yarrow Bay)

As shown in Exhibit 6, 30 to 33 percent of the project basins are covered by impervious surfaces. Exhibit 7 lists how much total impervious surface is located within each of the project basins and the total amount of impervious surfaces associated with the project.



Source: Ecology (2000) GIS Data (WRIA), WSDOT (2004) GIS Data (State Route), King County (2004) GIS Data (City Limits), King County (2005) GIS Data (Stream and Street), King County (2007) GIS Data (Waterbody), City of Bellevue (1999) GIS Data (City Limits), and King County (2006) GIS Data (Watershed). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 4. **Location of Affected Watersheds, Basins and Creeks**

Medina to SR 202: Eastside Transit and HOV Project

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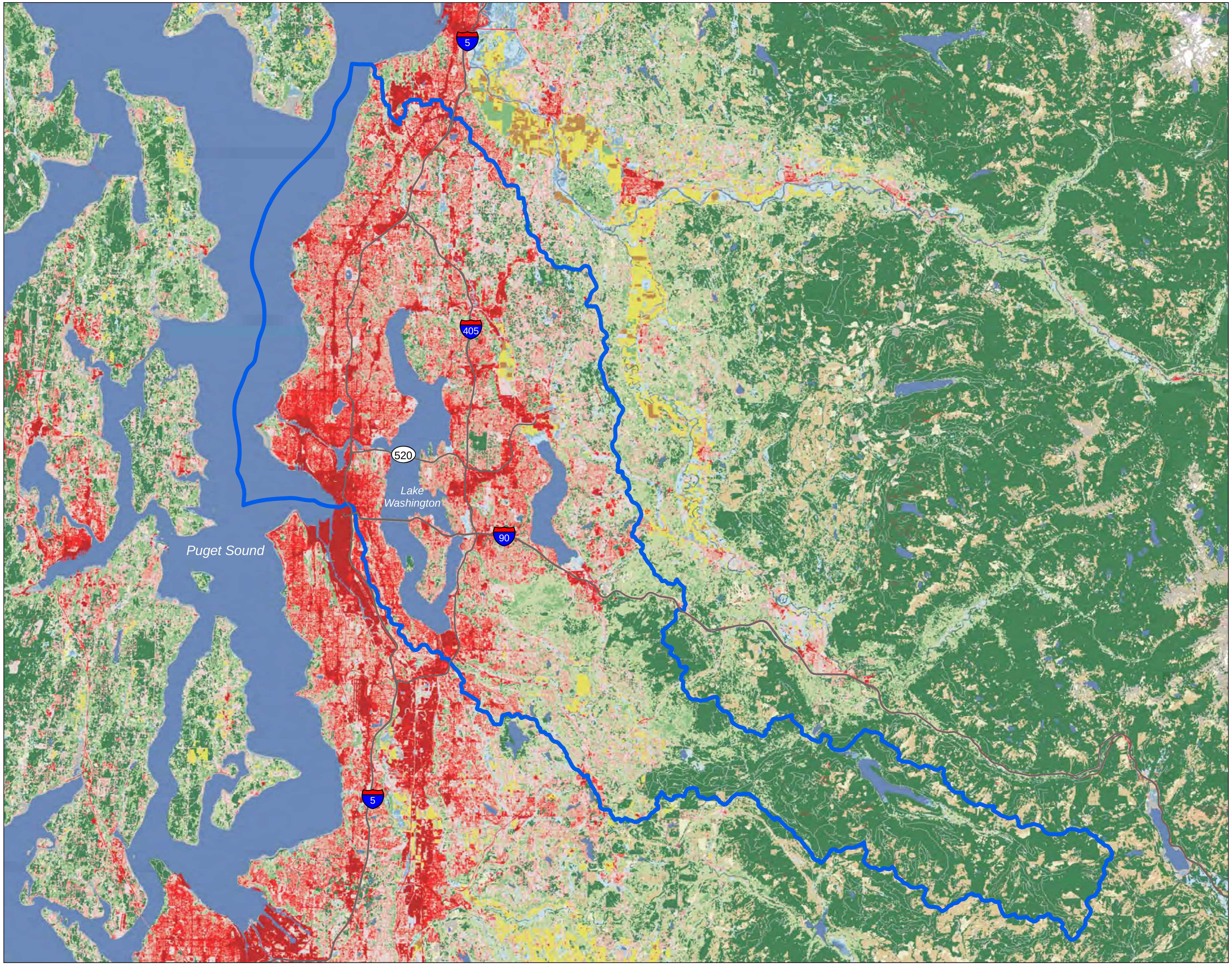
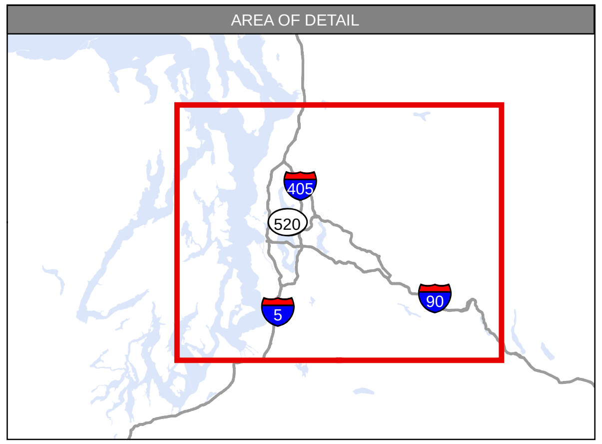
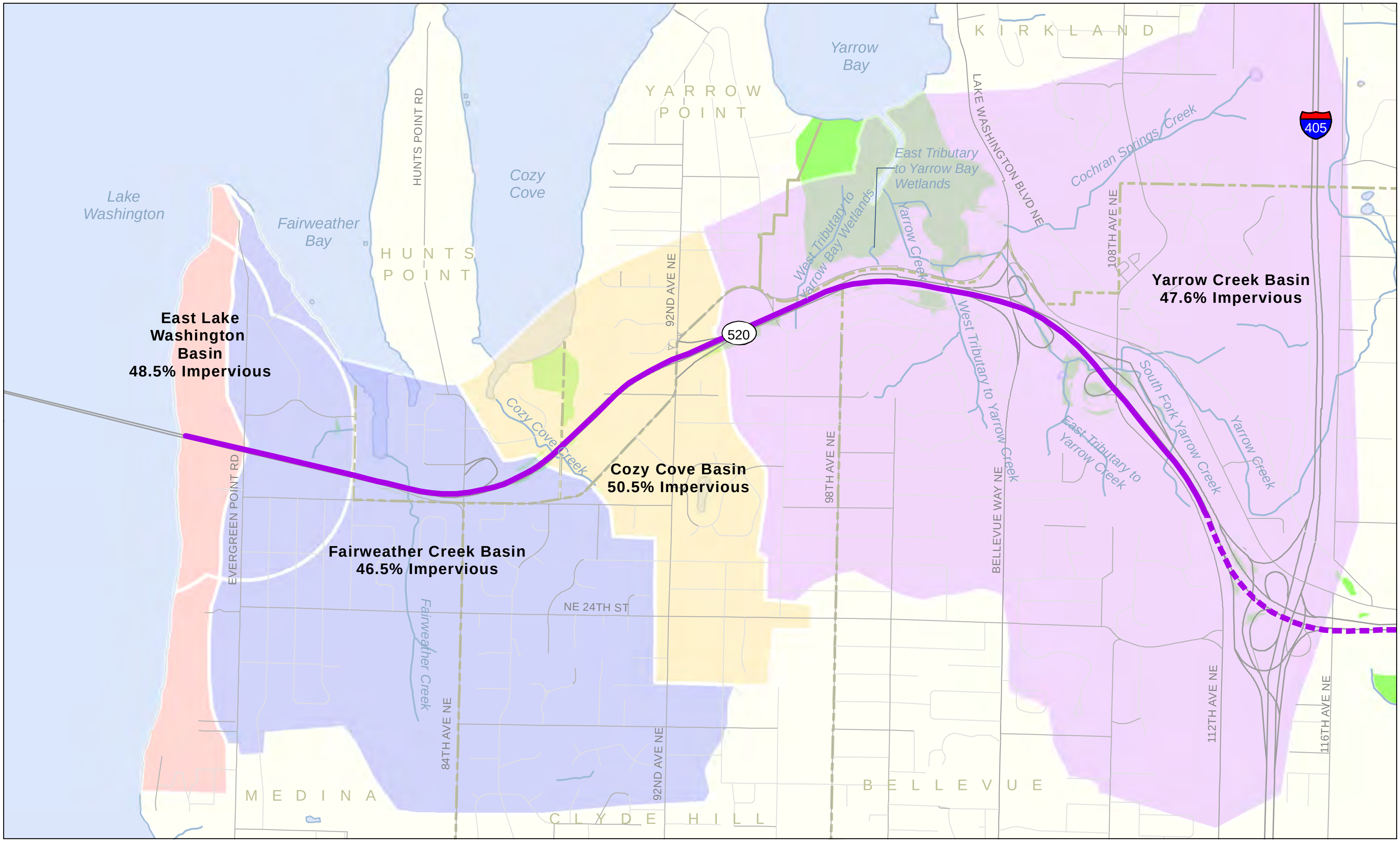


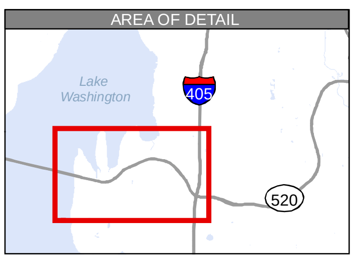


Source: USGS (2003) National Land Cover, Geology (2000) GIS Data (WRIA), and WSDOT (2004) GIS Data (State Route). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 5. **Land Cover**

Medina to SR 202: Eastside Transit and HOV Project





Construction Extent
Restriping Extent
Stream
Wetland
City Limits

N
0 500 1,000 2,000 Feet

Source: City of Bellevue (1999) GIS Data (City Limits), King County (2004) GIS Data (Stream), King County (2005) GIS Data (Street), King County (2007) GIS Data (Waterbody), and King County (2008) GIS Data (Stream). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 6. **Percent Impervious Surface in Study Area Basins**

Medina to SR 202: Eastside Transit and HOV Project

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Exhibit 7. **Basin and Total Impervious Surface Area on the Eastside**

Basin	Total Basin (acre)	Current Basin Impervious Surface (acre)	Existing SR 520 Impervious Surface (acre)	Current Basin-Wide Percent Impervious Surface
Fairweather Creek	548.0	165.5	12.3	30.2%
Cozy Cove Creek	189.1	58.6	8.4	31.0%
Yarrow Creek	1,427.7	471.2	26.1	33.0%

Note: The Lake Washington basin has been excluded from this analysis because it encompasses the entire shoreline of the lake, which is not affected by changes in flow associated with increases in impervious surfaces. As such, there is no need to consider any increases in impervious surface in this basin associated with the project.

