4.5 NOISE

Highway congestion relief projects have the potential to create noise impacts on the surrounding community. The potential for adverse impacts is greatest where there are noise sensitive land uses (or "noise receptors"). Noise sensitive receptors include residential development and a variety of non-residential land uses that could be impacted by highway noise such as parks and golf courses.

Highway noise is a combination of sound from the engine, exhaust, and tires of vehicles travelling on the highway. An increase in traffic volumes, vehicle speeds, or the percentage of heavy trucks on the roadway increases traffic noise levels. Defective mufflers, truck compression braking, steep grades, type of pavement (asphalt, concrete), condition and age of the pavement, terrain and vegetation near the roadway, shielding by earth berms, barriers and buildings, and the distance from the road all contribute to the traffic noise environment at the side of the road. Types of human activities nearby such as industrial or commercial, recreational parks and rest areas, may affect the current and projected noise levels next to the highway.

4.5.1 What Methods, Assumptions and Resources Were Considered in the Noise Evaluation?

The noise evaluation is based on FHWA and WSDOT regulations related to acceptable noise levels that protect public health and quality of life. Construction of a new roadway, re-alignment of interchanges, and addition of a new lane qualifies the Build Alternative as a Type 1 project. Type 1 projects require a noise study per the WSDOT 2011 *Traffic Noise Policy and Procedures Manual*.

State policy also requires the review and consideration of noise abatement on projects that create an adverse impact for which abatement is both feasible and reasonable to implement. Abatement in the form of noise walls was recommended at several locations for the Build Alternative to shield noise-sensitive receptors.

A traffic noise study was conducted using the FHWA Traffic Noise Model (TNM) version 2.5. The model was used to predict existing (2015) noise conditions in the noise analysis study area and to evaluate potential noise impacts in 2040 (design year) with the No Build and Build Alternatives.

NOTE TO READER: *This EA provides a tiered environmental review. Chapter 4 evaluates the project specific environmental impacts associated with construction of the North Study Area Build Alternative (See Section 3.4 for description). Chapter 5 provides a corridor level discussion of the South Study Area (See Section 3.5). Specific project footprint improvements are not currently defined for the South Study Area.*

How Is Traffic Noise Measured?

Traffic noise is the sound generated on streets and highways by motor vehicles. The relative loudness of noise (and all sound) is described in units called decibels (dB), a measure of sound pressure on a logarithmic scale. The human ear does not respond to all frequencies or changes in noise levels equally. As a result, sound levels (measured in dB) are adjusted to better reflect how an average person hears. The adjusted sounds are called "A-weighted levels" (or dBA). The A-weighted decibel scale begins at zero and represents the threshold of human hearing. Typical noise levels begin as soft as normal breathing at 10 dBA which is barely audible. Normal conversation at a distance of 3 feet is 60 dBA while highway traffic is typical 70 dBA at 50 feet. Construction equipment noise such as a generator is 85 dBA at 50 feet. Noise levels above 80 dBA are typically described as annoying. Perception of loudness varies from person to person, so there is no precise definition of loudness.

Traffic noise is averaged over peak traffic periods and expressed as an equivalent noise level (Leq). Thus, traffic noise conditions are generally discussed in terms of hourly average weighted noise levels in decibels, or Leq dBA.

How Are Traffic Noise Impacts Identified?

The FHWA has established criteria for identifying when noise impacts occur and when abatement should be considered. These Noise Abatement Criteria (NAC) are identified for varying land activity categories Highway Traffic Noise Analysis and Abatement Guideline. FHWA defines a traffic noise impact for a land use category as a predicted traffic noise level that approaches or exceeds the NAC shown in Table 4.5-1, or a substantial increase above the existing noise levels, but leaves the definition of "approach" and "substantial increase" to the individual states. The WSDOT 2011 *Traffic Noise Policy and Procedures Manual* defines "approach" as 1 dBA below the FHWA NAC and a "substantial increase" as an increase of 10 dBA or more over the existing noise levels, even if it does not approach the FHWA NAC (WSDOT 2012).

How Was the Noise Study Area Determined?

The Traffic Noise Study covers the I-5 mainline from Gravelly Lake Drive to Steilacoom-DuPont Road, and two areas where existing interchanges would be modified. The geographical coverage of

Table 4.5-1 *FHWA Noise Abatement Criteria by Land Use*

Land Use Category	Leq(h)	Evaluation Location	Activity Description
Category A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose
Category B*	67	Exterior	Residential
Category C*	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
Category D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
Category E*	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in Categories A through D or F
Category F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
Category G	--	--	Undeveloped lands that are not permitted

** Includes undeveloped lands permitted for this activity category.*
Source: 23 CFR, Part 772 (FHWA 2010)

existing noise study area was determined using the WSDOT 2011 *Traffic Noise Policy and Procedures Manual* with a straight-line model based on the FHWA Traffic Noise Model version 2.5. A 650-foot limit from the existing edge of pavement along I-5 was used as a starting point for the noise study area. During analysis, this boundary was modified to 500 feet or less at some locations because noise measurements indicated that all noise levels above the impact threshold were contained within the 500-foot distance from I-5.

What Are Current Land Uses in the Study Area?

For the majority of the study area, I-5 runs through JBLM with Lewis Main to the east and Tillicum, Camp Murray, Lewis North and portions of DuPont to the west. On JBLM there are military housing neighborhood areas, along with administrative and support buildings, primarily on the east side of I-5. On the west side of I-5 there are commercial and residential areas in Tillicum and DuPont, administrative and support buildings on Camp Murray, and open spaces, vehicle storage, and the Red Shield Inn/Lewis Army Museum.

