February 2020
Proposed Chehalis River Basin Flood Damage Reduction Project
SEPA Draft Environmental Impact Statement

Appendix H
Noise and Vibration Discipline Report

Publication No.: 20-06-002

DEPARTMENT OF
ECOLOGY
State of Washington

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About this Document

This discipline report has been prepared as part of the Washington Department of Ecology's (Ecology's) State Environmental Policy Act (SEPA) Environmental Impact Statement (EIS) to evaluate a proposal from the Chehalis River Basin Flood Control Zone District (Applicant).

Proposed Action

The Applicant seeks to construct a new flood retention facility and temporary reservoir near Pe Ell, Washington, and make changes to the Chehalis-Centralia Airport levee in Chehalis, Washington. The purpose of the Applicant's proposal is to reduce flooding originating in the Willapa Hills and improve levee integrity at the Chehalis-Centralia Airport to reduce flood damage in the Chehalis-Centralia area.

Time Frames for Evaluation

If permitted, the Applicant expects Flood Retention Expandable (FRE) facility construction would begin in 2025 and operations in 2030, and the Airport Levee Changes construction would occur over a 1-year period between 2025 and 2030. The EIS analyzes probable impacts from the Proposed Action and alternatives for construction during the years 2025 to 2030 and for operations from 2030 to 2080. For purposes of analysis, the term "mid-century" applies to the operational period from approximately 2030 to 2060. The term "late-century" applies to the operational period from approximately 2060 to 2080.

Scenarios Evaluated in the Discipline Report

This report analyzes probable significant environmental impacts from the Proposed Action, the Local Actions Alternative, and the No Action Alternative under the following three flooding scenarios (flow rate is measured at the Grand Mound gage):

- **Major flood:** Water flow rate of 38,800 cubic feet per second (cfs) or greater
- **Catastrophic flood:** Water flow rate of 75,100 cfs
- **Recurring flood:** A major flood or greater that occurs in each of 3 consecutive years

The general area of analysis includes the area in the vicinity of the FRE facility and temporary reservoir; the area in the vicinity of the Airport Levee Changes; and downstream areas of the Chehalis River to approximately river mile 9, just west of Montesano.

Local Actions Alternative

The Local Actions Alternative represents a local and nonstructural approach to reduce flood damage in the Chehalis-Centralia area. It considers a variety of local-scale actions that approximate the Applicant's purpose through improving floodplain function, land use management actions, buying out at-risk properties or structures, improving flood emergency response actions, and increasing water storage from Pe Ell to Centralia. No flood retention facility or Airport Levee Changes would be constructed.

No Action

Under the No Action Alternative, no flood retention facility or Airport Levee Changes would be constructed. Basin-wide large and small scale efforts would continue as part of the Chehalis Basin Strategy work, and local flood damage reduction efforts would continue based on local planning and regulatory actions.

SUMMARY

This discipline report describes noise and vibration impacts from the Proposed Action—the Chehalis River Basin Flood Damage Reduction Proposed Project—as well as a Local Actions Alternative, and a No Action Alternative. This report describes the regulatory setting, estimates the methods for assessing potential noise and vibration impacts, presents the current noise and vibration conditions in the study area, and assessment potential noise and vibration impacts. This report focuses on the noise and vibration impacts on humans and the vibration impacts on structures. Noise and vibration impacts on humans described in this report are summarized in Tables H-1 and H-2. All adverse noise and vibration impacts on humans identified would be **minor**.

Noise and vibration impacts on fish and wildlife are described in the *Fish Species and Habitat Discipline Report* (Anchor QEA 2020a) and the *Wildlife Species and Habitat Discipline Report* (Anchor QEA 2020b). Noise and vibration impacts on fish and wildlife would be significant and are described in those discipline reports in detail.