Lake Washington

Lake Washington is the largest of the three major lakes in King County and is located within the watersheds drained by Issaquah Creek, the Sammamish River, and the Cedar River, referred to as the Cedar-Sammamish Watershed basin, or WRIA 8. The basin of Lake Washington is a deep, narrow, glacial trough with steeply sloping sides, sculpted by the Vashon ice sheet, which is the last continental glacier to move through the Seattle area.

Fairweather Creek (Fairweather Creek Basin)

Fairweather Creek drains a small, urban, single-family residential basin (approximately 548 acres) that discharges north into Fairweather Bay, which is part of Lake Washington (Exhibit 4). The 1.4-mile-long stream is rock-lined in places and its banks are nearly vertical (4 to 6 feet high and higher) for much of its length (Anderson et al. 2001). The stream originates at the Overlake Golf Course ponds where drainage from the Medina and Clyde Hill communities is collected. These ponds function as storm-water flow control facilities that reduce flooding downstream. Beginning at the golf course ponds, Fairweather Creek passes through four culverts (including one under SR 520) before entering Lake Washington at Fairweather Bay.

It is estimated that flow rates in Fairweather Creek reach 47 cubic feet per second (cfs) under existing basin conditions (Parametrix, Inc. 2008) during a 2-year storm event. By comparison, the historical, predevelopment 2-year flow was estimated to be 15 cfs (Anderson et al. 2001). This tripling of the 2-year storm event peak flow in Fairweather Creek is a consequence of the extensive development that has occurred in the upper portions of this basin, as well as engineering practices in the stream (e.g., lining with rocks).

The time interval between major storms is used as a reference for the volume of runoff. A **2-year storm** is a storm that has a 50 percent chance of occurring in any given year.

The extensive development has likely reduced the overall habitat quality of Fairweather Creek for the aquatic community.

Cozy Cove Creek (Cozy Cove Creek Basin)

Cozy Cove Creek is a short, small stream (approximately 0.4 mile long) that drains from Clyde Hill through Hunts Point north into Cozy Cove, which is part of Lake Washington near Hunts Point (Exhibit 4). The stream flows through single-family residential neighborhoods, with landscaped lawns immediately adjacent to the stream. The stream crosses under SR 520 and continues approximately 1,000 feet north before entering the cove.

The water resources analysts did not find any information documenting the effects of basin urbanization on Cozy Cove Creek flow rates or aquatic habitat quality. Based on the level of basin development, however, they assumed that the stream hydrology would be comparable to other similarly sized urban streams in the Puget Sound lowland basins (Booth 1989; Booth and Jackson 1997). This determination means that current peak flows for Cozy Cove Creek would be higher than predevelopment levels. Information in the Clyde Hill *Comprehensive Plan* (City of Clyde Hill 2002) identified Lake Aqua Vista as a storm-water detention pond and headwaters for Cozy Cove Creek.

West Tributary of Yarrow Bay (Yarrow Bay Basin)

The West Tributary of Yarrow Bay originates from storm drainage in Clyde Hill, crosses under SR 520, flows 0.6 mile down a steep, wooded ravine, and discharges into the Yarrow Bay wetlands (Exhibit 4).

The water resources analysts did not find any information documenting the effects of basin urbanization on flow rates or aquatic habitat quality for this unnamed tributary. As stated above for Cozy Cove Creek, they assumed that the current peak flows for this unnamed tributary to Yarrow Bay would be higher than predevelopment levels because of the extensive amount of development in the basin.

Yarrow Creek (located in the Yarrow Bay Basin)

Yarrow Creek is approximately 3.5 miles long. This stream originates in Bridle Trails State Park and the surrounding single-family residential area. The stream, which drains approximately 1,428 acres, flows south along the I-405 corridor (Exhibit 4). In the study area, the stream flows in roadside ditches along Northup Way (northern SR 520 frontage road) and at two locations under SR 520 in culverts. A portion of the stream flows through an open channel located in the cloverleaf interchange located at the Lake Washington Boulevard off-ramp. From its headwaters to the mouth, Yarrow Creek crosses several municipal boundaries including Yarrow Point, Kirkland, and Bellevue. Cochran Springs Creek, a small tributary located in this watershed, originates west of I-405 in a small wetland and flows west through the Yarrow Bay wetland complex into Yarrow Creek just upstream of the mouth.

Development in the upper watershed is primarily single-family residential. As the stream crosses under I-405 into the middle watershed, land use is dominated by commercial facilities. The lower watershed contains multi-family residential housing and the Yarrow Bay wetlands.

The water resources analysts did not find any studies reporting discharge rates for this stream. As with the other basins, they assumed that the current peak flows for Yarrow Creek would likely be higher than predevelopment levels because of the extensive amount of development in the basin.

Project Floodplains

The Federal Emergency Management Agency (FEMA) flood rate insurance map for the study area does not show any 100-year floodplains associated with Fairweather Creek or Cozy Cove Creek. Fairweather Creek and its historical floodplain are currently disconnected because the stream is confined by high, steep banks along much of its length (Anderson et al. 2001).

The **100-year floodplain** is the area that would be inundated by a flood having a 1 percent chance of occurring in any given year.

The FEMA flood insurance rate map for Yarrow Creek shows no floodplains for the section of stream located in the study area. This same map shows 100-year floodplains associated with the upper reaches of Yarrow Creek between I-405 and NE 39th Street and at the mouth of Yarrow Creek, where numerous small, unnamed streams drain into Lake Washington. The area around the mouth of Yarrow Creek has also been identified as a wetland (see the Ecosystems Discipline Report [WSDOT 2009a] for more information).

What are the existing water resources characteristics of the study area?

In general, the overall quality of surface water bodies in the study area is listed by Ecology as impaired because of high temperatures and bacterial contamination[1]. The sections below present the specific types of impairment by surface water body.

Project Surface Water Quality

Lake Washington

On the recently approved 2009 Water Quality Impairment List (the 303(d) list), Lake Washington was listed in a number of areas as impaired for surface water and sediment quality. However, in the study area vicinity, Lake Washington was identified as exceeding water quality for fecal coliform only in a section adjacent to and just north of Hunts Point.

Fairweather Creek

Ecology placed Fairweather Creek on the 303(d) list because the stream exceeds the fecal coliform, dissolved oxygen, and temperature water quality criteria (Ecology 2009). This same listing identified pH in Fairweather Creek as meeting water quality standards (a 303(d) listing of Category 1). Metro sampled water quality in 1988 and between 1990 and 1993. The sampling showed that high temperature violations occurred during the summer low-flow months when the stream was nearly dry (King County 1994). Metro also measured fecal coliform and dissolved oxygen to determine if concentrations exceeded water quality criteria (Metro 1989), as well as elevated levels of copper, zinc, and nickel in sediments located at the mouth of the stream (King County 1994).

A study by The Watershed Company also determined water quality to be impaired in Fairweather Creek during the summer (the study was limited to the summer). Ammonia levels exceeded the state standard. For salmon, the creek’s manganese and iron levels were unacceptably high, dissolved oxygen levels were marginal to low, and temperature levels were higher than ideal during summer low flows but acceptable during summer high flows. The Watershed Company also noted a lack

[1] Highways are not major contributions of fecal coliforms to stormwater.

of stream shading and stream channel complexity, and a prevalence of nonnative and invasive vegetation along the stream corridor (Anderson et al. 2001). Potential storm-water pollutant sources in this basin, in addition to SR 520, include single-family residential neighborhoods, a golf course, and local roads.

Cozy Cove Creek

Little is known about the water quality of Cozy Cove Creek because this stream was not rated in the 303(d) water quality classification system. Single-family residential development has affected Cozy Cove Creek, which has been channelized and contained within riprapped banks. The stream receives runoff from landscaped lawns, single-family residential streets, and SR 520.

The banks of channelized streams are frequently "riprapped." **Riprap** is a lining of large stones and boulders intended to reduce undercutting and stabilize stream banks. Riprap reduces the habitat complexity of the stream channel and confines it, which increases the velocity of the stream flow. Increased stream flow velocity causes erosion and scouring. Riprapping stream banks can adversely affect juvenile salmon.

Forested riparian corridors provide shade to adjacent creeks, lowering stream temperatures compared with similar unshaded streams. Riparian vegetation also acts to clean stormwater, lowering pollutant concentrations discharged to streams and lakes.

Yarrow Creek

Yarrow Creek is on the Ecology 303(d) list because it exceeds the dissolved oxygen and fecal coliform water quality criteria (Ecology 2009). Between 1990 and 1993, Metro measured high nitrate concentrations (associated with the use of fertilizers) in this stream (King County 1994). Metro also measured two exceedances of the fecal coliform water quality criterion between 1988 and 1989, as well as high levels of nitrate, nickel, chromium, and lead (Metro 1989). Sources of metals in the runoff from this basin are primarily single-family residential neighborhoods and roads, while fecal coliform sources include manure from pets, horses, and cattle upstream of I-405 near Bridle Trails State Park.

How is stormwater managed in the study area?

Overall, stormwater is managed in the study area as follows:

- Most storm-water runoff discharged from SR 520 is not treated before it is discharged. Basic water quality treatment is provided to stormwater discharging from the SR 520 roadway in the Yarrow Bay basin. Between 92nd Avenue NE and 108th Avenue NE, the SR 520 drainage system consists of ditches, storm drains, and bioretention swales that discharge to Yarrow Creek and its tributaries (Exhibit 4). Two bioswales, one on either side of SR 520, provide basic water quality treatment for stormwater.