How Was the Noise Analysis Conducted?

The FHWA-approved noise model (TNM2.5) was used to characterize the existing noise environment and predict future traffic noise levels with the No Build and Build Alternatives. TNM2.5 accounts for roadway and receiver location and roadway geometry, traffic volumes and speeds, intersection control, vehicle classifications, and surface and topographic features affecting noise propagation. From these data, the model calculates hourly equivalent sound levels (Leq dBA) from vehicular traffic.

Existing and proposed roadway alignments and elevations are based on design information and geographic information system (GIS) data. The following assumptions are inherent in the noise analysis:

- I-5 is at-grade throughout most of the study area except at the Steilacoom-DuPont Road, Berkeley Street, and Gravelly Lake Drive overpasses where it is depressed, and at 41st Division Drive where it is on structure.
- I-5 traffic noise is partially shielded at the Steilacoom-DuPont Road, Berkeley Street, and Gravelly Lake Drive overpasses as it runs below these cross streets. I-5 currently has three travel lanes in each direction in the study area.
- Interchanges at Thorne Lane and Berkeley Street would be re-built in configurations that are laterally offset from the existing interchanges and at higher elevations to provide grade-separation with the railroad that runs west of and parallel to I-5.
- The Build Alternative would maintain existing I-5 travel speeds (posted for 60 mph).

Ambient noise levels were measured to identify major noise sources in the study area, and to validate the noise model. Short-term, 15-minute, noise measurements were monitored at 101 locations representative of all sound level environments within the study area during free-flow traffic conditions. FHWA allows 15-min Leq measurements to represent the hourly Leq(h). These traffic noise measurements are not a representation of "average" existing noise levels. Measured noise levels ranged from 53 dBA Leq to 79 dBA Leq dependent upon their proximity to I-5. The traffic noise measurements were not used to describe existing conditions. Instead, the existing noise conditions described in this report were outputs of the model after the noise model data had been validated.

Short-term noise events from aircraft, railroad trains, and traffic on side streets all contribute to the noise environment in the study area. However, the primary noise source throughout the study area is from vehicles travelling on I-5.

4.5.2 What Are Existing Noise Conditions in the Study Area?

Traffic noise from I-5 is the primary noise source in the study area and results in existing noise levels above the 66 dBA WSDOT Noise Abatement Criteria. Other sources of noise include JBLM flight operations, rail activity and JBLM artillery operations. However, this report only analyzes traffic noise sources and their effects on noise-sensitive land uses in the study area.

What Areas Are Currently Experiencing Noise Impacts?

A total of 331 locations were modeled to characterize the existing (2015) noise environment within the North Study Area. Existing modeled worst-hour traffic noise levels for residential areas range from 53 dBA to 79 dBA. The modeled noise levels at these receivers depend on the proximity of the receiver to I-5 and the relatively flat terrain that lies next to much of the study area.

A total of 169 locations currently experience traffic noise levels at or above the NAC of 66 dBA. Receiver locations include single and multi-family residences (largely within the Tillicum, Tacoma Country and Golf Club and JBLM neighborhoods), parks, museums (one each at Camp Murray and JBLM), a golf course, an auditorium at Camp Murray, the JBLM Community Center, hotels, offices, and the JBLM Family Resource Center. These locations included land uses in Activity Categories B and C.

4.5.3 What Would Be the Impact of the No Build Alternative?

Similar to existing conditions, 2040 modeled traffic noise levels for the No Build Alternative in residential portions of the North Study Area would range from 53 dBA to 78 dBA. The modeled noise levels at these receivers depend on the proximity of the receiver to I-5, and the relatively flat terrain with direct line-of-sight to the highway.

Of the 331 total receiver locations modeled in 2040 with the No Build Alternative, 132 are expected to experience future traffic noise levels at or above the NAC of 66 dBA. 2040 receiver locations are the same as the existing condition receivers with 37 fewer receivers experiencing an impact compared to existing conditions. It should be noted that this reduction in impacted receivers is, in part, due to JBLM's plans to demolish 109 houses between Thorne Lane and Gravelly Lake Drive along the east side of I-5. These receivers were identified as currently impacted, but were not included in the analysis of the 2040 No Build and Build Alternatives.

Roadway traffic noise levels under the No Build Alternative would not result in a noticeable change in noise levels as compared to existing conditions. For most receivers in proximity to I-5, noise levels in 2040 with the No Build Alternative would be within one to three dBA of existing noise levels. It is unlikely that this nominal difference would be perceptible to the human ear.

4.5.4 What Would Be the Long-Term Impact of the Build Alternative?

As with existing conditions and similar to the 2040 No Build Alternative, 2040 modeled traffic noise levels with the Build Alternative for residential areas ranged from 53 dBA to 79 dBA. Of the 331 total receiver locations modeled in 2040 with the Build Alternative, 140 are expected to experience future traffic noise levels at or above the NAC of 66 dBA. This is eight more impacted receivers than with the No Build Alternative due to changes in roadway alignment resulting from the Build Alternative.

Traffic noise levels under the Build Alternative would result in a small change (1 to 2 dBA) in noise levels compared to the No Build Alternative. These small changes are not perceptible to the human ear. Therefore, any changes in sound level from the No Build to

the Build Alternative would generally not be noticeable. Table 4.5-2 compares expected number of noise impacted locations by alternative including existing conditions (2015), the 2040 No Build Alternative, and the 2040 Build Alternative.

