# 4.5 Visual and Aesthetic Resources

## 4.5.1 Summary

This section analyzes the potential for FWLE to change the visual quality of the surrounding area and how that affects sensitive viewers. In the study area, sensitive viewers are predominantly residents. In addition to this EIS section, more information is available in Appendix G5, Visual and Aesthetic Resources Technical Report. Key findings include:

- The elevated guideway of the SR 99 Alternative would impact the greatest number of sensitive viewers (residents) of the four alternatives.
- The I-5 to SR 99 Alternative would impact the second largest number of sensitive viewers because of tree removal near residences located west of, and adjacent to, I-5 north of Kent/Des Moines Road, as well as the presence of the elevated guideway in the median of SR 99 adjacent to residences south of S 240th Street.
- The SR 99 to I-5 Alternative would impact the third greatest number of sensitive viewers from residences along the SR 99 corridor north of Kent-Des Moines Road and from residences west of, and adjacent, to I-5 south of S 240th Street.
- The I-5 Alternative would impact the fewest number of sensitive viewers, though it would affects some viewers located in residences west of, and adjacent, to I-5.

**Sensitive Viewers**

Sensitive viewers refers to viewers where the landscape contributes to their enjoyment of their activity and aesthetic of their living environment. Park users or residents are more sensitive to change in the landscape than office workers or motorists.

Table 4.5-1 presents the number of residences affected by each alternative. With the potential mitigation measures suggested in Section 4.5.5 or similar design measures, fewer sensitive viewers would be impacted by the alternatives.

None of the station or alignment options would greatly reduce the number of residences impacted for that alternative. The Kent/Des Moines HC Campus Station Option would impact sensitive viewers along the west side of 28th Avenue S south of Kent-Des Moines Road, whereas the segment of the SR 99 Alternative it would replace would not affect residences. The S 272nd Redondo Trench Station Option would impact residents between S 279th Street and S 302 Street in similar numbers to the corresponding portion of the SR 99 Alternative. The remaining station and alignment options would not have additional impacts on residents.

TABLE 4.5-1
**Number of Residences Near Alternative Corridors Where Visual Quality Would be Lowered**

| Alternative | Residences |
|---|---|
| **SR 99** | **215** (160-230) |
| **I-5** | **115** (1-115) |
| **SR 99 to I-5** | **130** (85-130) |
| **I-5 to SR 99** | **200** (190-200) |

**Note:** The estimated number of residences indicated is a proxy for number of sensitive viewers that could be impacted.

## 4.5.2 Introduction to Resources and Regulatory Requirements

Visual and aesthetic environments are the landscape's natural and cultural features that can be seen and that contribute to the public's appreciation and enjoyment of their surroundings. The visual environment encompasses elements from both the built and natural environments. They can include solitary built and natural landmarks (such as buildings, trees, and bodies of water) or entire landscapes. Impacts on the visual and aesthetic environment are defined in terms of the extent to which the project's presence would change the visual character and quality of the environment.

The description of existing visual and aesthetic conditions in the corridor and the assessment of changes that would be associated with the FWLE are based upon, but do not strictly follow, the visual assessment methodology developed by the Federal Highway Administration (FHWA), which is described in Appendix G5, the Visual and Aesthetic Resources Technical Report prepared for this project (FHWA, 1988).

This evaluation reports on the potential for change to the existing visual quality and provides a comparison between the alternatives by providing the number of adjacent residential units oriented toward the area from which residents could potentially see changes. The other factors—view blockage of Puget Sound, the Olympic Mountains, and Mt. Rainier and impacts associated with light and glare—are assessed qualitatively.

The FWLE corridor was divided into three landscape units to organize the description of the affected environment and impact assessment. Landscape units are identifiable and distinct geographic areas within a linear project corridor from which there are views (the viewshed) of a proposed action (see Exhibits 4.5-1, 4.5-2, and 4.5-3).

Consistency of the FWLE alternatives with the plans, policies, and ordinances of the cities of SeaTac, Des Moines, Kent, and Federal Way regarding visual or aesthetic resources and/or scenic views was evaluated. None of the documents reviewed from these four cities identified protected views from specific locations, linear features (such as highways), or view corridors that were applicable to the alternatives being evaluated. Similarly, the Washington State Department of Transportation (WSDOT) has not designated areas of SR 99 or I-5 within the FWLE study area as scenic or recreational highways (WSDOT, 2014a).

## 4.5.3 Affected Environment

The study area for visual and aesthetic resources is the viewshed of the alternatives being evaluated. Due to the presence of vegetation, terrain, and buildings, which can constrain views of the alternatives from many locations within the study area, the viewshed for the FWLE is generally between approximately 200 to 500 feet from the alternatives.

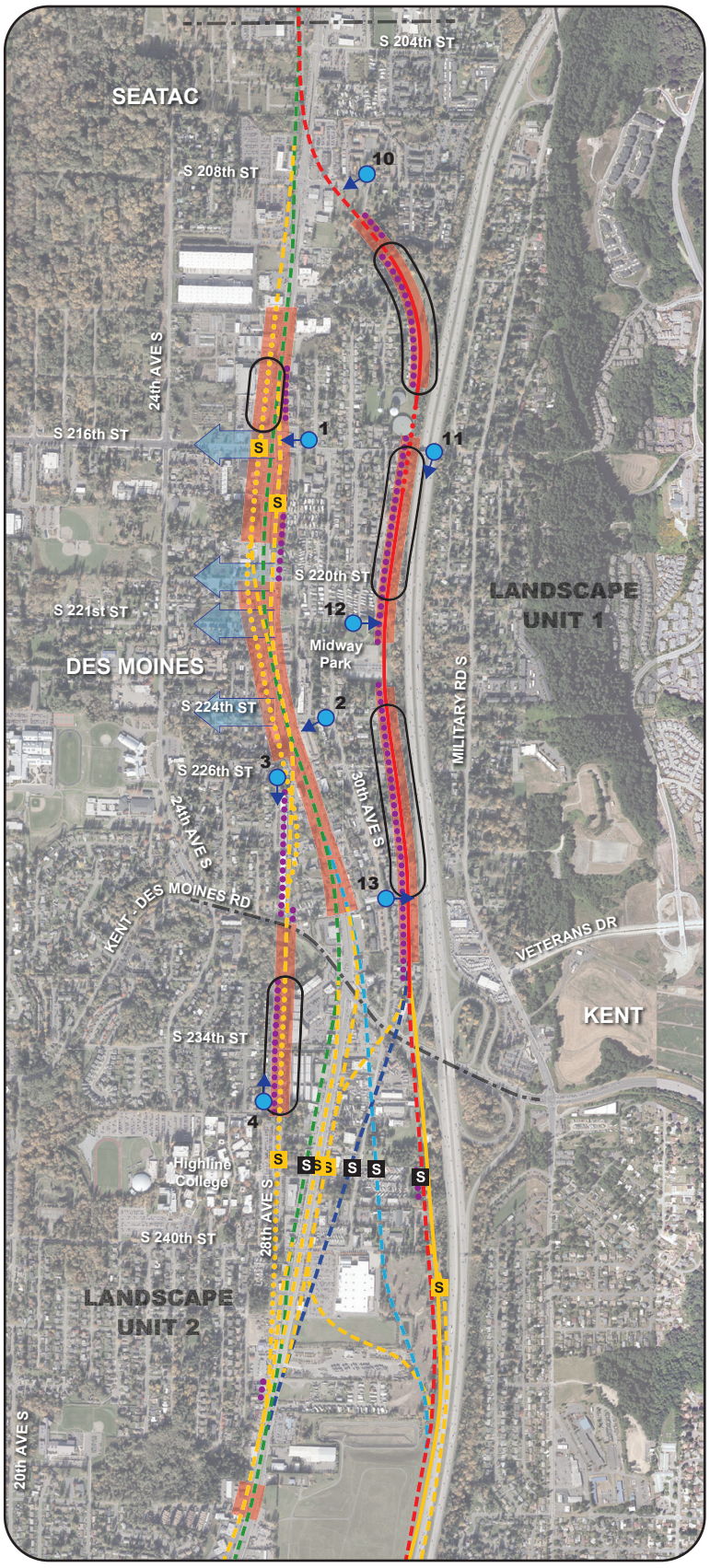
The description of the affected environment focuses on the landscape character and visual quality, viewer sensitivity, and views of Puget Sound, the Olympic Mountains, and Mt. Rainier by landscape unit. As indicated above in Section 4.5.2, no specific protected views were identified in plans or policies developed by cities within the FWLE corridor. However, during site visits and conversations with staff from these cities, westward views of Puget Sound and the Olympic Mountains from parts of the SR 99 corridor and of Mt. Rainier from a portion of the I-5 corridor were identified as important features to these communities, therefore views of features are described. The general locations of areas with views of Puget Sound, the Olympic Mountains, and Mt. Rainier that could be affected by the project are identified in Exhibits 4.5-1 to 4.5-3.

**Factors that Contribute to Visual Quality**

**Vividness** is the degree of drama, memorability, or distinctiveness of the landscape components. Vividness is composed of four elements—*landform, vegetation, water features, and human-made elements*—that usually influence the degree of vividness.

**Intactness** is a measure of the visual integrity of the natural and human-built landscape and its freedom from encroaching elements. Intactness is composed of two primary elements—*development and encroachment*—that influence the degree of intactness.

**Unity** is the degree of visual coherence and compositional harmony of the landscape when it is considered as a whole. High unity frequently attests to the careful design of individual components and their relationship in the landscape.




## Legend

**SR 99 Alternative**

- Elevated

**I-5 Alternative**

- Elevated
- At-Grade
- Trench

**SR 99 to I-5 Alternative**

- Elevated

**I-5 to SR 99 Alternative**

- Elevated

**Options**

- Elevated
- At-Grade
- Trench

**Stations**

- S — Station for Alternatives
- s — Station for Options
- Landscape Unit Boundary
- Area with Views of Puget Sound, the Olympic Mountains, or Mt. Rainier
- Area with Concentration of Sensitive Viewers
- 5 — Key Observation Point and View Direction
- Average Visual Quality

*Note: Portions of Alternative Corridors Not Categorized as Average Visual Quality Are Categorized as Low Visual Quality*

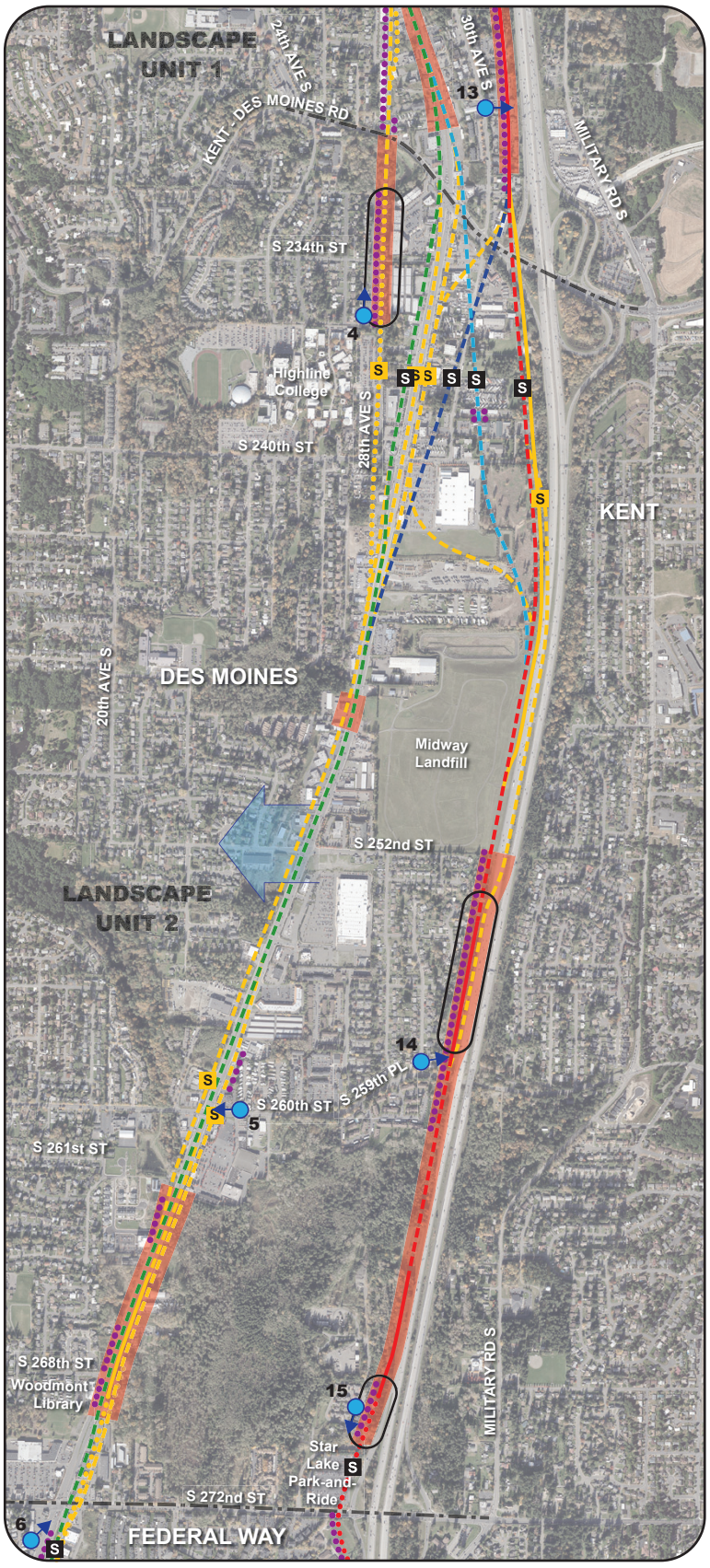
- Location Where Visual Quality Would Be Lowered Adjacent to Areas with Concentration of Sensitive Viewers