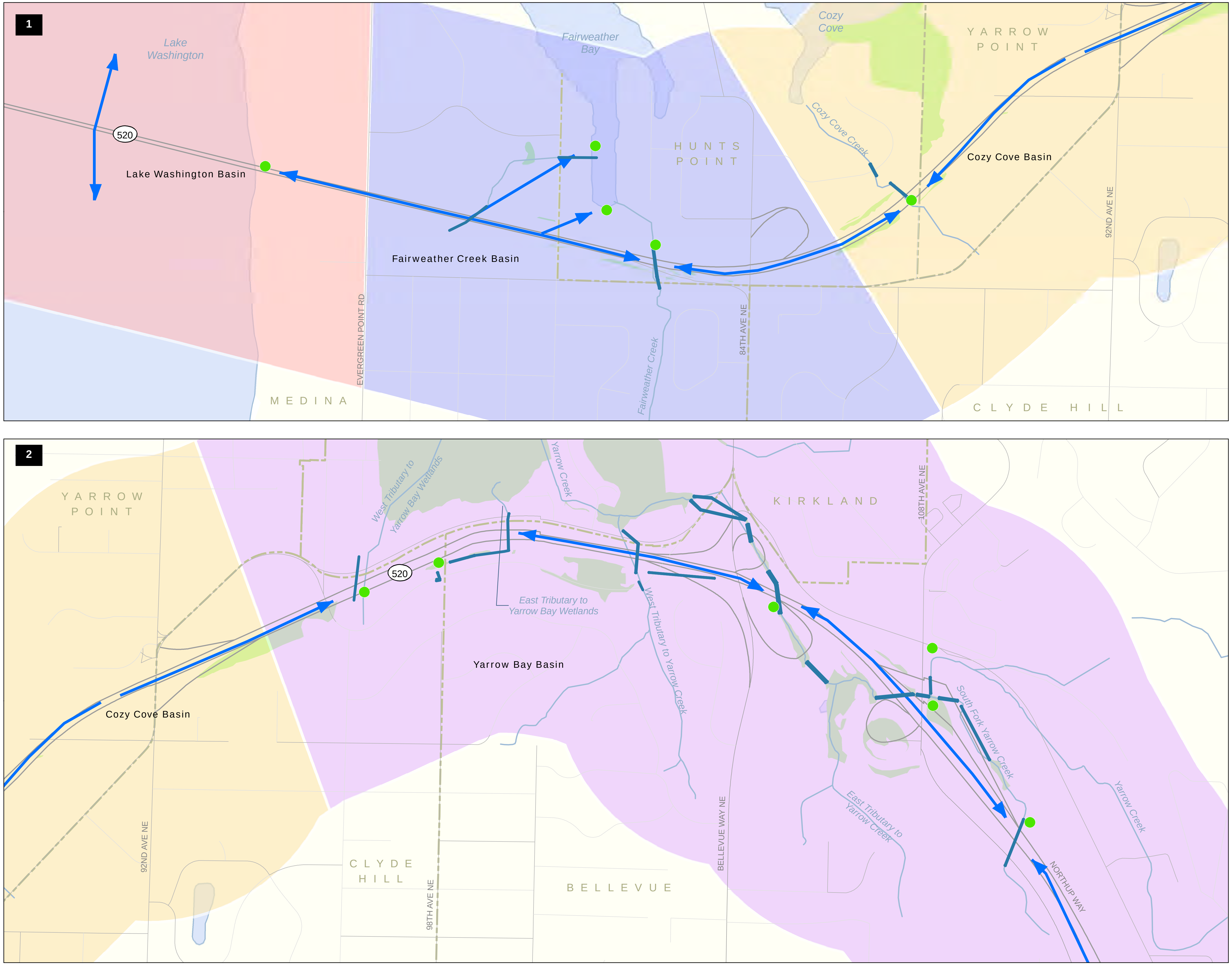
A **bioretention swale** is an engineered low gradient, open channel with vegetation designed to reduce pollutant concentrations in water by slowing flow and filtering the water through biological materials such as vegetation.

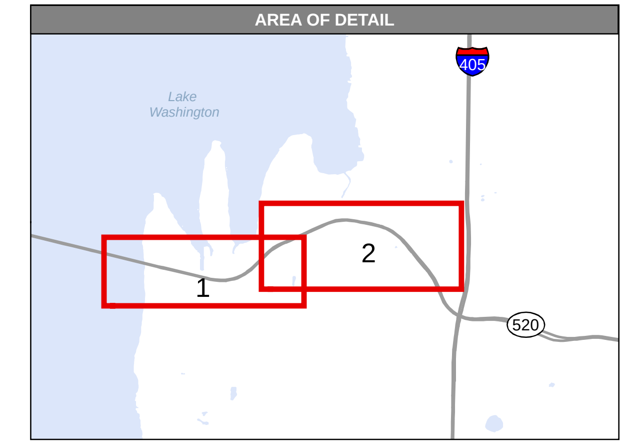
- Storm-water runoff in the study area discharges to either Lake Washington or to a series of small streams that ultimately drain to Lake Washington, the major receiving water body.

Fairweather Creek Basin

Stormwater from SR 520 is discharged to and conveyed in storm drains and curb openings at multiple locations and eventually flows into Fairweather Bay. There are four primary discharge locations from SR 520—Fairweather Park, 80th Avenue NE, a culvert under SR 520 at the tip of Fairweather Bay, and Fairweather Creek (Exhibit 8).

At Fairweather Park, a culvert beneath SR 520 conveys flows to a diversion structure near Medina. Low flows are conveyed through Fairweather Park to a steep ravine; high flows are conveyed around the park and down a storm drain under 80th Avenue NE to Fairweather Bay. This outfall is located on single-family residential property at the end of NE 32nd Street in Hunts Point. The third discharge location is a pipeline at the tip of Fairweather Bay between single-family residential properties. The easterly discharge location is Fairweather Creek, which crosses under SR 520 just west of the NE 84th Street ramp. The creek flows northwesterly for a short distance through single-family residential properties to Fairweather Bay.





Creek Basin

- Lake Washington
- Fairweather Creek
- Cozy Cove
- Yarrow Bay
- Outfall
- Flow Pattern to Outfall
- Culvert
- Stream

N

0 250 500 1,000 Feet

Source: City of Bellevue (1999) GIS Data (City Limits), King County (2004) GIS Data (Stream), King County (2005) GIS Data (Street), King County (2007) GIS Data (Waterbody), and King County (2008) GIS Data (Stream). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 8. **Creeks, Stormwater Outfalls, Culverts, and Basin Boundaries in the Study Area**

Medina to SR 202: Eastside Transit and HOV Project

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Cozy Cove Creek Basin

Stormwater from SR 520 between the 84th Avenue NE interchange and the 92nd Avenue NE interchange is conveyed west along SR 520 in curbs and ditches. This runoff is discharged to Cozy Cove Creek, which crosses under the highway east of 84th Avenue NE (Exhibit 8). Scuppers (openings for drainage in a wall or curb) were constructed along the centerline to help move stormwater off the roadway as there are no storm drains in this section of roadway.

Yarrow Creek Basin

Between 92nd Avenue NE and 108th Avenue NE, the SR 520 drainage system consists of ditches, storm drains, and bioswales that discharge to Yarrow Creek and its tributaries (Exhibit 8). Two bioswales, one on either side of SR 520, provide basic water quality treatment for stormwater. There are several places in this basin where stormwater is discharged into tributaries to the Yarrow Bay wetlands and Yarrow Creek. A 36-inch-diameter culvert just east of 92nd Avenue NE (a tributary of Yarrow Bay) discharges its flows north down a steep slope into the Yarrow Bay wetlands. Farther east near the end of NE 35th Street, a 24-inch-diameter culvert also discharges flows north into the wetlands.

How do Ecology’s storm-water regulations affect the design of the storm-water system for this project?

Ecology requires stormwater from all new PGIS to be treated before it is discharged to surface water bodies. In addition, Ecology often requires storm-water flows to be controlled (detained) before they are treated and discharged. Exhibit 9 describes how Ecology’s regulations apply to the design of storm-water systems for road projects, in general, and to the Medina to SR 202: Eastside Transit and HOV Project specifically.

Exhibit 9. **How Ecology's Storm-Water Regulations Apply to Road Projects**

If…	Then	How does this apply to the Medina to SR 202: Eastside Transit and HOV Project?
If a project proposes to add new impervious surfaces…	Stormwater from the new impervious surface area must be treated. In addition, storm-water flow control measures may be required.	This project must build and maintain storm-water treatment and required flow control facilities in areas where new impervious surfaces are proposed.
If a project proposes to retrofit existing impervious surfaces where stormwater is not treated and flows are not controlled…	A project must build a system to treat stormwater from the existing impervious surface area. In addition, flow control measures may be required.	This project must build and maintain storm-water treatment and required flow control facilities in areas where existing impervious surfaces will be replaced.

Ecology's *Stormwater Management Manual for Western Washington* (Ecology 2005) describes how project proponents must design storm-water systems that meet the water quality criteria. WSDOT implements this guidance on transportation projects by using the *Highway Runoff Manual* (HRM) to design storm-water systems to meet Ecology's regulations (WSDOT 2008a). WSDOT's manual has been approved by Ecology and is considered to be equivalent to the 2005 Stormwater Management Manual.

What level of water quality treatment and flow control is required?

The HRM establishes the level of water quality treatment (basic or enhanced) required for a project. It also identifies if and where flow controls are required. Using the guidelines provided in the HRM, the Build Alternative would construct combinations of flow control and water quality treatment facilities, as shown in Exhibit 10.

In the study area, all direct discharges to streams would require flow control facilities (WSDOT 2008a). Equally, direct discharges to streams would require installing enhanced treatment facilities for the Build Alternative (WSDOT 2008a).

What are basic and enhanced storm-water treatment BMPs?

Basic and enhanced storm-water treatment best management practices (BMPs) are different types of BMPs that have been designated in the *Highway Runoff Manual* to treat stormwater (see page 3-15, Chapter 3 of the HRM [WSDOT 2008a]).

- **Basic treatment BMPs** remove pollutants such as metals, suspended solids, and nutrients from contaminated stormwater. The HRM performance goal for basic treatment BMPs is 80 percent removal of total suspended solids (WSDOT 2008a).
- **Enhanced treatment BMPs** are designed to achieve greater removal of dissolved metals than basic treatment. In addition to removing 80 percent total suspended solids, the HRM performance goal for enhanced treatment is 50 percent removal of dissolved copper and zinc for influent concentrations, ranging from 0.003 to 0.02 milligram per liter (mg/L) for dissolved copper and 0.02 to 0.3 mg/L for dissolved zinc (WSDOT 2008a).

While these families of BMPs have different performance goals for the stormwater they are designed to treat, the intent of treatment is the same—to produce storm-water discharges that comply with state and federal water quality criteria.

Exhibit 10. **Stormwater Treatment and Flow Control Requirements for Study Area Basins**

Applicable Study Area Basins	Water Quality Treatment and Flow Control Requirements
Lake Washington	Water Quality – Basic Treatment Flow Control – None
Fairweather Creek basin	Water Quality – Basic Treatment Flow Control – None
Cozy Cove Creek basin	Water Quality – Enhanced Treatment Flow Control – None
Yarrow Creek basin[a]	Water Quality – Enhanced Treatment Flow Control – Provided

[a] The overpass crossing the SR 520 roadway, which drains to the Kirkland municipal separated storm sewer system, would be treated following Kirkland's municipal code. Similarly, other areas where surface streets would be improved as part of the project (e.g., 108th Avenue NE, Northup Way, and Points Drive NE) would be treated following the relevant municipal code.

How are the sizes determined for storm-water treatment and flow control facilities?

After establishing the type of treatment (basic or enhanced) system required, project engineers determined the size of the facilities based on the expected volume of stormwater that would be generated by what is termed the Water Quality Design Storm. The Water Quality Design Storm volume is defined as "the volume of runoff predicted from a 6-month, 24-hour storm" (Ecology 2005). The total volume of storm-water runoff is a function of the Water Quality Design Storm designated for the study area, and the amount of impervious surface on which rain falls. For this project, engineers determined the size of the individual treatment and flow control facilities based on the volume of water generated during the Water Quality Design Storm for each individual section of the study area.