Table 4.5-2 *Summary of Locations Exceeding Noise Abatement Criteria by Alternative*

	Number of Locations That Exceed Noise Abatement Criteria		
	2015	2040 No Build	2040 Build
Total Impacted Locations	169	132	140

Note: Existing number of impacted locations is higher than either the No Build or Build Alternatives as a large number of currently noise-impacted houses will be demolished by JBLM between 2015 and 2040.

Will There Be Noise Impacts in Tillicum?

Noise modeling indicates that the elevated Berkeley Street interchange would maintain or reduce the noise levels at the businesses along Union Avenue in Tillicum. The future noise levels in these areas will be 55 dBA which is well below impact levels of 67 dBA. For the residents along Washington Avenue (V-11) the noise model predicts a reduction of one decibel from 58 dBA to 57 dBA, also below impact levels. This reduction would come from the proposed elevated interchange partially shielding receivers in the Tillicum neighborhood from traffic noise on I-5.

The noise in the Tillicum area will also be decreasing as a result of the project building an elevated SB on-ramp at the Thorne interchange (Exit 123) and a feasible and reasonable noise wall along the west side of the on-ramp. This combination will result in noticeable noise reductions between 5 and 8 decibels for first and second row residents. Five of the nine first row residents will still be at or just above noise impact levels (66 to 67 dBA) after the wall and elevated on-ramp are built. WSDOT evaluated increasing the height of the noise barrier to further reduce noise levels but doing so would make the barrier not reasonable.

WSDOT considered noise barriers for all impacted residents at or above 66 dBA but some barriers did not meet the feasibility and reasonableness criteria which are shown in yellow (Figure 4.5-1). Options other than noise walls, such as traffic management, altering vertical or horizontal alignment, acquisition of property rights or noise insulation were not considered because they were not applicable or could not be implemented as part of this project. Berms were considered qualitatively but due to lack of sufficient ROW to construct a berm they were not reasonable. Other options such as crash barriers or vegetation to screen traffic from residents would not be considered noise abatement but may be considered in some areas during final design.

4.5.5 What Would Be the Short-Term or Construction Impact of the Build Alternative?

Construction noise impacts refer to the noise levels generated by the construction equipment and activities that are required to construct the Build Alternative. Construction would be carried out in stages, each of which has its own mix of equipment and, consequently, its own noise characteristics. These stages would also occur in different areas along the study area. The increase in noise levels would depend on the type of equipment being used and the duration of time it is in use. Construction noise effects are temporary and would cease after the Build Alternative has been completed.

Typical activities during construction would involve structure demolition, excavation, bridge construction activities, placement of embankment material, pavement removal, paving, grinders and utility relocation. The most constant noise source at construction

Table 4.5-3 *Typical Construction Equipment Noise*

Construction Activity	Equipment	Range of Noise Level at 50 Feet (dBA)
Materials Handling	Concrete Mixer	75-87
	Concrete Pump	81-83
	Crane (movable)	76-87
	Crane (derrick)	86-88
Stationary Equipment	Pump	69-71
	Generator	71-82
	Compressor	74-87
Impact Equipment	Pneumatic Wrench	83-88
	Rock Drill	81-98
Land Clearing	Bull Dozer	77-96
	Dump Truck	82-94
Grading	Scraper	80-93
	Bull Dozer	77-96
Paving	Paver	86-88
	Dump Truck	82-94

Source: EPA 1971

sites would be internal combustion engines, generators and compressors. Engine powered equipment includes excavation equipment, material-handling equipment, and stationary equipment. Mobile equipment operates in a cyclical fashion, while stationary equipment, such as generators and compressors, operate at sound levels fairly constant over time at a same location. Because trucks would be present during most phases and would not be confined to the construction site, noise from trucks could affect more receivers. Other noise sources would include impact equipment, which could be pneumatically powered, hydraulic, or electric. The typical noise range of construction equipment is from 68 dBA to 95 dBA at 50 feet from source. The use of jack hammers, pavement and hydraulic breakers and excavators can increase the noise up to 98 dBA at 50 feet from the source. Table 4.5-3 provides typical ranges of noise levels produced by frequently used construction equipment.

As shown in Table 4.5-3, sound levels 50 feet from construction equipment are expected to exceed the FHWA NAC for residential land uses. A few of the Build Alternative elements would likely require construction activities close to some existing property lines; at times, noise levels could exceed the levels shown in Table 4.5-3.

Traffic noise and construction noise are exempt from the property line noise limits during daytime hours, but noise limits still apply to construction noise at night. Noise levels in Table 4.5-3 apply only to construction noise at residential properties. Subtracting 10 dB from these values provides the construction noise limits at "night": between 10 PM and 7 AM. At night, construction noise must meet Washington State Department of Ecology property line regulations that set limits based on the Environmental Designation for Noise Abatement (EDNA) of the land use: residential (Class A), commercial (Class B), and industrial (Class C). (WAC 173-60-040)

4.5.6 How Can Impacts of the Build Alternative Be Minimized or Mitigated?

Roadway projects in Washington State must consider noise abatement when the noise levels reach 66 dBA or greater. While there were no substantive differences between existing noise levels and noise levels with the Build Alternative, 140 modeled locations were identified as exceeding the 66 dBA threshold. These locations included land uses in Activity Categories B, C and E for outside usage. These modeled sites were grouped into discrete areas where

noise barrier placement was considered. These areas were evaluated to determine if feasible and reasonable noise barriers could be recommended for construction.

WSDOT has established feasibility and reasonableness requirements for traffic noise abatement[1]. Feasibility requires that the noise barrier is physically constructible and provides a minimum of 5 dBA reduction in noise levels at the majority of the first row of affected receivers. Reasonableness requires that construction costs of the barrier be equal or less than the WSDOT allowed cost based on surface area and cost per square foot of the noise barrier for each benefited receiver, and would reduce traffic noise levels by at least 7dBA, at a minimum, for the first row of receivers behind the barrier.