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

N

0 0.25 0.5 Mile

**EXHIBIT 4.5-1**
Visual Conditions in Landscape Unit 1
*Federal Way Link Extension*




## Legend

**SR 99 Alternative**
- Elevated

**I-5 Alternative**
- Elevated
- At-Grade
- Trench

**SR 99 to I-5 Alternative**
- Elevated

**I-5 to SR 99 Alternative**
- Elevated

**Options**
- Elevated
- At-Grade
- Trench

**Stations**
- S — Station for Alternatives
- S — Station for Options
- Landscape Unit Boundary
- Area with Views of Puget Sound, the Olympic Mountains, or Mt. Rainier
- Area with Concentration of Sensitive Viewers
- 5 — Key Observation Point and View Direction
- Average Visual Quality

*Note: Portions of Alternative Corridors Not Categorized as Average Visual Quality Are Categorized as Low Visual Quality*

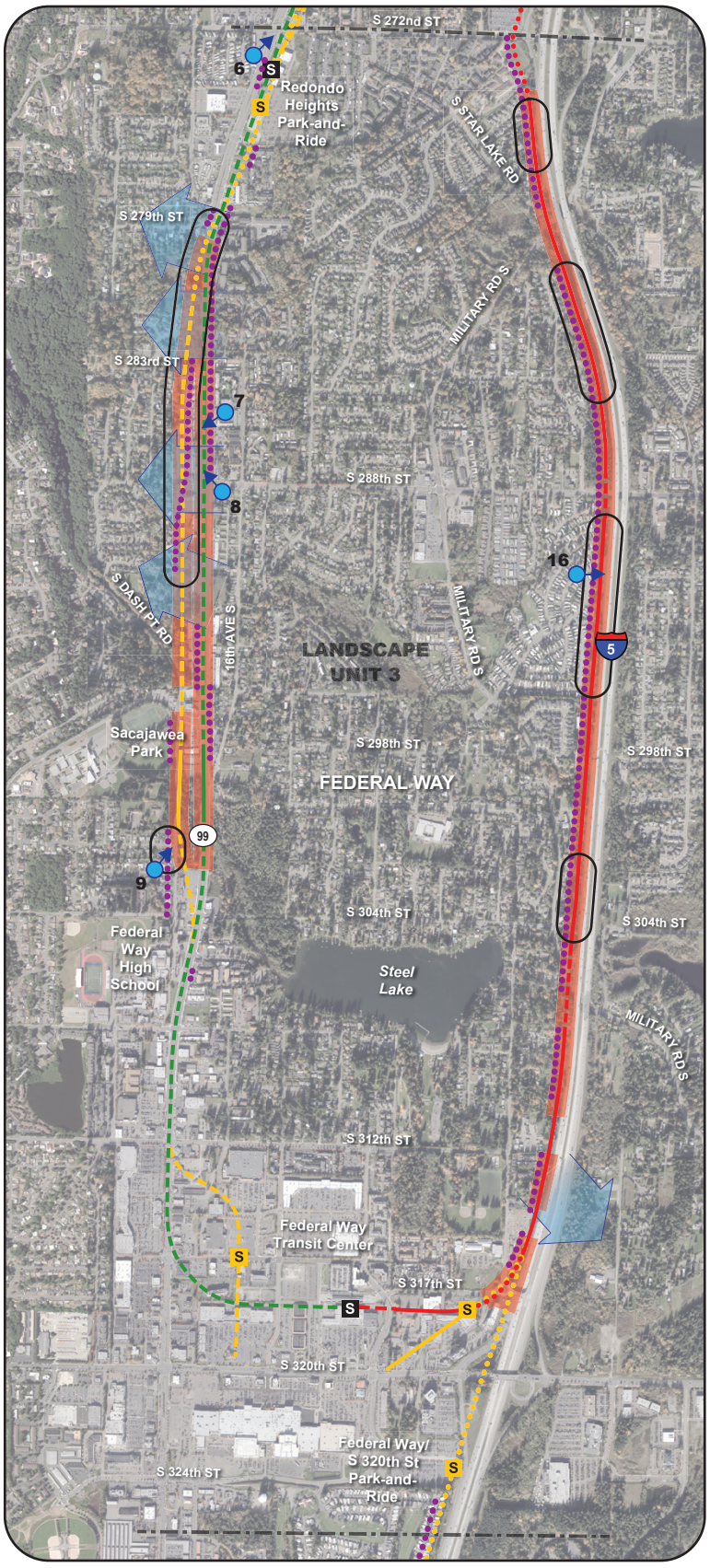
- Location Where Visual Quality Would Be Lowered Adjacent to Areas with Concentration of Sensitive Viewers

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

N

0 0.25 0.5 Mile

**EXHIBIT 4.5-2**
Visual Conditions in Landscape Unit 2
*Federal Way Link Extension*




## Legend

**SR 99 Alternative**

- Elevated

**I-5 Alternative**

- Elevated
- At-Grade
- Trench

**SR 99 to I-5 Alternative**

- Elevated

**I-5 to SR 99 Alternative**

- Elevated

**Options**

- Elevated
- At-Grade
- Trench

**Stations**

- S — Station for Alternatives
- S — Station for Options
- Landscape Unit Boundary
- Area with Views of Puget Sound, the Olympic Mountains, or Mt. Rainier
- Area with Concentration of Sensitive Viewers
- 5 — Key Observation Point and View Direction
- Average Visual Quality

*Note: Portions of Alternative Corridors Not Categorized as Average Visual Quality Are Categorized as Low Visual Quality*

- Location Where Visual Quality Would Be Lowered Adjacent to Areas with Concentration of Sensitive Viewers

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

N

0 0.25 0.5 Mile

**EXHIBIT 4.5-3**
Visual Conditions in Landscape Unit 3
*Federal Way Link Extension*

Landscape character is an objective assessment of a landscape view that is composed of various natural and human-built elements. Visual quality is an assessment of the composition of character-defining features of selected views. Under the FHWA visual quality analysis methodology, the visual quality of viewed landscapes are determined and evaluated in terms of vividness, intactness, and unity. Establishing visual quality categories assists in assessing changes in the visual environment that would occur with the various alternatives and options. Visual quality was categorized as low, average, or high in order to describe the existing visual quality along the FWLE alternatives and options. The visual quality ranking was also used in evaluating potential impacts associated with the alternatives. Exhibits 4.5-1, 4.5-2, and 4.5-3 depict the existing visual quality categories of the corridors the FWLE alternatives and options would pass through. There were no areas of high visual quality in the study area. Areas not highlighted as average on these exhibits are categorized as low visual quality.

**Visual Quality Categories**

**Low Visual Quality:** Areas with low visual quality have some combination of features that seem visually out of place, lack visual coherence, do not have compositional harmony, and/or might contain eyesores.

**Average Visual Quality:** Areas with average visual quality are commonly occurring or average-appearing landscapes that have a generally pleasant appearance but might lack enough distinctiveness, memorability, drama, and compositional harmony to place them in the high visual quality category. This is generally the most frequent category.

**High Visual Quality:** Areas with high visual quality must be outstanding in terms of being very memorable, distinctive, unique (in a positive way), and/or intact—they can be natural, park-like, or urban (with urban areas displaying strong and consistent architectural and urban design considerations).

Sensitive viewers refers to viewers where the landscape contributes to their enjoyment of their activity and aesthetic of their living environment. Park users or residents are more sensitive to change in the landscape than office workers or motorists.

#### 4.5.3.1 SR 99 Corridor

The character of the six-lane SR 99 corridor is typical of major arterial transportation corridors where automobile-oriented commercial development has evolved over the last several decades (see Section 4.2, Land Use, for a more detailed description of land uses along SR 99). The wide variety of land uses along the SR 99 corridor include many large-scale, low-rise commercial, manufacturing, and storage buildings with extensive paved areas for parking or storage that do not support visual order, intactness, or unity. As a result, large parts of the SR 99 corridor have a utilitarian appearance and a visual quality category of low. As areas along the SR 99 corridor develop, redevelop, or receive additional streetscape improvements, the character of the corridor has and will continue to evolve from large-scale commercial, “strip mall” commercial, and undeveloped, to residential and/or office and smaller commercial. Visual quality is expected to improve as this development occurs. Areas that in past years would have been considered to have low visual quality have improved in recent years,

and portions of the SR 99 corridor are categorized as having average visual quality (see Exhibits 4.5-1 to 4.5-3).

#### 4.5.3.2 I-5 Corridor

I-5's eight travel lanes, center divider, shoulder, cleared area adjacent to the shoulder, and vegetated areas beyond are typical of major interstate highways. Where I-5 can be seen from adjacent areas, its presence greatly influences the character of views. Most of the neighborhoods adjacent to I-5 are visually screened from the freeway by vegetation and/or sound walls. Vegetation along the edge of I-5 serves as a distinctive backdrop for many adjacent neighborhoods. Most of the residences west of I-5 are oriented away from the freeway. As depicted in Exhibits 4.5-1, 4.5.2, and 4.5-3, the visual quality of much of the I-5 corridor as viewed from nearby areas is average. Some multi-story buildings at the south end of the I-5 FWLE corridor have balconies that face east towards I-5 and include views of Mt. Rainier. The area west of I-5 (where the I-5 Alternative would be constructed) contains mature vegetation. These vegetated areas are not uncommon in the greater Seattle metropolitan area, but do offer visual relief from the large infrastructure of the freeway.

### 4.5.4 Environmental Impacts

The three factors listed below were used to determine whether the alternatives being evaluated would result in impacts to visual and aesthetic resources:

- Change to the visual quality of the corridors of the alternatives near areas with concentrations of sensitive viewers (mostly residents);
- Potential blockage or intrusion on existing views of Puget Sound, the Olympic Mountains, or Mt. Rainier; and/or
- Impacts associated with light and glare related to stations, parking areas, and trains.

#### 4.5.4.1 No Build Alternative

With the No Build Alternative, changes to the landscape would be limited to minor improvements of existing roadways and private development along the corridor. As individual properties redevelop over time, changes to the visual environment would occur incrementally. Westward views of Puget Sound and the Olympic Mountains from SR 99 might change over time if properties on the west side of SR 99 are redeveloped to their currently allowed zoning

heights (between 35 and 200 feet, depending upon location specific zoning).

### 4.5.4.2 Build Alternatives

This section discusses the potential visual impacts from permanent features of the FWLE. Short-term visual impacts during construction are described in Chapter 5, Construction Impacts. The FWLE alternatives were developed with consideration given to minimizing potential visual impacts. The minimization measures listed below were included during conceptual design to avoid and minimize impacts:

- Selecting and/or modifying alignments to avoid or reduce the need to acquire and clear new right-of-way. This measure has already been incorporated to a great degree in identifying alignment alternatives and station options and includes using existing transportation corridors (arterial streets and highways, limited-access highways) and a utility corridor.
- Minimizing the elevation or height of elevated structures and stations to the extent allowed by required vertical clearances.
- Incorporating trench and at-grade profiles where possible to eliminate the need for elevated structures, resulting in cost savings and reduced visual and aesthetic impacts.
- Minimizing clearing for construction and operation.
- Maintaining surplus property for redevelopment by other parties.

### 4.5.4.3 Direct Impacts

Visual simulations were developed for key observation points (KOPs) to depict the conceptual design of the FWLE alternatives and options and are included in Appendix C of the Visual and Aesthetic Resources Technical Report (Appendix G5). The simulations provide readers with an idea of the expected scale and general appearance of the alternatives and options. Although some simulations indicate general areas where mitigation such as vegetative screening or sound walls might be appropriate, they do not specifically depict the mitigation measures described in Section 4.5.5, Potential Mitigation Measures. Sound walls and landscaping that are shown in the simulations are conceptual in size and location. Details related to these measures would be developed during final design and

**Key Observation Points**

Sound Transit, in consultation with local jurisdictions, selected 16 site-specific locations, or key observation points (KOPs), from which to take photographs showing existing visual conditions. Those photographs were used to develop photographic simulations to (1) illustrate how existing visual characteristics of areas where the proposed project would be located would change with FWLE alternatives and options, (2) assist in evaluating changes to visual quality, and (3) depict areas where project components could potentially intrude upon, or block, views of Puget Sound, the Olympic Mountains and Mt. Rainier.

would include input from the community and cities in the FWLE project corridor.

### Impacts Common to All Build Alternatives

All of the FWLE alternatives and options would change the visual environments in which they would be constructed. The FWLE alternatives and options would require the removal of a variety of existing visual features such as buildings, street trees, landscaped areas, slopes, and parking lots. Some streets would require widening, and others would require bridging structures where the alternative would pass beneath them in a trench. Table 3-1 in Appendix G5 identifies the main components of the FWLE and describes their visual characteristics.

Although the evaluation focuses on impacts to residents, who are considered sensitive viewers, the visual changes from the FWLE alternatives and options would also be seen by other viewers such as workers, customers, and motorists. These additional views would see changes associated with the alternatives and options from buildings, sidewalks, and roadways. In addition to current viewers, people in the future who would be riding light rail trains as passengers would also be viewers and would have views from the proposed project. Along sections of elevated guideways and stations, passengers would have elevated views of the surrounding areas that could be quite extensive and, in some places, scenic.

Given the developed nature of areas in the vicinities of the potential stations and the mitigation measures described in Section 4.5.3, the presence of the lights at the stations and parking areas would not affect sensitive viewers (primarily residents). Headlights from passing trains are directed forward and downward to the guideway. While the train headlight on the elevated guideway may be visible to some, it is likely that sound walls (which would be located on alignments adjacent to residential areas) would block the train headlights and most of the interior lights depending upon the height and placement of the sound wall. The presence of passing trains at night would be brief, but might disturb some sensitive viewers, although similar lights from vehicles passing by along SR 99, I-5, or other arterials are currently seen along many of the alternative alignments.

### Impacts by Alternative

Table 4.5-2 provides a summary by landscape unit of the number of residences from which residents would see a reduction of visual

quality by alternative. Locations where these impacts would occur are described in this section, but areas where impacts would not occur are not discussed. Areas where station or alignment options associated with the alternatives would change the number of residences affected are also described.

