4.6 Air Quality and Greenhouse Gases

4.6.1 Summary

This air quality and greenhouse gas analysis provides information regarding potential local and regional impacts on air quality associated with the FWLE. The FWLE would have a minor benefit to air quality from reduced traffic volumes and congestion in the corridor. It would have no adverse impacts because light rail trains are electrically powered with no emissions.

The U.S. Environmental Protection Agency (EPA) has mandated improvements in fuel efficiency over the next 20 years that would reduce transportation emissions from existing conditions with both the No Build Alternative and build alternatives. King County is a "maintenance" area for carbon monoxide (CO). Regardless of the FWLE alternative chosen, CO concentrations would not exceed EPA's National Ambient Air Quality Standard (NAAQS) for CO. Because the FWLE is included in the Regional Transportation Improvement Program and would not exceed the CO NAAQS, the project would conform with the regional air quality maintenance plan.

Air Quality Attainment and Maintenance Areas

When a region meets the air quality standard for a given pollutant, it is designated as being in "attainment" for that pollutant. If it does not meet the air quality standard, it is designated as being in "nonattainment." Areas once designated as nonattainment areas that now meet the standard are designated "maintenance" areas. Areas with insufficient data to designate the area or where the designations have yet to be made are "unclassified."

For all build alternatives, mobile source air toxics (MSATs) emissions within the FWLE corridor would be lower than existing levels and the No Build Alternative because of continued improvements resulting from EPA's national control programs. As a result, the FWLE would have minimal air quality impacts for Clean Air Act (CAA) criteria pollutants and would not raise any special MSAT concerns.

Greenhouse gas (GHG) emissions are estimated to decrease from existing conditions to the 2035 No Build and build alternatives. All build alternatives would result in a reduction in vehicle miles traveled (VMT), which would lower GHG emissions within the project corridor. However, the light rail system's electrical consumption for each build alternative would indirectly add GHG emissions related to energy production outside the project corridor.

Appendix D4.6 presents information on air quality standards and modeling results.

4.6.2 Introduction

The Puget Sound Clean Air Agency (PSCAA), EPA, and Washington State Department of Ecology (Ecology) work together to regulate air quality in the FWLE corridor. Appendix D4.6 discusses these agencies' applicable regulations and regulatory guidance. It includes the detailed air quality analysis prepared for the FWLE project related to:

- Criteria pollutants and air toxic emissions
- Mobile source air toxic emissions
- Greenhouse gases
- Regional air quality conformity

4.6.3 Affected Environment

4.6.3.1 Regional Climate

The FWLE corridor is in lower-elevation lands surrounding Puget Sound. Variations in temperature, length of the growing season, fog, rainfall, and snowfall are related to such factors as distance from the sound, the rolling terrain, and air from the ocean reaching this area through the Strait of Juan de Fuca. Although this is the most densely populated and industrialized area in the state, there is sufficient wind most of the year to disperse air pollutants released into the atmosphere. Air pollution is usually most noticeable in the late fall and winter season, under clear skies, light wind, and a temperature inversion. These conditions may prevail for a few days before a weather system moves through and wind and rain remove the air pollution.

4.6.3.2 Pollutants of Concern

Air quality is affected by pollutants generated by both natural and human-caused sources. Of the latter, the largest contributors are generally fossil fuel combustion sources such as transportation and industrial operations. The largest contributors of transportation pollution are motor vehicles. Pollutants of concern for this project include the pollutants emitted from motor vehicles, which include CO; particulates; ozone (O_3) and its precursors, including nitrogen oxides (NO_x) and volatile organic compounds (VOCs); air toxics; and GHGs.

Carbon Monoxide

In urban areas, motor vehicles are the principal CO sources that cause ambient air quality levels to exceed the NAAQS. CO concentration increases occur during vehicle cold-starts and winter months when meteorological conditions favor the build-

Carbon monoxide is a colorless, odorless, and tasteless gas that results from the incomplete combustion of fuel. The major source of CO is vehicular traffic, along with industry, wood stoves, and slash burns.

up of directly emitted contaminants. CO's impact is usually localized, often near congested roadways and intersections.

Particulate Matter

Particulate matter is a complex mixture of small particles and liquid droplets made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. In the Puget Sound Region, most winter particle pollution comes from fireplaces and wood stoves. During the summer, vehicle exhaust, land-clearing burning, and backyard burning of yard waste are the predominant sources of fine particles.

Particulate matter (PM) can be made up of hundreds of different chemicals. Some particles, known as primary particles, are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks, or fires. Others form in complicated reactions of chemicals in the atmosphere such as sulfur dioxides and nitrogen oxides emitted from power plants, industries, and automobiles. These particles, known as secondary particles, make up most of the fine particle pollution in the U.S.

Ozone

Ozone (O_3) acts as a protective layer in the stratosphere high above the earth, but it can be harmful to breathe. It is also the primary element of smog. Sunlight and hot weather are the main causes of ground-level ozone. Many urban areas tend to have high levels of ozone, but the pollutants that form ozone can be blown miles away from their original sources.

Ground-level ozone is not emitted directly into the air, but is created by chemical reactions between NOx and VOCs in the presence of sunlight. VOC sources can be both naturally occurring and human-generated. Common sources include industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents. These sources are also the main sources of the ozone precursor NOx.

Hazardous Air Pollutants / Air Toxics

Air toxics are also regional pollutants of concern. FHWA's 1999 National Air Toxics Assessment shows that among the 188 EPA-regulated air toxics or hazardous air pollutants, mobile sources contribute heavily to seven compounds: benzene, formaldehyde, naphthalene, diesel particulate matter plus diesel exhaust organic gases, acrolein, 1,3-butadiene, and polycyclic organic matter. These seven MSATs are among the national and regional-scale cancer risk drivers. The EPA rule on Control of Hazardous Air Pollutants from Mobile Sources will decrease MSAT emissions through cleaner fuels and cleaner engines. The FWLE, as a transportation project with potential for MSAT effects, must perform project-level MSAT analysis.

At the state and regional level, Ecology and PSCAA list 400 pollutants as air toxics, including the 188 EPA national hazardous air pollutants and additional pollutants that are believed to be harmful. A 2010 study shows that mobile sources contribute most to health risk from air toxics in the Puget Sound Region.

Greenhouse Gas Contributors

Several gases and pollutants contribute to climate change and are considered greenhouse gases. The effect each GHG has on climate change is measured as a combination of the volume of its emissions and its global warming potential. "Carbon dioxide equivalent" (CO2e) is a measure used to compare the emissions from various greenhouse gases. It allows a single number to express a carbon footprint consisting of lots of different greenhouse gases. It is measured in terms of pounds, tons, or metric tons of CO2e.

Greenhouse Gases

In King County, 48 percent of GHG emissions come from transportation sources such as motor vehicles, aircraft,

construction equipment, and boats. To reduce these emissions, effective planning must incorporate modes of transport that use less energy per person per mile traveled or use energy derived from fuels that have a low carbon content per unit of energy.

Burning fossil fuel for electricity also produces GHG emissions, but because Puget Sound Energy (PSE) uses a relatively large amount of hydropower (36 percent of PSE's energy source mix), fossil fuel use is lower in King County than in many other regions of the United States. GHG emissions in the county rose 5 percent from 22.4 million metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2003 to 23.4 million $MTCO_2e$ in 2008, primarily because of population growth.

4.6.3.3 Existing Air Quality

King County is a maintenance area for CO under NAAQS, with the maintenance plan updated and approved by EPA on September 7, 2004. The FWLE corridor is designated as attainment or unclassified for all other criteria pollutants.

PSCAA monitors selected criteria pollutants at several locations in King County. The monitoring station closest to the FWLE corridor is at James Street and Central Avenue in Kent; it measures concentrations of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). The closest active monitoring station for CO, PM less than 10 microns in diameter (PM_{10}), and O_3 is the Beacon Hill station in Seattle. Monitoring for other criteria pollutants is not performed in King County. Table 4.6-1 shows that concentrations for these pollutants were below the applicable ambient air quality standards at the two stations from 2012 to 2014.

4.6.3.4 Sensitive Receptors

Sensitive air quality receptors typically include land uses where people would be most vulnerable to air pollutants, such as residences, schools, daycare centers, nursing homes, and hospitals. The ambient air concentrations presented in Table 4.6-1 are representative of the existing conditions experienced by sensitive receptors near the FWLE. The land uses in the project vicinity are mixed residential, commercial, and industrial.

TABLE 4.6-1
Ambient Air Quality Monitoring Data at Kent Station and Beacon Hill Station

Pollutant	NAAQS	2012 Maximum Concentration	2013 Maximum Concentration	2014 Maximum Concentration
Carbon Monoxide (CO)				
1-hour average (ppm)	35	1.0	1.8	1.0
8-hour average (ppm)	9	0.7	1.4	1.0
Ozone (O_3)				
1-hour average (ppm)	revoked	0.063	0.051	0.058
8-hour average (ppm)	0.075	0.049	0.047	0.048
Particulate Matter (PM_{10})				
24-hour average ($\mu g/m^3$)	150	28.0	30.0	25.0
Particulate Matter ($PM_{2.5}$)				
24-hour average (98th Percentile) ($\mu g/m^3$)	35	22	25	22
Annual arithmetic average ($\mu g/m^3$)	12	6.5	7.2	6.2

Source: EPA, 2016c.
Note: Beacon Hill Station is at 4103 South Beacon Hill in Seattle, WA. Kent Station is at 614 N Railroad Avenue in Kent, WA. Concentrations of CO, O_3 and PM_{10} are from the Beacon Hill station. Concentrations of $PM_{2.5}$ are from the Kent station.
ppm = parts per million; $\mu g/m^3$ = micrograms per cubic meter

4.6.4 Environmental Impacts

This section describes the potential for air quality impacts during operation of the FWLE, first at a regional level and then at the local level. A conformity determination for the project is also included based on the results of this analysis. Potential air quality impacts during construction are described in Chapter 5, Construction.

4.6.4.1 Regional Direct Impacts

Criteria Pollutant and Air Toxics Emissions

Sound Transit evaluated the impacts from long-term regional operations by calculating (a) tailpipe emissions for all criteria pollutants and (b) toxic air pollutants for the design year of 2035 for all alternatives. It used regional traffic distribution from the PSRC Travel Demand Model and traffic volumes from the project's traffic analysis. There would be only minor differences in travel patterns, traffic volumes, delay times, and roadway speeds between the No Build Alternative and the build alternatives.

After forecasting the future traffic conditions, Sound Transit calculated the emissions impacts using EPA's Motor Vehicle Emission Simulator (MOVES). MOVES estimates changes based on reductions in VMT. Sound Transit also compared tailpipe emissions under existing conditions (2014) with those of the 2035 No Build Alternative to show

the future trend in pollutant emissions for the Puget Sound regional airshed. Table 4.6-2 shows the tailpipe emissions analysis results.

TABLE 4.6-2
Daily Regional Emission Burden Assessment for Design Year 2035

Criteria Pollutant	Existing 2014	2035 No Build Alternative	2035 Preferred Alternative and other Build Alternative	Percent Change from Existing (2014) to No Build Alternative (2035)	Percent Change from No Build to Build Alternative (2035)
VMT	88,782,000	113,690,000	113,530,000	28%	-0.14%
CO (lb/day)	1,225,797	372,703	372,167	-69.60%	-0.14%
$PM_{2.5}$ (lb/day)	5,374	1,154	1,153	-78.52%	-0.12%
PM_{10} (lb/day)	5,943	1,290	1,288	-78.30%	-0.12%
VOCs (lb/day)	60,339	12,018	12,001	-80.08%	-0.14%
NO_x (lb/day)	225,981	37,576	37,533	-83.37%	-0.11%

Sources for 2014 conditions: PSRC Travel Demand Model and EPA MOVES model 2014a.
lb/day = pounds per day

No Build Alternative

Under the 2035 no build conditions, VMT would increase over existing conditions by 28 percent. However, pollutant emissions for all criteria pollutants would be lower than existing levels because of cleaner automobiles in 2035.

Build Alternatives

The build alternatives would reduce regional traffic levels slightly, with less VMT than the No Build Alternative in 2035. All criteria pollutants under the build alternatives would be well below existing pollutant levels.

Mobile Source Air Toxic Emissions

Sound Transit evaluated regional impacts of MSATs using FHWA's 2012 *Interim Guidance on Air Toxic Analysis in NEPA Documents*. Although there are no established criteria for determining when MSAT emissions should be considered a problem, the Interim Guidance provides an approved approach to evaluating potential MSAT effects.

EPA has developed several emission-control programs for vehicle engines and fuels to reduce MSATs over the next 20 years. FHWA determined that these programs will decrease MSAT emission rates by 83 percent from 1999 to 2050, even if VMT doubles.

No Build Alternative

Table 4.6-3 summarizes the existing and projected tailpipe emissions for toxic air pollutants in the project corridor. Under the No Build

Alternative, VMT would increase over existing conditions, but MSAT emissions would decrease due to the EPA national control programs.

TABLE 4.6-3
Mobile Source Air Toxic Emissions for Design Year 2035

MSAT	Existing 2014	2035 No Build Alternative	2035 Preferred Alternative and other Build Alternatives	Percent Change from Existing (2014) to No Build Alternative (2035)	Percent Change from No Build to Build Alternative (2035)
VMT	88,782,000	113,690,000	113,530,000	28%	-0.14%
1-3-Butadiene (lb/day)	278	61	60	-78.20%	-0.15%
Acrolein (lb/day)	78	19.57	19.55	-74.99%	-0.13%
Benzene (lb/day)	2,274	565	564	-75.14%	-0.14%
Formaldehyde (lb/day)	1,151	320	320	-72.17%	-0.12%
Diesel PM (lb/day)	3,278	371	371	-88.68%	-0.08%
Naphthalene (lb/day)	168	39	39	-76.89%	-0.13%
Polycyclic organic matter (lb/day)	68	13	13	-81.64%	-0.14%

Note: Results rounded to the nearest whole number.
Sources for 2014 conditions: PSRC Travel Demand Model and EPA MOVES model 2014a.
lb/day = pounds per day

Build Alternatives

For the build alternatives, MSAT emissions within the project corridor would be lower than existing because of EPA's national control programs. Minor changes in VMT occur between the No Build and build alternatives, which result in negligible reductions in MSAT emissions. The FWLE would generate minimal air quality impacts for CAA criteria pollutants and would not be linked with any special MSAT concerns.

Greenhouse Gases

Vehicle Emissions

As with the other pollutants, Sound Transit's GHG emission impact analysis first evaluated vehicle movements and then used MOVES to estimate GHG emissions for the existing conditions and for future design year 2035 No Build and build alternatives. Table 4.6-4 shows that the decrease in VMT with the project would lower CO_{2e} emissions from vehicles by 17,155 metric tons annually in the region. This is 0.13 percent less than under the No Build Alternative.

Sound Transit's Sustainability Plan

In January 2015, Sound Transit updated its *Sustainability Plan* that describes the agency's efforts in reducing energy use, greenhouse gases, and air pollution throughout the region. The *Sustainability Plan* is organized around the principles of People, Planet and Prosperity. With these principles in mind, Sound Transit has developed nine sustainability priorities to guide its long-term achievements. These priorities focus on expanding transit services and ridership, improving stations and facilities, and deploying the most fuel-efficient, clean, and cost-effective vehicles. Implementation of the Sustainability Plan during the operation of the FWLE will reduce VMT and GHG emissions within the region.

TABLE 4.6-4
VMT Greenhouse Gas Emissions in Terms of CO_{2e} for Design Year 2035

Emission	2035 No Build Alternative	2035 Build Alternative
Daily CO_{2e} (Metric tons/day)	36,132	36,085
Daily CO_{2e} reduction (Metric tons/day)	Not Applicable	47
Annual CO_{2e} reduction (metric tons/year)	Not Applicable	17,155

Sources for 2014 conditions: PSRC Travel Demand Model and EPA MOVES model 2014.

Energy Emissions

Operating the light rail system would create demand on the local electrical provider, PSE. Each of the build alternatives would consume about 40,771 megawatt hours annually. The energy required to operate the project would result in GHG emissions of 9,760 metric tons of CO_2e per year.

PSE would deliver the energy required for the build alternatives. In 2014, 43 percent of PSE's energy was generated by renewable sources (hydroelectric plants, cogeneration and wind), which do not produce GHG emissions. Based on these current fuel mix conditions, the total GHG emissions from energy demand would be 5,565 metric tons of CO_2e per year rather than 9,760. Changes in PSE's energy source mix in the future would increase or decrease this amount.

Reduced emissions from reduced VMT would be partially offset by the increased emissions from energy generation to operate the light rail system, producing a net decrease of 11,590 metric tons of CO_2e per year compared to the No Build Alternative. This is equivalent to reducing CO_{2e} emissions generated by 1,057 households.

4.6.4.2 Local Direct Impacts

The FWLE would have minimal air quality impacts because it would not substantially change the volumes of vehicular traffic or congestion in the project vicinity, and the light rail trains are electrically powered. Light rail is anticipated to improve overall air quality by shifting commuters from motor vehicles to light rail transit. Still, changes in traffic flow and volumes locally and regionally, and increased vehicular traffic near the light rail stations, could have noticeable local impacts. This could affect the project's ability to meet air quality conformity standards for a CO maintenance area.

EPA has developed guidance for "hot-spot analyses" to evaluate concentrations near roadway intersections where congestion and idling can cause high motor vehicle emissions. To prepare the FWLE hot-spot analysis, Sound Transit used EPA's CAL3QHC modeling tool to analyze the CO levels of impacted intersections. EPA's MOVES was used to calculate the CO emission rates needed as an input in the CAL3QHC model.

Traffic data identified the three worst intersections (in terms of level of service) operating within the project corridor:

- SR 99 and Kent-Des Moines Road
- Military Road S and S 272nd Street
- Star Lake Road and S 272nd Street

One-hour and 8-hour CO emissions were modeled at each of the three intersections for existing and design year 2035 No Build and build alternative conditions. (CO emissions were also modeled for the year 2040 No Build and build alternative conditions to demonstrate consistency with PSRC's Vision 2040 Transportation Plan, as discussed below. Table 4.6-5 shows that all alternatives would have CO concentrations less than the 1-hour and 8-hour NAAQS of 35 ppm and 9 ppm, respectively. The intersections pass the CO hot-spot modeling analysis.

TABLE 4.6-5
Modeled CO Concentrations (ppm)

Intersection	2014 Existing		2035 No Build		2035 Preferred Alternative and other Build Alternatives		2040 No Build		2040 Preferred Alternative and other Build Alternatives	
	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour	1-Hour	8-Hour
Pacific Hwy South and Kent-Des Moines Road	1.9	1.6	1.2	1.1	1.2	1.1	1.1	1.1	1.1	1.1
Military Road South and South 272nd Street	1.7	1.5	1.2	1.1	1.2	1.1	1.1	1.1	1.1	1.1
South Star Lake Road and South 272nd Street	2.0	1.7	1.3	1.2	1.3	1.2	1.2	1.1	1.2	1.1

Note: Background concentration is 1.0 ppm, based on maximum monitored CO concentration. The 1-hour and 8-hour NAAQS for CO are 35 ppm and 9 ppm, respectively.

4.6.4.3 Conformity Determination

Under the build alternatives, modeled CO concentrations for the top three worst-case intersections were similar for future design year 2035 No Build and build alternatives because of continued reductions from implementation of control measures for mobile sources. Regardless of the FWLE alternative chosen, CO concentrations would not exceed the NAAQS. The project is included in the region's Metropolitan Transportation Plan (*Transportation 2040*, PSRC, 2010b), in the *2040 Transportation Plan Update* (PSRC, 2014a), and in the *2015-2018 Regional Transportation Improvement Program* (PSRC, 2015). The plans and program meet regional conformity, as demonstrated in the Transportation 2040 Update Appendix E: Regional Air Quality Conformity Analysis (PSRC, 2014b). The FWLE meets the CAA transportation conformity requirement because it is included in the financially constrained and conforming regional plans.

Air Quality Conformity

Regional conformity is demonstrated if the project is included in a financially constrained conforming regional transportation plan and a regional transportation improvement program. Project-level conformity is demonstrated when three conditions are met:

- The project is listed in a conforming regional transportation plan and regional transportation improvement program.
- The project does not cause or contribute to any new localized CO violations or increase the frequency or severity of any existing violations of CO.
- The project does not delay the timely attainment of the CO standards.

Table 4.6-5 shows that intersections in the project vicinity currently do not exceed the CO NAAQS, and the FWLE would not create any new exceedances. Operating the FWLE would benefit the area's air quality by shifting bus ridership to light rail and attracting new transit users who currently drive cars. The project meets conformity requirements for CO.

4.6.4.4 Indirect Impacts

Energy for light rail operations would indirectly add GHG emissions outside the project corridor related to energy production. However, the net change between VMT and energy production would result in a net reduction in GHG.

4.6.5 Potential Mitigation Measures

The air pollutant and GHG emissions analyses demonstrated that no impacts are expected to occur during the operation of the project; therefore, no mitigation measures during project operation would be necessary.

4.7 Noise and Vibration

4.7.1 Summary

This section describes the number of sensitive receivers in the study area that are predicted to experience project noise or vibration levels that meet the FTA's impact criteria. Sensitive receivers are primarily residents of houses, apartments, and mobile homes. Also included is a summary of how, whenever possible, Sound Transit would provide mitigation to reduce or eliminate noise and vibration impacts.

Study Area

The study area for the light rail noise impacts analysis was determined by modeling the worst-case operational noise levels and including all potentially impacted noise-sensitive properties. For the vibration analysis, vibration propagation tests along the alignments resulted in a potential impact area of 150 feet to 200 feet away from the alignments, which was used as the study area.

The FWLE noise analysis accounts for the following noise sources:

- Light rail noise: Light rail noise from trains along the guideways
- Park-and-ride noise: Vehicle noise from buses and cars using the light rail park-and-rides
- Traffic noise: Other vehicle traffic noise from new roadways or where existing sound walls or buildings that shield highway noise would be removed

The FWLE vibration analysis accounts for vibration at buildings near the light rail and also vibration-generated groundborne noise inside buildings caused by the light rail.

Counting Noise and Vibration Impacts

Noise impacts are the number of residential units (apartments, condominiums, and manufactured homes) and/or hotel rooms with noise levels above the impact criteria. Vibration impacts are also provided in units; however, in cases of special buildings, such as concert halls, an impact refers to the building itself.

The light rail noise and vibration analyses were performed for approximately 3,100 properties along the I-5 corridor and for over 5,000 noise- and vibration-sensitive properties along the SR 99 corridor. The Preferred Alternative would have the fewest light rail noise impacts because noise-sensitive receivers are generally only on one side of that alignment. The SR 99 Alternative would have the most noise impacts because noise-sensitive receivers are on both sides of that alignment.

Similarly, the Preferred Alternative would have the fewest noise impacts related to vehicles using the park-and-rides. There would be only one park-and-ride noise impact, which would be near the Kent/Des Moines Station. This receiver would also be impacted by light rail and traffic noise. The SR 99 and I-5 to SR 99 alternatives would have up to eight park-and-ride noise impacts, depending upon the option being analyzed. None of these receivers would be impacted by light rail or traffic noise.

The traffic noise analysis evaluated changes from the FWLE both without and with the proposed SR 509 Extension Project. The Preferred Alternative would cause 262 traffic noise impacts without the SR 509 Extension, and approximately one-third of the properties would also be impacted by light rail noise. With the SR 509 Extension, which includes its own noise mitigation measures, the Preferred Alternative would cause 79 traffic noise impacts, and nearly all of those properties would also be impacted by light rail noise. Where an individual property has an impact from both light rail and traffic noise, mitigation would be designed to address both noise sources.

Traffic Noise

Because the FWLE would remove some traffic noise shielding, modify existing roadways, and construct new roadways in some areas, a traffic noise study was prepared to assess those impacts. Traffic noise impacts are identified using peak-hour noise levels, unlike light rail noise impacts, which use 24-hour day-night sound levels. The different methods of identifying impacts mean that the noise source types must be evaluated separately. Some sites identified with potential traffic noise impacts also have potential light rail noise impacts, and a single mitigation measure, such as a sound wall, might effectively mitigate both impacts.

The SR 99 to I-5 Alternative would have the most potential vibration impacts without considering options, but the SR 99 Alternative would have more vibration impacts when station options are included. The I-5 to SR 99 Alternative would have the fewest vibration impacts. The SR 99 Alternative would cause a groundborne noise impact at the Federal Way High School Performing Arts Center.

Table 4.7-1 summarizes the projected light rail noise, park-and-ride noise and vibration impacts by alternative. Note that Sound Transit would use standard measures to reduce project-related noise and vibration to levels below FTA's impact criteria.

TABLE 4.7-1
Summary of Light Rail Noise, Park-and-Ride Noise, and Vibration Impacts

Alternative	Light Rail Noise Impacts (Range with Options)		Park-and-Ride Impacts (Range with Options)		Vibration Impacts (Range with Options)		Groundborne Noise Impacts (Range with Options)	
	Before Mitigation	After Mitigation	Before Mitigation	After Mitigation	Before Mitigation	After Mitigation	Before Mitigation	After Mitigation
Preferred	**647** (618–864)	**0** (0-0)	**1** (0-1)	**0** (0-0)	**193** (185–193)	**4** (4-4)	**0** (0-0)	**0** (0-0)
SR 99	**2,266** (1,664-2,474)	**0** (0-0)	**8** (0-8)	**0** (0-0)	**50** (0–271)	**0** (0-0)	**1** (1-1)	**0** (0-0)
SR 99 to I-5	**1,200** (999-1,288)	**0** (0-0)	**0** (0-0)	**0** (0-0)	**209** (159–225)	**0** (0-0)	**0** (0-0)	**0** (0-0)
I-5 to SR 99	**1,860** (1,385-1,907)	**0** (0-0)	**8** (0-8)	**0** (0-0)	**45** (45–238)	**0** (0-0)	**1** (1-1)	**0** (0-0)

Potential avoidance and mitigation measures for project-related noise impacts (transit and traffic) would include sound walls (barriers on the light rail guideway or freestanding walls), special trackwork to reduce noise levels at crossovers, and consideration of sound insulation of residential buildings where other mitigation measures are not sufficient to eliminate impacts. Mitigation for vibration

impacts would include resilient fasteners, ballast mats, tire-derived aggregate, and special trackwork. At some locations, these measures may not be effective at reducing levels to below FTA criteria due to proximity of the buildings to the light rail guideway. In these cases, additional analysis during final design will evaluate the specific buildings and alternative mitigation measures may be warranted.

4.7.2 Introduction

This section discusses the fundamentals of noise and vibration analysis, and the regulatory setting governing train noise and vibration for federally funded projects. For more detailed information, see Appendix G3, Noise and Vibration Technical Report.

4.7.2.1 Fundamentals of Noise and Vibration Analysis

Noise

Noise is defined as unwanted sound. It is measured in terms of sound pressure level and usually expressed in decibels (dB), a unit of measurement that represents the way humans hear sounds. The human ear is less sensitive to higher and lower frequencies than it is to midrange frequencies. Therefore, a weighting system is used that reduces the sound level of higher and lower frequency sounds, similar to what the human ear does. This filtering system is used in virtually all noise ordinances. Measurements taken with this "A-weighted" filter are referred to as A-weighted decibel (dBA) readings.

Two primary noise measurement descriptors are used to assess noise impacts from traffic and transit projects: the *equivalent sound level* (Leq) and the *day-night sound level* (Ldn). Exhibit 4.7-1 shows typical Ldn noise levels and residential land use compatibility.

Leq

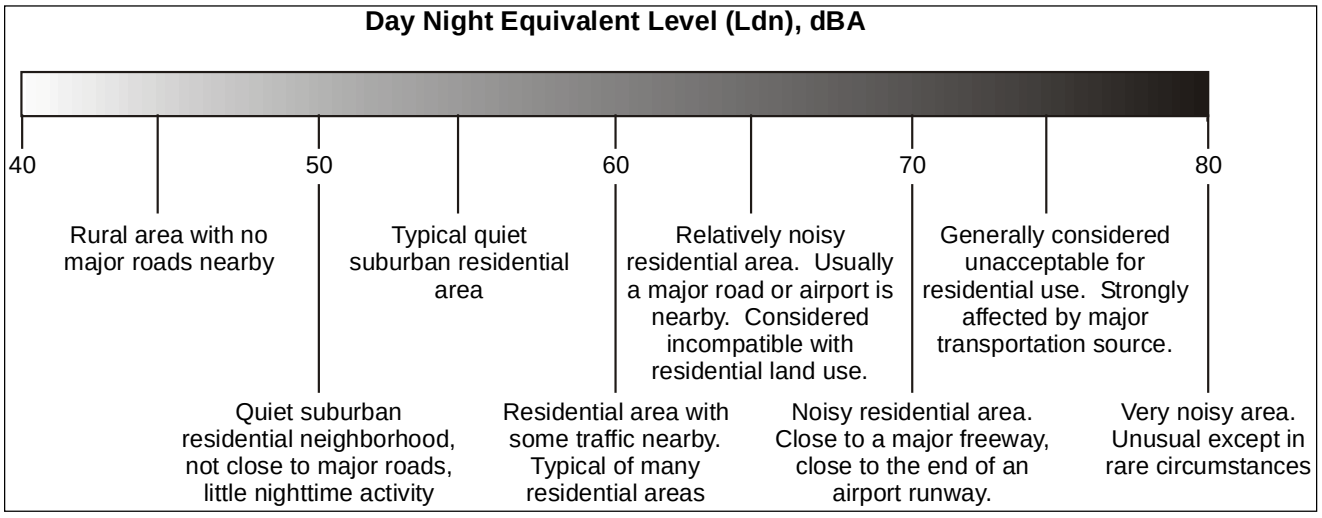
The Leq is the level of a constant sound for a specified period of time that has the same sound energy as an actual fluctuating noise over the same period of time. The peak-hour Leq is used for all traffic noise analyses and for light rail noise analyses at locations with primarily daytime use, such as schools and libraries.

Ldn

The Ldn is an Leq over a 24-hour period, with a 10-dBA "penalty" added to nighttime sound levels (between 10 p.m. and 7 a.m.) to account for the greater sensitivity and lower background sound levels during this time. The Ldn is the primary noise level descriptor for light rail noise at residential land uses.

Vibration

Groundborne vibration generated from FWLE train operations would be transmitted from the tracks through the soil. Vibration above certain levels can disrupt sensitive equipment and operations and annoy humans within buildings. Transit systems rarely produce vibration with sufficient magnitude to cause any structural damage.



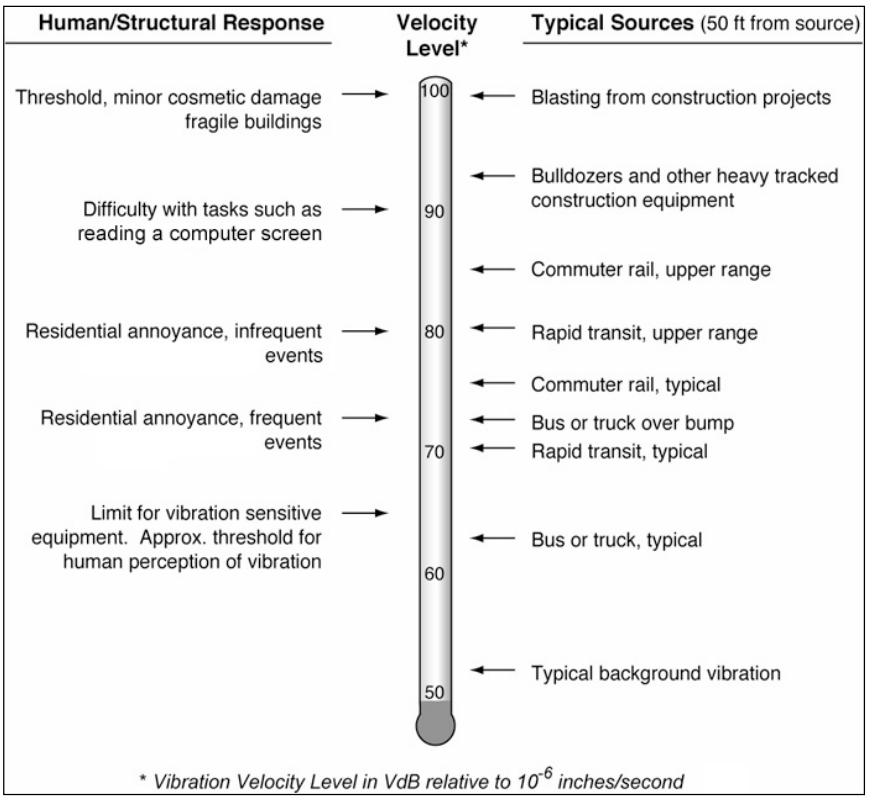
Source: FTA, 2006.

EXHIBIT 4.7-1
Typical 24-hour Ldn Noise Levels and Land Use Compatibility

Velocity is the measure for evaluating vibration from transit projects that corresponds best with human sensitivity. Vibration is expressed in terms of the *root-mean-square vibration velocity level* in decibels (VdB). The abbreviation VdB is used in place of dB to avoid confusing vibration decibels with sound decibels.

Building vibration could cause groundborne noise, which is noise that is generated inside indoor spaces from the vibration of room surfaces such as walls, and which in turn can cause a perceptible rumble. Groundborne noise only occurs where the light rail is in a tunnel or deep retained cut. In these situations, airborne noise emissions are low or imperceptible and groundborne noise becomes the main noise source from light rail operations.

Exhibit 4.7-2 illustrates typical vibration velocity levels for common sources, as well as thresholds for human and structural response to groundborne vibration. The relevant range is approximately 50 to 100 VdB (i.e., from imperceptible background vibration to the threshold of damage). The approximate threshold of human perception to vibration is 65 VdB. Humans generally do not find vibration from light rail operations annoying until the vibration exceeds 70 to 75 VdB. Construction activities can cause noise and vibration impacts, too, as discussed in Chapter 5.



Source: FTA, 2006.

EXHIBIT 4.7-2
Examples of Groundborne Vibration Levels and Human/Structural Response

4.7.2.2 Noise and Vibration Impact Criteria

Sound Transit evaluates light rail noise and vibration impacts for transit projects according to the FTA *Transit Noise and Vibration Impact Assessment* guidance manual (FTA, 2006). The FTA manual categorizes land uses based on their sensitivity to noise or vibration (see text box) and establishes noise impact criteria for each category. The analysis considers the existing noise levels combined with the predicted noise levels caused by the project to determine if there would be impacts. Methods for assessing noise and vibration impacts are described in Sections 4 and 5 of Appendix G3, Noise and Vibration Technical Report.

Sound Transit also analyzed the potential increased traffic noise for noise-sensitive land uses. This could result from the development of new or extended roadways in station areas, or from the removal of buildings, walls, or berms that shield traffic noise. FTA criteria and methods were used for non-federal-aid highways (e.g., new or modified local roadways) and FHWA methods and criteria for federal-aid highways (e.g., I-5). FHWA's

FTA Noise and Vibration Impact Categories

FTA's noise and vibration impact criteria are grouped into the following noise-sensitive land use categories:

- Category 1: For noise, Category 1 includes buildings or parks where quiet is an essential element of their purpose. For vibration, Category 1 includes buildings where vibration would interfere with interior operations.
- Category 2: Residences and buildings where people normally sleep, including residences, hospitals, and hotels where nighttime sensitivity is assumed to be important
- Category 3: Institutional land uses with primarily daytime and evening use, including schools, libraries, churches, and some parks

traffic noise impact threshold for residential land use is an hourly Leq of 66 dBA.

Local noise ordinances for SeaTac, Des Moines, Kent, and Federal Way would apply to ancillary facilities, such as park-and-ride lots and traction-power substations, and to project-related construction activities.

4.7.3 Affected Environment

This section summarizes existing land uses along the FWLE corridor and existing noise and vibration levels. There are no noise-sensitive parks in the FWLE corridor.

4.7.3.1 Noise- and Vibration-Sensitive Land Uses

A summary of noise- and vibration-sensitive land uses by FWLE alternative and option is provided below. Station or alignment options that would affect different land uses than the FWLE alternatives are noted.

Preferred Alternative

There is a concentration of multi-family residences north of Kent-Des Moines Road, and many single-family residential neighborhoods adjacent to the west side of the Preferred Alternative. There are commercial, hospitality, and school uses as well, but fewer than with the SR 99 Alternative. I-5 borders most of the east side of the alignment.

Landfill Median Alignment Option

Along this alignment option, land use on the east side of I-5 is almost entirely single-family residences.

SR 99 Alternative

Most land use along SR 99 is commercial, with some multi-family residences, schools, and a library. A performing arts center was included at recently reconstructed Federal Way High School. In most places, the single-family residential neighborhoods in the SR 99 corridor are not adjacent to SR 99.

Kent/Des Moines HC Campus Station Option

Land use near the alignment of the Kent/Des Moines HC Campus Station Option is predominantly single- and multi-family residences.

S 272nd Redondo Trench Station Option

South of S 288th Street and the Sacajawea Middle School, there are more single-family uses adjacent to this alignment than the SR 99 Alternative.

SR 99 to I-5 Alternative

Land uses along the SR 99 to I-5 Alternative are the same as along the SR 99 Alternative north of the Kent/Des Moines Station and the Preferred Alternative south of the Kent/Des Moines Station.