The **Water Quality Design Storm** is defined in the *Stormwater Management Manual for Western Washington* (Ecology 2005) as "a 24-hour storm with a 6-month return frequency" (also known as the 6-month, 24-hour storm). The Design Storm is used to calculate the size and capacity of flow control and stormwater treatment best management practices (BMPs) needed to effectively treat the volume of stormwater generated during such an event.

Basins versus Threshold Discharge Areas

In this report, two terms are used to refer to the land area where the water resources are located—basins and threshold discharge areas. The HRM (WSDOT 2008a) defines these terms as follows:

- **Basin:** The area of land drained by a river and its tributaries that drains water, organic matter, dissolved nutrients, and sediments into a lake or stream (see *watershed*). Basins typically range in size from 1 to 50 square miles.
- **Threshold Discharge Area (TDA):** An onsite area draining to a single natural discharge location or multiple natural discharge locations that combine within 0.25-mile downstream (as determined by the shortest flow path).

Essentially, the basin is the entire land surface that contributes water to the water resources of concern. The basin boundaries can change in size for different resources, as witnessed by the basins shown in Exhibit 4. The Lake Washington/Cedar watershed contributes water to the water resources evaluated here, as well as to additional water resources outside of the study area. The basins shown in Exhibit 4 contribute to the water features present in those basins. For example, the Fairweather Creek basin contributes water to Fairweather Creek.

For this report, the SR 520 water resources analysts evaluated the specific environmental effects of this project. As directed by the HRM, the water resources analysts focused on the impervious surfaces located in the study area that would generate storm-water runoff before and after construction. The TDA is the portion of the overall basin within the project boundaries that could be contributing water (i.e., redirecting infiltrated water to storm-water runoff).

Both basin and TDA types of information are presented in this report because they are necessary for evaluating different levels of effects to the water resources in the study area. Basin areas are used in describing the overall health of the aquatic resources. This is because total impervious surface in a basin has been demonstrated to limit the health of all the aquatic resources in the basin, not just those in the study area. TDAs provide a critical piece of information used to determine the volume of water treated for flow control and water quality, as mandated by state law and the HRM.

In this report, the correlation between basin and TDA is as follows:

- Yarrow Creek basin – TDA 1
- Cozy Cove Creek basin – TDA 2
- Fairweather Creek basin – TDA 3
- Lake Washington basin – TDA 4

How are types of storm-water treatment and flow control facilities determined?

The HRM presents two approaches to designing a system that complies with federal and state water quality regulations. These approaches are called the *presumptive approach* and the *demonstrative approach*. Both approaches "are based on best available science and result from existing federal and state laws that require stormwater treatment systems to be properly designed, constructed, maintained and operated" (WSDOT 2008a).

In the HRM, the presumptive approach specifies a menu of BMPs that engineers can use to design a storm-water system to meet Ecology's storm-water regulations. The HRM provides information to guide engineers in "the proper selection, design, construction, implementation, operation, and maintenance of BMPs" (WSDOT 2008a). "Projects that follow the stormwater BMPs contained in [the HRM] are presumed to have satisfied [the] demonstration requirement and do not need to provide technical justification to support the selection of BMPs" (WSDOT 2008a).

What are best management practices (BMPs)?

BMPs are practices and treatment technologies or methods that can be used to meet water quality criteria. There are many different types of BMPs. Some are treatment technologies such as wet vaults and storm-water treatment wetlands. Others are maintenance measures that can be implemented as part of a project, such as sweeping streets of debris. Some BMPs are permanent features of a project; others can be temporary measures employed during construction.

Alternatively, engineers can design storm-water systems using storm-water BMPs and management approaches that are not included in the HRM. This approach is called the demonstrative approach, which can be used if it can be:

- "[d]emonstrate[ed] that the project will not adversely impact water quality by collecting and providing appropriate supporting data to show that the alternative approach protects water quality and satisfies state and federal water quality laws; and by
- Meet[ing] the technology-based requirements of state and federal law" (WSDOT 2008a).

Based on this guidance from the HRM, the project engineers on the design team followed the presumptive approach to design the flow control and storm-water treatment facilities for the study area. However, project engineers determined that standard BMPs specified for flow control using the presumptive approach would not meet the HRM requirements in the Yarrow Creek basin because there is not enough pond volume available to meet the requirements of the HRM. Project engineers instead applied the demonstrative approach to design a storm-water flow control system for the affected waterways in this basin. Exhibit 11 identifies the steps followed to determine how the project would affect surface water resources using the presumptive and demonstrative approaches.

Exhibit 11. **Steps Involved in Applying the Presumptive and Demonstrative Approaches for this Project**

Steps followed to apply the presumptive approach for this project	
1)	Identify the surface water bodies receiving stormwater and the associated level(s) of flow control and water quality treatment required by the HRM.
2)	Determine the total area of PGIS and the Water Quality Design Storm for the study area. With that information, determine the appropriate size and location for required treatment and flow control facilities.
3)	Identify the types and combinations of flow control and water quality treatment BMPs to be used from the flowcharts provided in the HRM. Evaluate feasibility, location constraints, and costs.
4)	Presume that the project has demonstrated compliance with state and federal water quality criteria based on the HRM guidance (WSDOT 2008a).
Steps followed to apply the demonstrative approach for this project	
1)	Identify the surface water bodies receiving stormwater and the associated level(s) of flow control and water quality treatment required by the HRM.
2)	Determine the types of flow control BMPs that can be used. The BMPs can come from the HRM, or they can be new or innovative emerging technologies.
3)	Develop an approach to demonstrate that storm-water discharges would meet the flow control standards of the HRM and *Stormwater Management Manual for Western Washington*.
4)	Demonstrate that storm-water discharges would meet relevant state criteria.

What are the proposed storm-water treatment facilities for the Build Alternative?

For the proposed project, project engineers selected each BMP based on space constraints and discharge location. The engineers also sized the treatment facilities to meet the HRM requirements for the Build Alternative. This report includes a basin-by-basin description of the proposed storm-water treatment facilities, as well as preliminary design drawings, as summarized below. Exhibit 12 provides a map with the locations of the facilities discussed below. Each treatment facility has a distinct designation on the map (e.g., B1b); these designations are included in parentheses in the discussion below to assist the reader in finding the facility on the map.

Proposed Project Storm-Water Treatment Facilities

Lake Washington Basin

Stormwater generated from existing and proposed PGIS in the Lake Washington TDA would be treated with a single bioswale (Treatment Facility K, Exhibits 12 and 13) with no flow control, because Lake Washington is a flow-exempt water body (WSDOT 2008a) and only requires basic treatment of stormwater.

The **ordinary high water mark (OHWM)** is the line on the shore of rivers and lakes established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil destruction on terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding area.

The existing pipe would be replaced in kind. It currently discharges at or above the ordinary high water mark (OHWM) and would in the future. The pipe would require a riprap mat that would be approximately 10 feet by 10 feet (5 feet on either side of the outfall along the shoreline and extending 10 feet into the water).

Fairweather Bay Basin

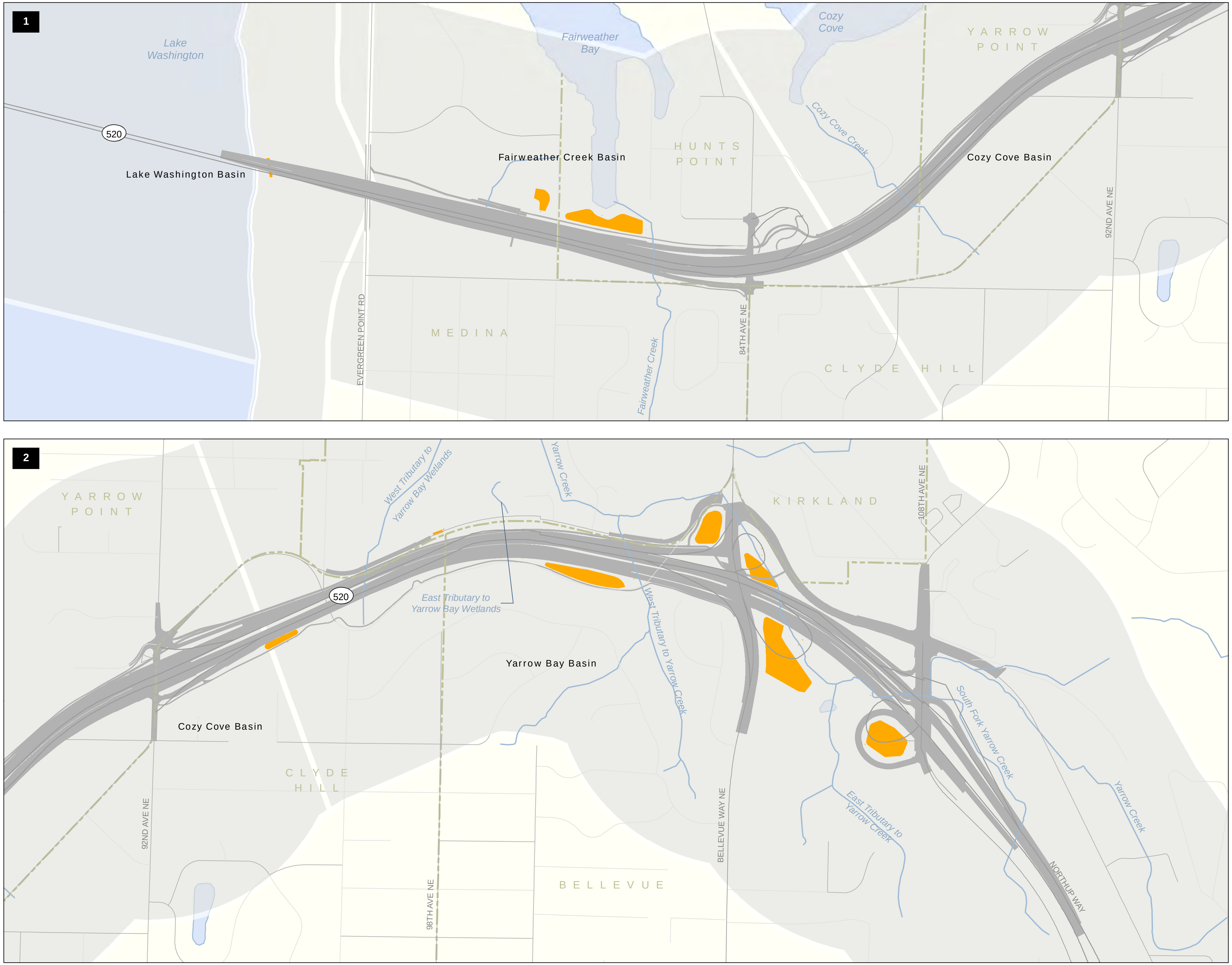
Stormwater generated within the Fairweather Bay TDA would be treated using a constructed wetland to enhance water quality. This treatment facility would not be designed for flow control because the receiving water body is Lake Washington, which is a flow exempt water body. This facility (Treatment Facility I3, Exhibits 12 and 13) would be approximately 1.5 acres, with a 4-foot settling basin.