Property owner involvement must occur when traffic noise abatement is recommended for Type I projects, even when property owner involvement is not required as part of the NEPA or SEPA processes. Property owner opinion must be considered when making a determination of reasonableness for traffic noise abatement. Noise abatement would not be planned if more than 50 percent of eligible property owners oppose the proposed noise abatement.

Proposed Noise Barriers and Analysis

The I-5 JBLM Vicinity Congestion Relief Project evaluated nine locations within the Build Alternative for the North Study Area to determine whether the addition of a barrier could sufficiently reduce existing and expected future traffic noise levels. These locations are shown in Figure 4.5-1. Table 4.5-4 summarizes the feasibility and reasonableness of each of the nine walls. A brief discussion of key findings and conclusions for each noise barrier are presented in the pages following this table. Recommended noise walls are illustrated in Figure 4.5-2 along with the modeled noise receptor locations. In this figure yellow dots indicate locations where there is no adverse noise impact with the proposed noise barriers in place. Red dots identify locations that would continue to be noise-impacted. Note that noise barrier #1 lies in the South Study Area and is not under consideration at the present time.

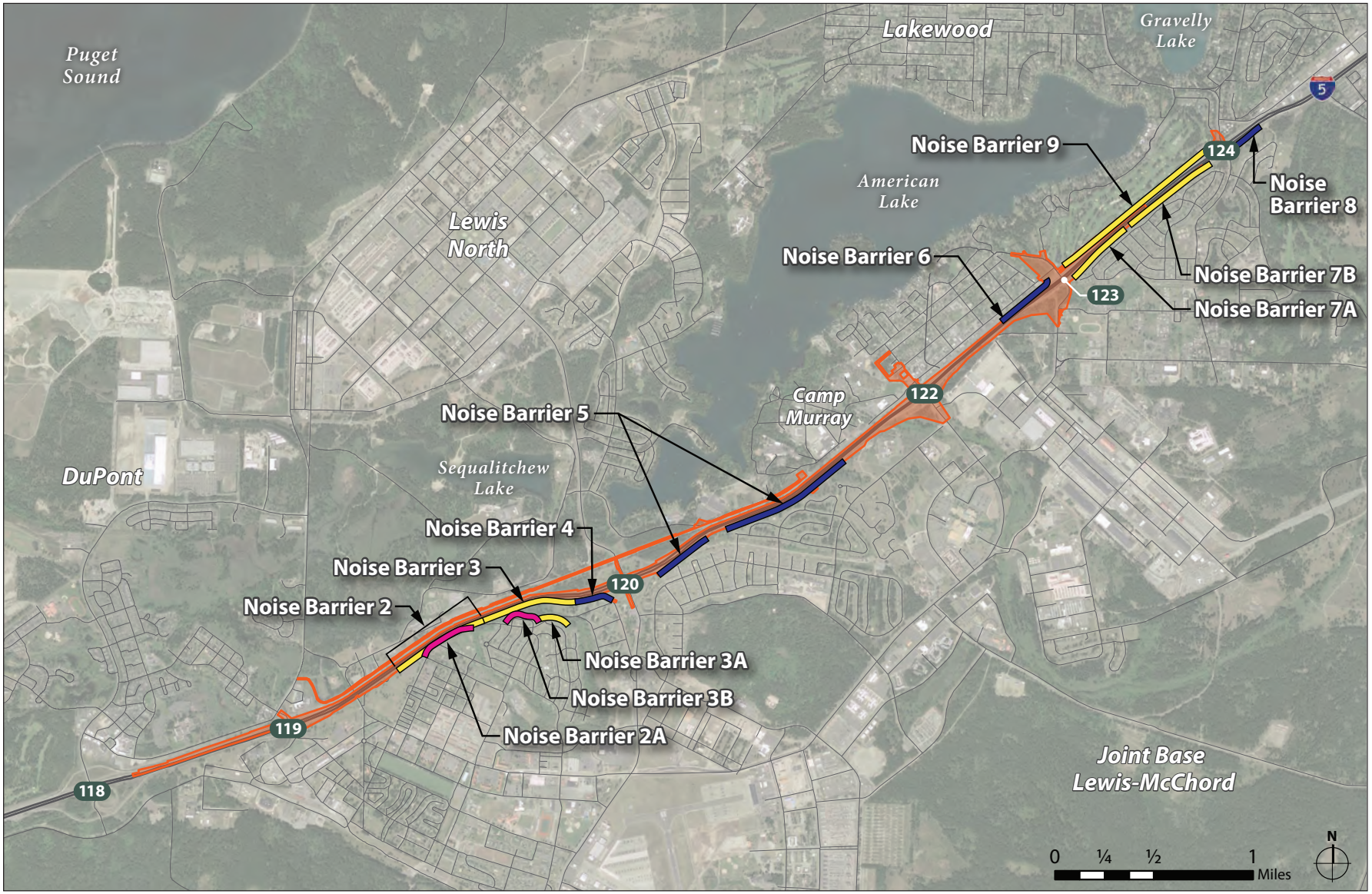
NOISE BARRIER #2 AT JBLM FAMILY RESOURCE CENTER AND GREENWOOD

Noise Barrier #2 was evaluated at a location along northbound I-5 at the WSDOT right of way boundary (see Figure 4.5-1). The Family Resource Center/Greenwood wall was evaluated with a variable height of 12 through 20 feet, and a length of approximately 1,500 feet. Analysis shows that 13 out of 14 noise sensitive receivers behind this wall would meet the feasibility criteria of 5 dBA noise reduction for the majority of residences. Further analysis shows that this wall fails to meet the reasonableness criteria of allowable square footage. A noise wall at this location is not recommended.