I-5 to SR 99 Alternative

Land uses along the I-5 to SR 99 Alternative are the same as along the Preferred Alternative north of the Kent/Des Moines Station and the SR 99 Alternative south of the Kent/Des Moines Station.

4.7.3.2 Noise Measurements

Long-term noise monitoring measurements were taken at 60 locations, and short-term monitoring measurements were taken at 39 locations in the FWLE corridor. Long-term noise-monitoring locations were measured for 36 to 48 hours, while short-term monitoring locations were measured for 15 minutes. Noise levels in the FWLE corridor are dominated by transportation-related noise sources. In the I-5 corridor, noise is dominated by I-5 traffic. Traffic on major and minor arterial roadways and ramps to and from the highway also create noise. Lesser contributors to the noise environment include aircraft using Sea-Tac Airport and construction activities. The Ldn noise levels along the I-5 corridor are typically between 65 and 72 dBA.

In the SR 99 corridor, noise is dominated by traffic along SR 99 and the other major arterials and cross streets, such as Kent-Des Moines Road, S 272nd Street, and S 320th Street. Other sources in the corridor include aircraft, miscellaneous industrial and commercial activities, and local construction projects. The Ldn noise levels along the SR 99 corridor are typically between 61 and 69 dBA.

Appendix B of Appendix G3 includes a table summarizing existing noise levels and maps of all measurement locations for both noise and vibration.

4.7.3.3 Vibration Testing and Measurements

Vibration propagation tests were performed at 20 sites in the FWLE corridor. These tests indicate how vibration levels will change as the vibrations travel through the ground. Data from the propagation tests were then used in the vibration impact analysis.

4.7.4 Environmental Impacts

This section summarizes the models used to identify specific locations where noise and vibration levels will likely exceed impact criteria.

4.7.4.1 Methodology and Assumptions for Noise and Vibration Analysis

The noise and vibration analysis followed the FTA 2006 guidance manual. The prediction of train operational noise was based on Sound Transit's existing fleet and operations—its train headways, speeds, and measured noise levels operating on the Link light rail system. Modeling also reflected the distance from properties to the light rail alignment, structural and topographical features, shielding, and track type. Noise levels associated with train-mounted warning bells reflect Sound Transit policy for audible warning devices. No at-grade road crossings would occur with any of the FWLE alternatives, so there would be no potential noise impacts from warning bells at such crossings. Vehicle and track design and maintenance measures to reduce light rail noise are also assumed. These include vehicles with wheel skirts, periodic rail grinding or replacement, periodic wheel truing or replacement, proper vehicle maintenance and operator training, and lubrication of curves with a radius of less than 600 feet near noise-sensitive areas.

Wheel Squeal

The noise model does not assume wheel squeal because Sound Transit requires that any curves with a radius of less than 600 feet near noise-sensitive properties must have track lubricators installed as part of the project; curves with a radius from 600 to1,250 feet must be built to allow for subsequent lubrication. These design requirements allow Sound Transit to add lubricators to mitigate wheel squeal that occurs during system operation.

The Kent/Des Moines, S 272nd, and Federal Way Transit Center stations all have park-and-ride and bus transfer areas that would generate noise from buses and personal vehicles. Noise impacts were evaluated for these facilities as stationary transit facilities under the FTA methods and local noise control ordinances and accounted for buses entering and exiting the station, and vehicles using parking lots or garages.

The potential for traffic noise impacts associated with the FWLE was assessed in areas where the project would construct new roadways, realign existing roadways, relocate existing sound walls, or remove existing shielding (including both buildings and topography). Sound Transit identified locations that might experience traffic noise impacts as a result of the FWLE based on existing noise measurements and FHWA impact criteria. In response to comments and requests from coordinating agencies, traffic noise modeling was performed for certain areas along the Preferred Alternative that might experience an increase in traffic noise levels as a result of the project. Due to the recent funding of the SR 509 Extension Project and the potential for overlapping construction schedules, traffic noise analysis along I-5 was performed both with and without the SR 509 Extension so that all

traffic noise impacts could be identified and considered for noise mitigation regardless of which project is constructed first.

To predict groundborne vibration from train operations, Sound Transit used measured vibration levels from its Central Link corridor and data from the vibration propagation tests described above.

4.7.4.2 No Build Alternative

With the No Build Alternative, noise along the project corridors would continue to be dominated by traffic, aircraft from Sea-Tac Airport, and miscellaneous industrial, commercial, and construction activities. After construction of the SR 509 Extension, there would be additional noise related to this highway extension between SR 99 and I-5 north of S 211th Street, and along I-5 from S 211th Street to S 317th Street. This is incorporated into the traffic noise analysis in Section 4.7.4.5. Modeled traffic noise levels under existing conditions and the No Build Alternative are provided in Appendix B of Appendix G3, Noise and Vibration Technical Report.

4.7.4.3 Light Rail Noise Impacts from Build Alternatives

This section summarizes the number of predicted light rail operations noise impacts from each of the FWLE alternatives before mitigation. Approximately 3,100 units were evaluated for noise impacts along the I-5 corridor, and over 5,000 units were evaluated along the SR 99 corridor. The actual number of units evaluated for each alternative varied slightly based on alternative and station options because of the many multi-family buildings and hotels along the corridors. Table 4.7-2 summarizes the projected noise impacts from light rail operations by alternative. The table shows the range of impacts with station and alignment options and the proposed mitigation. The low and high ends of the impact range reflect a combination of options to capture the minimum and maximum potential impacts.

All Preferred Alternative noise impacts would be mitigated with sound walls, but the other alternatives would likely require Sound Transit to consider including residential sound insulation where sound walls would not be sufficient to fully mitigate impacts. Projected impacts for each individual station and alignment option are included in Appendix G3 and summarized later in this section. All impacts are to Category 2 receivers unless otherwise noted.

TABLE 4.7-2
Summary of Projected Noise Impacts from Light Rail Operations

Alternative	Light Rail Noise Impacts (Range with Options)	Potential Mitigation[a]
Preferred Alternative	**647** (618–864)	Sound walls
SR 99 Alternative	**2,266** (1,664–2,474)	Sound walls and consider for insulation where necessary (67–138)
SR 99 to I-5 Alternative	**1,200** (999–1,288)	Sound walls and consider for insulation where necessary (23)
I-5 to SR 99 Alternative	**1,860** (1,385–1,907)	Sound walls and consider for insulation where necessary (67–138)

[a] Numbers in parentheses indicate the number of units where residential insulation would be considered because sound walls might not fully mitigate impacts.

Preferred Alternative

The Preferred Alternative would have 647 light rail noise impacts distributed throughout the length of the alternative and caused by noise from light rail operations and a crossover track near S 312th Street. Many of the properties where impacts would occur are multi-family complexes or motels. There would be no FTA Category 3 noise impacts under the Preferred Alternative because all the Category 3 sites are far enough from the alignment to have reduced noise levels, or in the case of the Mark Twain Elementary School, the alignment would be in a covered trench, which would shield the school from the noise.

Sound Transit evaluated the potential for noise impacts from wheel squeal based on the track's geometry along curves. The crossing of S 272nd Street near the Mark Twain Elementary School would have a 550-foot-radius curve but is in a covered trench, so noise from the curve would not be an issue. The 23rd Avenue S crossing curve would be less than 600 feet and would have the potential for impacts at nearby residences. Lubricators would be installed at this location to eliminate the noise. The tail track curve south of the crossing at S 320th Street would be less than 600 feet but would be located in a commercial area with no residences within 1,000 feet of the curve.

None of the options described below would have impacts on any Category 3 receivers.

With the **Kent/Des Moines At-Grade Station Option**, there would be 14 more impacts than with the Preferred Kent/Des Moines Station because of the different alignment of the guideway in the station area and difference in displacements. With the **Kent/Des Moines I-5 Station Option**, impacts would decrease by 29 for the same reasons.

The **Landfill Median Alignment Option** would have 41 more noise impacts than the Preferred Alternative—27 impacts along the east side of I-5 where the alignment would be in the I-5 median, and 14 impacts on the west side of I-5. Moving the alignment farther to the east than the Preferred Alternative would eliminate some impacts near S 244th Street on the west side of I-5. Conversely, south of S 252nd Street, there would be several additional impacts from this alignment option being elevated to S 260th Street.

The **S 272nd Star Lake Elevated Station Option** would have 64 additional impacts from being elevated instead of in a trench. These would occur at single-family and multi-family residences and at Mark Twain Elementary School.

The **S 317th Elevated Alignment Option** would have an additional 112 impacts from being elevated instead of in a trench. These would occur at several multi-family properties and the Hampton Inn Hotel.

The **Federal Way I-5 Station Option** would have 45 more impacts than the Preferred Federal Way Transit Center Station because of additional impacts at a hotel near the station option. The **Federal Way S 320th Park-and-Ride Station Option** would have three fewer impacts because the alignment would be farther away from several large multi-family complexes north of S 317th Street; however, there would be new impacts at a hotel and mobile home park south of S 320th Street.

SR 99 Alternative

There would be 2,266 noise impacts with the SR 99 Alternative distributed throughout the length of the alignment and caused by noise from light rail operations and a crossover track near S 272nd Street.

There would be a noise impact at the easternmost part of the Federal Way High School. Noise levels at the new Federal Way High School Performing Arts Center would exceed the FTA criteria.

Other Category 3 land uses with noise impacts along the SR 99 corridor include the Citadel Church, the Open Door Baptist Church, and the Seattle Full Gospel Church.

For all options that run along the side of SR 99, noise impacts would generally be greater on the same side of the road as the alignment, while impacts on the opposite side of the road would be lower. Changes in Category 3 receiver impacts are noted.

The **S 216th Street West Station Option** would have 201 fewer noise impacts than the SR 99 Alternative because the alignment would be relocated in a trench and farther away from several multi-family buildings. The **S 216th Street East Station Option** would affect four fewer receivers.

The **Kent/Des Moines HC Campus Station Option** would be elevated and closer to the residences west of SR 99 and would have 161 more impacts than the SR 99 Alternative. If this option were to connect to the S 216th West Station Option, impacts would decrease by 602 because of the trenched alignment for the majority of the distance. There would be no noise impacts at Citadel Church and Open Door Baptist Church because this option would relocate these churches.

Under the **Kent/Des Moines SR 99 Median Station Option**, there would be 36 more noise impacts than with the SR 99 Alternative, from moving closer to noise-sensitive receivers on the east side of SR 99. The **Kent/Des Moines SR 99 East Station Option** would decrease noise impacts by 40 because of additional displacements north and south of the station along the east side of SR 99.

With the **S 260th Street West Station Option**, there would be 88 fewer noise impacts than with the SR 99 Alternative because of a greater distance from noise-sensitive receivers and less development on the east side of SR 99 in this area. There would be no noise impacts at the Seattle Full Gospel Church because the church would be relocated. The **S 260th Street East Station Option** would reduce noise impacts by 36 because it would be farther away from some receivers.

The **S 272nd Redondo Trench Station Option** would have 439 fewer noise impacts than the SR 99 Alternative because it would be in a trench for most of its length. It would avoid impacts on the Woodmont Library and Smart Start Day Care.

The **Federal Way SR 99 Station Option** would have 47 more impacts than the SR 99 Alternative; noise impacts at one hotel would be eliminated, but additional noise impacts would affect a different hotel.

SR 99 to I-5 Alternative

This alternative would cause 1,200 noise impacts. North of Kent-Des Moines Road, the impacts would be the same as SR 99 Alternative. As the alignment transitions from SR 99 to I-5 near the Kent-Des Moines Road, there would be 223 impacts. South of S 240th Street, the impacts would be similar to the Preferred Alternative. Category 3

noise impacts would occur at the Citadel Church, the Open Door Baptist Church, and the Jesus Christ Salt and Light Church.

Impacts from the **S 216th West** or **East** station options would be the same as under the SR 99 Alternative. The **Federal Way I-5 Station Option** and the **Federal Way S 320th Park-and-Ride Station Option** would have the same impacts as described under the Preferred Alternative.

I-5 to SR 99 Alternative

With the I-5 to SR 99 Alternative, there would be 1,860 noise impacts. North of Kent-Des Moines Road, the impacts would be similar to the Preferred Alternative. As the alignment transitions from I-5 to SR 99 near the Kent-Des Moines Road, there would be 101 impacts. South of S 240th Street, the impacts would be the same as with the SR 99 Alternative.

Impacts from station options would be the same as under the SR 99 or Preferred alternatives, except that the S 260th West Station Option would only reduce the number of noise impacts by 47 (less than with the SR 99 Alternative) because the location where it would exit the SR 99 median would be farther south, at approximately S 246th Street.

4.7.4.4 Noise Impacts from Park-and-Rides

Park-and-rides with parking lots and garages were evaluated for noise impacts under both the FTA criteria and local noise control ordinances. All except one of the identified impacts are under the local noise ordinances only. One impact was identified under both the FTA and local ordinance criteria.

Preferred Alternative Stations

The **Kent/Des Moines Station** would have one noise impact at a single family residence under FTA and local ordinance criteria.

The **S 272nd Star Lake Station** would not have any park-and-ride impacts, including at the adjacent residences or at Mark Twain Elementary School. The **Federal Way Transit Center Station** would not have any park-and-ride noise impacts.

The **Kent/Des Moines I-5 Station Option** and **Kent/Des Moines At-Grade Station Option** would avoid the impacts associated with the Preferred Kent/Des Moines Station. The **S 272nd Star Lake Elevated Station Option** would not have any park-and-ride noise impacts, including at the adjacent residences or at Mark Twain Elementary

School. The **Federal Way I-5 Station Option** and **Federal Way S 320th Park-and-Ride Station Option** would have no noise impacts.

SR 99 Alternative Stations

Under the SR 99 Alternative, eight park-and-ride noise impacts are predicted under the local noise ordinance at a mobile home park near the **Kent/Des Moines SR 99 West Station**. None are predicted near the **S 272nd Redondo Station** or the **Federal Way Transit Center Station**.

The **Kent/Des Moines HC Campus Station Option** would avoid the park-and-ride noise impacts associated with the SR 99 Alternative. The **Kent/Des Moines SR 99 Median Station Option** and the **Kent/Des Moines SR 99 East Station Option** would have the same impacts as the Kent/Des Moines SR 99 West Station. The **S 272nd Redondo Trench Station Option** and the **Federal Way SR 99 Station Option** would have no noise impacts.

SR 99 to I-5 Alternative Stations

No park-and-ride noise impacts are predicted under the SR 99 to I-5 Alternative.

I-5 to SR 99 Alternative Stations

The **Kent/Des Moines 30th Avenue West Station** would have eight noise impacts under the local noise ordinance. There would be no noise impacts from the **S 272nd Redondo Station** or the **Federal Way Transit Center Station**, or from the station options.

4.7.4.5 Traffic Noise Assessment

There are a few locations where the project would build new roads or realign existing roadways. In a few others, existing shielding would be removed (such as buildings) or relocated (such as existing sound walls). Sound Transit modeled traffic noise levels for the Preferred Alternative to determine if any of the changes would result in traffic noise impacts. Sound Transit also performed an analysis for the other alternatives, which considered existing traffic noise levels, proximity of receivers, and the FHWA traffic noise impact criteria.

Preferred Alternative

The traffic noise analysis for the Preferred Alternative included three scenarios for the year 2035:

- FWLE No Build without the SR 509 Extension
- FWLE Preferred Alternative without the SR 509 Extension
- FWLE Preferred Alternative with the SR 509 Extension

This approach reveals the traffic noise impacts from I-5 without or with the SR 509 Extension. The analysis under the third scenario took into account the 2003 design of the SR 509 Extension, including mitigation proposed in the 2003 Final EIS for that project. Exclusion of the SR 509 Extension from the FWLE No Build Alternative in the second scenario ensured that the impacts analyzed were due to the FWLE alone. This scenario also acknowledges that the FWLE might be built and operating for some time before the SR 509 Extension is built.

The Preferred Alternative's potential traffic noise impacts were identified by comparing the traffic noise levels under the No Build Alternative without SR 509 to the Preferred Alternative without and with SR 509. Traffic noise impacts would occur if traffic noise levels under the Preferred Alternative produced new traffic noise impacts or increased the severity of existing traffic noise impacts when compared to the No Build Alternative without SR 509.

Noise Impact Severity

A traffic noise impact is increased in severity whenever a receiver with noise levels above the FHWA traffic noise impact criteria under the No Build Alternative is predicted to experience an increase in traffic noise levels under the Preferred Alternative without SR 509.

Areas where Preferred Alternative property acquisitions and roadway alterations might cause traffic noise impacts include:

- Buildings removed between S 212th Street and Kent-Des Moines Road
- Buildings removed and new and realigned roadways near the Kent/Des Moines Station
- Buildings removed and new and realigned roadways near the S 272nd Star Lake Station
- Construction grading and tree removal in the residential neighborhood between Military Road and S 288th Street
- Removal and replacement of a sound wall and traffic safety barrier at Camelot Square Mobile Home Park, and grading between S 288th Street and S 298th Street, including changes to a berm between I-5 and the Camelot Square Mobile Home Park

Traffic noise impacts identified under the Preferred Alternative for specified areas of analysis are provided in Table 4.7-3. It shows fewer impacts due to the FWLE with the 509 Extension than without the 509 Extension because the 509 Extension includes sound wall mitigation in some places.

Traffic Noise

Traffic noise impacts will be reevaluated during final design, in coordination with WSDOT, once the SR 509 Extension design has been updated.

The **Kent/Des Moines I-5 Station Option** would include a new S 236th Street and the removal of buildings. However, traffic noise modeling

for this area demonstrated that these changes would not cause traffic noise impacts.

TABLE 4.7-3
Summary of Traffic Noise Impacts under the Preferred Alternative

Analysis Area	Number of Units Modeled	FWLE Traffic Noise Impacts without SR 509[a]	FWLE Traffic Noise Impacts with SR 509[b]
S 212th Street to Kent-Des Moines Road	340	181	2
Kent/Des Moines Station	281	1	1
S 272nd Star Lake Station	27	5	5
Military Road to S 288th Street	54	16	16
S 288th Street to S 298th Street	244	59	55
Total	**946**	**262**	**79**

[a] Based on peak-hour modeled noise levels for the FWLE without any SR 509 Extension improvements. Approximately one-third of all of the impacted units are also impacted by noise from light rail operations.
[b] Based on peak-hour modeled noise levels for the FWLE with the SR 509 Extension improvements. Nearly all of the impacted units are also impacted by noise from light rail operations.

The **Kent/Des Moines At-Grade Station Option** would have a station access road at S 242nd Street instead of S 236th Street, but there are no noise-sensitive land uses in this area. The **Federal Way I-5 Station Option** would not have any new roads or other modifications that necessitate a traffic noise analysis. The **Federal Way S 320th Park-and-Ride Station Option** would likely cause traffic noise impacts at a mobile home park where it would remove shielding provided by an existing berm and front-line homes.

SR 99 Alternative

There are multiple locations along the SR 99 corridor that already meet or exceed the FHWA residential impact criterion of 66 dBA Leq during the traffic noise peak hour. Because of the speed of vehicles on SR 99 and the spacing of intervening buildings, traffic noise levels at or above 66 dBA are likely to occur up to 250 to 400 feet from the curb line of the roadway, depending on existing shielding and topographical conditions. In areas with cross streets that are also major arterials with high traffic volumes, the distance to the 66-dBA criterion could increase to over 400 feet.

The SR 99 Alternative might result in traffic noise levels exceeding the 66-dBA criterion at nearby homes at:

- The new S 236th Street that would be constructed for access to the Kent/Des Moines station and/or parking associated with the SR 99 Alternative and its options

- The S 272nd Redondo Station (including the trench option for this station), where a new road would be constructed for access to S 272nd Street

Removing buildings for construction of light rail guideway and stations, roadway modifications, and park-and-ride improvements could result in an increase in traffic noise levels at nearby receivers. Exposure to traffic noise could occur with all station options where buildings that currently provide shielding would be removed similar to the SR 99 Alternative, except the **Kent/Des Moines HC Campus Station Option** and the **Federal Way SR 99 Station Option**.

SR 99 to I-5 Alternative

Potential for traffic noise impacts from the SR 99 to I-5 Alternative would be the same as both the SR 99 Alternative north of Kent/Des Moines Road and the Preferred Alternative south of S 240th Street. The Kent/Des Moines 30th Avenue East Station would also include the S 236th Street extension, so it would have potential traffic noise impacts. Potential for traffic noise impacts from station options would be the same as for the potential additional stations at S 216th Street and the Federal Way S 320th Park-and-Ride Station Option.

I-5 to SR 99 Alternative

Potential for traffic noise impacts from the I-5 to SR 99 Alternative would be the same as both the Preferred Alternative north of Kent/Des Moines Road and the SR 99 Alternative south of S 240th Street. The Kent/Des Moines 30th Avenue West Station would also include the S 236th Street extension and therefore would have potential for traffic noise impacts. Potential for traffic noise impacts from station options would be the same as for the potential additional stations at S 260th Street.

4.7.4.6 Vibration Impacts from Build Alternatives

Table 4.7-4 summarizes the vibration impacts for the FWLE alternatives from light rail operations. For multi-family buildings with vibration impacts, the actual number of units with impacts at each specific building would be confirmed following additional testing and analysis performed during final project design.

The predicted impacts are based on the distance between the proposed tracks and the individual buildings, the track profile (elevated, trench, or at-grade), and the speed of the light rail vehicle. In most cases, vibration impacts are limited to buildings within 50 feet of at-grade or trench ballast-and-tie track, or elevated structures.

TABLE 4.7-4
Summary of Projected Vibration Impacts from Light Rail Operations

Alternative	Number of Vibration Impacts (Range with Options)		Potential Mitigation[a]
	Before Mitigation	After Mitigation	
Preferred Alternative	**193** (185–193)	**4** (4–4)	ballast mat, tire-derived aggregate, HCDF
SR 99 Alternative	**50** (0–271)	**0** (0–0)	HCDF
SR 99 to I-5 Alternative	**209** (159–225)	**0** (0–0)	HCDF
I-5 to SR 99 Alternative	**45** (45–238)	**0** (0)	HCDF

[a] For at-grade and trench sections, ballast mats, which are rubber mats placed between the track ballast and the ground, are recommended for vibration mitigation. Tire-derived aggregate can be used similar to ballast mats in these locations. HCDF is used as mitigation for aerial sections.
HCDF = high-compliance direct-fixation fastener

Because the vibration from elevated structures would enter the ground at the location of the guideway columns, this analysis assumes that columns could be installed anywhere along the alignment. The actual location of the support pillars would be developed and the vibration analysis revised during final design, which could reduce vibration impacts. For at-grade or trench profiles, the distance depends on the depth of the cut and the soils between the cut and the receiver. Options that would not change impacts are not discussed below.

Preferred Alternative

The Preferred Alternative would exceed FTA vibration criteria at 11 properties representing 193 units, including four single-family residences, two hotels, four multi-family residences, and a mobile home park. Of these, there are four multi-family residences within approximately 15 feet of the light rail guideway, and standard vibration mitigation might not be effective in reducing the vibration level to below FTA criteria. The Preferred Alternative and the S 272nd Star Lake Elevated Station Option would not have vibration impacts at Mark Twain Elementary School.

The **Kent/Des Moines At-Grade Station Option** and **Kent/Des Moines I-5 Station Option** would have additional impacts at a motel, where 20 units would be impacted. These options would avoid impacts at one hotel and one single family home because the buildings would be displaced with these options.

SR 99 Alternative

The SR 99 Alternative would impact 50 units at the Best Western Hotel at the north end of the alignment.

The **S 216th Street West Station Option** would have 50 fewer impacts than the SR 99 Alternative because it would displace the Best Western Hotel. The **S 216th Street East Station Option** would impact an additional 16 units at the New West Motel.

The **Kent/Des Moines HC Campus Station Option** would impact an additional 12 units in a multi-family building. If it were connected to the **S 216th West Station Option**, it would affect 28 more units at 5 additional single- and multi-family properties.

Compared to the SR 99 Alternative, the **S 260th West Station Option** would impact an additional 12 units at a multi-family property, and the **S 260th East Station Option** would impact 2 additional single-family residences.

The **S 272nd Redondo Trench Station Option** would impact an additional 181 units at five properties consisting of two single-family residences, two multi-family residences, and one hotel.

SR 99 to I-5 Alternative

The SR 99 to I-5 Alternative would impact 209 units on seven properties. Impacts north of Kent-Des Moines Road are similar to the Preferred Alternative and impacts south of S 240th Street are the same as with the SR 99 Alternative. One two-unit structure would have vibration impacts.

I-5 to SR 99 Alternative

The I-5 to SR 99 Alternative would impact 45 units on four properties. The **S 260th West Station Option** would not have the additional impacts that occur when this option connects to the SR 99 Alternative because it would be farther from these sensitive receivers on the west side of SR 99.

4.7.4.7 Groundborne Noise Impacts

The only "special" building (according to FTA criteria) in the FWLE corridor is the Federal Way High School Performing Arts Center next to SR 99. This building has greater sensitivity to groundborne noise because it is a performance hall, and the impact criteria account for this sensitivity. The SR 99 and I-5 to SR 99 Alternatives are predicted to exceed the groundborne noise criteria at this performing arts center because the tracks would be close to the building.

Special Buildings

Users of certain buildings, such as concert halls, recording studios, and theaters, can be very sensitive to vibration and groundborne noise, and these buildings warrant special attention during the environmental evaluation of a transit project. The FTA has criteria for acceptable levels of groundborne vibration and groundborne noise for various categories of special buildings.

4.7.5 Potential Mitigation Measures

Sound Transit will perform additional noise and vibration analysis during final design to verify impacts and review mitigation measures. If effective mitigation can be achieved by other means, or if refined analysis shows reduced impacts, it may apply different mitigation measures, and it may eliminate unneeded mitigation. This review will also account for any changes in the SR 509 design and its proposed traffic noise mitigation.

Appendix C of Appendix G3, Noise and Vibration Technical Report, contains maps showing the approximate locations of proposed sound walls based on the current noise analysis.

4.7.5.1 Light Rail Noise Mitigation

Sound Transit is committed to minimizing noise levels at their source for all of its light rail corridors. When noise impacts still occur, Sound Transit provides noise mitigation measures when determined to be reasonable and feasible, consistent with its Light Rail Noise Mitigation Policy (Motion No. M2004-08) and the FTA guidance manual (2006). After light rail operations have started, if the resulting noise exceeds FTA criteria, Sound Transit will evaluate the need for additional mitigation.

Sound walls are the primary noise mitigation option for FWLE operations because they are effective at reducing noise near the source. They would be proposed where Sound Transit determines that they are feasible and reasonable based on specific site conditions. Sound walls for elevated profiles would be along the side of the guideway structure, and for other profiles would be on the ground.

Another option is special trackwork, such as movable-point or spring-rail frogs, to eliminate the noise- and vibration-causing gap between tracks at switches and crossovers.

When source mitigation measures or sound barriers are infeasible or not entirely effective at reducing exterior noise levels below the FTA impact criteria, and where the affected building does not already achieve a sufficient exterior-to-interior reduction of noise levels, Sound Transit would consider residential sound insulation. Most newer buildings have effective exterior-to-interior noise reduction, and additional sound insulation might not be necessary.

The Preferred Alternative would mitigate all noise impacts with sound walls along the guideway (with any profile) and with special

trackwork at track crossover locations. Under the other alternatives, some units may need to be considered for sound insulation as described above.

Park-and-Ride Noise Mitigation

Noise mitigation for the park-and-rides includes transit center design and sound walls, or, if necessary, consideration of residential sound insulation. An example of transit center design mitigation is including short sound walls within the parking garage.

Potential Traffic Noise Mitigation

The proposed light rail sound walls would be modified in length and/or height in order to mitigate traffic noise impacts. For instance, the light rail sound wall proposed between S 225th Street and the Kent/Des Moines Station, which would range from 6 to 18 feet in height for light rail mitigation, would be increased to a range of 6 to 21 feet in height to effectively mitigate traffic noise. Overall, increases to light rail noise walls of 4 to 13 feet would be required in order to fully mitigate traffic noise in that area. Where the existing sound wall would be removed next to Camelot Square Mobile Home Park, the wall could be replaced on the east side of the light rail with a 16- to 22-foot-high sound wall. Alternatively, a 14- to 18-foot wall on the west side of the light rail would mitigate traffic noise, but could limit options for relocating Bingaman Creek south of S 288th Street. Either of these walls would fully mitigate the traffic noise impacts in this area without the SR 509 Extension.

With SR 509, an additional sound wall would be needed along the north and east sides of the mobile home park (i.e., along the western edge of the WSDOT right-of-way and along the south side of S 288th Street). Sound Transit would coordinate with WSDOT to determine the height and length of a second noise wall in this area. It should be noted that given the existence of Bingaman Creek in this area, it is unclear whether construction of this traffic sound wall would be feasible, and additional analysis would be performed during final design. Sound Transit would use sound walls to mitigate all of the traffic noise impacts associated with the Preferred Alternative except for one home at the Park of the Pines. This house would also have park-and-ride and light rail noise impacts and will be reviewed to verify the appropriate mitigation design during final design, which may include sound insulation.

4.7.5.2 Vibration and Groundborne Noise Mitigation

Sound Transit would mitigate vibration and groundborne noise impacts that exceed FTA criteria when determined to be reasonable and feasible. It would refine the locations requiring mitigation during final design.

For at-grade or trench segments, the most common type of vibration mitigation is the use of ballast mats, in which a rubber or rubberlike pad is placed on an asphalt or concrete base with the normal ballast, ties, and rail on top. A variation is the use of tire-derived aggregate (TDA), instead of the standard ballast. TDA consists of shredded tires wrapped with filter fabric.

Mitigation could also include the use of resilient (HCDF) fasteners for vibration isolation between rails and concrete slabs.

As described above, special trackwork can mitigate vibration impacts by eliminating the vibration-causing gap between tracks at crossovers.

The Preferred Alternative would likely use ballast mats and TDA to mitigate impacts. At four multi-family residences, these measures may not be effective in reducing the vibration levels to below FTA criteria because the buildings are close to the light rail guideway. At these locations, project design modification and additional information on affected buildings could eliminate or reduce these impacts. For instance, the type of building foundation might reduce vibration levels. Additional analysis during final design will evaluate the specific buildings, and alternative mitigation measures may be warranted. Final mitigation would be confirmed during final design.

4.8 Water Resources

4.8.1 Summary

Potential impacts on water resources from the FWLE due to an increase in impervious surface include additional erosion and pollutants in nearby streams and wellhead protection areas. Among the build alternatives, the Preferred Alternative would have the second largest increase in impervious surface, with a 73 percent increase in impervious surface in the project footprint (Table 4.8-1). Other build alternatives would increase impervious surface by between 14 and 80 percent. However, Sound Transit would implement stormwater management and best management practices (BMPs) for all light rail alternatives to protect surface waters from the additional surface runoff and avoid water quality impacts.

TABLE 4.8-1
Summary of Changes in Impervious Surface Within Alternative Footprints

Alternative	Existing Impervious Surface in Acres (Range with Options)[a]	Impervious Surface with FWLE Build Alternatives in Acres (Range with Options)[a]	% Increase in Impervious Surface (Range with Options)[b]
Preferred Alternative	**42** (15-42)	**73** (38-109)	**73** (73-195)
SR 99 Alternative	**104** (81-123)	**119** (92-135)	**14** (10-14)
SR 99 to I-5 Alternative	**42** (41-57)	**76** (76-91)	**80** (61-84)
I-5 to SR 99 Alternative	**95** (69-101)	**111** (88-114)	**17** (13-27)

Note: Totals may be greater than sum of individual areas in Table 4.8-3 due to rounding.
[a] The ranges provided show the potential range of impacts when each alternative is combined with one or more of its station or alignment options to create the lowest and highest areas of impervious surface.
[b] The range shown is the minimum and maximum increase for individual options.

The Preferred Alternative and the SR 99 to I-5 Alternative would realign approximately 1,000 feet of Bingaman Creek upstream of I-5. The SR 99 and I-5 to SR 99 alternatives and their options would span all stream crossings with an elevated guideway, avoiding encroachment impacts on streams. All alternatives would be within designated wellhead protection zones for Highline Water District in SeaTac and Lakehaven Utility District in Federal Way. With appropriate design and BMPs, all would avoid adverse impacts on groundwater.

4.8.2 Introduction

This section describes the affected water resources and potential hydrologic, flooding, and water quality impacts associated with the FWLE alternatives.

Appendix D4.8, Water Resources, contains the following supporting information:

- A list of relevant laws, ordinances, and guidelines
- A table of designated water uses for the water bodies in the study area
- A list of applicable stormwater ordinances and manuals
- Maps of major surface water bodies and stormwater facilities in the study area and hydrologic soil groups
- A table of changes in impervious surface
- BMPs for stormwater impacts

A detailed discussion of wetlands, stream habitat, and stream/wetland buffers is presented in Section 4.9, Ecosystems. Exhibit 4.8-1 shows the major water features in the study area.

4.8.3 Affected Environment

Topography in the study area ranges from a high elevation of roughly 500 feet along the SR 99/I-5 corridor to sea level at Puget Sound. Most of the study area crossed by the FWLE is urbanized. The most developed areas are along the SR 99 corridor and in the area surrounding the Federal Way Transit Center. Other areas are characterized by lower-density residential development and greater concentrations of vegetation.

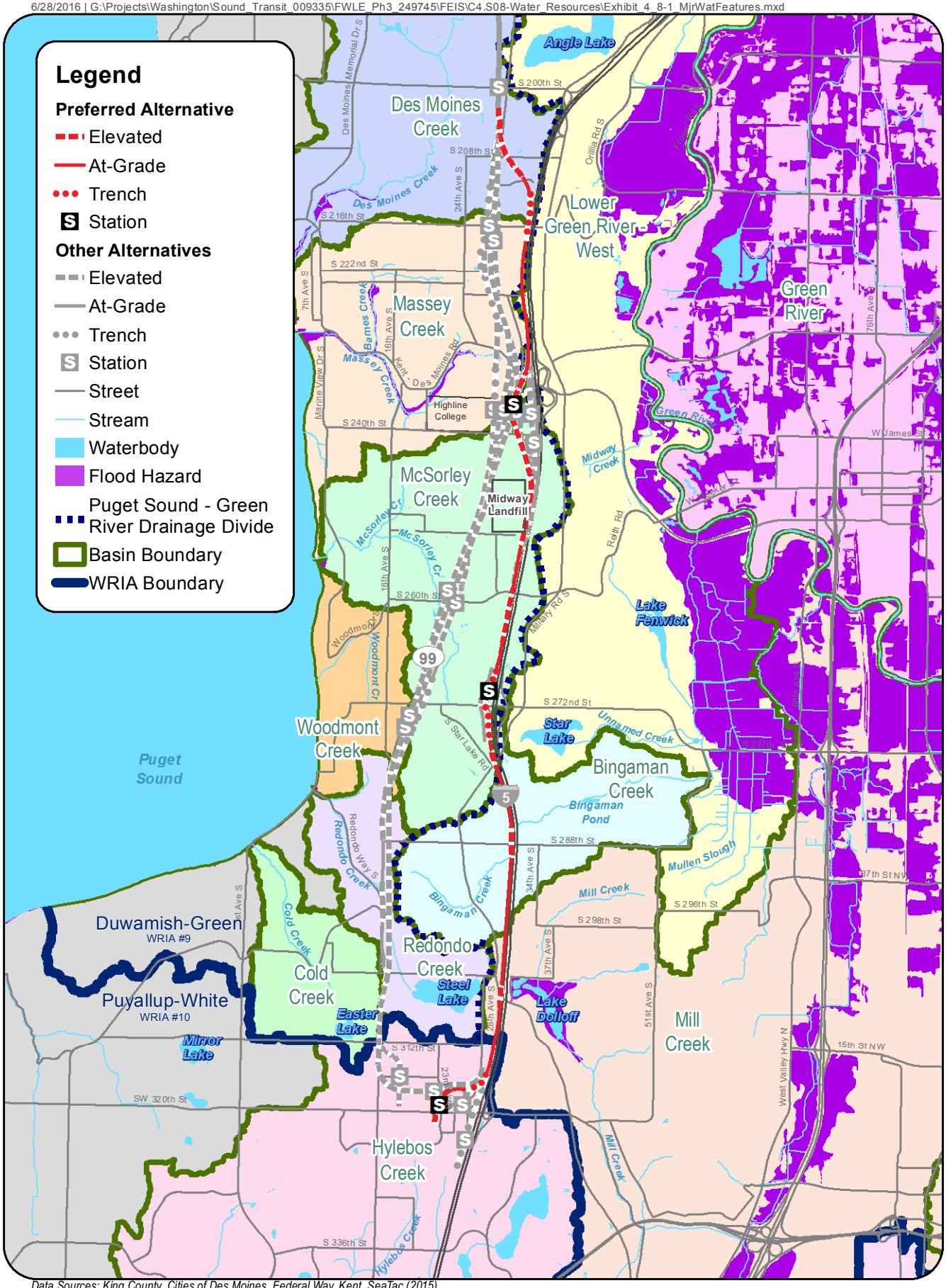
Study Area

The study area for water resources consists of the stream basins that the project would be constructed in. Most of the study area lies along the topographic ridge that drains west to Puget Sound and east to the Green River valley within the Duwamish/Green Water Resources Inventory Area (WRIA) 9. The southern end of the study area is within the Puyallup/White WRIA 10.

