Chapter 9 Water Quality and Hydrology

1 What are the dominant characteristics of water in the central Puget Sound region?

The central Puget Sound region has a rich array of water resources, including rivers, streams, lakes, wetlands, estuaries, and the waters of Puget Sound. Water resources also include groundwater aquifers, several of which are important sources of drinking water for the region. Water resources support the region's ecosystems and fish and wildlife species, and supply water for municipal, commercial, agricultural, and industrial uses. Nine large watersheds, or Water Resource Inventory Areas (WRIAs), occur in the central Puget Sound region (Exhibit 9-1).

How Climate, Geology, and Land Cover Affect Hydrology

The hydrology of the region is dominated by the interplay of climate, geology, and land cover. The regional climate is characterized by cool, rainy winters and warm, dry summers. Precipitation falls mainly as rain at lower elevations and snow at higher elevations. Winter snowpack stores precipitation during the colder months and slowly releases water during the spring and summer. Melting of the snowpack throughout the summer maintains stream flows and water supplies during the drier summer months. The upper Cedar watershed, the Green watershed, and portions of the Snohomish watershed provide drinking water supplies for much of the Seattle metropolitan region. Winter rains, especially when combined with rain-on-snow events, can produce large floods that fill river floodplains and rework stream channels.

Which elements of WAC 197-11-444 are addressed in this chapter?

This chapter addresses:

- Section (1)(c)(i) Surface water movement/quantity/quality
- Section (1)(c)(ii) Runoff/absorption
- Section (1)(c)(iii) Floods
- Section (1)(c)(iv) Ground water movement/quantity/quality
- Section (1)(c)(v) Public water supplies

What Water Resource Inventory Areas (WRIAs) are found in the region?

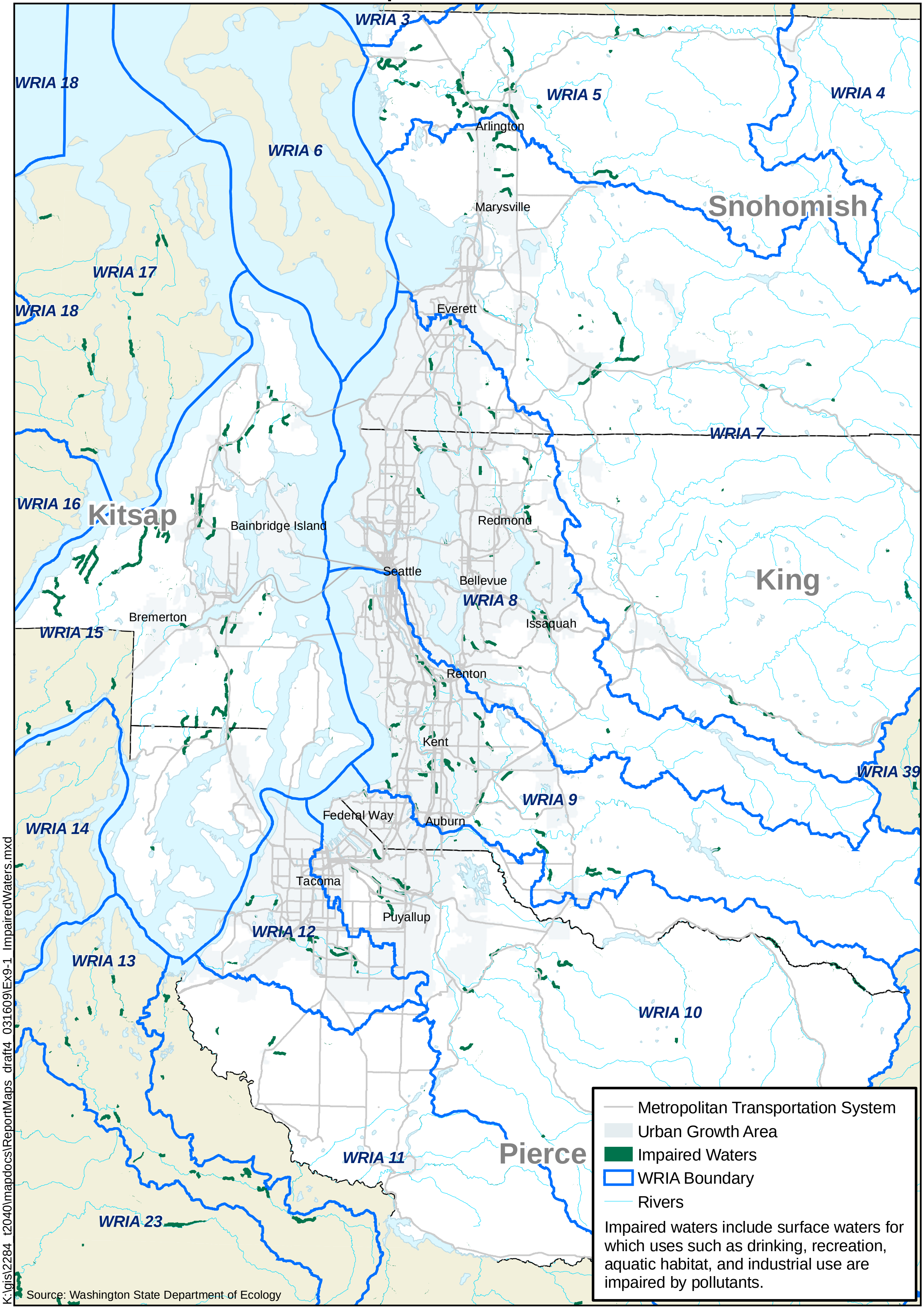
The WRIAs in the region are:

- Upper Skagit (WRIA 4)
- Stillaguamish (WRIA 5)
- Snohomish (WRIA 7)
- Cedar/Sammamish (WRIA 8)
- Green/Duwamish (WRIA 9)
- Puyallup/White (WRIA 10)
- Nisqually (WRIA 11)
- Chambers/Clover (WRIA 12)
- Kitsap (WRIA 15)

What is a watershed?

A watershed is an area of land where all water that is under it or drains off it goes into the same place.

Exhibit 9-1. WRIA Boundaries and Impaired Waters



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River floodplains are critical areas for storing these floodwaters, as well as being important habitat for fish and wildlife species. Floodplains and floodways are areas of high flood hazards for development within these areas. The Federal Emergency Management Agency (FEMA) has identified several flood hazard areas in the region, which are shown in Exhibit 9-2.

Forested land cover and native soils infiltrate and absorb most of the precipitation that falls as rain, resulting in very little surface runoff. By absorbing, filtering, and slowing runoff, forested lands reduce flooding and dampen variations in streamflow volumes, velocity, and sedimentation or turbidity. These forested areas also recharge groundwater and provide baseflows to streams.

The region's landscape features high-elevation mountains, steep slopes, flat lowland valleys, large floodplains, and the regionally defining presence of the Puget Sound. The region's history of glaciation has also resulted in a complex mosaic of highly permeable outwash areas intermixed with more compact and impermeable glacial till. In combination, these factors influence where the region's many lakes and wetlands occur. Wetlands are scattered throughout the region (Exhibit 9-3) and provide important water storage and water purification functions.

Groundwater

Where the region's soils allow water to soak in, they store large amounts of water and are important areas for aquifer recharge and groundwater storage. Groundwater that emerges at the surface as seeps or springs can be an important source of water for streams and wetlands and helps maintain cool water temperatures during the warm, dry summers. A number of large aquifers underlie the central Puget Sound region, and many of these are sole source aquifers critical for drinking water supplies (Exhibit 9-4).

What is a sole source aquifer?

The U.S. Environmental Protection Agency (EPA) defines a sole source aquifer as an underground water source that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. No other water source is available that can physically, legally, or economically supply the needs of those who rely on the aquifer for drinking water supplies.

Sole source aquifers in the region

Snohomish County:

Cross Valley Aquifer

Newberg Area Aquifer

King County:

Cedar Valley (Renton) Aquifer

Vashon-Maury Island Aquifer

Pierce County:

Center Pierce County Aquifer

Exhibit 9-2. Flood Hazard Areas

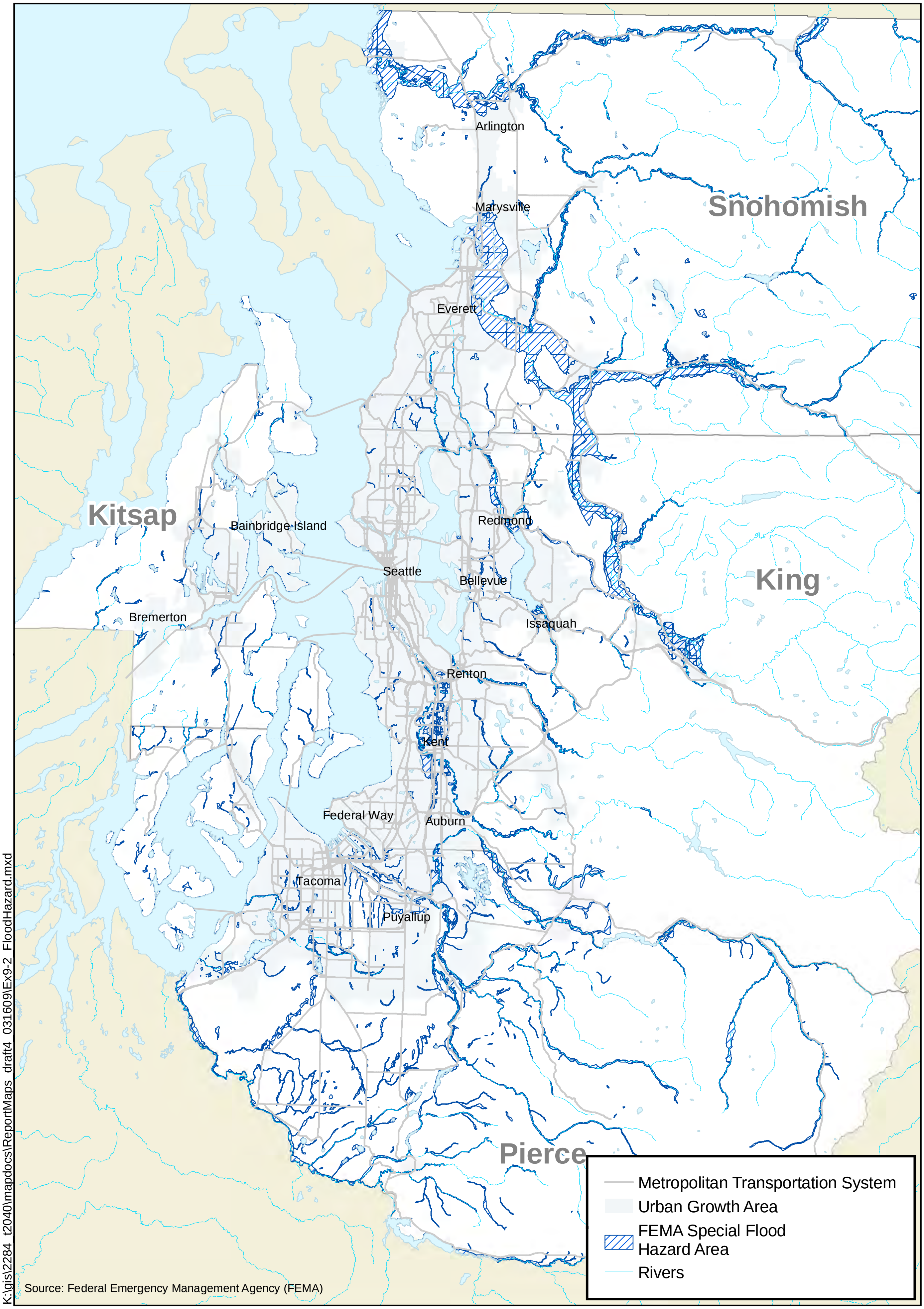

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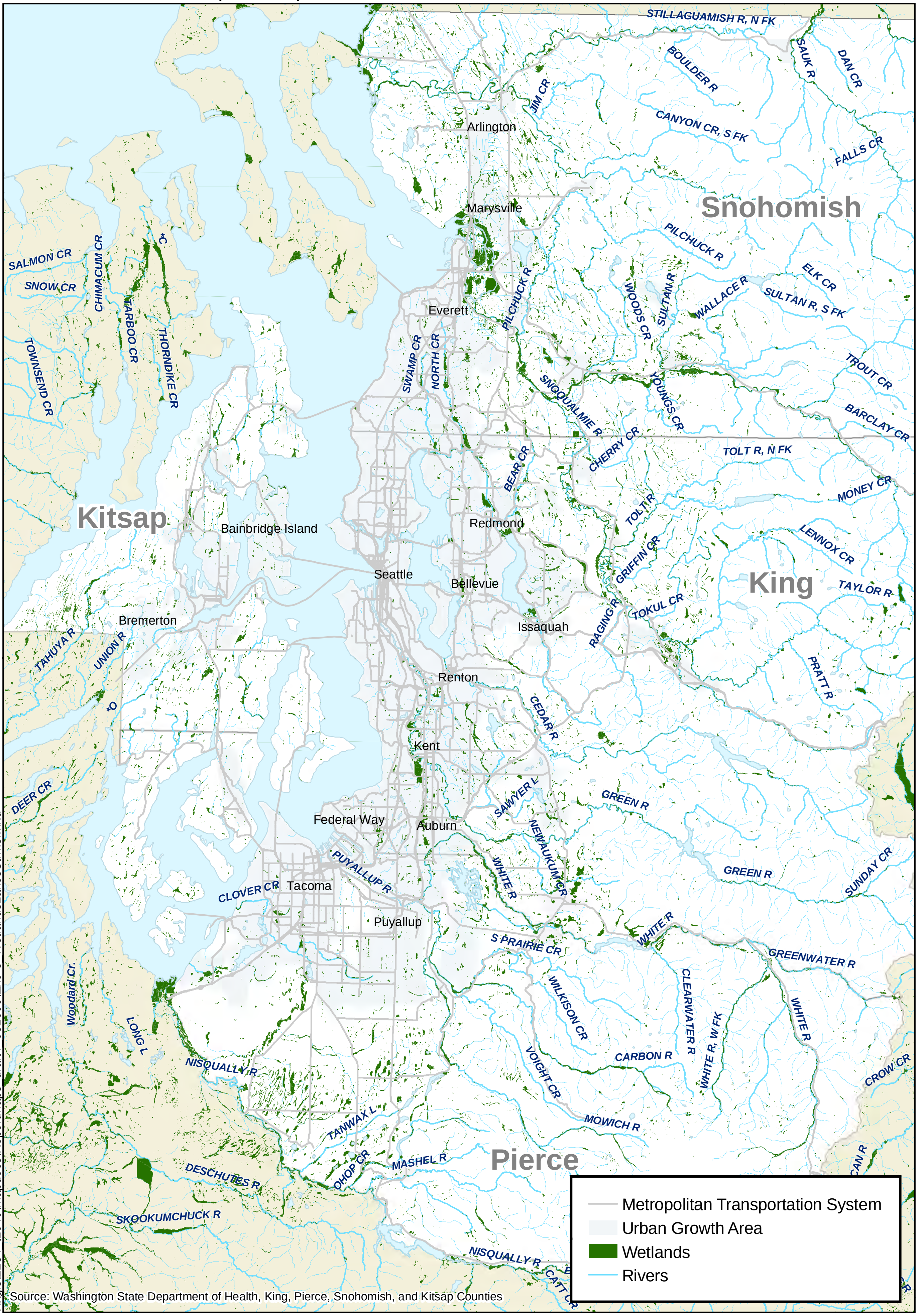
Exhibit 9-3. Wetlands, Rivers, Streams and Lakes



Source: Washington State Department of Health, King, Pierce, Snohomish, and Kitsap Counties

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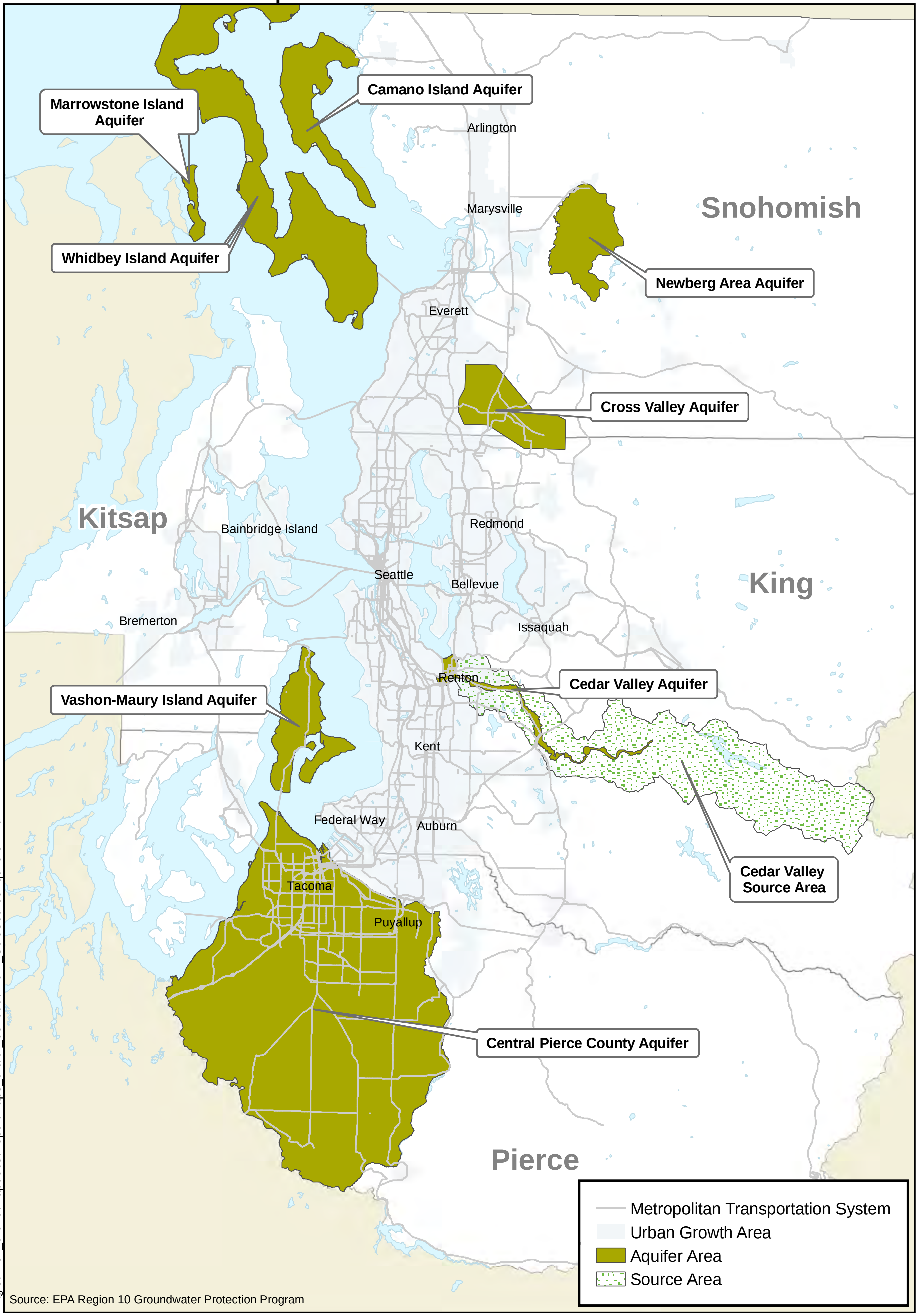
Exhibit 9-4. Sole Source Aquifers