NOISE BARRIER #2A AT JBLM GREENWOOD NEIGHBORHOOD

Alternative ways to evaluate the design of the noise barrier were considered because of the unique nature of the JBLM facility. Not only is JBLM a large government owned property, but it also includes miles of I-5 frontage and unique easement characteristics. Noise Barrier 2A was evaluated along the WSDOT/JBLM boundary on the east side of I-5 assuming a variable height of 14 through 18 feet tall, and a length of approximately 1,335 feet. The north and south ends of the Barrier would be angled inwards onto JBLM property. Analysis shows that all first row noise sensitive receivers behind this barrier would meet the feasibility criteria of 5 dBA noise reduction for the majority of residences. Further analysis shows that the wall area would be 19,613 square feet in size as compared to the allowable square footage of 20,880 square feet. Thus, the wall would meet WSDOT's

1 WSDOT 2011 Traffic Noise Policy and Procedures (WSDOT 2012).



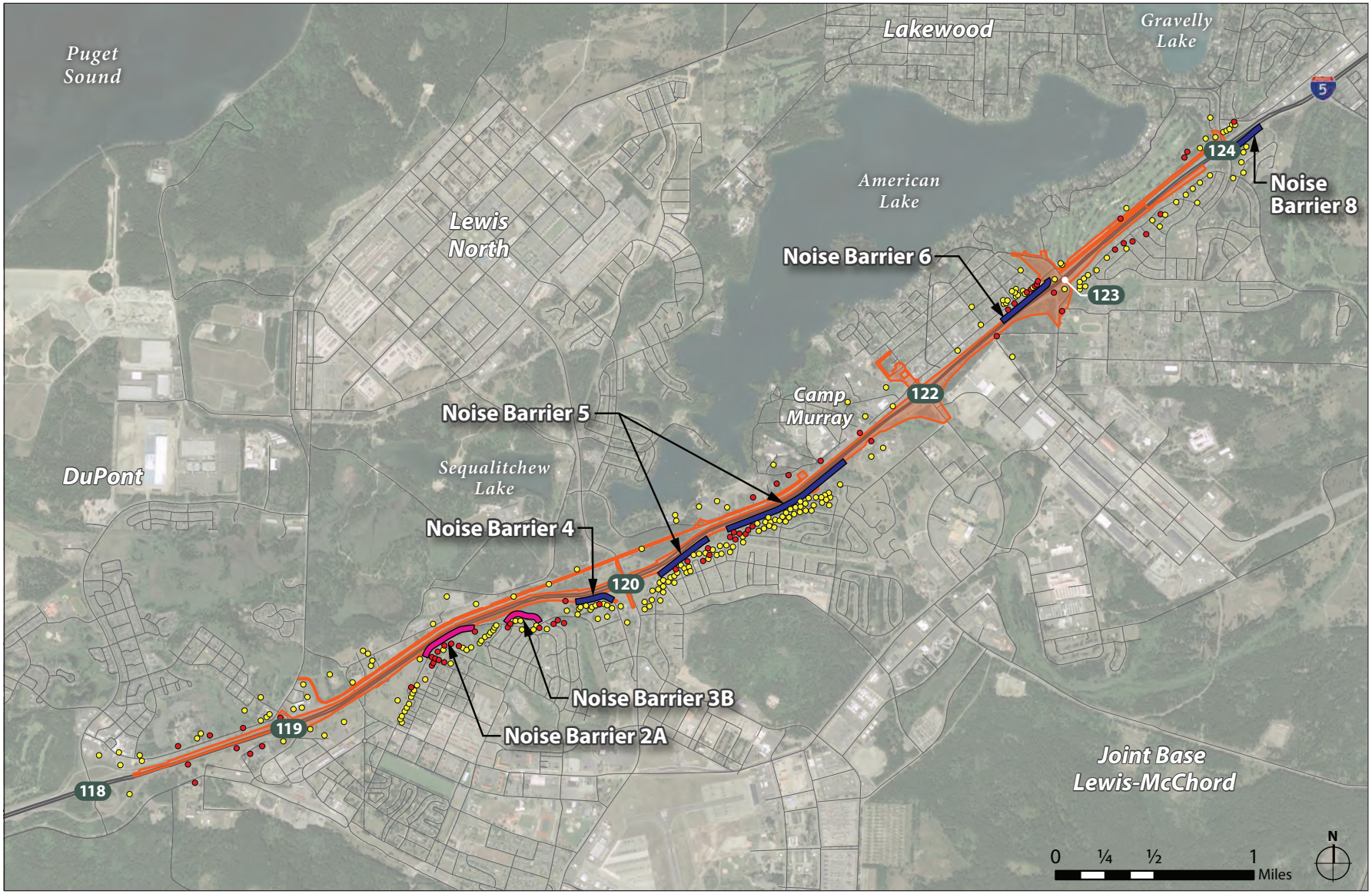
Noise Barrier – Proposed
Noise Barrier – Proposed Pending WSDOT & JBLM Agreement*
Noise Barrier – Evaluated, Not Advanced
Build Alternative Footprint

Note: Noise Barrier #1 located outside North Study Area.
**WSDOT and JBLM will need to come to agreement on maintenance, ownership and construction of this barrier before it can be recommended for construction.*