TABLE 4.5-2
**Approximate Number of Residences Near Alternative Corridors Where Visual Quality Would be Lowered By FWLE Alternative**

| Landscape Unit | Potential Number of Residences where Nearby Visual Quality Would be Reduced | | | |
|---|---|---|---|---|
| | SR 99 Alternative | I-5 Alternative | SR 99 to I-5 Alternative | I-5 to SR 99 Alternative |
| Landscape Unit 1: S 200th Street to Kent-Des Moines Road | 45 | 30 | 45 | 30 |
| Landscape Unit 2: Kent-Des Moines Road to S 272nd Street | 0 | 15 | 15 | 0 |
| Landscape Unit 3: S 272nd Street to Federal Way Transit Center | 170 | 70 | 70 | 170 |
| **Total All Landscape Units** | **215** | **115** | **130** | **200** |

**Note:** The estimated number of residences indicated is a proxy for number of sensitive viewers that could impacted.

### SR 99 Alternative

The SR 99 Alternative elevated guideway would be larger in height than most structures on adjacent lands. However, it would not be inconsistent with the utilitarian character of portions of the corridor, which are adjacent to large-scale low-rise commercial and industrial buildings that are surrounded by expansive paved areas for vehicle parking or storage. Most of these areas have low visual quality and do not contain sensitive viewers; the SR 99 Alternative would not reduce visual quality in these areas. In residential areas (primarily multi-story residential buildings) that have average visual quality, the SR 99 Alternative elevated guideway would be generally out of scale and would reduce the visual quality of the SR 99 corridor to low. Exhibits 4.5-1 through 4.5-3 show the affected areas.

**Future Development along SR 99**

As properties along the west side of SR 99 redevelop over time, views of Puget Sound and the Olympic Mountains from SR 99 and areas east of SR 99 could be impacted. For example, areas on the west side of SR 99 in the vicinity of S 216th Street have been zoned Pacific Ridge Commercial 2 (PR-C2). This zone allows a maximum height of 75 feet, except for 1-acre parcels where buildings as tall as 200 feet can be built if a floor area ratio height bonus is approved. As these properties redevelop over time, it is likely that views of Puget Sound and the Olympic Mountains from SR 99 and areas east of it could be restricted to road corridors like those near S 216th Street and S 224th Street.

The SR 99 Alternative would require portions of landscaped medians be removed for guideway support columns and/or turn lanes. Where medians that currently contain landscaping would be affected, existing vegetation would be preserved or replaced where feasible with smaller trees or shrubs. These landscaped

medians would be replanted in consultation with local jurisdictions and could take several years to for plantings to mature.

***Landscape Unit 1***

In Landscape Unit 1, the elevated structure would not be consistent with the residential character of the area on the east side of SR 99 directly north of S 216th Street and would reduce the average visual quality of this part of the SR 99 corridor to low.

The guideway would also intrude on views of Puget Sound and the Olympic Mountains seen from some of the residences, as well as views of these features from some areas east of SR 99 (see KOP 1, Exhibit 1b**,** and KOP 2, Exhibits 2b-1 and 2b-2, in Appendix G5).

***Landscape Unit 2***

Although there are some areas with concentrations of sensitive viewers adjacent to areas with average visual quality in Landscape Unit 2, the elevated guideway would not lower visual quality enough to reduce it from average to low.

***Landscape Unit 3***

In Landscape Unit 3, the elevated guideway would pass a series of residential areas adjacent to parts of the SR 99 corridor that have average visual quality. Most of the residential areas are found along the east side of SR 99 and consist of multi-story buildings that have been constructed on terrain higher than SR 99. Some isolated areas in Landscape Unit 3 contain single-family residences and mobile homes that are generally at the same elevation as SR 99. The scale and presence of the elevated guideway above the median in these residential areas would not be consistent with the residential character and would reduce the average visual quality of these areas to low (see Table 4.5-2). The elevated guideway would also intrude on, or block, views of Puget Sound and the Olympic Mountains from some areas along this section of the SR 99 corridor (see KOPs 7 and 8, Exhibits 7b and 8b, in Appendix G5).

**SR 99 Alternative Station Options**

The following paragraphs discuss the options associated with the SR 99 Alternative that would result in a lowering of visual quality near residential areas, or that would avoid lowering of visual quality relative to the elevated median alternative. Options not discussed would not result in a reduction in visual quality change in relative to the SR 99 Alternative.

***S 216th West Station Option***

The potential additional station (west option) would be west of SR 99 in a trench that would pass under S 216th Street. The guideway leading to and from the station would be in a trench that would be adjacent to an area with residential viewers on the east side of SR 99 that is north of S 216th Street. This option would avoid the SR 99 Alternative visual impacts to these sensitive viewers.

***S 216th East Station Option***

The elevated guideway leading into the S 216th Street East Station Option would pass within approximately 40 feet of the southern-most of three multi-story residential buildings north of S 216th Street and east of SR 99. The elevated structure would reduce the average visual quality of this part of the SR 99 corridor to low and intrude on, or block, views of Puget Sound and the Olympic Mountains. These impacts would also occur with the SR 99 Alternative and this option would not increase impacts. The location of the light rail, however, would be closer to these residences and would intensify impacts.

***Kent/Des Moines HC Campus Station Option***

The Kent/Des Moines HC Campus Station Option would not have any impacts in Landscape Unit 1 and does not extend into Landscape Unit 3. In Landscape Unit 2, this option would pass along the edge of a residential neighborhood and would require the removal of all residences on the east side of 28th Avenue S (see KOP 4, Exhibit 4b, in Appendix G5). The removal of the residences and associated vegetation, along with the presence of the sound wall, overhead catenary system, and the tops of trains, would not be consistent with the residential character of this area. These features would decrease the intactness and unity of 28th Avenue S and would decrease the average visual quality of this part of the option alignment to low. South of the residences, the alignment would continue in a trench to the HC Campus Station. If landscaping and sound walls were implemented next to the portion of the trench along 28th Avenue S that would be adjacent to residences, visual quality could be restored to average after several years, as plants matured. The Kent/Des Moines HC Campus Station Option would impact approximately 15 additional residences relative to the SR 99 Alternative.

### *S 272nd Redondo Trench Station Option*

The S 272nd Redondo Trench Station Option would be located in Landscape Units 2 and 3 and would pass next to several residential areas (see Exhibits 4.5-1 to 4.5-3). It would first pass east of (and uphill from) single-family residences north of S 284th Street where the cleared right-of-way would remove vegetation between the residences and SR 99. From approximately S 284th Street to Dash Point Road the S 272nd Redondo Trench Station Option would be on an elevated guideway and would pass between a series of residential areas. It would travel west (and downhill from) multi-story residential buildings on the west side of SR 99 and east of (and uphill from) several areas containing single-family residences. The presence of the cleared right-of-way and elevated guideway would be inconsistent with the residential character for these portions of the option. Between S 279th Street and Dash Point Road, the elevated guideway would be seen (beyond the residences west of SR 99) from some units in a series of multi-story residential buildings that line the east side of SR 99. The presence of the option would not be consistent with the residential character of the corridor seen by residents in the multi-story residential buildings. The potential mitigation measures identified in Section 4.5.5 would be somewhat effective within 5 to 8 years (as vegetation matured) in mitigating impacts to residential areas adjacent to the at-grade portions of the option, but would not mitigate the impacts of the elevated sections, which would lower visual quality.

South of Dash Point Road, the removal of vegetation along the east side of 16th Avenue S would be noticed, as would passing trains and a sound barrier. The average visual quality of the portion of the alignment along 16th Avenue S would be reduced to low. With mitigation measures, the visual quality of views along 16th Avenue S would be restored to average (see KOP 9, Exhibit 9b, in Appendix G5). When compared to the SR 99 Alternative, however, this option would reduce the total number of residential units impacted by approximately 10.

### I-5 Alternative

The greatest potential impact from the I-5 Alternative would be the removal of trees along the west side of I-5 and, in some portions of the alternative, the removal of residences in neighborhoods west of I-5. Although motorists other than those engaged in sight seeing are

considered to have moderate to low viewer sensitivity, the removal of trees would change motorists' experience driving on I-5 (see KOP 11, Exhibit 11b, in Appendix G5), and some would likely experience decreased driving pleasure. In addition to removing vegetation within the construction footprint, potentially dangerous trees outside of the construction footprint that might fall onto the guideway could be removed after consultation with an arborist, possibly including some on private property. The I-5 Alternative would remove approximately 35 acres of vegetation. The loss of trees would result in the FWLE elements being visible from some adjacent properties and by motorists on I-5. The removal of trees in the I-5 corridor would change the character of the corridor to that of a more urbanized environment with less tree canopy. WSDOT manages and maintains areas beyond interstate rights-of-way that are not required for operation of the interstate as buffers that may contain mature native vegetation. These areas are called Beautification Areas and Landscape Areas and are discussed in more detail in Appendix G5, the Visual and Aesthetic Resources Technical Report. Approximately 0.1 acre of Landscape Area would be impacted by the I-5 Alternative. The WSDOT *Roadside Policy Manual* (WSDOT, 2014b) provides policy requirements regarding removing and replacing trees within and adjacent to a highway right-of-way such as I-5.

While changes associated with the I-5 Alternative may be seen from more distant residences, the impacts would generally be experienced by adjacent residences. Because most of the neighborhoods west of the I-5 corridor are single-family neighborhoods and contain considerable mature vegetation and numerous buildings, views towards the I-5 Alternative within the neighborhood beyond residences adjacent to the I-5 Alternative would tend to be screened or blocked by vegetation and buildings. Where properties west of I-5 become more visible from I-5 due to vegetation removal, views of urbanized uses (primarily residential) would replace views of forested areas.

***Landscape Unit 1***

In Landscape Unit 1, construction of the I-5 Alternative would require the removal of a number of single-family and multi-story residential buildings, as well as of vegetation along the west side of I-5. Removing residences and/or vegetation for the I-5 Alternative would expose residences between S 211th Street and the Kent-Des Moines

Road to largely uninterrupted views of the elevated and at-grade portions of the I-5 Alternative. Even though I-5 is nearby and apparent, the presence of elevated and at-grade alignments would not be consistent with the residential character of these areas. These changes would reduce the existing average visual quality in this area to low and impact nearby residents (see Table 4.5-2 and Exhibits 4.5.1 to 4.5-3).

***Landscape Unit 2***

In Landscape Unit 2, the I-5 Alternative would pass a large residential area between approximately S 252nd Street and S 259th Street. Much of the mature vegetation along I-5 near these areas would be removed. The presence of the elevated and at-grade guideway and passing trains would not be consistent with the residential character of this area. The average visual quality of this part of the I-5 Alternative corridor would be reduced to low. The I-5 Alternative would also pass by a smaller residential area accessed via 28th Avenue S, north of the Star Lake Park-and-Ride. Residences on the east side of 28th Avenue S would be removed, along with most of the trees between these residences and I-5. These changes would be visible to some residences to the west of 28th Avenue S and the existing average visual quality in this area would be reduced to low, impacting nearby residents (see Table 4.5-2).

***Landscape Unit 3***

In Landscape Unit 3 between S 272nd Street and S 288th Street, the I-5 Alternative would require the removal of most of the trees along the western edge of I-5. The elevated and transitioning-to-at-grade guideway would not be consistent with the adjacent residential character and would reduce the existing visual quality of the portion of the corridor between S 272nd Avenue and S 288th Street from average to low next to nearby residences (see Table 4.5-2). South of S 288th Street, the removal of the trees and replacement of the existing sound wall would be noticed from residences in a mobile home park that have views towards I-5 (see KOP 15, Exhibit 15b, in Appendix G5). The removal of trees and presence of the retained-fill wall and sound walls would reduce the average visual quality of the corridor to low and impact nearby residents' views.

The mitigation measures discussed in Section 4.5.5 related to landscaping and sound walls would help reduce visual impacts from the I-5 Alternative on nearby residential areas. Near at-grade sections

of the I-5 Alternative, these measures could restore visual quality to average after several years, as plants matured. The I-5 Alternative would not intrude upon views of Mt. Rainier.

None of the I-5 Alternative station and alignment options would lower the existing visual quality adjacent to sensitive viewing areas and therefore are not described in this section.

**SR 99 to I-5 Alternative**

Between the Angle Lake Station and approximately S 240th Street, the SR 99 to I-5 Alternative would be the same as the SR 99 Alternative and would pass through areas with low visual quality and/or would not travel near areas with concentrations of sensitive viewers. There would be no visual impacts between Kent-Des Moines Road and S 240th Street. South of S 240th Street, this alternative would follow the I-5 Alternative alignment and have the same reductions in visual quality to portions of its corridor next to areas with concentrations of sensitive viewers in Landscape Units 2 and 3 (see Table 4.5-2). There would be no additional impacts from station or alignment options.

**I-5 to SR 99 Alternative**

The I-5 to SR 99 Alternative would have the same impacts to residents in Landscape Unit 1 as the I-5 Alternative. There would be no reduction in visual quality categories along the corridor near areas with residents between Kent-Des Moines Road and S 240th Street. After reaching the SR 99 median south of S 240th Street, the change in visual quality for the portion of the I-5 to SR 99 Alternative near residents would be the same as that of the SR 99 Alternative in Landscape Unit 3 (see Table 4.5-2). Visual changes from the S 272nd Redondo Trench Station Option would be the same as described under the SR 99 Alternative.

### 4.5.4.4 Indirect Impacts

The FWLE could support changes to nearby land uses, as allowed in adopted plans, and increases in the density of development could occur. This might result in changes to the visual setting of the areas where the FWLE would create changes.

## 4.5.5 Potential Mitigation Measures

In addition to the avoidance and minimization measures described in Section 4.5.4.2, supplemental measures might be appropriate to reduce visual impacts of the FWLE alternatives at various locations, particularly near residential areas. Areas where visual quality would

be lowered near residential areas are identified in Exhibits 4.5-1 to 4.5-3. These areas are places where some of the potential mitigation measures would be appropriate and successful in reducing impacts. Specific locations where mitigation would be appropriate would be determined in consultation with local jurisdictions, as alignment designs are refined.

Most of the potential mitigation measures identified below are related to the placement and design of the light rail facilities, or the use of landscaping or other features to help screen or soften views of facilities.