4.8.3.1 Surface Water

Exhibit 4.8-1 shows the major streams within the study area. Given the relatively narrow width and steep sides of the study area, the local streams are generally no more than a few miles long.

The western side of the study area drains to the East Passage of Central Puget Sound. The primary streams in the study area that flow to Puget Sound include Des Moines, Massey, McSorley, and Redondo creeks. The primary streams flowing east to the Green River include Bingaman and Mill creeks, both in the southeastern portion of the study area.



Data Sources: King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

EXHIBIT 4.8-1
Major Water Features

Federal Way Link Extension

The southernmost portion of the study area encompasses the northern end of the Hylebos Creek Basin. Runoff from this portion of the Hylebos Basin flows south to a large wetland south of S 348th Street. The wetland is the headwaters of Hylebos Creek, which flows south and then west, emptying into Commencement Bay east of downtown Tacoma.

All of the stream basins are highly urbanized and exhibit high stream flows (peak flows) during storm events, typical of developed basins. Urbanization has also changed base flow and increased seasonal flow fluctuations from pre-development conditions. These changes can have major effects on the physical, biological, and chemical nature of the stream. More information on these stream characteristics is available in the FWLE Ecosystems Technical Report, Appendix G2.

North of S 200th Street in SeaTac, a large regional detention facility reduces peak stormwater runoff in the upper Des Moines Creek basin. There are also several large regional detention ponds in the upper portion of the Hylebos Creek basin, and some stream and riparian restoration projects have been carried out in that basin's middle reaches.

The study area includes Angle Lake, Star Lake, and Steel Lake. All are of moderate size and have a relatively small area contributing runoff. Their shorelines are almost completely developed with single-family residences, docks, and piers. The King County Lakes Program (2013) indicates that they have "very good" to "excellent" water quality.

The study area also includes Lake Dolloff, which is undeveloped along its north side, with low-density residential development along the remaining shoreline. It has fair water quality but is considered eutrophic.

Eutrophic

A lake is eutrophic when it has high levels of nutrients that promote high algae production (algal blooms). This typically results in periods of very low water clarity. This can also result in low dissolved oxygen levels in the lake water that can adversely affect aquatic species.

The state Department of Ecology (Ecology) has assigned water uses to each of the water bodies in the study area (see Appendix D4.8.) These uses define the applicable water quality standards for each water body. Ecology periodically assesses state-wide water quality to develop a list of water bodies that do not meet water quality standards. Table 4.8-2 shows the listed water bodies in the study area. Bacteria and dissolved oxygen are the two parameters in the study area that most commonly do not meet Ecology's water quality standards. Water quality violations are also shown for copper in Des Moines, Massey, and McSorley creeks.

However, Massey and McSorley creeks are proposed for removal from the list for copper after a recent study showed no violations.

TABLE 4.8-2
Study Area Water Bodies Not Meeting Water Quality Standards (303[d] List)

	Dissolved Oxygen	Bacteria	Copper	PCBs (tissue)	Bioassessment
East Passage (Puget Sound)		✓		✓	
Des Moines Creek	✓	✓	✓		
Massey Creek	✓		✓ [b]		
McSorley Creek	✓	✓	✓ [b]		
Redondo Creek		✓			
Unnamed Creek[a]	✓	✓			
Hylebos Creek	✓				✓

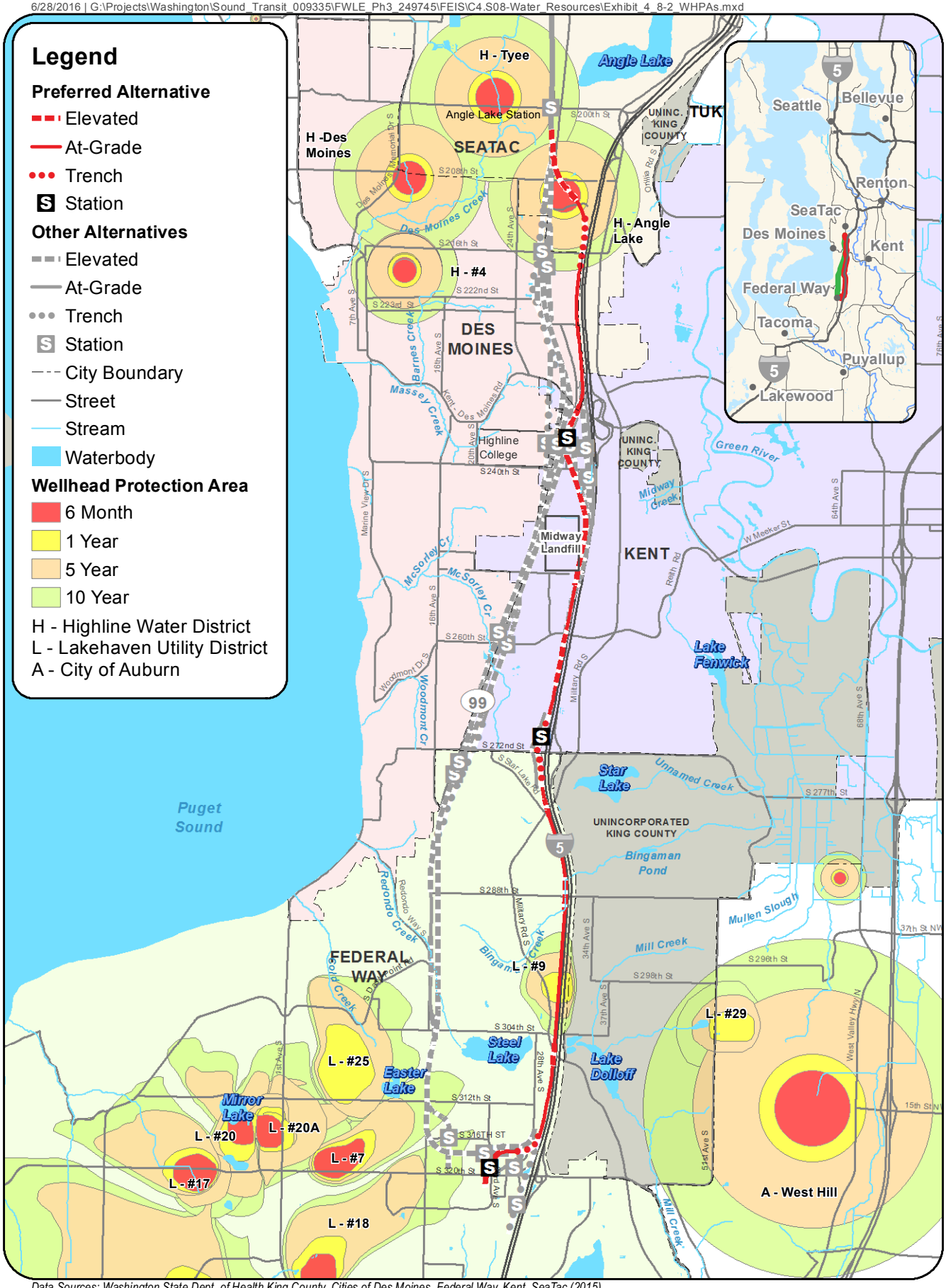
Source: Ecology, 2014a.
[a] Flows from Star Lake to the Green River.
[b] Proposed for removal based on 2010 data.
PCBs = polychlorinated biphenyls

4.8.3.2 Floodplains

The Federal Emergency Management Agency (FEMA) published flood insurance rate maps in 1995 for the study area. King County used more recent flood data to locate flood boundaries in the study area as shown in Exhibit 4.8-1. Only two flood hazard areas have been mapped within the study area by FEMA and King County, and they are not within 300 feet of any of the alternatives. One follows the upper portion of the south fork of Massey Creek, west of SR 99, which is approximately 725 feet from the nearest alternative. The second surrounds Lake Dolloff (east of I-5) and is approximately 330 feet from the nearest alternative.

4.8.3.3 Groundwater

There is no U.S. Environmental Protection Agency (EPA)-designated sole source aquifer within the study area. However, groundwater provides an important municipal water supply in the southern portion of the study area. Wellhead protection zones have been designated around a number of municipal drinking water supply wells (Exhibit 4.8-2). Each zone defines an area of land where infiltrating water would take a given period of time to directly recharge the municipal well. Four zones representing recharge times of 6 months, 1 year, 5 years, and 10 years are shown.



Data Sources: Washington State Dept. of Health,King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.5 1 2 Miles

EXHIBIT 4.8-2
Wellhead Protection Areas

Federal Way Link Extension

Wells in the study area with wellhead protection areas include:

- Highline Water District: Well 4 and Des Moines, Tyee, and Angle Lake wells
- Lakehaven Utility District: Wells 7, 9, 17, 18, 20, 20A, 25 and 29
- City of Auburn Water: West Hill well

The City of Seattle's Midway Landfill is a Superfund site next to I-5. After the landfill was closed in 1983, groundwater monitoring indicated that contaminants had entered the groundwater (EPA, 2000). Leachate from the landfill has migrated though the base of the landfill and entered a relatively porous formation known as the Upper Gravel Aquifer. It subsequently flowed to the underlying Southern Gravel Aquifer, which flows both east and west.

Groundwater Contaminants at Midway Landfill

The carcinogenic compounds ethylene dichloride and vinyl chloride were the primary contaminants of concern at Midway Landfill. Dioxane, a probable carcinogen, was detected in groundwater in this area in 2005 and is also monitored. Both ethylene dichloride and vinyl chloride have been detected in monitoring wells upgradient of the landfill, indicating that there are additional sources of these contaminants outside of the Midway Landfill.

To address the contamination, the landfill was capped in the 1990s and offsite run-on to the landfill was diverted. A stormwater pond now treats surface runoff from the landfill, and discharge from that pond enters McSorley Creek. The remedial actions have greatly reduced the amount of leachate from the landfill, causing groundwater levels below the landfill to decrease. Concentrations of volatile organic compounds in downgradient wells have also declined and are now below or approaching the Remedial Action Goals for the landfill (EPA, 2010).

More information on the Midway Landfill can be found in Section 4.11, Geology and Soils, and Section 4.12, Hazardous Materials.

4.8.3.4 Stormwater Management

Existing development in the study area includes an extensive stormwater drainage system. The stormwater ordinances and manuals applicable to the four cities in the FWLE corridor are listed in Appendix D4.8. With the exception of Kent, which has its own manual, the cities have adopted the 2009 King County *Surface Water Design Manual,* with addenda to address local concerns. The 2009 manual was revised and the new version became effective in April 2016.

Washington State Department of Transportation (WSDOT) stormwater management design standards would apply to the portion of the project within WSDOT right-of-way along I-5, although

WSDOT may choose to apply the standards of the local jurisdiction. Most of the WSDOT-operated drainage system serving I-5 was installed before the surrounding area was developed and consists largely of ditches that drain to local streams or to the adjacent cities' drainage systems. A few detention ponds have been constructed to manage road runoff. WSDOT reports that there are no substantial flooding or local drainage problems associated with I-5 in the study area (A.L. Williams, personal communication, 2013). There are no major funded additions or improvements to the I-5 drainage system currently planned in the project vicinity by WSDOT.

Sound Transit consulted with SeaTac, Kent, Des Moines, and Federal Way to identify possible drainage issues and gather relevant information. Because all the cities have upgraded their stormwater facilities associated with SR 99, none of them experience any serious drainage problems along that corridor (personal communications with Will Appleton, City of Federal Way; Mike Bryan, City of SeaTac; Loren Reinhold, City of Des Moines; and Beth Tan, City of Kent; May 2013).

A large wetland lies along the upper reach of the South Fork McSorley Creek, upstream of SR 99. Proper stormwater management for the protection of this critical area is a priority for the City of Kent (Beth Tan, personal communication, 2013).

The only planned major stormwater facility upgrade is relocation of WSDOT's stormwater detention pond (aka Executel Pond) in the northern portion of the study area (in the city of SeaTac west of SR 99; refer to Exhibit D4.8-1a in Appendix D4.8). WSDOT would relocate the pond to the west of its existing location as part of the SR 509 Extension Project (Mike Bryan, personal communication, May 30, 2013).

4.8.4 Environmental Impacts

4.8.4.1 No Build Alternative

Under the No Build Alternative, light rail would not be extended in the FWLE corridor and the potential impacts on water resources identified for the FWLE build alternatives would be avoided. The No Build Alternative would have no direct impacts on any water bodies. However, other public transportation projects included in the No Build Alternative would be independently constructed in the study area. Those projects could impact water quality, but they would be designed to manage stormwater to similar protective levels as the

FWLE build alternatives. For example, the SR 509 Extension would include stormwater detention and treatment BMPs in the Des Moines Creek basin.

4.8.4.2 Build Alternatives

This section describes the direct and indirect impacts of the FWLE alternatives on water resources. Construction impacts are discussed in Chapter 5.

Direct Impacts

Sound Transit assessed potential long-term impacts on water resources using GIS to overlay alternative footprints on a map of surface water bodies and identify stream crossings. These crossings and the characteristics of the associated water bodies were then visually reviewed in the field. GIS data of impervious surfaces in the study area were combined with design data layers to determine the change in impervious area and pollution-generating impervious surfaces (PGIS).

No shorelines of the state, shorelines of statewide significance, or designated floodplains lie within 200 feet of the FWLE. These resources would not be impacted, so are not discussed further.

Impacts Common to All Alternatives

Sound Transit would minimize impacts on water resources through project design and development in compliance with stormwater management regulations. It would minimize the amount of impervious surface area, avoid placing project elements in or near water resources where possible, and install appropriate stormwater management facilities. Sound Transit's *Link Design Criteria Manual* (2016) requires stormwater facilities for its projects to conform to the local jurisdiction's requirements. The manual emphasizes sustainability measures, including low-impact development (LID), to manage stormwater, if appropriate and feasible. The *Stormwater Management Manual for Western Washington* also requires LID approaches to stormwater management to the extent feasible (Ecology, 2014b). Depending upon the alternative or option selected, the project may be underlain by limited areas of infiltrative soils that could be suitable for LID measures. Existing development would limit such opportunities, but Sound Transit would incorporate LID measures into project design where feasible.

Low-Impact Development

LID is a stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes by emphasizing conservation, use of onsite natural features, site planning, and distributed stormwater management practices that are integrated into a project design. LID BMPs emphasize pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation, and transpiration. Common LID BMPs include bioretention, rain gardens, permeable pavements, minimal excavation foundations, vegetated roofs, and rainwater harvesting. *Source:* http://www.ecy.wa.gov/programs/wq/stormwater/municipal/LID/Resources.html.

The FWLE would provide stormwater detention throughout the corridor in new or existing ponds or in underground vaults where space is limited. Existing stormwater facilities in the study area are shown in Appendix D4.8. During final design, Sound Transit may explore the potential for creating new facilities or modifying existing regional stormwater facilities to manage project runoff in coordination with local jurisdictions and/or WSDOT. Some existing facilities would be temporarily impacted during construction, as described in Chapter 5.

PGIS and Non-PGIS

PGIS generally includes station facilities such as parking areas, bus holding areas, and road improvements needed to accommodate the project. Runoff from PGIS can increase pollutant loads to streams and degrade water quality. Non-PGIS includes the light rail tracks (including ties and ballast), guideways, and station platforms, and infrequently used access roads. Increases in impervious surface can also affect groundwater. These impacts are described in more detail below.

Impervious Surfaces

The FWLE would add pollution-generating and non-pollution-generating impervious surfaces as shown in Tables 4.8-1 and 4.8-3. Additional information on calculation of the impervious surface and PGIS is presented in Appendix D4.8.

TABLE 4.8-3
Changes in Impervious Surface in Acres (Range of Acreage with Options)

Alternative	Total Area	Existing Conditions			Conditions with FWLE Build Alternatives		
			Impervious			Impervious	
		Pervious	PGIS	Non-PGIS	Pervious	PGIS	Non-PGIS
Preferred Alternative	**82** (56-82)	**39** (34-60)	**28** (6-28)	**14** (9-14)	**8** (4-9)	**29** (29-64)	**45** (9-45)
SR 99 Alternative	**120** (97 to 136)	**17** (8 to 24)	**85** (63 to 104)	**19** (13 to 24)	**2** (1 to 2)	**97** (63 to 107)	**22** (22 to 39)
SR 99 to I-5 Alternative	**76** (76 to 92)	**34** (33 to 39)	**33** (31 to 47)	**9** (9 to 15)	**1** (1 to 1)	**45** (45 to 57)	**31** (31 to 37)
I-5 to SR 99 Alternative	**113** (92 to 115)	**18** (14 to 20)	**78** (59 to 85)	**17** (12 to 17)	**2** (1 to 2)	**82** (57 to 84)	**29** (29 to 34)

Surface Water

To evaluate potential impacts on surface water, Sound Transit considered:

- **Increases in impervious surfaces**: Impervious surfaces increase runoff volumes that can escalate flooding, stream erosion, and degradation of downstream aquatic habitat. Impervious areas subject to vehicular traffic and other pollution-generating activities accumulate contaminants (oil, grease, copper, zinc, etc.) that are transported to water bodies by stormwater runoff if not treated, which can impact water quality. Sound Transit would treat stormwater runoff from project-related PGIS, preventing degradation of water quality. In general, runoff from non-PGIS

surfaces would not be treated. Flow control would be provided for all runoff from project-related impervious areas.

- **Stream crossings**: Bingaman Creek would be directly impacted by the Preferred and SR 99 to I-5 alternatives, as described in the Impacts by Alternative section below. All other stream crossings by the FWLE alternatives would be on elevated guideways, to prevent impacts from fill or walls.
- **Parking facilities**: Most of the proposed parking facilities would be in areas of existing vehicular use or parking, such as park-and-rides, and all would be in areas that are developed and predominantly pavement. All parking facilities would incorporate stormwater management features, improving water quality and stormwater flow control in these areas.
- **Design BMPs**: LID strategies, stormwater treatment, and flow-control facilities would be constructed where feasible.

The project would meet the stormwater management requirements of the local jurisdictions and comply with applicable permit requirements. Stormwater detention and/or treatment would be incorporated into the project design, and stormwater would be discharged into the same drainage systems that currently serve the project corridor. Project runoff would be managed with detention ponds, vaults, and, where site conditions allow, LID to avoid intensifying any existing drainage problems.

Groundwater

The project's increase in impervious area could reduce the amount of groundwater recharge because there would be less pervious area available for precipitation to directly infiltrate. The soils along the alternatives are not generally conducive to onsite infiltration. However, Sound Transit would use stormwater management facilities such as ponds and vaults to infiltrate runoff from the project as much as the soils can accommodate. In addition, supplemental geotechnical investigations would be conducted in final design to assess the feasibility of implementing deep infiltration options. Thus, the project would not substantially impact groundwater levels. Sound Transit would treat project stormwater runoff before releasing it to avoid groundwater quality impacts.

Some alternatives and options would have guideway sections in 20- to 40-foot-deep trenches with solid concrete sides and bottoms, and

a water-tight lining to maintain the trench integrity and avoid seepage of groundwater into the trench. Some local changes in groundwater flow paths might occur, but no long-term groundwater impacts are expected.

All alternatives would cross two designated wellhead protection zones at the north end of the study area: Angle Lake Well and Tyee Well (Exhibit 4.8-2). Both wells are in the city of SeaTac and are operated by the Highline Water District. The District can impose special requirements on projects in the wellhead protection zone. Within these zones, the FWLE would consist of non-PGIS train track. The FWLE alternatives would also cross one or more wellhead protection zones in the Lakehaven Utility District in Federal Way (Table 4.8-4). The City of Federal Way places restrictions on the use and storage of petroleum products and other hazardous materials within wellhead protection zones. The FWLE alternatives would not require storage of petroleum products or other hazardous materials in these zones.

TABLE 4.8-4
Wellhead Protection Zones in the FWLE Study Area

Alternative	Highline Water District		Lakehaven Utility District		
	Angle Lake Well	Tyee Well	Well 9	Well 7	Well 18
Preferred Alternative	✓	✓	✓		
SR 99 Alternative	✓	✓		✓	✓
SR 99 to I-5 Alternative	✓	✓	✓		
I-5 to SR 99 Alternative	✓	✓		✓	✓

As mentioned above, reductions of pervious areas and surface disturbance of natural site features such as soil and vegetation can reduce the amount of groundwater recharge from direct precipitation. However, Sound Transit would use BMPs to facilitate infiltration of treated stormwater where feasible soils exist to minimize potential effects on groundwater recharge in wellhead protection zones. It would also consult with the Highline Water District and the Lakehaven Utility District during final design regarding proposed stormwater management measures within recharge zones to protect groundwater quality. No adverse impacts on groundwater are expected.

Impacts by Alternative

Preferred Alternative

Impervious Surface

The Preferred Alternative and options would increase impervious surface in the project footprint from the existing 42 acres to about 73 acres. This is a greater increase than the SR 99 or I-5 to SR 99 alternatives because much of the guideway would be in currently pervious areas adjacent to I-5.

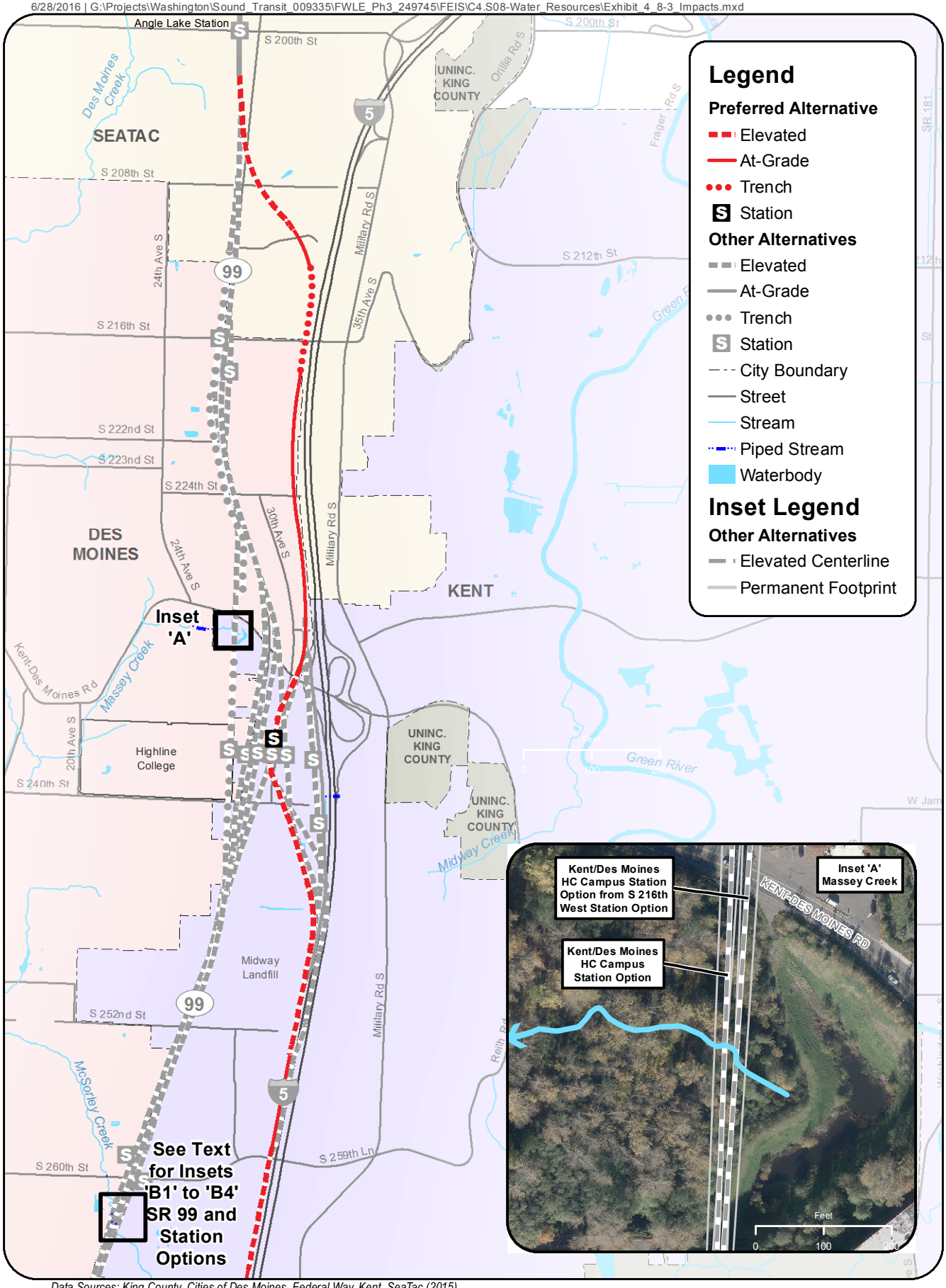
Surface Water

Stream crossings for the FWLE are shown on Exhibits 4.8-3 and 4.8-4. Bingaman Creek is a perennial stream that is intermittent within the WSDOT right-of-way. It flows parallel to the western side of I-5 in the vicinity of S 288th Street (Exhibit 4.8-4, Inset E).

The stream enters the right-of-way at the Camelot Square Mobile Home Park approximately 450 feet south of S 288th Street. It then runs north along the western edge of the I-5 right-of-way parallel to the freeway within an approximately 50-foot-wide forested area between a sound wall along I-5 and the mobile home park. The creek crosses under S 288th Street and continues north along the I-5 right-of-way for approximately 600 feet before turning east under I-5 in a culvert. North of S 288th Street is a 300-foot-wide forested area that lies west of I-5; however, the creek continues to closely parallel the freeway in this area. The Preferred Alternative would pass directly over Bingaman Creek on elevated structure north and south of S 288th Street.

South of S 288th Street, approximately 500 feet of the creek would be realigned around the guideway columns. North of S 288th Street, approximately 500 feet of the creek would also be realigned around the columns, and the alignment would span the creek as it flows into the culvert under I-5. Impacts on Bingaman Creek are described further in the ecosystems impacts discussion in Section 4.9.4.2.

The Preferred Alternative would impact an existing WSDOT stormwater detention pond between S 259th and S 272nd Streets (refer to Appendix D4.8, Exhibit D4.8-1b). The pond would be reconstructed or relocated.



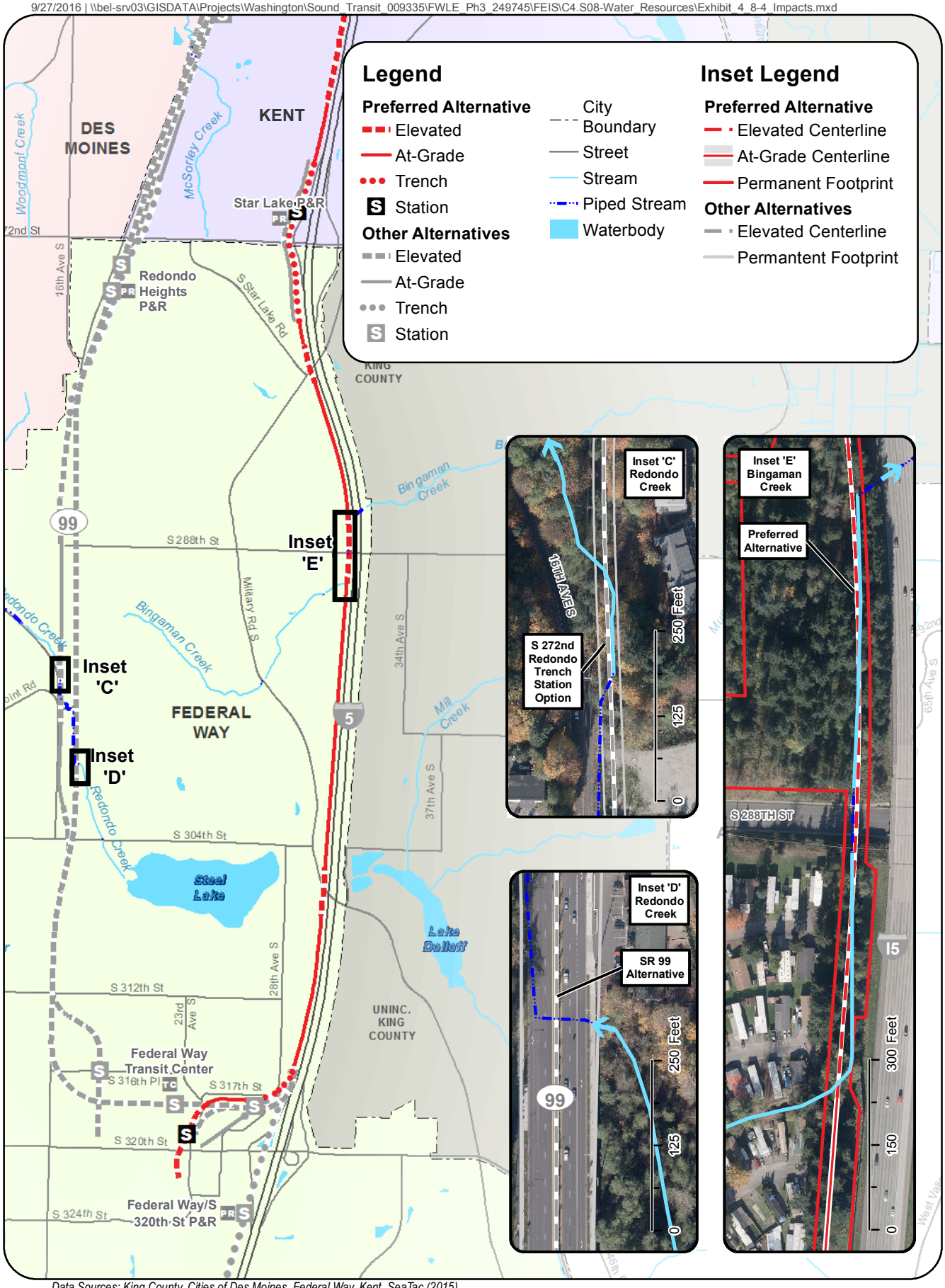
Data Sources: King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.25 0.5 1 Miles

EXHIBIT 4.8-3
Stream Crossings (North)

Federal Way Link Extension



Data Sources: King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.25 0.5 1 Miles

EXHIBIT 4.8-4
Stream Crossings (South)

Federal Way Link Extension

Groundwater

In addition to crossing wellhead protection zones, the Preferred Alternative would place columns in the Midway Landfill, with the potential to impact the Upper Gravel Aquifer and Southern Gravel Aquifer in the Midway Landfill. The column excavations and the landfill cover penetrations would be sealed to prevent leachate from traveling between aquifers (see Section 5.12, Hazardous Materials, for additional information on sealing methods). No impacts on groundwater are expected.

Preferred Alternative Station and Alignment Options

Impervious Surface

The Kent/Des Moines I-5 Station Option would have the most new impervious surface and the Federal Way I-5 Station would have the least, compared to the Preferred Alternative.

Surface Water

There would be no additional surface water impacts with any of the Preferred Alternative station or alignment options.

Groundwater

There would be no additional groundwater impacts with any of the station or alignment options. The Landfill Median Alignment Option would avoid potential impacts on the Upper Gravel Aquifer and Southern Gravel Aquifer in the Midway Landfill.

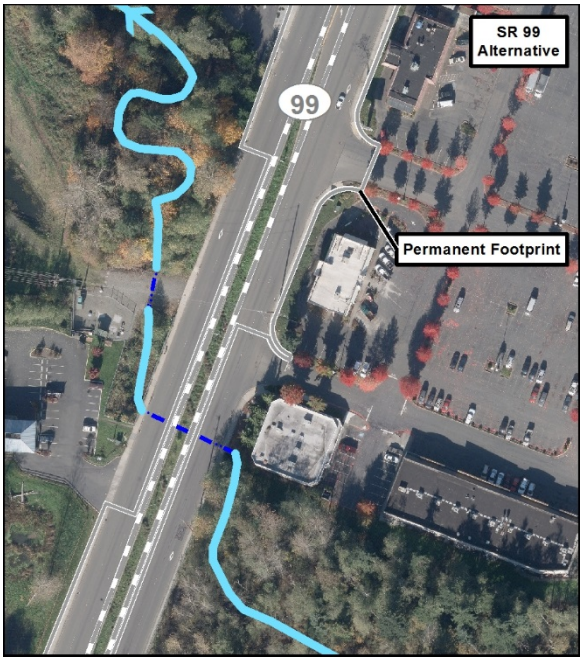
SR 99 Alternative

Impervious Surface

The SR 99 Alternative and options would have the least amount of new impervious surface. While the guideway would be exclusive and non-PGIS, PGIS would increase by about 10 acres because of station park-and-rides and road improvements along SR 99.

Surface Water

The SR 99 Alternative would be in the median of SR 99 where the road intersects with McSorley Creek and Redondo Creek. Road improvements would not affect the culverts in these locations (see Exhibits 4.8-3 and 4.8-4 and Inset B1 to Exhibit 4.8-3, at right). This alternative would not affect Massey Creek because the creek begins west of SR 99.



Inset B1 to Exhibit 4.8-3: SR 99 Alternative at McSorley Creek

Groundwater

The SR 99 Alternative would not have additional impacts beyond the crossing of wellhead protection zones discussed under Impacts Common to all Alternatives.

SR 99 Station Options

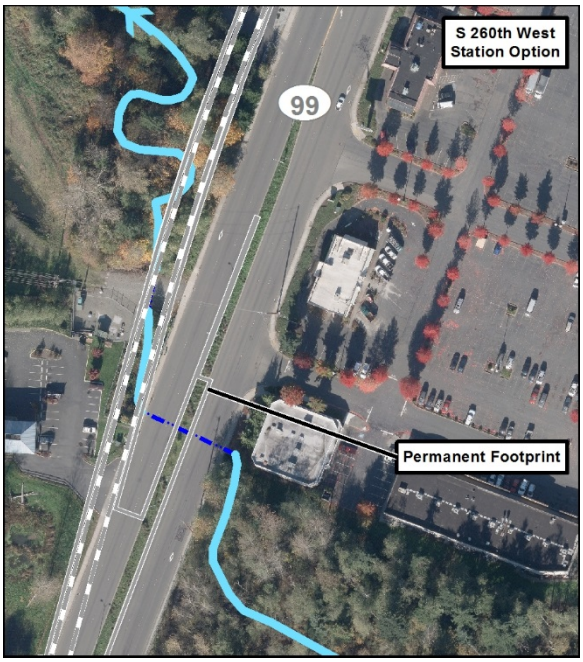
Impervious Surface

When compared to the SR 99 Alternative, the S 216th West Station Option would have the most new impervious surface, while the S 272nd Redondo Trench Station Option would have the least.

Surface Water

The Kent/Des Moines HC Campus Station Option would cross the uppermost section of Massey Creek just west of SR 99 (see Exhibit 4.8-3, Inset A). The creek channel lies approximately 200 feet south of the foot of the road embankment within a 600-foot-long, low-lying undeveloped area. The guideway would fully span the creek and most if not all of its buffer, avoiding impacts to the stream.

Immediately west of SR 99, the South Fork of McSorley Creek exits a culvert under SR 99 and flows west and then north for approximately 300 feet. The S 260th West Station Option would span this creek on the west side of SR 99 (Exhibit 4.8-3, Inset B2 at right), while the S 260th East Station Option would span it on the east side of SR 99 (Exhibit 4.8-3, Inset B3). No direct impacts on the creek would occur from either option. There is a potential for proximity impacts on the streams from removal of stream buffer for the guideway columns.



Inset B2 to Exhibit 4.8-3: S 260th West Station Option at McSorley Creek

The S 272nd Redondo Trench Station Option would have the same impacts on McSorley Creek as the S 260th East Station Option (Exhibit 4.8-3, Inset B4). This option would also span above approximately 150 feet of Redondo Creek where the creek leaves a pipe and enters a ravine on the west side of SR 99 (Exhibit 4.8-4, Inset C).

No permanent adverse impacts would occur to Redondo Creek because the elevated guideway would fully span it.

Groundwater

There would be no additional groundwater impacts with any of the SR 99 Station options.

SR 99 to I-5 Alternative

Impervious Surface

Similar to the Preferred Alterative, the SR 99 to I-5 Alternative would occur mostly in undeveloped right-of-way, resulting in an increase in impervious surface of about 34 acres.

Surface Water

This alternative would have impacts on Bingaman Creek similar to the Preferred Alternative.

Groundwater

The SR 99 to I-5 Alternative would also cross the Midway Landfill, similar to the Preferred Alternative. No impacts on groundwater are expected.

I-5 to SR 99 Alternative

Impervious Surface

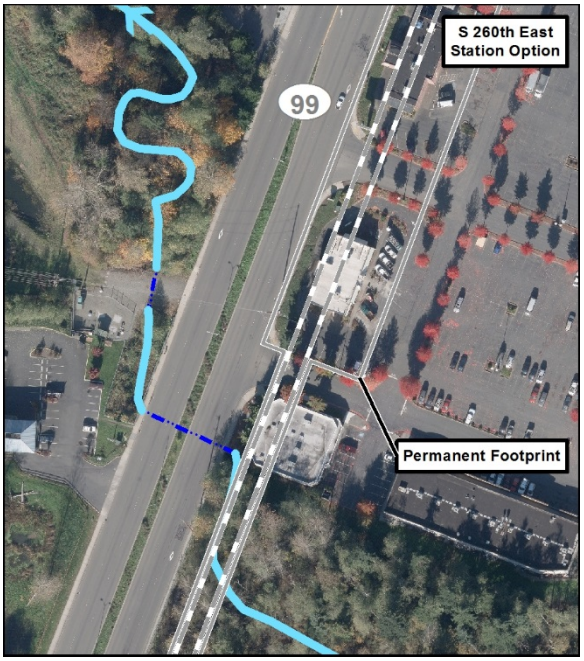
The I-5 to SR 99 Alternative would increase impervious surface by about 16 acres.