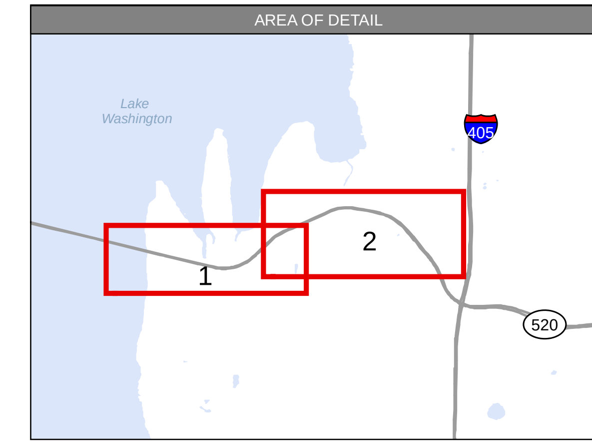
Acquisition of private property (the Aubin residence) located at the sound end of the bay means that there would be only one discharge to Fairweather Bay—at the center of the south facility between the Aubin and Madden properties (ponds J and I3 would both discharge to this location). This outfall would discharge above the OHWM into a constructed rock-lined ditch that would discharge through a weir constructed on the existing bulkhead. This weir would have a trapezoidal notch approximately 1 foot above lake full elevation. Water would be discharged through that weir. In-water work would be conducted during the allowable construction period and be limited to the installation of up to two gabion mats (approximately 6 feet by 9 feet by 6 inches thick). These mats would be used to prevent scouring under the outfall (water depth in this area is approximately 5 feet).

Cozy Cove Basin

For this project, a unique approach was proposed to handle the stormwater system that discharges to Cozy Creek. It was determined that the lowest impact option to the receiving water body would be to divert the flow from the current receiving water body (Cozy Cove Creek) to the Fairweather Bay stormwater treatment system. This water would all reach Lake Washington. The stormwater generated by the increase in impervious surface in the Cozy Cove Creek basin would be treated by passing through a constructed wetland, Treatment Facility J (Exhibits 12 and 13).

The diversion of stormwater from Cozy Cove Creek could potentially lead to unacceptable low flows in this receiving environment (meaning surface flows could fall to levels that would be harmful to the aquatic communities present in the creek). To contribute to the maintenance of necessary low flows in Cozy Cove Creek, sufficient water would be diverted from this transfer to be discharged after treatment by a media filter drain via sheet flow. The amount of water to be diverted is still under consideration, with the intent of meeting pre-forested discharge levels to this surface water body.





Stream
Proposed Stormwater Facility
Creek Basin
Pavement

N
0 250 500 1,000 Feet

Source: City of Bellevue (1999) GIS Data (City Limits), King County (2004) GIS Data (Stream), King County (2005) GIS Data (Street), King County (2007) GIS Data (Waterbody), and King County (2008) GIS Data (Stream). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 12. **Proposed Stormwater Management Facilities**

Medina to SR 202: Eastside Transit and HOV Project

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Exhibit 13. **Levels of Flow Control and Water Quality Treatment Associated with Each Proposed Storm-Water Treatment Facility**

	Proposed Facilities					
Facility Type	**C**	**B1b**	**E3**	**E2**	**E1**	**G4**
Flow Control Method	Media Filter Drain	Detention Combined with Constructed Wetland	Detention Combined with Constructed Wetland	Detention Combined with Constructed Wetland	Detention Combined with Constructed Wetland	Detention Combined with Constructed Wetland
Water Quality Method	Media Filter Drain	Constructed Wetland	Constructed Wetland	Constructed Wetland	Constructed Wetland	Constructed Wetland
Type of Proposed Facility	Media Filter Drain	Combined Detention and Storm-Water Wetland	Combined Detention and Storm-Water Wetland	Combined Detention and Storm-Water Wetland	Combined Detention and Storm-Water Wetland	Combined Detention and Storm-Water Wetland
Storm-Water Wetland/Wet Pond with Detention Depth	N/A	Presettling 4 feet, Wetland 1.5 feet, Detention 3 feet	Presettling 4 feet, Wetland 1.5 feet, Detention 3 feet	Presettling 4 feet, Wetland 1.5 feet, Detention 3 feet	Presettling 4 feet, Wetland 1.5 feet, Detention 3 feet	Presettling 4 feet, Wetland 1.5 feet, Detention 3 feet
Water Quality Volume (cf)	4,842	31,636	39,242	33,350	29,000	31,030
Detention Volume (cf)	0	141,337	200,376	56,192	38,332	54,450
Total Volume (cf)	4,842	172,973	239,618	89,542	67,332	85,480

Exhibit 13. **Levels of Flow Control and Water Quality Treatment Associated with Each Proposed Stormwater Treatment Facility (continued)**

Facility Type	Proposed Facilities: G2	92nd	I3	J	K
Flow Control Method	Per the City of Kirkland	Detention Only	Direct Discharge to Exempted Water Body	Direct Discharge to Exempted Water Body	Direct Discharge to Exempted Water Body
Water Quality Method	Water Quality Vault	Water quality directed to G4	Constructed Wetland	Constructed Wetland	Bioswale
Type of Proposed Facility	Water Quality Vault	Detention Pond	Constructed Wetland	Constructed Wetland	Bioswale
Storm-Water Wetland/Wet Pond with Detention Depth	N/A	Detention Only 4 feet	Presettling 4 feet, Wetland 1.5 feet	Presettling 4 feet, Wetland 1.5 feet	0.083 feeta
Water Quality Volume (cf)	3,149	0	116,092	35,439	6,237 (Interim Configuration)
Detention Volume (cf)	0	20,908	0	0	0
Total Volume (cf)	3,149	20,908	116,092	35,439	6,237

[a]The depth indicated is the flow depth that would provide the proper water quality treatment through the swale at the design rate.

cf = cubic feet

Source: HDR, Parametrix, and PB (2009)

Yarrow Creek Basin

As shown in Exhibit 4, the water resources of Yarrow Creek basin consist of a number of streams and a major wetland complex at the mouth of Yarrow Creek along the shoreline of Lake Washington. To address the environmental requirements of these water resources, the proposed storm-water treatment facilities were divided into a number of small subbasins for treatment and flow control (Exhibits 12 and 13).

Within the Yarrow Creek basin, the Build Alternative would install the following:

- Five constructed wetlands (Treatment Facilities B1b, E3, E2, E1, and G4 – Exhibits 12 and 13), each with combined detention facilities.
- A media filter drain with no detention (Treatment Facility C, Exhibits 12 and 13).
- A water quality vault (Treatment Facility G2, Exhibits 12 and 13), which would receive inflow from a detention pond (Treatment Facility at 92nd Avenue NE, Exhibits 12 and 13). Treatment Facility G2 would discharge to the Kirkland separated storm sewer system, and was developed following the guidelines of Kirkland's municipal storm-water code.

Potential Effects of the Project

What methods were used to evaluate the potential effects?

The water resources analysts used WSDOT- and Ecology- approved methods to evaluate effects on surface water bodies. WSDOT's approved methods for evaluating effects on surface water resources are described in WSDOT's *Environmental Procedures Manual* (EPM) (2008b) and the HRM (WSDOT 2008a). The EPM provides guidance to ensure compliance with federal, state, and local laws during the planning, design, construction, and maintenance of WSDOT road projects. The HRM is the manual used by WSDOT to design storm-water systems that meet Ecology's water quality standards.

In addition, the analysts evaluated temporary effects to surface water during construction. These effects were evaluated by determining construction actions that might disturb soil and in-water sediments and by evaluating the potential for accidental spills of hazardous materials.

How would construction of the project affect water resources?

The water resources analysts evaluated temporary construction effects on surface water bodies by determining construction actions that might disturb soil and in-water sediments and by evaluating the potential for accidental spills of hazardous materials.

No Build Alternative

Under the No Build Alternative, no construction activities would take place. As such, there would be no negative effects from construction under this alternative.

Build Alternative

Under the Build Alternative, water quality in Eastside streams could be temporarily affected by construction activities such as replacing or extending culverts and installing retaining walls. Construction activities occurring within or directly adjacent to streams could increase turbidity and TSS levels. Streams that could be affected are those crossing or flowing adjacent to SR 520, where construction work would take place in water (below the OHWM) or adjacent to or above study area water bodies. Construction of stream channels would also require dewatering or diversions during construction periods.

These effects would be avoided, minimized, and mitigated through the development and implementation of temporary erosion and sediment control (TESC) and spill prevention control and countermeasures (SPCC) plans (WSDOT 2008a). A TESC plan would discuss the risk of erosion in different parts of the study area and would specify BMPs to be installed prior to construction activities. The SPCC plan would be prepared by the contractor(s) selected to complete the final design of the project, as required by WSDOT Standard Specification 1-07.15(1) (WSDOT 2008a). Each of these plans would include performance standards based on state regulations, such as standards for turbidity and TSS levels in stormwater discharged from construction staging and work areas. Construction of the Build Alternative would require compliance with approved TESC and SPCC plans that would be based on these performance standards.

Effects during construction of the Build Alternative would additionally be avoided or minimized through the development and implementation of permit-required erosion plans, spill control plans, and concrete containment and disposal plan (CCDP) for handling and managing concrete onsite and other permit conditions. These plans and permits regulate construction activities on land and in the water to prevent or reduce temporary degradation of water quality from construction activities.

How would operation of the project affect water resources?

No Build Alternative

Under the No Build Alternative, stormwater collected from SR 520 within the study area would continue to be discharged to streams with no treatment or flow control. Compared with existing levels, the higher traffic volumes that would occur between 108th Avenue NE and I-405 between 2002 and 2030 could increase pollutant loading (e.g., copper and zinc from automobile tires and brakes) to project corridor pavement.

Build Alternative

Construction and operation of the Build Alternative would result in an increase of PGIS in each TDA, ranging from 1.8 to 10.8 additional acres (Exhibit 14). While PGIS would increase over existing conditions, both the existing and future PGIS would be treated for storm-water pollutants and controlled for flow increases as described above.

The Surface Water Discipline Report Checklist (page 430-21 in the EPM [WSDOT 2008b]) directs the evaluation of operational effects for each alternative by considering the effects of projected typical highway runoff on the total quantity of pollutants (loadings) entering the receiving waters. Using the *BA Writers Guidance for Preparing the Stormwater Section of Biological Assessments*, the water resources analysts calculated the annual mass loading in pounds/year generated by the existing PGIS to compare with the annual mass loading that would be generated by the future PGIS in each TDA (Exhibit 15). This procedure determines loadings for TSS, total and dissolved copper, and total and dissolved zinc using data collected from existing untreated and treated PGIS by WSDOT as required under their existing municipal NPDES stormwater permit.