Table H-1
Summary of Noise and Vibration Impacts on Humans from the Proposed Action

IMPACT	IMPACT FINDING	MITIGATION PROPOSED (SUMMARIZED, SEE SECTION 3.2.4)	SIGNIFICANT AND UNAVOIDABLE ADVERSE IMPACT
PROPOSED ACTION (FRE FACILITY AND AIRPORT LEVEE CHANGES) – CONSTRUCTION			
Noise during construction of the Flood Retention Expandable (FRE) facility and Airport Levee Changes would be below Federal Transit Administration (FTA) criteria for daytime construction noise affecting residential land uses.	Minor	None	No
Truck trips for construction of the FRE facility and Airport Levee Changes would make a negligible noise contribution to hourly noise levels along roadways.	Minor	None	No
Predicted vibration levels from pile driving and drilling for construction of the FRE facility and Airport Levee Changes are below FTA thresholds for disturbance to residential uses.	Minor	None	No
Blasting at quarry areas and temporary bypass tunnel would occur at substantial distance from humans.	Minor	None	No

IMPACT	IMPACT FINDING	MITIGATION PROPOSED (SUMMARIZED, SEE SECTION 3.2.4)	SIGNIFICANT AND UNAVOIDABLE ADVERSE IMPACT
PROPOSED ACTION (FRE FACILITY AND AIRPORT LEVEE CHANGES) – OPERATIONS			
Noise from vehicle trips for regular maintenance of the FRE facility and airport levee would produce negligible roadway noise.	No Impact	None	No

Table H-2

Summary of Noise and Vibration Impacts on Humans from Alternatives

IMPACT	IMPACT FINDING
LOCAL ACTIONS ALTERNATIVE	
Brief, localized construction-related noise over an extended period of time.	Minor
NO ACTION ALTERNATIVE	
None	None

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1 INTRODUCTION

1.1 Resource Description

Sound is mechanical energy transmitted by pressure waves through a medium such as air or water. The manner in which sound travels through this medium is influenced by the physical properties of the medium (such as temperature, density, and humidity). Noise is often defined as unwanted sound and can adversely affect both humans and aquatic and terrestrial wildlife. Of the various noise descriptors used to characterize the loudness of a sound, the sound pressure level is the most common, expressed in decibels (dB).

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, or acceleration. Some common vibration sources such as construction activities (e.g., blasting, pile driving, operating heavy equipment) produce groundborne vibrations that can be perceived by sensitive land uses or result in damage to nearby structures.

1.1.1 Noise Exposure and Metrics

An individual's noise exposure is a measure of the noise experienced by the individual over a period of time. A noise level is a measure of noise at a given instant in time; however, noise levels rarely persist consistently over a long period of time. Rather, community noise varies continuously over time because of the contributing sound sources of the community noise environment. Community noise is primarily the product of many distant noise sources, which constitute a relatively stable background noise, with the individual contributors unidentifiable. The background noise level changes throughout a typical day, but does so gradually, corresponding with the addition and subtraction of distant noise sources such as traffic and wind. What makes community noise constantly variable throughout a day, besides the slowly changing background noise, is the addition of short duration single event noise sources (e.g., aircraft flyovers, motor vehicles, sirens), which are readily identifiable to the individual.

The number of fluctuation cycles or pressure waves per second of a particular sound is the frequency of the sound. The human ear is less sensitive to higher and lower frequencies than to mid-range frequencies (Ecology 2017). Therefore, sound level meters and modeling tools used to measure and predict environmental noise generally incorporate a filtering system that discriminates against higher and lower frequencies, in a manner similar to the human ear, to produce noise measurements that approximate the normal human perception of noise (Ecology 2017). Measurements made using this filtering system are termed A-weighted decibels (dBA).

