Interstate 90 Snoqualmie Pass East Project

Phases 3, 4 and 5

Price Creek Vicinity to Easton

Add Lanes/Build Wildlife Bridges

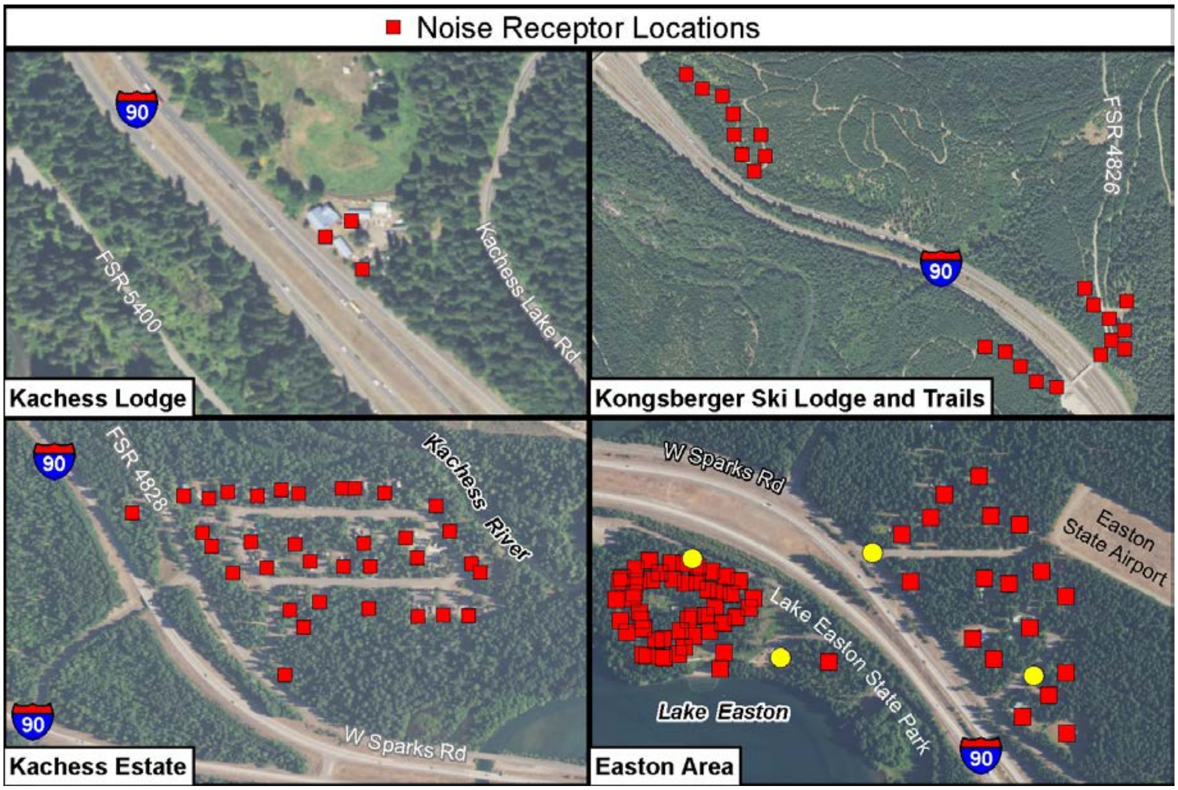
NEPA Reevaluation

March 2018

Attachment L

Noise Discipline Report Update

I-90 Snoqualmie Pass East Project



Noise Discipline Report I-90 Project Phase 3, 4 & 5 Update

Washington State Department of Transportation

February 2017 **Version 03**

Washington State Department of Transportation

U. S. Department of Transportation
Federal Highway Administration

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ACRONYMS AND ABBREVIATIONS

	A
ACP	asphalt concrete pavement
AADT	average annual daily traffic
	C
CFR	Code of Federal Regulation
	D
dBA	A-weighted decibel
	E
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EOP	edge of pavement
	F
FHWA	Federal Highway Administration
	I
I-90 Project	Interstate 90 Snoqualmie Pass East Project
IDT	Interdisciplinary Team
	L
Leq	Equivalent sound level during measurement period
Ln	"n" is the percent of time that a sound level is exceeded during the measurement period
	M
MP	milepost
mph	miles per hour
	N
NAC	Noise Abatement Criteria
NSRs	Noise Sensitive Recepters
	P
PCCP	Portland concrete cement pavement
	R
ROW	right-of-way
	S
SEL	Sound Exposure Level
	T
TNM	Traffic Noise Model (Federal Highway Administration)
	U
U.S.	United States

USFS	US Forest Service
	V
VMS	Variable Message Sign
	W
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation

Summary

This report analyzes traffic noise impacts of Phases 3, 4, and 5 of the Interstate 90 (I-90) Snoqualmie Pass East project (I-90 Project). The Washington State Department of Transportation (WSDOT) is improving I-90 from the Hyak vicinity at milepost (MP) 55.1 to MP 70.3 in Easton to enhance safety and freight mobility. As of 2016, construction of the first three miles of the I-90 Project from Hyak to the snowshed vicinity (MP 57.5) is complete; and construction from the snowshed vicinity to the Price Creek vicinity (MP 62) is expected to be complete in fall 2018. This analysis focuses on the remaining eight miles of the project from the Price Creek vicinity (MP 62) to Easton (MP 70.3), which reconstructs I-90 by adding a third travel lane in each direction and replacing two existing interchanges (Stampede Pass and Cabin Creek). In addition to other safety and mobility improvements, WSDOT will also replace existing concrete pavement, and reconstruct auxiliary lanes eastbound at Amabilis Grade and westbound at Easton Hill.

The I-90 Project is considered a Type I project and a noise analysis is required in accordance with WSDOT's *2011 Traffic Noise Policy and Procedures* (WSDOT 2012). All noise sensitive receptors (NSRs) that could be impacted by the I-90 Project were included in the traffic noise model, which is used to show whether traffic noise levels satisfy defined criteria and subsequently whether traffic noise abatement should be considered. Noise measurement locations were identified in coordination with WSDOT in order to establish ambient noise conditions. The information collected in the field was input into the traffic noise model for validation. Predicted noise levels were within two decibels, which is considered validated per WSDOT noise policy.

The growth rate for this section of I-90 was updated in 2016 and estimated to be one percent annually between 2015 and the design year 2041. This is a lower projected growth rate than estimated in 2008 (2.11 percent) and 2003 (3.5 percent) and results in a decrease of projected traffic volumes. The updated noise model also included more precise, surveyed locations for each campsite and picnic area within Lake Easton State Park, compared to the representative locations used in the 2008 Noise Report.

Future noise levels did meet or exceed the Noise Abatement Criteria within the study area. A total of 20 NSRs would be impacted under build conditions: one receptor at Kachess Lodge, six receptors at the Ski Lodge and Trails near Cabin Creek Interchange, eight campsites within the Lake Easton State Park, and five single-family homes near Easton Municipal Airport. None of the single-family homes south of Kachess Lake would be impacted since the proposed alignment would be shifted further away from the receptors. No receptors would experience a substantial noise increase over existing conditions (10 dB[A] or more) if the project was built. In fact, noise levels will be reduced for some NSRs on Easton Hill if the project is built, as a result of the planned design elevations and the bundled configuration of the new lanes. The total number of impacted NSRs decreased from 30 in the 2008 report to 20 in this analysis largely due to the decrease in projected traffic volumes and more precise modeling inputs.

Noise barriers were modeled for all impacted NSRs. However, none of the modeled noise barriers would meet both the feasible and reasonable criteria. Therefore, noise barriers are not recommended. If changes are made to the vertical or horizontal alignments that were analyzed in this report, the noise analysis may need to be reassessed in order to evaluate those changes.

Per the Kittitas County noise ordinance, construction noise is exempt during daytime hours between 6:00 a.m. and 10:00 p.m. In addition, temporary daytime construction is exempt from Washington State noise regulations. However, state regulation has set noise level limits that may apply if construction took place between the hours of 10:00 p.m. and 7:00 a.m. A variance may be required from Kittitas County if construction activities are conducted during nighttime hours.

1. Introduction

This section introduces the report and project triggers for a noise analysis; provides an overview of the Interstate 90 (I-90) corridor; states the purpose and need for the project; and provides a project description.

1.1. Report Overview

1.1.1. Trigger for Noise Analysis

A traffic noise analysis is required by law (23 CFR Part 772) for federally funded projects and required by state policy (WSDOT 2012) for other funded projects that:

- Involve construction of a new highway,
- Significantly change the horizontal or vertical alignment,
- Increase the number of through traffic lanes on an existing highway, or
- Alter terrain to create new line-of-sight to traffic for noise sensitive receivers.

While the I-90 Project would not create a new highway, modifying the vertical and horizontal alignment and adding capacity (through traffic lanes) and auxiliary lanes would trigger a Type I noise analysis. In addition, the project would require terrain alterations to address grade, interchange re-construction, and slope/rock stabilization. Project elements are listed below:

- Reconstruct I-90 to three lanes by adding one lane in each travel direction,
- Replace the existing westbound auxiliary lane,
- Replace the existing eastbound auxiliary lane,
- Reconstruct two existing interchanges, Stampede Pass and Cabin Creek,
- Construct 16 new bridges, including two wildlife overcrossings,
- Reconstruct westbound lanes adjacent to eastbound lanes between milepost (MP) 67.50 and 69.50. At this location, the westbound lanes of the highway are currently separated from the eastbound lanes.

1.1.2. Report Organization and Scope

This report has been prepared in accordance with Title 23 Code of Federal Regulations (CFR), Part 772, (CFR 2010) with additional guidance provided in WSDOT's *2011 Traffic Noise Policy and Procedures* (WSDOT 2012). The following methods were used to evaluate potential noise impacts associated with the project.

WSDOT first studied the noise impacts for the I-90 Project in 2001 and completed the final Noise Analysis in 2003. Comments regarding the residential equivalency calculations used to determine reasonable and feasible abatement for campsites and picnic areas in the 2003 report triggered a re-assessment in 2007. A supplement to the 2003 and 2007 reports was completed in 2008 that updated the Traffic Noise Model (TNM) using the most current version of TNM 2.5. This report provides a new Noise Discipline Report for the I-90 Project Phases 3, 4, and 5 based upon recent project design changes and includes the following updates:

- Existing activities and land uses within the study area that may be affected by noise from the proposed highway were identified from field surveys and aerial photographs of the corridor alignment;
- Short-term sound level measurements typical of existing conditions were collected at selected representative locations and used to characterize the existing noise environment throughout the project study area. These baseline monitoring results are described in Section 4.3. Simultaneous sound level measurements and traffic counts were used to verify the noise model. Appendix A includes the sound level measurements and resulting model results;
- Existing and future sound levels were estimated using the TNM and are described in Section 5.0;
- Noise abatement measures for reducing or eliminating noise impacts were identified and are described in Section 6.3, with noise barrier modeling results provided in Section 6.4.

1.2. Overview of I-90 Corridor

This section describes a brief history of I-90 and how it functions today.

1.2.1. History of I-90

I-90 spans 300 miles across Washington State from the Port of Seattle to the Idaho state line, then continues east across the United States to Boston, MA. WSDOT plans to improve a portion of this corridor on the eastern side of Snoqualmie Pass from MP 55.1 to MP 70.3 (Hyak vicinity to the West Easton Interchange). This part of the interstate was once the Snoqualmie Pass Road and became US 10, the Sunset Highway.

Starting in the mid-1920s and through the 1930s, the Sunset Highway was constructed with Portland cement concrete pavement (PCCP), replacing the older route known as Snoqualmie Pass Road. In the early 1950s, WSDOT constructed a snowshed in the vicinity of present-day MP 58. At that time, four-laning was also anticipated, and an allowance for two additional lanes to the outside of the Lake Keechelus Snowshed Bridge (snowshed) was made. During the late 1950s and early 1960s, WSDOT reconstructed most of the roadway along Keechelus Lake and Easton Hill as a four-lane highway with a common median, while new two-lane roadways were constructed alongside most of the remaining Sunset Highway alignment. By the late 1960s and early 1970s, WSDOT realigned what remained of the original portions of the Sunset Highway to meet interstate design standards, along with Slide Curve, and repaved with new PCCP. US 10 became part of the country's interstate highway system and became designated as I-90. The existing snowshed continued to cover the westbound lanes, but nothing was constructed to protect the eastbound lanes in the avalanche-prone area near MP 58.

The existing roadway is PCCP, and its estimated life was 30 years. In the early 1980s, pavement cracking and panel settlement of the sections that were built in the late 1950s became apparent, and projects were developed to find and retrofit the worst areas. By 2001, virtually the entire pavement structure from Hyak to the West Easton Interchange was showing signs of deterioration. WSDOT overlaid stretches of the PCCP with asphalt concrete pavement (ACP), or installed dowel bars into the existing concrete panels and diamond ground the concrete roadway, extending the life of the concrete another seven to 10 years.

1.2.2. I-90 Today

I-90 is the main east-west transportation corridor across Washington State, and is vital to the state's economy, including shipping, recreation, and business travel. Currently more than 30,000 vehicles cross the pass daily, including over 5,000 freight trucks. In the next 25 years, the daily traffic volume over Snoqualmie Pass is expected to increase to approximately 39,000 vehicles per day. A safe and reliable transportation system is needed to support the existing economy, facilitate desired growth, reduce inefficiency and costs associated with congestion, and provide a safer transportation route.

Washington State is one of the most trade-dependent economies in the country. According to the Washington Council on International Trade, at least 40 percent of all jobs in Washington are tied to trade-related activity. It is uniquely positioned as a gateway to the global economy. Maintaining transportation connections between ports, manufacturing and industrial centers, agricultural regions, and other key locations directly benefit the state's economic health.

Washington State possesses both a diverse geography and economy. Agriculture, wood products, fishing, aerospace, biomedical, manufacturing, technology, and other industry depend on the transportation network to move customers, employees, goods, and supplies. A sound transportation network means lower freight costs, which may be passed on to consumers as lower prices for goods, to workers as higher wages, and to owners of businesses as higher income. WSDOT is implementing a series of transportation improvements along the 15-mile I-90 Project corridor to accommodate increases to expected traffic volumes, improve safety, and protect Washington State's economy.

1.3. Purpose and Need for the Project

One of WSDOT's primary concerns is the safety of the traveling public. The purpose of the I-90 Project is to meet projected traffic demands, improve public safety, and meet identified project needs, which include:

- Reduce the risks of avalanche to the traveling public and road closures needed for avalanche control work;
- Reduce the risk of rock and debris falling onto the roadway from unstable slopes;
- Fix structural deficiencies by replacing damaged pavement;
- Provide for increased traffic volume; and

- Connect habitat for fish and wildlife across the 15-mile I-90 corridor.

The following subsections expand upon the issues and trends that influence the need for the proposed action, particularly with respect to travel demand and travel congestion, and the attendant effects on safety.

1.3.1. Growth in Travel Demand

The travel growth rate for this section of I-90 was updated in 2016. Between 2015 and the design year 2041, growth rates are estimated at one percent annually, versus the previously estimated growth rates of 2.11 percent in 2008 and 3.5 percent in 2003. The lower projected growth rate results in a decrease of projected traffic volumes and estimated noise levels when compared to the 2008 Noise Report. Changes to the 2016 projected growth rate are a result of actual traffic data collected at the Cabin Creek Interchange between 1996 and 2015. The 2025 design year peak volume of vehicles analyzed in the 2003 *Traffic Noise Discipline Report* was 7,700 vehicles per hour. The 2030 design year peak hour volume used in the 2008 *Noise Discipline Report Supplement* was 9,200 vehicles per hour based upon a traffic prediction methodology. This prediction, however, did not take into account that the highway could not physically accommodate the predicted numbers of vehicles. The 2041 design year peak hour volume used in this report is 5,043 vehicles per hour, which reflects the actual traffic growth on I-90 since 1996.

The current average annual daily traffic (AADT) volume on I-90 is about 30,000 vehicles near the Cabin Creek Interchange, with approximately 17.3 percent of the volume from freight trucks. It is estimated that in the 2041 design year, the AADT will be near 39,000. During certain summer holiday weekends, volumes can reach or exceed 50,000 vehicles per day. If improvements are not made to the highway, the expected traffic projections may lead to a higher number of crashes, add risks for economic impacts, and increase travel times.

1.3.2. Safety

Alignment – Many of the existing horizontal curves were designed for speeds below the current posted speed limit within the corridor and do not meet the context of the route due to the terrain and geology of the Cascade Mountains and Snoqualmie Pass.

Unstable Slopes – Rock fall and rockslides can happen without warning. Occasionally, the spontaneous release of rock debris has been catastrophic, causing closures and loss of property and life. WSDOT's Geotechnical Services Branch has identified numerous unstable slopes within the I-90 Project limits where rock fall and rockslides occur. During recent construction projects, WSDOT stabilized several of these areas by rock bolting and doweling. The remaining locations need to be addressed as part of the I-90 Project.

Structures – The Stampede Pass and Cabin Creek Interchanges have vertical clearances that do not allow for oversized loads to pass underneath. As a result, existing interchanges have been hit numerous times, causing damage to structures and vehicles. To avoid hitting the existing interchange structures, trucks with oversized loads are required to exit the highway at the off-ramps and then re-enter the highway at the on-ramps. The structures at both interchanges need to be replaced with larger structures with dimensions that allow oversized loads to pass underneath safely and efficiently.

1.4. Project Description

The Federal Highway Administration (FHWA) and WSDOT prepared a 2005 Draft Environmental Impact Statement (EIS) and a 2008 Final EIS for the I-90 Project corridor. Consistent with National Environmental Policy Act (NEPA) regulations, the United States (US) Forest Service (USFS) and US Bureau of Reclamation were cooperating agencies in preparing these documents. Following the 2008 Record of Decision (ROD) by FHWA and concurrence from the cooperating agencies, WSDOT proceeded with implementation of the Selected Alternative and construction of the I-90 Project has continued since 2009. Exhibit 1 depicts the I-90 Project corridor.

To improve project delivery opportunities, minimize impacts to traffic flow, and reduce safety risks to the traveling public during construction, WSDOT has divided the I-90 Project into construction phases. The timing of each construction phase is anticipated to occur sequentially.

Phase 1 – covers the first five miles of the 15-mile corridor from Hyak (MP 55.1) to Keechelus Dam (MP 59.9).

Phase 2 – covers the next two miles of the corridor from Keechelus Dam to the Price Creek vicinity (MP 62).