Exhibit 14. **Existing and Proposed Pollutant-Generating Impervious Surface by TDA**

Threshold Discharge Area	Existing Pollutant-Generating Impervious Area (ac)	Proposed Pollutant-Generating Impervious Area (ac)	Added Pollutant-Generating Impervious Area (ac)	Percent Increase in New over Existing Pollutant-Generating Impervious Area
TDA 1	24.7	35.4	10.8	56%
TDA 2	7.7	12.7	5	35%
TDA 3	10.3	15	4.7	54%
TDA 4	1.2	2.9	1.8	150%

Exhibit 15. **Pollutant Loading to Surface Water Bodies in the Eastside Study Area**

	Annual Mass Loading (pounds/year)				
Basins	**TSS**	**Total Zinc**	**Dissolved Zinc**	**Total Copper**	**Dissolved Copper**
No Build Alternative (No Storm-Water Treatment)					
TDA 1	13,955.5	27.17	9.88	4.94	1.31
TDAs 2 and 3	10,164.4	19.79	7.20	3.60	0.95
TDA 4	678.0	1.32	0.48	0.24	0.06
Project Total	24,797.9	48.3	17.6	8.8	2.33
Build Alternative (BMP Removal Efficiencies Applied)					
TDA 1	1,595.3	9.93	7.09	2.30	1.24
TDAs 2 and 3	1,246.1	7.75	5.54	1.80	0.97
TDA 4	132.8	0.83	0.59	0.19	0.10
Project Total	2,974.1	18.51	13.22	4.3	2.31
Net Change in Pollutant Loads between Pre- and Post-project Conditions					
TDA 1	-12,360.25	-17.24	-2.79	-2.64	-0.07
TDAs 2 and 3	-8,918.3	-12.04	-1.66	-1.8	0.02
TDA 4	-545.25	-0.49	0.11	-0.05	0.04
Project Total	-2,1823.8	-29.77	-4.34	-4.48	-0.01

Note: Blue shading indicates pollutant loads would be the same or less than those for the No Build Alternative.

For the purposes of this comparison, the existing and proposed PGIS for TDAs 2 and 3 (within Cozy Cove Creek and Fairweather Creek basins) were combined to facilitate the comparison of existing and future loadings.

Under the Build Alternative, the proposed storm-water treatment system would reduce TSS, total and dissolved zinc, and copper pollutant loadings from TDA 1 to Yarrow Bay, compared with the No Build Alternative (Exhibit 15). The combined TDAs 2 and 3 under the Build Alternative would decrease the pollutant loading to Fairweather Bay of all constituents, except dissolved copper, compared with the No Build Alternative (Exhibit 15). The Build Alternative would decrease the pollutant loading in TDA 4 of all constituents, except dissolved zinc and dissolved copper, compared with the No Build Alternative (Exhibit 15). The total combined effect of the Build Alternative would be a net decrease in TSS, total and dissolved zinc, and copper in the Lake Washington receiving environment (Exhibit 15).

In addition to the specific effects within the individual TDAs, increasing impervious surface could have a potential detrimental effect at the basin level. The proportion of each basin as impervious surface is already fairly substantial (Exhibit 16), because basins with greater than 25 percent impervious surface have degraded aquatic resources (Booth and Jackson 1997). With the basins already currently degraded due to current levels of impervious surfaces (30 to 33 percent) and given the low percent increase in impervious surface associated with this project action, it would not be possible to detect change.

Exhibit 16. **Proposed Changes in Impervious Surface in the Eastside Basins Associated with the Build Alternative**

Basin	Total Area (ac)	Current Imperv. Surface (ac)	Added Imperv. Surface (ac)	Future Imperv. Surface (ac)	Current % Imperv. Surface	Future % Imperv. Surface	% Increase, Imperv. Surface
Fairweather Creek	548	165.5	5.0	170.5	30.2%	31.1%	0.9%
Cozy Cove Creek	189.1	58.6	4.7	63.3	31.0%	33.5%	2.5%
Yarrow Creek	1427.7	471.2	1.8	473	33.0%	33.1%	0.1%

Mitigation

What has been done to avoid or minimize negative effects?

Permanent negative effects of the Build Alternative on water resources would be avoided by including storm-water treatment facilities as part of the project. Overall, these facilities would either not change existing pollutant loading levels or would reduce the current levels that are being discharged to surface water bodies in the project area.

Negative effects on receiving surface water bodies from construction activities would be avoided or minimized by (1) implementing water quality pollution control measures outlined in the required TESC and SPCC plans, and (2) by following permit conditions.

Potential sedimentation effects on Eastside streams during construction would be minimized in the following ways:

- **Avoidance** – Use of retaining walls to minimize effects to streams, wetlands, and other critical areas. Except where absolutely necessary and permitted, construction equipment would not enter below the OHWM of Eastside streams. Staging areas and stockpiling areas would be located at least 200 feet away from streams and lakes.

- **Prevention** – Use of appropriate BMPs to reduce the risk of erosion and reduce or minimize the potential of sediments entering project water bodies. Erosion and sediment control measures could include mulching, matting, and netting; filter fabric fencing; quarry rock entrance mats; sediment traps and ponds; surface water interceptor swales and ditches; and placing construction material stockpiles away from streams. Sedimentation would be minimized by limiting ground-disturbing work to the dry season and conducting all in-water work within the approved work window, as specified in the project's Hydraulic Project Approval. New or replacement culverts and stream reaches would be aligned adjacent to the existing structures so they could be constructed in a dry environment, thereby minimizing the amount of in-water work and associated water quality effects. In addition, a TESC plan would be prepared and implemented to minimize and control pollution and erosion from stormwater. Erosion and sediment control BMPs would be properly implemented, monitored, and maintained during construction. No long-term water quality effects would be expected, although even with BMPs, some temporary short-term water quality effects from sediment (such as increases in stream turbidity) could occur, particularly during large storm events. However, the magnitude of these effects would be small, and not likely to adversely affect stream water quality.

How could the project compensate for unavoidable adverse effects?

No compensation would be required because negative effects would be avoided or minimized through provision of storm-water treatment facilities as part of the project design. These permanent stormwater treatment facilities would be designed to meet or exceed HRM design requirements and water quality standards for stormwater discharged to surface water bodies.

Groundwater

The Clean Water Act establishes the basic structure for regulating pollutant discharges to groundwater. EPA has delegated enforcement and implementation of the Clean Water Act to Ecology. Ecology has developed regulations, water quality standards, programs, and guidelines to protect groundwater and allow its use for drinking water purposes, irrigation, and manufacturing and commercial uses, as shown in Exhibit 17. Groundwater resources were analyzed as described in this report to determine if drinking water resources would be affected by the project and if the project or construction activities would affect the quantity of groundwater located in the study area.

Exhibit 17. **Ecology's Policies and Regulations for Groundwater Management in the Study Area**

Agency/ Organization	Policies/Regulations	Role
Ecology	EPA water pollution control regulations (Section 431.02 of the Clean Water Act and corresponding State of Washington regulations)	Establishes the basic structure for regulating discharges of pollutants to groundwater.
	Water Quality Standards for Groundwaters of the State of Washington (WAC 173-200)	Establishes maximum contaminant concentrations for the protection of a variety of beneficial uses of Washington's groundwater.
	Washington Groundwater Management Areas (WAC 173-100)	Establishes procedures to designate groundwater management areas and procedures for developing groundwater management programs to protect groundwater quality.
	Washington Well Head Protection (WAC 246-290)	Establishes the boundaries for each well, well field, or spring with 6-month and 1-, 5-, and 10-year travel times; plans to identify potential contamination of groundwater; and contingency sources of drinking water for users of this water.
	Washington Underground Injection Control Program (WAC 173-218)	Protects groundwater quality by regulating the disposal of fluids into the subsurface.
	Washington water rights regulations (various)	Provides a permitting process to allow applicants to apply water to a specific beneficial use.
Local Cities	Local Critical Aquifer Recharge Area (CARA) ordinances	Provides local governments with a mechanism to classify, designate, and regulate areas deemed necessary to provide adequate recharge and protection for aquifers used as sources of potable (drinking) water.

Affected Environment

What information was collected to identify groundwater resources?

The water resources analysts obtained information on the following groundwater resources from Ecology, the Washington State Department of Health, the U.S. Geological Survey (USGS), and King County:

- Sole source aquifers
- Critical Aquifer Recharge Areas
- Public water supply wells
- Domestic/single-family residential water wells

What is a sole source aquifer?

A sole source aquifer is defined as an aquifer that supplies "at least 50 percent of the drinking water consumed in the area overlying the aquifer. These areas can have no alternative drinking water source(s), which can physically, legally, and economically supply all those who depend upon the aquifer for drinking water" (U.S. EPA 2004c).

What is a Critical Aquifer Recharge Area (CARA)?

A CARA is defined as a geographic area that has a critical recharging effect on aquifer(s) used for drinking water supply (RCW 36.70A.030(5)).

What groundwater resources are located in the study area?

Several aquifers are located in the study area, but human use of groundwater from these aquifers is limited. Groundwater resources and their uses are discussed in detail in the following sections.

General Groundwater Information

It is important to first provide a regional perspective on groundwater because of its complex, overlapping nature. Groundwater in the study area is contained within aquifers, which are geological units or groups of units that hold and convey water.

Every location within a drainage basin can be designated as either a groundwater *recharge* or *discharge* area. This designation depends on the direction that groundwater flows within the aquifer. Near the ground surface of a recharge area, flow is directed underground. In contrast, a discharge area has an upward flow to the surface (Freeze and Cherry 1979). In the Puget Sound basin, most groundwater recharge occurs from precipitation falling on upland areas and infiltrating—especially where higher permeability soils are present at or near land surface. In general, about 70 percent of the annual rainfall infiltrates and recharges the Puget Sound regional aquifers (Vaccaro et al. 1998).

When groundwater intercepts with land, it can be a source for springs, wetlands, and creeks. Many rural communities outside the study area may also use the water in aquifers for drinking water purposes.

Aquifers in the Puget Sound basin located close to the surface are often shallow, making them more susceptible to contamination. Deeper aquifers in the Puget Sound basin are better protected from contamination by aquitards. Attachment 1 contains a detailed description of the major study area aquifers and their relationships.

An **aquitard** is soil or rock that is less permeable than adjacent aquifers and restricts groundwater flow.

A **confined aquifer** is bounded above and below by aquitards.

An **unconfined aquifer**t has a water table. Non-confined aquifers are usually shallower and more susceptible to contaminants.

Study Area Groundwater Resources

As part of this analysis, the water resources analysts reviewed information to identify groundwater resources in the study area. Exhibits 18 and 19 summarize and provide the sources of this information.