- Where Sound Transit may need to acquire property beyond the footprint of light rail facilities, particularly in residential areas, there might be opportunities for additional landscaping and buffers to screen views of the facilities from adjacent neighborhoods. Where buildings would be removed, appropriate vegetation could be planted in order to provide screening of FWLE facilities or to screen areas exposed by the removal of the residences.
- In areas where the elevated guideway would remove existing landscaped medians for guideway columns, Sound Transit could replace landscaping between the guideway columns. The type of vegetation may be different; for example, shorter species may be planted because the existing species of trees in the median would grow too tall to fit underneath the elevated structure.
- Tree removal along the I-5 corridor (both within and outside of WSDOT Landscape Areas) would be minimized and would be mitigated according to the WSDOT *Roadside Policy Manual*.
- Where retaining walls are required, they could include landscaped areas, where practical, that would soften their appearance when viewed from adjacent residential neighborhoods. Retaining walls, at-grade sound walls, or other major structural elements near areas with concentrations of visually sensitive viewers could be designed with visually interesting elements, such as design treatments that incorporate texture, patterns, and color.
- Stations and park-and-ride facilities could include context sensitive design and islands of landscaping within areas of pavement and around their perimeter as required by local codes.

- Exterior lighting at stations and park-and-ride lots would be designed to minimize height and use source shielding to avoid luminaries (bulbs) that would be directly visible from residential areas, streets, and highways. Shielding would also limit spillover light and glare in residential areas.
- Architectural aspects of the FWLE, where visible from I-5, would be coordinated in color, texture, and materials to be consistent with the existing architectural features in the corridor.

This page intentionally left blank.

# 4.6 Air Quality and Greenhouse Gases

## 4.6.1 Summary

This air quality and greenhouse gas analysis provides information regarding potential impacts on air quality associated with the Federal Way Link Extension (FWLE).

Due to mandated improvements in fuel efficiency over the next 20 years, transportation emissions are expected to be reduced 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 the National Ambient Air Quality Standards (NAAQS) for CO. Because the FWLE is included in the Regional Transportation Improvement Program (RTIP) 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 the build alternatives, mobile source air toxics (MSATs) emissions within the FWLE corridor are expected to be lower than existing levels and the No Build Alternative due to continued improvements resulting from the United States Environmental Protection Agency's (EPA) national control programs. As a result, the FWLE would generate minimal air quality impacts for Clean Air Act (CAA) criteria pollutants and would not be linked with any special MSAT concerns. Consequently, MSATs impacts are not expected to occur as a result of the FWLE.

Greenhouse gas emissions are estimated to decrease from existing conditions for the 2035 No Build and build alternatives. All build alternatives would result in a reduction in vehicle miles traveled (VMT) that would lower greenhouse gas (GHG) emissions within the project corridor. However, the light rail system's consumption of electricity 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 to Resources and Regulatory Requirements

The FWLE corridor is located in south King County under the jurisdiction of the Puget Sound Clean Air Agency (PSCAA) for local air

quality regulation. Air quality in the Puget Sound Region is regulated and enforced by federal, state, and regional agencies—the EPA, Washington State Department of Ecology (Ecology), and PSCAA—each with its own role in regulating air quality.

This section discusses the applicable regulatory framework for the Puget Sound Region, describing the existing attainment status with established air quality standards in the project vicinity for each regulated pollutant.

### 4.6.2.1 Ambient Air Quality Standards

#### Criteria Pollutants

EPA's NAAQS (EPA, 2012a) set limits on concentration levels of certain pollutants, commonly referred to as the "criteria pollutants." The six criteria pollutants are:

- carbon monoxide
- particulate matter less than 10 microns in diameter ($PM_{10}$)
- particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)
- ozone ($O_3$)
- sulfur dioxide
- lead
- nitrogen dioxide

The NAAQS for these criteria pollutants are separated into two standard categories: the primary and the secondary standards (40 Code of Federal Regulations [CFR] 50). The primary standards were created to protect public health; the secondary pollutant standards were established to protect public welfare and the environment. Air quality is monitored and areas are designated according to whether or not they meet the NAAQS for each pollutant.

Washington State has established Washington Ambient Air Quality Standards (WAAQS) (Washington Administrative Code [WAC] 173-470, 474, and 475). PSCAA also adopted air quality standards for the Puget Sound Region. Table D4.6-1 in Appendix D4.6 lists the NAAQS, WAAQS, and PSCAA-adopted air quality standards for the criteria pollutants.

### Transportation Conformity Requirements

Under the CAA, a transportation project located in a nonattainment or maintenance area is required to meet a conformity determination with the SIP. Conformity requirements are met when a project does not cause or contribute to an exceedance of the NAAQS. In air quality maintenance areas, regionally significant projects are evaluated for their conformity to air quality maintenance plans. Projects that conform to the plan are not expected to cause exceedances of the standard. In the Puget Sound Region, PSRC determines regional conformity by including a project in the Metropolitan Transportation Plan (MTP) and the RTIP. Transit projects are not governed by state requirements; however, state requirements are referenced as guidance to demonstrate project conformity when transit projects have an effect on traffic patterns on local roadways.

King County is a maintenance area for CO. Therefore, the project is subject to transportation conformity requirements and needs to demonstrate conformity at both regional and project levels for CO. The project is in an attainment area for all other criteria pollutants (including $PM_{10}$ and $PM_{2.5}$); therefore, analysis of the other criteria pollutants is not required.

**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.

#### 4.6.2.2 Greenhouse Gases and Climate Change

Greenhouse gases are gases that trap heat in the atmosphere. Over time, as human activity has increased, GHG concentrations in the atmosphere have increased as well. Carbon dioxide ($CO_2$) makes up the largest component of GHG emissions and is the primary GHG emitted by vehicles. Other prominent transportation GHGs include methane and nitrous oxide.

Climate change, GHG emissions, and their associated effects are being addressed through various efforts at federal, state, and local levels. Examples include:

- The National Clean Vehicle Program (UCS, 2010)
- Presidential Executive Order 13514: Federal Leadership in Environmental, Energy and Economic Performance
- Washington State's Climate Change Challenge and supporting legislation
- Washington State's Executive Order 14-04: Washington Carbon Pollution Reduction and Clean Energy Action

- PSRC's *VISION 2040* policies addressing the state's climate change goals (PSRC, 2010b)
- King County's *Strategic Plan 2010-2014* (King County, 2010)
- The Greenhouse Gas Emissions in King County report (King County, 2012)

## 4.6.3 Affected Environment

### 4.6.3.1 Regional Climate

The FWLE corridor is located in the Puget Sound lowlands that comprise the lower-elevation lands surrounding the sound. Variations in the 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 conditions of clear skies, light wind, and a sharp temperature inversion. These conditions may prevail a few days before a weather system moves through and removes the air pollution by wind and rain (Washington Region Climate Center, 2013).

### 4.6.3.2 Pollutants of Concern

Characterizing the existing air quality environment is essential in developing a baseline to assess how changes in vehicle traffic patterns related to the FWLE might affect existing air pollutant concentration levels. Air quality is affected by pollutants that are generated by both natural and human-caused sources. In general, the largest man-made contributors to air emissions are 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, such as CO; particulates; $O_3$ and its precursors, including nitrogen oxides ($NO_x$) and volatile organic compounds (VOCs); air toxics; and GHGs.

### Carbon Monoxide

In assessing the localized air quality impacts of transportation projects, CO is a pollutant of concern. In urban areas, motor vehicles are the principal sources of CO 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-up of directly emitted contaminants. CO is a pollutant whose impact is usually localized, with the higher ambient concentrations of CO occurring near congested roadways and intersections.

**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.

### Particulate Matter

Particulate matter is a complex mixture of small particles and liquid droplets that are 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 particle pollution comes from burning in fireplaces and wood stoves in winter. During the summer, vehicle exhaust, land-clearing burning, and backyard burning of yard waste are the predominant sources of fine particles (PSCAA, 2013).

**Particulate matter** comes in many sizes and shapes and 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 in the atmosphere of chemicals such as sulfur dioxides and nitrogen oxides that are 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 acts as a protective layer in the stratosphere high above the earth, but it can be harmful to breathe. Ozone is also the primary element of smog. Sunlight and hot weather are the main causes of ground-level ozone formation. As a result, ozone is referred to as a summertime air pollutant. Many urban areas tend to have high levels of ozone, although even rural areas are subject to increased ozone levels due to the wind carrying ozone and because the pollutants that form ozone can be carried 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. Human-generated emissions of VOCs are from 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

In addition to the criteria pollutants, air toxics are another group of pollutants of concern in the region. Of 188 air toxics or hazardous air pollutants regulated by EPA, seven compounds have significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers according to the 1999 National Air Toxics Assessment. This subgroup of seven mobile source air toxics (MSATs) includes benzene, formaldehyde, naphthalene, diesel particulate matter plus diesel exhaust organic gases, acrolein, 1,3-butadiene, and polycyclic organic matter (Federal Highway Administration [FHWA], 2012a). The EPA rule on Control of Hazardous

Air Pollutants from Mobile Sources will decrease MSAT emissions through cleaner fuels and cleaner engines (FHWA, 2012a). Transportation projects with potential for MSAT effects, such as the FWLE, are required to perform project-level MSAT analysis.

At the state and regional level, Ecology and PSCAA list 400 pollutants as air toxics. This list includes the 188 national hazardous air pollutants identified by EPA as well as additional pollutants believed to be harmful. The 2010 PSCAA air toxic study of the Seattle-Tacoma area shows that mobile sources contribute most to health risk from air toxics in the Puget Sound Region (PSCAA, 2010).

#### Greenhouse Gases

In King County, 48 percent of the GHG emissions are attributable to transportation sources, including motor vehicles, aircraft, construction equipment, and boats (PSCAA, 2012). To reduce GHG emissions from transportation sources, 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 to produce electricity is also a source of GHG emissions, although less of a source in King County than in many other regions of the United States, because of the prevalence of hydropower. The updated GHG inventory for King County shows that GHG emissions 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 (King County, 2012).

### 4.6.3.3 Existing Air Quality

#### Criteria Pollutants

The FWLE corridor includes portions of the cities of SeaTac, Des Moines, Kent, and Federal Way in south King County. King County is currently a maintenance area for CO under NAAQS, with the maintenance plan updated and approved by EPA on September 7, 2004 (PSRC, 2010b). The FWLE corridor is designated as attainment or unclassified for all other criteria pollutants (PSRC, 2010b, and EPA, 2012b). Although the project corridor crosses a portion of Kent, the project is not within the boundary of the Kent Valley industrial area where the designation is maintenance for $PM_{10}$ under NAAQS.

PSCAA monitors criteria air pollutant concentrations at several locations in King County, but there is only one active monitoring station that is near the project corridor, located in Kent. The Kent

monitoring station is located at James Street and Central Avenue and measures $PM_{2.5}$ concentrations. The closest active monitoring station for CO, $PM_{10}$, 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 displays the last 3 years (2011-2013) of monitoring data at these two stations.

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

| Pollutant | NAAQS | 2011 Maximum Concentration | 2012 Maximum Concentration | 2013 Maximum Concentration |
|---|---|---|---|---|
| **Carbon Monoxide (CO)** | | | | |
| 1-hour average (ppm) | 35 | 1.0 | 1.0 | 1.8 |
| 8-hour average (ppm) | 9 | 0.9 | 0.7 | 1.4 |
| **Ozone** | | | | |
| 1-hour average (ppm) | revoked | 0.059 | 0.063 | 0.051 |
| 8-hour average (ppm) | 0.075 | 0.046 | 0.049 | 0.047 |
| **Particulate Matter ($PM_{10}$)** | | | | |
| 24-hour average ($\mu g/m^3$) | 150 | 23.0 | 28.0 | 30.0 |
| **Particulate Matter ($PM_{2.5}$)** | | | | |
| 24-hour average (98th Percentile) ($\mu g/m^3$) | 35 | 25 | 22 | 25 |
| Annual arithmetic average ($\mu g/m^3$) | 12 | 7.7 | 6.5 | 7.2 |

Source: EPA, 2012c.
Note: Beacon Hill Station is located at 4103 South Beacon Hill in Seattle, WA. Kent Station is located at 614 N Railroad Avenue in Kent, WA. Concentrations of CO, ozone, 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

Concentrations for these pollutants were below the applicable ambient air quality standards at the two stations during 2011 to 2013.

#### 4.6.3.4 Sensitive Receptors

Sensitive air quality receptors typically include land uses where people might be most vulnerable to air pollutant effects on their health, 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 located near the FWLE. The land uses in the project vicinity are mixed residential, commercial, and industrial.

### 4.6.4 Environmental Impacts

This section describes the potential for air quality impacts during operation of the FWLE, discussed 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

Long-term regional operations impacts were evaluated by calculating tailpipe emissions for all criteria pollutants and toxic air pollutants for existing and future scenarios in the design year of 2035 for all alternatives. Regional traffic distribution from the PSRC Travel Demand Model and traffic volumes from the project's traffic analysis were used to calculate criteria pollutants and toxic air pollutants from tailpipe emissions. An analysis of the 2035 build alternatives' traffic data demonstrates only minor differences in travel patterns, traffic volumes, delay times, and roadway speeds when compared to the No Build Alternative.

Long-term regional emission rates for criteria pollutants and toxic air pollutants for existing conditions and for future design year 2035 No Build and build alternatives were calculated utilizing EPA's Motor Vehicle Emission Simulator (MOVES) model version 2010b, which estimates change based on reduction in VMT. Tailpipe emissions for existing conditions (2014) were compared to the 2035 No Build Alternative to illustrate the future trend in pollutant emissions for the Puget Sound regional airshed.

Table 4.6-2 summarizes tailpipe emissions for criteria pollutants for the existing and FWLE build alternatives.

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

| Criteria Pollutant | Existing 2014 | 2035 No Build Alternative | 2035 Build Alternative | Percent Change from Existing (2014) to No Build Alternative (2035) | Percent Change from No Build to Build Alternative (2035) |
|---|---|---|---|---|---|
| VMT | 87,624,020 | 103,863,480 | 103,709,090 | 18.53% | -0.15% |
| CO (lb/day) | 58,304 | 32,711 | 32,657 | -43.90% | -0.17% |
| $PM_{2.5}$ (lb/day) | 471 | 177 | 177 | -62.42% | 0% |
| $PM_{10}$ (lb/day) | 500 | 192 | 192 | -61.60% | 0% |
| VOCs (lb/day) | 1,711 | 197 | 197 | -88.49% | 0% |
| $NO_x$ (lb/day) | 8,638 | 2,031 | 2,027 | -76.49% | -0.20% |

Sources for 2014 conditions: PSRC Travel Demand Model and EPA MOVES model 2010b.
lb/day = pounds per day

### No Build Alternative

As shown in Table 4.6-2, under the 2035 no build conditions, VMT is expected to increase over existing conditions by 18.53 percent. However, pollutant emissions for all criteria pollutants would be lower than existing levels due to the assumption of a newer and cleaner automobile fleet in 2035.