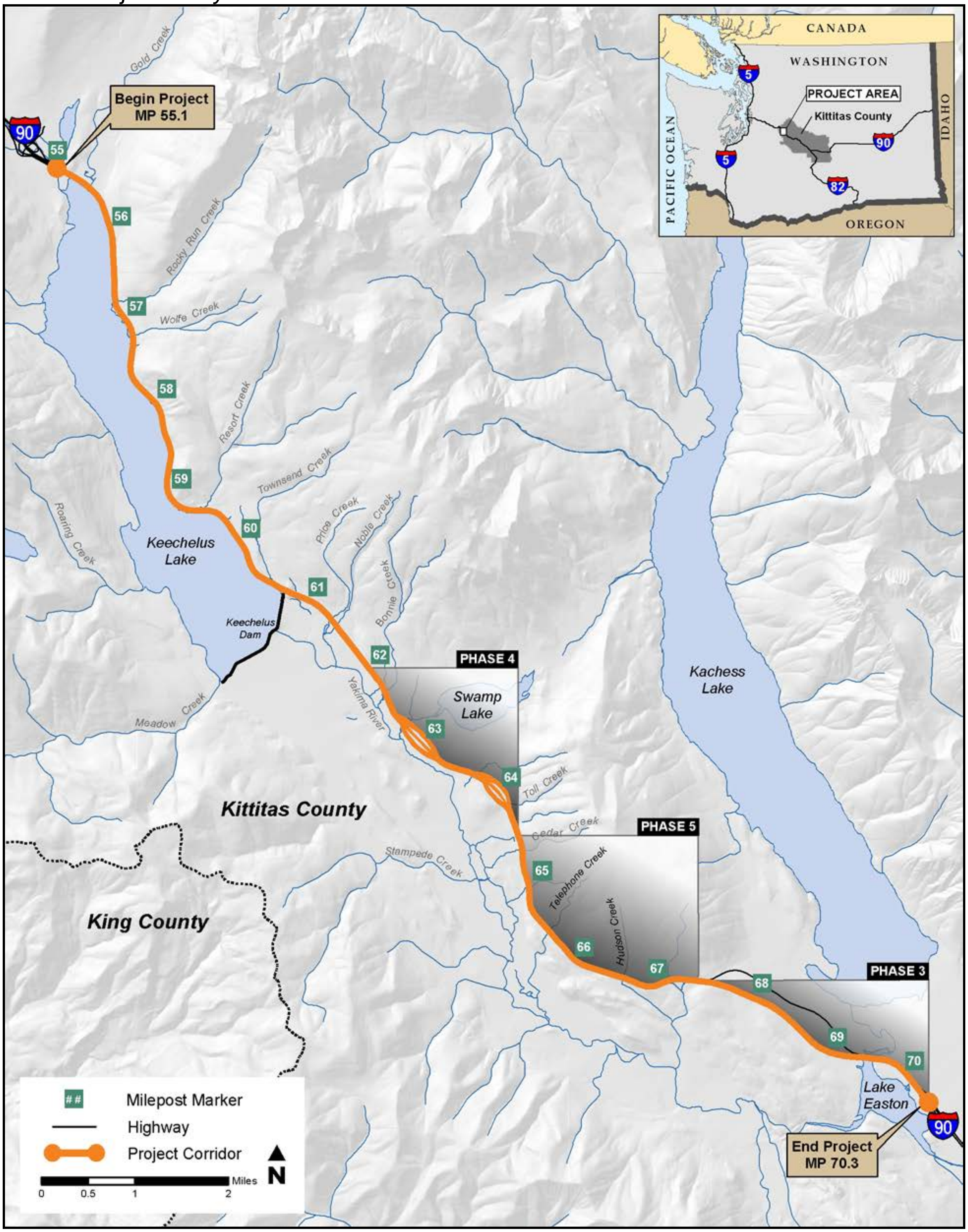
As of 2016, the first three miles of the I-90 Project have been completed and Phase 1C and 2A, that take the project to MP 62, are under construction with an anticipated completion date of fall 2018. In fall 2015, the Washington State Legislature passed the Connecting Washington Transportation funding package that included funding for the remainder of the I-90 Project from MP 62 to MP 70.3. The remainder of the project was divided into three construction segments including phase(s) 3, 4 and 5 (see Exhibit 1).

Phase 3 – starts at approximately MP 67.3 and extends to the end of the I-90 Project corridor at MP 70.3. This phase can be generally described as Easton Hill to Easton. Phase 3 is expected to begin construction in the spring of 2021.

Phase 4 – extends from the eastern limits of the Phase 2A project from MP 62 to approximately MP 64.5. This phase can be generally described as the Price Creek vicinity to Cabin Creek Interchange. Phase 4 is expected to begin construction in the spring of 2022.

Phase 5 – Phase 5 is located between Phase 3 and Phase 4 and extends from approximately MP 64.50 to MP 67.3. This phase is generally described as Cabin Creek Interchange to Easton Hill. Phase 5 is expected to begin construction in the spring of 2026.

Exhibit 1: Project Vicinity



I-90 Project elements include:

- Reconstruct I-90 to three lanes in both directions
- Design the new highway to match the context of the route
- Replace the existing westbound auxiliary lane
- Replace the existing eastbound auxiliary lane
- Reconstruct two existing interchanges, Stampede Pass and Cabin Creek
- Bring the new highway to current Highway Runoff Manual standards
- Improve cross highway drainage
- Construct low mobility wildlife structures (quantity unknown at this time)
- Construct seven pairs of new bridges (approximate lengths provided):
    - 600-feet at MP 62.3
    - 200-feet at MP 62.5
    - 80-feet at MP 62.7 (Swamp Creek)
    - 200-feet at MP 63.7
    - 230-foot bridge at MP 67.1 (Hudson Creek)
    - 100-feet at MP 69.1 (Sparks Road)
    - 200-feet at MP 69.5 (Kachess River)
- Construct two 150-foot-long Wildlife Overcrossings at approximately MP 67.5 and MP 68.7
- Improve several large rock cuts and rock slope stabilization areas
- Reconstruct westbound lanes adjacent to eastbound lanes between MP 67.5 and 69.5. The westbound lanes of the highway are currently separated from the eastbound lanes at this location.
- Construct several Hydrologic Connectivity Zones
- Widen I-90 through a geotechnical challenging area known as Amabilis Grade, including placement of embankment

Typical roadway sections for the reconstructed I-90 Project are provided in Exhibits 2 and 3 below.

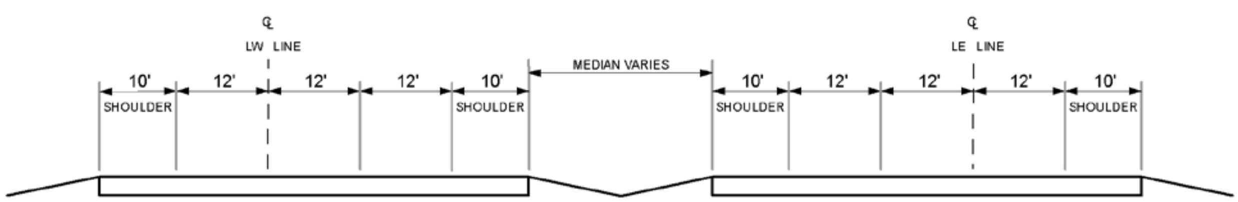


Exhibit 2: Typical Roadway Section without Auxiliary Lane

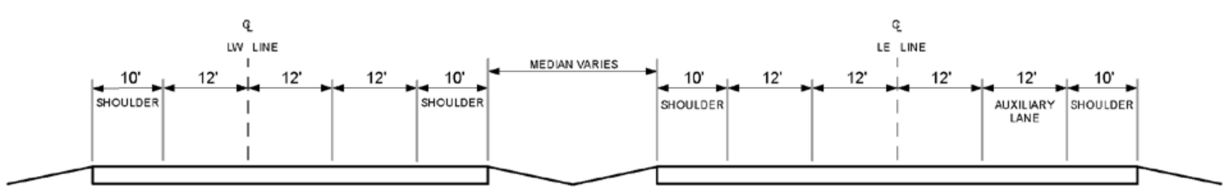


Exhibit 3: Typical Roadway Section with Auxiliary Lane

This noise analysis focuses on Phases 3, 4, and 5 of the I-90 Project from MP 62 to MP 70.3. Anticipated design changes within this section of the project from the 2008 Final EIS include:

- Bundling the eastbound and westbound lanes near Easton Hill. This is a practical solution recommendation from the I-90 Interdisciplinary Team (IDT).
- Modifications to bridge locations and lengths that equal the overall bridge lengths found in the EIS and based on recommendations from the I-90 IDT.

2. Characteristics of Sound and Noise

2.1. Definition of Sound and Noise

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure, called sound pressure. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA 1974). Magnitude is a measure of the physical sound energy in the air. The range of magnitude the ear can hear, from the faintest to the loudest sound, is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness refers to how people subjectively judge a sound and varies between people.

In addition to magnitude, humans also respond to a sound's frequency or pitch. The human ear is very effective at perceiving frequencies between 1,000 Hz and 5,000 Hz, with less efficiency outside this range. Environmental noise is composed of many frequencies. A weighting (dBA) of sound levels is applied electronically by a sound level meter and combines the many frequencies into one sound level that simulates how an average person hears sounds of low to moderate magnitude.

Using the logarithmic decibel scale to measure sound, a doubling of the number of noise sources, such as the number of cars on a roadway, increases noise levels by 3 dBA. Therefore, when you combine two noise sources emitting 60 dBA, the combined noise level is 63 dBA, not 120 dBA. The human ear can barely perceive a 3 dBA increase, while a 5 dBA increase is about one and one-half times as loud. A 10 dBA increase appears to be a doubling in noise level to most listeners. A tenfold increase in the number of noise sources will add 10 dBA.

Noise is defined as unwanted or unpleasant sound. Noise is a subjective term because, as described above, sound levels are perceived differently by different people. Magnitudes of typical noise levels are presented in Exhibit 4.

Exhibit 4: Typical Noise Levels

NOISE SOURCE OR ACTIVITY		SUBJECTIVE IMPRESSION	RELATIVE LOUDNESS (human judgment of different sound levels)
Jet aircraft takeoff from carrier (50 feet)	140	Threshold of pain	64 times as loud
50-horsepower siren (100 feet)	130		32 times as loud
Loud rock concert near stage Jet takeoff (200 feet)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 feet)	110		8 times as loud
Jet takeoff (2,000 feet)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 feet)*	90		2 times as loud
Garbage disposal (2 feet) **Pneumatic drill (50 feet)**	80	**Moderately loud**	**Reference loudness**
Vacuum cleaner (10 feet) Passenger car at 65 mph (25 feet)*	70		1/2 as loud
Typical office environment	60		1/4 as loud
Light auto traffic (100 feet)*	50	Quiet	1/8 as loud
Bedroom or quiet living room Bird calls	40		1/16 as loud
Quiet library, soft whisper (15 feet)	30	Very quiet	
High quality recording studio	20		
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	

Sources: Beranek (1988) and U.S. EPA (1974)

2.2. Noise Level Descriptors

The equivalent sound level (L_{eq}) is a measure of the average noise level during a specified period of time. A one-hour period, or hourly L_{eq} [L_{eq} (h)], is used to measure highway noise. L_{eq} is a measure of total noise during a time period that places more emphasis on occasional high noise levels that accompany general background noise levels. For example, if you have two different sounds, and one contains twice as much energy, but lasts only half as long as the other, the two would have the same L_{eq} noise levels.

Either the total noise energy or the highest instantaneous noise level can describe short-term noise levels, such as those from a single truck passing by. The sound exposure level (SEL) is a measure of total sound energy from an event, and is useful in determining what the L_{eq} would be over a period in time when several noise events occur. L_{max} is the maximum sound level that occurs during a single event and is related to impacts on speech interference and sleep disruption. L_{min} is the minimum sound level during a period of time.

With L_n, "n" is the percent of time that a sound level is exceeded and is used to describe the range of sound levels recorded during the measurement period. For example, the L_{10} level is the noise level that is exceeded 10 percent of the time. Sound varies in the environment and people will generally find a higher, but constant, sound level more tolerable than a quiet background level interrupted by higher sound level events. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in an otherwise quiet area.

2.3. Traffic Noise Sources

An increase in traffic volumes, vehicle speeds, or the amount of heavy trucks will increase traffic noise levels. Traffic noise is a combination of noises from the engine, exhaust, and tires. Defective mufflers, truck compression braking, steep grades, the terrain and vegetation near the roadway, shielding by barriers and buildings and the distance from the road can also contribute to the traffic noise heard at the roadside.

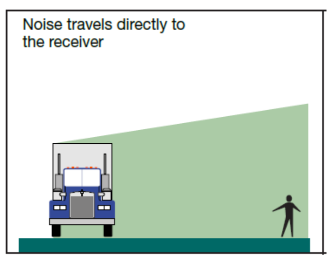
2.4. Sound Propagation

Sound propagation, or how far the sound travels, is affected by the terrain and the elevation of the receiver relative to the noise source. Noise levels can be reduced by breaking the line of sight between the receiver and the noise source.

2.5. Effects of Noise

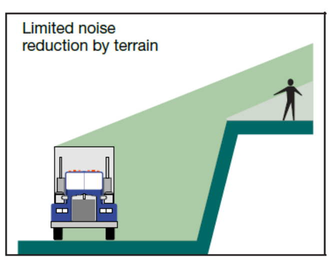
The FHWA noise abatement criteria (NAC) are based on speech interference, which is a well-documented impact that is relatively reproducible in human response studies. Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. Prolonged exposure to very high levels of environmental noise can cause hearing loss and the Environmental Protection Agency (EPA) has established a protective level 70 dBA L_{eq}(24) (EPA 1974) for hearing loss. Noise also can affect some types of wildlife during certain activities.

- Level ground: noise travels in a straight path between the source and receiver.



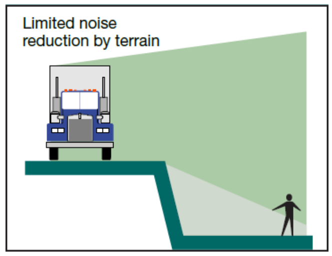
Level Ground

- Depressed source/elevated receiver: terrain may act like a partial noise barrier and reduce noise levels if it crests between the source and receiver.



Depressed source/elevated receiver

- Elevated source/depressed receiver: the edge of the roadway acts as a partial noise barrier. Even a short barrier, like a concrete safety barrier, can reduce noise levels to a depressed receiver.



Elevated source/depressed receiver

Noise levels decrease with distance from the noise source. For a line source, like a highway, noise levels decrease 3 dBA for every doubling of distance, e.g., from 50 feet to 100 feet, between the source and the receiver over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass). For point source, like most construction noise, the levels decrease between 6 dBA and 7.5 dBA for every doubling of distance.

3. Traffic Noise Analysis Methodology

This section describes the overall report approach, general information on sound, and noise impact criteria and regulations.

3.1. Noise Impact Criteria and Regulations

3.1.1. Traffic Noise Impact Criteria

The Federal Noise Control Act of 1972 (Public Law 92-574) requires that all federal agencies administer their programs in a manner that promotes an environment free from noises that may jeopardize public health or welfare.

FHWA and WSDOT have adopted criteria for evaluating noise impacts associated with federally funded highway projects, and for determining whether those impacts are sufficient to justify noise abatement funding. These criteria are specified in 23 CFR 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise* (CFR 2010). FHWA provides additional guidance on implementation in its *Highway Traffic Noise: Analysis and Abatement Guidance* (FHWA 2010).

WSDOT has adopted FHWA's criteria for evaluating noise impacts and for determining whether those impacts are sufficient to justify noise abatement funding. These criteria are specified in WSDOT's *Environmental Procedures Manual*. A noise impact occurs when a predicted traffic sound level under design-year conditions approaches or exceeds the NAC listed in Exhibit 5, or when the predicted traffic sound level is substantially higher than the existing sound level (USDOT 1982). In its 2011 policy, WSDOT has defined "approach" to mean 1 dBA below the NAC shown in Exhibit 5. A 10 dBA increase over existing sound levels is considered to be substantial. For the I-90 Project, a noise impact would consist of either of the following:

- Outdoor peak-hour Leq of 66 dBA or greater at a NSR (categories B and C) as categorized in Exhibit 5; or
- Increase in outdoor peak-hour (Design Year 2041 minus Year 2015) of 10 dBA or greater.

Exhibit 5: Noise Abatement Criteria (NAC) by Land Use

Activity Category	Leq(h)* (dBA) at Evaluation Location	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and 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
B	67 (Exterior)	Residential (single and multi-family units)
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
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.
E	72 (Exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F. Includes undeveloped land permitted for these activities.
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
G	--	Undeveloped lands that are not permitted

Source: WSDOT 2012.
**Leq(h) are A-weighted (dBA) hourly equivalent steady state sound levels used for impact determination and are not design standards for abatement.*

3.1.2. State and County Noise Regulations

Kittitas County

The Kittitas County noise ordinance, updated in February 2016, states that it is unlawful for "any person to make, continue, or cause to be made or continued or any person owning or in possession of property to make, continue, or cause to be made or continued or allow to originate from the property any sound which:

- a) Is plainly audible within any dwelling unit, which is not the source of the sound, or is generated within two hundred feet of any dwelling unit, and;
- b) Either reasonably annoys, disturbs, injures or endangers the comfort, repose, health, peace or safety of others.

Section 9.45.040 of the noise ordinance exempts construction activity that occurs between the hours of 6:00 a.m. and 10:00 p.m. This means that daytime construction activities along I-90 would be exempted from the county noise ordinance. The noise ordinance further exempts sounds created by motor vehicles on public highways and sounds created by auxiliary equipment on motor vehicles used for highway maintenance. While Kittitas County establishes noise standards for people and property, it is not directly applicable to noise generated by commercial activity such as constructing or operating the I-90 Project.

Washington State

Washington Administrative Code (WAC) 173-60, *Maximum Environmental Noise Levels* (WAC 1989), limits noise exposure from various activities. Temporary daytime construction is exempt from Washington State noise regulation. However, nighttime limits would apply if construction was to take place between 10:00 p.m. and 7:00 a.m. At night, construction noise must meet Washington State Department of Ecology (Ecology) property line regulations that set limits based on the Environmental Designation for Noise Abatement (EDNA) of the land use, as shown in Exhibit 6: residential (Class A), commercial (Class B), and industrial (Class C). WSDOT policy considers construction and operation within a highway right-of-way to be commercial activity (Class B).

Allowable nighttime (10:00 p.m. to 7:00 a.m.) noise levels for construction activity (Class B) at residential receiving properties (Class A) are reduced by 10 dBA from the allowable daytime noise levels shown in Exhibit 6.

Exhibit 6: Maximum Permissible Environmental Noise Levels

EDNA of Noise Source	EDNA of Receiving Property (dBA)		
	Class A	Class B	Class C
Class A	55	57	60
Class B	57	60	65
Class C	60	65	70

Short-term exceedance of the sound levels in Exhibit 6 is allowed. According to WAC 173-60-040, during any one-hour period, the maximum level may be exceeded by:

- 5 dBA for a total of 15 minutes,
- 10 dBA for a total of 5 minutes, or
- 15 dBA for a total of 1.5 minutes.

The allowed exceptions are defined by the percentage of time a given level is exceeded. For example, L_{25} is the noise level exceeded 15 minutes during an hour. Therefore, the permissible L_{25} would be 5 dBA greater than the values in Exhibit 6, provided that the noise level is below the permissible level for the rest of the hour and never exceeds the permissible level by more than 5 dBA.

An hourly L_{eq} of approximately 2 dBA higher than the values in Exhibit 6 is an equivalent sound level to the permissible levels, including the short term exceedances. A L_{eq}(h) of 59 dBA corresponds approximately to a noise level of 57 dBA for 45 minutes and 62 dBA for 15 minutes, which are the maximum permissible noise levels created by a commercial source (Class B) and received by a residential property (Class A).

3.2. Determination of the Traffic Noise Study Area

Per WSDOT's *2011 Noise Policy and Procedures* (WSDOT 2012), the study area (Exhibit 7) includes all receptors that could be impacted by the proposed project. The 2008 *Noise Discipline Report Supplement* was based on the previous noise policy and identified receptors within 500 feet of the proposed improvements. According to the 2008 analysis, noise impacts appeared to drop off at approximately 300 feet to 500 feet from the proposed improvements. Therefore, a buffer of 500 feet was initially used to identify NSRs. However, under current noise policy methodology, receptors beyond 500 feet were included if there was a clear line of sight from the receptor to the proposed improvements where impacts may occur. In addition, where receptors were identified within a community (regardless of distance), all receptors were included in the model and analysis.

Noise measurement locations were documented in the field on October 5, 2016 using a cellular device. A geotagged photograph was taken at each location, with post-processing completed in Google Earth using the geotagged latitude and longitude. With exception of the NSRs at Lake Easton State Park, NSRs within the study area were identified using Google Earth in October 2016. NSRs at Lake Easton State Park were recorded using a handheld global positioning system (GPS) unit for input into the model on January 13, 2017. The GPS unit was a Trimble GeoExplorer 6000, which utilizes the GPS and GlONASS satellite constellations, multipath rejection, and H-Star data post-processing to achieve sub-meter accuracy.

Additional information and methodology regarding the identification of NSRs is summarized in Section 4.0 and in a technical memorandum prepared to verify NSRs and noise measurement locations (Jacobs 2016). Exhibit 7 depicts the NSRs identified within the study area that were included in the model and analysis.

3.3. Traffic Noise Model Inputs

Traffic noise models were developed for existing and future build conditions. The purpose of the models is to show whether traffic noise levels satisfy defined criteria and subsequently whether traffic noise abatement should be considered.

FHWA's approved TNM 2.5 was used for this analysis. The basic inputs to noise modeling include roadway network layout, site characteristics, traffic volume projections, fleet mix, and vehicular posted speeds. Roadway and receptor geometry were provided by WSDOT and included based on a Micro Station design file (pers. comm. WSDOT 2016) and aerial photography. The files used for this analysis were based on a NAD 83 State Plane system; x, y, and z coordinates were input into the model. All input and output files for TNM 2.5 are included in Appendix A on the enclosed CD.

Traffic data was provided by WSDOT and is included as Appendix C (WSDOT 2016). Exhibit 8 summarizes the I-90 traffic volumes and truck percentages that represent "worst hourly noise levels". Exhibit 9 summarizes the Exit 70 ramp volumes.