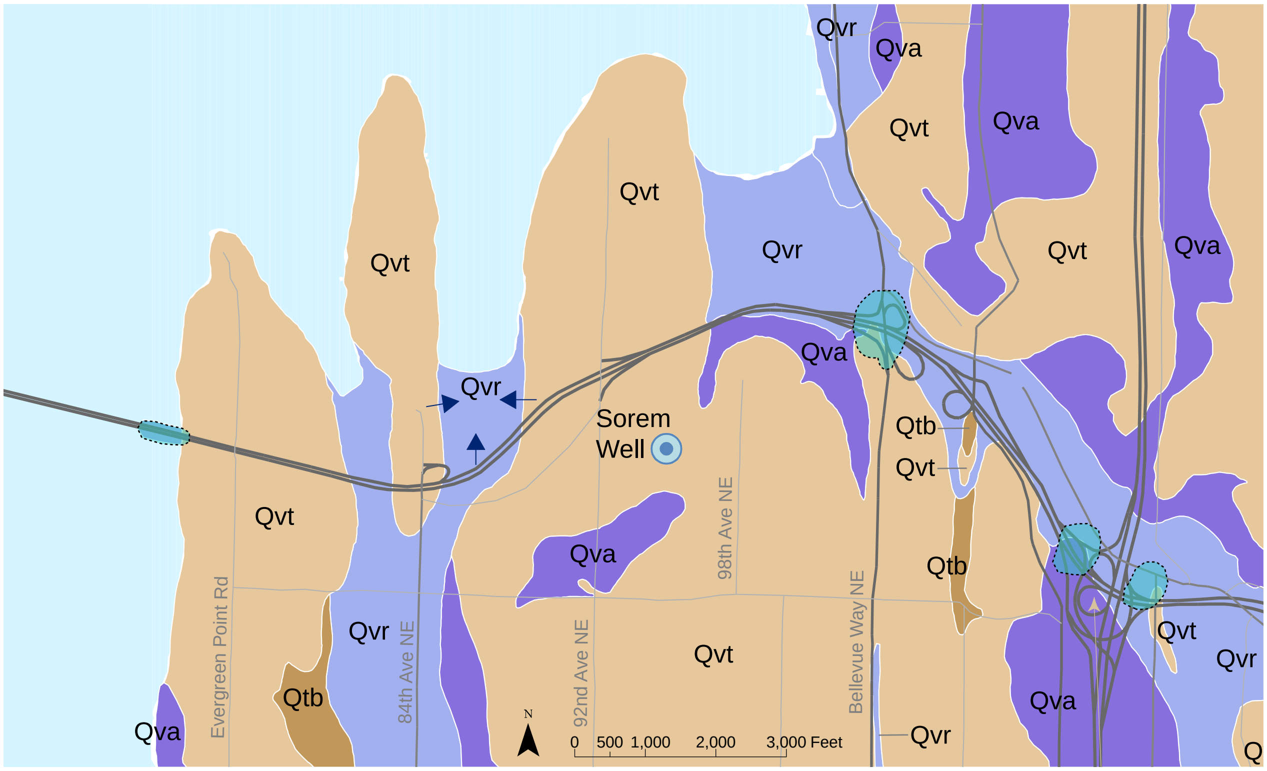
Study Area Groundwater Use

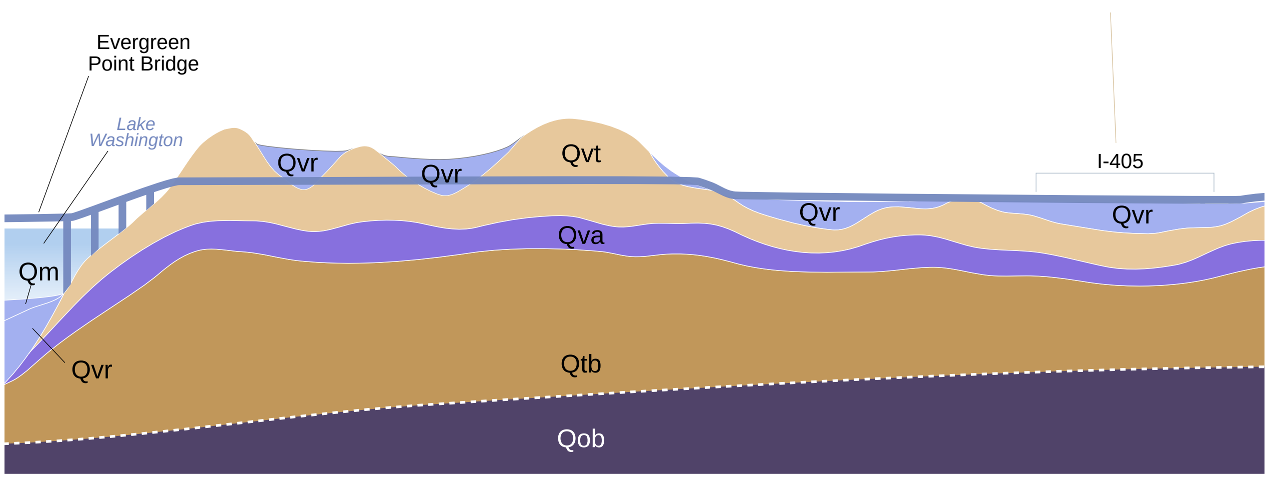
The use of groundwater as a drinking water supply is limited within the study area. Seattle Public Utilities supplies most of the drinking water in the study area from three primary sources—Chester Morse Reservoir, South Fork Tolt Reservoir, and the Highline Well Field (located in the Renton area). One community public water supply well is located in Bellevue (Exhibits 18 and 19) (Ken Johnson, Groundwater Program Lead, King County Department of Natural Resources; Seattle, Washington; September 23, 2002; personal communication). This well, the Sorem Group B well, is more than 500 feet away from SR 520 in Clyde Hill. The well has been in use since at least 1970 and currently serves four connections (one per household). The well is 50 feet deep and has a pumping capacity of 5 gallons per minute (gpm) (Ken Johnson, Groundwater Program Lead, King County Department of Natural Resources; Seattle, Washington; March 11 and August 3-4, 2004; personal communication) (DOH 2004).

Group A public water supply wells provide drinking water to 15 or more connections (such as households).

Group B public water supply wells provide drinking water to 14 or fewer connections.

There are 23 water wells of record listed in the area 1 mile north and south of SR 520. The current condition, uses, or continued existence of these wells are unknown. Because they are generally located in areas supplied by municipal water (if these wells are still actively being used), the wells are most likely not used for drinking water supply.





Regional Hydrogeologic Units	Regional Geologic Units	Geologic Description
Ground Surface		
Alluvial Aquifer	Qal	**Alluvium** (Qal) - fine-grained sand, silt, clay and organic matter.
Vashon Recessional Outwash Aquifer	Qvr	**Vashon recessional outwash** (Qvr) - loose to medium dense, silty sand with scattered gravel.
Vashon Till Aquitard	Qvt	**Vashon till** (Qvt) - usually a very dense mixture of glacial sand, silt and gravel.
Vashon Advance Outwash Aquifer	Qva	**Vashon advance outwash** (Qva) - stratified clean sand and gravel with silt beds.
Transition Beds Aquitard	Qtb Qob *(fines)*	**Transition beds** (Qtb) - fine-grained laminated clayey silt with minor lenses of sand, gravel, peat and wood.
Sea-Level Aquifer	Qob *(coarse)*	**Olympia beds** (Qob) - stratified sand with minor silt and clay beds deposited by streams.
	Older Deposits	**Older** - undifferentiated sedimentary deposits and bedrock

Group B Well

Groundwater Flow in Upland Aquifer

NOTES:
Cross-section schematic drawing not to scale.

Please see other exhibits for surficial geology and geologic hazard areas.

Sea-level aquifer is not exposed at ground surface.

SOURCE FOR SURFICIAL GEOLOGY:
King County (2003); Minard (1983)

Exhibit 18. **Surficial and Cross-Section View of Aquifer and Aquitard Units in the Study Area**

Medina to SR 202:
Bridge Replacement and HOV Project

Exhibit 19. **Study Area Groundwater Resources**

Type of Resource	Does this resource exist in the study area?	Source
Sole source aquifer	No	U.S. EPA (2004c)
Critical Aquifer Recharge Area	No	King County iMap Tool; King County Groundwater Department (Ken Johnson, Groundwater Program Lead, King County Department of Natural Resources; Seattle, Washington; March 11 and August 3-4, 2004; personal communication)
Designated wellhead protection area	No	King County iMap Tool; King County Groundwater Department
Group A public water supply well	No	Washington State Department of Health; King County Groundwater Department
Group B public water supply well	Yes, the Group B Sorem well with four connections (see Exhibit 18)	Washington State Department of Health; King County Groundwater Department
Domestic/single-family residential water well	Yes, 23 water wells of record are listed in the area 1 mile north and south of SR 520. The current condition, uses, or existence of the wells are unknown, but because they are generally located in areas supplied by municipal water, if they exist, they are most likely not used for drinking water supply.	DOH (2004)
Exposed aquifers crossed by the project corridor	Yes (Exhibit 18), as follows: Eastside Study Area – SR 520 crosses 600 feet of exposed Alluvial Aquifer deposits and 10,700 feet of exposed Vashon Recessional Outwash Aquifer deposits.	
Aquifer recharge areas where stormwater percolates to groundwater in the project corridor	Yes, all pervious surfaces are potential aquifer recharge areas.	Morgan and Jones (1999)

Study Area Groundwater Aquifers

The east shore of Lake Washington consists of Alluvial Aquifer deposits that are overlain by the Vashon Till Aquitard in the Medina highlands. Vashon Recessional Outwash Aquifer deposits are exposed in low areas where Vashon Till deposits have eroded at 80th Avenue NE and 86th Avenue NE. The Vashon Advance Outwash Aquifer becomes exposed at 96th Avenue NE, followed by Vashon Recessional Aquifer deposits at 98th Avenue NE. Groundwater flow between 95th Avenue NE and Bellevue Way/104th Avenue NE is generally northward toward Yarrow Bay.

What is the quality of groundwater in the study area?

In Washington, all groundwater is considered a potential drinking water source, and the State regulates the quality of this resource to protect it from degradation. In general, groundwater quality in the study area is good and suitable for most purposes (Vaccaro et al. 1998).

Groundwater contamination may occur locally due to industrial, commercial, or agricultural activities. Soil and groundwater contamination has been documented at a number of locations on the Eastside (see the Hazardous Materials Technical Memorandum [WSDOT 2009b] for further details).

The most commonly found groundwater contaminant in the Puget Sound region is nitrate (Stewart et al. 1994, as cited by Staubitz et al. 1997). Nitrates come from many possible sources, including fertilizers used on farms and lawns, sewage and animal waste, or naturally occurring nitrogen sources. The EPA maximum contaminant level goal for nitrate in drinking water is 10 mg/L (U.S. EPA 2004e). Elevated nitrate levels greater than 5 mg/L have been found in shallow wells located in highly permeable soils in urban and suburban areas (Stewart et al. 1994, as cited by Staubitz et al. 1997).

Potential Effects of the Project

What methods were used to evaluate effects on groundwater resources?