Surface Water

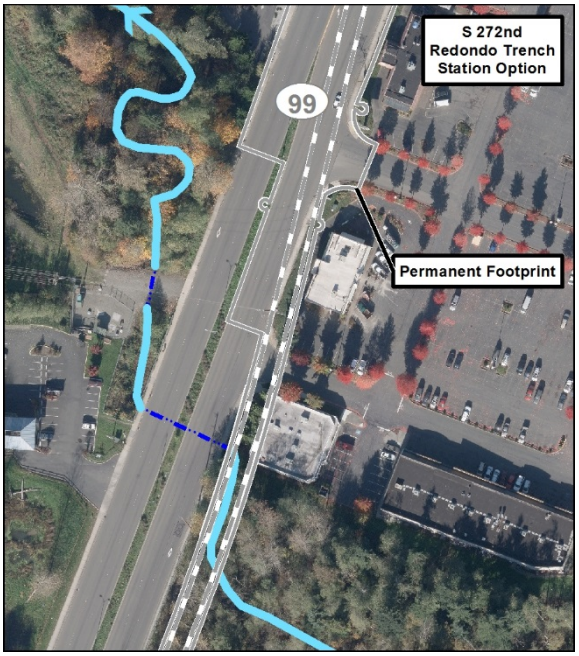
This alternative would have the same potential impacts on McSorley Creek as the SR 99 Alternative. Potential impacts from the S 260th West Station Option, the S 260th East Station Option, or the S 272nd Redondo Trench Station Option would be the same as described under the SR 99 Alternative Station Options.

Groundwater

The I-5 to SR 99 Alternative would not have additional impacts beyond the crossing of wellhead protection zones discussed under Impacts Common to all Alternatives.



Inset B3 to Exhibit 4.8-3: S 260th East Station Option at McSorley Creek



Inset B4 to Exhibit 4.8-3: S 272nd Redondo Trench Station Option at McSorley Creek

Indirect Impacts

Population in Washington is expected to increase, which would increase demand for development and vehicular traffic in many parts of the state. The FWLE could convert some future vehicle traffic to light rail and reduce vehicle-related stormwater pollutants. The project could attract residents and increase density in the urban

areas, reducing development pressure and associated increases in stormwater runoff in undeveloped areas in other portions of the watershed. The project would also support redevelopment around station areas, which could lead to associated infrastructure improvements. Upgraded stormwater treatment in these redeveloped areas would improve water quality. Therefore, the FWLE could indirectly offset some adverse impacts on water resources caused by population increases.

4.8.5 Potential Mitigation Measures

Sound Transit would design the FWLE to comply with all federal, state, and local regulations. This would avoid or reduce potential impacts on water resources through project planning, design, and the application of required BMPs (see Appendix D4.8). Measures to minimize long-term impacts include LID stormwater facilities; stormwater flow control using detention or infiltration ponds or vaults, or dispersion; water quality treatment using water quality ponds, bioretention, or media filter vaults; and avoiding galvanized or copper roofs for project facilities that are considered pollution-generating surfaces. With these measures incorporated, impacts on water resources are expected to be minor except for the Bingaman Creek realignment.

To minimize impacts, the Preferred Alternative would be elevated over Bingaman Creek, but approximately 1,000 feet would be realigned south and north of S 288th Street. Unavoidable impacts on stream riparian areas would be mitigated by improving stream habitat and riparian function by replanting affected areas with native shrub species, although additional off-site mitigation may still be required. Mitigation for impacts on Bingaman Creek would be approved by the appropriate permitting agencies and jurisdictions prior to construction. More detailed information can be found in the Ecosystems mitigation section (Section 4.9.5).

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4.9 Ecosystems

4.9.1 Summary

The FWLE corridor is in an urbanized area. Ecosystem resources have been extensively impacted by development, leaving few areas of good quality habitat. The Preferred Alternative would have the greatest impact on wetlands and wetland buffers. It would relocate and/or pipe approximately 1,000 feet of Bingaman Creek and would cause the greatest loss of vegetation and wildlife habitat through clearing of approximately 33 acres of forested areas along the west side of I-5. All impacts would be mitigated.

The SR 99 Alternative and the I-5 to SR 99 Alternative would have the fewest impacts on wetlands, buffers, and wildlife habitat, and would avoid impacts on streams. Station and alignment options would increase impacts on these resources. Table 4.9-1 summarizes the permanent impacts of each alternative on wetlands, buffers, streams, and vegetation. Temporary, construction-period impacts are addressed in Chapter 5.

TABLE 4.9-1
Summary of Ecosystem Impacts

Alternative	Acres of Wetlands Impacted (Range with Options)[a]	Acres of Wetland Buffer Impacted (Range with Options)	Acres/Linear Feet of Streams Impacted (Range with Options)	Acres of Stream Buffer Impacted (Range with Options)	Acres of Vegetation Impacted (Range with Options)[b]
Preferred Alternative	**1.3** (1.3-2.0)	**6.6** (6.4-8.1)	**0.2** (0.2-0.2)/**1,015** (1,015 to 1,015)	**2.5** (2.5-2.5)	**35.0** (33.6-38.9)
SR 99 Alternative	**<0.1** (<0.1-0.7)	**0.2** (0.2-0.7)	**0** (0-0)/**0** (0-0)	**<0.1** (<0.1-0.6)	**2.9** (1.9-8.0)
SR 99 to I-5 Alternative	**0.7** (0.7-0.8)	**4.1** (3.8-4.3)	**0.2** (0.2-0.2)/**1,015** (1,015 to 1,015)	**1.4** (1.4-1.9)	**21.7** (21.6-22.8)
I-5 to SR 99 Alternative	**<0.1** (<0.1-0.4)	**0.4** (0.5-0.9)	**0** (0-0)/**0** (0-0)	**<0.1** (<0.1-0.6)	**3.5** (3.5-7.9)

Note: The ranges provided show the potential range of impacts when each alternative is combined with one or more of its station or alignment options. For streams, only one stream is permanently impacted and there is no change in impacts for the options.
[a] To estimate wetland impacts, the impact analyses for all alternatives and options assumed an at-grade alignment that would result in a complete loss of wetland or buffer within the permanent footprint of the alternative or option.
[b] Does not include acreage for Vegetation Clear Zone

4.9.2 Introduction

An ecosystem is a community of organisms and their environment functioning as an ecological unit. Ecosystem components in the FWLE study include wetlands, streams and aquatic habitat, vegetation,

wildlife habitat, and species of concern and their habitats. Ecosystem impacts are described using these components.

Wetlands, streams, and fish and wildlife species and their habitats are protected by federal, state, and local regulations. These govern planning, land use, and management activities affecting such resources.

These regulations, along with applicable guidance from federal, state, and local agencies and consultation with local Indian tribes, prescribe procedures and substantive requirements that apply during EIS preparation and throughout construction and operation of the project. Sound Transit therefore considered them as part of this analysis. The Ecosystems Technical Report, Appendix G2, provides detailed information on the regulations, analysis methods, affected environment, species, and impacts discussed in this section.

4.9.3 Affected Environment

Sound Transit evaluated ecosystem components by using:

- Scientific literature and agency websites
- Consultation with federal, state, and local agencies and local tribes
- Field investigations (especially at wetlands and streams crossed by the FWLE footprint)
- Aerial maps, GIS maps, and aerial images

Sound Transit applied resource-specific classification systems to assess the type and quality of the ecosystem components.

Study Areas

The study areas for wetlands, streams, vegetation, and wildlife habitat were measured from each edge of the permanent, operational footprint for each project alternative or option, as follows:

- Wetlands: 300 feet
- Streams: 100 feet upstream and 300 feet downstream of crossings, and streams paralleling project within 200 feet of the edge of the permanent footprint
- Vegetation and wildlife habitat: 200 feet

The affected environment subsections describe the ecosystem components as follows:

- Wetlands, streams, and vegetation are described separately for the I-5 and SR 99 corridors.
- Wildlife habitat and potential occurrences of species of concern are described jointly for both corridors because of the similarity of the habitats and potential species occurrences.

4.9.3.1 Wetlands

The FWLE corridor is on the broad, flat terrace between Puget Sound and the Green River Valley. Plateau landforms on the terrace, such as depressions, slope and seep areas, and stream valleys, may support wetlands. Some of the wetlands in the study area are fragments of

larger historical wetland systems; others formed more recently through changes in land use and surface water drainage patterns over the last half-century. Appendix G2 provides wetland details, and Exhibits 4.9-1 through 4.9-3 show the wetland locations.

I-5 Corridor

Sound Transit identified 27 wetlands in the I-5 study area, varying from less than 0.1 acre to over 108 acres. Most are small, isolated features. The McSorley Creek Wetland (Wetland 12-1) is the largest wetland in the FWLE corridor; it is relatively undisturbed and forms the headwaters of McSorley Creek. Most wetlands in the I-5 corridor are deciduous forested wetlands dominated by red alder trees. Less common scrub-shrub and emergent wetlands are predominantly vegetated with willows and non-native invasive reed canarygrass.

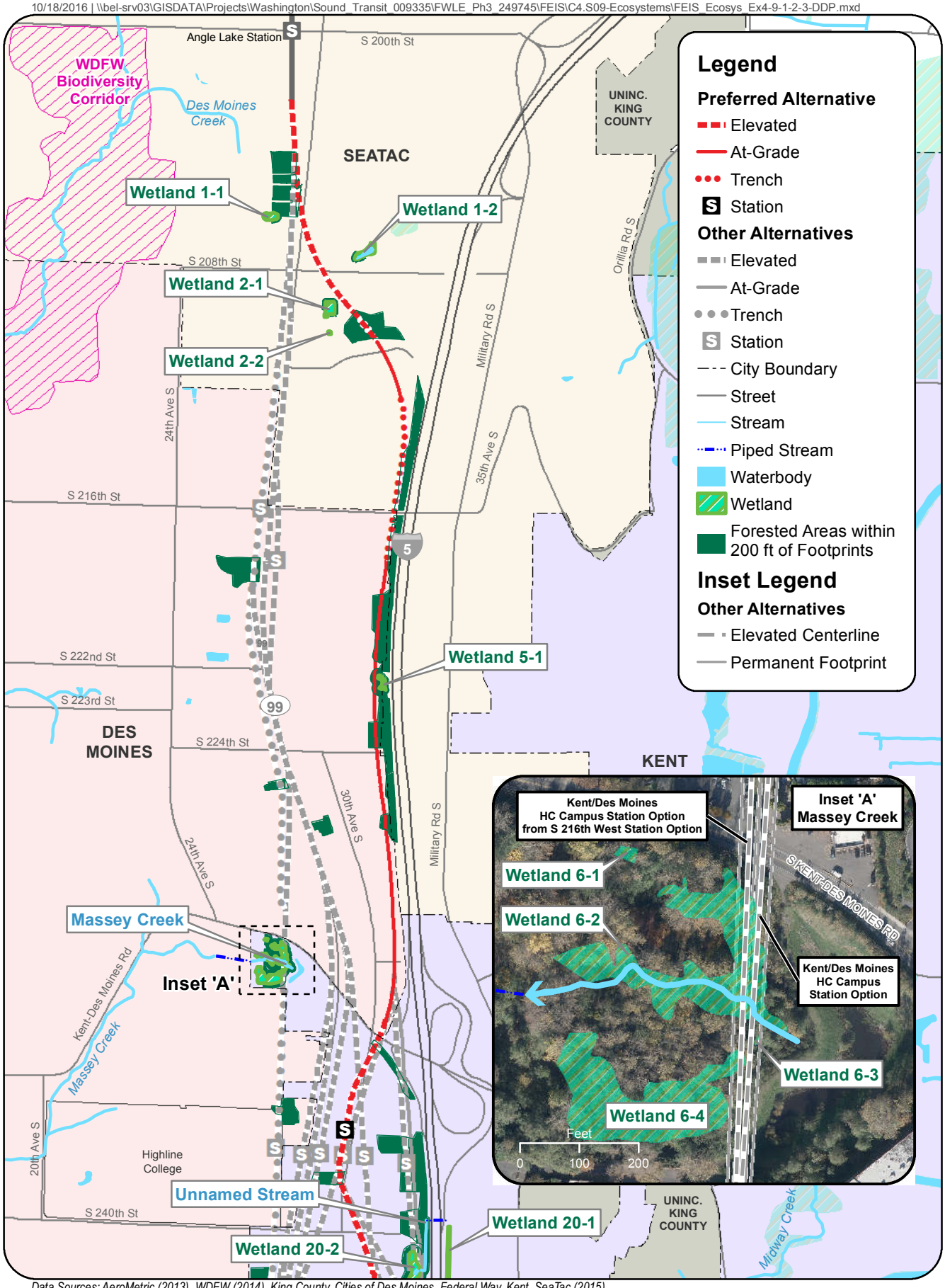
SR 99 Corridor

Sound Transit identified 17 wetlands in the SR 99 study area. As in the I-5 corridor, the wetlands vary from less than 0.1 acre to more than 108 acres (McSorley Creek Wetland, Wetland 12-1). Wetlands in the SR 99 corridor are primarily deciduous forested wetlands dominated by red alder, although the vegetation cover in wetlands immediately adjoining SR 99 reflects prior disturbances and is dominated by invasive species. The Massey Creek wetlands (Wetlands 6-1 through 6-4) are on undeveloped parcels and are less disturbed than other, smaller wetlands in the study area.

4.9.3.2 Streams and Aquatic Habitat

Four named streams, one unnamed stream, and a drainage ditch are in the study area. In general, these are low-gradient streams typical of Puget Sound lowland drainages that receive their flow from springs, seeps, lake outlets, rainfall, and groundwater runoff. Roadways and development in the area have resulted in all of the streams being conveyed through culverts and pipes for at least some portion of their length. This alters flow patterns and natural stream processes, and can pose passage barriers for fish. Development and urbanization have degraded all of the aquatic habitat.

Streams in the FWLE corridor are shown on Exhibits 4.9-1 through 4.9-3 and listed in Table 4.9-2. Stream-type terminology varies among jurisdictions, but is based on the size of the stream and its ability to support fish.

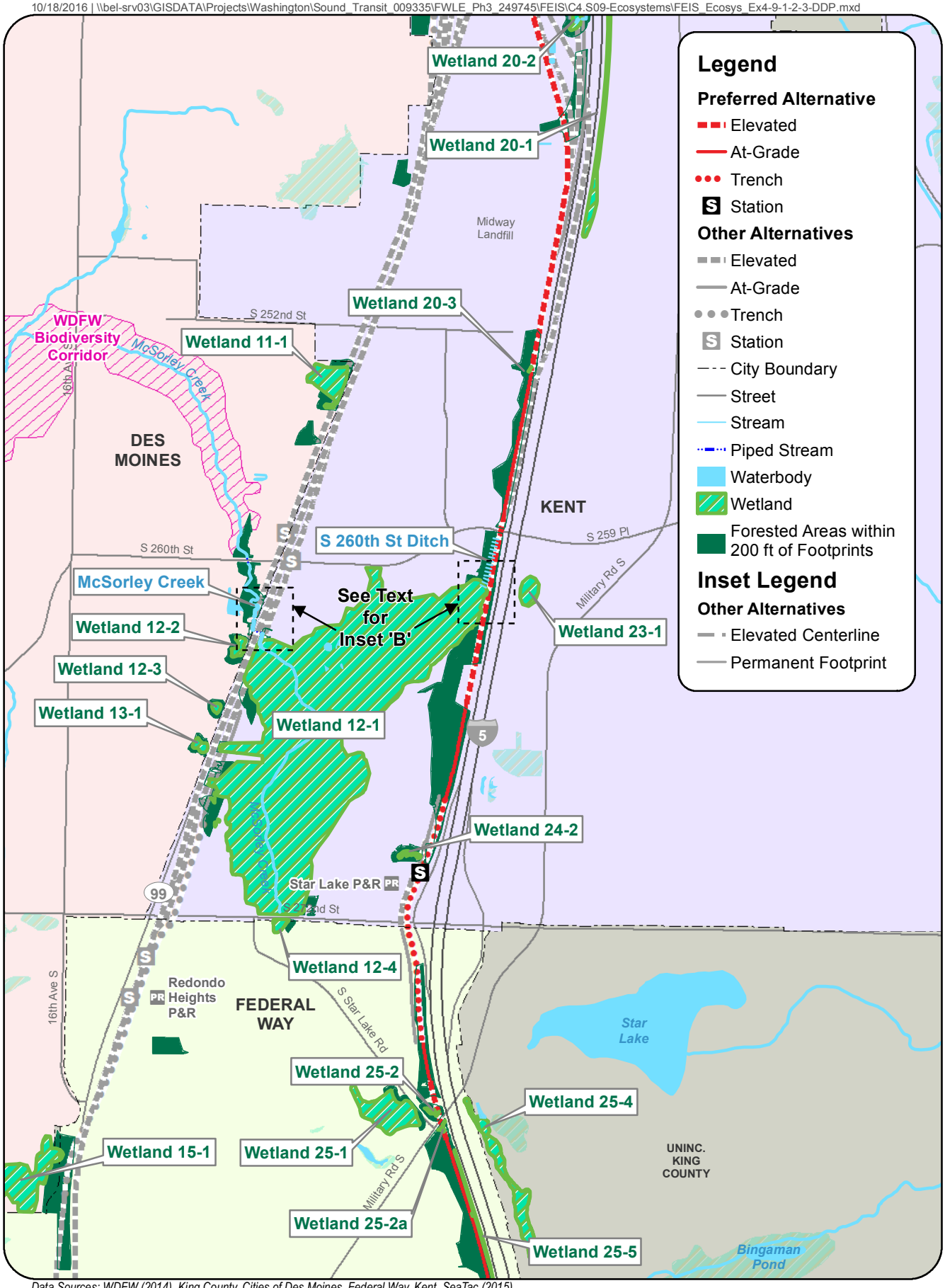


Data Sources: AeroMetric (2013). WDFW (2014), King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.25 0.5 Miles

EXHIBIT 4.9-1
Ecosystems Resources
Angle Lake Station to Kent/Des Moines Station
Federal Way Link Extension

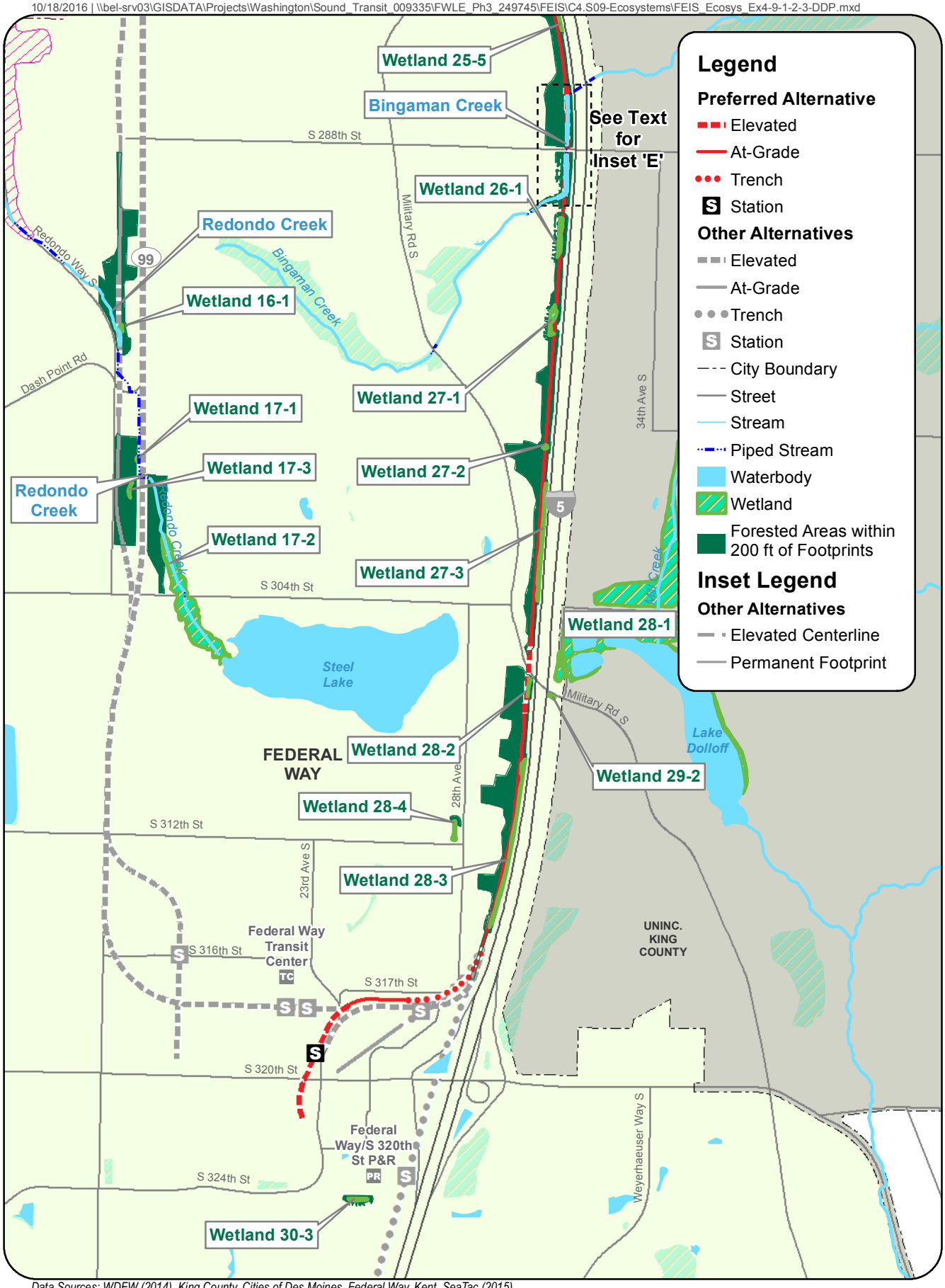


Data Sources: WDFW (2014), King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.25 0.5 Miles

EXHIBIT 4.9-2
Ecosystems Resources
Kent/Des Moines Station to S 272nd Station
Federal Way Link Extension



Data Sources: WDFW (2014), King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.25 0.5 Miles

EXHIBIT 4.9-3
Ecosystems Resources
S 288th to Federal Way Transit Center Station
Federal Way Link Extension

TABLE 4.9-2
Streams in the Federal Way Link Extension Study Area

Stream Name	Corridor	Stream Type per City Code[a]	Jurisdiction	Local Jurisdiction Stream Buffer Width	Stream Type per WAC 222-16-031[b]	Documented Salmonid Presence in Study Area
Unnamed stream in I-5 right-of-way (north of S 240th Street)	I-5	3	Kent	40 feet	5	No
S 260th Street Ditch[c]	I-5	N/A	Kent	N/A	N/A	No
Bingaman Creek	I-5	F	Federal Way	100 feet	Type 3	No
Massey Creek	SR 99	3	Kent	40 feet	3	No
McSorley Creek (west of SR 99)	SR 99	F	Des Moines	115 feet	3	No
McSorley Creek (east of SR 99)	SR 99	3	Kent	40 feet	3	No
Redondo Creek (downstream of Dash Point Road)	SR 99	F	Federal Way	115 feet	3	No
Redondo Creek (east side of SR 99)	SR 99	F	Federal Way	115 feet	3	No

[a] Stream type terminology varies among jurisdictions, but all are based on the size of the stream and its ability to support fish. In Kent, Type 3 streams are segments of natural waters within bankfull width of defined channels that are perennial or intermittent streams within the portion of the channel where there is no documented salmonid use. In Des Moines, Type F streams are those that are salmonid bearing or (as is the case here) have the potential to support salmonids. Type F streams under Federal Way jurisdiction are streams that contain fish habitat. Type Ns streams are seasonal non-fish habitat streams.

[b] Where fish use has not been determined, stream classifications are provisionally designated according to definitions in WAC 222-16-031.

[c] The City of Kent does not regulate activities in artificial drainages intentionally created from nonwetland sites, including, but not limited to, grass-lined swales, irrigation and drainage ditches, retention or detention facilities, and landscape features (Kent City Code 11.06.040).

N/A = not applicable
WAC = Washington Administrative Code

Sound Transit performed aquatic habitat surveys where it had access to streams. The width of the riparian area alongside the streams typically was 50 feet or less and terminated by the edges of roadways and development. The surveys:

- Evaluated aquatic habitat conditions and functional status based on fish life histories, spawning and rearing habitat requirements, and seasonal use and field observations
- Identified the presence and type of downstream fish passage obstructions
- Assumed that habitat which might one day be accessible (even if inaccessible under present conditions) was usable by anadromous fish, unless natural obstructions blocked it

I-5 Corridor

Two streams and a drainage ditch intersect the I-5 study area. Just south of the Kent-Des Moines Road interchange, a small unnamed stream channel originates in Wetland 20-2 on the west side of I-5 (see Exhibit 4.9-1). This small channel flows north alongside I-5 for approximately 600 feet, then through a culvert under I-5. This channel does not provide suitable habitat for salmonids or other fish species and it has no connection to streams that could contain fish downstream in the Green River Valley.

The drainage ditch is south of S 260th Street along an old gravel road bed beside the I-5 embankment (see Exhibit 4.9-2). The riprap-lined artificial channel conveys water from a culvert under S 260th Street to the northern portion of the McSorley Creek Wetland area. This channel does not provide suitable habitat for fish and is not connected to any fish-inhabitable waters.

Bingaman Creek is the largest stream intersecting the I-5 study area. Bingaman Creek flows roughly northeast from wetlands west of Military Road and south of S 288th Street, then bends north along I-5, then passes under I-5 and continues east to Bingaman Pond. It enters the I-5 study area from a mobile home park approximately 500 feet south of S 288th Street, and then runs north along the western edge of the I-5 right-of-way. It crosses under S 288th Street in a syphoned culvert and continues north along the I-5 right-of-way for approximately 540 feet, where it enters a culvert under I-5. Both culverts are considered as barriers to fish passage by Washington State Department of Transportation (WSDOT). The creek continues east of I-5 through a forested corridor and under several roadways, and connects to Bingaman Pond. East of the pond, it continues eastward into the Green River Valley and flows into the Green River. The stream reach in the study area has habitat features suitable for fish and is hydraulically connected to Bingaman Pond. However, several culvert barriers downstream block fish from this reach. There is also a steep, scoured reach downstream (east) of I-5 that likely precludes passage of smaller fish but does not meet the Washington Department of Fish and Wildlife (WDFW) criteria for natural barriers (WDFW, 2009). The creek channel in the study area is fairly straight and uniform and runs alongside the base of the I-5 road prism. The reach north of S 288th Street has a well-defined gravel and cobble bed and lies within a mature mixed-forest riparian area. The reach south of S 288th Street has eroded banks and silty substrate. The

stream channel is dry during much of the year and is not connected to areas suitable for fish refuge during dry periods.

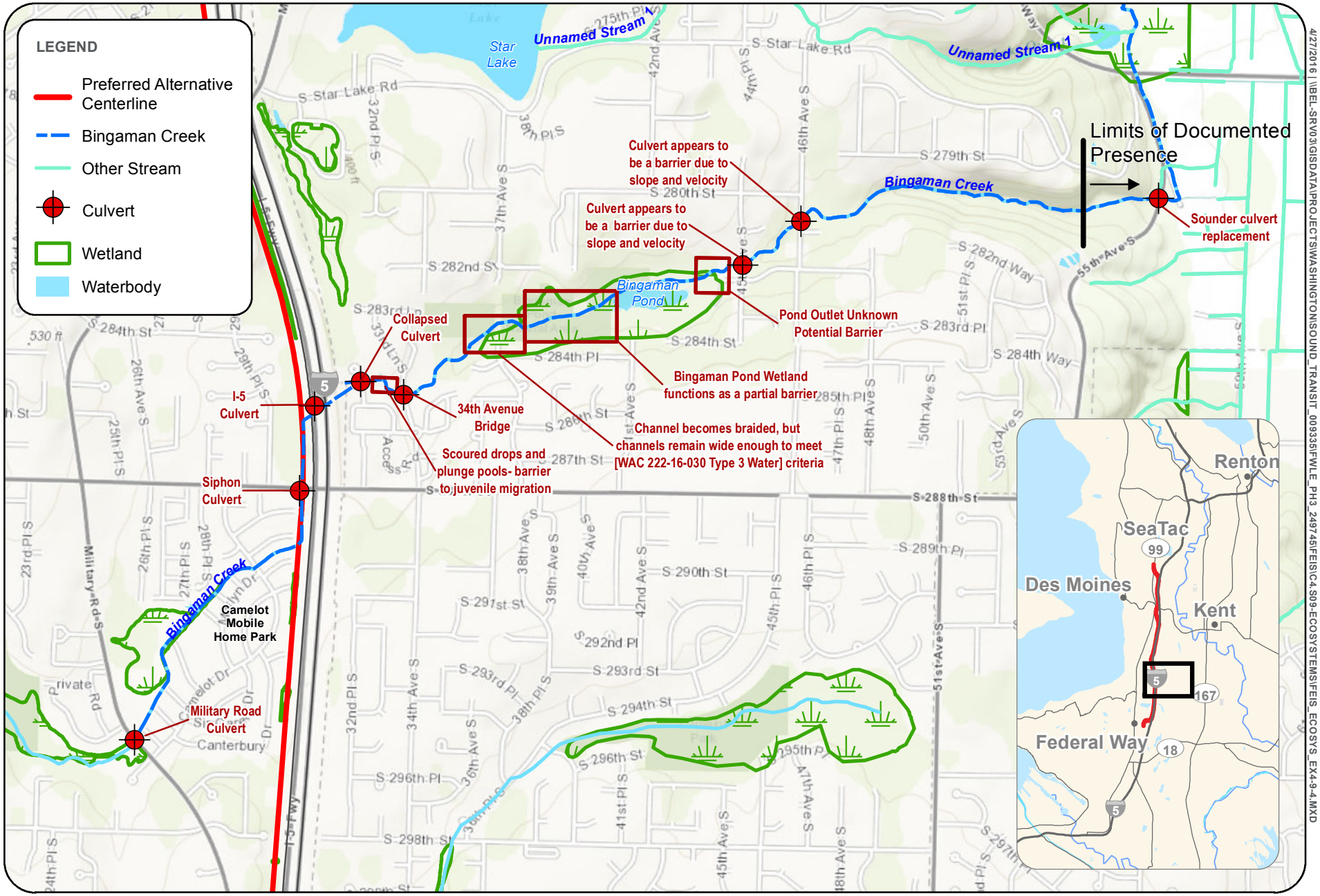
Although habitat features in the creek on the west side of I-5 create the potential for fish to occur during seasonal flows, lack of fish-passable connectivity to perennial and fish-inhabited reaches in the watershed currently preclude the use of the reach by fish. Under current conditions, only the lower reaches of Bingaman Creek support fish including coho and cutthroat trout in the Green River Valley downstream of 55th Avenue S, east of I-5 (WDFW, 2014a). WDFW Salmonscape (2014b) and Kerwin and Nelson (2000) report that the upstream reaches of Bingaman Creek could support coho salmon during periods of flow, if barriers downstream of Bingaman Pond connecting to the Green River were not present (Exhibit 4.9-4).

At the southernmost end of the study area, the upper reach of the West Fork Hylebos Creek is conveyed under I-5 and the S 320th Park-and-Ride south of S 320th Street through a culvert that is considered a fish passage barrier. The entire reach within the study area and beyond is piped underground and therefore was not included in discussions of streams and stream habitat. The creek also continues through ditches and multiple culverts and piped sections through developments downstream. Salmon are documented in Hylebos Creek, including coho, Chinook, and steelhead, but in stream reaches over 2.5 miles downstream.

SR 99 Corridor

Three streams intersect the SR 99 study area:

- **Massey Creek** originates from a stormwater pond and flows west through a forested depressional wetland for approximately 500 feet (see Exhibit 4.9-1). The stream channel is very shallow and poorly defined, with some standing water and side channels through the wetland. A vertical drain and culvert downstream serve as a complete barrier to fish passage and no fish are present in this reach.
- **McSorley Creek** flows northwest out of a large wetland east of SR 99 (see Exhibit 4.9-2). The stream channel within the wetland contains good habitat conditions for fish, and is somewhat protected from the surrounding urban developed areas by a large riparian area of mixed forest. Cutthroat trout and coho salmon have been documented the creek's mouth at Puget Sound upstream to 16th Avenue S (WDFW, 2014a, 2014b).



Data Sources: King County (2015), HDR Field Visit (2016)

N

0 500 1,000 2,000 Feet

EXHIBIT 4.9-4
Ecosystems Resources
Bingaman Creek
Federal Way Link Extension

However, the culvert under S 260th Street is a complete passage barrier to fish (WDFW, 2014b), making the stream reach within the project study area currently inaccessible to fish from downstream. The culvert under SR 99 is listed as a partial barrier to fish passage (WSDOT, 2015a; WDFW, 2014b). The reach of McSorley Creek in the project corridor is non-fish-bearing (Washington Department of Natural Resources, 2014). Although this reach is now isolated from the parts of McSorley Creek where fish are present, it contains habitat that has the potential to support fish if downstream barriers were removed (see Appendix G2). The stream channel has a predominantly gravel substrate with vegetated banks, including tree cover for shading and large woody debris recruitment, and is low-gradient with a variety of riffle and run habitat.

- **Redondo Creek** originates at Steel Lake and passes under S 304th Street and through a wetland on the east side of SR 99, after which it is conveyed within the stormwater system under SR 99 before emerging from a culvert near the intersection of SR 99 and Dash Point Road (see Exhibit 4.9-3). From this crossing, Redondo Creek flows northwest for approximately 1 mile through several pipe systems before discharging to Puget Sound. Coho salmon are documented as present downstream of S 291st Place to Puget Sound, but the reach in the study area does not contain fish (WDFW, 2014b; StreamNet, 2014). Approximately 750 feet downstream of the culvert under SR 99 and Dash Point Road, the creek enters a vertical drain structure that poses a complete barrier to fish moving upstream into the study area.

4.9.3.3 Vegetation

The FWLE corridor is within the western hemlock forest zone (Franklin and Dyrness, 1988). Western hemlock and western redcedar are the dominant forest species in this zone, with Douglas-fir also very common. Deciduous species occur primarily in disturbed areas and along rivers and streams. Exhibits 4.9-1 through 4.9-3 show forested areas within 200 feet of the project footprint.

I-5 Corridor

The undeveloped areas west of I-5 (both within and outside of the right-of-way) are predominantly vegetated by non-native species. The I-5 median is maintained clear of trees; vegetation consists of mowed areas with mixed domestic and invasive grass species and weeds, and

small patches of non-native shrubs. Three patches of contiguous forest cover were identified along the western side of I-5 (see Exhibits 4.9-1, 4.9-2, and 4.9-3):

- From Military Road/Star Lake Road to S 288th Street
- From approximately S 292nd Street to S 301st Street
- From Military Road near S 304th Street to approximately S 311th Street

Native species dominate the forest patch north of S 288th Street, but the other forest patches are mostly non-native vegetation that are of low value to wildlife.

SR 99 Corridor

Because the SR 99 corridor is developed, most of the vegetation reflects typical landscaping for urban and suburban areas, with scattered areas of remnant tree canopy. Within the maintained road rights-of-way, the vegetation includes a mixture of trees, native and non-native shrubs, landscaped areas, mowed grasses, and invasive weeds. There are several notable areas of upland vegetation, the majority comprising mixed deciduous and coniferous forests with disturbed understories (not a native upland classification). The largest remnant of native upland forest is in the McSorley Creek riparian corridor west of SR 99.

4.9.3.4 Wildlife Habitat

The I-5 and SR 99 corridors are in a mapped medium-density urban habitat zone, with 30 to 59 percent impervious surface (Chappell et al., 2001). Wetland and riparian areas can support reptiles and amphibians, such as garter snakes and frogs. These areas also can support small mammal species and possibly some larger mammal species, such as deer and coyotes.

The FWLE corridor lies within the Pacific Flyway, a migratory bird corridor consisting of the western coastal areas of North, Central, and South America. Wetlands, lakes, and forested areas in the project vicinity serve as foraging, resting, or nesting grounds for migratory and resident bird species.

In urban environments such as the FWLE corridor, where natural habitats are fragmented and isolated, habitat reserves consist of designated areas, such as wildlife refuges, and undesignated areas, such as parks and open spaces. Wildlife corridors—whether remnant habitat, regenerated habitat, or artificially created habitat—connect

the larger areas of wildlife habitat. They may consist of vegetated slopes, riparian corridors, or fence rows. The patches or pathways of vegetation cover and habitat allow animals to move between larger areas.

Sound Transit assessed upland forested habitat in the I-5 and SR 99 corridors using methods adapted from the *Bellevue Urban Wildlife Habitat Functional Assessment Model* (The Watershed Company, 2010). Using the functional assessment model, Sound Transit categorized upland habitat as Category A, B, C, or D wildlife habitat, with Category A habitat denoting the highest relative quality of habitat and potential wildlife use, and Category D representing little or no functional habitat and low potential for wildlife use. Table 4.9-3 summarizes total acreage of upland habitat by category in the I-5 and SR 99 corridors.