Exhibit 7: Project Study Area

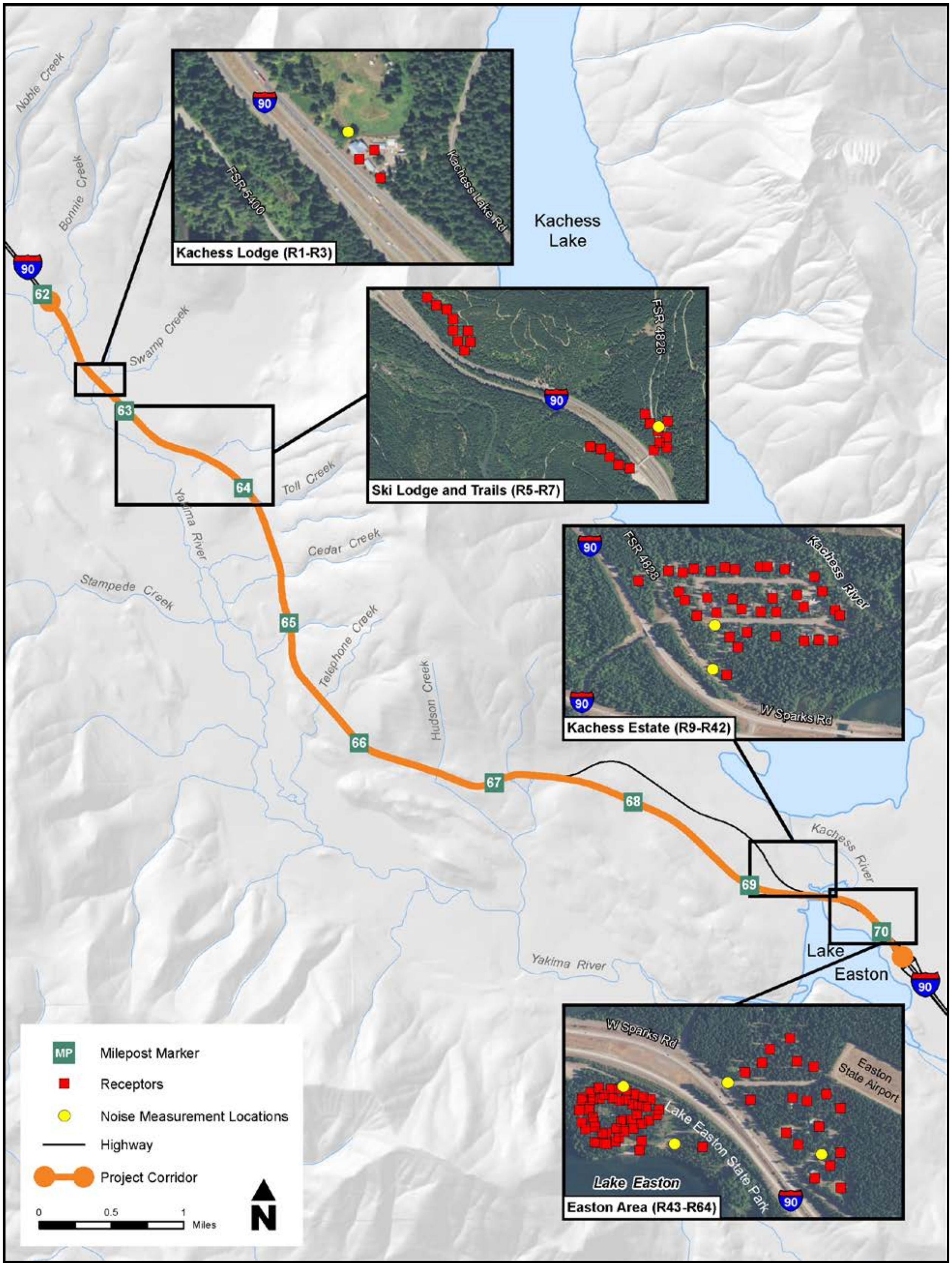


Exhibit 8: Modeled PM Peak Hourly Traffic Volumes along I-90 for Existing and Future Build Conditions

Vehicle Type Category	% of Total Vehicles*	Existing 2015		Design Year 2041	
		EB	WB	EB	WB
Total Directional Peak Hourly Volume	100%	1446	2456	1869	3174
Autos	90.1%	1303	2213	1684	2860
Medium Trucks	4.4%	64	108	82	140
Heavy Trucks	5.5%	80	135	103	175

Source: WSDOT 2016.

*Peak hour volumes occur on weekends when auto % is greater than truck % compared to current AADT.

Exhibit 9: Modeled PM Peak Hourly Traffic Volumes for Exit 70 Interchange for Existing and Future Build Conditions

Roadway and Direction	Existing Conditions (2015)			Build Design Year Traffic (2041)		
	Cars	Medium Trucks	Heavy Trucks	Cars	Medium Trucks	Heavy Trucks
Exit 70 EB off-ramp	47	3	2	60	4	3
Exit 70 EB on-ramp	47	3	2	60	4	3
Exit 70 WB off-ramp	56	3	2	70	4	3
Exit 70 WB on-ramp	44	2	2	54	3	3

Source: WSDOT 2016.

4. Affected Environment

This section describes land uses and NSRs, baseline sound level monitoring, and noise model verification used for TNM noise modeling.

4.1. Noise Information within the Study Area

Existing speed limits observed within the study area are 65 mph for cars and 60 mph for trucks from MP 62 to MP 67, and 70 mph for cars and 60 mph for trucks from MP 67 to MP 70. Speed limits on the on/off ramps were modeled at an average 45 mph as directed by WSDOT. The I-90 Project is being planned to meet specific design speeds that match the context of the highway, with consideration given to the terrain and environmental constraints.

Design speeds are the maximum speeds recommended for vehicles for a specific highway design. In some instances, the design speed will exceed the posted speed limit, and in some instances, will match the posted speed limit. According to the *I-90 Snoqualmie Pass East Corridor Analysis Errata* (WSDOT 2013), the design speed within the study area (MP 62 to MP 70.3) is 70 mph. Typically, the posted speed is equal to or lower than the design speed. However, recent changes to the WSDOT Design Manual (Chapter 1100, Practical Design), allows the posted speeds to be used as the design speeds for the I-90 Project. The existing posted speed limit for trucks is 60 mph, which was also used for future conditions.

The project exists within the Cascade Mountains and Snoqualmie Pass where WSDOT applies an active traffic management approach that has seasonal needs and considerations, including variable speed limits that can be different than the posted speed limit. WSDOT has installed and will continue to improve the use of Variable Message Signs (VMS) within the I-90 corridor to alert users of driving conditions, collisions, and traffic slowdowns. During the late spring, summer, and early fall when winter driving conditions largely diminish, construction and maintenance activities increase on I-90 that require variable speed limits be established for safety reasons. While I-90 is under construction for the next 10 to 14 years, drivers can expect infrequent rolling slow-downs, reduced lane widths, detours, and/or temporary blasting closures through the project area. Construction and maintenance activities are planned in advance to the degree possible so WSDOT can notify drivers of potential delays. WSDOT uses a variety of media outlets such as the WSDOT website, Highway Advisory Radio, VMS, Intelligent Transportation Systems, and other venues. Regular maintenance of I-90 outside of planned construction activities may also require the use of variable speed limits for public safety reasons.

During the late fall, winter, and early spring when inclement weather conditions occur, the roadway conditions are assessed and variable speed limits may be put in place for driver safety, to aid in snow removal/maintenance operations, and/or for avalanche control work. WSDOT uses the VMS, variable speed limits and other tools such as rolling slow-downs and temporary closures to accomplish these objectives. While winter driving conditions are not as easy to predict as seasonal construction activities, WSDOT tries to use the same media and communication techniques to help drivers plan their trips when practical.

The activities and use of variable speed limits within the study area may result in conditions that vary from the operational speeds and associated traffic noise that are represented in the noise model for this analysis.

4.2. Noise Sensitive Receptors and Noise Measurement Locations

The following describes each NSR identified within the study area (Exhibit 7), including single family residences, two lodges, a park, campsites, and trails. These NSRs represent land use categories B, C, and E. Usage factors and residential equivalents were calculated for parks, trails, and campsites. The calculations are based on guidance provided in WSDOT's *2011 Traffic Noise Policy and Procedures* (WSDOT 2012). The usage factors account for time variables such as hours per day, days per week, and months per year the facility operates. Once the usage factor has been determined, it is applied to the projected average use of the facility and then divided by the average number of people per household (based on Washington State average) to calculate the residential equivalent. Appendix B provides detailed calculations.

Land use categories A, F, and G were not identified or included in this noise analysis. Land use category D was not identified since outdoor use was observed at all NSRs.

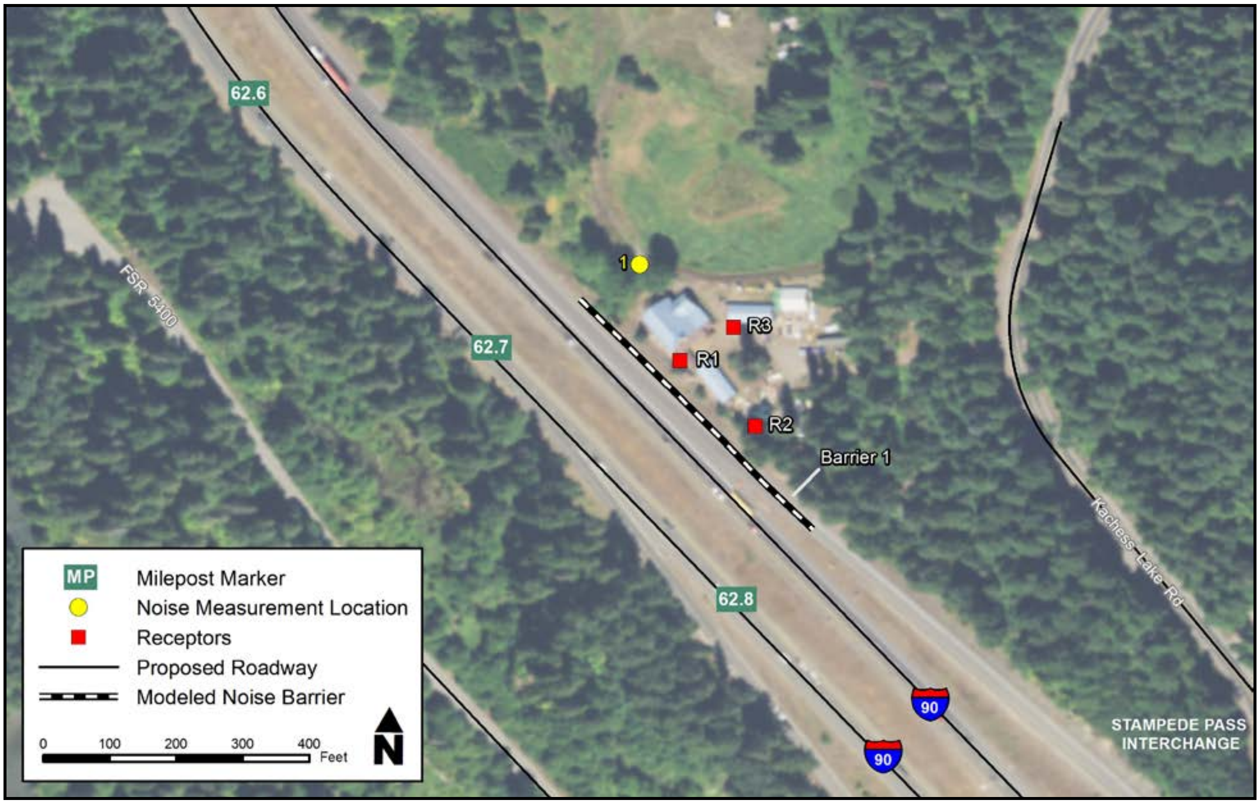
The number of receptors for each site was confirmed in the field on October 5, 2016, with a follow-up visit to Lake Easton State Park on January 13, 2017 to identify the location of NSRs using a handheld GPS unit (see Section 3.2). Noise measurement locations were selected based on line of sight to the highway and locations that would accurately represent the study area including first and second row receptors. Additional information regarding the identification of the NSRs and noise measurement locations is provided in a memorandum to WSDOT (Jacobs 2016).

4.2.1. Kachess Lodge (R1 – R3)

The Kachess Lodge receptor is located at 351 Kachess Lake Road at MP 62.75 and approximately 92 feet from the proposed centerline of the nearest westbound travel lane (Exhibit 10). Based on the October 5, 2016, field review and a discussion with the owner (pers. comm. Halstead 2016), there are two structures that represent the Kachess Lodge and a single family dwelling unit. Only portions of the Kachess Lodge are occupied. However, since all structures on-site are permitted for use, all three structures were modeled as individual receptors.

This receptor was not identified or modeled in the 2008 *Noise Discipline Report Supplement* since it was a proposed acquisition at that time.

Exhibit 10: Kachess Lodge



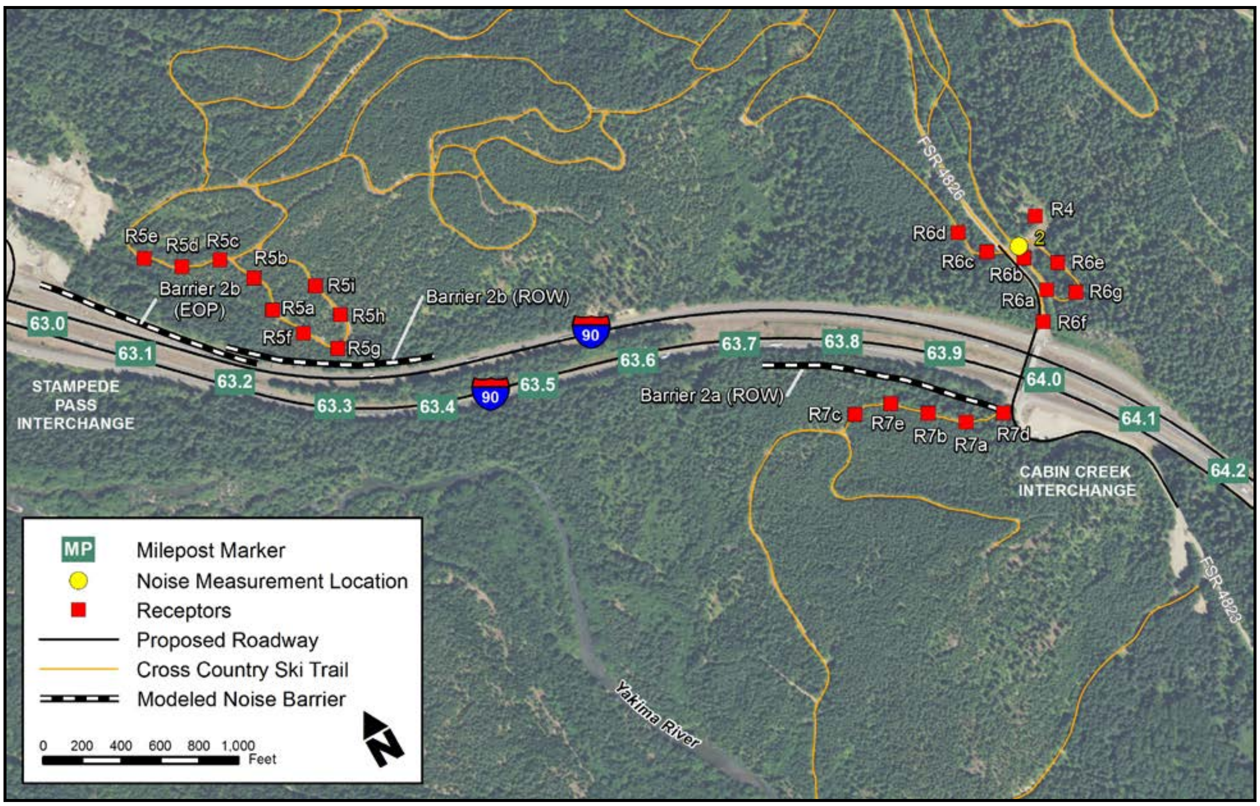
4.2.2. Ski Lodge and Trails near Cabin Creek Interchange (R5 – R7)

Several non-motorized winter recreational trails and a ski club (Kongsberger) lodge are located on National Forest System Land near exit 64 at MP 63.96 (Exhibit 11). The lodge is located approximately 500 feet from the proposed centerline of the nearest westbound travel lanes. The lodge represents one receptor.

Winter recreational trails are located on both sides of the highway. Information was obtained from Debra Davis with the USFS and from the Washington State Park website for Cabin Creek Sno-Park. According to the state park website, average daily use was estimated at 117. The usage factor was based upon 24 hours per day, seven days per week, and four months per year. The residential equivalent for the trail was estimated at 15 based upon a usage factor of 0.33. A total of 22 receptors were modeled along portions of the trail within 500 feet from the proposed improvements. The number of receptors modeled was based upon an average lot size within the study area (Kittitas County 2016). In addition, the residential equivalent for each receptor was conservatively rounded up to one for the purposes of the analysis and modeling. Appendix B provides detailed information for calculating the usage factor and residential equivalent.

These receptors were not identified or modeled in the 2008 *Noise Discipline Report Supplement*.

Exhibit 11: Ski Lodge and Trails near Cabin Creek Interchange

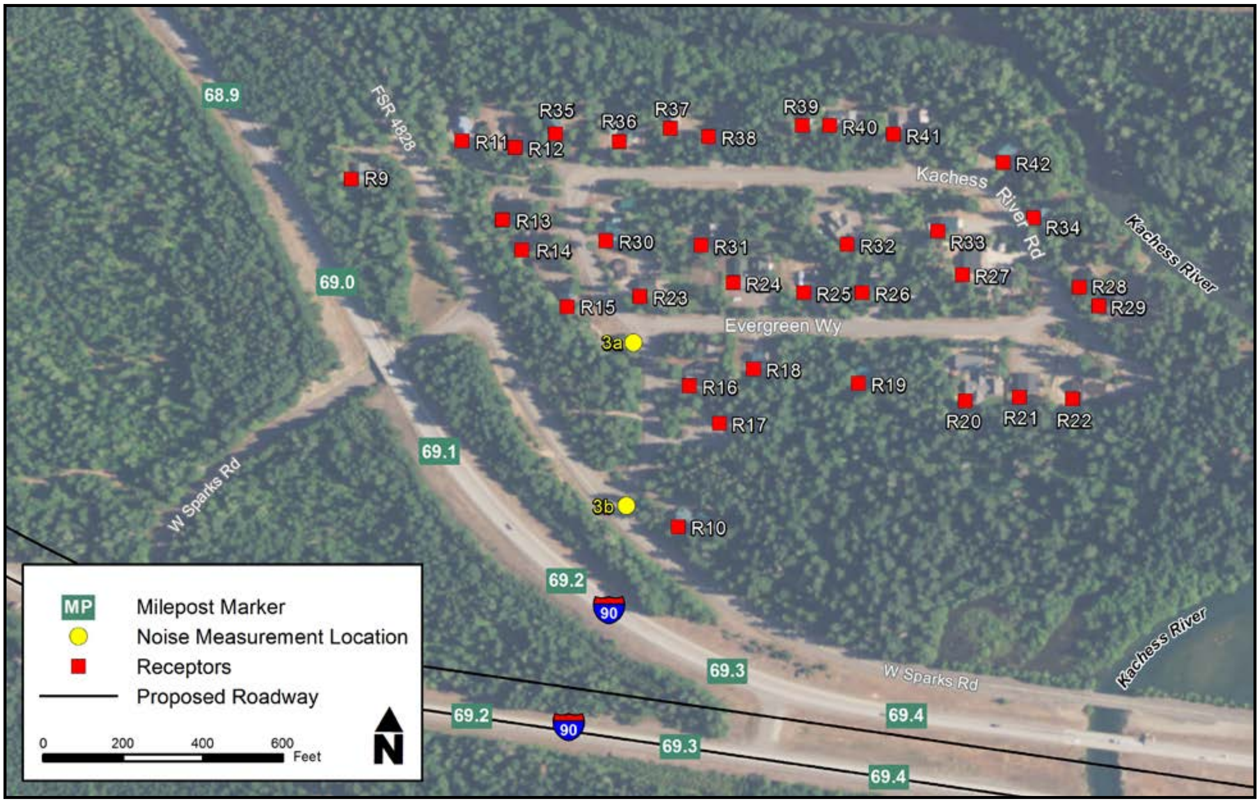


4.2.3. Single Family Homes South of Kachess Lake (R9 – R42)

The single family homes south of Kachess Lake are located a minimum of 485 feet from the proposed centerline of the nearest westbound travel lanes at MP 69.3 (Exhibit 12). There are a total of 34 NSRs within this subdivision and each dwelling unit was modeled as one receptor.