### Build Alternatives

The build alternatives would have a slightly smaller increases in VMT than the No Build Alternative in 2035. All criteria pollutants under the build alternatives would be well below existing conditions pollutant levels.

## Mobile Source Air Toxic Emissions

Regional impacts of MSATs are evaluated in accordance with FHWA's *Interim Guidance on Air Toxic Analysis in NEPA* [National Environmental Policy Act] *Documents* (FHWA, 2012b). Currently, there are no established criteria for determining when MSAT emissions should be considered a problem; however, FHWA's Interim Guidance provides an approved approach to evaluating potential MSAT effects.

EPA has developed several emission control programs for vehicle engines and fuels that will reduce MSATs over the next 20 years. According to a study conducted by FHWA (FHWA, 2012b) utilizing the MOVES model, even if VMT increases by 102 percent, implementing approved control programs will decrease MSAT emission rates by 83 percent from 1999 to 2050.

**MSAT Reduction Programs**

These programs include reformulated gasoline, a product of CAA legislation targeting the nation's more acute $O_3$ nonattainment areas; National Low Emissions Vehicle standards; Tier 2 motor vehicle emission standards and associated gasoline sulfur control requirements; heavy-duty engine standards and on-highway diesel sulfur control requirements; the final rule for non-road diesel engines; and proposals for marine and locomotive engines and the 2001 MSAT rule toxic emissions performance standard.

### 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 is expected to increase over existing conditions, however MSAT emissions would decrease due to EPA's national control programs.

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

| MSAT | Existing 2014 | 2035 No Build Alternative | 2035 Build Alternatives | Percent Change from Existing (2014) to No Build Alternative (2035) | Percent Change from No Build to Build Alternative (2035) |
|---|---|---|---|---|---|
| VMT | 87,624,020 | 103,863,480 | 103,709,090 | 18.53% | -0.15% |
| 1-3-Butadiene (lb/day) | 43.05 | 5.32 | 5.31 | -87.65% | -0.15% |
| Acrolein (lb/day) | 12.33 | 2.83 | 2.83 | -77.06% | -0.06% |
| Benzene (lb/day) | 322.87 | 40.64 | 40.58 | -87.41% | -0.15% |
| Formaldehyde (lb/day) | 190.24 | 56.49 | 56.46 | -70.31% | -0.06% |
| Diesel PM (lb/day) | 2,078.83 | 997.83 | 996.45 | -52.00% | -0.14% |
| Naphthalene (lb/day) | 30.98 | 6.11 | 6.10 | -80.28% | -0.09% |
| Polycyclic organic matter (lb/day) | 51.12 | 10.71 | 10.30 | -79.05% | -3.84% |

Sources for 2014 conditions: PSRC Travel Demand Model and EPA MOVES model 2010b.
lb/day = pounds per day

### Build Alternatives

For the build alternatives, MSAT emissions within the project corridor are expected to be lower than existing levels due to continued improvements resulting from EPA's national control programs; they would also be lower than the No Build Alternative due to lower VMT. As a result, the FWLE would generate minimal air quality impacts for CAA criteria pollutants and would not be linked with any special MSAT concerns. Consequently, MSATs impacts are not expected to occur as a result of the FWLE.

## Greenhouse Gases

### *Vehicle Emissions*

The analysis of GHG emission impacts included evaluating the vehicle movements occurring within King County. MOVES was used to estimate GHG emissions, typically presented as the total $CO_2$ equivalent ($CO_{2e}$) released, for the existing and future design year 2035 No Build and build alternatives. As shown in Table 4.6-4, $CO_{2e}$ emissions from vehicle movement are estimated to decrease by 2,038 metric tons annually in the region with the project due to the slight decrease in VMT, an 0.11 percent reduction compared to the No Build Alternative.

**Sound Transit's Sustainability Plan**

In June 2011, Sound Transit released a *Sustainability Plan* that gives an overview of 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 their 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. Successfully focusing on these priorities will reduce VMT within the region. Implementation of this *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 $CO_{2e}$ (lb/day) | 29,928 | 29,894 |
| Daily $CO_{2e}$ reduction (lb/day) | Not Applicable | 34 |
| Annual $CO_{2e}$ reduction (lb/day) | Not Applicable | 12,410 |
| Annual $CO_{2e}$ reduction (metric tons/year) | Not Applicable | 2,038 |

Sources for 2014 conditions: PSRC Travel Demand Model and EPA MOVES model 2010b.
lb/day = pounds per day

***Energy Emissions***

According to the energy analysis performed for this project, operation of the light rail system would produce a demand on the local electrical provider, Puget Sound Energy. Assuming that the light rail system would operate 365 days per year, the annual megawatt hours (MWh) consumed by the build alternatives would be about 4,800 MWh. The energy demand from the operation of the build alternatives would result in GHG emissions of 5,720 metric tons of $CO_2e$ per year.

The energy required for the build alternatives would be delivered by PSE. In 2012, the PSE energy source mix was 42 percent generated by hydroelectric plants, which produce essentially no GHG emissions (PSE, 2012). Based on these current fuel mix conditions, not all of the energy required by the build alternatives would generate GHG emissions and would lower the total GHG emissions described above to 3,318 metric tons of $CO_2e$ per year. Changes in PSE's energy source mix in the future could increase or decrease this amount.

While there would be a reduction in emissions from reduced VMT as shown in Table 4.6-4, there would be an increase in emissions from energy generation to operate the light rail system. When emissions from VMT and energy generation for operations are combined, there would be a net increase of 1,280 metric tons of $CO_2e$ per year when compared to the No Build Alternative. This is equivalent to the average energy consumed by 176 households (EPA Equivalency, U.S. Energy Information Administration, 2009; EPA, 2014a). These GHG emissions would be less than 0.000133 percent of the statewide 2011 inventory and less than 0.000002 percent of the 2012 national GHG

inventory (Washington State Department of Ecology, 2012; EPA, 2014b).

### 4.6.4.2 Local Direct Impacts

The FWLE build alternatives would not substantially change the volumes of vehicular traffic in the project vicinity, and minimal air pollutant emissions would occur during operation because light rail trains are electrically powered. In addition, light rail is anticipated to improve air quality by shifting commuters from motor vehicles to light rail transit. As presented in Table 4-6.1, data collected from CO monitoring sites in the project vicinity demonstrate that the area has not exceeded the CO NAAQS in the last 3 years. However, air quality in the project vicinity could be affected by changes in traffic flow and volumes locally and regionally and as a result of increased vehicular traffic near the light rail stations. Further, the project must meet air quality conformity standards for a CO maintenance area.

EPA has developed guidance to evaluate concentrations near roadway intersections where motor vehicle emissions can be high due to increased congestion and idling at traffic signals. Procedures and guidance used for this analysis to conduct a CO hot-spot analysis are consistent with 40 CFR 93. 123 (a) and 40 CFR Part 51, Appendix W (Guideline on Air Quality Models).

To evaluate whether the project would cause potential CO hot spots, the EPA's CAL3QHC modeling tool was used to analyze the CO levels of the impacted intersections in the project vicinity. In addition, EPA's MOVES was used to calculate CO emission rates needed as an input in the CAL3QHC model.

Traffic data were used to identify the three worst intersections (in terms of level of service) operating within the project corridor. These intersections are:

- Kent-Des Moines Road and SR 99
- Kent-Des Moines Road and I-5 southbound ramps
- Kent-Des Moines Road and Military Road S

CO emissions were modeled at each of the three intersections for existing and design year 2035 No Build and build alternative conditions. Modeling results of the 1-hour and 8-hour CO concentrations are presented in Table 4.6-5.

TABLE 4.6-5
**Modeled CO Concentrations**

| Intersection | 2014 Existing | | 2035 No Build | | 2035 Build | |
|---|---|---|---|---|---|---|
| | 1- Hour | 8-Hour | 1- Hour | 8-Hour | 1- Hour | 8-Hour |
| Kent-Des Moines Road and SR 99 (ppm) | 2.4 | 1.7 | 2.2 | 1.5 | 2.2 | 1.5 |
| Kent-Des Moines Road and I-5 Southbound Ramps (ppm) | 2.3 | 1.6 | 2.2 | 1.5 | 2.2 | 1.5 |
| Kent-Des Moines Road and Military Road S (ppm) | 2.4 | 1.7 | 2.3 | 1.6 | 1.9 | 1.3 |

Note: Background concentration is 1.8 ppm. The 1-hour and 8-hour NAAQS for CO are 35 ppm and 9 ppm, respectively.

A summary of the modeling results is shown in Table D4.6-3 in Appendix D4.6. The specified receptor CO concentrations are less than the 1-hour and 8-hour NAAQS of 35 ppm and 9 ppm, respectively, and the intersections do not require further CO hot-spot dispersion modeling; therefore, they pass the complete CO hot-spot modeling analysis. CO concentrations are not expected to exceed the NAAQS, and no additional modeling is required.

### 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 the continued reductions from the implementation of control measures for mobile sources. Regardless of the FWLE build alternative chosen, CO concentrations would not exceed the NAAQS. The project is included in the region's MTP (*Transportation 2040*, PSRC, 2010a), in the *2040 Transportation Plan Update* (PSRC, 2014a), and in the *2013-2016 Regional Transportation Improvement Program* (PSRC, 2012). The FWLE is in both the MTP and RTIP, which meets regional conformity, as demonstrated in the Transportation 2040 Update Appendix E: Regional Air Quality Conformity Analysis (PSRC, 2014b). Therefore, the FWLE has met the CAA transportation conformity requirement of being included in the financially constrained and conforming regional plans, which have been found to conform to the SIP.

As shown in Table D4.6-3, intersections in the project vicinity currently do not exceed the CO NAAQS and the FWLE would not create any new exceedances. Therefore, the project meets conformity requirements for CO. Operation of the FWLE is expected

to provide an air quality benefit to the surrounding area due to the shift of bus ridership to light rail ridership.

#### 4.6.4.4 Indirect Impacts

The traffic analysis prepared for the FWLE evaluated the long-term VMT generated by the project. As shown in Table 4.6-2, the comparison of VMT for 2035 for No Build and build alternatives indicates that an indirect air quality benefit would occur because the project would decrease traffic and reduce congestion. Improvements such as these in the project corridor would help decrease air pollutant and GHG emissions throughout the region. The use of energy to operate the light rail would indirectly add GHG emissions outside the project corridor related to energy production.

### 4.6.5 Potential Mitigation Measures

The air pollutant and GHG emissions analysis 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

The noise and vibration analysis was performed for over 5,000 noise- and vibration-sensitive properties along the SR 99 corridor and approximately 3,100 properties along the I-5 corridor. Generally there would be greater impacts for alternatives along SR 99 because there are sensitive receivers along both sides of the entire alignment, including nearby multi-family residences and motels with large numbers of units. The Kent/Des Moines HC Campus Station Option from the potential additional station at S 216th Street (West option) and the S 272nd Redondo Trench Station Option would substantially reduce the impacts from the SR 99 Alternative. The lowest number of noise impacts occurs with the I-5 Alternative with the Federal Way S 320th Park-and-Ride Station Option. Table 4.7-1 summarizes the number of noise impacts by alternative before and after mitigation. All impacts could be mitigated using a combination of sound walls and sound insulation where necessary.

TABLE 4.7-1
**Summary of Noise and Vibration Impacts**

| Alternative | Noise Impacts (Range with Options)[a] | | Vibration Impacts (Range with Options) | | Groundborne Noise Impacts | |
|---|---|---|---|---|---|---|
| | Before Mitigation | After Mitigation | Before Mitigation | After Mitigation | Before Mitigation | After Mitigation |
| **SR 99** | **3,726** (2,015-3,786) | **0** | **50** (0-271) | **0** | **1** | **0** |
| **I-5** | **1,450** (1,330-1,646) | **0** | **222** (202-225) | **0** | **0** | **0** |
| **SR 99 to I-5** | **2,190** (1,793-2,210) | **0** | **209** (209-227) | **0** | **0** | **0** |
| **I-5 to SR 99** | **2,942** (2,340-2,986) | **0** | **45** (45-238) | **0** | **1** | **0** |

[a] Moderate and severe impacts combined.

Under the SR 99 Alternative, the only vibration impact would occur at a hotel in the northern section of the corridor. The S 216th West Station Option would avoid impacting this hotel, resulting in no vibration impacts for this alternative. The SR 99 Alternative would have up to 271 vibration impacts when combined with other station options. The I-5 Alternative would have 222 potential vibration impacts, with impacts at single- and multi-family buildings, along with two hotels. There would be a groundborne noise impact at the

Federal Way High School Performing Arts Center (currently under construction) with the SR 99 and I-5 to SR 99 alternatives. Table 4.7-1 summarizes the projected noise and vibration impacts before and after potential mitigation measures. Using standard vibration-reducing methods, all vibration impacts could be mitigated.

Potential mitigation measures for noise impacts could include sound walls (barriers on the light rail guideway and/or freestanding walls), installing special track work to reduce noise levels at crossovers, and insulating residential buildings where necessary. Mitigation for vibration impacts could include resilient fasteners, ballast mats, and special track work.