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Marine Waters

The marine waters of Puget Sound ultimately receive all of the surface water runoff that flows from the central Puget Sound region. Freshwater flows from the major rivers and smaller streams influence the circulation of water within Puget Sound and help determine how well marine waters are mixed. Freshwater inflows also carry pollutants from the land surfaces into the marine environment.

The marine waters of the central Puget Sound region include portions of the Whidbey Basin, Central Sound, and South Sound. The Puget Sound Partnership has defined a number of action areas for Puget Sound and four of these occur, in whole or in part, in the central Puget Sound region (Exhibits 9-5 through 9-8). The Whidbey Basin, North Central, South Central, and South Sound action areas are characterized by different patterns of circulation and water quality. The Whidbey Basin area has large freshwater inputs from the Skagit, Stillaguamish, and Snohomish River systems and relatively high rates of mixing due to wind, wave, and tidal energy. The North Central and South Central action areas include most of the highly urbanized portion of the central Puget Sound region. The South Sound is characterized by many long, narrow, and shallow embayments, low wind and wave energy, and slow rates of mixing or flushing.

What are action areas?

An important part of the Puget Sound Partnership’s work is connecting with the public, watershed groups, and local governments. The legislation that created the Partnership established seven geographic action areas around the Sound to address and tackle problems specific to those areas.

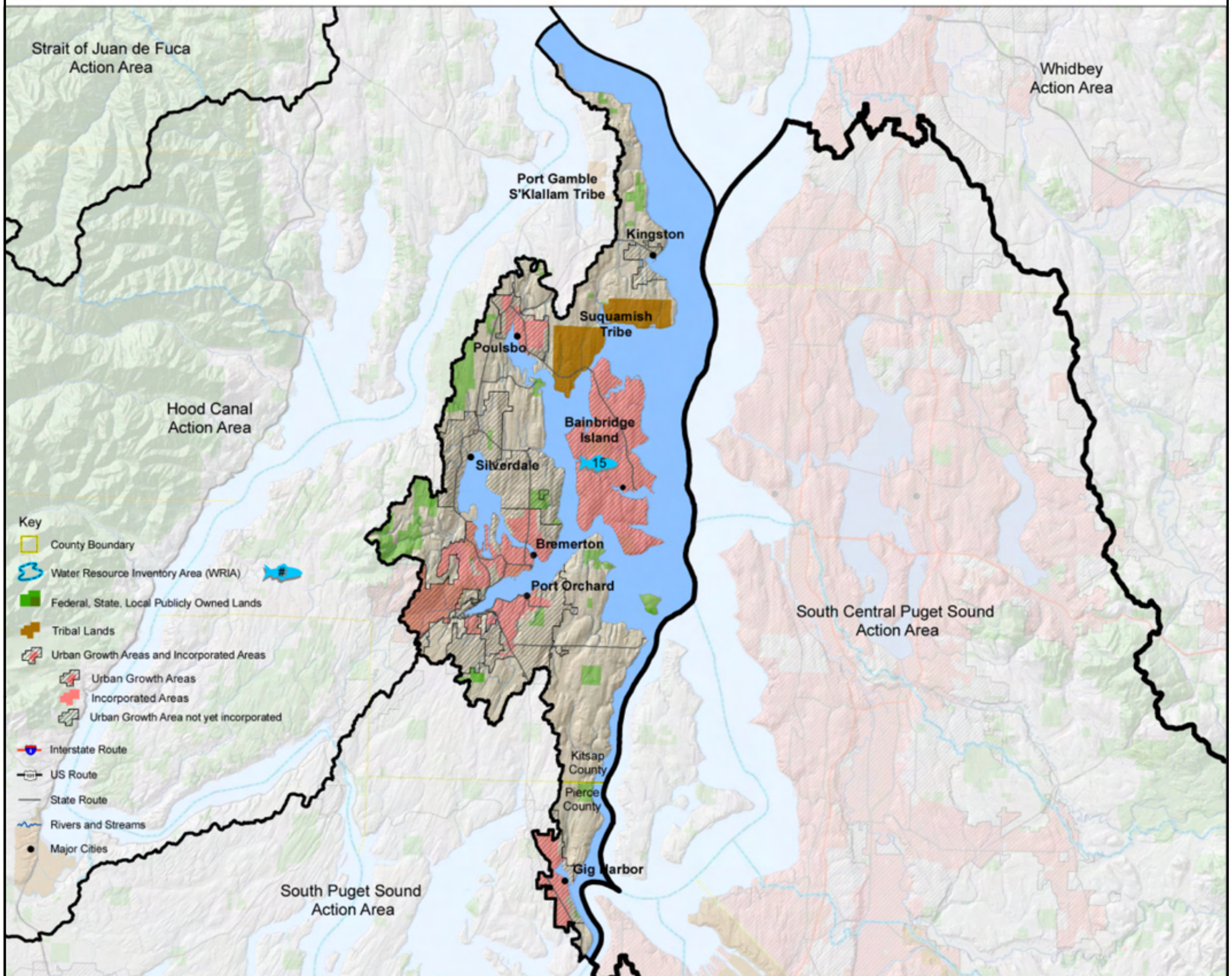
The Partnership’s Leadership Council will build the Action Agenda in part on the foundation of the existing programs that address or contribute to the health of Puget Sound. To develop the Action Agenda, the Partnership will work with local watershed groups, tribes, cities, counties, special purpose districts, and the private sector in each of the action areas. These areas collectively encompass the entire Puget Sound basin and include the uplands that drain to the marine waters.

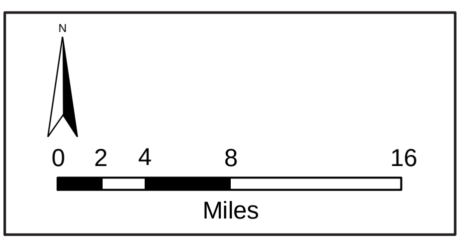
For more information, refer to www.psp.wa.gov /aa_action_areas.php.

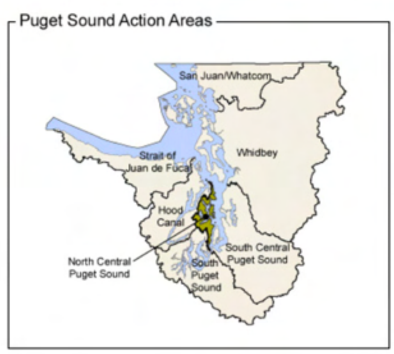
2 What factors affect hydrology in the region?

Four major factors that affect the region’s hydrology are (1) the conversion of natural land cover to developed, impervious surface, (2) filling and development in floodplains, (3) increased demand on the water supply, and (4) effects of climate change.