Forest Habitat Categories

The four upland forest habitat categories are:

- Category A: highest relative quality of habitat and wildlife use. Consists of relative large areas with mature conifer or mixed forest canopy, and an abundance of native shrub understory.
- Category B: slightly less habitat quality than Category A, but wildlife use still likely. Consists of smaller patch sizes with mature conifer or mixed forest canopy and more invasive species.
- Category C: Areas where potential for wildlife to use the site is likely low. Forest patch size is relatively small and lacks connectivity, there is less canopy cover and greater presence of invasive species.
- Category D: forested areas with little or no functional wildlife habitat and low potential for use.

TABLE 4.9-3
Acreage of Upland Forest Habitat Categories Assessed in the I-5 and SR 99 Corridors

Category	I-5	SR 99
A	45.8	11.5
B	48.6	9.7
C	14.1	26.4
D	9.7	5.4
Total	118.2	53.0

Although the I-5 corridor contains more and a higher quality of upland forested habitat than the SR 99 corridor, much of this habitat is configured in a linear strip that parallels the freeway. This creates a lot of edge habitat relative to the total amount of forest available. Edge areas are attractive to invasive species that can colonize interior portions of the habitat, altering the types of plant species and affecting the suitability of habitat for various wildlife species.

Throughout the length of the project area, I-5 impedes wildlife movements between the Green River Valley in the east and the natural areas west of I-5, including the McSorley Creek wetlands and the Puget Sound shoreline. The SR 99 corridor poses a similar barrier to overland movement for wildlife and has few connected patches of forested areas. Underpasses provide potential crossing points for terrestrial animals, particularly where tracts of natural vegetation

occur on each side and along roadways, such as under I-5 at Military Road and S 288th Street.

Redondo Creek and McSorley Creek have the largest areas with potential for wildlife movement connecting to the Puget Sound shoreline. The McSorley Creek Wetland between SR 99 and I-5 has the largest tract of forested habitat along the FWLE corridor. The vegetated tracts along the McSorley Creek riparian corridor, which continue to the west of the study area through Saltwater State Park and out to the Puget Sound shoreline, provide one of the few potential wildlife movement corridors in the area.

Some small mammals may be able to use the Bingaman Creek culvert under I-5 during much of the year when the creek bed and culvert are dry. The forested areas along the west side of I-5, including the Preferred Alternative corridor, also allow north-south movements of wildlife along the west side of I-5.

4.9.3.5 Threatened and Endangered Fish and Wildlife Species, Species of Concern, Essential Fish Habitat, and WDFW Priority Species and Habitat

Table 4.9-4 summarizes species of concern that are known to occur or potentially occur in the FWLE corridor. No Endangered Species Act critical habitat is designated in the FWLE corridor, and no listed species or federal species of concern are known to occur within the project corridor (WDFW, 2014a, 2014b; StreamNet, 2014; Kerwin and Nelson, 2000).

Puget Sound Chinook salmon, steelhead trout, and bull trout are all listed as threatened. They have been documented in the Green River east of the study area.

The Magnuson-Stevens Fishery Conservation and Management Act protects essential fish habitat (EFH) for federally managed species of Pacific salmon, specifically Chinook, pink, and coho salmon. Coho salmon inhabit the lower reaches of McSorley and Bingaman creeks downstream of passage barriers outside the study area. While not currently present in the study area, these water bodies are considered to have EFH because coho were likely present further upstream in Redondo, Bingaman, and McSorley creeks prior to development.

WDFW has identified the McSorley Creek riparian corridor west of SR 99 as a Biodiversity Area and Corridor, which is a WDFW priority habitat area.

TABLE 4.9-4
Species of Concern Potentially Occurring in FWLE Corridor

Species	Status	Occurrence in Study Area
Oregon spotted frog	Federal Threatened State Endangered	Not documented in the study area. Likely limited to relatively intact wetlands in the Green River Valley. The headwater wetlands for Bingaman Creek are in the watershed, but do not provide suitable habitat and are inaccessible from areas in the Green River Valley.
Marbled murrelet	Federal Threatened State Threatened	Not documented in the study area. There is the potential that a few marbled murrelets could fly over the project action area while transiting between marine foraging areas in Puget Sound and inland nesting sites.
Streaked horned lark	Federal Threatened State Endangered	Not documented in the study area. The Midway Landfill has potentially suitable streaked horned lark habitat. Individuals have not been documented at the landfill or in surveys at Seattle-Tacoma International Airport north of the action area.
Western yellow-billed cuckoo	Federal Threatened State Candidate	Not documented in the study area. Potential migratory habitat including secondary growth woodland and hedgerows is present. The FWLE corridor's forested areas have some suitable resting and foraging habitat that a transient individual could potentially use during migration. There is no nesting habitat for these species in the study area and project vicinity.
Western toad	Federal Species of Concern State Candidate	Not documented in the study area. It is found in Lake Washington and other water bodies in the area. It is unlikely to occur in most of the study area, but the McSorley Creek Wetland may provide suitable habitat.
Coho salmon	Federal Species of Concern	Not documented in the study area. Currently inhabits the lower reaches of McSorley and Bingaman creeks downstream of passage barriers outside of the study area.

4.9.4 Environmental Impacts

4.9.4.1 No Build Alternative

Although the No Build Alternative would not build light rail, it includes the SR 509 Extension Project (SR 509 Extension). The SR 509 Extension would directly and indirectly affect existing wetlands, streams, vegetation, and wildlife habitat within the FWLE study area (FHWA, 2003). However, the portion of the SR 509 Extension within the FWLE study area is predominantly developed, and therefore ecosystems impacts would be limited to clearing some forested vegetation. Another indirect impact would be that, unlike the action alternatives, the No Build Alternative would not support the concentration of growth in urbanized areas instead of less-developed, rural areas where high-value habitat and wetlands are more prevalent.

4.9.4.2 Build Alternatives

The following subsections describe the operational impacts of the build alternatives. Construction impacts related to ecosystems are discussed in Chapter 5, Construction.

Direct Impacts

Sound Transit overlaid the FWLE alternative footprints on a GIS map of ecosystem resources to assess stream and wetland impacts. It assessed impacts on wildlife and vegetation using GIS to calculate the amount of vegetated areas potentially affected.

The wetland impact analysis conservatively assumes a complete loss of any wetland or buffer that is within the permanent footprint of the guideway, regardless of the guideway's profile at that location. Although elevated guideways would not permanently fill the wetlands within the permanent footprint, some wetland areas below elevated guideways would likely experience long-term effects from shading. During the project permitting phase, Sound Transit would prepare a more detailed assessment of long-term impacts and identify detailed temporary construction limits to distinguish which resources might be temporarily affected and could be restored following construction.

For safety reasons, Sound Transit allows only grasses and shrubs within a 11-foot vegetation "clearance area" on each side of the footprint of the track to prevent debris from falling onto the guideway. The resulting removal of forest cover would be a long-term impact on wildlife habitat because the types of vegetation and associated habitat would change. The vegetation clear zone in at-grade sections of track would preclude the growth of shrubs and understory vegetation but could retain grasses and groundcover. Impacts on herbaceous and shrub wetlands, streams, and their buffers in this clearance area along elevated sections would be temporary because grass and shrub vegetation would be reestablished following construction, restoring wetland or stream buffer functions. Wetlands and riparian corridors comprised of forested vegetation would be permanently converted to lower-growing shrub and emergent vegetation communities.

Exhibits 4.9-1 through 4.9-3 show potential impacts of the build alternatives and their options on wetlands, streams, vegetation, and wildlife. Table 4.9-1 summarizes these impacts, by alternative. Station or alignment option impacts are shown as an increase or decrease relative to the alternative(s) they are associated with.

Wetlands

Wetlands Impacts Common to All Alternatives

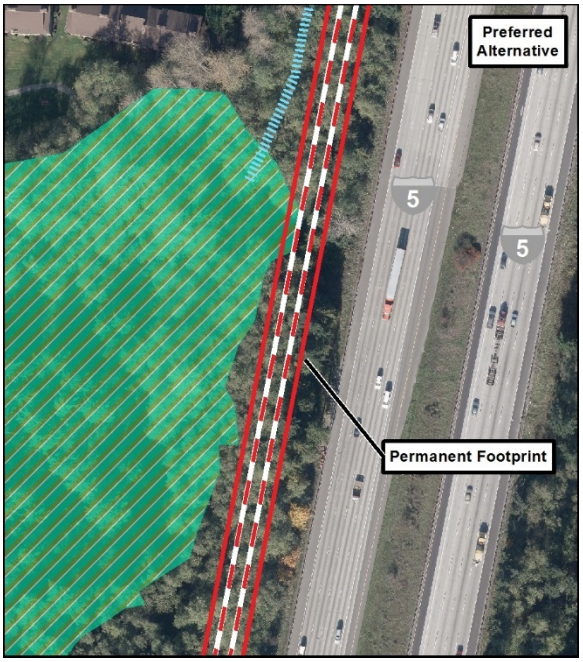
All of the build alternatives would have direct, long-term impacts on wetlands and wetland buffers. Filling or excavating within wetlands

for column placement, at-grade guideways, and retaining walls would reduce wetland area or function by permanently changing surface or subsurface water flows or vegetation. Grading and filling can permanently change a wetland's capacity to store stormwater, filter pollutants, protect stream banks, and provide habitat for wildlife. Elevated rail would have a smaller long-term footprint than at-grade and trench profiles, with more retention of wetland area and regeneration of vegetation under the guideway. However, the shade from elevated profiles would affect the type of vegetation established.

Wetlands Impacts by Alternative

Preferred Alternative

The Preferred Alternative would primarily be at-grade, which would permanently convert existing vegetated land and wetlands to a developed condition in the project footprint. The Preferred Alternative would result in 1.25 acre of permanent impacts to 11 wetlands, including the McSorley Creek Wetland, and would permanently impact 6.6 acres of seven wetland buffers. (See Exhibit 4.9-2 and Inset B1 for impacts on the McSorley Creek Wetland and buffer.) It would affect an additional 0.7 acre of wetland and 1.5 acres of buffer if the Kent/Des Moines At-Grade Station Option and the Federal Way S 320th Park-and-Ride Station Option were both selected.



Inset B1 to Exhibit 4.9-2: Preferred Alternative at McSorley Creek Wetland, which will impact less than 0.1 acre of wetland

SR 99 Alternative

The SR 99 Alternative would be elevated (except for some station options including trenches) and would impact less than 0.1 acre of three wetlands and 0.2 acre of five wetland buffers. The FWLE elevated guideway would be approximately 40 feet wide and more than 15 feet above the ground surface in most places, with minimal shading or other impacts on vegetation.

This alternative would not impact McSorley Creek Wetland, as shown on Inset B2 to Exhibit 4.9-2. It would affect another 0.7 acre of wetland and 0.9 acre of wetland buffer if the Kent/Des Moines HC Campus Station Option, the S 260th West Station Option, and the S 272nd Redondo Trench Station Option were all selected. A segment

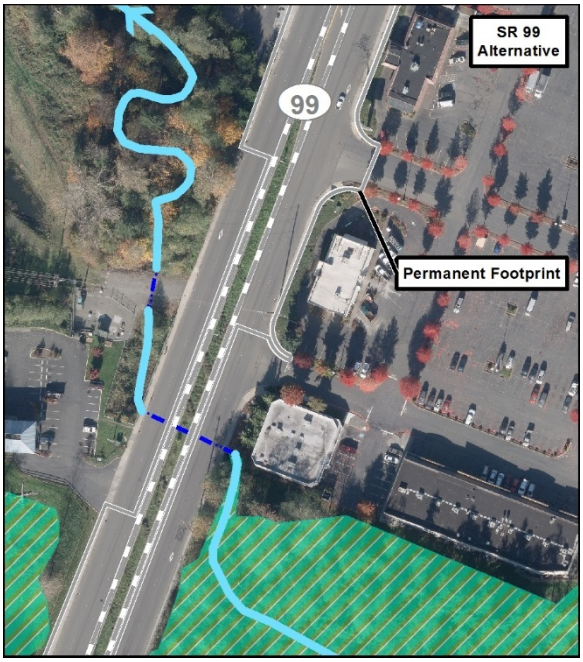
of the S 272nd Redondo Trench Station Option would require trenching within a small portion of the McSorley Creek Wetland adjacent to SR 99, as shown on Inset B3 to Exhibit 4.9-2.

SR 99 to I-5 Alternative

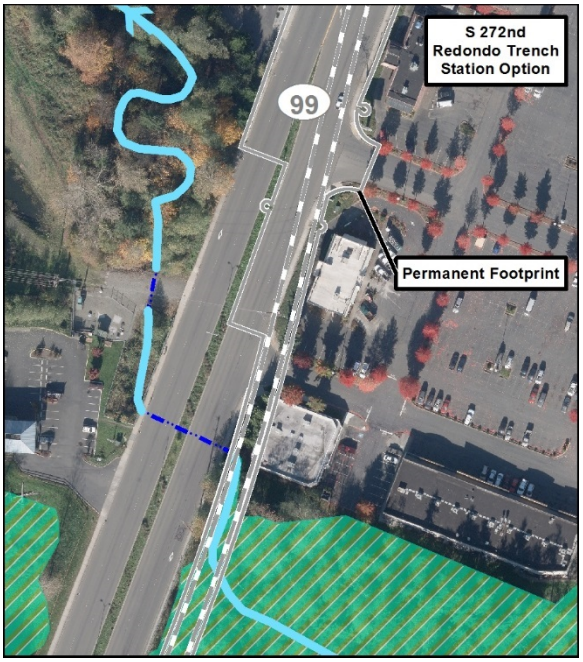
The SR 99 to I-5 Alternative would have 0.7 acre of permanent impacts on 8 wetlands and 4.1 acres of impacts on 13 wetland buffers. It would affect another 0.1 acre of wetland and 0.3 acre of wetland buffer if the Federal Way S 320th Park-and-Ride Station Option were selected.

I-5 to SR 99 Alternative

The I-5 to SR 99 Alternative would have less than 0.1 acre of impacts to two wetlands, and 0.4 acre of impacts to five wetland buffers. It would affect another 0.5 acre of wetland and 0.7 acre of wetland buffer if the S 260th West Station Option and S 272nd Redondo Trench Station Option were selected.



Inset B2 to Exhibit 4.9-2: SR 99 Alternative at McSorley Creek Wetland



Inset B3 to Exhibit 4.9-2: S 272nd Redondo Trench Station Option at McSorley Creek

Streams and Aquatic Habitat

Impacts on streams could occur when alternatives cross a stream or are parallel to a stream. The FWLE would not have direct, permanent physical impacts on in-stream habitat that could not be mitigated onsite since stream crossings would be elevated or stream segments would be re-meandered. Riparian areas would be impacted by the loss of forested vegetation in the long-term footprint, which would preclude forest habitat regeneration. Noise and human activity from the operation of the FWLE would have minimal impacts on fish species because the streams are within highly urbanized environments.

Stream and Aquatic Habitat Impacts by Alternative

Preferred Alternative

The Preferred Alternative would run on the west side of I-5 and within WSDOT right-of-way south of Kent-Des Moines Road.

The small unnamed stream south of Kent-Des Moines Road is outside the project footprint and would not be affected. An artificial drainage

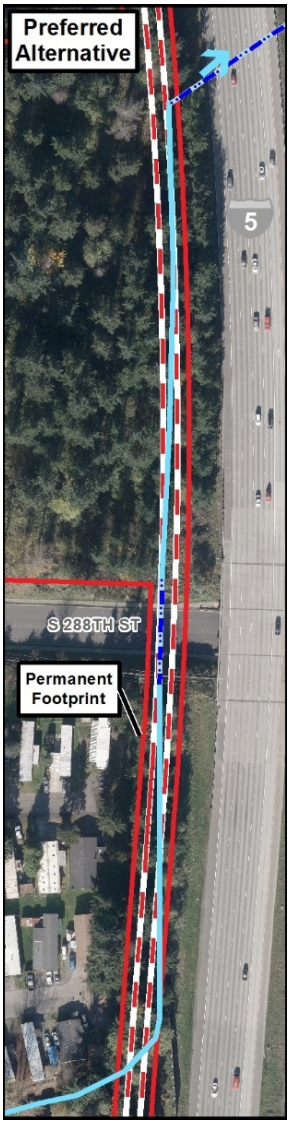
ditch on the north side of the McSorley Creek Wetland lies parallel to the I-5 corridor, but also would not be directly impacted.

Bingaman Creek would be directly under the Preferred Alternative footprint, resulting in long-term impacts on about 1,015 feet of the stream channel and 2.5 acres of the riparian forest buffer. North of S 288th Street, Bingaman Creek flows north parallel to and west of I-5 within a wooded area approximately 300 feet wide (see Exhibit 4.9-3 and Inset E). South of S 288th Street, Bingaman Creek lies between an I-5 sound wall to the east and a 50-foot-wide band of forested area to the west, next to a mobile home park.

Sound Transit would reroute the stream channel in the footprint to meander around the guideway columns to maintain an open channel. This would permanently impact the stream because the site would not be returned to its previous condition, and changing the physical characteristics of a stream could affect its hydrology and sedimentation downstream. The design of the new channel would maintain flows and water quality conditions. The Preferred Alternative would also impact the riparian vegetation and bank characteristics and reduce large woody debris, nutrient inputs, and vegetative shade to the stream bank and channel.

In response to comments on the Draft EIS, Sound Transit coordinated with WSDOT, WDFW, and the Muckleshoot Indian Tribe to identify any culverts that are fish passage barriers along the Preferred Alternative alignment. As a result of the coordination, Sound Transit modified the Preferred Alternative near Bingaman Creek to not preclude WSDOT's ability to replace state-owned barrier culverts with stream-simulation-designed culverts for fish passage. Additional design work would occur during final design and project permitting. If it is determined that the state-owned culverts would not be made fish passable in the future, Sound Transit may modify the design of the Preferred Alternative near Bingaman Creek. The modified design could include rerouting and permanently piping a portion of the creek and would have impacts similar to those described in the Draft EIS.

The Federal Way S 320th Park-and-Ride Station Option could conflict with a culvert containing Hylebos Creek that travels under the park-and-ride. Sound Transit would coordinate closely with WSDOT,



Inset E to Exhibit 4.9-3: Preferred Alternative at Bingaman Creek

WDFW, and the Muckleshoot Indian Tribe on the culvert during final design if this option were selected.

The other Preferred Alternative station and alignment options would not have any additional impacts on streams or stream buffers.

SR 99 Alternative

Where the SR 99 Alternative would cross stream channels, the guideway would span the streams with columns on either side, beyond the banks. This would have little to no direct effect on in-stream habitat. However, an elevated guideway near streams could remove mature trees and/or preclude forest growth, reducing the potential for the recruitment of large woody material to adjacent streams. Shading from the structure may provide overhead cover and temperature regulation otherwise lost from removal of riparian vegetation.

The SR 99 Alternative would cross three streams. There would be no permanent impacts on the stream channels because all three channels are in culverts under SR 99 (see Table 4.9-1). Stream buffer impacts would be nonexistent at Massey Creek, less than 0.1 acre at McSorley Creek, and less than 0.1 acre at Redondo Creek. All station and alignment options would span the three creeks and would avoid long-term impacts. If the Kent/Des Moines HC Campus Station Option, the S 260th West Station Option, and the S 272nd Redondo Trench Station Option were all selected, the stream buffer impacts could increase by 0.6 acre.

SR 99 to I-5 Alternative

Like the Preferred Alternative, this alternative would avoid most of the stream crossings in the study area and the only surface water crossing would be Bingaman Creek. North of S 288th Street, the creek would be relocated next to the alignment. South of S 288th Street, the stream would be piped under the guideway. If this alternative were identified as the project to be built, the alignment in this area could be redesigned similar to the Preferred Alternative to reduce impacts on the stream. The SR 99 to I-5 Alternative station options would not have any additional impacts on streams or stream buffers.

I-5 to SR 99 Alternative

The I-5 to SR 99 Alternative would span McSorley Creek and Redondo Creek with no direct impacts on the creeks and less than 0.1 acre of impact on stream buffers. Impacts would be greater with some

station and alignment options, affecting another 0.6 acre of stream buffer with the S 260th West Station Option and the S 272nd Redondo Trench Station Option.

Vegetation and Wildlife

Vegetation and Wildlife Impacts Common to All Alternatives

The amount of forest cover removed for each build alternative indicates the potential long-term impacts on vegetation and wildlife (see Table 4.9-1). Clearing of trees, snags, and understory vegetation would reduce nesting and foraging sites for many species of birds, and reduce hiding cover for small mammals and roosting and foraging sites for bats. Elevated guideway would have less impact on upland vegetation than at-grade trackways, although it would permanently convert forested vegetation to herbaceous and shrub vegetation cover. At-grade alignments would permanently remove vegetation in the guideway footprint. Vegetation and wildlife habitat 11 feet beyond the footprint of the guideway would be permanently converted from forested vegetation to herbaceous and shrub vegetation.

Where the project eliminates forest cover, it could impact habitat in several ways. In all undeveloped vegetation communities, there would be an increased risk of introducing or spreading invasive species. Loss of habitat in forested riparian areas, such as McSorley and Bingaman creeks, can reduce their value in providing connectivity for transiting wildlife that inhabit remnant patches of undeveloped habitat. However, impacts are not expected to substantially affect connectivity to higher-quality habitat in the Green River Valley and nearshore Puget Sound since contiguous wildlife corridors in the project study areas are already restricted by existing development.

The FWLE corridor is highly urbanized and is primarily centered on roadways that carry thousands of vehicles per day. The risk of wildlife disturbance from the project's increased human access, noise, and light would be low. The areas with the most forest cover in the study area are along I-5 and around McSorley Creek east of SR 99. The FWLE would be along the edges of these areas near roadways. None of the alternatives fragment large undisturbed areas, and the potential for materially impacting wildlife habitat is minimal. Elevated alignments would maintain passage of ground-dwelling animals underneath. Impacts on vegetation and habitat are summarized in Tables 4.9-1 and 4.9-5.

TABLE 4.9-5
Summary of Acreage of Upland Habitat Impacts

Alternative	Category A (Range with Options)	Category B (Range with Options)	Category C (Range with Options)	Category D (Range with Options)	Total (Range with Options)[a]
Preferred Alternative	**14.6** (14.6-14.9)	**13.8** (12.1-16.8)	**5.5** (4.5-6.2)	**1.1** (1.1-2.6)	**35.0** (33.6-38.9)
SR 99 Alternative	**0.3** (0.3-1.6)	**0.1** (0.1-1.6)	**1.1** (1.1-3.6)	**1.4** (0.4-1.4)	**2.9** (1.9-8.0)
SR 99 to I-5 Alternative	**9.8** (9.8-9.8)	**7.6** (6.9-7.6)	**3.2** (3.1-4.3)	**1.1** (1.1-1.8)	**21.7** (21.6-22.8)
I-5 to SR 99 Alternative	**0.3** (0.3-1.6)	**1.7** (1.7-3.2)	**1.3** (1.3-2.9)	**0.2** (0.2-0.2)	**3.5** (3.5-7.9)

[a] Does not include acreage for Vegetation Clear Zone.

Vegetation and Wildlife Impacts by Alternative

Preferred Alternative

The Preferred Alternative would eliminate the most forest cover on primarily Category A and Category B habitat. There would also be an additional 4.5 acres of trees removed for the vegetation clear zone, although this area could be replanted and maintained with lower growing shrubs and trees, providing some habitat value. It would affect the forested riparian areas along Bingaman Creek and along the McSorley Creek Wetland that provide relatively large habitat areas within the I-5 corridor. The mature trees and shrubs provide roosting and potential nesting habitat for birds, and forest cover for small mammals. Although these forested areas are bounded by roadways and residential development, they still provide refuge and transient corridors for animals. The Kent/Des Moines At-Grade Station Option, Kent/Des Moines I-5 Station Option, Landfill Median Alignment Option, and Federal Way I-5 Station Option would reduce impacts by traveling through more developed areas. The Federal Way Transit Center S 320th Park-and-Ride Station Option would increase impacts. The options for the Preferred Alternative would result in a range of 33.6 to 38.9 acres of long-term impacts.

SR 99 Alternative

The SR 99 Alternative would eliminate the least forest cover, the majority of which would be Category D habitat. It would remove an additional 0.3 acre of trees in the vegetation clear zone. The potential additional station at S 216th Street (East option), Kent/Des Moines

SR 99 East Station Option, Kent/Des Moines HC Campus Station Option, Kent/Des Moines SR 99 Median Station Option, and Federal Way SR 99 Station Option would reduce these impacts by traveling through more developed areas. The potential additional station at S 216th Street (West option), both options (West and East) for the potential additional station at S 260th Street, and the S 272nd Redondo Trench Station Option would increase these impacts. The options for the SR 99 Alternative would result in a range of 1.9 to 8.0 acres of long-term impacts.

SR 99 to I-5 Alternative

The SR 99 to I-5 Alternative would eliminate the second most amount of forest cover, the majority of which would be Category A habitat. It would remove an additional 6.4 acres of trees in the vegetation clear zone. This number would increase if the S 216th West Station Option and the Federal Way Transit Center S 320th Park-and-Ride Station Option were selected. The options for the SR 99 to I-5 Alternative would result in 21.6 to 22.8 acres of long-term impacts.

I-5 to SR 99 Alternative

The I-5 to SR 99 Alternative would eliminate the second smallest area of forest cover. It would remove an additional 1.1 acres of trees in the vegetation clear zone. This would decrease if the Federal Way SR 99 Station Option were selected and would increase if one of the S 260th Street station options (West or East) and the S 272nd Redondo Trench Station Option were selected. The options for the I-5 to SR 99 Alternative would result in 3.5 to 7.9 acres of long-term impacts.

4.9.4.3 Threatened and Endangered Fish and Wildlife Species, Species of Concern, and WDFW Priority Species

Potential long-term impacts on threatened and endangered species (aquatic and terrestrial) include direct mortality, disturbance and displacement effects, and loss or degradation of habitat.

There are no ESA-listed species documented to occur in the project study area. Listed salmon species occur in the Green River and Puget Sound to the east and west of the project corridor respectively, but any potential aquatic impacts from the FWLE would be in reaches and wetlands well upstream of areas that fish are known to use, and would not impact the Green River or Puget Sound.

Several listed bird species occur in the region and could transit the project corridor as described above in section 4.9.3.5. The Biological Assessment developed for this project (included in Appendix G2, Ecosystems Technical Report) assesses the presence and potential impacts on Endangered Species Act listed species and their habitat, and on EFH as required by the Magnuson-Stevens Fishery Conservation and Management Act. Based on the analysis in that document, construction of the FWLE may affect, but is not likely to adversely affect, ESA listed species. The project would have no effect on any critical habitat. Table 4.9-6 summarizes effect determinations for federally-listed species that may occur in the FWLE corridor. The United States Fish and Wildlife Service concurred with these determinations in September 2016 (see Appendix I of Appendix G2, Ecosystems Technical Report).

TABLE 4.9-6
Species of Concern Potentially Occurring in FWLE Corridor

Species	Status	Effect Determination
Oregon spotted frog	Federal Threatened State Endangered	NE Critical Habitat: NE
Marbled murrelet	Federal Threatened State Threatened	NE Critical Habitat: NE
Streaked horned lark	Federal Threatened State Endangered	NLAA Critical Habitat: NE
Western yellow-billed cuckoo	Federal Threatened State Candidate	NLAA Critical Habitat: NE

NE = No Effect
NLAA = Not Likely to Adversely Affect

The Biological Assessment also included a determination of "no adverse effect" on essential fish habitat protected under the Magnuson-Stevens Fishery Conservation and Management Act.

4.9.4.4 Indirect Impacts

Indirect impacts from operations could result in long-term wetland degradation from stormwater discharges and alterations in wetland hydrology. However, improved stormwater detention and treatment would minimize long-term indirect effects on wetlands.

The FWLE would have minimal indirect impacts on aquatic species and habitat because the surrounding areas are heavily developed. The FWLE would not interfere with future projects that may provide habitat improvements, such as the replacement of culverts under

SR 99 and I-5 that are currently fish barriers, or projects to enhance vegetated and wetland areas. Further design and evaluation of compatibility with future WSDOT culvert replacement projects would occur during permitting.

Indirect impacts on vegetation, wildlife, and wildlife habitat could include disturbance from increased human activity near retained forested habitat in the vicinity of the project alignment. The introduction of light rail transit to the area would slightly reduce vehicular traffic on the roadways in the project vicinity compared to the No Build Alternative. This would slightly decrease automotive emissions and contaminated stormwater runoff from roadways. The FWLE would support more concentrated future development in station areas.

4.9.5 Potential Mitigation Measures

Sound Transit's policy on ecosystem mitigation is to avoid impacts on environmentally sensitive resources and provide adequate mitigation for unavoidable impacts to ensure no net loss of ecosystem function and acreage. Mitigation for ecosystem impacts would be based on a prioritized sequence of avoiding, minimizing, and compensating for unavoidable adverse impacts. This approach is consistent with federal, state, and local regulatory priorities.

4.9.5.1 Avoidance and Minimization Measures

Sound Transit would avoid and minimize adverse operational effects of the FWLE on wetlands through design, to the extent practicable. Design features could include:

- Elevating guideways over streams
- Siting support columns and other elevated guideway features to span and avoid direct impacts on wetlands
- Using retaining walls to reduce the at-grade footprint of guideway sections, reducing the extent of fill in wetlands

Example of Elevated Guideway over Re-aligned Southgate Creek on the Sound Transit Central Link Project

Sound Transit would design permanent stormwater treatment facilities and flow-control measures to minimize impacts on stream water quality and flow (see Section 4.8, Water Resources). The risk of introducing or spreading invasive species would be minimized by replanting cleared areas and implementing best management practices.

The FWLE would avoid existing stream channels and culverts, with the exception of the Preferred Alternative and the SR 99 to I-5 Alternative at Bingaman Creek, and the Federal Way S 320th Park-and-Ride Station Option at the Hylebos Creek culvert. The Preferred Alternative would be elevated over Bingaman Creek, but the channel would be realigned around the columns to minimize impacts on the creek and to not preclude replacement of the I-5 and S 288th Street culverts in the future by WSDOT. Some unavoidable impacts on stream riparian areas would be mitigated by improving stream habitat and riparian function by replanting affected areas with native shrub species. Mitigation for impacts on Bingaman Creek would be approved by the appropriate permitting agencies and jurisdictions prior to construction. Sound Transit would continue to work with WSDOT to ensure that the FWLE provides adequate space for any future replacement of culverts in WSDOT right-of-way that convey fish-bearing or potentially fish-bearing streams per federal, state, and local permit requirements and tribal consultation. Mitigation would be similar for the SR 99 to I-5 Alternative.

Sound Transit would minimize tree removal along the I-5 corridor where possible for the Preferred and SR 99 to I-5 alternatives according to the WSDOT *Roadside Policy Manual* (WSDOT, 2015b). Sound Transit would coordinate with WSDOT to minimize tree removal while also minimizing impacts on highway safety.

Operational effects on vegetation, wildlife, and wildlife habitat would be reduced by minimizing the project footprint through forested areas and connected riparian corridors.

4.9.5.2 Compensatory Mitigation

To the extent that impacts cannot be avoided, Sound Transit would provide compensatory mitigation to achieve no net loss of ecosystem function and acreage.

The critical areas ordinances for the cities of Kent and Federal Way allow compensatory mitigation through a certified in-lieu fee program. Sound Transit plans to mitigate long-term impacts on wetlands and wetland buffers by replacing resources through the King County in-lieu fee program. Sound Transit could also use one or more of the following methods, if available:

- Approved wetland mitigation banks
- Advance offsite compensatory mitigation

- Project-specific mitigation developed by Sound Transit and approved by appropriate regulatory agencies

Sound Transit would implement compensatory mitigation in accordance with applicable federal, state, and local requirements and guidelines. To the extent practical, mitigation sites would be identified close to impacts and compensate in-kind for lost values. Publicly or privately owned portions of the McSorley Creek Wetland may provide opportunities for mitigation through enhancement, or by removing fill materials along the perimeter of the wetlands to create and reestablish wetland acreage and function. Sound Transit would determine final wetland mitigation actions during final design and permitting.

Sound Transit would provide mitigation for unavoidable impacts on other ecosystem components (e.g., streams, stream buffers, vegetation, and wildlife habitat) protected under federal, state, and local regulations. With the exception of Bingaman and Hylebos creeks, the project design would avoid impacts on existing streams.

The Preferred Alternative would be elevated over Bingaman Creek, but the channel would be realigned around the columns to minimize impacts on the creek and to not preclude replacement of the I-5 and S 288th Street culverts by WSDOT. Mitigation for impacts on Bingaman Creek would be approved by the appropriate permitting agencies and jurisdictions prior to construction.

Improving stream habitat and riparian function by replanting affected areas with native vegetation would mitigate some unavoidable impacts on stream riparian areas.

Sound Transit would mitigate for impacts on forested vegetation using applicable policies and regulations. Tree removal within the I-5 corridor would be mitigated according to the WSDOT *Roadside Policy Manual* (WSDOT, 2015b). Tree removal outside of WSDOT right-of-way would be mitigated to comply with local jurisdictions' tree replacement requirements.

Roadside Policy Manual

Sound Transit must restore or replace impacted vegetation in the highway right-of-way in accordance with the WSDOT *Roadside Policy Manual* (WSDOT, 2015). Specific types, amounts, and locations for replanting are identified in consultation with WSDOT and through development of a roadside master plan.

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4.10 Energy Impacts

4.10.1 Summary

FWLE operation would slightly reduce passenger and transit vehicle miles traveled, as people shift to riding light rail. Overall, operating any FWLE build alternative would use approximately 0.1 percent less energy than the No Build Alternative.

4.10.2 Introduction

Motor vehicles (for personal, business, and transit use), commuter trains, and light rail in the Puget Sound Region consume large amounts of energy. This section estimates the amount of energy consumed by motor vehicles and trains operating in the study area. Energy estimates include gasoline and diesel fuel as well as electricity purchased from Puget Sound Energy (PSE).

No federal, state, or local laws regulate energy consumption in the transportation sector. Many state, local, and regional transportation plans and policies identify goals for energy efficiency and conservation.

Sound Transit has a Sustainability Plan that encourages car trip reduction, the efficient use of energy in operations and facilities, and the use of construction practices that incorporate recycling, salvage, and greenhouse gas (GHG) reduction (Sound Transit, 2015). Section 4.6, Air Quality and Greenhouse Gases, describes estimated GHG emissions for the project.

4.10.3 Affected Environment

Sound Transit used state-level energy data to estimate energy consumption at the local level because detailed information about existing energy use and supply in the study area is not available.

Study Area

The study area for the energy impacts analysis is the same as the study area for the regional transportation analysis (the Puget Sound Regional Council [PSRC] four-county region, which includes King, Pierce, Snohomish, and Kitsap counties) because the regional travel model for vehicle miles traveled (VMT)/ vehicle hours traveled (VHT) includes all four counties.

4.10.3.1 Washington State Energy Consumption Trends

According to the Energy Information Administration, nearly 2,061,000,000 million British thermal units (MMBtu) of energy were consumed in Washington in 2013, enough to meet the needs of nearly 50 million households (U.S. Energy Information Administration, 2015a). From 1970 to 1999, Washington's per capita energy consumption averaged approximately 290 MMBtu, which is the energy equivalent of approximately 2,300 gallons of gasoline per person (Washington State Department of Commerce, 2014).

Recently, the per capita energy consumption has lowered to around 240 MMBtu per capita.

In 2013, the transportation sector in the state of Washington consumed approximately 309,400,000 MMBtu of gasoline and approximately 132,100,000 MMBtu of diesel fuel and oils (U.S. Energy Information Administration, 2015b). This accounts for approximately 21 percent of all energy consumed in the state. Table 4.10-1 presents daily VMT and energy consumption by transportation mode for the study area. According to the PSRC travel demand model (PSRC, 2014) and the Sound Transit ridership model (Sound Transit, 2014), the existing daily VMT for the study area is approximately 88.8 million miles. The associated daily energy use is approximately 564,000 MMBtu.

TABLE 4.10-1
Study Area Existing Daily Vehicle Miles Traveled and Energy Consumption (2014)

Vehicle Type	Energy Consumption Rate (Btu per mile)	Existing Conditions	
		Daily VMT[a]	MMBtu
Passenger Vehicle	5,626	84,956,140	477,974
Heavy Duty Truck	21,540[b]	3,618,000	77,932
Transit Bus	37,422[b]	193,300	7,234
Light Rail	32,904[c]	8,800	290
Commuter Rail	108,252[c]	5,600	606
Total		88,781,840	564,035

[a] Sources: PSRC, 2014; Sound Transit, 2014.