These successive additions of sound to the community noise environment vary the community noise level from instant to instant, requiring the measurement of noise exposure over a period of time to accurately characterize a community noise environment and evaluate cumulative noise impacts. This

time-varying characteristic of environmental noise is described using statistical noise descriptors. The most frequently used noise descriptors are summarized as follows:

- **L_{eq}**: Equivalent sound level used to describe noise over a specified period of time, typically 1 hour, in terms of a single numerical value; L_{eq} is the constant sound level, which would contain the same acoustic energy as the varying sound level, during the same time period (i.e., the average noise exposure level for the given time period).
- **L_{max}:** Instantaneous maximum noise level for a specified period of time.
- **L_{50}:** Noise level that is equaled or exceeded 50% of the specified time:
  - This is the median noise level during the specified time. An L_{50} represents the noise level exceeded for 30 minutes in a given hour.
  - The numerical subscript may be changed to reflect other percentages. For example, a noise level exceeded for 5 minutes in a given hour would be the noise level exceeded 8.3% of the time or the $L_{8.3}$.
- **L_{90}:** Noise level that is equaled or exceeded 90% of the specified time; L_{90} is often considered the background noise level averaged over the specified time.
- **DNL** (also referred to as "Ldn")**:** Day/Night Average Sound Level (DNL) is the 24-hour day and night A-weighed noise exposure level, which accounts for the greater sensitivity of most people to nighttime noise by weighting noise levels at night:
  - Noise between 10:00 p.m. and 7:00 a.m. is weighted (penalized) by adding 10 dBA to take into account the greater annoyance from nighttime noise.
- **CNEL:** Similar to the DNL, the Community Noise Equivalent Level (CNEL) adds a 5-dBA "penalty" for the evening hours between 7:00 p.m. and 10:00 p.m. in addition to a 10-dBA penalty between the hours of 10:00 p.m. and 7:00 a.m.

1.1.2 Effects of Noise on People

Human response to noise varies considerably from one individual to another. Noise at various levels can interfere with sleep, concentration, and communication and cause physiological and psychological stress and hearing loss. Given these effects, some land uses are considered more sensitive to ambient noise levels than others, referred to as **human sensitive receptor locations**. In general, human sensitive receptor locations including residences, schools, hotels, hospitals, and nursing homes are considered to be the most sensitive to noise. Places such as churches, libraries, and cemeteries (i.e., where people engage in prayer, study, and contemplation) are also sensitive to noise.

The effects of noise on people can be placed into the following three categories:

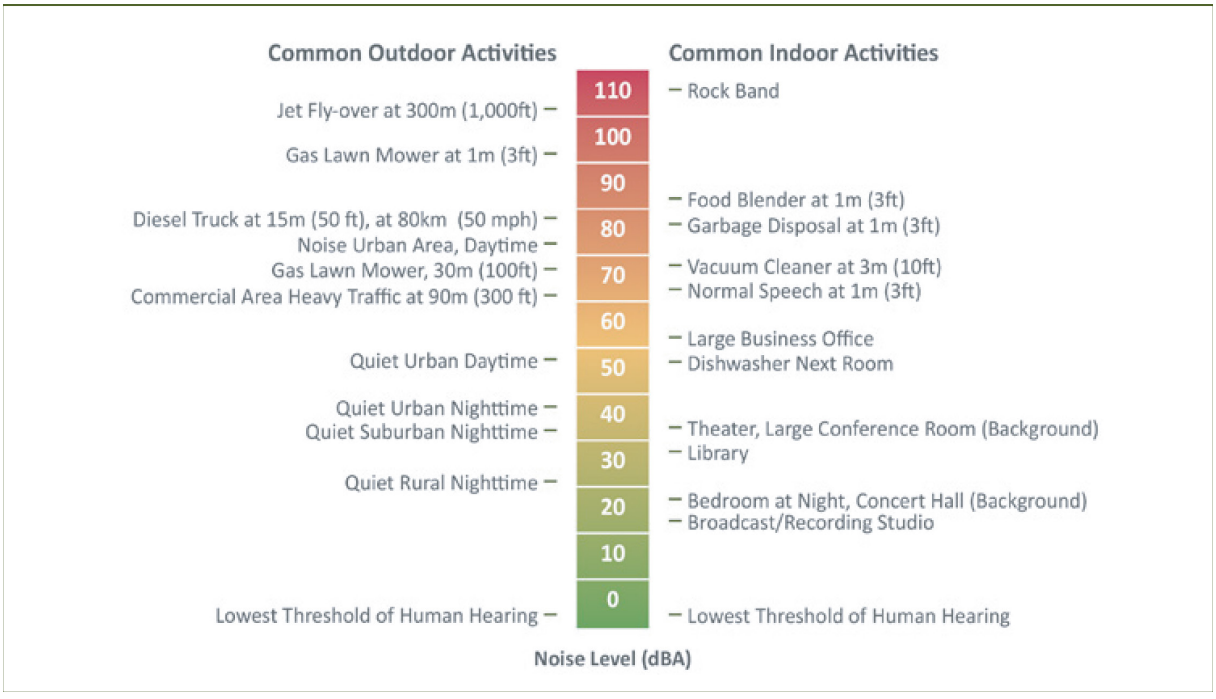
- Subjective effects of annoyance, nuisance, dissatisfaction
- Interference with activities such as speech, sleep, learning
- Physiological effects such as hearing loss or sudden startling