A total of six single family homes were identified and modeled in the 2008 *Noise Discipline Report Supplement*.

Exhibit 12: Single Family Homes South of Kachess Lake



4.2.4. Lake Easton State Park (R43 – R46)

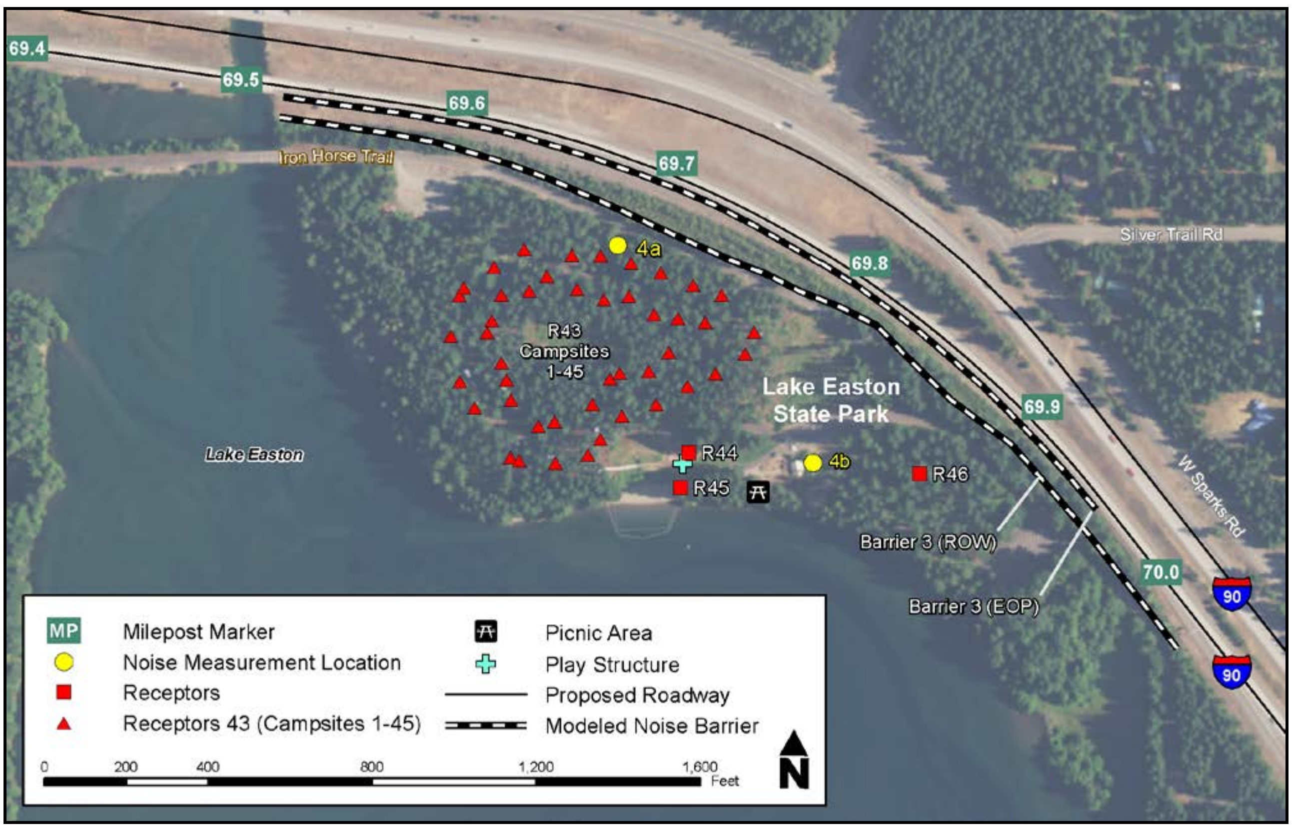
The Lake Easton State Park receptors are located approximately 185 feet from the centerline of the nearest eastbound travel lane at MP 69.64 (Exhibit 13). Usage information was obtained from Jason Both, Area Manager at Lake Easton State Park and from the Lake Easton State Park website. Detailed assumptions and calculations regarding usage are provided in Appendix B.

According to the state park (pers. comm. Both 2016), there are approximately six picnic areas identified within this portion of the park. This analysis assumed usage of four people per picnic area per day. This analysis assumed two seasonal usage periods with six "summer" months and six "winter" months. The day use park area closes at dusk every day and opens at 6.30 a.m. in the summer and 8:00 a.m. in the winter, seven days a week. Therefore, the summer usage factor was based upon 13 hours per day and the winter usage factor was based upon 10 hours per day. Outdoor use of the picnic areas is considered minimal during the winter months at approximately five percent. WSDOT guidance specifies that picnic sites are open 10 hours per day with a usage factor of 0.17. Based upon the extended usage of the Lake Easton State Park picnic areas during the summer months, the usage factor for this analysis was increased to 0.28. The residential equivalent for the picnic areas within the park was conservatively rounded up to three for the purposes of the analysis and modeling. There are also playground and beach areas that are represented by one receptor each.

According to the state park (pers. comm. Both 2016), there are 45 campsites identified within this portion of the park. Each campsite was identified using a GPS unit (see Section 3.2) and modeled individually in this analysis. All campsites were assumed to represent first row receptors since there was a clear line of sight to the noise source for most campsites and there would be little to no shielding from the campsites closest to the roadway. This analysis assumed usage of four people per campsite per day. Seasonal usage for campsites during the winter months is 0 percent because the campsites are closed. During the summer months, usage is 100 percent on the weekends and fluctuates from 75 percent to 90 percent on the weekdays, where weekdays are Monday through Thursday and weekends are Friday through Sunday. The summer usage factor (assumed no winter use as the campsite is closed) was based upon 24 hours per day, 7 days per week (3 weekend days and 4 weekdays), and 6 months per year. Based upon information obtained from the park website and received from the state park, the usage factor was calculated as 0.46. The residential equivalent for each campsite was calculated as 0.73, but conservatively rounded up to one for the purposes of the analysis and modeling. Therefore, a total of 45 receptors were modeled to represent each campsite (see Appendix B).

These receptors were identified and modeled in the 2008 *Noise Discipline Report Supplement*. Based upon information received at that time, the residential equivalent for the campsites and picnic areas was estimated to be 25. In addition, one receptor was modeled to represent all 25 residential equivalents. This information was updated and confirmed with the park for this report.

Exhibit 13: Lake Easton State Park

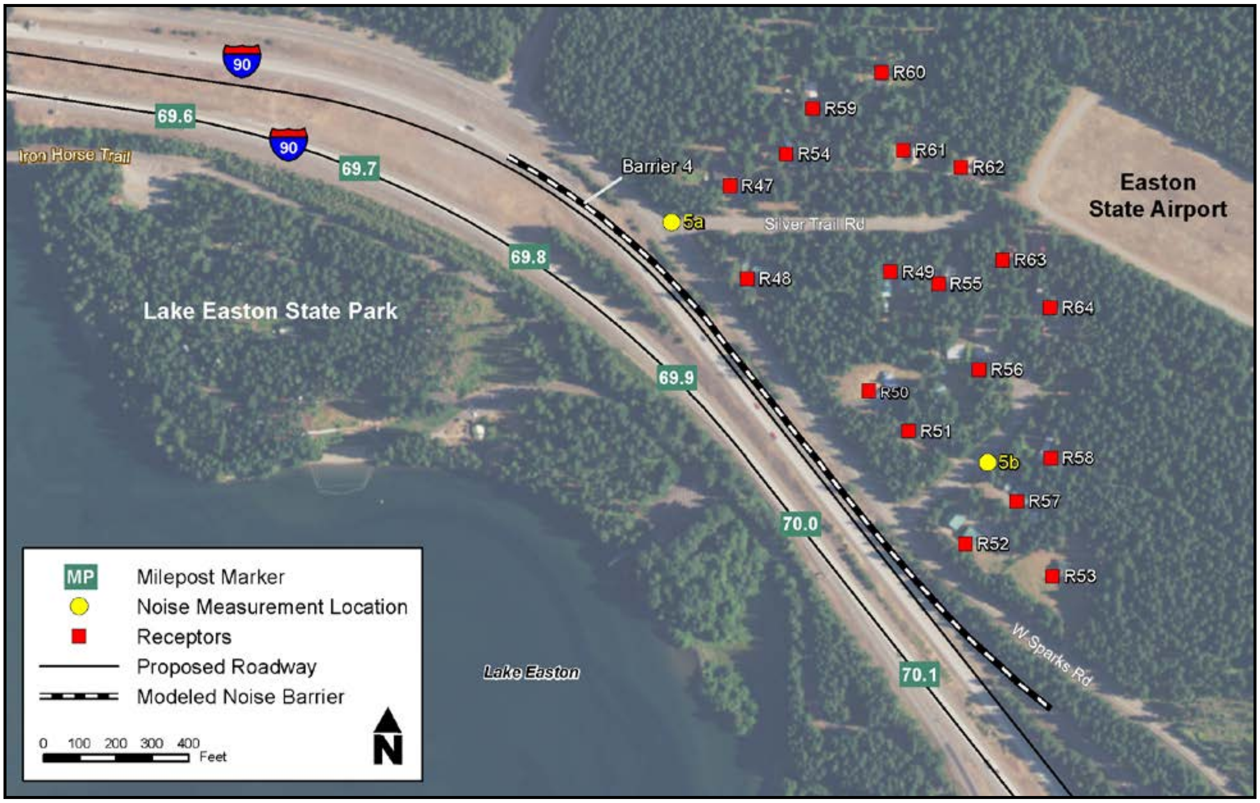


4.2.5. Single Family Homes near Easton Municipal Airport (R47 – R64)

The single family homes near Easton Municipal Airport are located approximately 150 feet east of the proposed centerline of the nearest westbound travel lane at MP 69.87 (Exhibit 14). There are a total of 18 NSRs within this subdivision and each dwelling unit was modeled as one receptor.

A total of 14 single family homes were identified and 11 were modeled in the 2008 *Noise Discipline Report Supplement*.

Exhibit 14: Single Family Homes near Easton Municipal Airport



4.3. Baseline Sound Level Monitoring and TNM Validation

4.3.1. Sound Level Monitoring

Eight locations were identified and approved by WSDOT and noise measurements were collected within the study area on October 5, 2016 to determine ambient noise levels (Exhibit 7). Weather conditions were clear with estimated winds of zero to five miles per hour (mph). Temperatures ranged from approximately 49 degrees to 54 degrees Fahrenheit throughout the day. Additional information regarding the identification of the noise measurement locations is provided in a memorandum to WSDOT (Jacobs 2016). Field datasheets are included in Appendix D.

Noise monitoring was conducted using a Quest 2900 Type II sound level meter that meets American National Standards Institute (ANSI) standards. In March 2016, the sound level meter and calibrator were calibrated by Engineering Dynamics who provides National Institute of Standards and Technology (NIST) traceable calibration services.

Meters were calibrated before each event and placed at five feet above ground surface, as this is the average height of the human ear. Noise measurements were collected for approximately 15 minutes per event at each location as called for by WSDOT and FHWA policies. Two events were collected per measurement location. Traffic counts were collected on I-90 by vehicle type simultaneously with each noise measurement event, and during periods when traffic was free flowing. Operating speeds (per posted speed limits) and existing geometry were also collected. Traffic on side streets was also noted during events.

4.3.2. Traffic Noise Model Validation

Ambient noise levels, traffic counts, and operating speed data were input into the FHWA-approved TNM 2.5 software for validation analysis. Exhibit 15 summarizes the field recorded and TNM predicted noise levels. The difference between the field recordings and the noise levels predicted by the model was less than 2 dBA, which is considered validated per WSDOT policy. Therefore, the model was considered an accurate representation of the existing conditions. The modeling of field noise measurements was only used to validate the TNM and was not used to predict existing noise conditions.

Exhibit 15: Model Validation of Field Recorded and TNM Predicted Noise Levels

Noise Measurement Location	Start Time	Field Recorded Noise Levels L_{eq} (dBA)	TNM Predicted Noise Levels L_{eq} (dBA)	Difference L_{eq} (dBA)
#1 – 351 Kachess	11:14 am	69.9	70.3	+0.4
#2 – Ski Lodge	12:12 am	55.6	57.3	+1.7
#3a – Single Family Homes South of Kachess Lake (second row)	1:20 pm	57.0	58.4	+1.4
#3b – Single Family Homes South of Kachess Lake (first row)	2:07 am	66.7	64.8	-1.9
#4a – Lake Easton State Park (campsites)	3:21 pm	64.1	65.1	+1.0
#4b – Lake Easton State Park (picnic area)	4:17 pm	60.5	61.5	+1.0
#5a – Single Family Homes near Easton Municipal Airport (Silver Trail – first row)	5:14 pm	69.8	70.1	+0.3
#5b – Single Family Homes near Easton Municipal Airport (Smith Drive – second row)	9:03 am	61.8	61.7	-0.1

4.4. Predicted Existing Traffic Noise Levels

Traffic noise models were developed to evaluate existing conditions beyond ambient noise measurements. The dominant noise source in the study area is traffic along I-90. Under existing conditions, there are approximately 21 NSRs impacted by traffic noise. Exhibit 16 in Section 5.1 summarizes existing noise levels at each identified NSR. Existing noise levels within the study area range from approximately 53 dBA to 74 dBA.

5. Traffic Noise Impact Analysis

This section describes operational noise impacts. Traffic noise models were developed to evaluate future noise conditions. The purpose of the models is to show whether traffic noise levels satisfy defined criteria and subsequently whether traffic noise abatement should be considered.

Exhibit 16 summarizes future noise levels and receptors impacted as a result of the build condition. As shown in the Build Impact column, an impact occurs when the noise level approaches or exceeds the NAC even if future noise levels are lower compared to existing noise levels.

5.1. Build Design

The proposed improvements would result in traffic noise levels that would meet or exceed the NAC at approximately 20 NSRs. No sensitive receptors would experience a substantial noise increase over existing conditions (10 dB[A] or more). Noise levels range from approximately 54 dBA to 75 dBA. I-90 Project highway build design features increased vertical geometry, resulting in a lower predicted noise level for some NSRs (see Exhibit 16). South of Kachess Lake, noise levels associated with the build design are predicted to be lower for some receivers along the north side because of the bundled configuration of the new lanes (see Exhibit 12).

Exhibit 16: Existing and Future Noise Levels

Receptor No. and Land Use Category	Receptor Location	No. of NSRs	NAC (Leq) (dBA)	Existing 2015 Noise Levels (Leq) (dBA)	No Build 2041 Noise Levels (Leq) (dBA)	Build 2041 Noise Levels (Leq) (dBA)	Difference Between Existing 2015 and Build 2041 Noise Levels (+ or -) (dBA)	Build Impact
Kachess Lodge								
R1 (E)	351 Kachess Lake Road	1	71	**74**	**75**	69	-5	No
R2 (E)	351 Kachess Lake Road	1	71	**74**	**75**	**75**	1	**Yes**
R3 (E)	351 Kachess Lake Road	1	71	69	70	68	-1	No
Ski Lodge and Trails near Cabin Creek Interchange								
R4 (E)	Ski Lodge	1	71	53	54	54	1	No
R5 (C)	Winter Recreational Trail – WB north	9*	66	60 – **72** (2)**	61 – **73** (2)**	60 – **72** (2)**	0	**Yes**
R6 (C)	Winter Recreational Trail – WB south	8*	66	53 – 65	54 – **67** (1)**	54 – **69** (1)**	1 - 4	**Yes**
R7 (C)***	Winter Recreational Trail – EB south	5*	66	63 – **67** (4)**	64 **– 68** (4)**	63 – **68** (3)**	1	**Yes**
Single Family Homes South of Kachess Lake								
R9 (B)	3720 W Sparks Rd	1	66	**67**	**68**	57	-10	No

Exhibit 16: Existing and Future Noise Levels

Receptor No. and Land Use Category	Receptor Location	No. of NSRs	NAC (Leq) (dBA)	Existing 2015 Noise Levels (Leq) (dBA)	No Build 2041 Noise Levels (Leq) (dBA)	Build 2041 Noise Levels (Leq) (dBA)	Difference Between Existing 2015 and Build 2041 Noise Levels (+ or -) (dBA)	Build Impact
R10 (B)	2 Kachess River Road	1	66	**67**	**68**	65	-2	No
R11 (B)	251 Kachess River Rd	1	66	57	58	53	-4	No
R12 (B)	261 Kachess River Road	1	66	56	57	53	-3	No
R13 (B)	231 Kachess River Rd	1	66	55	56	52	-3	No
R14 (B)	221 Kachess River Rd	1	66	55	56	53	-2	No
R15 (B)	211 Kachess River Rd	1	66	57	58	55	-2	No
R16 (B)	10 Kachess River Rd	1	66	60	62	59	-1	No
R17 (B)	Kachess River Road	1	66	63	64	61	-2	No
R18 (B)	80 Evergreen Way	1	66	60	61	59	-1	No
R19 (B)	170 Evergreen Way	1	66	61	62	60	-1	No
R20 (B)	250 Evergreen Way	1	66	59	61	60	1	No
R21 (B)	Evergreen Way	1	66	59	60	59	0	No
R22 (B)	770 Kachess River Road	1	66	59	60	59	0	No
R23 (B)	190 Kachess River Road	1	66	57	58	55	-2	No
R24 (B)	73 Evergreen Way	1	66	57	58	56	-1	No
R25 (B)	115 Evergreen Way	1	66	57	58	56	-1	No
R26 (B)	171 Evergreen Way	1	66	57	58	57	0	No
R27 (B)	630 Kachess River Road	1	66	56	57	56	0	No
R28 (B)	691 Kachess River Road	1	66	56	57	56	0	No
R29 (B)	691 Kachess River Road	1	66	56	57	57	1	No
R30 (B)	316 Kachess River Road	1	66	58	59	55	-3	No
R31 (B)	396 Kachess River Road	1	66	57	58	56	-1	No
R32 (B)	480 Kachess River Road	1	66	56	57	56	0	No
R33 (B)	610 Kachess River Road	1	66	56	57	55	-1	No
R34 (B)	621 Kachess River Road	1	66	54	56	55	1	No
R35 (B)	271 Kachess	1	66	56	57	53	-3	No

Exhibit 16: Existing and Future Noise Levels

Receptor No. and Land Use Category	Receptor Location	No. of NSRs	NAC (Leq) (dBA)	Existing 2015 Noise Levels (Leq) (dBA)	No Build 2041 Noise Levels (Leq) (dBA)	Build 2041 Noise Levels (Leq) (dBA)	Difference Between Existing 2015 and Build 2041 Noise Levels (+ or -) (dBA)	Build Impact
	River Road							
R36 (B)	291 Kachess River Road	1	66	55	57	53	-2	No
R37 (B)	346 Kachess River Road	1	66	55	56	54	-1	No
R38 (B)	371 Kachess River Road	1	66	55	56	54	-1	No
R39 (B)	421 Kachess River Road	1	66	54	55	54	0	No
R40 (B)	471 Kachess River Road	1	66	54	55	53	-1	No
R41 (B)	521 Kachess River Road	1	66	54	55	54	0	No
R42 (B)	571 Kachess River Road	1	66	54	55	54	0	No
Lake Easton State Park								
R43 (C)	Campsites	45*	66	58 – **67** (6)**	59 – **68** (10)**	59 – **68** (8)**	2 - 8	**Yes**
R44 (C)	Playground	1	66	57	59	59	2	No
R45 (C)	Beach	1	66	57	59	59	2	No
R46 (C)	Picnic Area	3*	66	58	59	60	2	No
Single Family Homes near Easton Municipal Airport								
R47 (B)	61 Silver Trail Road	1	66	**67**	**68**	**67**	0	**Yes**
R48 (B)	120 Silver Trail Road	1	66	**71**	**72**	**68**	-3	**Yes**
R49 (B)	200 Silver Trail Road	1	66	62	63	62	0	No
R50 (B)	2131 W Sparks Road	1	66	**68**	**69**	**68**	0	**Yes**
R51 (B)	71 Smith Drive	1	66	**68**	**69**	**68**	0	**Yes**
R52 (B)	60 Smith Drive	1	66	**70**	**71**	**70**	0	**Yes**
R53 (B)	1851 W Sparks Road	1	66	65	**66**	65	0	No
R54 (B)	50 Silver Trail Ln	1	66	62	63	63	1	No
R55 (B)	240 Silver Trail Road	1	66	60	61	60	0	No
R56 (B)	171 Smith Drive	1	66	61	62	61	0	No
R57 (B)	90 Smith Drive	1	66	64	65	64	0	No
R58 (B)	150 Smith Drive	1	66	61	62	61	0	No
R59 (B)	141 Silver Trail Road	1	66	59	60	60	1	No
R60 (B)	161 Silver Trail Road	1	66	56	57	57	1	No
R61 (B)	221 Silver Trail Road	1	66	57	58	58	1	No
R62 (B)	231 Silver Trail Road	1	66	56	57	57	1	No
R63 (B)	260 Silver	1	66	57	58	58	1	No

Exhibit 16: Existing and Future Noise Levels

Receptor No. and Land Use Category	Receptor Location	No. of NSRs	NAC (Leq) (dBA)	Existing 2015 Noise Levels (Leq) (dBA)	No Build 2041 Noise Levels (Leq) (dBA)	Build 2041 Noise Levels (Leq) (dBA)	Difference Between Existing 2015 and Build 2041 Noise Levels (+ or -) (dBA)	Build Impact
	Trail Road							
R64 (B)	180 Smith Drive	1	66	57	58	58	1	No

**Based on usage factors and residential equivalent calculations.*
***For multiple receptors, the total number of impacts is provided in ().*
****R8 was removed from the TNM and analysis. Therefore, receptor numbering is not sequential.*
Note: Impacts (noise levels that meet or exceed the NAC) are noted by bolded values.