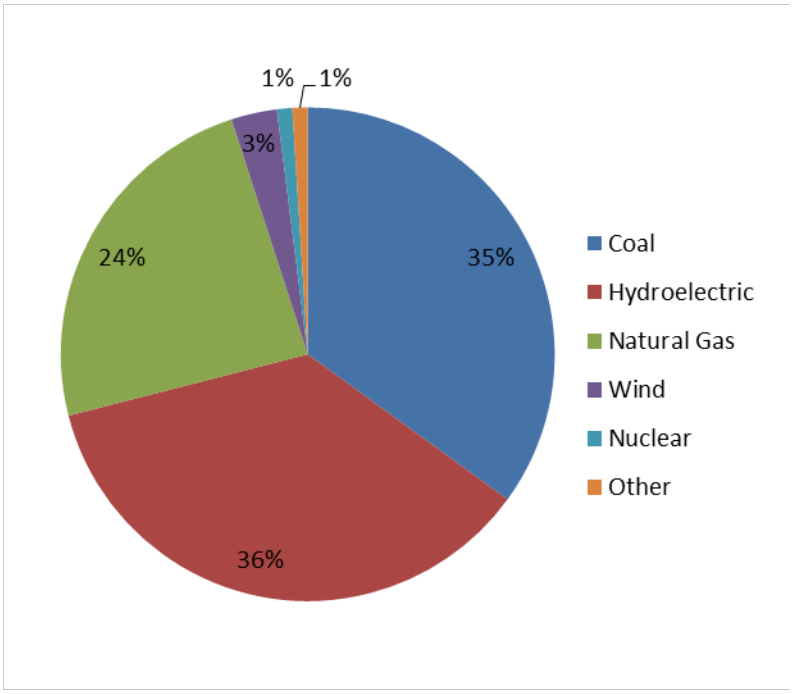
[b] Source: Oak Ridge National Laboratory, 2015.

[c] Source: Energy Use per Vehicle Revenue Mile, Sound Transit, 2014.

4.10.3.2 Electricity Supply in Study Area

PSE provides electricity to the study area, including to electric-powered light rail trains. It is the largest energy utility in Washington and provides electric power to more than 1 million customers. PSE generates electricity through multiple resources and processes as shown in Exhibit 4.10-1.

In 2014, PSE had peak power resources of approximately 4,889 megawatts (PSE, 2015a). Of this total, the utility had about 3,600 megawatts of company-controlled power-generating capacity. The remaining power supply came from a variety of other utilities, independent power producers, and energy marketers across the western United States and Canada (PSE, 2015a). Total generation and purchased power in 2014 was 23.7 million megawatt hours (MWh) (PSE, 2015b). Approximately 52 percent of the electricity PSE customers use comes from company-owned generation.



Source: Puget Sound Energy, 2015a.

EXHIBIT 4.10-1
Puget Sound Energy's Fuel Source Mix for Electricity Delivered to Customers in 2014

4.10.4 Environmental Impacts

The energy analysis evaluated operational energy use by the FWLE and the demand on regional energy supply.

Sound Transit estimated operational impacts based on the VMT estimates by mode in the PSRC travel demand model. The study area total light rail VMT estimates were based on the operations plan for the combined Link light rail system. Regional VMT estimates separated passenger miles from heavy truck miles to account for differences in energy consumption levels. Energy consumed was converted to Btu to provide a common measure among all energy sources. The energy consumption rate (Btu per vehicle mile) for each vehicle type (cars, trucks, and buses) comes from the *Transportation Energy Data Book, Edition 34* (Oak Ridge National Laboratory, 2015). The energy consumption rate for light rail vehicles and commuter rail comes from the Sound Transit Sustainability Inventory (Sound Transit, 2014). Table 4.10-2 shows the VMT, energy consumption rate (Btu per mile), and total energy consumption for the No Build and build alternatives. Light rail VMT for the No Build Alternative includes light rail system extensions to Lynnwood in the north and Overlake Transit Center in the East; these projects are expected to be complete before or around the same time as the FWLE.

TABLE 4.10-2
Daily Vehicle Miles Traveled and Energy Consumption

Vehicle Type	Energy Consumption Rate (Btu per mile)	2035 No Build Alternative		2035 Build Alternatives		% Change in MMBtu from No Build Alternative
		Daily VMT[a,b]	MMBtu	Daily VMT[b]	MMBtu	
Passenger Vehicle	5,626[c]	108,114,880	608,268	107,953,590	607,361	-0.1%
Heavy Duty Truck	21,540[c]	5,270,820	113,533	5,269,820	113,512	0.0%
Transit Bus	37,422[c]	222,600	8,330	220,100	8,237	-1.1%
Light Rail	32,904[d]	69,600	2,290	77,600	2,553	11.5%
Commuter Rail	108,252[d]	7,200	779	7,200	779	0.0%
Total		**113,685,100**	**733,201**	**113,528,310**	**732,442**	**-0.1%**

[a] Source: PSRC, 2014.
[b] Source: Sound Transit, 2014.
[c] Source: Oak Ridge National Laboratory, 2015.
[d] Source: Sound Transit, 2014.

4.10.4.1 No Build Alternative

Under the No Build Alternative, the daily VMT for the study area is projected to increase from approximately 88.8 million in 2014 (see Table 4.10-1) to approximately 113.7 million in 2035. The No Build Alternative would place additional demands on energy in the region because of increased passenger trips, greater levels of congestion, and slower speeds, which would also increase GHG emissions. However, the additional demand that the light rail system would place on the electric grid would not occur.

4.10.4.2 Build Alternatives

Because all build alternatives would be of similar length and ridership, direct impacts would be similar. No indirect impacts would occur. Chapter 5 discusses construction impacts related to energy.

When compared to the No Build Alternative, the FWLE would result in a slight regional reduction of passenger and transit VMT as people shift to riding light rail. Less total energy would be consumed; however, FWLE operation would increase demand for electricity from PSE. Under the build alternatives, light rail vehicles are expected to travel 8,000 more total rail car miles per day than the No Build Alternative. This additional mileage would result in energy use of approximately 263 MMBtu per day, or 77.1 MWh per day. The additional annual MWh consumed by the build alternatives would be nearly 28,000 MWh. This represents less than 0.2 percent of the total power PSE generated in 2014.

Overall, operating the FWLE would use approximately 0.1 percent less energy than the No Build Alternative.

Sound Transit's Sustainability Plan was approved in 2011 and updated in 2015. It commits Sound Transit to integrate efficient operating practices at existing and new facilities, using energy-saving equipment to reduce energy demand, and maximizing intermodal transit connections to reduce automobile VMT. Many of these practices have been incorporated into the initial Central Link light rail segment that began operating in 2009. The Sustainability Plan identifies a long-term energy target in which all fleets would deploy fuel-efficient, clean, and cost-effective vehicles to optimize the use of proven technologies. It also identifies initiatives to develop and implement an energy management strategy and to continue to develop and implement fuel-reduction strategies for Sounder commuter rail, Sound Transit Express buses, and the non-revenue fleet. Implementing the plan involves tracking fuel and energy consumption annually, reporting on progress, and reevaluating targets regularly. Sound Transit's design standards for light rail also require designers to maximize the energy efficiency of transit facilities, buildings, and systems. Implementing the Sustainability Plan and Sound Transit's design standards could further reduce energy consumption during FWLE construction and operations.

4.10.5 Potential Mitigation Measures

Operation of the FWLE is expected to consume less energy overall than the No Build Alternative. It is not expected to overburden the electric utility's power availability. No mitigation would be required.

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4.11 Geology and Soils

4.11.1 Summary

All build alternatives would require new slopes and new earth fills and would travel though geologic hazard areas (areas at risk for erosion, steep slopes, landslides, and seismic hazards). These hazard areas are not extensive for any alternative. Sound Transit anticipates that the effects of the FWLE on local geology and effects of geology on the FWLE would be minor for all the build alternatives and manageable through typical design efforts.

Appendix D4.11 presents additional information on the geology of the FWLE corridor, including a summary of the geologic units and engineering properties in the study area and maps of geotechnical boring locations, local geology, topography, erosion hazard areas, steep slopes, and seismic hazard areas.

4.11.2 Introduction

Geology and soil considerations that could affect or be affected by the build alternatives include topography, geology, soil characteristics, groundwater location, and geologic hazards. These considerations were assessed at both regional and project-specific levels. Regional considerations include geology and seismicity of the Puget Sound area. Project-specific considerations include topography, soil conditions, groundwater location, and geologic hazards along the build alternatives alignments.

Study Area

While this section describes the geology and soil conditions of the project vicinity, the potential for impacts was determined by looking within a study area of 100 feet from either side of each alternative, station, and ancillary facility.

The Washington State Growth Management Act (GMA) requires all cities and counties to identify and regulate development in and near critical areas. The GMA defines geologically hazardous areas as critical areas susceptible to erosion, sliding, earthquake, or other geological events. The hazards could affect the design, construction, and operation of the FWLE. If not considered appropriately, they could pose a risk to public health and safety.

Geology and soils considerations are closely related to groundwater conditions. This section includes general information on groundwater in the project vicinity, as related to the assessment of geologic hazards. More information on groundwater locations and uses along each alternative is presented in Section 4.8, Water Resources. Locations of possible contaminated soils and contaminated groundwater are discussed in Section 4.12, Hazardous Materials.

4.11.3 Affected Environment

Sound Transit assessed the regional geology, topography, seismicity, site geology, and geologic hazards using available printed and online maps published by the U.S. Department of Agriculture and the U.S. Geological Survey (USGS), as well as select previous geotechnical reports completed for the area. Over 50 geotechnical reports from previous projects conducted in and near the FWLE corridor between 1954 and 2007 were identified, and exploration logs from these reports were reviewed. Geotechnical reports for Midway Landfill were reviewed in full. Sound Transit also conducted 82 geotechnical soil borings and installed 32 groundwater monitoring devices (piezometers) to characterize the geology along the Preferred Alternative footprint. Sound Transit would conduct additional geotechnical borings along the corridor during the final design. Information from the maps, reports, and exploration was used to develop the following descriptions of the affected environment for the FWLE.

4.11.3.1 Regional Geology

The FWLE is in the central Puget Lowland, a north-south trending trough bordered by the Cascade Mountains to the east and the Olympic Mountains to the west. The existing topography and regional geology have been largely shaped by past glacial activity. The regional geology includes a thick sequence of glacially consolidated soils overlying bedrock, typically 600 to 1,200 feet below the ground surface in the project vicinity (Jones, 1996). The surface geology along both the SR 99 and I-5 corridors was heavily modified during construction of I-5 and SR 99.

4.11.3.2 Topography

The study area is in an upland area bounded by the Green River Valley to the east and Puget Sound to the west. Ground surface elevations typically range from approximately 250 to over 400 feet above sea level (USGS, 2004a; USGS, 2004b). The study area has local depressions, stream channels, lakes, and wetlands that are underlain by more recent soils, including recessional outwash and wetland deposits.

4.11.3.3 Seismicity

The Puget Sound Region is at the convergent continental plate boundary known as the Cascadia Subduction Zone (CSZ). Relative movement between the North American Plate and subducting Juan

de Fuca Plate at this boundary has resulted in a long history of seismic events in the Puget Sound Region. These events are associated with three primary sources: shallow earthquakes in the crust of the North American Plate, deep subcrustal zone (intraslab) earthquakes in the subducted Juan de Fuca Plate in the CSZ below Puget Sound, and very large earthquakes at the interface between the Juan de Fuca Plate and North American Plate off the coasts of northern California, Oregon, Washington, and British Columbia.

Some of the consequences of plate movement are strong ground shaking, regional land subsidence, and the potential for ground displacement from fault rupture within the North American Plate. The closest active faults in the area include the Seattle and Tacoma fault zones. The FWLE corridor is outside of known fault zones, so the risk of fault displacement is low. Regional subsidence could occur from very large earthquakes on the CSZ interface, but the zone of subsidence is expected to occur along the coastline of the Pacific Ocean and not extend to the Puget Sound area.

Regional Subsidence

Seismic events can cause a region-wide settlement of the ground (regional subsidence), potentially on the order of several feet over an area of tens of miles. This displacement occurs as rock at great depth displaces downward. The regional subsidence issue is of greatest concern along the Pacific coast during a mega-thrust earthquake, but could also occur near shallow crustal faults when normal or reverse movement occurs.

4.11.3.4 Site Geology and Groundwater Conditions

Based on the geologic mapping and existing geotechnical reports, the study area is typically underlain by glacially consolidated soils and more recent soils, including unconsolidated recessional outwash and wetland deposits. Groundwater is typically found from 5 feet to 95 feet below the ground surface. Some locations have shallow or perched groundwater (Washington State Department of Natural Resources [WDNR], 2014). In wetlands, groundwater can range from a few feet below the ground surface to the surface itself.

Similar geologic and groundwater conditions exist for all build alternatives, with the exception of the Preferred Alternative at the Midway Landfill. The landfill is a Superfund site, as discussed in Section 4.12, Hazardous Materials. The demolition debris and municipal waste that make up the landfill create a zone of compressible, low-strength material susceptible to large and erratic settlement. The material could undergo bearing failures when subjected to new earth or structural loading. The landfill also potentially contains gas and contaminated groundwater, as discussed in Section 4.8, Water Resources; Section 4.12, Hazardous Materials; and Chapter 5, Construction.

4.11.3.5 Geologic Hazards

The cities of SeaTac, Des Moines, Kent, and Federal Way and unincorporated King County have defined geologically hazardous areas in their respective land use codes. Those areas include:

- Erosion hazard areas, which have soils that are potentially susceptible to erosion. In general, the potential for erosion in the study area is limited. Surficial soils are prone to erosion if left exposed (e.g., during land-clearing activities for installation of alignment infrastructure), and certain types of soil, such as silt, are more prone to erosion. The potential for erosion also increases as the slope steepness increases.
- Steep slope hazard areas, with slope angles between 15 and 40 percent. These slopes can become unstable during wet weather and seismic events.
- Landslide hazard areas, where past slides have occurred. The combination of soil types and groundwater conditions within steep slopes determines whether they will be unstable. Slopes that are steeper than 40 percent have a high potential for instability.
- Seismic hazard areas, which are subject to fault displacement or earthquake-induced ground shaking. Some areas have saturated loose granular soils that can liquefy and become unstable in a seismic event. Wetlands or areas underlain by soft soils are considered seismic hazard areas.
- Settlement hazard areas, where soft soils may settle under increased loads from embankments or structures. Wetland areas and the Midway Landfill are considered settlement hazard areas.

Geologic hazards can also include tsunamis, seiches, and volcanic hazards. The FWLE is at an elevation that precludes tsunami hazards, and bodies of water near the corridor are too small to result in a hazardous seiche. The alignments are also outside areas that would be affected by lahars (volcanic mudflow) associated with a volcanic eruption in the Cascade Mountain range.

Tsunamis and Seiches

Tsunamis are seismic sea waves that are generated from earthquakes, large landslides, or volcanic eruptions occurring beneath the ocean's surface. Seiches are standing waves oscillating from one side to the other in a confined body of water, and can be caused by earthquakes or severe storms. Seiches can occur in lakes, ponds, and even swimming pools. Seiche waves are usually much smaller than tsunamis.

4.11.4 Environmental Impacts

This section summarizes the impacts that could result from the No Build Alternative and the build alternatives. The impacts

include both changes to geology and soils caused by the FWLE and effects on the project from geologic hazards that could affect safely operating light rail.

4.11.4.1 No Build Alternative

Under the No Build Alternative, the existing geology and soils environment would essentially remain unchanged.

4.11.4.2 Build Alternatives

The section below covers the general impacts common to all alternatives, followed by key differences in impacts between the alternatives. Chapter 5, Construction, provides an overview of the potential construction activities, their impacts, and timing of those activities.

Direct Impacts

Slope Stability, Retaining Structures, and Landslides

Earth slopes and retaining wall structures could be a hazard if not permanently stabilized. Earth slopes include existing slopes, slopes that could be steepened as part of the FWLE, and slopes for embankment fills needed to support the alignment. Instability could result in damage to structures in the path of the moving soil or in a loss of the soil's supporting capacity for structures on or near the slope. The risk of inadequate slope stability would be greater if a large seismic event were to occur.

All build alternatives have steep slope and landslide hazard areas along the alignments (see Exhibit D4.11-5 in Appendix D4.11, Geology and Soils Data). Most of the landslide hazard areas are over 500 feet from the alternatives. The extent of steep slope areas is limited, and ground conditions for the slopes are generally stable in most areas along the alternative corridors. Land clearing in steep slope areas could increase soil erosion hazards. Erosion-control management practices would be implemented to mitigate hazards, keeping the overall risk low.

The one exception to these conditions is along the S 272nd Redondo Trench Station Option with the SR 99 Alternative. Although the geologic units underlying this area are mapped as being dense to very dense and should provide excellent foundation support and stable cuts (Table D4.11-2 in Appendix D4.11), approximately 3 miles of the station option alignment are in areas with steep slopes, as shown on Exhibits D4.11-3 and D4.11-5 in Appendix D4.11. In combination with shallow groundwater, if encountered, this area could be susceptible

to slope instability. Groundwater depths throughout the FWLE corridor range from 20 to 155 feet below ground surface and are suspected to be at the higher end of the range along this station option alignment (WDNR, 2014). Sound Transit would use measures such as slope stabilization or retaining walls to stabilize the areas of potential risk.

Seismic Hazard

The primary seismic hazard is ground shaking caused by a seismic event, as noted above under Seismicity. Potential impacts include:

- Seismic ground shaking during light rail operation would be transmitted into the light rail vehicles operating on the tracks, causing increased horizontal forces and movement within structures supporting the light rail system.
- If the FWLE is built on sloping ground, the ground shaking could result in permanent movement of the ground and the supported facilities.
- Seismic ground shaking could also lead to liquefaction of loose, saturated, cohesionless soils; settlement from densification of loose soils; increased risk of unstable earth slopes and retaining walls; and increased earth pressures on retaining walls. The areas underlain by soft or loose soils along the alternatives are identified as seismic hazard areas because these areas are more likely to experience intense ground shaking from seismic events.

Although these impacts present a risk to light rail facilities and users, Sound Transit would minimize the risk by designing the elevated, at-grade, and below-grade light rail support systems and retaining structures (including retained fills or cuts) to withstand the effects of seismic ground shaking.

Seismic Design Standards

Sound Transit's light rail design standards are based on the occurrence of a rare, very large seismic event with a probability of occurrence of 2 percent in 50 years, which equates to an approximate return period of once every 2,475 years. This makes the risk of damage from seismic ground shaking low.

Settlement of New Earth Fills

Retained fills would be used in some areas where the FWLE facilities would be above the existing grade. Walls generally would be used to retain the fill, or fills would be sloped down to the ground surface. The fill would cause increased loads on the existing soil, resulting in soft soil settling. If not mitigated, this settlement could damage light rail structures and nearby structures, roadways, and utilities.

The overall risk of settlement for all alternatives is low. Project design would incorporate measures to improve the soils where the potential

for settlement is identified, or would allow tolerances for anticipated settlement. Most of the new earth fills would be in areas underlain by glacially consolidated soils, which are not expected to experience settlement, as these soils have already been loaded with much higher pressures from glaciers.

Design measures would be used to avoid the detrimental effects of settlement in areas where settlement-prone soils exist, such as at the Midway Landfill along the Preferred Alternative and in areas near wetlands north of S 272nd Street where the potential additional station at S 260th Street (East option) and the S 272nd Redondo Trench station options would be built. For example, two crossing methods are being considered to cross the Midway Landfill for the Preferred Alternative. The preferred method is to cross it using an elevated guideway supported by drilled shafts. This would not require new fill on the landfill and therefore would avoid the settlement risk. Another method would be to cross it at-grade on new fill, which would require provisions for handling settlement during operation.

Light Rail Facilities

Light-rail facilities would create new loads and potentially affect groundwater conditions along the alignments as described below:

- Loads imposed by foundations for stations and guideway structures could cause settlement of the surrounding soils. The magnitude of and impacts from these loads would be evaluated during design studies.
- Retaining structures would be required in areas where the track or stations would be below-grade in a trench or above-grade on retained fills. Some could require permanent soil anchors or tiebacks that extend beyond the limits of the project footprint onto adjacent properties, which would require permanent easements and could affect the future use of neighboring properties. Retaining structures can affect or be affected by local groundwater movement and seepage. The design of the retaining structures would consider groundwater conditions and provide appropriate means of drainage or waterproofing for control of groundwater.
- Parking structures could be supported on shallow or deep foundations, depending on ground conditions, or improved ground combined with shallow foundations in some circumstances. Surface parking lots would be supported at-grade.

Impacts from the parking structures would be limited primarily to settlement of soils directly beneath the structures.

- Stormwater facilities would be required to manage increased runoff from the project's impervious areas, such as guideways, parking lots, and structures. Where possible, infiltration and other low-impact design principles would be used. Information about the permeability characteristics of the area's geologic units is included in Table D4.11-2 in Appendix D4.11. Section 4.8, Water Resources, provides additional information on stormwater facilities.

Changes in Groundwater Flow

As noted above, retaining walls can affect or be affected by local groundwater movement and seepage. In areas where groundwater depths are 20 feet or less below the ground surface, the retaining structures could change shallow groundwater flow directions. Increased infiltration from stormwater runoff over impervious areas, such as parking lots, could temporarily increase groundwater levels and flow following storm events. Design of the Preferred Alternative considers groundwater conditions and provides appropriate means of drainage or waterproofing for control of groundwater. The elevated structures of the S 272nd Star Lake Elevated Station Option and the S 317th Elevated Alignment Option would not require groundwater controls that the Preferred Alternative would require.

Indirect Impacts

Indirect impacts could result from permanent soil anchors or tiebacks that would be used in retaining wall structures. These wall support systems could restrict the type of excavations feasible for future developments within the anchor zones.

4.11.5 Potential Mitigation Measures

During final design, Sound Transit would conduct additional geotechnical studies involving borings and other exploration methods, laboratory testing of soil, and detailed foundation design along the FWLE corridor. This work will inform and refine the FWLE design and construction techniques and potential mitigation measures. At sites where geologic conditions are not suitable, appropriate design and construction measures as described in Section 4.11.4 and Section 5.2.12 would be refined and implemented to avoid potential adverse effects and geologic risks during operations.

4.12 Hazardous Materials

4.12.1 Summary

The Preferred Alternative has the fewest high-risk hazardous material sites within or adjacent to its footprint (Table 4.12-1) and the SR 99 Alternative has the most. However, the Preferred Alternative crosses the Midway Landfill, a Superfund site categorized as a high-risk site. Sound Transit did not identify hazardous materials in geotechnical borings at the landfill near the Preferred Alternative; however, hazardous materials might be present in areas not investigated. Sound Transit would also need to complete the regulatory processes associated with disturbing a Superfund site. The I-5 Landfill Median Alignment Option would avoid the landfill. The Arco #5241 site is also in the Preferred Alternative construction footprint. It is a high-risk site since petroleum-impacted soil and groundwater are present. Appendix D4.12 includes a table of all known hazardous material sites in the study area and a map of soil arsenic concentrations in the study area associated with the ASARCO smelter plume.

TABLE 4.12-1
Number of High-Risk Sites within the Project's Long-Term Footprint

Alternative	Number of High-Risk Sites within Project's Long-Term Footprint (Range with Options)
Preferred Alternative	**3** (0-3)
SR 99 Alternative	**7** (6-8)
SR 99 to I-5 Alternative	**4** (3-5)
I-5 to SR 99 Alternative	**4** (3-4)

4.12.2 Introduction

Hazardous materials can be classified in a number of different ways based on laws and regulations that define their characteristics and use. The categories generally include hazardous waste, dangerous waste, hazardous substances, and toxic substances. Applicable laws and regulations are listed in Appendix D4.12.

Section 4.2, Land Use, describes existing land uses in the study area. Section 4.8, Water Resources, describes regulatory requirements related to groundwater quality.

4.12.3 Affected Environment

Sound Transit acquired information from multiple sources about sites with known contamination or potential contamination within the study area, as well as relevant historical conditions within the study area.

U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) databases were reviewed in January 2013 (Environmental Data Resources, Inc. [EDR], 2013a and b). These databases track properties with potential or confirmed hazardous material releases and facilities that manage hazardous materials as part of their operations. Appendix D4.12 provides maps and tables with additional information about these sites.

The information allowed the team to prioritize sites as follows based on the need for avoidance, remediation, or mitigation, while considering associated costs and liability:

- **High-risk** sites are properties that might be substantially contaminated and might create liability for Sound Transit either from construction activities or by virtue of acquiring all or a portion of the site. High-risk sites typically have difficult-to-treat contaminants (for example, tetrachloroethene [PCE]), large volumes of contaminated materials, or long histories of industrial or commercial use.
- **Medium-risk** sites are properties where the nature of potential contamination is known based on existing investigation data, the potential contaminants are not extremely toxic or difficult to treat, and probable remediation approaches are straightforward. These sites are typically in or adjacent to project construction limits and have soil contaminated with petroleum products. Nearby sites that have groundwater contaminated with petroleum products may also be medium-risk.
- **Low-risk** sites are properties where the nature of contamination is known based on existing investigation data, and sites are not expected to have noticeable impacts on the project alternatives because of their location. These sites are typically not directly adjacent to the FWLE right-of-way and do not have groundwater contamination.

Study Area

The hazardous materials analysis study area is the area within about 1/8 mile from each alternative. Within this study area, contaminated sites could affect the project or the project could affect the contaminated site.

Information Sources

- Environmental agency database records (EDR, 2013a, 2013b)
- Historical aerial photographs (Washington State Department of Transportation, 2013)
- Online King County Assessor data (King County GIS Center, 2013)
- Current and historical topographic maps (EDR, 2013b)
- Historical city directories for south King County and Kent, Washington
- Windshield survey of the FWLE corridor on March 15, 2013

Table 4.12-2 lists the number of sites within the project's long-term footprint for each alternative by risk category and provides a range of these sites for the options associated with each alternative. These sites are shown on Exhibits 4.12-1 and 4.12-2. For the high-risk sites, files were reviewed at Ecology in January and February 2014 to further understand the potential risks of the sites. Files on the Midway Landfill were also obtained from Seattle Public Utilities in October 2013 and January 2014.

TABLE 4.12-2
Number of Hazardous Material Sites within Study Area (1/8 Mile of Each Alternative)

Alternatives	Number of Hazardous Material Sites within Study Area (Range with Options)		
	High Risk Level	Medium Risk Level	Low Risk Level
Preferred Alternative	**3** (1-4)	**5** (3-9)	**59** (59-60)
SR 99 Alternative	**12** (12-13)	**71** (63-71)	**86** (86-86)
SR 99 to I-5 Alternative	**6** (5-7)	**37** (34-37)	**48** (48-49)
I-5 to SR 99 Alternative	**8** (8-8)	**38** (37-38)	**68** (68-68)

Note: The number of hazardous material sites for all risk levels should be considered as a snapshot in time. Actual facility environmental conditions vary over time and environmental databases are constantly being updated. Sites are added or deleted regularly. The number of medium- and low-risk sites should be approximate because the site locations have been identified as a single point and portions of a property can fall inside or outside of the 1/8-mile (660-foot) buffer.

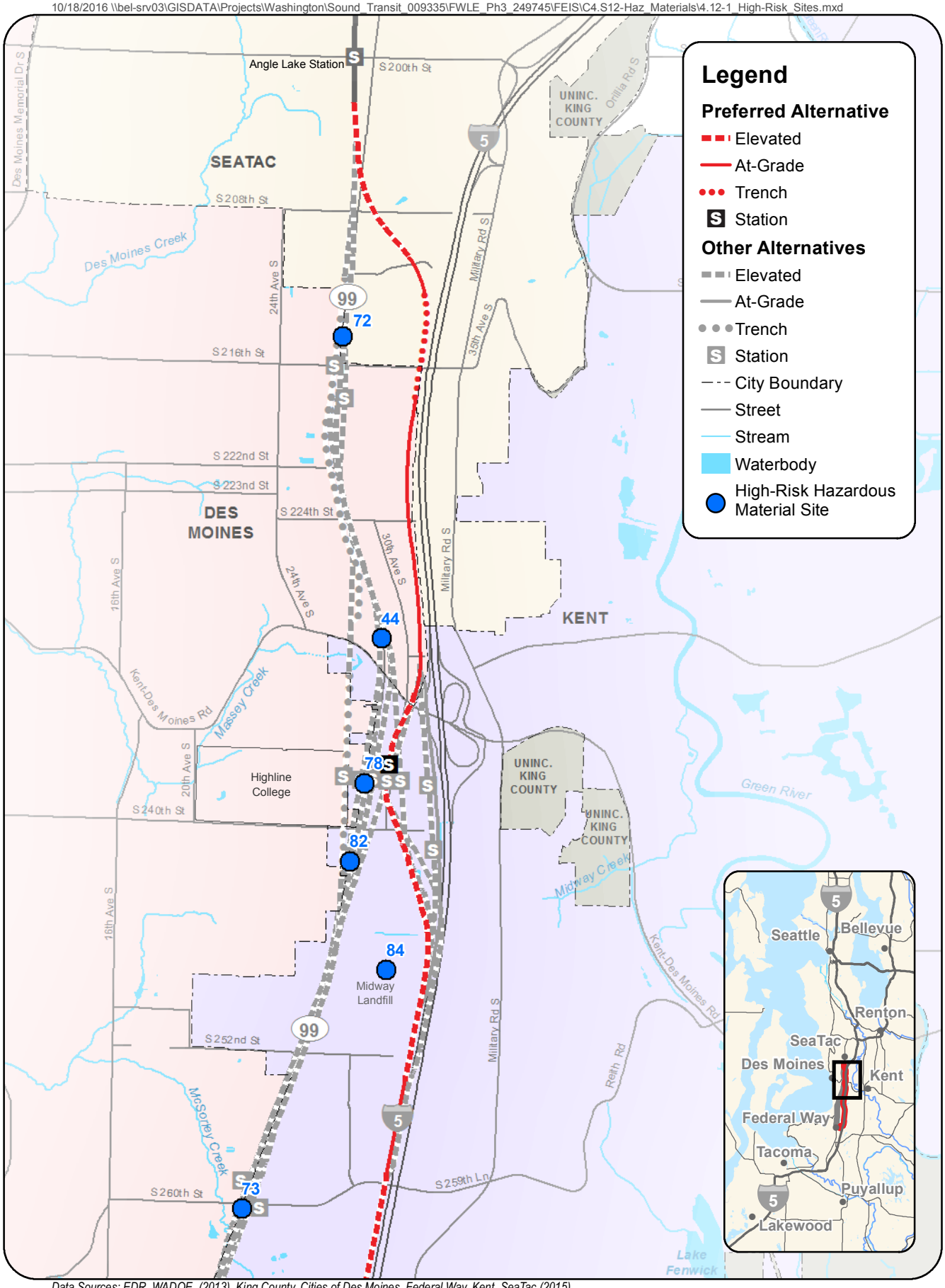
The study area for all alternatives is within a plume of arsenic- and lead-impacted soils originating from aerial deposition of metals emitted from the former ASARCO smelter in Tacoma, which operated from 1890 until 1985. Appendix D4.12 includes a Department of Ecology map showing arsenic concentrations in the top 6 inches of soil in the Puget Sound Region (Ecology, 2009, 2012).

Elevated levels of lead are also associated with the ASARCO smelter plume, but have not been mapped.

4.12.4 Environmental Impacts

4.12.4.1 No Build Alternative

With the No Build Alternative, there would be no project-related removal or cleanup of potentially hazardous materials in the study area, including contaminated soil or groundwater. The potential uncontrolled migration of existing contaminants would likely continue.

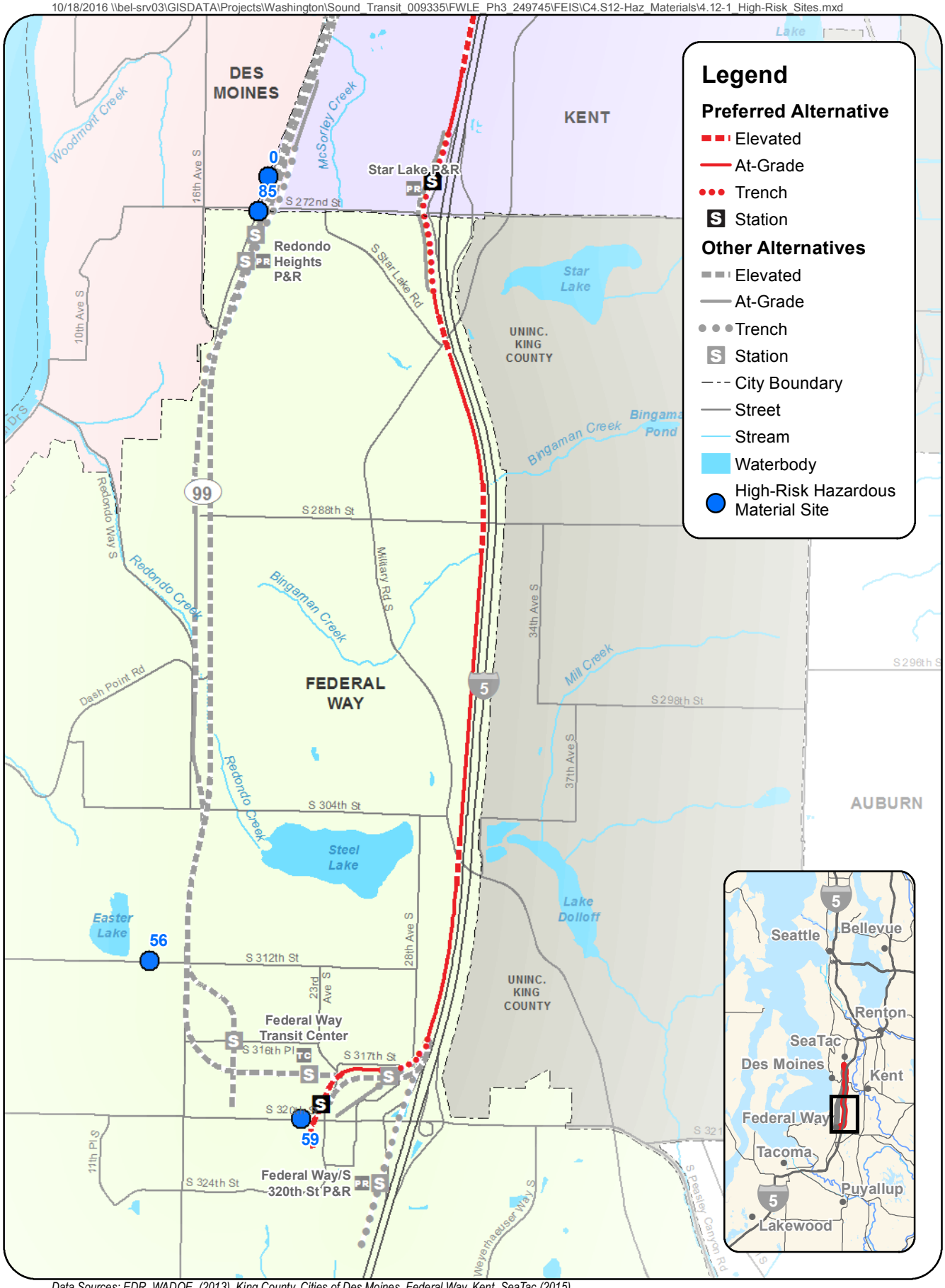


Data Sources: EDR, WADOE, (2013), King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.25 0.5 1 Miles

EXHIBIT 4.12-1
High-Risk Hazardous Material Sites
(North)
Federal Way Link Extension



Data Sources: EDR, WADOE, (2013), King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

N

0 0.25 0.5 1 Miles

EXHIBIT 4.12-2
High-Risk Hazardous Material Sites (South)
Federal Way Link Extension

4.12.4.2 Build Alternatives

This section discusses the potential long-term, operational impacts that the build alternatives could have on known contaminated sites, and the potential impacts that the contaminated sites could have on project development and Sound Transit's liability. Impacts during construction activities, including excavation and soil disturbance, are discussed in Chapter 5, Construction.

Direct Impacts

Long-term impacts could occur when Sound Transit acquires contaminated properties that require ongoing monitoring and cleanup responsibility and liability. Such sites are typically associated with groundwater contamination or are large and complex. The actual long-term impacts at such hazardous materials sites cannot be identified or assessed without evaluating in detail site-specific conditions, which would be performed before or during construction. The high-risk sites within the build alternative footprints are described below by alternative. Additional high-risk sites present within the FWLE study area but not in the project footprint are listed in Appendix D4.12;these sites would not be acquired for or disturbed by the FWLE.

Contaminated sites affected by the FWLE would be addressed before and during project construction (see Chapter 5). Long-term monitoring or other protective measures or restrictions could be required. Long-term monitoring is currently occurring at the Midway Texaco (Map ID site 44), Midway Cleaners (Map ID Site 78), Arco 5363 (Map ID Site 85), 7-Eleven 18758 (Map ID Site 73), Arco # 5241 (Map ID Site 59), and the Midway Landfill (Map ID Site 84). Each of these sites is within the footprint of one or more alternatives. Each site would be handled following the requirements of applicable regulations and approvals and the specific site needs.

The likelihood of impacts (i.e., releases) from FWLE operations and maintenance activities would be low. Because train operation is electrical, fuel spills would not occur and impacts during normal operation are unlikely. Minor impacts during operations could result from hazardous materials used for track-maintenance activities, such as a small spill of diesel fuel or hydraulic fluid. There would be no long-term impacts related to arsenic- and lead-impacted soil from the ASARCO smelter plume from operation of the FWLE. Construction

impacts related to soil contaminated by the smelter plume are discussed in Chapter 5, Construction.

Preferred Alternative

Long-term impacts from crossing the Midway Landfill (Map ID Site 84); soil, groundwater, and potential vapor intrusion impacts associated with Arco #5241 (Map ID Site 59); and potential vapor intrusion impacts associated with Midway Cleaners (Map ID Site 78) would occur. The Midway Landfill site is a 60-acre former gravel quarry used as an unlined landfill from 1966 to 1983 (EPA, 2000). It is listed on the National Priorities List (NPL). Sites on the NPL, also known as Superfund, have been identified for priority cleanup by EPA.