## 4.7.2 Introduction to Resource and Regulatory Requirements

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

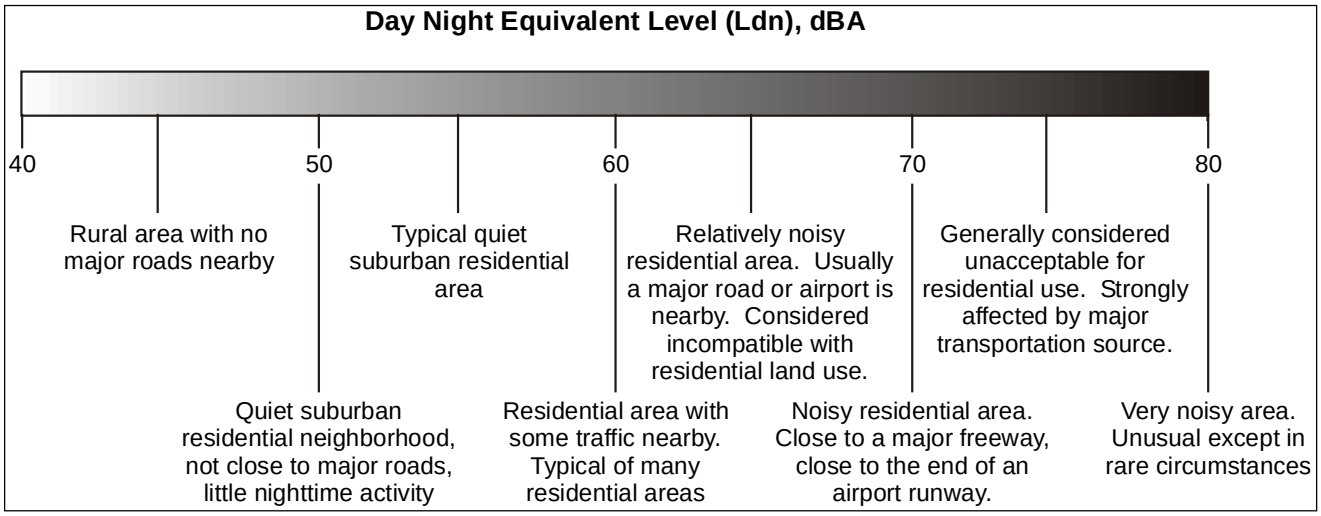
**Noise**

Noise is defined as unwanted sound; it is measured in terms of sound pressure level and is usually expressed in decibels (dB), a conversion of the air pressure to 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. To provide a measurement meaningful to humans, a weighting system was developed 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), defined below:

- **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 daytime use, such as schools and libraries.

- **Ldn:** The Ldn is an Leq over a 24-hour period, with 10 dBA added to nighttime sound levels (between 10 p.m. and 7 a.m.) as a penalty 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. Exhibit 4.7-1 graphs typical Ldn noise levels and residential land use compatibility.




*Source: Federal Transit Administration, 2006.*

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

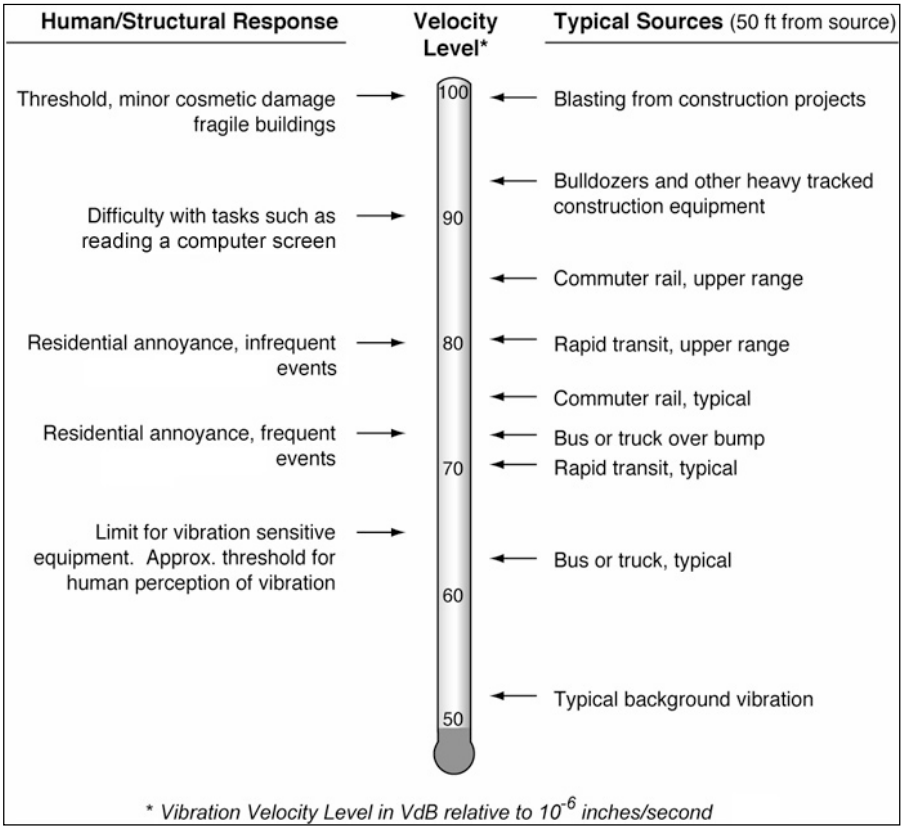
## Vibration

Groundborne vibration generated from train operations on the FWLE would be transmitted from the tracks through the soil. Vibration above certain levels can disrupt sensitive operations, and cause annoyance to humans within buildings. Transit systems rarely produce vibration with sufficient magnitude to cause any structural damage. Vibration can be measured in terms of displacement, velocity, or acceleration. The response of humans, buildings, and equipment to vibration is most accurately described using velocity or acceleration. Velocity is the preferred measure for evaluating vibration from transit projects because it is typically considered to correspond 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.

The vibration of a building could result in generation of noise inside indoor spaces from the movement of room surfaces such as walls.

This is called groundborne noise and can be experienced as a perceptible rumble. Groundborne noise levels are expressed in A-weighted decibels (dBA).

Exhibit 4.7-2 illustrates typical vibration velocity levels for common sources, as well as thresholds for human and structural response to groundborne vibration. As shown, the range of interest is from approximately 50 VdB 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.




*Source: Federal Transit Administration, 2006.*

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

### 4.7.2.2 Noise and Vibration Impact Criteria

The following sections provide an overview of the criteria used for evaluating FWLE noise and vibration impacts, which are defined by the Federal Transit Administration (FTA) for transit-related noise and vibration and by the Federal Highway Administration (FHWA) for traffic-related noise. Because this project includes funding from FTA,

the FTA methods are the governing methods for the noise and vibration analysis. The FTA noise and vibration analyses are performed based on actual land uses, not zoning designations. Therefore, under FTA methods, if a residence is located in an area zoned commercial, that property is analyzed as a residential land use with nighttime sensitivity to noise.

The potential for increased exposure to traffic noise was also evaluated 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 currently provide shielding from traffic noise.

Finally, FWLE would operate in the cities of SeaTac, Des Moines, Kent, and Federal Way, all of which are in King County. Hence, several different local noise ordinances would be applicable to the operation of ancillary facilities, such as park-and-ride lots, and traction-power substations, along with project-related construction activities. Local noise ordinances are discussed further in Appendix G3, Noise and Vibration Technical Report.

### Transit Noise Criteria

The analysis of potential noise impacts from the FWLE alternatives is based on the criteria defined in the FTA guidance manual Transit Noise and Vibration Impact Assessment (FTA, 2006). The FTA noise impact criteria are founded on well-documented research of community reaction to noise and are based on changes in existing noise levels because of the transit project. The Ldn is used to characterize noise exposure for residential areas or places where people sleep, such as hotels and hospitals (Category 2). For other noise-sensitive land uses, such as outdoor amphitheaters and school buildings (Categories 1 and 3), the maximum 1-hour Leq during the facility's operating period is used. Two levels of impacts are included in the FTA criteria: moderate, and severe. These are described in more detail in Appendix G3.

**FTA Impact Categories**

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

- Category 1: Buildings or parks where quiet is an essential element of their purpose
- 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

Parks are considered a special case under the FTA criteria. Whether a park is considered noise-sensitive is dependent on the typical uses in the park. Parks that are primarily used for recreational activities or sporting events, such as football, baseball, soccer, and other active sports and recreation, are not considered noise-sensitive. Parks that are primarily used for passive

activities, such as reading, conversation, and meditation, could be considered noise-sensitive, but only those parks with low existing noise levels.

Parks along the FWLE corridor were reviewed for their use, existing noise levels, and proximity to major noise sources, such as highways and major arterial roadways. Each of these factors was considered when evaluating parks and making the determination of the noise sensitivity of each park.

### Transit Vibration Criteria

The FTA's groundborne vibration impact criteria are based on existing land use and anticipated train frequencies. Unlike noise, the FTA vibration thresholds do not specifically account for existing vibration because it is rare that even substantial volumes of vehicular traffic, including trucks and buses, generate perceptible ground vibration unless there are irregularities in the roadway surface, such as potholes or wide expansion joints. The FTA vibration criteria are applied primarily to residential (including hotels and other places where people sleep) and institutional land uses. Commercial land uses are only considered when they contain vibration-sensitive uses, such as medical offices or sensitive manufacturing equipment. The criterion applied to these locations is dependent on the sensitivity of the use. The impact criteria are for the maximum indoor train vibration level at the sensitive receivers as a train passes. Table 4.7-2 shows the FTA vibration criteria used in this analysis. More detail on these criteria is provided in Appendix G3. Mitigation will be evaluated for all vibration impacts.

Some buildings, such as concert halls, recording studios, and theaters, can be very sensitive to vibration but do not easily fit into any of the three categories listed in Table 4.7-2. FTA categorizes them as "Special Buildings" and provides separate criteria for groundborne noise and vibration. The only building in the FWLE corridor that qualifies as a special building would be the Federal Way High School Performing Arts Center, currently under construction along the west side of SR 99 near S 308th Street. Impacts on this building were evaluated based on construction drawings provided by Federal Way Public Schools.

TABLE 4.7-2
**FTA Groundborne Vibration and Noise Impact Criteria**

| Land Use Category | Groundborne Vibration Impact Levels (VdB with reference to 1 micro inch/sec) | Groundborne Noise Impact Levels (dB with reference to 20 micro Pascals) |
|---|---|---|
| **Category 1**: Buildings where low ambient vibration is essential for interior operations | 65 VdB[a] | N/A[b] |
| **Category 2**: Residences and buildings where people normally sleep | 72 VdB | 35 dBA |
| **Category 3**: Institutional land uses with primarily daytime use | 75 VdB | 40 dBA |
| **Special Buildings-Auditorium** | 65 VdB | 25 dBA |

Source: FTA, 2006.

[a] This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes.
[b] Vibration-sensitive equipment is generally not sensitive to groundborne noise.

The Federal Way Performing Arts and Conference Center is currently being designed and reviewed by the City of Federal Way. When built, this facility would be located along S 316th Street north of the Federal Way Transit Center. The proposed auditorium would also be considered a special building. Because the design of the facility is not yet determined, potential groundborne noise and vibration effects at this location are discussed qualitatively in Chapter 6, Cumulative Impacts. Impact criteria for this type of building are provided in Table 4.7-2. Also, outdoor spaces such as parks are not considered vibration-sensitive by the FTA.

For transit systems that are at-grade or on an elevated guideway, groundborne noise is not applied to any of the three FTA categories listed in Table 4.7-2. Noise from alternatives in trenches can cause groundborne noise, but it would only be noticeable in areas with low existing noise levels (e.g., below 50 dBA). Due to higher existing noise levels in the FWLE corridor, groundborne noise is not expected to be an issue with the FWLE.

### Traffic Noise Criteria

FTA directs projects to use FHWA traffic noise assessment and mitigation processes on certain kinds of joint FTA and FHWA projects. Because the FWLE is not a joint project, FTA criteria apply.

Where a transit project could change traffic noise levels experienced by sensitive receivers (for instance, because it would relocate existing highway sound walls or remove existing structures that screen highway noise), FTA requires analysis of both transit noise impacts,

using the FTA criteria, and traffic noise impacts, using the FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise, *Code of Federal Regulations* (CFR) Title 23, Subchapter H, Section 772 (1982).

A traffic noise impact occurs if predicted traffic noise levels approach the criteria levels for specific land use categories or substantially exceed existing noise levels (e.g., a 10 dB increase). These levels are defined as noise abatement criteria (NAC), and are based on hourly Leq levels for the peak hour of traffic noise. The land use of greatest concern in the FWLE corridor would be Type B, which includes residences, motels, hotels, playgrounds, active sports areas, parks, schools, churches, libraries, and hospitals. The NAC used to determine impacts on this land use is 67 dBA. Based on the *2011 Traffic Noise Policy and Procedures* (Washington State Department of Transportation [WSDOT], 2012), a traffic noise impact occurs if predicted noise levels are within 1 dB of the NAC. Therefore, an impact to Type B land uses would occur at 66 dBA.

### Washington State and Local Noise Criteria

The cities of SeaTac, Des Moines, Kent, and Federal Way have their own local noise ordinances that would be applicable to the FWLE. In the absence of a local noise ordinance, the State of Washington defines maximum environmental noise levels (WAC 173-60). State regulations make clear that the function of noise abatement and control is left to local government (WAC 173-60-110). Therefore, the various local noise ordinances would be applicable to the operation of FWLE light rail stations/park-and-rides, and to project construction.

For stationary land uses with noises originating from outside public roadways and rights-of-way, all of the local ordinances use three classes of property use, called Environmental Designation for Noise Abatement (EDNA). The maximum allowable noise levels for each EDNA are shown in Table 4.7-3. For example, the noise caused by a commercial property must be less than 57 dBA at the closest residential property line. Between 10 p.m. and 7 a.m., the maximum allowable levels shown in Table 4.7-3 are reduced by a 10-dBA "penalty" at such a residential property line.

Construction noise is discussed in Chapter 5, Construction. More detailed information on the applicable noise regulations for each city is provided in Appendix G3.

TABLE 4.7-3
**Local Noise Limits**

| Property Usage | Maximum Allowable Sound Level (dBA) | | |
|---|---|---|---|
| | Residential | Commercial | Industrial |
| Residential | 55 | 57 | 60 |
| Commercial | 57 | 60 | 65 |
| Industrial | 60 | 65 | 70 |

Source: WAC Chapter 173-60-040. Also used by: SeaTac Municipal Code, Chapter 8.05.360; City of Des Moines Municipal Code section 7.16.010; City of Kent Municipal Code Chapter 8.05; and City of Federal Way Code Section 7.10.050.

## 4.7.3 Affected Environment

This section summarizes existing land uses along the FWLE corridor, as well as existing noise and vibration levels as measured for the FWLE analysis. 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 with different land uses than the FWLE alternatives are noted below.