As mentioned above, a total of 20 NSRs would be impacted under build conditions. For multiple receptors, the total number of impacts is shown in parentheses in Exhibit 16. Of the 20 impacted NSRs, one receptor is located at Kachess Lodge, six receptors are located at the Ski Lodge and Trails near Cabin Creek Interchange, eight campsites are impacted within the Lake Easton State Park, and five single-family homes are impacted near the Easton Municipal Airport. Noise abatement was considered for all impacted receptors. None of the single-family homes south of Kachess Lake would be impacted as a result of the build design since the alignment would be shifted further away from the receptors.

Actual projected traffic volumes have decreased, resulting in lower noise levels and lower reasonableness allowance for the 2041 design year compared to the design years utilized in the previous 2003 and 2008 noise analyses. As a result of the changes in traffic volumes and more precise modeling inputs at Lake Easton State Park, the total numbers of impacted receptors in the future build condition decreased from 30 NSRs in the 2008 report to 20 NSRs in this analysis.

5.2. No Build

Under no-build conditions, no improvements to I-90 are proposed aside from routine maintenance activities. However, as shown in Exhibit 16, approximately 27 NSRs would experience traffic noise levels that would meet or exceed the NAC in 2041, with noise levels ranging from approximately 54 dBA to 75 dBA. This constitutes seven additional impacted receptors compared to build conditions. In addition to the 20 NSRs identified in the build condition, one additional receptor would be impacted at Kachess Lodge due to vertical geometry changes in this area. One additional receptor would be impacted along the trail near Cabin Creek Interchange due to the distribution of traffic along the proposed eastbound travel lanes. Two single-family homes south of Kachess Lake would be impacted since the westbound lanes would remain further north compared to the build design, closer to the residents. Two additional campsites at Lake Easton State Park would be impacted due to the distribution of traffic along the proposed eastbound travel lanes. One additional single-family home near Easton Municipal Airport would be impacted due to the reconfiguration of the Lake Easton Road westbound on-ramp.

Although traffic noise impacts are anticipated, no project-related improvements are proposed under the no-build scenario. Therefore, traffic noise abatement was not considered.

6. Traffic Noise Abatement Analysis

This section describes operational noise abatement strategies and evaluates the feasibility and reasonableness of potential abatement options.

6.1. Feasibility

Feasibility is a combination of acoustic and engineering considerations. All of the following must occur for abatement (e.g., noise barrier) to be considered feasible.

- Abatement must be physically constructible.
- The majority first row impacted receivers must obtain a minimum 5 dBA of noise reduction as a result of abatement (insertion loss); assuring that every reasonable effort will be made to assess outdoor use areas as appropriate.

6.2. Reasonableness

If abatement is determined feasible, the reasonableness of abatement will be evaluated. WSDOT will only construct noise walls, or other types of abatement, if they have been determined to be reasonable by satisfying three criteria below.

- **Cost Effectiveness** – the cost of noise abatement must be equal to or less than the allowable cost of abatement for each noise wall location analyzed and must provide at least the minimum feasible noise reductions.
- **Design Goal Achievement** – the minimum design goal for abatement is at least 7 dBA of reduction for one receiver. In addition, WSDOT will make reasonable efforts to get 10 dBA or greater insertion loss where abatement is recommended.
- **Desire for Abatement from Public within the Noise Study Area** – abatement is determined desirable by the benefiting receptors.

6.3. Evaluation of General Noise Abatement Strategies

A variety of noise abatement methods can effectively reduce traffic sound levels. For example, noise impacts can be reduced by implementing traffic management measures, realigning the highway, acquiring land as buffer zones, installing noise insulation on public buildings, and constructing noise barriers.

WSDOT qualitatively evaluated these abatement measures for their potential to reduce noise impacts, and the following exhibits summarize the results of the evaluation. Final determination of size and placement of noise barriers, and implementation of other abatement measures, occurs during detailed project design and after an opportunity for public involvement and approval at the local, state, and federal levels.

6.3.1. Traffic Management Measures

Traffic management measures include time restrictions, traffic control devices, signing for prohibition of certain vehicle types (such as motorcycles and heavy trucks), modified speed limits, and exclusive land designations. Restricting vehicle types and lowered speed limits on I-90 could worsen congestion, and would conflict with the stated objectives for the proposed improvements. Noise impacts could be reduced by land use controls throughout the corridor, although some land use controls are in place due to USFS land ownership.

6.3.2. Realigning the Highway

The horizontal alignment is defined by available right-of-way. WSDOT has analyzed strategic movements of the horizontal alignment for multiple reasons, and the current build design reflects alignment adjustments. WSDOT will continue to review the least impact design as design progresses. Vertically lowering the mainline to provide sound level reduction to some receptors would be expensive compared to constructing noise walls, and would increase constructability concerns, requiring additional roadway closure and reconstruction.

6.3.3. Land Acquisition for Noise Buffers

The highway is bordered by residential properties, state parks, and federal land. Land acquisition for noise buffer zones or barriers to protect receptors where impacts are predicted would require relocation of residents. Private land is limited within the corridor and relocation would be unreasonably expensive for noise abatement purposes.

6.3.4. Noise Insulation of Buildings

Insulating buildings is approved abatement for public and non-profit buildings, but not for residential structures or outdoor use areas. Because this option does not mitigate for outdoor use, it was not considered.

6.3.5. Construction Noise Barrier Walls

Noise barrier walls could be constructed within the highway right-of-way to shield nearby noise sensitive receivers. Detailed modeling of noise wall performance at each impacted area is described in the following section of this report.

6.4. Modeling of Traffic Noise Barriers

6.4.1. Kachess Lodge (R1 – R3)

The Kachess Lodge is located east of I-90 and north of Kachess Lake Road. There are two structures on-site that represent the Kachess Lodge and a single-family dwelling unit. Each structure represents one receptor. All three receptors were included in the model. A noise barrier was not modeled along the right-of-way boundary since topography slopes to the east. Modeling the barrier adjacent to the roadway edge of pavement (EOP) would provide the most effective insertion loss.

Noise Barrier 1

<u>Feasibility Criteria</u>
A noise barrier (Barrier 1) was modeled adjacent to the proposed I-90 roadway EOP. The modeled noise barrier of 12-feet tall and 492-feet in length (or 5,904 square feet) would be the minimum amount of barrier that would provide at least 5 dBA noise reduction for approximately 100 percent of the first row receptors (see Exhibit 17). Therefore, Barrier 1 would be feasible to construct.

Exhibit 17: Summary of Feasibility Analysis – Noise Barrier 1

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	1st Row?	Min. Design Goal NW		Feasible?
						Insertion Loss (dBA)	% 1st Row Impacted ≥ 5 dBA	
R1 (E)	1	**74**	**69**	62	Yes	7	100%	Yes
R2 (E)	1	**74**	**75**	65	Yes	10		
R3 (E)	1	**69**	**68**	63	Yes	5		

Impacts are noted by bolded values.

<u>Reasonableness Allowance Criteria</u>
Barrier 1 would meet the reasonable design goal of 7 dBA. However, based on the WSDOT reasonable allowances criteria, Barrier 1 would exceed the allowed wall surface area of 3,052 square feet and the allowed cost of $157,513, as shown in Exhibit 18. The total barrier cost allowed is based on the allowed cost per qualified residence as specified in the WSDOT noise policy. The total cost to construct the barrier is based on the wall square footage and the 2011 construction cost of $51.61 per square foot.

Exhibit 18: Summary of Reasonableness Evaluation for Cost – Noise Barrier 1

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq ft)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R1 (E)	1	**74**	**69**	62	904	3,052	$157,513	$304,705	7
R2 (E)	1	**74**	**75**	65	1,312				10
R3 (E)	1	**69**	**68**	63	836				5
					Design Goal Achieved?			Yes	
					Cost Effective?			No	

Impacts are noted by bolded values.
Reasonableness allowance based on $51.61/ft^2

Exhibit 17 summarizes the feasibility analysis and Exhibit 18 summarizes the reasonableness evaluation for cost for Noise Barrier 1. This barrier meets the feasibility criteria, but would not be cost effective and therefore is not recommended.

6.4.2. Ski Lodge and Trails near Cabin Creek Interchange (R5 – R7)

Noise barriers were not modeled for the Ski Lodge since traffic noise impacts are not anticipated under build conditions. Noise barriers were also not modeled for the portion of the winter recreational trail located adjacent to the westbound travel lanes south of Kachess Lake Road since gaps would be required for access, rendering the noise barrier ineffective. Further, placing walls close to access points would result in inadequate sight distance, which would be a safety concern (see Exhibit 11).

Noise Barrier 2a was modeled adjacent to the right-of-way boundary and Noise Barrier 2b was modeled adjacent to the proposed I-90 roadway EOP and the right-of-way boundary. Barrier 2a was modeled on the eastbound side and Barrier 2b was modeled on the westbound side for the impacted receptors along portions of the trail within the study area (see Exhibit 11).

Noise Barrier 2a

Feasibility Criteria

The modeled noise barrier of 24-feet tall and 404-feet in length (or 9,696 square feet) would provide 5 dBA noise reduction for approximately 67 percent of the first row impacted receptors (see Exhibit 19). Therefore, Barrier 2a would be feasible to construct.

Exhibit 19: Summary of Feasibility Analysis – Noise Barrier 2a

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	1st Row?	Min. Design Goal NW		Feasible?
						Insertion Loss (dBA)	% 1st Row Impacted ≥ 5 dBA	
R7a (C)	1	**67**	**68**	**66**	Yes	2	67%	Yes
R7b (C)	1	**67**	**68**	62	Yes	6		
R7c (C)	1	63	63	61	Yes	2		
R7d (C)	1	**66**	65	65	Yes	0		
R7e (C)	1	**66**	**66**	59	Yes	7		

Impacts are noted by bolded values.

Reasonableness Allowance Criteria

Barrier 2a would meet the reasonable design goal of 7 dBA. However, based on the WSDOT reasonable allowances criteria, Barrier 2a would exceed the allowed wall surface area of 2,372 square feet and the allowed cost of $122,419, as shown in Exhibit 20. The total barrier cost allowed is based on the allowed cost per qualified residence as specified in the WSDOT noise policy. The total cost to construct the barrier is based on the wall square footage and the 2011 construction cost of $51.61 per square foot.

Exhibit 20: Summary of Reasonableness Evaluation for Cost – Noise Barrier 2a

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq ft)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R7a (C)	1	**67**	**68**	**66**	836	2,372	$122,419	$500,411	2
R7b (C)	1	**67**	**68**	62	836				6
R7c (C)	1	63	63	61	-				2
R7d (C)	1	**66**	65	65	-				0
R7e (C)	1	**66**	**66**	59	700				7
Design Goal Achieved?								Yes	
Cost Effective?								No	

Impacts are noted by bolded values.
Reasonableness allowance based on $51.61/ft^2$

Exhibit 19 summarizes the feasibility analysis and Exhibit 20 summarizes the reasonableness evaluation for cost for Noise Barrier 2a. This barrier meets the feasibility criteria, but would not be cost effective and therefore is not recommended.

Noise Barrier 2b

Feasibility Criteria

Due to elevation changes in this area, Barrier 2b was modeled as a system barrier: two separate barriers, one adjacent to the roadway EOP and one along the right-of-way boundary. Per WSDOT noise policy, the barrier analysis was conducted for two scenarios: modeling the barriers independently and as a system to determine if the barriers are feasible and reasonable independently or together.

Barrier along ROW only – The modeled noise barrier of 14-feet tall and 779-feet in length (or 10,906 square feet) along the right-of-way only would provide 5 dBA for approximately 100 percent of the first row impacted receptors (see Exhibit 21). Therefore, Barrier 2b along the right-of-way only would be feasible to construct.

Barrier along EOP only – The modeled noise barrier of 24-feet tall and 1,188-feet in length (or 28,512 square feet) along EOP only would not provide 5 dBA for the first row impacted receptors (see Exhibit 21). Therefore, Barrier 2b along the EOP only would not be feasible to construct and no further analysis was conducted.

Barrier along ROW and EOP – The modeled noise barriers ranging in heights from 14-feet to 20-feet tall and 1,572-feet in length (or 27,330 square feet) along the right-of-way and EOP would provide 5 dBA for approximately 100 percent of the first row impacted receptors (see Exhibit 21). Therefore, Barrier 2b along the right-of-way and EOP would be feasible to construct.

Exhibit 21: Summary of Feasibility Analysis – Noise Barrier 2b

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	1st Row?	Min. Design Goal NW		Feasible?
						Insertion Loss (dBA)	% 1st Row Impacted ≥ 5 dBA	
Noise Barrier 2b ROW only								
R5a (C)	1	64	64	61	Yes	3	100%	Yes
R5b (C)	1	61	61	60	Yes	1		
R5c (C)	1	60	61	60	Yes	1		
R5d (C)	1	62	63	63	Yes	0		
R5e (C)	1	62	63	63	Yes	0		
R5f (C)	1	**68**	**67**	62	Yes	5		
R5g (C)	1	**72**	**72**	64	Yes	8		
R5h (C)	1	63	63	61	Yes	2		
R5i (C)	1	60	60	59	Yes	1		
Noise Barrier 2b EOP only								
R5a (C)	1	64	64	60	Yes	4	0%	No
R5b (C)	1	61	61	57	Yes	4		
R5c (C)	1	60	61	55	Yes	5		
R5d (C)	1	62	63	56	Yes	5		
R5e (C)	1	62	63	57	Yes	5		
R5f (C)	1	**68**	**67**	**66**	Yes	1		
R5g (C)	1	**72**	**72**	**72**	Yes	0		
R5h (C)	1	63	63	62	Yes	1		
R5i (C)	1	60	60	58	Yes	2		
Noise Barrier 2b ROW and EOP								
R5a (C)	1	64	64	58	Yes	6	100%	Yes
R5b (C)	1	61	61	56	Yes	5		
R5c (C)	1	60	61	55	Yes	6		
R5d (C)	1	62	63	56	Yes	7		
R5e (C)	1	62	63	58	Yes	5		
R5f (C)	1	**68**	**67**	60	Yes	7		
R5g (C)	1	**72**	**72**	63	Yes	9		
R5h (C)	1	63	63	59	Yes	4		
R5i (C)	1	60	60	57	Yes	3		

Impacts are noted by bolded values.

Reasonableness Allowance Criteria

Barrier 2b would meet the reasonable design goal of 7 dBA for all scenarios except the barrier modeled along the EOP only. Based upon the WSDOT reasonable allowances criteria, Barrier 2b would exceed the allowed wall surface areas and the allowed costs for all scenarios as shown in Exhibits 22a and 22b. The total barrier cost allowed is based upon the allowed cost per qualified residence as specified in the WSDOT noise policy. The total cost to construct the barrier is based upon the wall square footage and the 2011 construction cost of $51.61 per square foot.

Exhibit 22a: Summary of Reasonableness Evaluation for Cost – Noise Barrier 2b ROW only

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq ft)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R5a (C)	1	64	64	61	-	1,876	$96,820	$562,859	3
R5b (C)	1	61	61	60	-				1
R5c (C)	1	60	61	60	-				1
R5d (C)	1	62	63	63	-				0
R5e (C)	1	62	63	63	-				0
R5f (C)	1	68	67	62	768				5
R5g (C)	1	72	72	64	1,108				8
R5h (C)	1	63	63	61	-				2
R5i (C)	1	60	60	59	-				1
					Design Goal Achieved?			Yes	
					Cost Effective?			No	

Impacts are noted by bolded values.
Reasonableness allowance based on $51.61/ft^2

Exhibit 22b: Summary of Reasonableness Evaluation for Cost – Noise Barrier 2b ROW and EOP

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq ft)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R5a (C)	1	64	64	58	700	5,376	$277,455	$1,410,501	6
R5b (C)	1	61	61	56	700				5
R5c (C)	1	60	61	55	700				6
R5d (C)	1	62	63	56	700				7
R5e (C)	1	62	63	58	700				5
R5f (C)	1	**68**	**67**	60	768				7
R5g (C)	1	**72**	**72**	63	1,108				9
R5h (C)	1	63	63	59	-				4
R5i (C)	1	60	60	57	-				3
					Design Goal Achieved?			Yes	
					Cost Effective?			No	

Impacts are noted by bolded values.
Reasonableness allowance based on $51.61/ft^2

Exhibit 21 summarizes the feasibility analysis and Exhibits 22a and 22b summarize the reasonableness evaluation for cost for Noise Barrier 2b. This barrier meets the feasibility criteria, but would not be cost effective and therefore is not recommended.

6.4.3. Single Family Homes South of Kachess Lake (R9 – R42)

Noise barriers were not modeled for the single family homes south of Kachess Lake since the westbound travel lanes would be realigned further south away from the residences resulting in reduced noise levels. The model showed no residents would be impacted (see Exhibit 12).

6.4.4. Lake Easton State Park (R43 – R46)

Lake Easton State Park is located south of I-90 and west of exit 70 (Sparks Road). There are several NSRs within the park including campsites, picnic areas, a playground, and beach access. Based on information obtained from the park, all recreational areas have a residential equivalent of one, except for the picnic areas, which are estimated to have a residential equivalent of three. As shown in Exhibit 16, the picnic areas, playground, and beach are not impacted under build conditions. However, noise abatement was evaluated for the eight campsites impacted under build conditions.

Noise Barrier 3

<u>Feasibility Criteria</u>
Due to elevation changes in this area, Barrier 3 was modeled as a system barrier: two separate barriers, one adjacent to the roadway EOP and one along the right-of-way boundary. Per WSDOT noise policy, the barrier analysis was conducted for two scenarios: modeling the barriers independently and as a system to determine if the barriers are feasible and reasonable independently or together.

All campsites were assumed to represent first row receptors since there was a clear line of sight to the noise source for most campsites and there would be little to no shielding from the campsites closest to the roadway.

Barrier along ROW only – The modeled noise Barrier 3 at a height of 24-feet tall and 2,112-feet in length (or 50,688 square feet) along the ROW only would provide 5 dBA for approximately 100 percent of the first row impacted receptors (see Exhibit 23). Therefore, Barrier 3 along the ROW only would be feasible to construct.

Barrier along EOP only – The modeled noise Barrier 3 of 24-feet tall and 910-feet in length (or 21,840 square feet) along the EOP only would not provide 5 dBA for the first row impacted receptors (see Exhibit 23). Therefore, Barrier 3 along the EOP only would not be feasible to construct and no further analysis was conducted.