Exhibit 9-5. North Central Puget Sound Action Area







Source: Puget Sound Partnership

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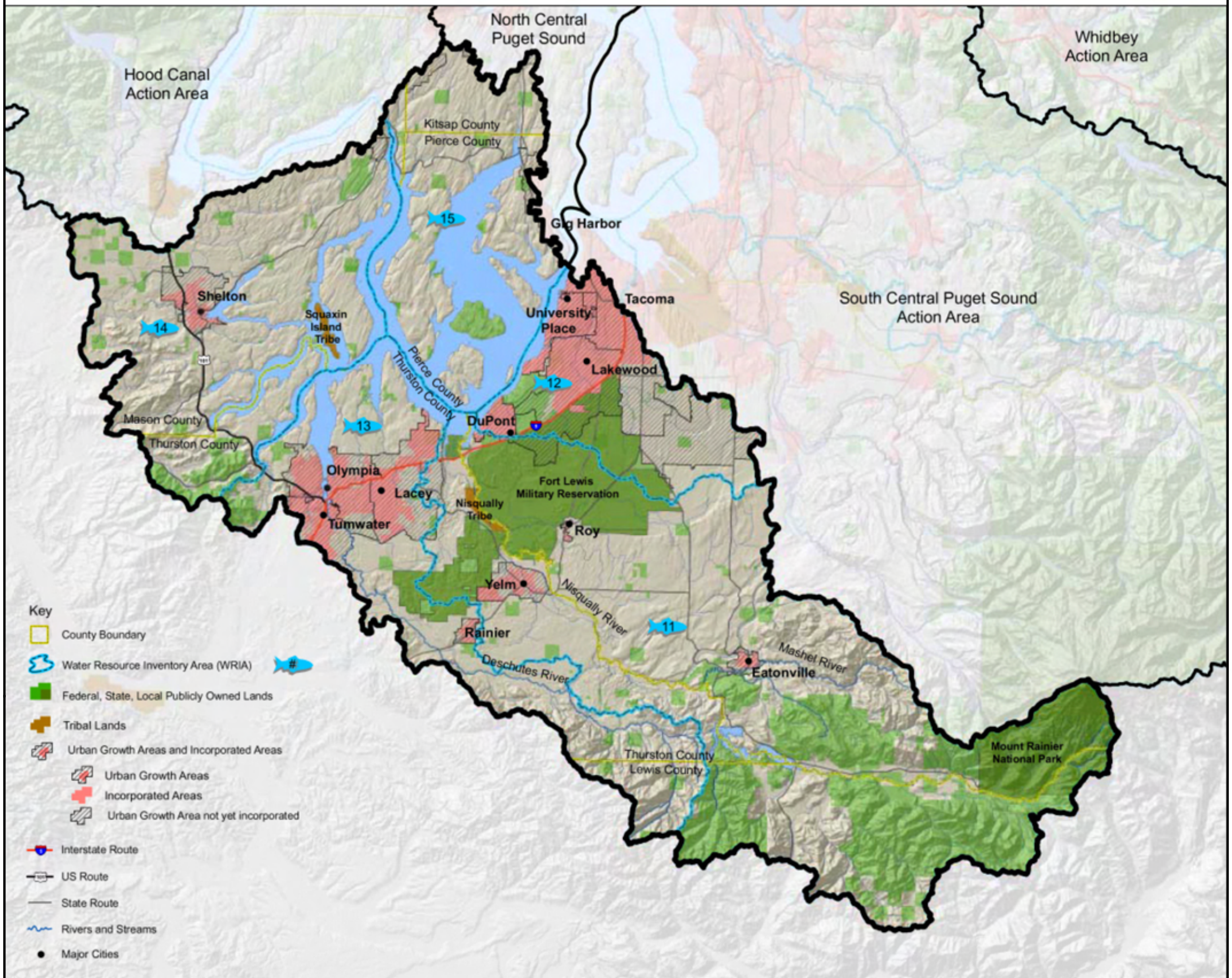
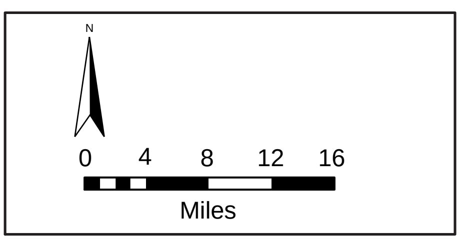
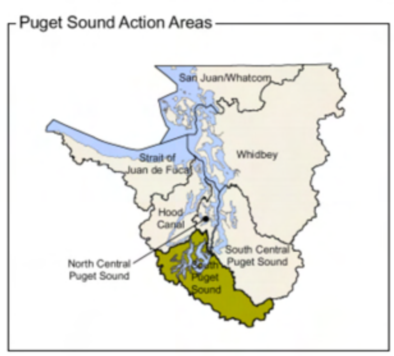
Exhibit 9-6. South Puget Sound Action Area







Source: Puget Sound Partnership

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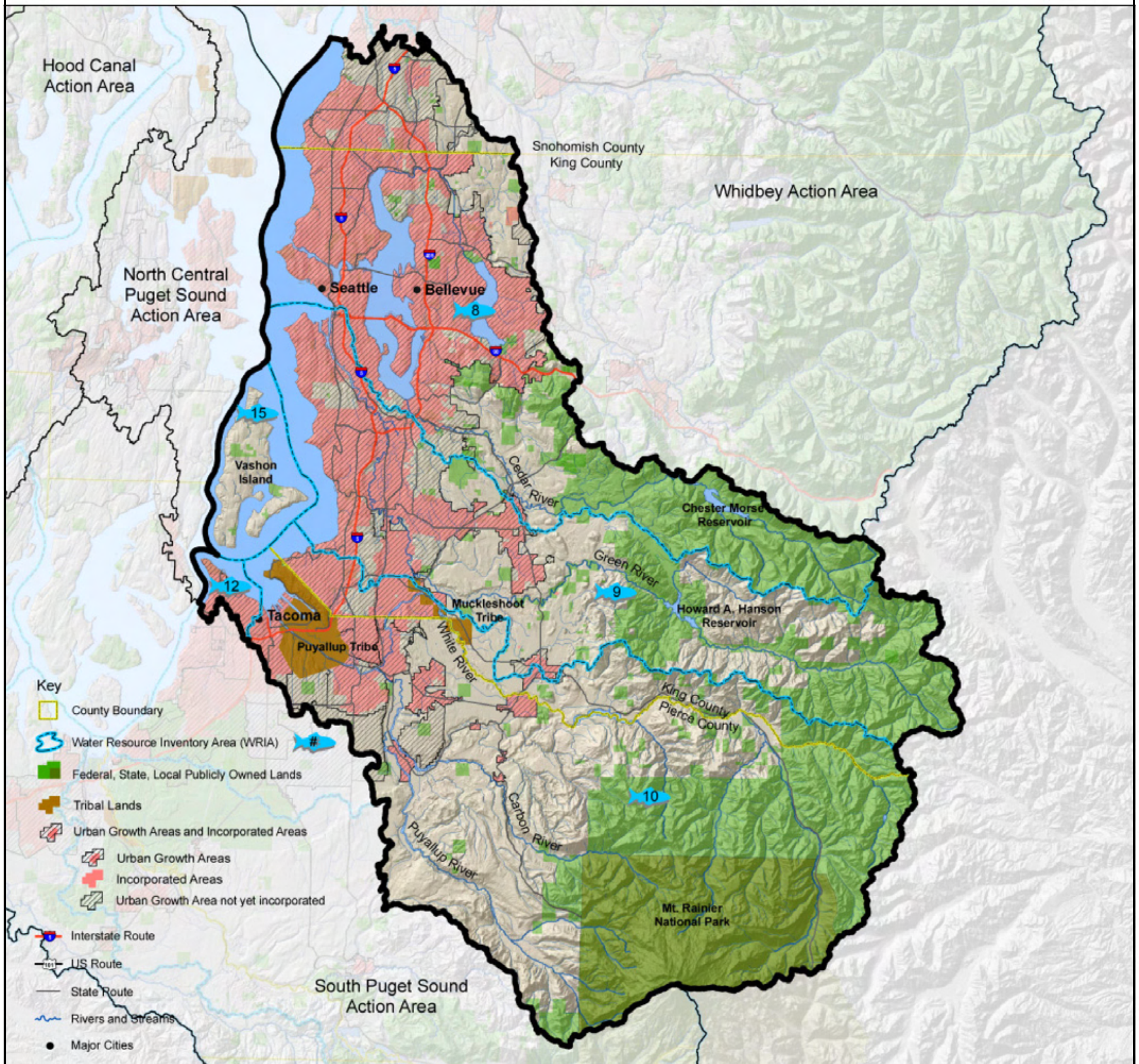
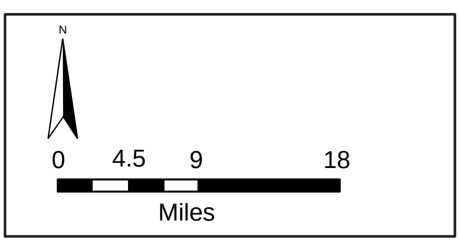
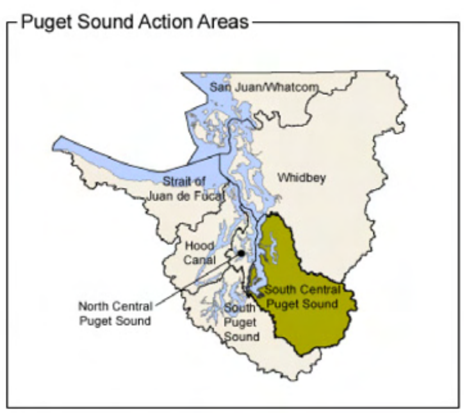
Exhibit 9-7. South Central Puget Sound Action Area