The Midway Landfill is closed and capped. The landfill cap consists of (from the top layer down): 1 foot of cover soil, a 1-foot drainage layer, filter fabric, a drainage net, a 50-mil high-density polyethylene membrane, and a 1-foot compacted soil/clay layer. Wells are in place to capture gases from below the cap. The type and magnitude of impacts at the landfill would depend on the crossing method.

Two crossing methods are being considered. The preferred method is to cross the landfill using an elevated guideway supported by drilled shafts. The construction of the drilled shafts would require removing a portion of the landfill cap, removing waste material, drilling shafts up to 10 feet in diameter, and replacing the landfill cap around the shafts. Another method would be to construct the tracks at grade. This would require removing a portion of the cap, compacting waste material in place, replacing the cap over the compacted waste, and placing ballast material for the tracks at ground level. The overhead catenary system poles would be supported by small drilled shafts. Both methods would require regulatory approval from EPA and Ecology. Based on previous approvals for disposal of waste removed from the landfill, Public Health of King County and Seattle is expected to allow for disposal of waste removed for the project as municipal solid waste. Sound Transit would monitor waste being removed from the landfill for hazardous material and would consult with EPA, Ecology and Public Health regarding disposal if any is identified.

Penetrations of the landfill, such as drilled shafts, would be constructed so that all layers of the landfill cap are replaced around the shafts to prevent long-term surface water infiltration and leachate migration. Compaction of waste and replacement of the liner would prevent any surface water infiltration post-construction

because the existing liner and replacement liner would be reconnected and sealed. The current conceptual design shows drilled shafts about 50 to 75 feet deep, probably about 35 feet or more above groundwater.

There is an unused landfill gas extraction system in the FWLE construction footprint that is disconnected from the main landfill gas collection system. It might need to be removed during construction. This would be determined during final design when column placement is finalized. The drainage system on the east side of the landfill along I-5 is reportedly 3.5 to 5 feet from the edge of the existing I-5 pavement and not within the expected footprint of the project construction.

Long-term commitments associated with crossing the Midway Landfill would include working with Ecology and EPA to prepare either a Record of Decision Amendment or an Explanation of Significant Difference to the Record of Decision, and to monitor the landfill cap to ensure its integrity, prevent surface water infiltration into the landfill, and prevent gas migration from the landfill. The Landfill Median Alignment Option would avoid landfill-related impacts.

Arco #5241 has been an active service station since 1975. It would be within the construction footprint for the Federal Way Transit Center Station. Petroleum hydrocarbon concentrations in the soil and groundwater at this site are above Model Toxics Control Act (MTCA) Method A cleanup levels. Although a multiphase extraction remedial system and groundwater monitoring have occurred, petroleum-impacted groundwater remains under the Arco #5241 property and nearby properties and subsurface vapor could have migrated beyond the property. The presence of petroleum hydrocarbons in soil and groundwater and vapor in the soil would be investigated prior to station construction, and remediated or mitigated if found.

Volatile Organic Compounds

Petroleum hydrocarbons and chlorinated solvents are volatile organic compounds and may travel as vapors in the subsurface.

Midway Cleaners (Site 78) is an active dry cleaning business that has been in operation since the 1950s. It is approximately 100 feet west of the Kent/Des Moines Station. Chlorinated solvent concentrations in soil and groundwater are above MTCA Method A cleanup levels. While there is currently a soil vapor extraction remedial system and groundwater monitoring in place, subsurface vapor could have migrated to the station area. Sound Transit would investigate conditions and mitigate the vapor intrusion, if any. The Kent/Des

Moines I-5 Station Option and At-Grade Station Option would be farther away from Midway Cleaners and less likely to be affected by vapor intrusion. No other contaminated sites within the study area would be affected by this alternative or options.

SR 99 Alternative

The SR 99 Alternative would have more high-risk sites within its footprint than the Preferred Alternative. Table 4.12-3 summarizes the types of high-risk sites and impacts to them from the SR 99 Alternative and its options.

TABLE 4.12-3
High-Risk Sites within Footprint of SR 99 Alternative and Options

Site[a]	Name	Type of Contamination	Alternatives or Options
72	Sunmart 1	Former service station with known groundwater contamination for petroleum.	Partially acquired for the SR 99 alternative and most station options. It would be fully acquired for the potential additional station at S 216th Street.
44	Midway Texaco	Active service station with groundwater contamination for petroleum.	Fully acquired for the SR 99 Alternative as well as for the Kent/Des Moines SR 99 Median Station Option.
78	Midway Cleaners	Dry cleaning business with known contamination of chlorinated solvents in soil and groundwater.	Fully acquired for the SR 99 Alternative and station options except the Kent/Des Moines SR 99 East Station Option.
82	Japanese Auto Sales & Service	Former auto sales and service property investigated by regulatory agencies for failing to store and handle dangerous waste properly.	Partially acquired for the SR 99 Alternative. The Kent/Des Moines HC Campus Station Option and the potential additional station at S 260th Street (West option) would fully acquire this property.
73	7-11 Eleven No. 18758	Active service station with known groundwater contamination for petroleum.	Partially acquired for the potential additional station at S 260th Street (West option).
85	Arco 5363	Active service station with known groundwater contamination for petroleum.	Fully acquired for the SR 99 Alternative.

[a] Site numbers are shown on Exhibits 4.12-1 and 4.12-2.

SR 99 to I-5 Alternative

Long-term operational impacts could occur at the following high-risk sites with the SR 99 to I-5 Alternative: Sunmart 1 (Site 72), Midway Texaco (Site 44), and the Midway Landfill (Site 84). Potential impacts associated with Sunmart 1 and Midway Texaco would be the same as discussed for the SR 99 Alternative. Potential impacts associated with Midway Landfill would be the same as discussed for the Preferred Alternative.

I-5 to SR 99 Alternative

Long-term operational impacts could occur at Arco 5363 (Map ID Site 85) with the I-5 to SR 99 Alternative, and would be the same as discussed for the SR 99 Alternative.

Indirect Impacts

The FWLE would support redevelopment of properties around station areas where local zoning allows. Properties where contamination is present could be cleaned up for redevelopment earlier than might otherwise occur, which would be an indirect benefit of the project.

4.12.5 Potential Mitigation Measures

To mitigate potential impacts from hazardous materials sites, Sound Transit would perform a level of environmental due diligence appropriate to the size and presumed past use at all properties along the corridor before they are acquired. Phase 2 environmental site assessments would be conducted where appropriate. Where identified hazardous materials are present, Sound Transit would be responsible for remediating contaminated soil and groundwater, including any previously unknown and found during construction. To the extent practical, Sound Transit would limit construction activities that might encounter contaminated groundwater or contaminated soil.

4.13 Electromagnetic Fields

4.13.1 Summary

The FWLE study area contains no sensitive facilities with equipment susceptible to electromagnetic interference. Utilities can be affected by stray electric currents, but avoidance measures are part of the project design. Therefore, there is no potential for electromagnetic field impacts in the study area.

4.13.2 Introduction

The use of electricity produces electric and magnetic fields, or electromagnetic fields (EMFs): electric fields are produced by charges; magnetic fields, by the flow of electric current. The greater the electric charge or current, the greater the electric or magnetic field. EMFs are produced by electrical equipment and facilities, including power lines and electrical devices. They can also be emitted when vehicles move, as with truck traffic. Whatever the source, they can interfere with sensitive equipment.

Study Area

EMFs create electromagnetic interference, which can cause disruptions and possible malfunction of some types of equipment. The EMF study area for FWLE depends on the proximity of sensitive equipment to the light rail line and the amount of electrical power required to accelerate or decelerate light rail vehicles near sensitive facilities. A light rail vehicle will probably not adversely affect sensitive equipment from more than 100 feet away.

Stray currents can occur when part of an electric current finds an alternative conducting path, such as metal, water, or a buried pipe or cable. Over time, a stray current can cause corrosion, which in turn can cause pipes to leak or wires to break.

Although there are no regulatory requirements limiting EMFs, their effects are known to the design and construction community. Utility lines are normally insulated and cathodic protection systems are used to prevent corrosion damage from stray currents.

4.13.3 Affected Environment

Sound Transit reviewed existing and planned property uses where potential EMFs from light rail vehicles might interfere with normal operation and function of sensitive research or medical equipment. Most clinics, offices, or other facilities do not appear large enough to use highly sensitive equipment, such as MRI, CAT scan, or laser equipment. Sound Transit interviewed the owners of five medical facilities to determine if they use sensitive equipment:

- **UW Medicine Neighborhood Clinic Kent/Des Moines:** A community medical clinic at 23213 Pacific Highway South, Kent, WA 98032, adjacent to SR 99.

- **Sea Mar Community Health Center's Des Moines Medical and Dental Clinic:** A community medical and dental clinic at 24215 Pacific Highway South, Des Moines, WA 98918, adjacent to SR 99.
- **HealthPoint Midway Medical:** A community health clinic at 26401 Pacific Highway South, Des Moines, WA 98198, adjacent to SR 99.
- **Pacific Medical Center Federal Way:** A community health clinic at 31833 Gateway Center Boulevard S, Federal Way, WA 98003, adjacent to I-5.
- **UW Medicine Neighborhood Clinic Federal Way:** A community medical clinic at 32018 23rd Avenue S, Federal Way, WA 98003, between SR 99 and I-5.

Based on communications with each clinic, none of these clinics contain medical equipment sensitive to EMFs.

4.13.4 Environmental Impacts

4.13.4.1 No Build Alternative

If the FWLE is not built, the existing EMF environment would not change.

4.13.4.2 Build Alternatives

The following subsections describe the direct and indirect impacts of the build alternatives. Construction impacts related to EMFs are discussed in Chapter 5, Construction Impacts.

Direct Impacts

Electromagnetic Fields

The FWLE alternatives would not interfere with sensitive medical or electronic equipment. The clinics mentioned above do not contain sensitive medical equipment, and no other industrial or scientific facilities with sensitive equipment have been identified. The electric current from the traction power substations carried by the catenary wires is a pulsating form of direct current, which can interfere with the radio waves of AM radio broadcasts. Electric charges such as high-voltage power lines, trolley wires for electric buses, and hybrid cars can also interfere with low-frequency radio waves. This interference can annoy the listener, but does not damage the radio equipment.

Stray Currents

Without control measures, a portion of the electrical current flowing through the light rail trains could stray to underground metallic objects such as buried pipes, cables, or rebar. The current could then flow along conducting metallic lines in the ground back to the traction

power substation or to nearby utilities. To avoid this, Sound Transit would coordinate control measures with the owners and operators of the utility lines that could be affected.

Sound Transit would minimize or avoid the potential for stray current impacts by selecting best management practices (BMPs) appropriate for the circumstances. The BMPs may include one or a combination of the following:

- Installing cathodic protection systems in nearby utility lines to protect them from corrosion. Cathodic protection system components include the following:
  - Galvanic anodes
  - Electrical isolation with insulating unions at connections to existing piping
  - Pipe coatings
  - Bonded mechanical pipe joints
  - Permanent test facilities to monitor stray currents and rates of corrosion
- Installing insulating unions to break the electrical conductivity of the pipe and force the stray current to take another path.
- Isolating the electrical rails from the ground.
- Installing stray-current-control track-fastening systems where appropriate, such as:
  - Tie-and-ballasted track using high-resistance track-fastening systems on concrete ties
  - Direct-fixation track using high-resistance, rubberized track-fastening systems
  - Embedded track using various methods of rail encapsulation such as rail coatings, polyurethane encasement, and rail boots

Galvanic Anodes

Galvanic anodes, also known as "sacrificial" anodes, are metals designed to corrode in order to prevent another material from corroding.

The return current cannot get to the ground as easily on elevated structures; therefore, EMFs from tracks elevated on overhead guideway structures are less likely to affect underground utility lines.

Potential Health Effects from Light Rail Alternatives

In certain situations with sufficiently high exposure, EMFs can also affect human health. EMFs can cause a variety of effects on humans including shock and burn injuries through direct contact with energized components, and interference with electrical and magnetic devices such as heart pacemakers. Data from similar rail systems

show that light rail operation is unlikely to generate health impacts for riders or people along the tracks. Anticipated EMF intensities within and adjacent to the light rail line are considerably below exposure guidelines established by the American Conference of Governmental Industrial Hygienists and the International Commission on Non-Ionizing Radiation Protection. These guidelines address known biological effects, not speculative concerns about cancer and other possible health effects. Among the various alternatives, no notable differences exist in potential health impacts related to EMFs.

Indirect Impacts

There is no potential for indirect impacts because there are no sensitive equipment or facilities in the project study area.

4.13.5 Potential Mitigation Measures

No impacts were identified; therefore, no mitigation will be necessary.

4.14 Public Services, Safety, and Security

4.14.1 Summary

The FWLE would not result in adverse impacts on public services because all alternatives are grade-separated from traffic and would not affect travel or response times for public service vehicles, including fire, emergency medical, and police. Emergency access to the light rail for fire, emergency medical, and police personnel will be provided, whether the profile is elevated, at-grade, or in a trench.

The Preferred Alternative would require an easement from Mark Twain Elementary School and the S 272nd Star Lake Elevated Station Option would require property acquisition affecting a small (0.1-acre) portion of the school's playfield, but neither is expected to affect the current operation of the school. A minor property acquisition from Federal Way High School for the SR 99 Alternative and from Highline College for the Kent/Des Moines HC Campus Station Option for the SR 99 Alternative would not affect operation of the schools. The Highline College Outreach Center on SR 99, which is in leased space outside the campus, would be displaced by the Kent/Des Moines SR 99 West Station and Kent/Des Moines HC Campus Station options. The Outreach Center would be relocated near or on the campus. A U.S. Postal Service post office in Kent would be relocated for the SR 99 to I-5 Alternative and the Kent/Des Moines SR 99 East Station Option to the SR 99 Alternative.

4.14.2 Introduction

This section discusses potential impacts from the FWLE on public services in the study area. These services include fire and emergency medical services (including hospitals), police, schools (public and private), solid waste and recycling collection, and mail delivery. This section also discusses project-related operations that could change emergency response services related to crime or other emergencies. There are no relevant regulatory requirements related to public services.

Study Area

The study area for public services is 1/2 mile around the FWLE alternatives and includes the cities of SeaTac, Des Moines, Kent, and Federal Way.

4.14.3 Affected Environment

Table 4.14-1 summarizes information on the public service providers within the study area. Facility locations are shown on Exhibits 4.4-1 and 4.4-2 in Section 4.4, Social Impacts, Community Facilities, and Neighborhoods.

TABLE 4.14-1
Summary of Public Service Providers within Study Area

	Location			
	SeaTac	**Des Moines**	**Kent**	**Federal Way**
Police				
Local	SeaTac Police Department	Des Moines Police Department	Kent Police Department	Federal Way Police Department
County	King County Metro Transit Police King County Sheriff			
State	Washington State Patrol			
Fire/Emergency Medical				
Local	Kent Fire Department Regional Fire Authority	South King Fire & Rescue	Kent Fire Department Regional Fire Authority	South King Fire & Rescue
County	King County Medic One			
Solid Waste				
Private	Recology Cleanscapes	Recology Cleanscapes	Republic Services	Waste Management
Schools				
Local School District	Highline Public Schools Kent School District	Highline Public Schools	Kent School District	Federal Way Public Schools
Private	Private schools throughout the study area.			
Post-Secondary	Highline College			
Other Government Facilities				
Federal Government Facilities	Federal Detention Center	U.S. Post Office	U.S. Post Office	None

Sources: City of SeaTac, 2013; City of Des Moines, 2013; City of Kent, 2013; City of Federal Way, 2013.

4.14.3.1 Fire and Emergency Medical Services

The Kent Fire Department Regional Fire Authority and South King Fire & Rescue provide fire and emergency medical services in the study area. There are four stations:

- SeaTac Fire Station 45, 2929 S 200th Street, SeaTac
- South King Fire & Rescue Station 67, 2238 S 223rd Street, Des Moines
- South King Fire & Rescue Station 66, 27010 15th Avenue S, Des Moines
- Kent Fire Station 73, 26512 Military Road S, Kent

There are no hospitals or emergency medical facilities in the study area.

4.14.3.2 Police Services

There are three police substations in the study area:

- Kent Police Substation, 26200 Pacific Highway S, Kent (Woodmont Place Shopping Center)
- Des Moines Police Substation, 27005 Pacific Highway S, Des Moines (Redondo Square Shopping Center - not open to the public)
- Federal Way Police, 31620 23rd Avenue S, Federal Way (across from the Federal Way Transit Center) (City of Federal Way, 2014)

Sound Transit compared crime data for the cities in the study area with Washington State to show the relative crime rates at the local and statewide levels. The crime reporting program provides statistics for violent crimes (i.e., murder, forcible rape, robbery, and aggravated assaults) and property crimes (i.e., burglary, larceny-theft, motor vehicle theft, and arson). Table 4.14-2 lists the numbers of offenses and crime rates by jurisdiction for 2013 and 2014, based on available data (Washington Association of Sheriffs and Police Chiefs, 2014, 2015).

TABLE 4.14-2
2013 or 2014 Violent and Property Crime Rates by Jurisdiction

Jurisdiction	Part 1 Offenses (Violent and Property Crimes)	Violent Crime Rate (per 1,000 Population)	Property Crime Rate (per 1,000 Population)
City of SeaTac	1,986	14.9	57.8
City of Des Moines	2,045	13.0	55.0
City of Kent	11,674	19.7	76.5
City of Federal Way	8,947	15.4	83.7
Washington State	351,238	10.5	39.9

Note: Crime rates for the City of SeaTac are for 2013 and other jurisdictions are 2014.
Source: Washington Association of Sheriffs and Police Chiefs, 2014, 2015.

Information was also collected on criminal activity reported near Sound Transit and King County Metro facilities near the proposed FWLE station locations. Table 4.14-3 shows the number of violent and property crimes reported within 1/2 mile of these facilities between June and December 2015 (Crimereports.com, 2015); most are related to property and motor-vehicle theft.

TABLE 4.14-3
Crimes near Transit Centers and Park-and-Ride Lots in Study Area between June and December 2015

Owner	Location	Violent Crimes	Property Crimes
Sound Transit	Federal Way Transit Center	5	48
King County	Star Lake Park-and-Ride	1	9
King County	Redondo Heights Park-and-Ride	3	17
King County	S 320th Park-and-Ride	3	36

Source: CrimeReports.com, 2015.

4.14.3.3 Solid Waste Services

All nonhazardous solid waste collected in the study area is taken to transfer stations and then to the King County Cedar Hills Landfill in Maple Valley. The closest facility that accepts household hazardous waste is the South Transfer Station in Seattle, managed by Seattle Public Utilities.

4.14.3.4 Schools

The 16 public and private primary and secondary schools in the study area (see Exhibits 4.4-1 and 4.4-2 in Section 4.4) served approximately 11,000 students in the 2014-2015 school year. The schools nearest the alternatives are Mark Twain Elementary School, Harry S. Truman High School, and Federal Way High School. The Truman High School property also includes a Head Start preschool, a Boys & Girls Club, and a community garden. Highline College also has evening programming that takes place at Truman High School.

Approximately 17,000 students attended Highline College for the 2014-2015 academic year (Highline College, 2015).

4.14.3.5 Other Government Facilities

The study area also contains a Federal Detention Center at 2425 S 200th Street in SeaTac and U.S. Postal Service post offices at 23418 Pacific Highway S in Kent and 2003 S 216th Street in Des Moines.

4.14.4 Environmental Impacts

Sound Transit reviewed design drawings to identify possible changes in the travel and response times for public service vehicles, including project elements that could alter access to public service facilities. Sound Transit qualitatively compared the crime rates of the cities within the study area with the overall crime rate of Washington State and performed a literature review for information on crime associated with light rail.

4.14.4.1 No Build Alternative

Continued growth in population and employment in the study area would increase public service demands. Increased traffic congestion would likely affect emergency services' response times.

4.14.4.2 Build Alternatives

The following subsections describe the direct and indirect impacts of the build alternatives. Chapter 5, Construction, describes construction period impacts related to public services in.

Direct Impacts

Impacts Common to All Alternatives

All of the build alternatives would have similar impacts on public services and safety and security. The Fire/Life Safety Committee and other Sound Transit safety and security specialists would address public service issues throughout design, construction, and operation.

Fire and Emergency Medical Services

Sound Transit design criteria seek to avoid conflicts with vehicular, bicycle, and pedestrian traffic for several reasons, including public safety. Sound Transit will prepare an FWLE-specific safety and security management plan (SSMP). The SSMP will organize FWLE needs for integrating safety and security into the project life cycle (design, construction, and operation).

The FWLE would operate in its own (exclusive) right-of-way and would not conflict with vehicular traffic, bicycles, and pedestrians. Because light rail trains would not cross surface streets at grade, light rail operations would not directly affect emergency and incident response routes or times. Increased congestion at station areas and park-and-ride lots could affect response times. Chapter 3, Transportation Environment and Consequences, identifies locations where traffic congestion and delays could occur and potential traffic mitigation measures.

All of the jurisdictions along the project corridor currently operate emergency vehicle preemption programs that give emergency vehicles priority through signalized intersections. Sound Transit would work with the jurisdictions to identify emergency vehicle preemption needs around stations.

Sound Transit would maintain access to fire hydrants, fire lanes, and fire response access points in or adjacent to the FWLE facilities, where possible. Where it is not possible, Sound Transit would

coordinate with the appropriate agencies and jurisdictions to redesign access. Fire department regulations and procedures prohibit placing fire hoses over active railroad tracks, so light rail operations could be temporarily shut down during fire emergencies.

Fires associated with the FWLE would be unlikely because the guideway and stations would be made primarily of concrete and steel. The vehicles are electrically powered and do not use combustible fuels. First responders and fire and emergency service vehicles would use different methods and, in some cases, equipment, for incidents occurring on different profile types. Emergency service providers and Sound Transit personnel would be trained to respond to emergencies on elevated guideways or in trenches and restricted areas in WSDOT right-of-way. Design for elevated and trenched guideway emergency access and evacuation would conform with state and local codes and with National Fire Protection Association (NFPA) 130: Standard for Fixed Guideway Transit Systems, with emergency vehicle access about every 2,500 feet. Where necessary, Sound Transit would build new access points, such as new roads or cul-de-sacs. Trains on the adjacent track could provide access to trains on elevated and trenched guideways. When a second train is not practical, Sound Transit would follow state and local fire codes and NFPA 130. Local fire departments in the study area would respond to incidents on elevated structures using ladder trucks.

Sound Transit would form a Fire/Life Safety Committee to review safety requirements and develop solutions regarding access to the light rail system, emergency routes, water and fire hydrant needs, training, costs, and other design features. Sound Transit would obtain concurrence from local authorities that have jurisdiction and would continue to consult with local jurisdictions throughout FWLE design to minimize impacts on emergency response times. Implementing the project-specific SSMP would minimize impacts on fire and emergency medical services during FWLE operation.

Police

Police vehicles traveling in the FWLE study area should not experience increased response times. Police vehicles could find it difficult to respond to calls at elevated sections of track or stations. This would require additional planning between Sound Transit and local emergency providers.

All build alternatives include facilities where additional police and security staff would be needed to monitor stations, parking facilities, and other areas to protect people and property. Sound Transit operates its own security force at its facilities. This includes Sound Transit contracted security personnel and/or contracted law enforcement officers that function as transit police. Security personnel are stationed at some facilities throughout the day, and some roam and patrol transit facilities and respond to incidents in coordination with local law enforcement. Although an increase in crime at transit facilities is not anticipated, research from other transit systems shows that some petty crimes could occur at transit stations or park-and-ride lots. Studies have consistently found that crime at transit facilities, such as stations, generally reflects crime rates in the surrounding neighborhoods (Billings et al., 2011; City of Seattle, 1999; Loukaitou-Sideris et al., 2002). Quality of life crimes (for example, vandalism, drunkenness, and panhandling) and property crimes account for more than 90 percent of crimes at transit facilities. Crimes are more likely to occur at a station than on a light rail vehicle, and at stations with park-and-ride lots rather than at stations without parking. Station access (stairs, escalators, or elevators) does not appear to influence criminal activity, but access design and location can be a factor if facilities provide places where criminals can act without being observed by others.

During the preliminary design phase, Sound Transit's Agency Safety and Security Management Plan calls for conducting a Threat and Vulnerability Assessment for all new transit facilities. This work includes reviewing existing crime data in proposed station locations, and interviewing local law enforcement to help identify potential security threats and risks. Measures are identified and incorporated to address such risks, using "crime prevention through environmental design" principles. For example, to deter criminal activity and generally make light rail stations and parking facilities more secure, stations would be spacious, well lit, and uncluttered, and would provide open access. The design would consider lines of sight and visibility, and would eliminate or minimize corners, dark or hidden areas, and opaque shelter screens. Patrons, police, and Sound Transit security personnel would easily be able to see public waiting areas, including station platforms. Sound Transit would also implement security features such as closed-circuit television cameras connected to the Link Control Center and the 24/7 Sound Transit Security

Operations Center, passenger emergency telephones, sealed fare boxes, controlled exits, and security personnel.

Sound Transit also held two workshops in support of the Preliminary Hazard Analysis to identify safety hazards and their causes, and to agree on design-based solutions. Sound Transit will work with the FTA, local law-enforcement agencies, the U.S. Department of Homeland Security, and emergency service providers to further develop strategies to prevent and respond to potential threats to public safety throughout design, construction, and operation.

Solid Waste

Operating the FWLE would not have adverse impacts on solid waste collection and disposal. The FWLE would not acquire any property currently used by recycling, composting, and solid waste facilities or operating bases. The project would not affect collection routes, and minor changes in the existing roadways would not cause delays. The FWLE would not cause a noticeable increase in demand for solid waste services.

Schools

No FWLE build alternatives would cross roadways that have signed grade school crossing zones. All of the build alternatives include a station in the Kent/Des Moines area, which would improve access to Highline College. No adverse impacts related to school transportation are anticipated. Chapter 3, Transportation Environment and Consequences, explains that overall transit travel times would improve, which would improve the commute times for students and school staff commuting by transit.

Government Facilities

No adverse impacts are anticipated to postal collection or delivery. Postal vehicles would not experience delays from changes to the existing roadways. FWLE would begin south of the Federal Detention Center in SeaTac and would have no impact on this facility.

Impacts by Alternative

Preferred Alternative

The Preferred Alternative would travel under the playfield and driveway/bus loop at Mark Twain Elementary School. The school is at 2450 S Star Lake Road in Federal Way, south of the S 272nd Star Lake Station. The alignment would require an underground easement for

the covered trench, but no surface property. The lidded structure would be able to support a two-story building if the school district chose to build on that part of their property in the future. Larger structures might require additional structural support in the trench. The playfields and the driveway loop would be closed temporarily during construction, but they would be restored to existing conditions and no permanent impacts on the school facilities or students would occur. Widening of S 272nd Street would not require acquisition of part of the school property. For further discussion, see Chapter 5, Construction.

The **S 272 Star Lake Elevated Station Option** would require the permanent acquisition of approximately 0.1 acre of the 1.6 acre school playfield where the light rail would be on retained fill. The remaining 1.5 acres is expected to be sufficient to accommodate current school and community uses of the field, including two youth soccer fields. The remainder of the playfield would be usable up to the retaining wall, although landscaping may be included next to the wall to mitigate visual impacts (see Section 4.5.4 for further discussion of visual mitigation). Sound Transit would maintain the retaining wall, including cleaning if it is vandalized. Graffiti would typically be removed within 24 to 72 hours of it being reported. Noise barriers on the guideway (approximately 6 feet tall) would also visually screen the light rail trains. Fencing would be installed at the top of the retaining wall to keep the guideway secure and to ensure safety of playfield users. The acquisition of this property would not affect school bus operations but would reduce the area available for future development of the site. The FWLE would not produce fumes, odor, or dust that could adversely affect school users. As described in Section 4.12, Hazardous Materials, the potential for releases of hazardous materials along the project is low because the trains are electric powered.

The Preferred Alternative, SR 99 to I-5 Alternative, and the S 317th Street Elevated Alignment Option would be near Truman High School. The **S 317th Street Elevated Alignment Option** would be partially visible from portions of this school property, but would be over 400 feet from any buildings and would not affect school uses or school bus operations.

Information on construction period impacts on these schools is discussed in Chapter 5, Construction Impacts.

SR 99 Alternative

The **Kent/Des Moines SR 99 East Station Option** would acquire the post office property at 23418 Pacific Highway S in Kent. Sound Transit would work with the U.S. Postal Service to identify a location to relocate this post office to serve the community.

The **Kent/Des Moines HC Campus Station Option** would locate the station on the Highline College campus in the current East Parking Lot. No buildings on campus would be removed or altered. The displaced parking would be replaced within a similar distance to the campus, potentially between the East Parking Lot and SR 99. Parking for this station, along with the Kent/Des Moines SR 99 West Station, would displace the current Highline College Outreach Center at 23835 Pacific Highway S, which is a leased facility. The Outreach Center would be relocated near or on the campus.

The SR 99 Alternative would acquire a portion of the eastern side of the Federal Way High School property for minor roadway improvements. This would not affect buildings or school uses.

SR 99 to I-5 Alternative

The SR 99 to I-5 Alternative would have the same impacts as the SR 99 and Preferred alternatives where it is similar to those alignments. This alternative would acquire the U.S. Postal Service property at 23418 Pacific Highway S in Kent.

I-5 to SR 99 Alternative

Impacts from the I-5 to SR 99 Alternative would include minor property acquisition from Federal Way High School for roadway improvements as described for the SR 99 Alternative. No additional impacts would be associated with this alternative.

Indirect Impacts

The FWLE would not lead to an unplanned or induced increase in the population of south King County, so it would not require additional public services beyond those already planned. It could redistribute some population and employment growth by focusing it in the station areas. The study area service providers would adapt to such a redistribution.

4.14.5 Potential Mitigation Measures

Displaced public services would be relocated in accordance with the Uniform Relocation Assistance and Real Property Acquisitions Policies Act of 1970 and the Sound Transit Real Estate Property Acquisition

and Relocation Policy, Procedures and Guidelines, as described in Sections 4.1.6 and 4.1.7. With these measures in place as part of the project, no additional mitigation would be needed.

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4.15 Utilities

4.15.1 Summary

All FWLE build alternatives would have similar electrical requirements. The project would not require new electrical system capacity. FWLE operation would result in no long-term adverse effects on existing utilities in the FWLE corridor. Most utility impacts would be from utility relocations during construction, which are discussed in Chapter 5, Construction Impacts.

The Preferred Alternative and the I-5 to SR 99 Alternative would require property acquisition to relocate a Puget Sound Energy (PSE) lattice tower at the PSE substation on S 221st Street to an adjacent PSE-owned vacant property. Alternatives or options with trenched areas would have more potential to cause long-term corrosion to underground utilities, which can result from stray underground electrical transmissions from traction power substations (TPSSs). This impact would be minimized or avoided with the implementation of best management practices such as cathodic protection systems (see Section 4.13, Electromagnetic Fields).

4.15.2 Introduction

State and local regulations and permitting processes regulate the relationship between transportation projects and utilities in the project corridor. The cities of SeaTac, Des Moines, Kent, and Federal Way administer local policies and procedures, and Washington Administrative Code 468-34 and Washington State Department of Transportation (WSDOT) policies regulate procedures in WSDOT right-of-way.

4.15.3 Affected Environment

Sound Transit identified the following existing and planned utilities in the study area through database research and communication with local municipalities and utility companies:

Study Area

The study area for utilities is 1/2 mile around the alternative alignments and stations.

- Electrical power
- Natural gas
- Water
- Sanitary sewer
- Communications
- Stormwater drainage systems

Table 4.15-1 summarizes the utility providers in each jurisdiction.

TABLE 4.15-1
Summary of Existing Utility Providers

Utility	SeaTac	Des Moines	Kent	Federal Way
Natural Gas	PSE			
Electricity	PSE			
Water	Highline Water District			Highline Water District Lakehaven Utility District
Sanitary Sewer	Midway Sewer District			Midway Sewer District Lakehaven Utility District
Stormwater	WSDOT, City of SeaTac	WSDOT, City of Des Moines	WSDOT, City of Kent	WSDOT, City of Federal Way
Communications	Century Link, Comcast, Level 3			

Sound Transit contacted utility providers to identify planned upgrades or new projects in the study area. The water and sewer districts identified in Table 4.15-1 have plans to upgrade their systems over time, including Midway Sewer District's plan to upgrade systems within the Pacific Ridge neighborhood. PSE also has plans to upgrade the substation at S 221st Street in Des Moines from 115 kilovolts (kV) to 230 kV. Sound Transit would continue to coordinate with PSE through final design regarding how the FWLE could affect this upgrade.

4.15.4 Environmental Impacts

4.15.4.1 No Build Alternative

The No Build Alternative would not impact utilities in the study area.

4.15.4.2 Build Alternatives

Impacts of the FWLE during operation would include the utility demands of the operating light rail system. Most of the project impacts on utilities would occur during construction, rather than from operations. Chapter 5, Construction Impacts, discusses these impacts.

Direct Impacts

Impacts Common to All Alternatives

Long-term, direct impacts are similar for all build alternatives. The FWLE light rail line would increase electricity usage in the study area through:

- Operation of trains with up to four cars using direct-current power taken from 26-kV electric distribution facilities
- Lighting installed at stations, and safety lighting along the alignments, parking areas, and other light rail facilities

PSE would provide the electricity to operate the FWLE light rail vehicles, stations, and facilities. The energy needed to power the FWLE light rail vehicles is less than 0.2 percent of the total PSE 2014 power generation and is not expected to adversely affect the power system or require PSE to develop additional energy resources. Sound Transit has coordinated with PSE on local substations and no upgrades would be necessary as a result of the FWLE. Section 4.10, Energy Impacts, describes energy consumption rates.

TPSSs placed approximately every 2 miles would distribute power to the overhead catenary system (OCS). TPPSs would be powered by 26-kV electric lines connecting to the nearest power pole. In some cases, additional distribution lines may be needed to serve individual TPSSs.

Underground utilities in or adjacent to the project footprint, including communications, gas, sewer, water, and electric lines, could be susceptible to corrosion from stray electrical currents traveling from the TPSS to OCS poles. Trenched areas of FWLE alternatives or options would have the greatest potential for stray current impacts. Sound Transit would coordinate with utility providers to identify appropriate control measures to avoid or minimize corrosion. Typical design measures include:

- Installing cathodic protection systems
- Installing insulating unions to break the electrical conductivity of the utility
- Isolating electrical rails from the ground
- Installing stray-current-control track fastening systems, where appropriate

Section 4.13, Electromagnetic Fields, provides additional discussion of the effects on utilities of stray currents from light rail vehicles.

Major service disruptions to utility customers during light rail repair and maintenance operations are unlikely. Sound Transit would design the light rail alignment to maintain access to utilities for maintenance and repair. In some cases, that would require Sound Transit to relocate sewer manholes, pipes, vaults, or other access points. Sound Transit would work closely with utility providers to maintain required access to these utilities and any relocated sewer holes and vaults, utility mains, fire hydrants, and other features.

Sound Transit would integrate efficient operating practices at existing and new facilities and use equipment to reduce energy and water demand and to recycle water. Implementing these and other sustainable practices would reduce consumption and demand on utilities.

Impacts by Alternative

Only the Preferred Alternative and I-5 to SR 99 Alternative would result in any additional impacts beyond those common to all build alternatives. The Preferred Alternative and the I-5 to SR 99 Alternative would acquire part of the PSE substation property at S 221st Street in Des Moines. This would reduce the size of PSE's property, potentially limiting its ability to make future upgrades to this substation. Both alternatives would also affect vehicular access to a PSE steel lattice tower on the property, requiring the tower to be relocated to an adjacent PSE-owned vacant property to the south.

Based on coordination with WSDOT during the Final EIS, Sound Transit shifted the Preferred Alternative alignment approximately 15-feet east to reduce potential impacts on this property. This shift preserves space for the future SR 509 Extension Project.

Indirect Impacts

The improved transit access from light rail service availability would support planned development or redevelopment near the FWLE stations. This would likely increase demand for utility services in certain locations. Local governments have planned for increased development in their adopted local land use plans and policies, consistent with regional plans. The project corridor is within the urban growth boundaries of the cities of SeaTac, Des Moines, Kent, and Federal Way, and development near the FWLE would not be denser than that allowed in those cities' adopted land use plans. Indirect impacts on utilities are not expected to be greater with or without the FWLE. See Section 4.4, Land Use, for more details on the indirect impacts related to land use development.

4.15.5 Potential Mitigation Measures

No long-term adverse impacts on utilities are anticipated; therefore, no mitigation is proposed.

4.16 Historic and Archaeological Resources

4.16.1 Summary

No archaeological resources were identified within the FWLE area of potential effects (APE). There are no historic buildings in the APE for the Preferred Alternative. FTA made a finding of "No Adverse Effect" to historic properties for the Preferred Alternative and the Washington Department of Archaeology and Historic Preservation (DAHP) concurred with this finding in May 2016.

There are 11 historic buildings eligible for the National Register of Historic Places (NRHP) in the APE for other FWLE build alternatives. The SR 99 Alternative Kent/Des Moines HC Campus Station Option would occupy the eastern edge of the Highline College parking lot. Nine individually NRHP-eligible buildings are on the same parcel. The parking lot is not a contributing element to these buildings, so project elements in the parking lot would not constitute an adverse effect.