INTERCHANGES

118 Center Drive interchange
119 Steilacoom-DuPont Road interchange
120 Main Gate interchange
122 Berkeley Street interchange
123 Thorne Lane interchange
124 Gravelly Lake Drive interchange

Figure 4.5-1
Noise Barriers Evaluated with Build Alternative



- Noise Receiver – Below Impact
- Noise Receiver – Impact
- Noise Barrier – Proposed
- Noise Barrier – Proposed Pending JBLM Approval
- Build Alternative Footprint

INTERCHANGES

- 118 Center Drive interchange
- 119 Steilacoom-DuPont Road interchange
- 120 Main Gate interchange
- 122 Berkeley Street interchange
- 123 Thorne Lane interchange
- 124 Gravelly Lake Drive interchange

Figure 4.5-2
2040 Build Alternative Noise Impacts and Proposed Noise Barriers

Table 4.5-4 *Summary of Noise Wall Evaluation Results*

Wall #	Location	Feasible?	Reasonable?	Recommended For Construction?
2	JBLM Family Resource Center/Greenwood	Yes	No	No
2A	JBLM Greenwood	Yes	Yes	Yes*
3	Davis Hill	No	No	No
3A	Davis Hill	Yes	No	No
3B	Davis Hill	Yes	Yes	Yes*
4	Parkway JBLM Residences	Yes	Yes	Yes
5	Discovery Village/New Hillside	Yes	Yes	Yes
6	Thorne Lane Interchange	Yes	Yes	Yes
7A	Carter Lake JBLM Residences	Yes	No	No
7B	Carter Lake JBLM Residences	Yes	No	No
8	Cascade Village JBLM Residences	Yes	Yes	Yes
9	Tacoma Country and Golf Club Golf Course	Yes	No	No

Source: WSDOT, 2016.
** WSDOT and JBLM will need to come to agreement on maintenance, ownership and construction of this barrier before it can be recommended for construction.*

reasonableness criteria. WSDOT will need to work closely with JBLM regarding design, security, maintenance and ownership of the wall before it can be recommended for construction. If it is determined that the above issues can be agreed to by WSDOT and JBLM, any impacts of building this barrier will need to be evaluated. The location of this proposed wall is shown in Figure 4.5-1 as a pink line in the vicinity of Noise Barrier #2, and in Figure 4.5-2.

NOISE BARRIER #3 AT DAVIS HILL

Noise Barrier #3 was evaluated along the I-5 right of way boundary on the east side of the freeway and immediately north of Noise Barrier #2 (see Figure 4.5-1). A minimum feasible barrier height up to 36 feet and a length of 1,500 feet would not reduce traffic noise levels by at least 5 dBA at the majority of first row receiver locations in this area. This wall is not feasible and will not be considered further.

NOISE BARRIER #3A AT DAVIS HILL

Similar to Barrier #2A, due to the unique nature of the JBLM facility an option for Barrier #3 was evaluated well within JBLM property on Davis Hill. Two noise barriers (3A and 3B) were evaluated (see Figure 4.5-1). Both barriers would be located entirely on JBLM property within the Davis Hill neighborhood. Noise Barrier 3A would be located along the local access road. A minimum feasible barrier height of 12 feet and length of 880 feet would meet the feasibility criteria of 5 dBA noise reduction at the majority of first row receiver locations. Further analysis shows that wall 3A area would be 7,114 square feet in size as compared to the allowable square footage of 5,736 square feet. As the proposed wall would substantively exceed the criteria for determining reasonableness, the wall is not recommended for construction.

NOISE BARRIER #3B AT DAVIS HILL

Noise Barrier 3B would be located at the top of the slope of a natural ravine and would meet the feasibility criteria with an average height of 14 feet and length of approximate 1,077 feet. Further analysis of Barrier 3B indicates it would be 10,269 square feet in size as compared to an allowable area of 10,760 square feet. Wall 3B would reduce

traffic noise levels by at least a 7 dBA at a minimum of one first row receiver behind the wall, so the wall would meet the reasonableness criteria. WSDOT will need to work closely with JBLM regarding wall design, configuration, and ownership before the wall can be recommended for construction. The unique location of this wall entirely outside WSDOT right of way and inside a secure military installation demands further analysis and discussion with JBLM prior to recommendation.

NOISE BARRIER #4 AT PARKWAY JBLM RESIDENCES

Noise Barrier #4 was evaluated along the I-5 right of way boundary following the northbound I-5 off-ramp and the Main Gate exit (see Figure 4.5-1). This barrier would have a variable height of 10 feet to 20 feet with a proposed length of 1,136 feet. This wall would reduce traffic noise levels by at least 5 dBA at the majority of first row receivers in this area. Noise wall dimensions were evaluated as part of the reasonableness assessment. The wall was determined to be reasonable and is recommended for construction.

NOISE BARRIER #5 AT DISCOVERY VILLAGE AND NEW HILLSIDE

A noise barrier 'system' was evaluated along the WSDOT right of way boundary, as well as two separate walls analyzed independently for Discovery Village and New Hillside (see Figure 4.5-1). A minimum feasible barrier height of 12 feet and a total 'system' length of 4,795 feet is expected to reduce traffic noise levels by at least 5 dBA at the majority of first row receiver locations. The noise walls at this location, were analyzed both individually and as a 'system' with a break in the middle. The wall system with a break in the middle meets WSDOT feasibility criteria. A reasonableness assessment of this system wall concluded that the noise barrier is reasonable since the allowable square footage of the walls is higher than the calculated square footage and would reduce traffic noise levels by at least 7 dBA at a minimum of the first row of receivers behind the wall. The recommended abatement would have a gap with an earth-berm between the Greenwood area and New Hillside area as shown in Figure 4.5-2.