The water resources analysts reviewed Ecology's policies and regulations to establish the criteria for determining the potential effects of this project. The analysts then evaluated the potential permanent effects on groundwater quantity and quality, focusing on how each alternative could decrease existing well yields, decrease base flow discharge to local surface waters, or degrade the quality of groundwater pumped for water supply or local surface water flow. The water resources analysts also evaluated whether the project would reduce the size of the recharge areas, degrade the quantity of runoff entering the recharge area, or cause dangerous and hazardous chemical spills. The qualitative and quantitative measures used to evaluate potential effects were as follows:

- Length of highway crossing over CARAs and wellhead protection areas
- The number of people using groundwater for their water supply who could be affected
- Length of highway crossing over shallow unconfined aquifers unprotected by overlying till or another similar low-permeability layer

A **confined aquifer** is a water-saturated layer of soil or rock that is bounded above and below by impermeable layers. An **unconfined aquifer** is one that is open to receive water from the surface, and whose water table surface can fluctuate up and down, depending on the recharge/discharge rate. Unconfined aquifers are usually shallower and more susceptible to contaminants.

The water resources analysts determined the effects on groundwater by asking the following questions:

1. Could storm-water infiltration transport contaminants into groundwater aquifers and degrade aquifer water quality?
2. Would groundwater recharge be affected enough to reduce the quantity of groundwater for drinking sources and base flows to surface water?

Based on the potential of the Build Alternative to temporarily alter the flow of surface and groundwater, the analysts identified the potential short-term construction effects on the quantity and quality of groundwater resources.

How would the project permanently affect groundwater?

No Build Alternative

There would be no change in the quantity or quality of study area groundwater under the No Build Alternative. The No Build Alternative would not change the amount or quality of stormwater percolating to the groundwater.

Build Alternative

The Build Alternative would have minimal or no effect on the quantity or quality of study area groundwater.

The increased impervious surface associated with the Build Alternative would also have minimal or no effect on groundwater recharge because the roadway would be only a fraction of the size of the total recharge area of the groundwater system. Exhibit 16 shows the amount of increased impervious surface under the Build Alternative and how much the potential recharge areas would be reduced. These amounts would vary between 0.1 to 2.5 percent for the surface water drainage basins.

The size of the associated groundwater basins is unknown, but typically they are much larger than surface water basins. Therefore, these minimal reductions in potential recharge areas based on surface water basin sizes are conservative.

There is a Group B well located in the Eastside study area (Exhibit 18). Because this well is located more than 500 feet upgradient of SR 520, there would be minimal or no effect from stormwater on the roadway infiltrating and affecting groundwater that supplies water to the well. Currently, stormwater from SR 520 is discharged to creeks flowing north of the roadway and ultimately to Lake Washington and south through the West Tributary of Kelsey Creek, which also discharges to Lake Washington. Similarly, groundwater quality would be unaffected because stormwater from each alternative would be treated before being discharged directly to Fairweather Creek, Cozy Cove Creek, the unnamed tributary to Yarrow Bay, and Yarrow Creek. While the connectivity of these streams with groundwater is uncertain, it is unlikely that these water bodies would contribute contaminants to the groundwater and vice versa.

How would project construction temporarily affect groundwater?

Potential effects on groundwater during construction of the Build Alternative would be related to the following:

- The project's disturbed area footprint during construction
- Any dewatering required during construction

Construction of roadways and bridges could temporarily alter the flow of groundwater. For example, dewatering wells could be used to lower groundwater levels to allow subsurface construction in a dry environment. This could cause a temporary reversal of groundwater flow toward the construction area; however, these effects would be localized and temporary.

Possible areas of dewatering include the east side of the Bellevue Way interchange and 124th Avenue NE (Karen Dawson, Geotechnical Engineer, CH2M HILL; Bellevue, Washington; June 8, 2004; personal communication). Other areas that could require dewatering include 112th Avenue NE, 116th Avenue NE, and 120th Avenue NE. Where retaining walls needed to be installed, dewatering rates would be an estimated 5 gpm or less per linear foot of wall construction. The duration of a wall installation would be between 1 and 5 weeks (Karen Dawson, Geotechnical Engineer, CH2M HILL; Bellevue, Washington; June 8, 2004; personal communication).

Groundwater generated from dewatering activities during construction would be stored in either temporary treatment ponds at or near the location of the permanent storm-water treatment wetlands, or in portable steel tanks. Before the water was discharged to the storm-water system, it would be stored for a sufficient amount of time to allow particles to settle, or chemical flocculants could be used to reduce suspended particles (for more details, see the Geology and Soils Technical Memorandum [WSDOT 2009c]).

The temporary effects on groundwater used for drinking in the study area would be negligible. The temporary effects to groundwater-supported surface water systems would be minimal because water that was removed during construction would be discharged to surface water systems.

Under the Build Alternative, intermittent dewatering could temporarily alter groundwater flow direction. The groundwater flow direction would return to normal after construction was completed. The effect of the project on the Sorem Group B water supply well and the 23 potential wells located within 1 mile of the study area would most likely be negligible.

How do the alternatives differ in their effects on groundwater?

The Build Alternative would add impervious surface, thereby reducing the size of the recharge area. This reduction in recharge area would be small compared with the entire groundwater basin (12.9 acres for the Build Alternative). The differences in recharge area between the alternatives would be within normal annual and climatic variability. Therefore, for all practical purposes, there would no difference between the alternatives in their effects on groundwater recharge.

The permanent installation of auger-cast piles to support lids covering the roadway and for culvert support could act as obstacles that groundwater must flow around. This would be a permanent effect of the project on groundwater, but would only have a minimal effect on rates of groundwater flow to surface water bodies.

The effects on groundwater quality from the Build Alternative would be minor. Under the No Build Alternative, storm-water runoff would continue to be directly discharged to surface water bodies, but the Build Alternative would treat the storm-water runoff before discharge. Treating storm-water runoff would remove particles and compounds before the stormwater was discharged to surface water bodies. The treated stormwater would infiltrate into the ground and provide some groundwater recharge within the study area.

Construction effects on groundwater would also be similar under the Build Alternative.

Groundwater Mitigation

What has been done to avoid or minimize negative effects to groundwater?

Permanent negative effects of the Build Alternative to groundwater resources would be avoided by including storm-water treatment facilities as part of the project. Overall, these facilities would either not change existing pollutant loading levels or would reduce the current levels. Negative effects on groundwater resources occurring from construction activities would be avoided or minimized by implementing water quality pollution control measures outlined in the required TESC and SPCC plans.

Additionally, the minimal amount of impervious surface added as part of this project would preclude any negative effects from groundwater recharge.

How could the project compensate for unavoidable negative effects to groundwater?

The Build Alternative would increase the amount of land covered by PGIS in the study area; however, this increase would not cause a detectable change to groundwater recharge. Pollutant loading in storm-water discharges would be maintained or reduced; therefore, potential groundwater contamination would not be a concern. During construction of the Build Alternative, effects would be avoided or minimized through the development and implementation of permit-required plans for erosion control, spill control, and concrete containment and disposal for handling and managing concrete onsite, as well as other permit conditions. These plans and permits regulate construction activities on land and in the water to prevent or reduce temporary degradation of water quality from construction activities. Because permanent effects on groundwater would be negligible, and human use of groundwater in the study area is limited, no additional compensation would be required.

Potential effects on groundwater during construction would be negligible. These potential effects would be minimized by implementing TESC, SPCC, and CCDP plans.

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Attachment 1

Description of Puget Sound Area Aquifers

Description of Study Area Aquifers

In the Puget Sound basin, groundwater is contained in two major aquifers—the Vashon Advance Outwash Aquifer and the Sea-Level Aquifer. These aquifers are also known as the Fraser Aquifer and the Puget Aquifer, respectively (Vaccaro et al. 1998). The Vashon Advance Outwash and Sea-Level Aquifers are present throughout most of the study area and are sufficiently thick and water-saturated to be considered an important source of groundwater (see Exhibit 18 in the main text).

Two minor aquifers also underlie parts of the study area: the Alluvial Aquifer and the Vashon Recessional Outwash Aquifer. These aquifers are either not present in the large majority of the study area, or, where present, do not store large amounts of groundwater (Vaccaro et al. 1998). These aquifers can be found in a few places in the study area such as around Lake Washington and atop several hills (Exhibit 18).

Vashon Advance Outwash Aquifer

The Vashon Advance Outwash Aquifer consists of glacial advance outwash sand and gravel deposits. In areas where it is overlain by the Vashon Till Aquitard, it is semi-confined. Where the till has eroded, the Vashon Advance Outwash Aquifer is unconfined. The Vashon Advance Outwash Aquifer is located in the highlands on both sides of Lake Washington (Exhibit 18). The main source of recharge to the aquifer in the study area is precipitation or downward seepage through the Vashon Till. In areas where the Vashon Advance Outwash Aquifer is close to the ground surface, the aquifer is susceptible to contamination. Water from the aquifer is transported underground and discharged into creeks and lakes. This water can be an important contribution to these water bodies during the summer when precipitation and flows are low. Some of the water contained in the aquifer leaks through the aquitard and provides recharge to the Sea-Level Aquifer.

Sea-Level Aquifer

The Sea-Level Aquifer, the deepest regional aquifer, is confined. Although it is present throughout the Puget Sound basin and has good water quality, the Sea-Level Aquifer is seldom used for water supply in the study area because of its greater depth beneath other aquifers (Exhibit 18). Recharge to the Sea-Level Aquifer occurs from precipitation in the Puget Sound basin, as well as leakage from overlying aquifers, lakes, and rivers. Because of the great thickness of this aquifer, its large areal extent, and the quantity of precipitation in the Puget Sound basin, this aquifer has the capacity to store the greatest amount of groundwater. The Sea-Level Aquifer ultimately discharges to Puget Sound.

Alluvial Aquifer

The Alluvial Aquifer consists of sand and gravels deposited by water on the shores of lakes and in streams or river valleys (Exhibit 18). Groundwater in this aquifer is unconfined and is generally encountered just below the ground surface to 100 feet below ground throughout the study area. The gravel composing the Alluvial Aquifer is permeable. Water, and any contaminants it may contain, is easily transported into and through the aquifer. Within the study area, this aquifer is located near the ground surface and is susceptible to contamination.

Vashon Recessional Outwash Aquifer

The Vashon Recessional Outwash Aquifer consists of stratified sand and gravel and well-bedded silty sand and silty clay deposited during the retreat of the Vashon glaciers (Booth et al. 2002). Groundwater in this aquifer is unconfined or semi-confined. Groundwater in the aquifer is generally encountered from just below the ground surface to 100 feet below ground surface throughout the study area. The Vashon Recessional Outwash Aquifer is saturated beneath Portage Bay and Lake Washington, while east of Lake Washington (between the highlands) the aquifer may be unsaturated (Exhibit 18). In areas where the permeable geologic units that comprise the Vashon Recessional Outwash Aquifer are close to the ground surface, the aquifer is also susceptible to contamination.