Barrier along ROW and EOP – The modeled noise Barrier 3 at a height of 24-feet tall and 2,462-feet in length (or 59,088 square feet) along the ROW and EOP would provide 5 dBA for approximately 100 percent of the first row impacted receptors (see Exhibit 23). Therefore, Barrier 3 along the ROW and EOP would be feasible to construct.

Exhibit 23: Summary of Feasibility Analysis – Noise Barrier 3

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	1st Row?	Min. Design Goal NW		Feasible?
						Insertion Loss (dBA)	% 1st Row Impacted ≥ 5 dBA	
Noise Barrier 3 ROW only								
R43 (C)	45	58 – **67** (6)**	59 – **68** (8)**	57 - 61	Yes	1 - 8 (14)	100%	Yes
R44 (C)	1	57	59	57	Yes	2		
R45 (C)	1	57	59	57	Yes	2		
R46 (C)	3*	58	60	57	Yes	3		
Noise Barrier 3 EOP only								
R43 (C)	45	58 – **67** (6)**	59 – **68** (8)**	57 - 65	Yes	0 - 4	0%	No
R44 (C)	1	57	59	56	Yes	3		
R45 (C)	1	57	59	56	Yes	3		
R46 (C)	3*	58	60	56	Yes	4		
Noise Barrier 3 ROW and EOP								
R43 (C)	45	58 – **67** (6)**	59 – **68** (8)**	57 - 60	Yes	2 – 8 (19)	100%	Yes
R44 (C)	1	57	59	56	Yes	3		
R45 (C)	1	57	59	57	Yes	2		
R46 (C)	3*	58	60	57	Yes	3		

Impacts are noted by bolded values.
**Based on usage factors and residential equivalent calculations.*
***For multiple receptors, the total number of impacts and benefits are provided within ().*

Reasonableness Allowance Criteria

Barrier 3 would meet the reasonable design goal of 7 dBA for all scenarios except the noise barrier modeled along the EOP only. Based on the WSDOT reasonable allowances criteria, Barrier 3 would exceed the allowed wall surface areas and the allowed costs for all scenarios as shown in Exhibits 24a and 24b. The total barrier cost allowed is based on the allowed cost per qualified residential equivalent as specified in the WSDOT noise policy. The total cost to construct the barrier is based on the wall square footage and the 2011 construction cost of $51.61 per square foot.

Exhibit 24a: Summary of Reasonableness Evaluation for Cost – Noise Barrier 3 ROW only

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq. ft.)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R43 (C) – Site 1	1	65	66	60	700	13,776	$710,977	$2,348,461	6
R43 (C) – Site 2	1	64	65	60	700				5
R43 (C) – Site 3	1	**66**	**68**	60	836				8
R43 (C) – Site 4	1	64	64	59	700				5
R43 (C) – Site 5	1	63	65	59	700				6
R43 (C) – Site 6	1	63	64	59	700				5
R43 (C) – Site 7	1	**66**	**67**	60	768				7
R43 (C) – Site 8	1	63	64	59	700				5
R43 (C) – Site 9	1	**66**	**67**	60	768				7
R43 (C) – Site 10	1	62	63	59	-				4
R43 (C) – Site 11	1	**66**	**67**	60	768				7
R43 (C) – Site 12	1	63	63	59	-				4
R43 (C) – Site 13	1	**66**	**67**	60	768				7
R43 (C) – Site 14	1	64	64	59	700				5
R43 (C) – Site 15	1	65	**66**	59	700				7
R43 (C) – Site 16	1	63	64	59	700				5
R43 (C) – Site 17	1	64	64	59	700				5
R43 (C) – Site 18	1	63	64	59	700				5
R43 (C) – Site 19	1	63	64	59	700				5
R43 (C) – Site 20	1	62	63	59	-				4
R43 (C) – Site 21	1	62	63	60	-				3
R43 (C) – Site 21	1	61	62	59	-				3
R43 (C) – Site 23	1	60	61	59	-				2
R43 (C) – Site 24	1	60	61	59	-				2
R43 (C) – Site 25	1	59	60	58	-				2
R43 (C) – Site 26	1	60	61	59	-				2
R43 (C) – Site 27	1	58	59	58	-				1

Exhibit 24a: Summary of Reasonableness Evaluation for Cost – Noise Barrier 3 ROW only

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq. ft.)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R43 (C) – Site 28	1	60	61	58	-				3
R43 (C) – Site 29	1	58	59	58	-				1
R43 (C) – Site 30	1	59	60	58	-				2
R43 (C) – Site 31	1	59	60	58	-				2
R43 (C) – Site 32	1	59	60	58	-				2
R43 (C) – Site 33	1	58	59	57	-				2
R43 (C) – Site 34	1	60	61	59	-				2
R43 (C) – Site 35	1	59	60	58	-				2
R43 (C) – Site 36	1	61	62	59	-				3
R43 (C) – Site 37	1	60	61	59	-				2
R43 (C) – Site 38	1	61	62	59	-				3
R43 (C) – Site 39	1	62	63	60	-				3
R43 (C) – Site 40	1	62	63	59	-				4
R43 (C) – Site 41	1	63	64	60	-				4
R43 (C) – Site 42	1	63	64	60	-				4
R43 (C) – Site 43	1	64	65	61	-				4
R43 (C) – Site 44	1	65	65	60	700				5
R43 (C) – Site 45	1	**67**	**67**	61	768				6
R44 (C)	1	57	59	57	-				2
R45 (C)	1	57	59	57	-				2
R46 (C)	3*	58	60	57	-				3
					Design Goal Achieved?			Yes	
					Cost Effective?			No	

Impacts are noted by bolded values.
Reasonableness allowance based on $51.61/ft²
**Based on usage factors and residential equivalent calculations.*

Exhibit 24b: Summary of Reasonableness Evaluation for Cost – Noise Barrier 3 ROW and EOP

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq. ft.)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R43 (C) – Site 1	1	65	**66**	59	700	17,976	$927,739	$3,049,531	7
R43 (C) – Site 2	1	64	65	60	700				5
R43 (C) – Site 3	1	**66**	**68**	60	836				8
R43 (C) – Site 4	1	64	64	59	700				5
R43 (C) – Site 5	1	63	65	59	700				6
R43 (C) – Site 6	1	63	64	58	700				6
R43 (C) – Site 7	1	**66**	**67**	59	768				8
R43 (C) – Site 8	1	63	64	58	700				6
R43 (C) – Site 9	1	**66**	**67**	60	768				7
R43 (C) – Site 10	1	62	63	58	700				5
R43 (C) – Site 11	1	**66**	**67**	60	768				7
R43 (C) – Site 12	1	63	63	58	700				5
R43 (C) – Site 13	1	**66**	**67**	60	768				7
R43 (C) – Site 14	1	64	64	59	700				5
R43 (C) – Site 15	1	65	**66**	59	700				7
R43 (C) – Site 16	1	63	64	58	700				6
R43 (C) – Site 17	1	64	64	59	700				5
R43 (C) – Site 18	1	63	64	59	700				5
R43 (C) – Site 19	1	63	64	59	700				5
R43 (C) – Site 20	1	62	63	59	-				4
R43 (C) – Site 21	1	62	63	60	-				3
R43 (C) – Site 21	1	61	62	59	-				3
R43 (C) – Site 23	1	60	61	59	-				2
R43 (C) – Site 24	1	60	61	59	-				2
R43 (C) – Site 25	1	59	60	58	-				2
R43 (C) – Site 26	1	60	61	58	-				3
R43 (C) – Site 27	1	58	59	57	-				2

Exhibit 24b: Summary of Reasonableness Evaluation for Cost – Noise Barrier 3 ROW and EOP

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver (sq. ft.)	Total Wall Allowed (sq. ft.)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R43 (C) – Site 28	1	60	61	58	-				3
R43 (C) – Site 29	1	58	59	57	-				2
R43 (C) – Site 30	1	59	60	58	-				2
R43 (C) – Site 31	1	59	60	58	-				2
R43 (C) – Site 32	1	59	60	58	-				2
R43 (C) – Site 33	1	58	59	57	-				2
R43 (C) – Site 34	1	60	61	58	-				3
R43 (C) – Site 35	1	59	60	57	-				3
R43 (C) – Site 36	1	61	62	58	-				4
R43 (C) – Site 37	1	60	61	58	-				3
R43 (C) – Site 38	1	61	62	58	-				4
R43 (C) – Site 39	1	62	63	59	-				4
R43 (C) – Site 40	1	62	63	58	700				5
R43 (C) – Site 41	1	63	64	59	700				5
R43 (C) – Site 42	1	63	64	59	700				5
R43 (C) – Site 43	1	64	65	59	700				6
R43 (C) – Site 44	1	65	65	59	700				6
R43 (C) – Site 45	1	**67**	**67**	60	768				7
R44 (C)	1	57	59	56	-				3
R45 (C)	1	57	59	57	-				2
R46 (C)	3*	58	60	57	-				3
					Design Goal Achieved?			Yes	
					Cost Effective?			No	

Impacts are noted by bolded values.
Reasonableness allowance based on $51.61/ft²
**Based on usage factors and residential equivalent calculations.*

Exhibit 23 summarizes the feasibility analysis and Exhibits 24a and 24b summarize the reasonableness evaluation for cost for Barrier 3. This barrier meets the feasibility criteria but would not be cost effective and therefore is not recommended.

6.4.5. Single Family Homes near Easton Municipal Airport (R47 – R64)

The single family homes near Easton Municipal Airport are located east of I-90 and north of exit 70. There are 18 NSRs. Each dwelling unit represents one receptor.

A noise barrier was not modeled along the ROW boundary since a barrier along a portion of the boundary adjacent to roadway approximate station 1985 would be at a lower elevation requiring a taller barrier to mitigate noise levels. Placing the barrier south of this station back to the interchange would generally produce the same insertion loss due to similar elevations between the roadway and the ROW boundary.

Noise Barrier 4

Feasibility Criteria

Noise Barrier 4 was modeled adjacent to the proposed I-90 roadway EOP. The modeled noise Barrier 4 at a height of 12-feet and 2,150-feet (or 25,800 square feet) in length would provide 5 dBA for approximately 100 percent of the first row impacted receptors (see Exhibit 25). Therefore, Barrier 4 would be feasible to construct.

Exhibit 25: Summary of Feasibility Analysis – Noise Barrier 4

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	1st Row?	Min. Design Goal NW		Feasible?
						Insertion Loss (dBA)	% 1st Row ≥ 5 dBA	
R47 (B)	1	**67**	**67**	60	Yes	7	100%	Yes
R48 (B)	1	**71**	**68**	59	Yes	9		
R49 (B)	1	62	62	56	Yes	6		
R50 (B)	1	**68**	**68**	59	Yes	9		
R51 (B)	1	**68**	**68**	61	Yes	7		
R52 (B)	1	**70**	**70**	61	Yes	9		
R53 (B)	1	65	65	60	Yes	5		
R54 (B)	1	62	63	58	No	5		
R55 (B)	1	60	60	55	No	5		
R56 (B)	1	61	61	56	No	5		
R57 (B)	1	64	64	58	No	6		
R58 (B)	1	61	61	57	No	4		
R59 (B)	1	59	60	56	No	4		
R60 (B)	1	56	57	54	No	3		
R61 (B)	1	57	58	55	No	3		
R62 (B)	1	56	57	54	No	3		
R63 (B)	1	57	58	55	No	3		
R64 (B)	1	57	58	54	No	4		

Impacts are noted by bolded values.

Reasonableness Allowance Criteria

Barrier 4 would meet the reasonable design goal of 7 dBA. However, based on the WSDOT reasonable allowances criteria, Barrier 4 would exceed the allowed wall surface area of 9,148 square feet and the allowed cost of $472,128, as shown in Exhibit 26. The total barrier cost allowed is based on the allowed cost per qualified residence as specified in the WSDOT noise policy. The total cost to construct the barrier is based on the wall square footage and the 2011 construction cost of $51.61 per square foot.

Exhibit 26: Summary of Reasonableness Evaluation for Cost – Noise Barrier 4

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build without Noise Barrier (L_{eq}) (dBA)	Build with Noise Barrier (L_{eq}) (dBA)	Reasonableness Allowance			Minimum Design Goal Noise Wall	
					Per Modeled Receiver	Total Wall Allowed (sq. ft.)	Total Cost Allowed	Total Cost	Insertion Loss (dBA)
R47 (B)	1	**67**	**67**	60	768	9,148	$472,128	$1,423,404	7
R48 (B)	1	**71**	**68**	59	836				9
R49 (B)	1	62	62	56	700				6
R50 (B)	1	**68**	**68**	59	836				7
R51 (B)	1	**68**	**68**	60	836				8
R52 (B)	1	**70**	**70**	60	972				10
R53 (B)	1	65	65	60	700				6
R54 (B)	1	62	63	58	700				5
R55 (B)	1	60	60	55	700				5
R56 (B)	1	61	61	56	700				5
R57 (B)	1	64	64	58	700				6
R58 (B)	1	61	61	56	700				5
R59 (B)	1	59	60	56	-				4
R60 (B)	1	56	57	54	-				3
R61 (B)	1	57	58	54	-				4
R62 (B)	1	56	57	54	-				3
R63 (B)	1	57	58	54	-				4
R64 (B)	1	57	58	54	-				4
Design Goal Achieved?								Yes	
Cost Effective?								No	

Impacts are noted by bolded values.
Reasonableness allowance based on $51.61/ft^2$

Exhibit 25 summarizes the feasibility analysis and Exhibit 26 summarizes the reasonableness evaluation for cost for Barrier 4. This barrier meets the feasibility criteria, but would not be cost effective and therefore is not recommended.

6.5. Recommendation for Traffic Noise Abatement

None of the modeled noise barriers would meet both the feasible and reasonable criteria. Therefore, noise barriers are not recommended at this time. In addition, the 10 dBA noise reduction goal was not evaluated since the modeled noise barriers do not meet the reasonable criteria. If changes are made to the vertical or horizontal alignment analyzed in this report, the noise analysis may need to be reassessed in order to evaluate those changes.

7. Construction Noise

7.1. Construction Noise Background

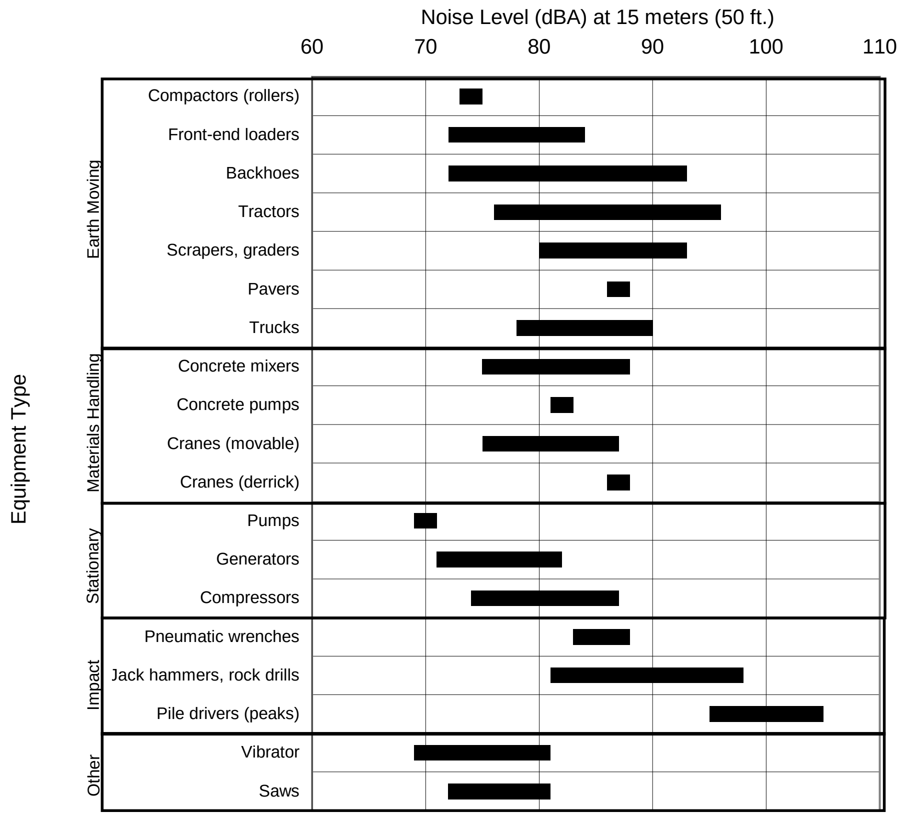
Construction activities create temporary noise. Construction is usually carried out in reasonably discrete steps, each with its own mix of equipment and noise characteristics. For example, roadway construction involves demolition, construction, and paving.

The most constant noise source at construction sites is usually engine noise. Mobile equipment generally operates intermittently or in cycles of operation, while stationary equipment, such as generators and compressors, generally operates at fairly constant sound levels. Trucks are present during most phases of construction and are not confined to the project site, so noise from trucks may affect more receivers than other construction noise. Other common noise sources include impact equipment, which could be pneumatic, hydraulic, or electric powered.

- Noise levels during the construction period depend on the type, amount, and location of construction activities.
- The type of construction methods establishes the maximum noise levels.
- The amount of construction activity establishes how often certain noises occur throughout the day.
- The location of construction equipment relative to adjacent properties determines the effect of distance in reducing construction noise levels.

The maximum noise levels of construction equipment will be similar to the maximum construction equipment noise levels presented in Exhibit 27 and typically range from 69 dBA to 106 dBA at 50 feet. As a point source, construction noise decreases by 6 dBA per doubling of distance from the source moving away from the equipment. The various pieces of equipment are almost never operating simultaneously at full-power and some will be turned off, idling, or operating at less than full power at any time. Therefore, the average L_{eq} noise levels will be less than the aggregate of the maximum noise levels in Exhibit 27.

Exhibit 27: Construction Equipment Noise Ranges



Source: EPA, 1971 and WSDOT, 1991.

7.2. Construction Noise Levels Limits

Section 3.1.2 summarizes regulations regarding construction noise within Kittitas County and Washington State. The noise standards established by the Kittitas County noise ordinance are not directly applicable to construction activity. WAC 173-60 establishes statewide noise standards that are applicable to daytime and nighttime construction noise. Exhibit 6 summarizes allowable noise levels for construction activities (a Class B noise source) at any dwelling (a Class A receiving property). As shown in Exhibit 28, allowable nighttime (10:00 p.m. to 7:00 a.m.) noise levels at Class A receiving properties (residential) are reduced by 10 dBA from allowable daytime noise levels.

Exhibit 28: Allowable Construction Noise Levels

Averaging Period	Daytime Limit (Exempt)	Nighttime Reduction	Nighttime Limit (10 dBA decrease)
$L_{2.5}$ (1.5 minutes per hour)	72 dBA	10 dBA	62 dBA
$L_{8.3}$ (5 minutes per hour)	67 dBA	10 dBA	57 dBA
L_{25} (15 minutes per hour)	62 dBA	10 dBA	52 dBA

7.3. Construction Noise Assessment

Construction could cause temporary impacts to local residences as well as campers and day-users of the areas near the highway at Lake Easton State Park.

Exhibit 29 summarizes sound levels caused by typical construction equipment (expressed in dBA at 50 feet from the source). This exhibit also lists the use factor for each equipment item, defined as the fraction of time that the equipment typically runs at maximum capacity. The types of construction equipment expected to be used on the I-90 Project include trucks, pavers, backhoes, bulldozers, scrapers, loaders, and pneumatic tools.

This report also considers construction noise as it relates to the production, storage, stockpiling, processing, blasting and disposal of building material for the I-90 Project. The *Materials and Staging Report*, April 2007, gives general details of the likely locations and type of work expected for many of the proposed sites. Construction noise from these activities can affect residents, hikers and bicyclists along trails and campgrounds beyond 500 feet of these material production and storage areas. Sites that are further from human activities will be less likely to cause impacts. Specific sound levels from project activities will vary greatly from project to project based on many variables, such as material type, equipment used, and construction method employed. Actual construction sound levels cannot be determined until some of these final design details are completed.

Because temporary daytime construction activities are exempt from Kittitas County and Washington State noise regulations, there are no regulatory requirements applicable to daytime construction. However, Washington State sets nighttime construction noise limits, and exceedances of stated limits are prohibited without permits from the local jurisdiction.

Some night work may be required on the I-90 Project. If so, a noise variance may be required from Kittitas County.