NOISE BARRIER #6 AT THORNE LANE INTERCHANGE

Noise Barrier #6 was assessed along the I-5 southbound on-ramp at the Thorne Lane interchange (see Figure 4.5-1). The wall was evaluated at the edge of pavement of the proposed on-ramp configuration. A minimum feasible variable height barrier ranging between 8 to 18 feet with a length of 1,500 feet would reduce traffic noise levels by at least 5 dBA at the majority of first and second row receiver locations in this area. The reasonableness evaluation determined that the allowable square footage for the wall is 19,488 square feet. As the area of the proposed noise wall is 18,986 square feet and would reduce traffic noise levels by at least a 7 dBA at a minimum of the first row of receivers behind the wall, the wall is considered reasonable and recommended for construction.

NOISE BARRIER #7A AT CARTER LAKE JBLM RESIDENCES

Noise Barrier #7A was evaluated along the WSDOT right of way boundary on the east side of I-5 south of Gravelly Lake Drive where an existing concrete wall is located (see Figure 4.5-1). JBLM plans to demolish 109 residences by 2017, so the second row residences were evaluated in lieu of first row residences. A minimum feasible variable wall height of 12 to 20 feet and a length of 2,662 feet would reduce noise levels by at least 5 dBA at the majority of first row residences.

The area of the proposed noise wall is 39,233 square feet which is higher than WSDOT's reasonableness criteria of an allowable 21,696 square feet. Consequently, the wall it does not meet WSDOT's reasonableness criteria and is not recommended for construction at the right of way.

As an alternative, a barrier was also evaluated in the same area along the east side of I-5 south of Gravelly Lake Drive at the shoulder of the existing roadway. This alternative would minimize impacts to the existing wall on the edge of the WSDOT right of way. A minimum feasible variable wall height of eight to 12 feet and a length of 2,964 feet would reduce noise levels by at least 5 dBA at the majority of first row residences. A second reasonableness evaluation was conducted on the minimum feasible wall along the I-5 northbound shoulder which would avoid many of the additional costs for replacing the existing concrete wall. The total square footage of the proposed barrier on the shoulder is 33,698 square feet and the square foot allowance for the wall is 30,368 square feet which does not pass WSDOT's reasonableness criteria. Accordingly, the wall is not recommended for construction.

NOISE BARRIER #7B AT CARTER LAKE JBLM RESIDENCES

Noise Barrier #7B was evaluated along the WSDOT right of way boundary on the east side of I-5 north of Thorne Lane where an existing concrete wall is located (see Figure 4.5-1). JBLM plans to demolish 109 residences by 2017 so the second row residences were evaluated as first row residences. A minimum feasible average wall height of 14 feet and a length of 2,105 feet long would reduce noise levels by at least 5 dBA at the majority of first row residences.

The area of the proposed noise wall is 27,839 square feet which does not meet the WSDOT reasonableness criteria of an allowable 19,848 square feet. Consequently, the wall does not meet WSDOT's reasonableness criteria and is not recommended for construction at the right of way.

As an alternative, a barrier was also evaluated in the same area along the east side of I-5 north of Thorne Lane at the shoulder of the existing roadway. This alternative would minimize impacts to the existing wall on the edge of the WSDOT right of way. A minimum feasible wall with an average height of 11 feet and a length of 2,248 feet would reduce noise levels by at least 5 dBA at the majority of first row residences. A second reasonableness evaluation was conducted on the minimum feasible wall along the I-5 northbound shoulder which would avoid many of the additional costs for replacing the existing concrete wall. The total square footage of the proposed barrier on the shoulder is 26,195 square feet and the square foot allowance for the wall is 19,984 square feet. Accordingly, the wall does not meet the WSDOT reasonableness criteria and is not recommended for construction.

NOISE BARRIER #8 AT CASCADE VILLAGE JBLM RESIDENCES

Noise Barrier #8 was evaluated along the east side of I-5 north of Gravelly Lake Drive at the WSDOT right of way boundary where an existing concrete fence is located (see Figure 4.5-1). A minimum feasible wall height of 12 feet and a length of 931 feet would reduce traffic noise levels by at least 5 dBA at the majority of the first row receivers.

The area of the proposed barrier is 13,553 square feet which meets WSDOT reasonableness criteria of an allowable 13,648 square feet. However, there are additional costs associated with constructing the wall on the right of way boundary and replacing the existing concrete wall. As with Barrier #7, square footage was converted to costs to conduct the reasonableness analysis. The barrier has a reasonableness allowance of $704,373 and the proposed 12-foot tall barrier would cost approximately $699,470. Adding the additional cost of $642,861 for removal of the existing wall and other expenses yields a new total cost of $1,342,331, which is higher than the allowable cost. Consequently, the wall does not meet WSDOT's reasonableness criteria and is not recommended for construction at the right of way.

As an alternative, a barrier was also evaluated in the same area along the east side of I-5 north of Gravelly Lake Drive at the shoulder of the existing roadway. A minimum feasible wall height of 12 feet and a length of 931 feet would reduce noise levels by at least 5 dBA at

the majority of first row residences. The reasonableness assessment of the shoulder wall avoids many of the additional costs for replacing the existing concrete wall. The total square footage of the proposed barrier on the shoulder is 11,177 square feet and the square foot allowance for the wall is 13,648 square feet and would reduce traffic noise levels by at least 7 dBA at a minimum of the first row of receivers behind the wall. Thus, the wall would pass the WSDOT reasonableness criteria. However, even though the wall is recommended for construction, determination of final constructibility of the wall on the shoulder will be made during final design.