Source: Puget Sound Partnership

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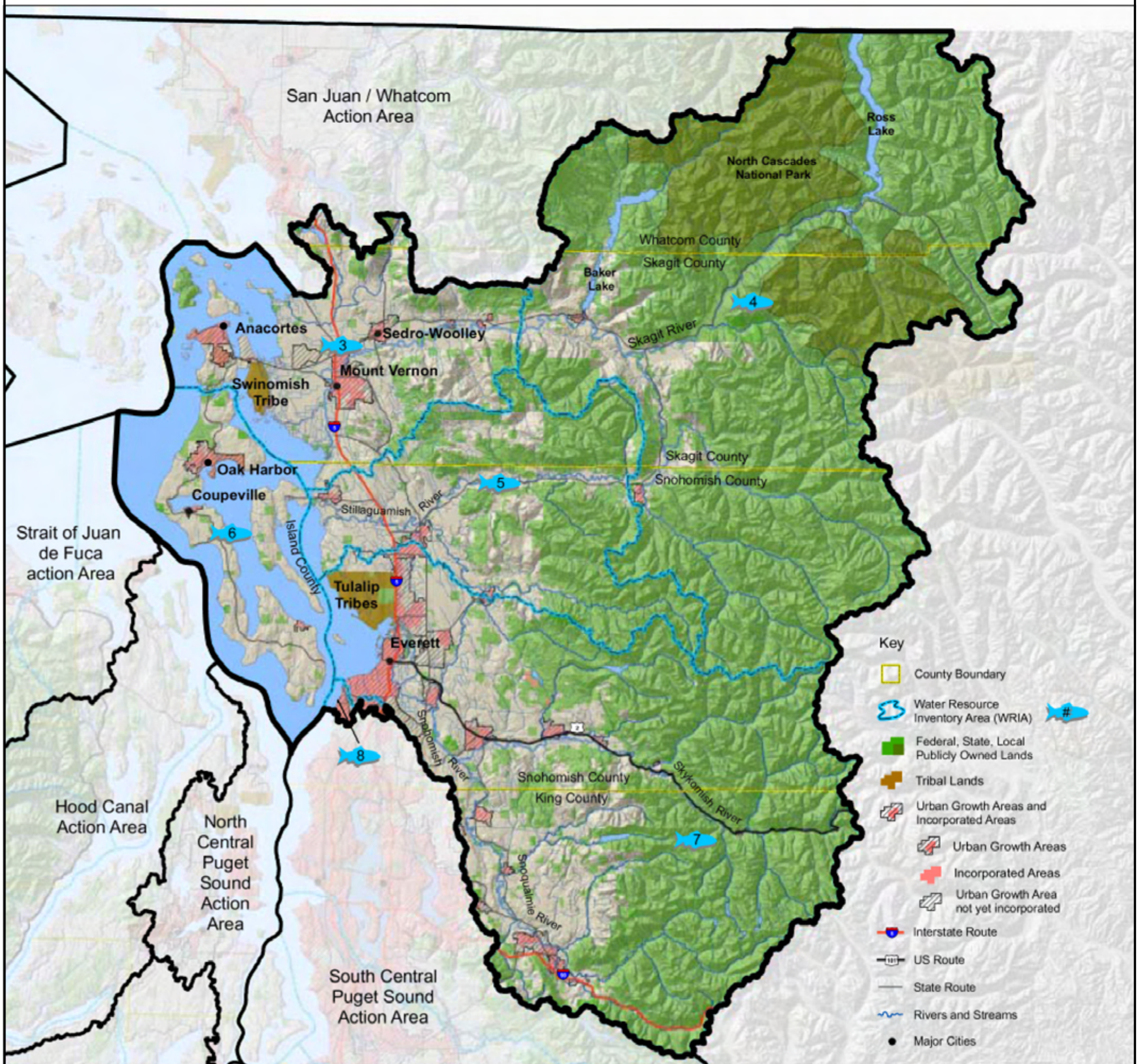
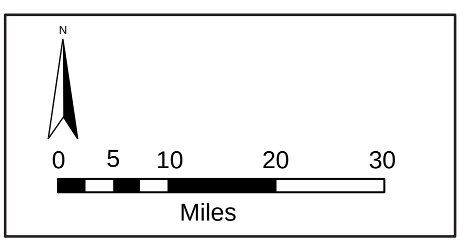
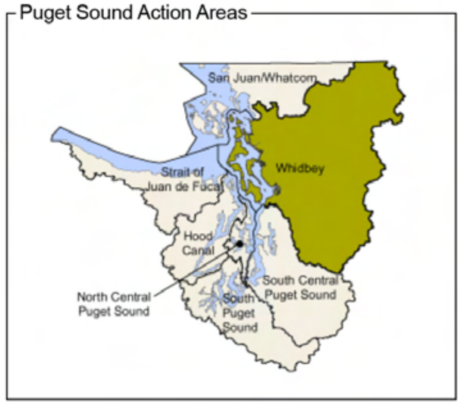
Exhibit 9-8. Whidbey Basin Action Area





Puget Sound Action Areas



Source: Puget Sound Partnership

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The Puget Sound Partnership Action Agenda identified the following primary threats to water quantity:

- The use of surface water and groundwater for municipal, industrial, or agricultural uses
- Increases in water use due to the region's growth
- Land use practices that increase impervious surfaces, change runoff patterns, disconnect surface and groundwater, and reduce wetland storage; this includes the development of transportation facilities
- Loss of coastal freshwater supply due to seawater intrusion
- Modified stream channels (including dams and levees, bridges, or culverts) and floodplains

Loss of Forest and Increase in Impervious Surface

Impervious surfaces prevent rainfall from infiltrating into the soil and groundwater and increase the volume and rate at which water runs off the surface into wetlands, streams, lakes, and the Sound. The greater volume of runoff increases the frequency of flooding, erodes channel banks and streambeds, increases sediment movement, increases the amount of pollutants carried into water bodies, and damages aquatic life. By reducing the amount of water that infiltrates, impervious surfaces can decrease aquifer recharge and reduce summer baseflow to streams. Reduced summer baseflow in streams can result in warmer temperatures that are harmful to fish and other aquatic life. Also, low stream flows and shallow water can form barriers to fish movement and migration.

In addition to impacts from increased peak flows and volumes associated with new impervious surface areas, water quality can be affected if the new impervious surfaces are significant sources of pollutants. Runoff from pollutant-generating impervious surfaces can affect the quality of drinking water supplies, as well as negatively affect aquatic life in surface waters.

Examples of impervious surfaces:

- Paved roadways, driveways, and sidewalks
- Parking lots
- Building/roof surfaces
- Roads crossing streams
- Lawns with compacted soils

What are pollutant-generating surfaces?

Pollutant-generating impervious surfaces are those surfaces that are considered to be a substantial source of pollutants in stormwater runoff and generally include surfaces subject to vehicular use, industrial activities, and storage of erodible or leachable materials.

Filling and Development in Floodplains, Estuaries, and Shorelines

Many of the large river floodplains and estuaries at the mouths of rivers have been developed during the past 150 years. Much of the shoreline of Puget Sound, including rivers and lakes, has also been altered by development. Large floodplains and estuaries were often desirable areas for agricultural, industrial, and urban development. Many roadways and other transportation facilities have followed water bodies because they provided natural pathways through the hills and mountains in the region, or around the waterways themselves. As a consequence, many of these areas were drained, filled, or altered by dikes, levees, and embankments. Transportation facilities ranging from airports to port terminals, to railways and roadways, have filled wetlands, bridged waterways, or reconstructed shorelines to accommodate transportation functions. This development has greatly reduced the flood storage, habitat, and water quality benefits that were provided by undeveloped floodplains and estuaries. Both floodplains and estuaries are critical habitat for salmonids, providing conditions for migration, rearing and refuge, foraging, and physiological adjustment during the transition from fresh to salt water.

Areas in the central Puget Sound region that have experienced significant loss of floodplain and estuary habitat include the Green/Duwamish, Puyallup, and Snohomish River systems. The loss of floodplain water storage functions results in a greater risk of flooding when levees fail, high costs associated with maintaining levees or flood insurance, and repairing damage to critical infrastructure and private property when floods occur. During the past several years, in 2006 and 2008, devastating floods occurred in many central Puget Sound rivers, where development in floodplains resulted in significant damage to property and infrastructure.

The National Marine Fisheries Service (NMFS) determined in September 2008 that the current National Flood Insurance Program in the Puget Sound region was in violation of the Endangered Species Act (ESA) because of the effects of

Homes and businesses in floodplains are at higher risk of flood damage.

Source: Washington State Department of Ecology, 2009

What are salmonids?

Salmonids are soft-finned fishes of cold and temperate waters in the family Salmonidae, which includes salmon, trout, and whitefish.

What is consumptive use?

Consumptive use of a resource reduces the supply of that resource. For water, consumptive uses include withdrawing water from rivers or groundwater for use as drinking water, for irrigation, for watering lawns, or for industrial purposes. Water extracted for these uses is not returned to the river or groundwater, but is either lost through evaporation or goes into the wastewater or stormwater system.

floodplain development on listed salmon species. By allowing development to occur in floodplains, NMFS determined that the program results in a “take” of a listed species. FEMA must revise the flood insurance program and many municipalities in the region will likely be required to revise their zoning, land use codes, and rating systems for flood insurance to avoid violating the ESA. FEMA and NMFS are currently in the process of developing new guidance, and the time frame for completion is not certain.

Water Withdrawals and Consumptive Use

In the central Puget Sound region, surface water and groundwater are consumed for municipal, commercial, agricultural, and industrial uses. With the estimated population increase of 1.5 million people in the Puget Sound region expected between 2006 and 2040, and assuming an average per capita water use of 97 gallons per day, the region would use an additional 136 million gallons of water each day, compared to current use levels (Lane, 2004).

The response to Question 6 describes how climate change would likely affect hydrology and water quality.

3 What is the current status of water quality in the central Puget Sound region?

Clean water is critical for basic needs of human and aquatic life, including safe drinking water, healthy habitats for aquatic organisms, and safe consumption of food grown in aquatic environments. The Puget Sound Partnership, in their review of water quality issues in the region, concluded that the primary transporter of pollution throughout the Puget Sound basin is surface water runoff. Past and current development and the resulting land use changes in the central Puget Sound region have resulted in degraded water quality and impairment to many water bodies. Exhibit 9-1 shows these impaired waters.