Environmental noise typically produces effects in the first two categories (see Figure H-1). There is no completely satisfactory way to measure the subjective effects of noise, or the corresponding reactions of annoyance and dissatisfaction; individual thresholds of annoyance are highly variable.

Thus, an important way of predicting a human reaction to a new noise environment is the way it compares to the existing environment to which one has adapted: the so called "ambient noise" level. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged by those hearing it. With regard to increases in A-weighted noise level, the following relationships occur:

- Under controlled conditions in an acoustics laboratory, the trained healthy human ear is able to discern changes in sound levels of 1 dBA.
- Outside these controlled conditions, the trained ear can detect changes of 2 dBA in normal environmental noise.
- The average healthy ear, however, can barely perceive changes in the noise level of 3 dBA.
- A change in level of 5 dBA is a readily perceptible increase in noise level.
- A 10 dBA change is recognized as twice as loud as the original source (FHWA 2011).

Figure H-1
Perceptible Noise Thresholds



Source: Caltrans 2009

1.1.3 Vibration Fundamentals and Metrics

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, or acceleration. Groundborne vibration causes buildings to shake and generates audible rumbling sounds (FTA 2018). Vibration levels can also result in interference or annoyance impacts at residences or other land uses where people sleep, such as hotels and hospitals. Some common sources of groundborne vibration, such as construction activities, involve operating heavy earth-moving equipment. Vibration intensity is generally expressed as peak particle velocity (the maximum speed that the ground moves while it temporarily shakes, referred to as PPV). Since ground-shaking speeds are very small, PPV is measured in inches per second. The PPV is defined as the maximum instantaneous peak of the vibration signal and is frequently used to describe physical vibration impacts on buildings. Another useful vibration descriptor is known as vibration decibels (VdBs). VdBs are generally used when evaluating human response to vibration, as opposed to structural damage (for which PPV is the more commonly used descriptor). Vibration decibels are established relative to a reference quantity, typically 1 x 10^{-6} inch per second (FTA 2018).

Types of construction activities associated with groundborne vibration include pile driving, use of hoe rams for demolishing large concrete structures, and drilling. Typically, groundborne vibration generated by human activities attenuates rapidly with distance from the source of the vibration.

1.2 Regulatory Context

Table H-3 identifies the laws, plans, and policies relevant to noise and vibration in the study area.

Table H-3
Regulations, Statutes, and Guidelines for Noise

REGULATION, STATUTE, GUIDELINE	DESCRIPTION
FEDERAL	
Noise Control Act of 1972 (42 U.S. Code 4910)	• Protects the health and welfare of U.S. citizens from the growing risk of noise pollution, primarily from transportation vehicles, machinery, and other commerce products. • Increases coordination between federal researchers and noise-control activities; establishes noise emission standards; and presents noise emission and reduction information to the public (see Section 1.2.1.).
Federal Transit Administration Construction Noise Impact Criteria for General Assessment; Transit Noise and Vibration Impact Assessment	Provides procedures and guidance for analyzing the level of noise and vibration, assessing the resulting impacts, and determining possible mitigation for most federally funded transit projects.