Road widening for the SR 99 Alternative and the I-5 to SR 99 Alternative would partially acquire the parcel occupied by the NRHP-eligible US Bank building. The building is set back on the parcel and would not be physically impacted by the acquisition, and it would not be adversely affected.

The Federal Way I-5 Station Option for the Preferred Alternative and the SR 99 to I-5 Alternative would be approximately 150 feet from the NRHP-eligible Calvary Lutheran Church, but would not affect the church or its setting.

APE and Study Area

The FWLE APE for archaeology includes areas that would experience ground disturbance within 200 feet of the guideway centerline, and within 200 feet of the edge of ground disturbance for stations and other ancillary facilities. The study area used for the archaeology literature review is a 1/2-mile radius of the project alternative centerlines. This is larger than the APE to provide greater context for the type of historic properties that may be encountered within the APE.

The APE for the built environment generally extends 200 feet from the edge of each alternative's long-term footprint, including guideways, stations, parking, ancillary facilities, and road improvements.

The APE for government-to-government consultation with Native American tribes regarding potential traditional cultural properties encompassed the APE for archaeological and architectural resources.

4.16.2 Introduction

The two main federal laws protecting historic and archaeological resources are the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA). "Historic properties" are defined in NHPA's regulations as any prehistoric or historic district, site, building, structure, or object that is included in or eligible for the NRHP. Cultural resources must also be given consideration under NHPA and NEPA. In addition, for U.S. Department of Transportation projects, Section 4(f) of the U.S. Department of Transportation Act protects NRHP-eligible properties.

Applicable state laws and authorities include the Washington State Environmental Policy Act and laws and regulations relating to cultural and archaeological resources such as the Washington Heritage Register (WHR) program. The WHR program is administered by the Department of Archaeology and Historic Preservation (DAHP). Under state law, any alteration to an archaeological site requires a permit from DAHP. State law also protects Native American burial sites.

The King County Landmarks Commission may, under the King County Historic Preservation Program, designate and protect properties within unincorporated areas of King County as King County landmarks. The Commission also acts as a municipal landmarks board for cities (including Des Moines and Kent) that have entered into interlocal agreements with the County for historic preservation services. An historic resource may be designated as a King County Landmark if it is more than 40 years old or, in the case of a landmark district, contains resources that are more than 40 years old. This differs from NRHP criteria, which require that a property be 50 years old unless it is exceptionally important. The King County Landmarks Commission determines if a property is eligible as a King County Landmark. Discussions of potential King County Landmark eligibility in this Final EIS are based on a review of the King County Landmarks Commission criteria. There are no designated King County Landmarks in the APE.

4.16.3 Affected Environment

The Historic and Archaeological Technical Report (Appendix G4) includes a history of the FWLE study area; additional information about federal, state, and local regulations affecting cultural resources; and further detail regarding the NRHP-eligible resources described in the following sections. It also includes information on each of the parcels inventoried as part of the built environment survey.

4.16.3.1 Archaeology

A file search using DAHP's Washington Information System for Architectural and Archaeological Records Data (WISAARD) database showed that there were 10 previous cultural resource studies in the 1/2-mile study area, but no recorded archaeological resources within the APE. The DAHP archaeological predictive model identifies some areas within the APE as high probability areas. These areas are primarily along the SR 99 corridor or concentrated near stream

drainages. This information was used to target areas for archaeological investigation.

An initial reconnaissance-level survey was conducted on publicly owned parcels. No archaeological sites were recorded or encountered during the survey. Additional archaeological investigations were conducted at 17 private properties along the Preferred Alternative corridor. No archaeological sites were encountered during the survey. More information is provided in Appendix G4.

4.16.3.2 Traditional Cultural Properties

FTA conducted government-to-government consultation with the following Native American tribes about the project and its potential effects to archaeological sites and traditional cultural properties:

- Yakama Nation
- Muckleshoot Indian Tribe
- Puyallup Tribe of Indians
- Snoqualmie Indian Tribe
- Stillaguamish Tribe of Indians
- Suquamish Tribe

Sound Transit and FTA also initiated consultation under Section 106 with the non-federally-recognized Duwamish and Snohomish tribes. Consultation with the tribes has revealed no traditional cultural properties in the project vicinity.

4.16.3.3 Built Environment

The standard NRHP age threshold for significance is 50 years. Sound Transit used 1970 as the threshold year to capture all properties that will be 50 years old at the time the project is likely to be acquiring and demolishing structures in the project right-of-way.

Literature Review

To evaluate potential effects, Sound Transit expanded the APE specifically to encompass nine buildings along the eastern edge of the Highline College campus, even though they are more than 200 feet from any project component. A literature search indicated four of the buildings (Buildings 4, 5, 6, and 11; see Inset A of Exhibit 4.16-1) were previously determined eligible for the NRHP under Criterion C and are eligible for the WHR. No other NRHP- or WHR-listed resources and no King County Landmarks were identified in the APE.

Eligibility Criteria for the National Register of Historic Places

- Criterion A: Associated with events that have made a significant contribution to the broad patterns of our history; or
- Criterion B: Associated with the lives of persons significant in our past; or
- Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D: Yielded, or may be likely to yield, information important in prehistory or history.

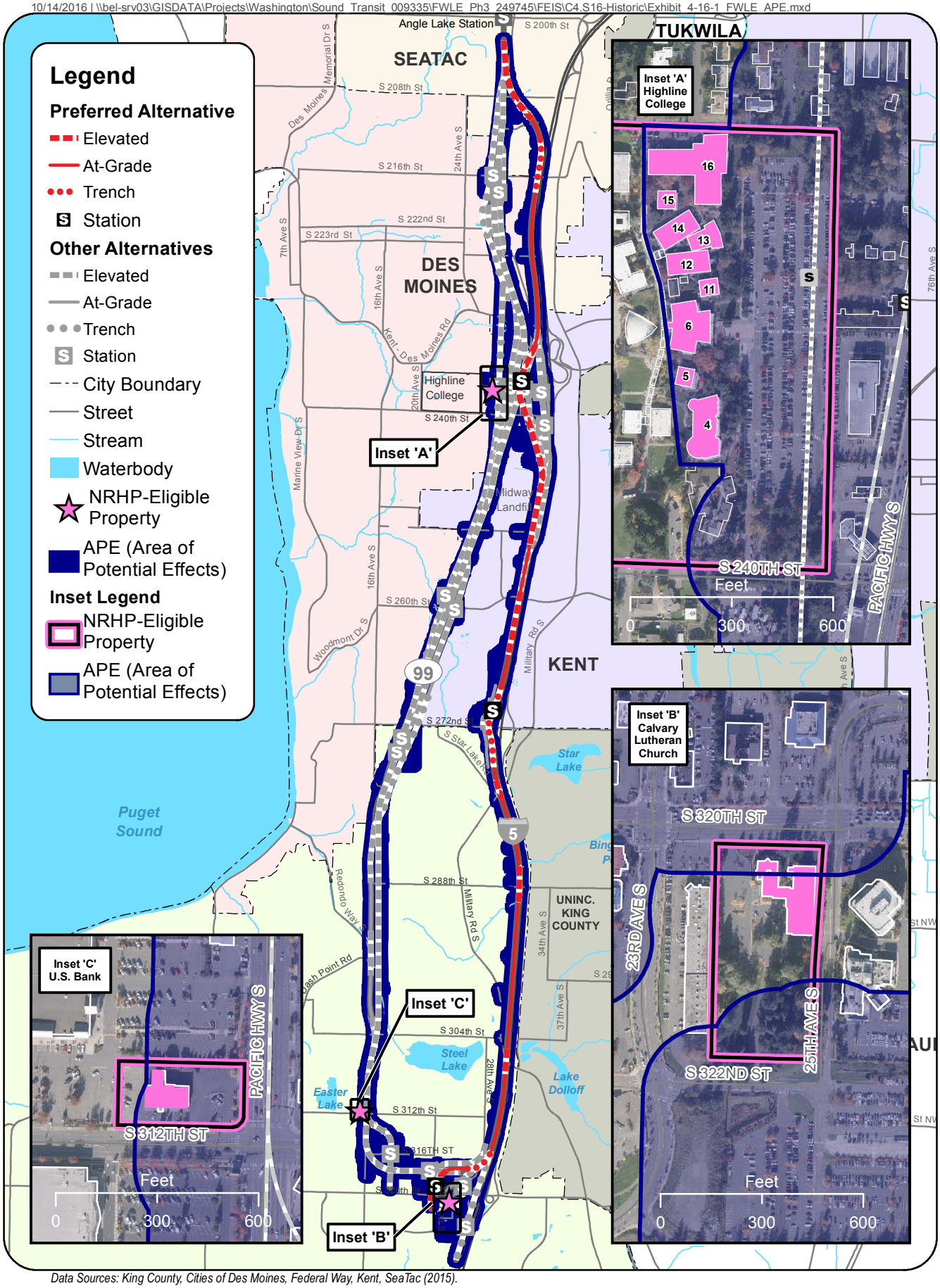

EXHIBIT 4.16-1
Location of Historic Properties in the APE

Federal Way Link Extension

Field Survey

The APE contains 390 parcels with buildings built before 1971. They include a mix of commercial and residential properties constructed between 1910 and 1970. The field survey identified three parcels with buildings that are potentially eligible for listing in the NRHP/WHR. The parcels are the sites of Highline College, Calvary Lutheran Church, and the US Bank building.

Findings of Eligibility

In consultation with DAHP, FTA determined that the following buildings are eligible for listing in the NRHP (Table 4.16-1):

- Five Highline College buildings (buildings 12, 13, 14, 15, and 16), in addition to the four previously found eligible
- Calvary Lutheran Church
- The US Bank building

TABLE 4.16-1
NRHP-Eligible Properties within the APE

Building Name	Date of Construction
Highline College Building 4	1964
Highline College Building 5 (Faculty Offices)	1964
Highline College Building 6 (Student Union)	1964
Highline College Building 11 (Faculty Offices)	1964
Highline College Building 12	1964
Highline College Building 13	1964
Highline College Building 14	1964
Highline College Building 15	1967
Highline College Building 16	1967
Calvary Lutheran Church	1956, 1968
US Bank	1960

Notes:
All Highline College buildings are located at 2400 S 320th Street, Des Moines. Calvary Lutheran Church is located at 2415 S 320th Street, Federal Way. US Bank is located at 1436 S 312th Street, Federal Way.
All Highline College buildings appear to meet King County Landmark Status designation criteria.

All other surveyed properties were determined not eligible. DAHP concurred with these determinations. Additional information on these buildings is provided below. Exhibit 4.16-1 shows their locations.

All nine buildings on the Highline College campus appear to meet King County landmark designation criteria.

Highline College

Highline College was founded in 1961 and established at its current Des Moines location in 1963. Ralph H. Burkhard (1908-1993) was the architect for the original buildings. Burkhard received numerous awards and was known for his educational buildings and unusual techniques, and he continued his innovative designs at Highline College. In 1966, the American Association of School Administrators gave the campus an award for exceptional design. The campus contains nine buildings in the APE eligible for the NRHP (Buildings 4, 5, 6, 11, 12, 13, 14, 15, and 16). All are individually eligible under Criterion C for their architectural significance as examples of 1960s-era tilt-up construction.

Highline College Building 4, West Elevation

Highline College Building 5, Northwest Corner

Highline College Building 6, West Elevation

Highline College Building 11, Southwest Corner

Highline College Building 12, Northeast Elevation

Highline College Building 13, West Elevation

Highline College Building 14, North Elevation

Highline College Building 15, West Elevation

Highline College Building 16, Northeast Elevation

Calvary Lutheran Church

Established in 1954, the Calvary Lutheran Church comprises the original church (now a classroom building) and a larger sanctuary constructed in 1968. The sanctuary, designed by the Seattle firm of Steinhart, Theriault & Anderson, is a good example of the Neo-Expressionist architectural style, with its exaggerated, tall, hipped roof and flared eaves. The property has undergone several additions and renovations that have diminished the integrity of the 1954 building. However, the 1968 sanctuary retains much of its integrity and is eligible for listing in the NRHP/WHR under Criterion C for its architectural significance.

Calvary Lutheran Church, North Elevation

NRHP Seven Aspects of Integrity

Setting, feeling, association, location, materials, design, and workmanship

US Bank Building

The US Bank building was constructed in 1960. It employs certain materials and design elements commonly used in the 1950s and 1960s, making it a good example of mid-century commercial architectural design.

The defining characteristics of the building include the glass curtain wall on the building's front (south) elevation, the flat roof, and the brick veneer walls with decorative honeycomb brickwork on the west elevation. Other features of the building, such as the drive-through banking overhang, are utilitarian features common to bank buildings of the era. The original brick veneer has been painted and a small glass enclosure for the ATM machine was added on the front elevation. However, the building retains integrity overall. It is eligible for listing in the NRHP/WHR under Criterion C for embodying distinctive characteristics of mid-century modern commercial architecture.

US Bank, Southwest Corner

4.16.4 Environmental Impacts

This section discusses long-term impacts of the FWLE on historic resources. Section 5.2.17 of Chapter 5, Construction, addresses potential impacts to and treatment of archaeological sites encountered before or during construction.

Section 106 regulations allow three findings for effects to historic properties:

- No Historic Properties Affected

- No Adverse Effect
- Adverse Effect

FTA has made a preliminary determination of effect for each property potentially affected.

4.16.4.1 No Build Alternative

The No Build Alternative would not affect any historic properties.

4.16.4.2 Build Alternatives

Direct Impacts

Table 4.16-2 summarizes each alternative's potential effects to NRHP/WHR-eligible buildings. Research and initial surveys did not identify NRHP-eligible archaeological sites within the APE.

TABLE 4.16-2
Historic Properties and Findings of Effect

Property Name	Alternative	Proximity to the Alternative	Potential Impact	Section 106 Finding[a]
Calvary Lutheran Church	Federal Way I-5 Station Option to the Preferred Alternative and to the SR 99 to I-5 Alternative	152 feet	None	No Historic Properties Affected
Highline College Building 4	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	206 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 5 (Faculty Offices)	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	277 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 6 (Student Union)	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	249 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 11 (Faculty Offices)	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	233 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 12	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	249 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 13	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	215 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 14	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	289 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 15	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	362 feet	Minor alteration to setting	No Adverse Effect
Highline College Building 16	Kent/Des Moines HC Campus Station Option to the SR 99 Alternative	210 feet	Minor alteration to setting	No Adverse Effect
US Bank	SR 99 Alternative and I-5 to SR 99 Alternative	172 feet	Minor alteration to setting	No Adverse Effect

[a] FTA's preliminary determination.

Preferred Alternative and SR 99 to I-5 Alternative

FTA determined and DAHP concurred that the Preferred Alternative would result in no adverse effect to historic properties under Section 106.

The Federal Way I-5 Station Option would not affect the Calvary Lutheran Church. The station plaza would be partially in a trench and partially at-grade approximately 518 feet away from the historic property. The parking lot and a tail track would be across S 320th Street and approximately 152 feet from the church. This property experiences visual and noise effects of heavy street traffic on S 320th Street. FWLE operations across the street would not change the church's setting. This station option would result in no impacts and in no historic properties affected under Section 106.

SR 99 Alternative and I-5 to SR 99 Alternative

The Kent/Des Moines HC Campus Station Option includes a light rail station plaza in the Highline College campus parking lot. The plaza would be approximately 206 feet from the nearest eligible building. The station would be in an open trench on the eastern edge of Highline College's east parking lot. The addition of the station would be noticeable, but the changes to the setting of the nine eligible buildings (Buildings 4, 5, 6, 11, 12, 13, 14, 15, and 16) would be minimal. While the parking lot is adjacent to the historic buildings, it does not contribute to their eligibility. The buildings face west, oriented away from the parking lot and towards the interior of the campus. Because the buildings are on a lower grade than the parking lot, at the bottom of a small slope, they are visually separated from the parking lot and potential station location. The above-grade improvements for the station would not physically alter the buildings. The minor impacts to their setting would not affect what qualifies the nine Highline College buildings for listing in the NRHP/WHR. This station option would result in minor impacts and no adverse effect to historic properties under Section 106.

For the SR 99 Alternative and I-5 to SR 99 Alternative, Sound Transit would acquire part of the US Bank building parcel, but no physical changes would affect the building. A paved parking lot creates an approximately 172-foot buffer between the building and the alignment. The east elevation of the building, which faces Pacific Highway S, is a brick veneer side elevation broken only by a service entrance. Notable character-defining features on the west and south

elevations do not face Pacific Highway S and would not be affected by the FWLE. Removing a narrow sliver of the parking lot would be a minor impact to the setting of the building, and would not compromise any aspects that qualify it as eligible for the NRHP/WHR. Therefore, the SR 99 Alternative and I-5 to SR 99 Alternative would have minor impacts and no adverse effect to the property under Section 106.

Indirect Impacts

The project alternatives would have no indirect impacts to the NRHP-eligible properties in the project area.

Section 4(f) Applicability

Section 4(f) addresses three types of use: (1) the permanent incorporation of land into a transportation facility, (2) a temporary occupancy of land that is adverse in terms of the statute's purposes, and (3) proximity impacts such that they impair important features or characteristics of the property (a "constructive use"). Section 4(f) also recognizes a *de minimis* use, which is when there is only a minor impact to the resource. FTA's preliminary finding is that only the SR 99 Alternative and the I-5 to SR 99 Alternative would have Section 4(f) use of an historic property.

De Minimis Use

A de minimis impacts use cannot "adversely affect the activities, features, and attributes" of a Section 4(f) resource. For historic and archaeological sites, a *de minimis* impact use is allowed if FTA has determined "no adverse effect" in compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA). When FTA has made a *de minimis* determination, the project is not required to analyze avoidance alternatives for that Section 4(f) property.

The project's Section 4(f) use of historic properties is limited to partial acquisitions of parcels with eligible buildings. Under the SR 99 Alternative Kent/Des Moines HC Campus Station Option, the FWLE would acquire part of the Highline College parcel. The SR 99 Alternative and I-5 to SR 99 Alternative would acquire a narrow strip of the US Bank property. This acquisition would not affect the physical integrity of the building and would have only a minor effect to the building's setting. FTA's preliminary determination is that these acquisitions would be a *de minimis* use.

There is no constructive use under Section 4(f) because the project's proximity impacts would not substantially impair any historic properties. See Appendix E for more information about Section 4(f).

4.16.5 Potential Mitigation Measures

No known archaeological sites are in the APE. The project's operations would not have adverse effects to historic properties. Therefore, no long-term mitigation measures are required. Construction activity could encounter unknown archaeological resources. Sound Transit would implement construction mitigation measures as described in Section 5.2.17.2.

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4.17 Parkland and Open Space

4.17.1 Summary

Seven existing parks or recreation facilities are in the FWLE study area. The Preferred Alternative and SR 99 to I-5 Alternative would have temporary construction effects on playfields at Mark Twain Elementary School, but no long-term impacts (see Chapter 5). Sound Transit would acquire 0.1 acre of the playfield at Mark Twain Elementary School for the S 272nd Star Lake Elevated Station Option and would acquire 0.7 acre of the Federal Way Town Square Park for the Federal Way SR 99 Station Option. The project would not affect any other parks.

4.17.2 Introduction

The FWLE parkland and open space study area includes recreational facilities in Des Moines, Kent, and Federal Way.

Section 4(f) of the U.S. Department of Transportation Act applies to U.S. DOT projects, including the FWLE. It protects "publicly owned land of a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance." Appendix E includes a Section 4(f) analysis and preliminary determination.

Study Area

The FWLE study area extends about one block (250 feet) from the alternatives, staging areas, and ancillary facilities, and 1/4 mile (1,320 feet) from the stations. Typically, impacts on recreational resources occur within these distances. Topography and distance prevent effects to parks east of I-5, so this area is not included in the study area.

4.17.3 Affected Environment

Parkland and open space resources include the following:

- Public parks
- Land protected and preserved as open space
- Recreational pedestrian and bicycle trails
- Playfields
- School district play areas that are available for public use during non-school hours

Resource Conservation Area

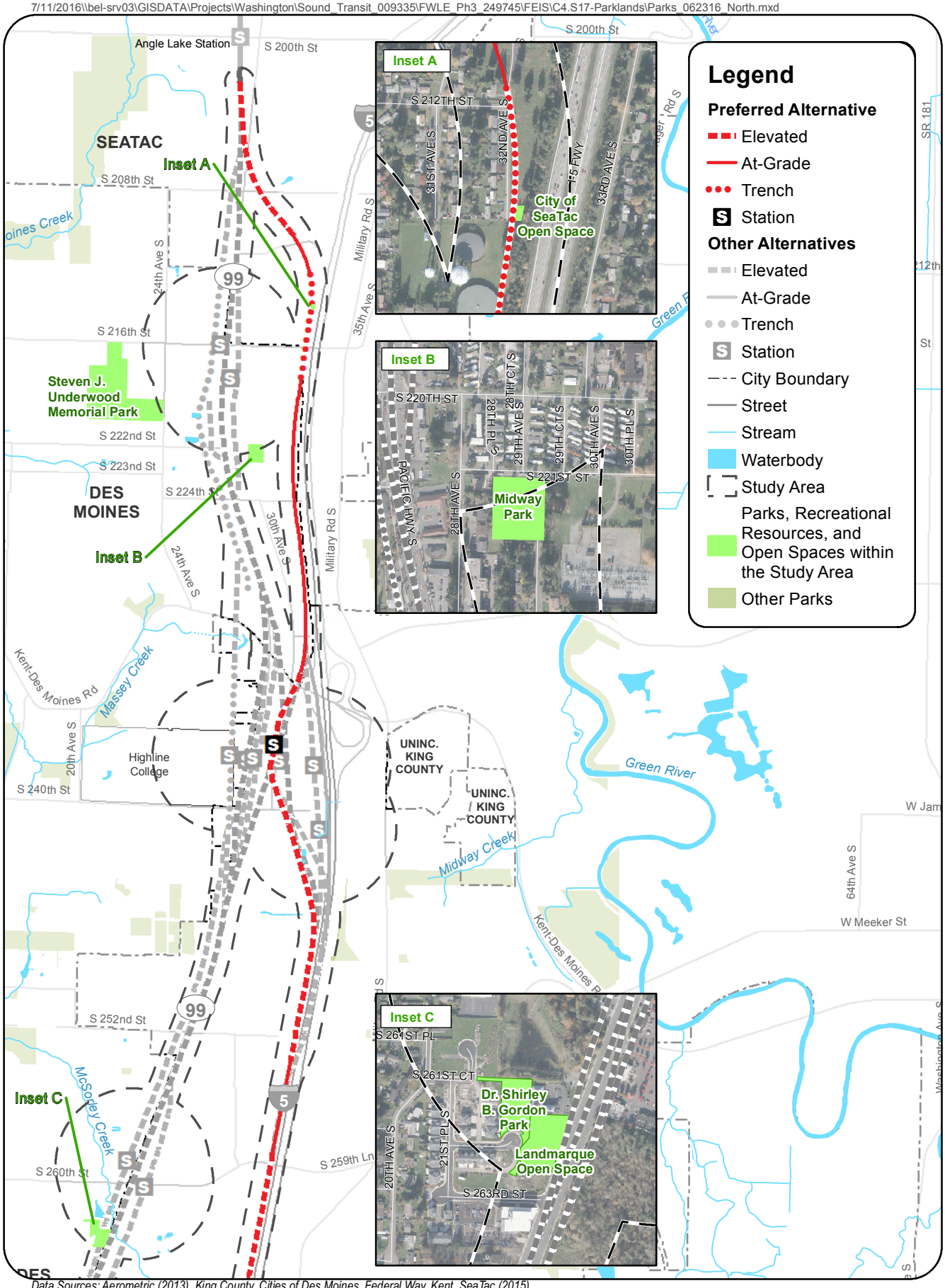
Resource conservation areas (RCAs) are natural areas purchased by WSDOT to provide a vegetated buffer between the highway and adjacent land uses. RCAs are considered open space.

Table 4.17-1 and Exhibits 4.17-1 and 4.17-2 summarize and show existing park, recreational resources, and open spaces in the study area. The cities of Kent and Federal Way have identified possible future parks in their local planning documents that could be in the study area, but not specific locations. As described in Appendix E, Section 4(f) does not apply to Mark Twain Elementary School playfield. It also does not apply to the four open space areas, Greenfield Park Native Growth Protection Area, or the four WSDOT

RCAs because there is no public access to these properties or they are privately owned.

TABLE 4.17-1
Parks, Recreation Resources, and Open Spaces in the FWLE Study Area

Resource Name	Size (acres)	Type and/or Function	Facilities	Ownership	Corridor
City of SeaTac Open Space	0.1	Open space	None	City of SeaTac	I-5
Steven J. Underwood Memorial Park	20.5	Community park	Three lighted softball fields	City of Des Moines	SR 99
Midway Park	1.6	Community park	Play area, picnicking areas, basketball hoops, and a walking path	City of Des Moines	SR 99
Dr. Shirley B. Gordon Park	0.9	Community park	Basketball court, natural area, parking, picnic area, play area, seating, and walking path	City of Des Moines	SR 99
Landmarque Open Space	1.1	Open space	none	private	SR 99
Sacajawea Park	18.0	Community park	Two lighted baseball fields, a tennis court, a soccer field, a football field, a 440-yard track, walking pathways, a playground, and restrooms	City of Federal Way	SR 99
Greenfield Park Native Growth Protection Area	0.8	Open space	None	private	I-5
Mark Twain Elementary School Playfields	1.7	School athletic field	Playfield for softball and soccer, playground	Federal Way Public Schools	I-5
RCA 1	0.4	Open space	None	WSDOT	I-5
RCA 2	0.2	Open space	None	WSDOT	I-5
Ridge West Open Space	1.2	Open space	None	King County	I-5
Steel Lake Park	52.0	Community park	Beach, swimming area, boat launch, a sand volleyball pit, horseshoe pits, a concession building, restrooms, playgrounds, five picnic areas, open lawn areas, a trail, parking	City of Federal Way	SR 99 and I-5
RCA 3	0.1	Open space	None	WSDOT	I-5
RCA 4	0.1	Open space	None	WSDOT	I-5
Federal Way Town Square Park	4.1	Community park	Basketball courts, splash park, open lawn, path, play area, picnic shelter, picnic tables, and areas set aside for development of potential future park facilities	City of Federal Way	SR 99 and I-5



Data Sources: Aerometric (2013), King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

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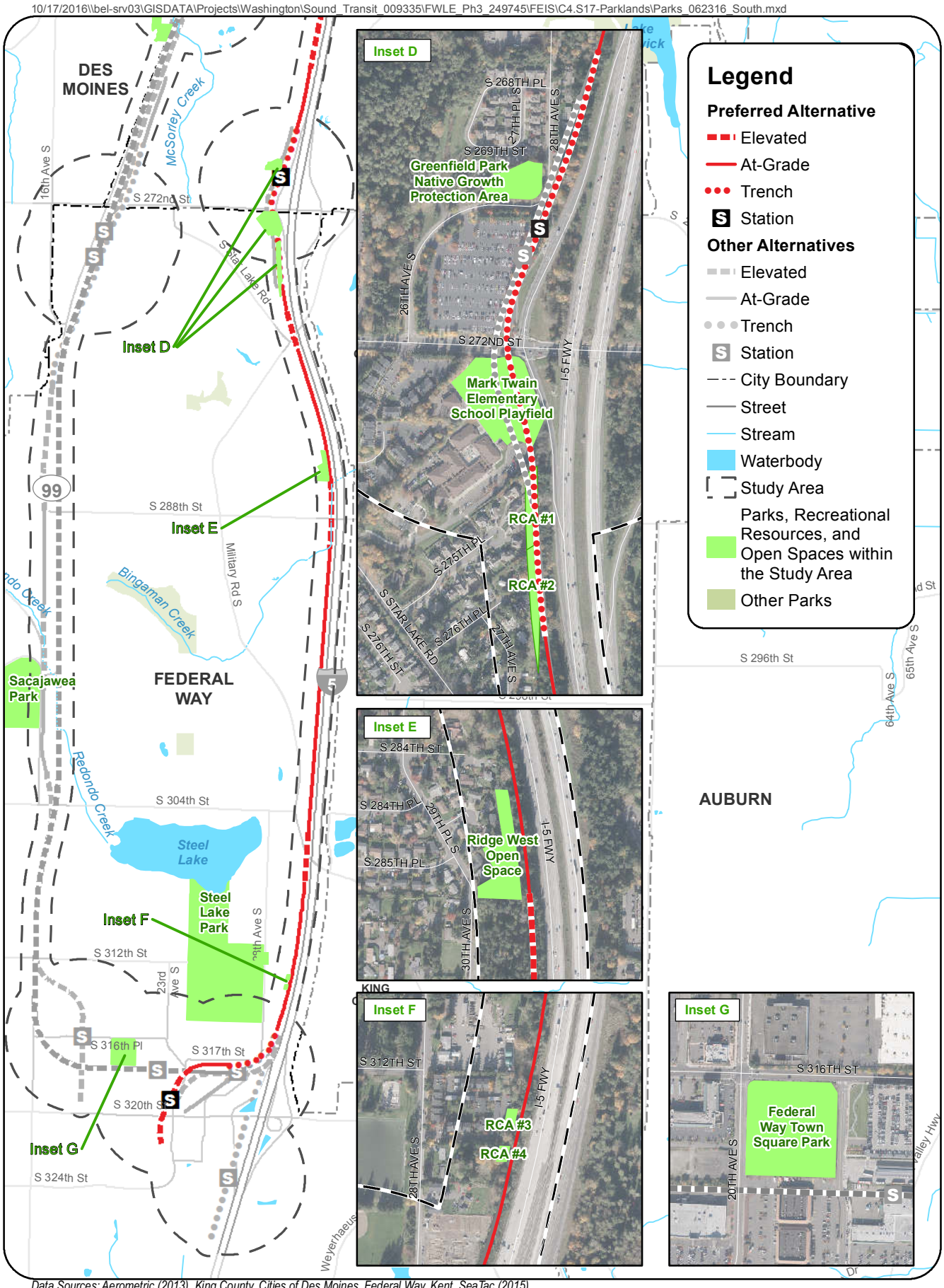
EXHIBIT 4.17-1

Parks, Recreational Resources, and Open Spaces (North)

Federal Way Link Extension



Data Sources: Aerometric (2013), King County, Cities of Des Moines, Federal Way, Kent, SeaTac (2015).

EXHIBIT 4.17-2

Parks, Recreational Resources, and Open Spaces (South)

4.17.4 Environmental Impacts

Direct long-term impacts typically include permanent changes to a resource, such as converting a park, open space, or recreational resource to another use. Indirect long-term impacts could include improved access to parks or changes to surroundings and park users' experiences. Planned parks could not be evaluated for long-term impacts because specific locations and designs have not been developed.

4.17.4.1 No Build Alternative

The No Build Alternative would not affect any park, recreational resource, or open space in the study area.

4.17.4.2 Build Alternatives

Construction impacts related to parks, recreational resources, and open space are discussed in Chapter 5. Table 4.17-2 summarizes each build alternative's potential for direct and indirect long-term impacts on these resources. Temporary impacts are described in Chapter 5, Construction.

TABLE 4.17-2
Summary of Potential Long-Term Park Impacts

Alternative	Parks in Study Area	Direct Impacts	Indirect Impacts
Preferred Alternative	Steel Lake Park, Mark Twain Elementary School playfield, Federal Way Town Square Park	The Preferred Alternative would not have adverse long-term effects on recreational resources or parks. It would permanently convert less than 0.1 acre of the City of SeaTac Open Space and Ridge West Open Space. It would also convert 0.6 acre of WSDOT RCA open space areas. The S 272nd Star Lake Elevated Station Option would convert 0.1 acre of the playfield at Mark Twain Elementary School to a guideway on retained fill. The guideway would be on the eastern edge of the playfield and the remainder of the playfield west of the guideway would be usable. The current playground adjacent to the playfield would not be affected.	No adverse impacts. Accessibility would increase at Steel Lake Park and Town Square Park with the Preferred Federal Way Transit Center Station because they would be within 1/4 mile of a station. Station options would not increase accessibility to these parks.
SR 99	Steven J. Underwood Memorial Park, Midway Park, Dr. Shirley B. Gordon Park, Sacajawea Park (only in the study area for the S 272nd Redondo Trench Station Option), Steel Lake Park, Federal Way Town Square Park	The SR 99 Alternative would permanently convert less than 0.1 acre of the Landmarque Open Space. The Federal Way SR 99 Station Option would convert 0.7 acre of the Federal Way Town Square Park for a transit connection between the new station and the Federal Way Transit Center. Affected areas include parking, a retention pond, a small portion of a path and open lawn, and landscaping. Sound Transit would work with the City to relocate the path and retention pond.	No adverse impacts. Accessibility would increase at the following parks that are within 1/4 mile of a station or potential additional station: Steven J. Underwood Memorial Park, Midway Park, Steel Lake Park, and Town Square Park, where access would be improved with the SR 99 Alternative Federal Way Transit Center Station and the Federal Way SR 99 Station Option.
SR 99 to I-5	Steel Lake Park, Mark	The SR 99 to I-5 Alternative would also convert	Same as Preferred Alternative.

TABLE 4.17-2
Summary of Potential Long-Term Park Impacts

Alternative	Parks in Study Area	Direct Impacts	Indirect Impacts
	Twain Elementary School playfields, Federal Way Town Square Park	0.2 acre of Landmarque Open Space and 0.6 acre of WSDOT RCA open spaces, neither of which has recreational facilities.	
I-5 to SR 99	Dr. Shirley B. Gordon Park, Sacajawea Park, Steel Lake Park, Federal Way Town Square Park	The I-5 to SR 99 Alternative would permanently convert less than 0.1 acre of the City of SeaTac Open Space and Landmarque Open Space.	No adverse impacts. Accessibility would increase at Steel Lake Park and Town Square Park with the Preferred Alternative Federal Way Transit Center Station because these parks would be within 1/4 mile of a station. Other station options would not increase accessibility to these or other parks in the study area.

Direct Impacts

All of the build alternatives would impact a small area of open space. None of the open space areas affected are used for recreational purposes. None of the build alternatives would result in any direct long-term impacts on parkland and recreational resources. Long-term adverse impacts would occur only with two station options: the S 272nd Star Lake Elevated Station Option and the Federal Way SR 99 Station Option.

The S 272nd Star Lake Elevated Station Option to the Preferred Alternative would be on retained fill on the eastern edge of the Mark Twain Elementary School playfield. The retaining wall would be approximately 25 feet tall with fencing and a sound wall at the top. This would require acquiring 0.1 acre of the 1.6-acre playfield. The remainder of the playfield west of the guideway would still be available for recreational use and there would be adequate space left for two soccer fields used by a local recreational league.

The Federal Way SR 99 Station Option to the SR 99 and I-5 to SR 99 alternatives would affect 0.7 acre of the Federal Way Town Square Park's parking lot, retention pond, a small portion of the path and open lawn, and landscaping to a new transit-only roadway. Sound Transit would work with the City to relocate the path and the retention pond. The parking lot would remain operational, but would lose approximately 26 of 64 parking spaces. Other recreational resources such as the basketball courts, splash park, play area, picnic shelter, and picnic tables would not be affected.

Indirect Impacts

Indirect long-term impacts to parkland and open space include changes to surroundings that can affect the recreational experience, such as increased noise levels. As discussed in Section 4.7, Noise and Vibration, none of the parks in the study area are considered noise-sensitive, and no adverse noise or vibration impacts would occur. As discussed in Section 4.5, Visual and Aesthetic Resources, no visual impacts on parks would occur.

Parks within 1/4 mile of a station would benefit from enhanced access from people walking from the light rail station. The SR 99 Alternative has the most parks near station areas.

Section 4(f) Applicability

The Preferred Alternative would not affect Section 4(f) properties. The Federal Way SR 99 Station Option would directly affect Town Square Park. This park is considered a Section 4(f) property, and consultation with the City of Federal Way, which owns and maintains the property, is ongoing. FTA anticipates that if this station option were part of the project to be built, the nature of the impacts would not adversely affect the activities, features, or attributes qualifying the park for protection under Section 4(f) and would warrant a "*de minimis* impact" finding. The City of Federal Way must agree with this conclusion for FTA to make this finding.

***De Minimis* Impacts**

De minimis impacts do not "adversely affect the activities, features, and attributes" of a Section 4(f) resource. For public parks or recreation properties, a *de minimis* impact finding requires written concurrence from the agency with jurisdiction over the property. When FTA has made a *de minimis* determination, the project is not required to analyze avoidance alternatives for that Section 4(f) property.

4.17.5 Potential Mitigation Measures

If the S 272nd Star Lake Elevated Station Option were selected as part of the project to be built, Sound Transit would provide financial compensation or replacement land to mitigate impacts at the Mark Twain Elementary School playfield in consultation with Federal Way Public Schools.

If the Federal Way SR 99 Station Option was selected as part of the project to be built, lost parking at Town Square Park would be mitigated with replacement parking at or near the park, or by monetary compensation. Sound Transit would work with the City of Federal Way to relocate the path and retention pond at Town Square Park.

With the Preferred Alternative or SR 99 to I-5 Alternative, Sound Transit would mitigate permanent impacts on WSDOT RCAs according to the WSDOT *Roadside Policy Manual* (WSDOT, 2015). Mitigation for other open space areas with all alternatives would be determined in consultation with property owners during the acquisition process.

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