The Puget Sound Partnership Action Agenda (Puget Sound Partnership, 2008a) identifies the current status and major threats to water quality in the region. Key conclusions include the following:

Types of toxics that are of concern in the region:

Metals – copper, zinc

Oil and petroleum products

Polycyclic aromatic hydrocarbons (PAHs)

Polychlorinated biphenyls (PCBs)

Pharmaceuticals and personal care products

Pesticides

Phthalates – plasticizers

Endocrine disruptors

Polybrominated diphenyl ethers (PBDEs) – flame retardants

- More than 1,000 rivers and lakes are listed as impaired (Clean Water Act listings) from pathogens, nutrients, or chemicals.
- Low levels of dissolved oxygen and 'dead zones' are occurring with increasing frequency in Hood Canal and the South Sound, related to increased nutrients entering the Sound.
- About 30,000 acres of shellfish beds that were closed in 1980 remain closed due to the presence of pathogens, toxic contaminants, and shellfish toxins related to harmful algal blooms.
- Health advisories limiting the consumption of fish from Puget Sound have been issued due to polychlorinated biphenyls (PCBs) and mercury, among other contaminants.

Major categories of pollutants affecting the region's water quality include toxics, pathogens, and nutrients. In addition, a number of other types of impairment, including high temperatures, low levels of dissolved oxygen, suspended solids, and changes in acidity, are affecting water quality in the region.

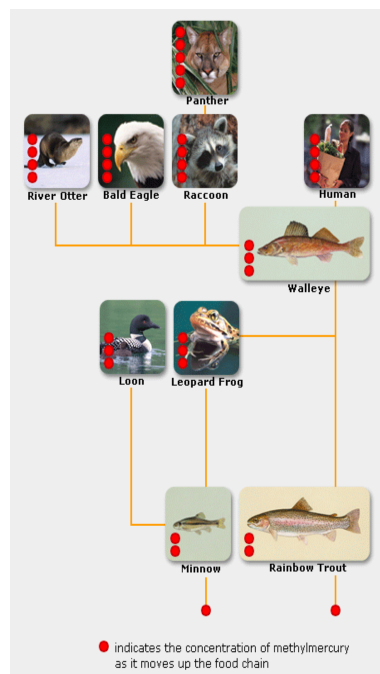
Toxics include metals, oil and petroleum products, phthalates, pesticides, PCBs, endocrine disruptors, pharmaceuticals, and polybrominated diphenyl ether (PBDE) flame retardants. Air deposition of toxics from vehicles onto the water is potentially a major contributor to water pollution (PSCAA and Public Health, 2008). These pollutants can have acute or chronic toxicity for people and wildlife and the effects of contact or ingestion of contaminated water are much greater in vulnerable populations such as children, the elderly, and those with compromised immune systems (Frumkin and Gaffield, 2004).

Many of these substances can increase in concentration as they move up the food web. As a consequence, fish, such as salmon, that feed on invertebrates and other fish often have very high concentrations of these substances in their tissues and can be a health risk for people consuming them. Southern Resident orcas in Puget Sound have some of the highest concentrations of PCBs of any animals in the world, due to their consumption

What is bioaccumulation?

Bioaccumulation refers to the process by which a concentration of a substance increases as it moves up the food chain. When mercury enters the water, it is transformed into a more toxic substance called methylmercury. Methylmercury is absorbed more easily by bacteria and small plants. These bacteria and plants are eaten by small fish, which in turn are eaten by larger fish. By the time a fish-eating bird or mammal eats the larger fish, the concentration of methylmercury in the fish can be up to a million times higher than in the surrounding water.

Source: National Wildlife Federation, 2009



of contaminated fish from Puget Sound. Orcas are now a listed species under the ESA (refer to Chapter 10: Ecosystems and Endangered Species Act Issues for more information).

Human consumption of these fish can lead to chronic health problems, and children are at the greatest risk for developmental effects from such exposure. Tribes in the region and some immigrant populations are at particular risk because they tend to consume more of what they catch and eat more bottom fish than the general population. They may also experience serious health, social, and economic consequences if traditional marine food sources become scarce or unavailable because of contamination (PSCAA and Public Health, 2008).

4 What factors are affecting water quality in the region?

The transportation system is a significant source of pollutants that affect water quality. Roadways and parking lots are a source of metals, polycyclic aromatic hydrocarbons (PAHs), oil and petroleum products, and particulates. Vehicles (including buses, trains, and ferries) are a source of greenhouse gas emissions and particulates. Although these enter the air, deposition to surface waters is one route by which nitrogen and particulates enter surface waters.

The Puget Sound Partnership Action Agenda identified several sources of water pollution from the transportation system, including land-based vehicles, planes, and recreational and commercial ships. Roads and rail systems contribute pollutants from road surfaces, brake pads, oil leaks, vehicle emissions, and maintenance of rights of way. Aviation contributes emissions, deicing compounds, brake pads, and oil/fuel leaks, and ships contribute anti-fouling compounds, oil/fuel leaks, personal care products, pathogens, fecal coliforms, emissions, and ballast water. Ballast water can contain pollutants but can also be a source of invasive non-native species.

Transportation-related pollutants may enter regional water bodies.

Source: NOAA, 2008

Transportation programs that are designed to address issues such as congestion, emissions, fuel use, or waste management can indirectly benefit water quality through reduction of pollutants entering the environment. There have been limited studies on the link between air emissions and water quality degradation. Therefore, it is difficult to know if emission control programs are having any effect on improved water quality. However, historical data on lead reduction in dust or along roadways when leaded gasoline was phased out demonstrate that control of air emissions and adoption of new automotive products or technologies can significantly reduce sources of pollution.

Increased population pressure and development, with the conversion of forested areas to impervious surfaces, is the major factor affecting water quality in the region (Puget Sound Partnership, 2008a). Similarly, greater numbers of people in the region result in greater volumes of wastewater, more septic systems, and more sources of nutrients entering surface waters.

5 How is water regulated?

A number of policies and regulations directly affect both water quantity and water quality and focus specifically on managing the impacts of growth and development. The federal Clean Water Act (CWA) and the state's Water Pollution Control Act govern water supply, discharges of pollutants to waters, water quality standards, and discharges to wetlands and streams. The Growth Management and Shoreline Management Acts govern land use, provide protection for critical areas including surface waters and groundwater, and provide protection to reduce the potential for impacts to water quality and quantity.

Stormwater is regulated by the Washington State Department of Ecology (Ecology), through comprehensive stormwater management regulations for construction and operation phases of projects, and the National Pollutant Discharge Elimination System (NPDES) permits under the CWA for municipal stormwater systems.

Water quality and quantity are also affected by the ESA when aquatic areas are designated as critical habitat, or when impacts to water quality could affect listed species. Finally, water quantity is affected by a number of regulations and policies in

Major federal and state regulations affecting water in Washington state include the following:

Federal

National/State Environmental Policy Acts
Coastal Zone Management Act
Federal Insecticide, Fungicide, and Rodenticide Act
Federal Drug and Cosmetic Act
Toxic Substances Control Act
Federal Clean Water Act
Federal Clean Air Act

State

Floodplain Management Act
Growth Management Act
Shoreline Management Act
Forest Practices Act
Model Toxics Control Act
Water Code of 1917
The 1945 Ground Water Code
Water Resources Act of 1971
1969 Minimum Water Flows and Levels
1998 Watershed Planning Act
Metals, Mining and Milling Act
Vessel Oil Spill Prevention and Response
Water Pollution Control Act
Oil and Hazardous Substance Spill Prevention and Response
Dairy Nutrient Management Act
State Clean Air Act
Motor Vehicle Emission Control Act
Hazardous Waste Reduction Act
State Solid Waste Act
Hazardous Substance Information Act

Washington state. Water rights law and in-stream flow rules established by Ecology govern the right to withdraw water from streams and groundwater.

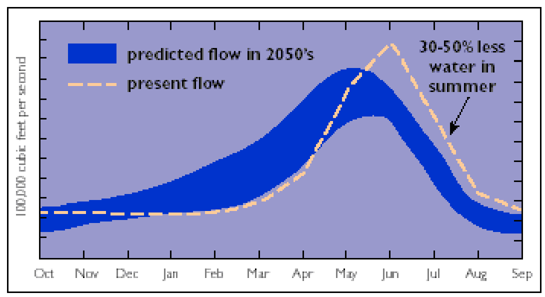
A large number of federal and state regulations also deal with factors that indirectly affect water quality—source control, pollution prevention, water resource management, and waste management (refer to sidebar for a partial list).

6 How is climate change expected to affect hydrology or water quality?

Although climate change models do not provide detailed predictions at the local level, several general conclusions about the effects of climate change in the Pacific Northwest are now well accepted by scientists. The University of Washington Climate Impacts Group models indicate that the combination of reduced snowpack and earlier peak runoff times will affect regional water supplies and flooding. In addition, the biological communities of rivers, freshwater wetlands, and estuaries—fish, aquatic insects, birds, mammals, plants, and amphibians—are affected by the volume, timing, velocity, and rates of change of water supplies. Changes in the natural hydrology in terms of volumes or timing will affect aquatic life, although some of these impacts are not well understood.