Exhibit 29: Equipment Sound Level Usage Factor Database

Equipment Description	Impact Device?	Use Factor (%)	Specification 721.560 @ 50 ft.	Actual Measured Avg. Lmax @ 50 ft.
All Other Equipment > 5 HP	No	50	85	N/A
Auger Drill Rig	No	20	85	84
Backhoe	No	40	80	78
Bar Bender	No	20	80	N/A
Blasting	Yes	N/A	94	N/A
Boring Jack Power Unit	No	50	80	83
Chain Saw	No	20	85	84
Clam Shovel (dropping)	Yes	20	93	87
Compactor (ground)	No	20	80	83
Compressor (air)	No	40	80	78
Concrete Batch Plant	No	15	83	N/A
Concrete Mixer Truck	No	40	85	79
Concrete Pump Truck	No	20	82	81
Concrete Saw	No	20	90	90
Crane	No	16	85	81
Dozer	No	40	85	82
Drill Rig Truck	No	20	84	79
Drum Mixer	No	50	80	80
Dump Truck	No	40	84	76
Excavator	No	40	85	81
Flat Bed Truck	No	40	84	74
Front End Loader	No	40	80	79
Generator	No	50	82	81
Generator (<25KVA, VMS signs)	No	50	70	73
Gradall	No	40	85	83
Grader	No	40	85	N/A
Grapple (on backhoe)	No	40	85	87
Horizontal Boring Hydraulic Jack	No	25	80	82
Hydra Break Ram	Yes	10	90	N/A
Impact Pile Driver	Yes	20	95	101
Jackhammer	Yes	20	85	89
Man Lift	No	20	85	75
Mounted Impact Hammer (hoe ram)	Yes	20	90	90
Pavement Scarafier	No	20	85	90
Paver	No	50	85	77
Pickup Truck	No	40	55	75
Pneumatic Tools	No	50	85	85
Pumps	No	50	77	81
Refrigerator Unit	No	100	82	73
Rivet Buster/Chipping Gun	Yes	20	85	79
Rock Drill	No	20	85	81
Roller	No	20	85	80
Sand Blasting (single nozzle)	No	20	85	96
Scraper	No	40	85	84
Shears (on backhoe)	No	40	85	96
Slurry Plant	No	100	78	78
Slurry Trenching Machine	No	50	82	80
Soil Mix Drill Rig	No	50	80	N/A
Tractor	No	40	84	N/A
Vacuum Excavator (vac-truck)	No	40	85	85
Vacuum Street Sweeper	No	10	80	82
Ventilation Fan	No	100	85	79
Vibrating Hopper	No	50	85	87
Vibratory Concrete Mixer	No	20	80	80
Vibratory Pile Driver	No	20	95	101
Warning Horn	No	5	85	83
Water Jet Deleading	No	20	85	92
Welder / Torch	No	40	73	74

FHWA's Roadway Construction Noise Mode Database, 2005

7.4. Construction Noise Abatement

To reduce the potential for temporary, adverse noise impacts associated with construction, the contractor will be required to comply with all federal, state, and local regulations relating to construction noise. Construction noise can be reduced by using enclosures or walls to surround noisy equipment, installing mufflers on engines, substituting quieter equipment or construction methods, minimizing time of operation, and locating equipment farther away from noise sensitive receivers; e.g., homes. To reduce construction noise at nearby receptors, the following abatement measures can be incorporated into construction plans and contractor specifications:

- Limiting construction activities to between 7 a.m. and 10 p.m., which would reduce construction noise levels during sensitive nighttime hours;
- Equipping construction equipment engines with adequate mufflers, intake silencers, and engine enclosures, which would reduce their noise by 5 dBA to 10 dBA (U.S. EPA, 1971);
- Constructing temporary noise barriers or curtains around stationary equipment that must be located close to residences, which would decrease noise levels at nearby sensitive receptors;
- Specifying the quietest equipment available, which would reduce noise by 5 dBA to 10 dBA;
- Turning off construction equipment during prolonged periods of non-use, which would eliminate noise from construction equipment during those periods;
- Requiring contractors to maintain all equipment and train their equipment operators, which would reduce noise levels and increase efficiency of operation; and
- Locating stationary equipment away from receiving properties, which would decrease noise from that equipment in relation to the increased distance.

8. Conclusion

Operational Noise

The build design would result in traffic noise levels that would meet or exceed the NAC at approximately 20 NSRs. Of the 20 impacted NSRs, one receptor is located at Kachess Lodge, six receptors are located at the Ski Lodge and Trails near Cabin Creek Interchange, eight campsites are impacted within the Lake Easton State Park, and five single-family homes are impacted near the Easton Municipal Airport. Noise abatement was considered for all impacted receptors.

The 2008 *Noise Discipline Report Supplement* recommended one noise barrier adjacent to the Lake Easton State Park for noise impacts to recreational uses at the campsites and picnic areas. The residential equivalent estimated as part of the 2008 noise analysis was 25 for the campsites, with one receptor modeled to represent all 25 residential equivalents. Based on more current information, the residential equivalent for this noise analysis was estimated to be one at the campsites, for a total of 45 receptors. As previously stated, the residential equivalent of one was determined using a conservative approach (see Appendix B). Each campsite and picnic area was identified using a GPS unit (see Section 3.2) and modeled individually to determine noise levels. The more precise locations for campsite and picnic areas, which were inputs to the updated noise model, provided more accurate modeling results than was previously analyzed. Compared to the 2008 report, the updated model for this analysis reduced the total number of impacted receptors within the park from 16 to eight, resulting in the noise barrier not meeting the reasonable criteria. In addition, the 2008 noise analysis was conducted based on a previous noise policy that included benefitted receptors with a 3 dBA or more noise reduction. The updated noise policy only considers a minimum 5 dBA noise reduction. As a result of the updated modeling, a noise barrier does not meet the reasonable criteria for the park.

Actual projected traffic volumes have decreased resulting in lower noise levels for the 2041 design year compared to the previous noise analyses design years, which would also lower the reasonableness allowance and result in the modeled noise barrier not meeting the WSDOT abatement criteria for recommended noise barriers.

As mentioned above, none of the modeled noise barriers meet the reasonable criteria. Therefore, noise barriers are not recommended at this time. If changes are made to the vertical or horizontal alignments that were analyzed in this report, the noise analysis may need to be reassessed in order to evaluate those changes.

Construction Noise

Because temporary daytime construction activities are exempt from Kittitas County and Washington State noise regulations, there are no regulatory requirements applicable to daytime construction. However, Washington State sets nighttime construction noise limits, and exceedances of stated limits are prohibited without a variance from the local jurisdiction of Kittitas County. If nighttime construction is anticipated, a noise variance may be required from Kittitas County and WSDOT will determine what construction-related abatement measures will be required.

9. References

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Both, Jason. 2016. Personal communication between Jason Both, Area Manager for Washington State Parks, and Maggie Buckley and Dana Ragusa, Jacobs Environmental Planners, on October 6, December 14, and December 20, 2016.

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Appendix A – TNM Data (on enclosed CD)

Appendix B –Detailed Noise Calculations

Winter Recreation Trails near Cabin Creek Exit

Average use from WSP website
14,000 annual users / 120 days (open 4 months) = 117 daily users

Usage Factor
24 hours per day / 24 hours in a day = 1
7 days per week / 7 days in a week = 1
4 months per year / 12 months in a year = 0.33
Usage factor = 0.33

Residential Equivalent
0.33 (usage factor) x 117 (daily weekday users)/2.53 (Washington State average) **= 15 residential equivalent (RE)**

Frontage
Average lot frontage 200 feet (kachess subdivision averages 145 feet and silver trail averages 280 feet for an overall average of 200 feet)

- Linear trail westbound south (#1 and #3) = 1550 feet / 200 feet lot frontage = 8 receivers/15 RE = 0.53 (rounded to one unit per receiver location)
- Linear trail westbound north (#2) = 1825 feet / 200 feet lot frontage = 9 receivers/15 RE = 0.60 (rounded to one unit per receiver location)
- Linear trail eastbound south (#6) = 1000 feet / 200 feet lot frontage = 5 receivers / 15 RE = 0.33 (rounded to one unit per receiver location)

Lake Easton State Park Picnic Areas

Summer usage factor
13 hours per day / 24 hours in a day = 0.5416
7 days per week / 7 days in a week = 1
6 months per year / 12 months in a year = 0.5
Usage factor = 0.27

Winter usage factor
10 hours per day / 24 hours in a day = 0.4167
7 days per week / 7 days in a week = 1
6 months per year / 12 months in a year = 0.5
0.21
Usage factor (5%) = 0.010

Total usage factor = 0.28

Residential equivalent
0.28 (usage factor) x 6 (sites) x 4 (average users per site)/ 2.53 (Washington State average) =
2.66 RE (rounded to three receptors for the park)

Lake Easton State Park Campsites
Summer usage factor (no winter use)
Weekend use 100% occupied
60% use for 2 days half the time
40% use for 3 days half the time
100% use for 3 days – worst case scenario

24 hours per day / 24 hours in a day = 1 (assumed 100% including sleeping)
3 days per week / 7 days in a week = 0.428
6 months per year / 12 months in a year = 0.5
0.214 weekend usage factor

Weekday use
75% for 2 months
90% for 4 months

24 hours per day / 24 hours in a day = 1 (assumed 100% including sleeping)
4 days per week / 7 days in a week = 0.571
2 months per year / 12 months in a year = 0.167
0.095
Usage factor (75%) = 0.072 weekday

24 hours per day / 24 hours in a day = 1 (assumed 100% including sleeping)
4 days per week / 7 days in a week = 0.571
4 months per year / 12 months in a year = 0.333
0.190
Usage factor (90%) = 0.171 weekday

Total usage factor = 0.46

Residential equivalent
0.46 (usage factor) x 4 (average users per site) / 2.53 (Washington State average) = **0.73 RE (rounded to one receptor per campsite)**

Appendix C – Traffic Data

Washington State
Department of Transportation

Memorandum

TO: Mark Reynolds
SCR Environmental Coordinator

COPY

FROM: Todd Daley
SCR Traffic Engineer

SUBJECT: I-90 Snoqualmie Pass East – Noise Study Traffic Data

Traffic Volumes

WSDOT selected a base year (2015), and a design year (2041) and the 30th highest peak hour volume (PHV) was chosen for the design hour volume using data from permanent traffic recorder at the Cabin Creek Interchange (PTR S903) in 2015. The 30th peak hour volume is 3,900 vehicles per hour which includes both directions. Environmental office classifies trucks as medium or heavy. WSDOT traffic office records trucks as single, double, or triple. Single trucks will be classified as medium; double and triples will be classified as heavy trucks. For estimating purposes, the base year vehicle mix (% trucks) is assumed to be similar for the design year.

Base Year Data (2015)

I-90 at Cabin Creek Interchange had an annual average daily traffic (AADT) volume of 30,180. I-90 **Eastbound** directional peak hour volume at Cabin Creek Interchange is 1,446 vehicles per hour (37% of volume). I-90 **Westbound** directional peak hour volume is 2,456 (63% of volume) vehicles per hour. The average vehicle mix at this location is 4.4% medium trucks and 5.5% heavy trucks during peak hour. The average vehicle mix (% trucks) was calculated using 2010 to 2015 peak hour data collected from permanent traffic recorder at the Cabin Creek Interchange.

Note: 2015 average daily traffic was made up of 3.54% medium and 17.26% heavy trucks.

I-90 **Exit 70** traffic data is limited and collected by WSDOT Transportation Data, GIS & Modeling Office (TDGMO). Peak hour volumes were calculated using short duration counts from 2001 to 2009. The percent of trucks is available for average daily traffic but not for peak hour traffic. Assuming half of average daily truck percentages for peak hour. An average peak hour volume was developed for the base year due to the erratic annual volume changes. An average percent of AADT (K-factor) for each ramps peak hour was also

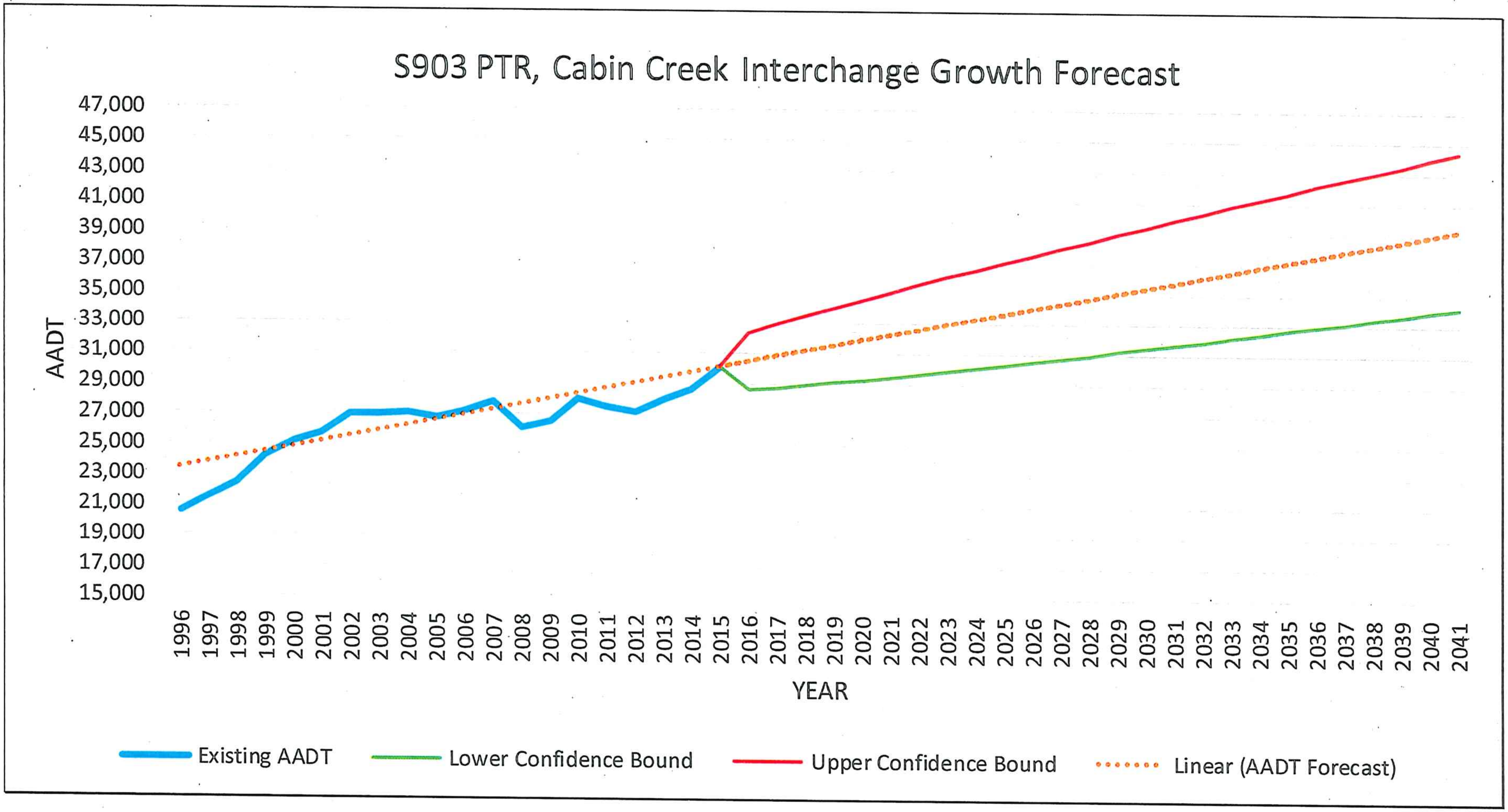
calculated from 2001 to 2009 data (approximately 10%). Assuming the same K-factor for design year.
Eastbound off-ramp PHV is 52 vehicles per hour, 5.4% medium and 4.3% heavy trucks.
Eastbound on-ramp PHV is 52 vehicles per hour, 5.9% medium and 3.8% heavy trucks.
Westbound off-ramp PHV is 61 vehicles per hour, 5.4% medium and 3.6% heavy trucks.
Westbound on-ramp PHV is 48 vehicles per hour, 5% medium and 4.4% heavy trucks.

Design Year Data (2041)

Traffic growth rates can be determined for a transportation corridor using historic traffic data. For this project, historic traffic data was collected from permanent traffic recorder S903 located at Cabin Creek Interchange (MP 63.98). The average daily traffic averaged over a full year is referred to as a AADT. Future AADT's were forecasted along a linear trend line by using historical traffic data (See Growth Chart). WSDOT forecasts an AADT of approximately 39,000 for design year 2041 on I-90 near Cabin Creek Interchange. WSDOT TDGMO estimated approximately 1% annual average growth rate. For estimating design year peak hour volumes, the percent of AADT (12.93%) during peak hour is assumed to be similar to base year (37% eastbound and 63% westbound). As noted earlier, the truck percentages are also assumed to be similar to the base year.

I-90 peak hour volume for design year 2041 is 5,043 vehicles per hour. I-90 **Eastbound** directional peak hour volume at Cabin Creek Interchange is 1,869 vehicles per hour. I-90 **Westbound** directional peak hour volume is 3,174 vehicles per hour. Estimating 4.4% Medium Trucks and 5.5% Heavy Trucks during peak hour.

I-90, **Exit 70** ramp PHV's estimated using a straight-line annual growth rate of 1%. Eastbound off-ramp PHV is 66 vehicles per hour, 5.4% medium trucks and 4.3% heavy trucks. Eastbound on-ramp PHV is 66 vehicles per hour, 5.9% medium and 3.8% heavy trucks. Westbound off-ramp PHV is 77 vehicles per hour, 5.4% medium and 3.6% heavy trucks. Westbound on-ramp PHV is 60 vehicles per hour, 5% medium and 4.4% heavy trucks.


S903 PTR, Cabin Creek Interchange Growth Forecast
AADT
47,000
45,000
43,000
41,000
39,000
37,000
35,000
33,000
31,000
29,000
27,000
25,000
23,000
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2038
2039
2040
2041
YEAR
Existing AADT
Lower Confidence Bound
Upper Confidence Bound
Linear (AADT Forecast)

JTD/jmd

Washington State Department of Transportation

Memorandum

July 30, 2013

TO: File

THRU: Troy Suing, P.E., Assistant Regional Administrator for Development
Scott Zeller, P.E., Assistant State Design Engineer for SCR
Liana Liu, P.E., Federal Highway Administration Area Engineer

FROM: Julie Heilman-Suarez, P.E. JHS
SCR Development Branch Project Engineer

SUBJECT: I-90 Snoqualmie Pass East
XL2779 (509009B) & XL4134 (509090O)
MP 55.1 to MP 70.3
Corridor Analysis Errata

The approved Corridor Analysis for the I-90 Snoqualmie Pass East project has a discrepancy regarding the milepost limits of the 65 MPH and 70 MPH design speeds. Based on the following paragraphs the original intended limits of the 65 mph design speed were from MP 55.1 to MP 60.7 and a 70 mph design speed from MP 60.7 to MP 70.3.

Under the heading "Proposed Design Speed Standard" it states that "A 65 mph design speed will be used in the first section of the corridor (Coal Creek MP 55.1 to the Keechelus Lake Dam MP 60.1) due to terrain constraints. A design speed of 70 mph will be used for the remaining section of the corridor due to slightly more favorable terrain." This reference to MP 60.1 was in error as the Lake Keechelus Dam is actually at MP 60.7.

The Snoqualmie Pass East Corridor has been broken into the following three phases:

Phase 1 – MP 55.1 to MP 59.5; Coal Creek to Resort Creek
(Fully funded / partially constructed)
Phase 2 – MP 59.5 to MP 64.23; Resort Creek to Cabin Creek Interchange
(Partially funded for Design)
Phase 3 – MP 64.23 to MP 70.3; Cabin Creek Interchange to West Easton Interchange
(Not funded)

JHS/dlb

cc: Will Smith

Appendix D – Field Data Sheets

Noise Measurement Data Sheet

Site #56 Smith Dr. Data file: 01LOC+02LOC		**Date** 10/05/16

Noise Meter Model	**Response**	**Weighting**	**Battery***
Quest Tech model 2900	Fast ☐ Slow ☒	A ☒ C ☐	7.7 *replace if below 50%

Calibrator Model	Calibrator @ 114 dBA
Quest Tech QC-10/QC-20	Start 114.3 End 114.0

Weather Data

Temp 49°F Humidity Wind Speed N/A mph Notes Fog + Damp, Road Dry

Measurement Data

Event	**Begin Time**	**End Time**	**L_{eq} (dBA)**	**L_{min} (dBA)**	**L_{max} (dBA)**
1	08:48	09:03	61.8	51.6	69.7
2	09:08	09:23	61.6	51.6	73.3

Traffic Data (Speed = 70 mph) (Trucks = 60 mph)

Event	**Direction**	**Autos**	**Medium Trucks**	**Heavy Trucks**	**Motorcycle**	**Buses**
1	EB	85	8	32	–	–
	WB	103	8	44	–	–
2	EB	115	12	30	–	1
	WB	113	7	39	–	–

Site Sketch

Notes

(Major sources, background noise, unusual events, etc.)