Table 4.5-5 *Noise Wall Recommendations*

	Location	Average Height (ft)	Length (ft)	Cost
Noise Wall 2A*	JBLM Greenwood	16	1,335	$1,012,227
Noise Wall 3B*	Davis Hill	14	1,077	$529,983
Noise Wall 4	Parkway JBLM Residences	16	1,136	$933,519
Noise Wall 5	Discovery Village/New Hillside	12	4,795	$1,834,890
Noise Wall 6	Thorne Lane Interchange	12.7	18,986	$979,867
Noise Wall 8	Cascade Village Shoulder**	12	931	$699,470

** These two noise walls are conditionally recommended. WSDOT and JBLM will need to come to agreement on maintenance, ownership and construction of this barrier before it can be recommended for construction.*
*** To minimize costs associated with removal of existing wall at this location, barriers are recommended to be built adjacent to the highway shoulder (subject to final engineering feasibility).*

NOISE BARRIER #9 AT TACOMA COUNTRY AND GOLF CLUB

Noise Barrier #9 is located along the I-5 southbound shoulder east of the golf course (see Figure 4.5-1). This area was analyzed because the proposed Gravelly-Thorne connector roadway extends the Build Alternative to Gravelly Lake Drive. A feasible barrier with an average height of 14 feet and a length of 4,780 feet would reduce traffic noise levels by at least a 7 dBA noise reduction at one location behind the wall. The reasonableness evaluation determined that the allowable square footage for the wall is 2,236 square feet. As the area of the proposed noise wall is 66,375 square feet, the wall does not meet WSDOT's reasonableness criteria and there is not recommended for construction.

Summary of Recommended Traffic Noise Abatement

In the North Study Area, noise abatement was evaluated for eight locations near noise sensitive receivers with outside usage areas where traffic noise impacts were predicted. At all eight locations evaluated, noise barriers were found to meet WSDOT feasibility criteria. However, only four locations (Noise Barriers 4, 5, 6 and 8) met both WSDOT feasibility and reasonableness criteria. Noise Barrier #4 is proposed to be located along the boundary of I-5 following the northbound I-5 off-ramp at the Main Gate exit. Noise Barrier #5 includes two separate walls for Discovery Village and New Hillside and is located along the WSDOT right of way boundary. Noise Barrier #6 at Thorne Lane is proposed to be located along the shoulder of the proposed new ramp and Noise Barrier #8 is proposed to be located along the I-5 northbound shoulder. Barriers #2A and #3B also met WSDOT's feasibility and reasonableness criteria and are recommended for construction predicated on the results of coordination between WSDOT and JBLM to allow walls outside WSDOT right of way. The noise barriers shown in Table 4.5-5 are proposed as mitigation for the Build Alternative.

Construction Noise Abatement

Construction noise can be reduced by using enclosures or walls to surround stationary equipment, installing mufflers on engines,

substituting quieter equipment or construction methods, minimizing time of operation, and locating equipment farther away from noise sensitive receivers (such as residences). To reduce construction noise at nearby receptors, the following abatement measures could be incorporated into construction plans and contractor specifications:

- Using haul vehicles with approved bed-liners to reduce noise from loading trucks.
- Equipping trucks with ambient backup alarms to reduce the noise for equipment backing.
- Equipping construction equipment engines with adequate mufflers, intake silencers, and engine enclosures to reduce their noise by 5 to 10 dBA (U.S. EPA, 1971), which WSDOT may ask the contractor to do under specification special provisions.
- Constructing temporary noise barriers or curtains around stationary equipment to attenuate noise.

Additional methods for reducing construction noise levels that may be incorporated by the project engineering office or required by a jurisdiction include the following:

- Turning off construction equipment during prolonged periods of nonuse.
- Requiring contractors to maintain all equipment and train their equipment operators to reduce noise levels and increase efficiency of operation.
- Locating stationary equipment away from receiving properties to decrease noise from that equipment in relation to the increased distance.
- Driven by citizen complaints, in some instance WSDOT may specify the quietest equipment available to reduce noise by 5 to 10 dBA.

4.5.7 Would There Be Any Unavoidable Adverse Impacts from the Build Alternative?

For the Build Alternative, modeling indicates that without the analyzed walls, noise levels would approach or exceed the NAC at 140 modeled receivers. This represents single and multi-family residences and non-residential receivers including parks, museums (one each at Camp Murray and JBLM), a golf course, an auditorium at Camp Murray, the JBLM Community Center, and the JBLM Family Resource Center. The recommended noise barriers would reduce traffic noise levels at 42 of those modeled noise sensitive receivers to below 66 dBA, while four additional locations representing five dwelling units would still be above 66 dBA, (receivers 4-09, 4-11, 4-13 and 4-15).

A total of 98 noise sensitive receivers would be above the 66 dBA NAC, and are situated in locations where WSDOT's feasibility and reasonableness criteria for noise abatement could not be met. Consequently, they would be remain adversely impacted.

With the inclusion of the recommended four noise walls (4, 5, 6 and 8), 37 single and multi-family residences would benefit and would experience noise levels below the NAC 66 dBA. No receivers would experience severe noise impacts.

The Build Alternative would not cause any substantial unavoidable adverse noise impacts related to construction as FHWA guidance that stipulates that temporary construction noise impacts are not substantial. Also, none of the remaining impacts would result in a substantial increase over existing noise levels, nor would they meet the criteria for severe noise impacts. As a result, the traffic noise levels are not substantially increased by the Build Alternative.