The Climate Impacts Group from the University of Washington conducted modeling of the major water supply drainage basins (the Sultan, Tolt, Cedar, Green, and White rivers), which indicated that by 2075 the average discharge is predicted to decrease by 27 to 42 percent during the summer (Polebitski et al., 2007). Warmer temperatures during the summer would likely result in an increased demand for water use at a time when flows are reduced. These changes are likely to put additional pressure on water supplies for human consumption. At the same time, low flow conditions and warmer summer stream temperatures may negatively affect habitat for aquatic life, especially salmonids.

With more precipitation falling as rain and a predicted increase in the frequency of rain-on-snow events, the frequency and



Climate Impacts Group Waterflow Forecasts

The blue band indicates the upper and lower bounds of projected average streamflow in the 2050s. Note the higher winter flows, reduced spring/summer flows, and the shift in the timing of peak spring flows earlier into the spring season.

Source: Polebitski et al., 2007

severity of winter flooding is expected to increase. The Climate Impacts Group's models for central Puget Sound river basins predict that winter flows will increase by 41 to 57 percent (Polebitski et al., 2007). A more rapid runoff regime, as opposed to the slow release of water from the snowpack, could also decrease groundwater recharge and negatively affect groundwater supplies.

Water quality could be affected by changes in water quantity in two ways: (1) increased rainfall during the winter over impervious surfaces may increase the discharge of pollutants to surface waters, and (2) if low flow conditions become more common in the summer, any pollutants in surface waters will be more concentrated, with potentially greater effects on aquatic life.

What is the difference between plan-level and project-level environmental review?

This FEIS is a plan-level (rather than a project-level) EIS. Accordingly, alternatives are defined and environmental effects are evaluated at a relatively broad level. More detailed project-specific environmental review will be developed as appropriate in the future for projects identified in the Transportation 2040 plan that are selected for implementation by their respective sponsors, for example, Washington State Department of Transportation (WSDOT), transit agencies, and local jurisdictions.

7 What effects on water quality and hydrology are common to all alternatives?

While specific hydrology and water quality effects would be determined during the project-level environmental review for the projects included in the Transportation 2040 plan alternatives, some systemwide effects common to all alternatives are described in this section.

Long-term Effects

For some of the factors affecting hydrology and water quality previously noted in the responses to Questions 2 and 4, there is likely to be little differentiation among the alternatives. These include (a) the use of surface water and groundwater for municipal, industrial, or agricultural uses; (b) increases in water use due to the region's growth; and (c) loss of coastal freshwater supply due to seawater intrusion. For each of these factors, few differences exist among the different transportation alternatives. There are also consistent land use assumptions among each of the alternatives, and relatively modest land use differences at the sub-regional level.

Potential impacts resulting from the Transportation 2040 alternatives include those due to the creation of new impervious surfaces and new pollutant-generating impervious surfaces, and effects from automobile emissions. Water quality and hydrology impacts would include increased sources of pollutants, increased runoff, and decreased infiltration associated with new impervious surfaces.

Impervious surfaces. In terms of hydrology and water quality, all alternatives would result in new or replaced impervious surfaces, including impervious surfaces that generate pollutants. New impervious surfaces can increase the frequency of peak flow rates and the volume of stormwater runoff. Both of these could result in increases in impacts to stream beds, stream banks, and altered wetlands. Eroded sediment can be deposited as the stream slope decreases, which could lead to drainage problems and local flooding. In addition, large areas of new impervious surface could reduce groundwater recharge and summer low flow rate and increase summer water temperatures. The types of effects on water quality and hydrology are expected to be similar across all the alternatives, because these effects are primarily caused by the amount of impervious surface. While the overall impact of any alternative on increasing the amount of impervious surfaces would likely be relatively minor compared to the current amount of impervious surfaces that exist in the region, some differences do exist among the alternatives.

Pollutants. In addition to impacts from increased peak flows and volumes associated with new impervious surface areas, water quality could also be affected if the new impervious surfaces are pollutant-generating. Runoff from pollutant-generating impervious surfaces contains numerous pollutants that can negatively affect the beneficial uses of the receiving water if treatment prior to discharge is not provided. While the overall impact of any alternative on increasing the amount of pollutant-generating impervious surfaces would be relatively minor compared to the current amount of these surfaces that exist in the region, differences do exist among the alternatives.

All of the alternatives would result in continuing air emissions (a potential source of pollutants to water, as well as a source of greenhouse gases that are linked to climate change). In addition, all of the alternatives assume the continued operation of the existing transportation system. As such, the existing impacts to water quality and hydrology would continue unless additional mitigation measures are implemented.

Effects on water quality and hydrology from all the alternatives would include the following:

- Water quality or hydrology impacts may result from the major new projects that are included in all alternatives, such as the Alaskan Way Viaduct and SR 520 improvements; however, as these and other projects replace or improve existing facilities, an opportunity exists to improve their environmental performance compared to today. Many of these facilities lack modern systems for water quantity or quality management.
- Roadways and parking lots will be a continuing and increased source of pollutants (metals, PAHs, oil/petroleum products, particulates) that enter surface water and groundwater, particularly as traffic volumes increase. There will be an increase in the amount of, and effects of, impervious surfaces on hydrology in the form of increased peak flows, decreased infiltration, decreased aquifer recharge, and increased frequency of low flows.

Construction Impacts

All the alternatives would be affected by construction because new transportation facilities are part of each alternative. The construction-related impacts would be temporary and could be minimized or prevented through the proper implementation of best management practices. Construction impacts could include (1) erosion and sedimentation, (2) compaction and soil disturbance during staging, (3) in-water construction for culverts or bridges, and (4) dewatering.

Sediment and other contaminants in construction runoff can increase turbidity and affect other water quality parameters, such as the amount of oxygen available in the water. Clearing and grading, particularly in locations adjacent to streams or wetlands, could temporarily increase turbidity. This increase would occur due to erosion of disturbed soil areas or soil stockpiles, and stormwater runoff transporting silt and sediment to receiving water. Stormwater runoff could also carry other contaminants, such as fuel and oil from construction operations, particularly at staging areas. Impacts associated with spills are most likely to occur at staging areas.

Construction impacts associated with culvert extensions and/or replacements and bridge construction are only likely to occur on perennial streams, because this work would likely require a stream diversion during construction, increasing turbidity and temporarily affecting water quality. Any in-water construction would be required to comply with permit conditions that are designed to avoid and minimize impacts to fish and other aquatic life. Construction of retaining walls or short tunnels would likely require temporary dewatering. The water resulting from the dewatering process would be treated, as needed, prior to discharge to minimize or prevent impacts such as increased turbidity or erosion.

What is a lane mile?

The term lane mile is used to describe the size of a transportation project because it accounts for the width of a project in addition to its length.

For example, one mile of a two-lane highway equals two lane miles. Therefore, a project that widens four miles of a two-lane highway to four lanes is said to have created eight new lane miles.

8 What effects on water quality and hydrology are specific to individual alternatives?

Two factors are related to potential impacts to water quality and hydrology: (1) total area of new impervious surface (in particular to pollutant-generating impervious surface from roadways, rail lines, and parking lots), and (2) vehicle miles traveled (VMT). The total acreage of new infrastructure (e.g., lane miles and park-and-ride stalls) is used as a surrogate for total new impervious surface, and the estimated new impervious surface can be used to assess the potential impacts from the different alternatives. It should be noted that new infrastructure projects are often built on existing impervious surface, so the new projects offer an opportunity to improve existing stormwater treatment methods, resulting in improved water quality. These opportunities would be discussed in detail in future project-level environmental review. For the purposes of this analysis, however, new impervious surface is used to provide a rough comparison among the plan alternatives. The amount of VMT could also affect the quantity of pollutants (runoff from surfaces and air emissions).

Water Quality Impacts from New Impervious Surface and VMT

The Transportation 2040 alternatives contain varying levels of new acres of impervious surface (Exhibit 9-9), and it is likely that the alternatives with the most new impervious surface would result in the greatest number of effects on water resources. The types of impacts to hydrology are expected to be similar among alternatives. These include changes in flow regimes, such as increases in peak flows, greater volumes of runoff, and potentially lower baseflows.

Exhibit 9-9[1]

Acres of New Lane Miles and Park-and-Ride Stalls for Each Alternative

	2040 Baseline	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Preferred Alt
Acres of New Lane Miles	28,582	28,871	29,839	29,150	29,072	28,842	29,482
Acres of New P&R Stalls	539	619	707	690	631	765	657
TOTAL ACRES	29,121	29,490	30,546	29,840	29,703	29,607	30,139

Source: PSRC, 2010

Total acres of impervious surface due to new lane miles and park-and-ride stalls were assumed to be a surrogate for impacts caused by new impervious surfaces. Alternative 2 contains the greatest number of new acres of impervious surface, and the Preferred Alternative has the second-greatest area of new impervious surface. The Baseline Alternative contains the fewest acres of new impervious surface. Of the action alternatives, Alternative 1 contains the fewest number of new acres of impervious surface. Therefore, Alternative 2 would likely result in the highest number of effects on water quality

[1] This exhibit has changed since the DEIS.

and hydrology, with effects from the Preferred Alternative being slightly lower than Alternative 2. The Baseline Alternative would likely result in the lowest number. Among the action alternatives, Alternative 1 would likely result in the lowest number of effects on water quality and hydrology. The number of effects resulting from Alternatives 3, 4, 5, and the Preferred Alternative would likely fall between the overall number of effects expected for Alternatives 1 and 2.