Low hanging clouds, Damp ancilary roads, Dry highway

car passby @08:57

Delete 03LOC (Fast Response toggle) Delete 18LOC

Noise Measurement Data Sheet

Site #5a Silver Trail 17LOC & ~~18LOC~~ 19LOC | **Date** 10/5/16

Noise Meter Model	**Response**	**Weighting**	**Battery***
" "	Fast ☐ Slow ☒	A ☒ C ☐	76 *replace if below 50%

Calibrator Model	Calibrator @ 114 dBA
"	Start 114.0 End 114.0

Weather Data
Temp 54°F Humidity Wind Speed 12 mph Notes Partly cloudy

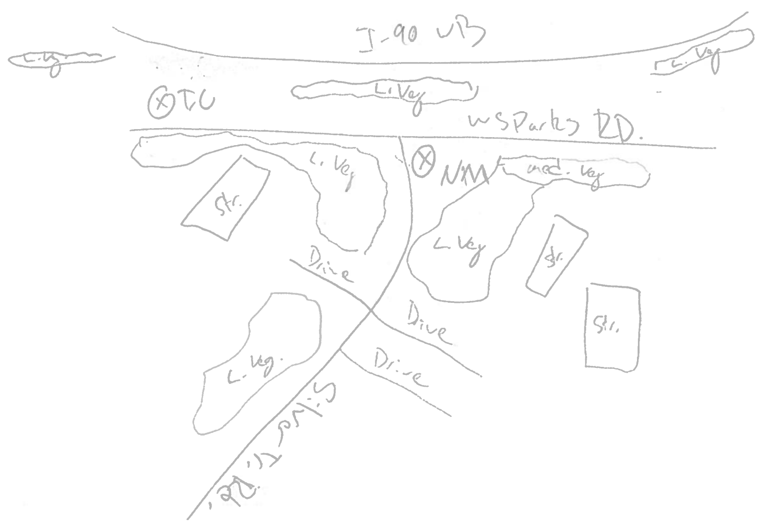
Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	16:59	17:14	69.8	61.5	76.5
2	17:18	17:33	69.5	59.1	76.4

Traffic Data (Speed = 70 mph) (60 = Trucks)

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
1	EB	170	10	51	–	–
	WB	122	15	45	–	–
2	EB	169	17	51	–	1
	WB	130	11	32	1	1

Site Sketch



1st visit @ 10:00

LOC 4 is now Redundant

Notes
(Major sources, background noise, unusual events, etc.)

I-90 elevated ~10' from N.M., Clear line of site to WB lanes, EB lanes not visible, Dry Road~~way~~
revisit site @ 17:00 due to stripping work, rerunning tests
– auto @ 17:05 on west sparks Rd. ~15' from NM
– auto @ 17:09 on w sparks Rd. ~15' from NM
– auto @ 17:13 on w sparks turning to Silver Trail, ~15' from NM
– auto @ 17:18 on w sparks, ~20' from NM
– auto @ 17:19 on w sparks, ~15' from NM

over →

- auto @ 17:20 on W sparks Rd., ~20' from NM
- auto @ 17:21 on W sparks Rd., ~15' from NM
- auto @ 17:28 on W sparks Rd turning on to Silver trail, ~15' from NM

Noise Measurement Data Sheet

Site #4b, Easton State Pk., Picnic Area 1510C + 1600C

Date 0 /

Noise Meter Model "
"
"

Response Fast ☐ Slow ☒

Weighting A ☒ C ☐

Battery* 5

*replace if below 50%

Calibrator Model "

Calibrator @ 114 dBA
Start 114.0 End 114.0

Weather Data

Temp 53°F Humidity Wind Speed ~3 mph Notes partly cloudy, slight breeze

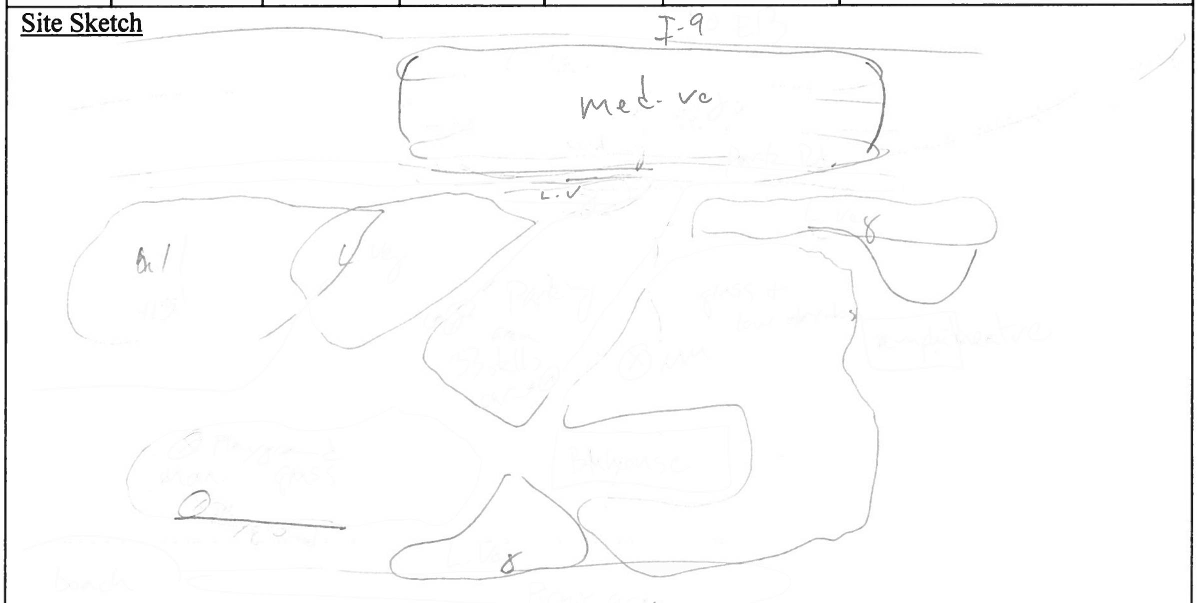
Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	16:02	16:17	60.5	54.1	73.3
2	16:23	16:38	60.2	54.3	67.6

Traffic Data (Speed = mph)

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
1	EB	169	9	61	—	—
	WB	179	8	36	1	2
2	EB	183	16	56	—	—
	WB	129	14	31	2	—

Site Sketch



Notes
(Major sources, background noise, unusual events, etc.)

~~car~~ auto @ 16:05 in parking lot,

- ~15 picnic/ BBQ grills

- car running @ 16:13 ~15' from mm

Noise Measurement Data Sheet

Site #4a, Easton St. Pk, campsite #7, LOC13 + LOC14 | Date 10/5/16

Noise Meter Model	Response	Weighting	Battery*
" "	Fast ☐ Slow ☒	A ☒ C ☐	7.5 *replace if below 50%

Calibrator Model	Calibrator @ 114 dBA
"	Start 114.0 End 114.0

Weather Data
Temp 54°F Humidity Wind Speed 2 mph Notes Partly Cloudy

Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	15:06	15:21	64.1	53.7	68.9
2	15:27	15:42	64.7	58.8	69.6

Traffic Data (Speed = mph)

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
1	EB	128	19	64	–	–
	WB	149	15	26	–	–
2	EB	170	17	81	–	1
	WB	132	16	42	–	–

Site Sketch

Notes
(Major sources, background noise, unusual events, etc.)

- campsite is essentially empty, ~4 RV's towards the South
- ~25' drop from NM to EB I-90, ~10' to WB I-90
- Roads in park ~8-10' wide, pull outs for each campsite

Noise Measurement Data Sheet

Site #36, 2 Kachess, 11LOC & 12LOC **Date** 10/5/16

Noise Meter Model	Response	Weighting	Battery*
" "	Fast ☐ Slow ☒	A ☒ C ☐	7.5 *replace if below 50%

Calibrator Model	Calibrator @ 114 dBA
"	Start 114.0 End 114.0

Weather Data
Temp 53°F Humidity Wind Speed ~2 mph Notes Overcast to Partly Cloudy

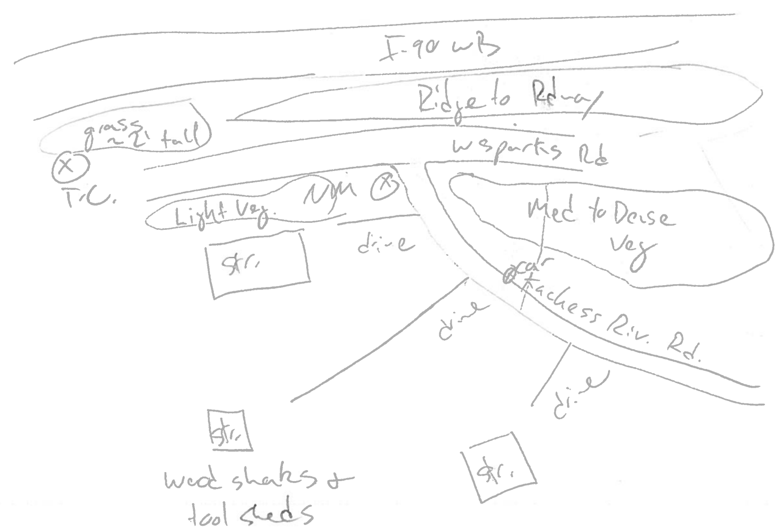
Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	13:52	14:07	66.2	52.7	85.3
2	14:13	14:28	65.6	54.9	74.3

Traffic Data (Speed = mph)

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
1	EB	154	16	52	–	–
	WB	165	18	35	–	–
2	EB	147	13	45	–	–
	WB	152	20	39	–	–

Site Sketch



Notes
(Major sources, background noise, unusual events, etc.)

auto @ 13:53 on Kachess Riv. Rd. ~15' from NM
Heavy truck @ 13:54 on W Sparks Rd. ~25' from NM
- Interstate elevated between ~10-25' from NM location.
- auto @ 14:06 on W Sparks Rd. ~25' from NM
- auto @ 14:15 on W Sparks Rd. ~25' from NM
- Periodic wind gusts ~4mph @ 14:20-14:23
- auto @ 14:23 on W Sparks Rd. ~25' from NM
- auto @ 14:24 on W Sparks Rd. ~25' from NM

Noise Measurement Data Sheet

Site #2a, Kachess Lake Neighborhood 09LOC + 10LOC	Date 10/5/16

Noise Meter Model	Response	Weighting	Battery*
" "	Fast ☐ Slow ☒	A ☒ C ☐	7.6 *replace if below 50%

Calibrator Model	Calibrator @ 114 dBA
"	Start 114 End 114

Weather Data

Temp 51°F Humidity Wind Speed N/A mph Notes Overcast,

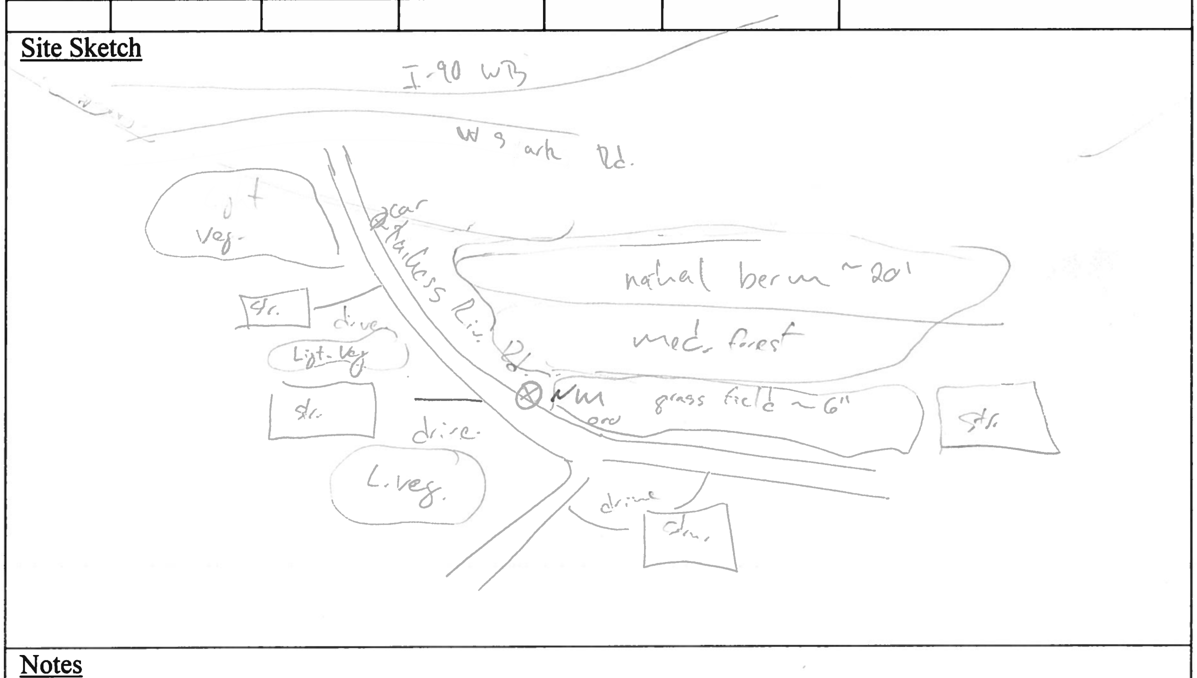
Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	13:05	13:20	57.0	51.6	62.8
2	13:23	13:38	56.8	51.6	62.5

Traffic Data (Speed = mph)

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
1	EB	170	13	54	—	2
	WB	151	18	47	—	1
2	EB	160	13	73	—	1
	WB	135	16	43	—	2

Site Sketch



Notes

(Major sources, background noise, unusual events, etc.)

- Free flowing traffic
- Berm between WB I-90 and NM
- no clear line of site to WB I-90
- army convoy at end of reading

90 numbers

Noise Measurement Data Sheet

Site #2, Kongsberger lodge 0710C+0810C			**Date** 10/05/16
Noise Meter Model '' ''	**Response** Fast ☐ Slow ☒	**Weighting** A ☒ C ☐	**Battery*** 75 *replace if below 50%
Calibrator Model ''	**Calibrator @ 114 dBA** Start 114.0 End 114.0		
Weather Data Temp 51°F Humidity	Wind Speed <1 mph	Notes Overcast.	

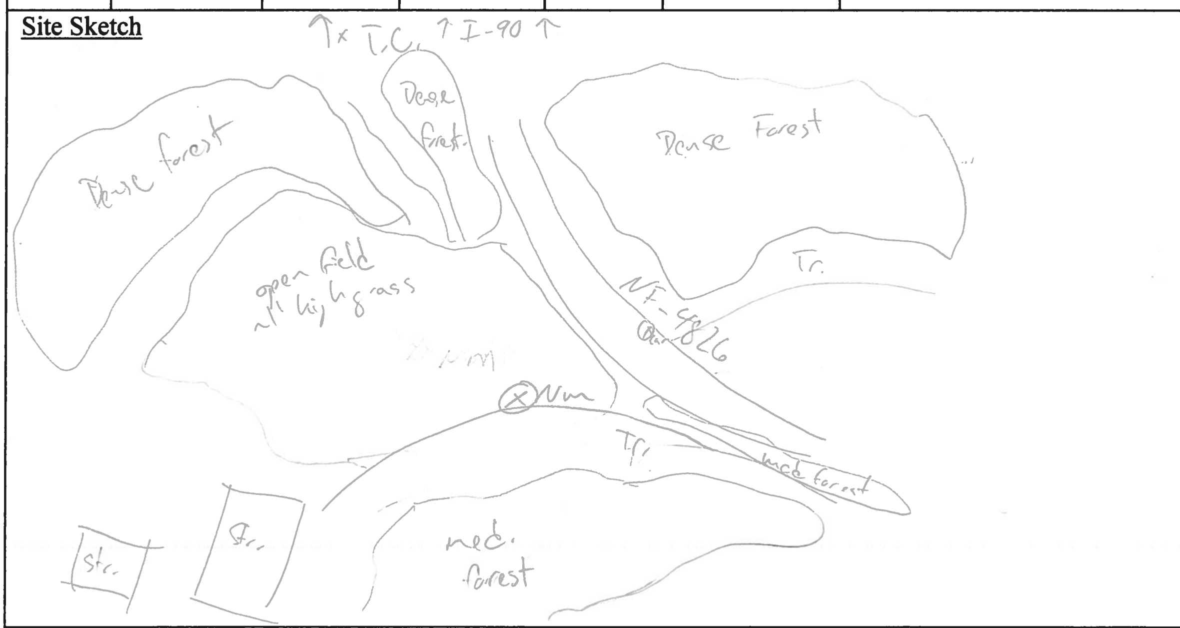
Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	11:57	12:12	55.6	51.6	65.8
2	12:19	12:34	55.4	51.6	63.5

Traffic Data (Speed = 65 mph) (Trucks = 60 mph)

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
1	EB	149	20	68	1	—
	WB	144	24	67	–	–
2	EW	154	12	56	–	–
	WB	131	17	37	–	1

Site Sketch



Notes
(Major sources, background noise, unusual events, etc.)

auto @ 12:04 along NF-4826, ~50' from NM Free flowing traffic
auto @ 12:06 along NF-4826, ~50' from NM
dog bark @ 12:11
auto @ 12:12 along NF-4826, ~50' from NM
med truck @ 12:31 along NF-4826, ~50' from NM

Noise Measurement Data Sheet					
Site #1, Halstead Property/ 05LOC + 06LOC				Date 10/05/16	
Noise Meter Model			Response: Fast ☐ Slow ☒	Weighting: A ☒ C ☐	Battery* 7.5 *replace if below 50%
Calibrator Model "			Calibrator @ 114 dBA Start 114 End 114		
Weather Data					
Temp 53° F Humidity		Wind Speed N/A mph	Notes Overcast,		

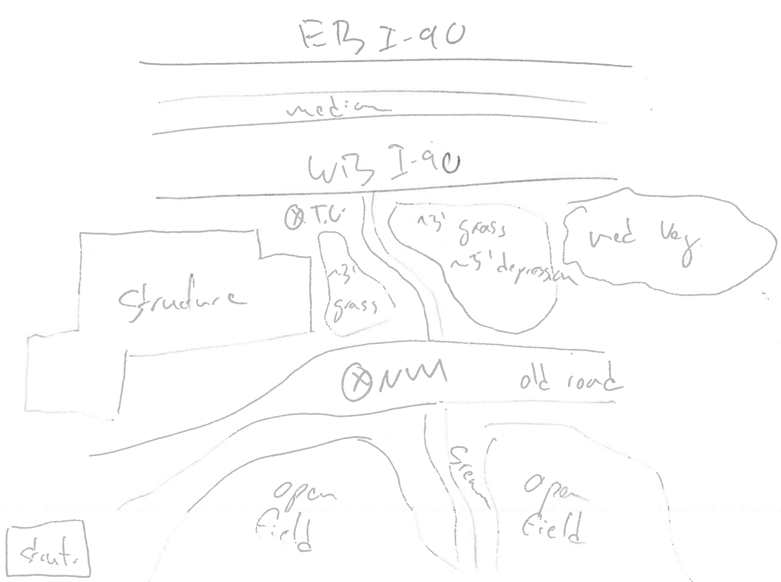
Measurement Data

Event	Begin Time	End Time	L_{eq} (dBA)	L_{min} (dBA)	L_{max} (dBA)
1	10:59	11:14	69.9	51.4	80.9
2	11:17	11:32	69.9	58.5	77.8

Traffic Data (Speed = 65 mph) (Trucks = 60 mph)

Event	Direction	Autos	Medium Trucks	Heavy Trucks	Motorcycle	Buses
1	EB	179	14	96	–	–
	WB	124	10	59	–	1
2	EB	184	23	73	–	–
	WB	148	21	61	–	1

Site Sketch



Notes
(Major sources, background noise, unusual events, etc.)

Traffic free flowing, orange cones off to side of roadway