#### SR 99 Alternative

Along SR 99, most of the land use is commercial, with some multi-family residences, schools, and a library. In most places, the single-family residential neighborhoods in the SR 99 corridor are not located immediately on or adjacent to SR 99.

#### Kent/Des Moines HC Campus Station Option

The distinguishing land use feature of the Kent/Des Moines HC Campus Station Option is the proximity of single- and multi-family residential neighborhoods to the alignment.

#### S 272nd Redondo Trench Station Option

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

#### I-5 Alternative

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

#### 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 to I-5 Alternative

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

### 4.7.3.2 Noise Measurements

Long-term noise monitoring locations were measured for 24 to 36 hours, while short-term monitoring locations were measured for 15 minutes. Noise levels in the project corridor are dominated by transportation-related noise sources. For 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 noise sources in the corridor include aircraft from Seattle-Tacoma International Airport (Sea-Tac Airport) and miscellaneous industrial activities, commercial activities, and local construction projects. The Ldn noise levels along the SR 99 corridor generally ranged from 61 to 69 dBA, with a few locations above and below this range.

In the I-5 corridor, noise is dominated by I-5 traffic. As with the SR 99 corridor, major and minor arterial roadways and ramps to and from the highway also contribute to the overall noise in this corridor. Lesser contributors to the noise environment include aircraft to and from Sea-Tac Airport, and construction activities. The Ldn noise levels along the I-5 corridor generally ranged from 63 to 72 dBA, with a few locations above and below this range.

A table summarizing existing conditions and maps of all monitoring locations are provided in Appendix G3.

### 4.7.3.3 Vibration Testing and Measurements

Vibration propagation tests were performed at 12 sites in the FWLE corridor, with 4 sites located along SR 99, 5 sites located along I-5, and 2 sites located along 30th Avenue. The data from the propagation testing were used in the vibration analysis. Appendix G3 contains a

table summarizing existing conditions, as well as maps of these testing locations.

## 4.7.4 Environmental Impacts

This section summarizes the models used to predict future noise and vibration levels and identifies where levels are predicted to exceed impact criteria at specific locations. These sources include light rail operation, changes in traffic due to the FWLE, and construction activities. Additional information on the technical assessment of impacts is provided in Appendix G3.

### 4.7.4.1 Methodology and Assumptions for Noise and Vibration Analysis

The light rail noise and vibration analysis was performed in accordance with FTA's 2006 guidance manual. The noise and vibration analysis that follows was performed using the conceptual FWLE design and follows the detailed analysis methods described in the FTA guidance manual.

Input to the model for the prediction of noise from train operations includes train headways, speeds, and measured reference noise levels of the existing fleet of Sound Transit light rail vehicles. Noise measurements of actual train operations on Central Link were used and allow more accurate noise modeling for future light rail conditions of other Sound Transit projects. Also included in the modeling were the elevations of properties, shielding and topographical features, and information on the track type. Noise levels associated with train-mounted warning bells were modeled in accordance with Sound Transit policy for audible warning devices. No at-grade road crossings would occur with any of the FWLE alternatives; therefore, there would be no potential for noise impacts from warning bells at such crossings. The model does not assume wheel squeal because under Sound Transit's light rail design criteria, any curves with a radius of less than 1,250 feet near noise-sensitive properties must be built to allow for subsequent lubrication. This lets Sound Transit add lubricators if wheel squeal occurs during system operation. The FTA noise assessment methodology was also applied to the park-and-rides and transit centers as stationary transit facilities.

The potential to create or increase exposure to traffic noise because of the transit project was evaluated qualitatively. As defined in FHWA noise abatement policy (FHWA, 2011), changes in the traffic noise

environment could occur if the project creates new or alters existing roadways in relation to noise-sensitive properties, or changes the pathway for traffic noise by removing or altering barriers (buildings, berms, or walls) that currently provide some level of shielding from traffic noise. These locations were identified and evaluated for potential traffic noise impacts based on existing noise measurements and FHWA impact criteria.

The prediction of groundborne vibration from train operations for the FWLE alternatives used measured vibration levels from Sound Transit's Central Link corridor and vibration propagation tests performed along the FWLE alternatives.

#### 4.7.4.2 No Build Alternative

With the No Build Alternative, noise levels in the project corridor would continue to be dominated by other transportation-related noise sources, including cars, trucks, and aircraft from Sea-Tac Airport. Other noise sources could include miscellaneous industrial activities, commercial activities, and local construction projects. With the No Build Alternative, there would be no light rail project, and therefore no light rail-related noise or vibration.

#### 4.7.4.3 Noise Impacts from Build Alternatives

This section provides a summary of the number of predicted noise impacts from each of the FWLE alternatives from light rail operations without mitigation. Along the SR 99 corridor, there were over 5,000 units evaluated for noise impacts, and along I-5, there were approximately 3,100 units evaluated for noise impacts. The actual number of units may vary slightly based on alternative and station options because of the many multi-family buildings and hotels along the corridors. Table 4.7-4 summarizes the projected noise impacts by alternative, the range of impacts with station and alignment options, and proposed mitigation. The low and high ends of the impact range can reflect a combination of options to capture the minimum and maximum potential impacts. Most impacts could be mitigated with sound walls, but some impacts are expected to require residential sound insulation as well where walls cannot be built tall enough to fully mitigate impacts. The number of units that are expected to require insulation is provided in parentheses in the mitigation column of Table 4.7-4. Details on projected impacts for each individual station and alignment option are included in Appendix G3 and described further in this section.

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

| Alternative | Light Rail Noise Impacts (Range with Options)[a] | Potential Mitigation[b] |
|---|---|---|
| **SR 99 Alternative** | **3,726** (1,738-3,786) | Sound walls and insulation where necessary (79 to 228) |
| **I-5 Alternative** | **1,450** (1,330-1,646) | Sound walls and insulation where necessary (1) |
| **SR 99 to I-5 Alternative** | **2,190** (1,793-2,210) | Sound walls and insulation where necessary (25) |
| **I-5 to SR 99 Alternative** | **2,942** (2,273-2,986) | Sound walls and insulation where necessary (79 to 228) |

[a] Moderate and severe impacts combined.
[b] Numbers in parentheses indicate the number of units where residential insulation would be necessary because sound walls may not fully mitigate impacts.

## SR 99 Alternative

There would be 3,726 noise impacts with the SR 99 Alternative. The impacts would be distributed throughout the length of the alternative, and many of the properties where impacts would occur are multi-family complexes or motels, which contributes to the high number of impacts.

There would be a noise impact at the easternmost part of the Federal Way High School, with operational noise levels just meeting the FTA impact criteria. In addition, exterior noise levels at the new Federal Way High School Performing Arts Center would result in an impact. It is important to note that the noise impact predicted for Federal Way High School is an exterior noise impact. The typical mitigation measures used by Sound Transit are to first mitigate at the source, which would include installing sound walls between the light rail and the school. As a new building under construction adjacent to SR 99, the building may have sufficient exterior to interior noise reduction. Based on a review of the building design, the interior noise levels at all noise-sensitive parts of the school are estimated to be 35 to 45 dB (or more) lower than the exterior noise levels, and therefore no interior noise impacts are expected. If this alternative is advanced, additional acoustical testing may be performed when construction is complete to determine the exterior-to-interior noise reduction and verify that noise levels in classrooms, the performing arts area, and other noise-sensitive parts of the building are within the applicable standards.

Other Category 3 land uses (including schools, libraries, and churches) with noise impacts along the SR 99 corridor include the Citadel

Church, the Open Door Baptist Church, the Seattle Full Gospel Church, the Woodmont Library, the Rissho Kosei Kai of Seattle Buddhist Learning Center, Church of Christ West Campus, the Jesus Christ Salt and Light Church, and the Smart Start Day Care.

For all options discussed below that are located on the side of SR 99, noise impacts would generally be greater on the side of the road the alignment would be located on, while impacts on the opposite side of the road would be less.

**S 216th Station Options**

The potential additional station at S 216th Street (West option) would reduce the number of noise impacts by 277 because the alignment would be relocated in a trench along the west side of SR 99, farther away from several multi-family buildings. With this option, there would be one less Category 3 noise impact, because the Jesus Christ Salt and Light Church would no longer have a noise impact.

With the potential additional station at S 216th Street (East option), the number of impacts would decrease by 14. Category 3 noise impacts with the S 216th East Station Option would be the same as discussed above under the SR 99 Alternative.

**Kent/Des Moines Station Options**

The Kent/Des Moines HC Campus Station Option would be closer to the residences west of SR 99 but would decrease the number of impacts by 154 because it would mostly be located in a trench. If the Kent/Des Moines HC Campus Station Option were to connect to the S 216th West Station Option however, there would be a substantial decrease in impacts (1,042) due to the alignment being located in a trench for the majority of the distance. Category 3 impacts would no longer occur for the Citadel Church and Open Door Baptist Church because both would be displaced by this option.

Under the Kent/Des Moines SR 99 Median Station Option, there would be 8 more noise impacts because of moving closer to noise-sensitive receivers on the east side of SR 99. There would be no change in the Category 3 noise impacts.

The Kent/Des Moines SR 99 East Station Option would increase noise impacts by 16 because of moving closer to noise-sensitive receivers on the east side of SR 99. The Category 3 noise impacts with this option would be the same as under the SR 99 Alternative.

### S 260th Station Options

With the potential additional station at S 260th Street (West option), noise impacts would be reduced by 150 because of a greater distance from noise-sensitive receivers and less development on the east side of SR 99 in this area. FTA Category 3 noise impacts would be the same as under the SR 99 Alternative, with the exception of the Woodmont Library, where the alignment would be farther away and the noise levels would be lower, thus eliminating this impact.

With the potential additional station at S 260th Street (East option), noise impacts would be reduced by 6. There is also one fewer FTA Category 3 noise impact under the S 260th West Station Option because of the displacement of the Seattle Full Gospel Church.

### S 272nd Redondo Trench Station Option

With the S 272nd Redondo Trench Station Option, noise impacts would be reduced by 519 because the option would be located in a trench for most of its length. FTA Category 3 noise impacts would be reduced by two, at the Woodmont Library and Smart Start Day Care.

### Federal Way SR 99 Station Option

Relative to the SR 99 Alternative, the Federal Way SR 99 Station Option would have 44 additional impacts because a hotel that would be displaced by the SR 99 Alternative would remain with this option. FTA Category 3 impacts would be the same as with the SR 99 Alternative.

## I-5 Alternative

The I-5 Alternative would have 1,450 noise impacts. All impacts would be to single- and multi-family residences and hotels. The impacts would be distributed throughout the entire length of the alternative, and many of the properties where impacts would occur are multi-family complexes or motels, which would increase the number of impacts. There are no FTA Category 3 noise impacts under the I-5 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 is in a deep covered trench, which would shield the school from the noise.

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

### Kent/Des Moines Station Options

With the Kent/Des Moines At-Grade Station Option, the number of impacts would increase by 41. The change in noise impacts would be

due to the realignment of the guideway and a difference in displacements near the Kent/Des Moines At-Grade Station.

With the Kent/Des Moines SR 99 East Station Option, there would be an increase of 103 impacts because the alignment would move closer to SR 99, which is closer to more noise-sensitive receivers.

**Landfill Median Alignment Option**

With the Landfill Median Alignment Option, there would be additional noise impacts along the east side of I-5 where the alignment would be in the I-5 median. Some impacts near S 244th Street on the west side of I-5 would not occur due to the alignment moving farther to the east compared to the I-5 Alternative. This would increase noise impacts by 73. No Category 3 impacts were identified under the Landfill Median Alignment Option.

**Federal Way City Center Station Options**

Relative to the I-5 Alternative, the Federal Way I-5 Station Option would increase impacts by 20 because of new impacts at a hotel near the Federal Way I-5 Station Option. No new Category 3 impacts were identified with the Federal Way I-5 Station Option.

With the Federal Way S 320th Park-and-Ride Station Option, the alignment would be farther away from several large multi-family complexes north of S 317th Street. This would reduce noise impacts by 120, although there would be new impacts on a hotel and mobile home park south of S 320th Street.

### SR 99 to I-5 Alternative

With the SR 99 to I-5 Alternative, there would be 2,190 noise impacts. North of Kent-Des Moines Road, the impacts would be similar to the SR 99 Alternative.

As the alignment transitions from SR 99 to I-5 near the Kent-Des Moines Road, there would be 419 impacts. South of S 240th Street, the impacts would be the same as with the I-5 Alternative. Three Category 3 noise impacts were identified under the SR 99 to I-5 Alternative, at the Citadel Church, the Open Door Baptist Church, and the Jesus Christ Salt and Light Church.

Impacts from station options would be the same as described above under the SR 99 or I-5 alternatives.

### I-5 to SR 99 Alternative

With the I-5 to SR 99 Alternative, there would be 2,942 noise impacts. North of Kent-Des Moines Road, the impacts would be the same as

with the I-5 Alternative. As the alignment transitions from I-5 to SR 99 near the Kent-Des Moines Road, there would be 202 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 described above under the SR 99 or I-5 alternatives with the exception of the S 260th West Station Option. This option would only reduce the number of noise impacts by 83 (less than would occur 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 and Stations

Noise from park-and-rides and stations with parking lots and garages was evaluated for noise impacts under the FTA and local noise control ordinances. For all stations and station options, no impacts would occur under the FTA criteria for station impacts.

##### SR 99 Alternative Stations

Under the SR 99 Alternative, there are 8 noise impacts predicted under the local noise ordinance at a mobile home park near the Kent/Des Moines SR 99 West Station Option. No noise impacts are predicted near the S 272nd Redondo Station or the Federal Way Transit Center under the local noise ordinances.

###### SR 99 Station Options

The Kent/Des Moines HC Campus Station Option would have no noise impacts from the park-and-ride or station. 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 under the local noise ordinances.

##### I-5 Alternative Stations

There are no station-related noise impacts predicted under the I-5 Alternative.

###### I-5 Station Options

The only I-5 station option with a change in noise impacts is the Kent/Des Moines SR 99 East Station Option, with 8 noise impacts at a mobile home park under the local noise ordinance. The Kent/Des Moines At-Grade Station Option, Federal Way I-5 Station Option, and Federal Way S 320th Park-and-Ride Station Option would all have no noise impacts.