The comparisons presented here are intended to approximate the number of effects expected from each alternative and do not identify specific effects to water quality and hydrology. Future project-level environmental review would identify these effects.

The generation of pollutants by the transportation system is also dependent on VMT. Alternative 5 has the lowest VMT, and the Preferred Alternative has the second-lowest VMT, due to a reduction in the number and average length of trips (refer to Chapter 4: Transportation), reliance on demand management, and emphasis on alternatives to single-occupancy vehicle travel. The greater trip reduction associated with Alternative 5 and the Preferred Alternative would result in fewer sources of vehicle-generated pollutants (e.g., brake pads, oil) and reduced greenhouse gas emissions. Therefore, pollutant sources would be somewhat lower for these alternatives, and water quality impacts would be lower as well.

Marine Water Quality Impacts from the Ferry System

Potential water quality impacts (oil spills, oil leaks) from new ferry routes and impervious surfaces associated with terminals and parking lots would likely differ among alternatives. Alternatives that expand the ferry system could affect marine water quality due to new ferry routes, impervious surfaces associated with terminals and parking lots, and ferry terminal construction. Water quality impacts could result from increased oil spills or leaks associated with increased ferry trips, increased emissions from ferry traffic, and increased runoff and pollutant sources from parking lots and ferry terminal roadways.

Detailed information is not available on the specific number of ferry-related projects. However, the alternatives can be ranked based on the general emphasis on using the existing ferry system or constructing new components. The Baseline Alternative and Alternative 1 rely on the existing ferry system. Alternatives 3, 4, and 5 include minor expansion of the system, focusing mostly on expanding passenger-only services, which would reduce the need for larger terminals, compared to auto ferries. Alternative 2 includes expansion of the existing ferry system based on demand.

Based on this general ranking, Alternative 2 would be expected to have the greatest potential impacts to water quality and hydrology, with the Preferred Alternative resulting in similar but slightly lower impacts. The Baseline Alternative and Alternative 1 would be similar and have the lowest potential impacts.

Development and Impervious Surface near Estuaries and Floodplains

Changes to hydrology and water quality impacts would depend on how much new impervious surface is associated with transportation infrastructure and where this occurs (e.g., in or adjacent to wetlands, streams, or shorelines). As noted above, construction of new facilities can provide opportunities to improve existing impervious surfaces, resulting in improved water quality, which would be discussed in future project-level environmental documents. Detailed information on project locations is not available for this plan-level FEIS. However, potential impacts to water quality and hydrology from increases in impervious surface and construction near surface waters can be estimated by the number of transit, roadway, and ferry-related projects in the vicinity of mapped floodplains or flood zones (Exhibit 9-10).

What are the limitations of the proximity analysis?

The purpose of the proximity analysis was to identify relative potential for impacts among alternatives, not to identify absolute numbers of potential impacts. As these projects are implemented, the actual number of impacts would be far less than shown, since the projects would be designed to avoid these impacts.

Exhibit 9-10
Projects in the Vicinity of Flood Zones

Project Type	Baseline Alt	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Preferred Alt
Transit, roadway, and ferry related projects	50	82	205	113	117	106	232
Nonmotorized projects	7	19	41	39	41	108	105*

*Alternative 5 included many small bike concepts in urban centers throughout the region. During review of the DEIS alternatives, it was discovered that many of these concepts were already built, others were unable to find a sponsor, and others were deleted for other reasons. Concurrently, a smaller number of long nonmotorized projects were added to the Preferred Alternative that weren't in Alternative 5. This explains why the total nonmotorized mileage increased for the Preferred Alternative relative to Alternative 5, but the number of project proximity impacts decreased.

The Preferred Alternative has more transit, roadway, and ferry-related projects near flood zones than the Baseline Alternative or other action alternatives. Without adequate mitigation, this would result in greater increases in peak flows, a potential increase in flooding, greater runoff of pollutants to surface waters, and changes to aquatic habitat structure that can affect aquatic species. Increased channel incision, loss of floodplain connections, scouring, and erosion could result from increased impervious surfaces and habitat loss in floodplains or wetlands.

The Baseline Alternative would result in the fewest potential impacts to flow regimes and water quality adjacent to aquatic habitats. Of the action alternatives, Alternative 1 would result in the fewest potential impacts to flow regimes and water quality.

9 What cumulative effects could occur if the Transportation 2040 actions coincide with other planned actions?

The existing sources of hydrology and water quality impairments in the central Puget Sound region reflect past and present cumulative effects. Future cumulative effects on water quality and hydrology could be affected by other regional plans and actions. Local jurisdictions throughout the region may revise their existing land use plans to be consistent with VISION 2040 and complement the Transportation 2040 Preferred Alternative. New development resulting from these plans could have both positive and negative effects on the environment.

What are cumulative effects?

Cumulative effects address the impact on the environment that results from the incremental impact of the action being considered when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

PSRC has analyzed the development pattern changes that could result from the transportation alternatives (refer to Chapter 5: Land Use, Population, Employment, and Housing). Based on the results of this analysis, PSRC has concluded that none of the Transportation 2040 alternatives would induce future land use and development pattern changes that are substantively different than the Baseline Alternative. In addition, all of the Transportation 2040 alternatives are consistent with the adopted VISION 2040 Regional Growth Strategy. Therefore, none of the Transportation 2040 alternatives would result in additional cumulative effects on water quality and hydrology.

10 How can the effects to water quality and hydrology be mitigated?

Mitigation of Construction Impacts

All projects associated with the Transportation 2040 actions would meet all applicable requirements for controlling runoff and limiting erosion at construction sites. However, the transportation alternatives have differing levels of construction, and different mitigation actions could be required depending on the alternative.

Water quality impacts during construction could be substantially reduced or eliminated by implementing temporary erosion and sediment control best management practices (BMPs). Examples of temporary erosion and sediment control BMPs include cover measures, perimeter protection, and sediment ponds. Contractors would be required to develop a Surface Water Pollution Prevention Plan, which could include a Spill Prevention, Control, and Countermeasures Plan as part of NPDES permit requirements. These plans would develop site-specific BMPs, operating procedures, and monitoring protocols intended to minimize or prevent impacts to water quality during construction.

Impacts associated with in-water or over-water work could also be minimized and/or prevented by using BMPs to prevent construction materials or runoff from entering surface waters, and/or complying with permit conditions. Use of concrete or steel pilings, and vibrating pilings in place rather than pile driving, can minimize potential pollutants entering the water or disturbance to sediments.

For alternatives that rely more on use or expansion of the existing transportation system, construction mitigation could include the following measures:

- Conduct work from existing roadways or rights of way rather than clearing new staging areas.
- Protect adjacent surface waters with sediment and erosion control fencing.
- Develop a Surface Water Pollution Prevention Plan, which could include a Spill Prevention, Control, and Countermeasures Plan to avoid runoff from the construction site.

Detention ponds are stormwater control structures that hold and treat stormwater runoff.

Source: Wikipedia, 2007

Mitigation of Long-term Effects

Stormwater treatment and detention for any of the alternatives would be designed in accordance with applicable stormwater management and water quality regulations and permit conditions. Potential stormwater impacts could be mitigated by designs that minimize the amount of impervious surface, use of low-impact design techniques such as the use of pervious pavers or dispersal BMPs, and/or created wetlands or swales to manage runoff volumes. Implementation of low-impact design techniques could be used particularly for new park-and-ride stalls for all alternatives to reduce impacts from new impervious surfaces.

In the design of new facilities or retrofit of existing facilities, projects could use improved stormwater detention and treatment systems to address erosion, increased flows, and pollution. These improvements could include natural systems and measures such as providing wetlands, as well as measures to restore buffers and natural channels for streams alongside transportation facilities. Where these locations are not the most beneficial, project sponsors could consider mitigation banking programs to create economies of scale for larger projects. In addition, where existing infrastructure limits opportunities to mitigate for stormwater or habitat, off-site mitigation opportunities could be used. Off-site mitigation is typically implemented using a watershed approach that offsets project impacts at areas within the local watershed where effects would be most beneficial.

Reductions in VMT would reduce the amount of pollutants generated by vehicles. The use of innovative technologies (e.g., sweepers capable of picking up fine particulates) could also help control potential water pollution at the source, as could programs that promote cleaner fuels and vehicles.

A combination of incentives and disincentives could be used to promote clean vehicles, such as higher taxes on ‘dirty’ fuels or tax credits for clean fuels and vehicles. As part of future regional or national greenhouse gas cap and trade programs, incentives could be provided for offsets or reductions in greenhouse gas emissions from other sectors to balance expected emissions from the transportation sector. Such offsets would mitigate greenhouse gas emissions and potentially other air pollutants such as particulates.

11 Are there significant unavoidable adverse impacts to water quality and hydrology?

It is expected that any of the alternatives could have some significant unavoidable adverse impacts to water quality and hydrology, in particular with respect to construction. New impervious surfaces, new pollutant-generating impervious surfaces, and increases in VMT would result in some adverse impacts to water quality and hydrology, but at different levels among the alternatives. Minimization and mitigation measures for specific projects, if properly designed and implemented, would be able to largely offset these adverse impacts. Facilities for specific project actions would be designed to meet all applicable federal, state, and local regulations related to stormwater runoff and water quality.