### SR 99 to I-5 Alternative

There are no station-related noise impacts predicted under the SR 99 to I-5 Alternative. None of the station options would have any impacts.

### I-5 to SR 99 Alternative

With the Kent/Des Moines 30th Avenue West Station Option there would be 8 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, and no station noise impacts are predicted for the station options.

## 4.7.4.5 Traffic Noise Assessment

There are a limited number of locations in the project corridor where new roads would be constructed or where existing shielding would be removed (in the case of buildings) or relocated (in the case of existing sound walls). Predicted noise impacts from light rail operations, particularly from elevated alignments, can affect two to three rows of noise-sensitive receivers. Where the light rail alignment is within or adjacent to roadways or the highway, it is unlikely that potential increases in exposure to existing traffic noise would occur at properties not already identified as impacted by light rail noise. In addition, the light rail guideway (including sound barriers for light rail noise mitigation) and other project elements (such as garage structures or elevated stations) would provide some shielding from traffic noise. Areas with potential for increased traffic noise levels are described by alternative below. Traffic noise will be evaluated in the Final EIS for the Preferred Alternative where the conditions described above occur.

### SR 99 Alternative

There are multiple locations along the SR 99 corridor that currently meet or exceed 66 dBA during the peak hour of traffic noise. 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 the area. In areas with cross streets that are also major arterials with high traffic volumes, the distance to the NAC could increase to over 400 feet, as noise from some major arterials also currently meets or exceeds the NAC.

Areas where property acquisitions and roadway alterations associated with the SR 99 Alternative might result in traffic noise levels exceeding the NAC at nearby homes include:

- The new S 236th Lane 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

Other areas affected by the SR 99 Alternative could have increased exposure to traffic noise by removal of buildings. Properties in these areas would already be subject to light rail noise impacts and/or park-and-ride noise impacts (if located near a station). The design of the station and parking structures may provide new shielding and reduce the potential for traffic noise impacts.

***SR 99 Station Options***

Exposure to traffic noise could occur with the all station options where buildings that currently provide shielding would be removed, except the Kent/Des Moines HC Campus Station Option and the Federal Way SR 99 Station Option. Properties that could have increased exposure to traffic noise in these areas would already be subject to light rail noise impacts.

**I-5 Alternative**

Traffic noise at properties adjacent to I-5 may currently be influenced by physical shielding (e.g., from berms and other structures), noise walls, and topography. In most areas, existing noise levels are 66 dBA or greater. Based on measured noise levels and proximity to I-5 travel lanes, the NAC is exceeded at distances up to 400 to 600 feet from I-5, and most existing shielding is not effective at reducing noise levels. For example, typical daytime noise levels behind an existing traffic noise wall at the Camelot Square Manufactured Home Park were measured at 69 to 73 dBA Leq.

Areas where property acquisitions and roadway alterations associated with the I-5 Alternative might result in traffic noise levels exceeding the NAC at nearby homes include:

- The new S 236th Lane that would be constructed for access to the Kent/Des Moines station and/or parking

- The realignment of 28th Avenue S north of the Star Lake Park-and-Ride

Other areas affected by the I-5 Alternative could have increased exposure to traffic noise by removal of buildings. In addition, an existing sound wall would be relocated at the Camelot Square Mobile Home Park, south of S 288th Street.

The design of the station and parking structures may also provide new shielding and reduce the potential for traffic noise impacts where they could occur near stations.

***I-5 Station and Alignment Options***

The only station or alignment option that would have potential for traffic noise impacts would be the Federal Way S 320th Park-and-Ride Station Option, where there would be a loss of shielding south of S 324th Street on the east side of the Belmor Mobile Home Park. 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.

**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 I-5 Alternative south of S 240th Street. The Kent/Des Moines 30th Avenue East Station would also include the S 236th Lane extension and therefore would have potential for traffic noise impacts. As with the SR 99 and I-5 alternatives, mitigation for park-and-ride noise may mitigate any traffic noise impacts as well. 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 I-5 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 Lane extension and therefore would have potential for traffic noise impacts. As with the SR 99 and I-5 alternatives, mitigation for park-and-ride noise may mitigate any traffic noise impacts as well. 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 4.7-5 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 determined following additional testing that is performed during preliminary or final project design.

TABLE 4.7-5
**Summary of Projected Vibration Impacts from Light Rail Operations**

| Alternative | Number of Vibration Impacts (Range with Options) | | Potential Mitigation[a,b] |
|---|---|---|---|
| | Before Mitigation | After Mitigation | |
| **SR 99 Alternative** | **50** (0-271) | **0** (0-0) | HCDF |
| **I-5 Alternative** | **222** (202-225) | **0** (0-0) | HCDF, LIC, and ballast mat |
| **SR 99 to I-5 Alternative** | **209** (209-227) | **0** (0-0) | HCDF |
| **I-5 to SR 99 Alternative** | **45** (45-238) | **0** (0) | HCDF |

[a] HCDF = high-compliance direct-fixation fastener. It is used as mitigation for aerial sections with direct-fixation tracks. 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.
[b] LIC = low-impact crossover, or special track work. A LIC is a crossover where the gap in the rail is closed, preventing increased vibration as the train crosses over the crossover.

The impacts identified and described in the sections below are based on the distance between the proposed tracks and the individual buildings, the type of track (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 elevated structures. Because the vibration from elevated structures enters the ground at the location of the guideway columns, this analysis assumes that columns could be installed anywhere along the alignment. During preliminary or final design, the actual location of the support pillars would be developed and the vibration analysis would be revised, which could result in a reduction in the number of vibration impacts.

#### SR 99 Alternative

Under the SR 99 Alternative, there would be 50 vibration impacts at a hotel with two buildings. No other vibration impacts are predicted because the alignment is mainly in the center of the roadway on structure, reducing the level of vibration emitted to the ground.

##### S 216th Station Options

The potential additional station at S 216th Street (West option) would not have any vibration impacts, a decrease in 50 impacts. With the

potential additional station at S 216th Street (East option), additional vibration impacts would occur at one hotel.

**Kent/Des Moines Station Options**

With the Kent/Des Moines HC Campus Station Option, there would be 12 additional vibration impacts at multi-family buildings. If the Kent/Des Moines HC Campus Station Option were connected to the S 216th West Station Option, there would be vibration impacts at six additional single- and multi-family residences along this alignment. Fifty impacts would no longer occur at a hotel that would be displaced, however, and the overall number of impacts with this combination would decrease by 22. Finally, the other two Kent/Des Moines station options, SR 99 Median and SR 99 East, would not have any additional impacts.

**S 260th Station Options**

With the potential additional station at S 260th Street (West option), there would be three additional potential vibration impacts at multi-family residences. With the potential additional station at S 260th Street (East option), there would be potential vibration impacts at two additional single-family residences along the alignment.

**S 272nd Redondo Trench Station Option**

With the S 272nd Redondo Trench Station Option, 181 additional vibration impacts would occur at single-family residences, multi-family residences, and one hotel.

**Federal Way SR 99 Station Option**

There would be no additional vibration impacts with the Federal Way SR 99 Station Option.

### I-5 Alternative

There would be 10 properties, representing 222 units, which would have vibration levels that exceed the FTA vibration criteria with the I-5 Alternative. Impacts would occur at two single-family residences, six multi-family residences, and two hotels. There would be no additional impacts with the Landfill Median Alignment Option.

**Kent/Des Moines Station Options**

With the Kent/Des Moines At-Grade Station Option, potential vibration impacts would occur at one additional single-family property. With the Kent/Des Moines SR 99 East Station Option, there would be 20 fewer vibration impacts.

**Federal Way City Center Station Options**

The Federal Way I-5 Station Option would not have any additional impacts. The Federal Way S 320th Park-and-Ride Station Option would have potential vibration impacts at one mobile home park.

### SR 99 to I-5 Alternative

The SR 99 to I-5 Alternative would have 209 impacts, with impacts north of Kent-Des Moines Road the same as the I-5 Alternative and the impacts south of S 240th Street the same as the SR 99 Alternative. There would be 1 multi-family structure with a total of 2 units that would have vibration levels exceeding the FTA vibration criteria along 30th Avenue South between Kent-Des Moines Road and S 240th Street.

Impacts with the S 216th West and Federal Way I-5 station options would be the same as described above under the SR 99 and I-5 alternatives.

### I-5 to SR 99 Alternative

The I-5 to SR 99 Alternative would have 58 impacts, with impacts north of Kent-Des Moines Road the same as the SR 99 Alternative, and impacts south of S 240th Street the same as the I-5 Alternative. Impacts under the Federal Way SR 99 Station Option are the same as the I-5 to SR 99 Alternative.

Impacts from station options would be the same as described above under the SR 99 or I-5 alternatives for applicable station and alignment options, except for the S 260th West Station Option. For this option, there would be no additional impacts because it would be located farther from the sensitive receivers on the west side of SR 99 that are impacted with this option when it connects to the SR 99 Alternative.

## 4.7.4.7 Groundborne Noise Impacts

Groundborne noise impacts were not assessed for FTA Category 1, 2, and 3 sensitive receivers because the track for all alternatives and options is above or just below ground level and airborne noise effects from normal operations are higher than those from groundborne noise. The Performing Arts Center at Federal Way High School (currently under construction), which qualifies as a special building, would be located within 100 feet of the proposed tracks for the SR 99 Alternative and the I-5 to SR 99 Alternative. Groundborne noise levels at this location would be 35 dBA, which is 10 dBA above the FTA criteria of 25 dBA, resulting in a potential groundborne noise impact

on this facility from these alternatives. There are no special buildings near the I-5 Alternative and the SR 99 to I-5 Alternative, and therefore there are no groundborne noise impacts for these alternatives.

## 4.7.5 Potential Mitigation Measures

### 4.7.5.1 Noise Mitigation

Sound Transit is committed to minimizing noise levels at the source for all transit corridors it operates, including the FWLE. This includes using state-of-the-art vehicles equipped with wheel skirts to reduce noise. In addition, Sound Transit has committed to a maintenance program that includes periodic rail grinding or replacement, wheel truing or replacement, vehicle maintenance, operator training, and lubrication of curves with a radius of less than 600 feet near noise-sensitive areas, which all help to reduce noise levels along transit corridors. For noise impacts that would still exist after these source noise treatments, potential noise mitigation measures that are consistent with Sound Transit's Light Rail Noise Mitigation Policy (Motion No. M2004-08) would be provided. During final design, all potential impacts and mitigation measures would be reviewed for confirmation. During preliminary and final design, if it is discovered that mitigation could be achieved by a less costly means or if the detailed analysis shows no impact, then a mitigation measure may be eliminated or modified. After light rail operations have started, if the resulting noise exceeds FTA criteria, then more mitigation may be required.

The potential mitigation options available for noise from FWLE transit operations would primarily be sound walls. Sound walls would be proposed where feasible and reasonable, as determined by Sound Transit based on specific site conditions. Sound walls would be located along the side of the guideway structure for elevated profiles, and on the ground for at-grade or trench profiles. Sound walls are preferred because they are effective at reducing noise at the source.

Another potential mitigation measure is special track work, which includes movable point or spring rail frogs, which eliminate the gap between tracks at crossovers that causes noise and vibration at these locations.

When source mitigation measures or sound walls are infeasible or not entirely effective at reducing noise levels below the FTA impact criteria, residential sound insulation would be evaluated and implemented for affected properties where the existing building does

not already achieve a sufficient exterior-to-interior reduction of noise levels. Most new buildings have good exterior-to-interior noise reduction, and additional sound insulation might not be necessary.

#### 4.7.5.2 Park-and-Ride and Station Noise Mitigation

Noise mitigation for the park-and-rides includes station design and sound walls. Station design can include designing the parking garages with short noise barriers, and modifying the entrances and exits to place them away from nearby noise-sensitive properties. In addition, noise barriers can be placed between the station and the noise-sensitive properties, reducing noise levels and eliminating noise impacts.

#### 4.7.5.3 Potential Traffic Noise Mitigation

Potential traffic noise impacts could likely be mitigated in conjunction with the proposed light rail mitigation. In most of these areas, mitigation for impacts specific to traffic noise would be considered where mitigation for transit or park-and-ride noise impacts is not sufficient.

Additional mitigation may need to be considered for the realignment of 28th Avenue S and the north end of Camelot Square Mobile Home Park, where the I-5 Alternative would be elevated over S 288th Street and the existing sound wall would be relocated. The replacement sound wall would be modeled using future traffic volumes for the project design year (2035) to assure that it would continue to mitigate traffic noise into the future. The replacement sound wall would be designed such that there would be no new traffic noise impacts and no increase in the severity of any existing traffic noise impacts. The wall may also be designed to mitigate any light-rail-related noise impacts in addition to the traffic noise.

#### 4.7.5.4 Vibration and Groundborne Noise Mitigation

Vibration and groundborne noise impacts that exceed FTA criteria would be mitigated when determined to be reasonable and feasible. The locations requiring mitigation would be refined during the FWLE preliminary and final design process. There are some locations where the light rail guideways would be close to buildings; therefore, vibration mitigation might be more difficult.

Mitigation could include the use of high compliance direct fixation (HCDF) fasteners to provide vibration isolation between rails and concrete slabs. These fasteners include a resilient element between

the rail and concrete to provide greater vibration isolation than standard rail fasteners.

For at-grade segments, where ballast and tie track are used, there are two potential forms of vibration mitigation. The most common form is the use of ballast mats, which consist of a pad made of rubber or rubberlike material placed on an asphalt or concrete base with the normal ballast, ties, and rail on top. The reduction in groundborne vibration provided by a ballast mat is strongly dependent on the vibration frequency content and the design and support of the mat. A relatively new form of vibration mitigation for ballast and tie installations includes the use of tire-derived aggregate (TDA), instead of the standard ballast. TDA consists of shredded tires wrapped with filter fabric that is added to the base below the track ties.

To mitigate vibration impacts related to the added vibration from track crossovers, special track work could be employed. Special track work includes movable point or spring rail frogs, which eliminate the gap between tracks at crossovers that causes increased vibration.