REGULATION, STATUTE, GUIDELINE	DESCRIPTION
STATE	
Washington State Noise Control Act of 1974 (Revised Code of Washington 70.107) Maximum Environmental Noise Levels (Washington Administrative Code [WAC] 173-60)	Establishes maximum environmental noise levels.
LOCAL	
Lewis County General Land Use Standards (Lewis County Code [LCC] 17.142.020)	Establishes general land use standards that recognize the maximum environmental noise levels established by Chapter 173-60 WAC.
Lewis County Surface Mining Areas (LCC 17.142.200)	Addresses surface mining areas and prohibits development or activity that exceeds the maximum environmental noise levels established by Chapter 173-60 WAC.
Pacific County Local Board of Health Ordinance No. 9, Section 1.6(m)	Defines public nuisances including those generating noise during "quiet hours."
City of Chehalis Municipal Code (Section 7.04.320)	Defines public nuisances including noise disturbance.

1.2.1 Federal

In 1972, the Noise Control Act was passed by Congress to promote an environment for all Americans free from noise that jeopardizes their health and welfare. It also established the U.S. Environmental Protection Agency (EPA) Office of Noise Abatement and Control to coordinate federal noise control activities. EPA established guidelines for noise levels that would be considered safe for community exposure without the risk of adverse health or welfare effects. Table H-4 presents important noise exposure levels established by the guidelines.

Table H-4

Summary of Noise Levels Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety

EFFECT	LEVEL	AREA
Hearing loss	< 70 dBA[a] (L_{eq}, 24 hour)	All areas
Outdoor activity interference and annoyance	< 55 dBA (L_{dn})	Outdoor residential areas and farms as well as other outdoor areas where people spend varying amounts of time and places where quiet is a basis for use
Outdoor activity interference and annoyance	< 55 dBA (L_{eq}, 24 hour)	Outdoor areas where people spend limited amounts of time, such as school yards or playgrounds
Indoor activity interference and annoyance	< 45 dBA (L_{dn})	Indoor residential areas
Indoor activity interference and annoyance	< 45 dBA (L_{eq}, 24 hour)	Other indoor areas with human activities, such as schools

Source: EPA 1974
Note:
a. Yearly average equivalent sound levels in decibels; the exposure period that results in hearing loss at the identified level is 40 years.

EPA found that to prevent hearing loss over the lifetime of a receptor, the yearly average L_{eq} should not exceed 70 dBA, and the L_{dn} should not exceed 55 dBA in outdoor activity areas or 45 dBA indoors to prevent interference and annoyance (EPA 1974). In 1982, responsibility for noise control was largely passed to state and local governments.

Federal regulations establish noise limits for medium and heavy trucks (more than 4.5 tons, gross vehicle weight rating) under Title 40 of the Code of Federal Regulations, Part 205, Subpart B. The federal truck pass-by noise standard is 80 dBA at 50 feet from the vehicle pathway centerline, under specified test procedures. These requirements are implemented through regulatory controls on truck manufacturers. There are no comparable standards for vibration, which tend to be specific to the roadway surface, the vehicle load, and other factors.

1.2.2 Washington State Noise Control Act of 1974

Recognizing the harm that excessive noise can have on public health, safety, and well-being, the State of Washington established rules to abate and control noise pollution (Revised Code of Washington 70.107).

The Washington Administrative Code (WAC) imposes limits on the allowable environmental noise levels from a variety of sources in any 1-hour period (WAC 173-60). The maximum allowable levels depend on the classification of the property receiving the noise and the noise source. The classification system is called the Environmental Designation for Noise Abatement (EDNA), and is generally based on a property's use.

WAC 173-60-040 establishes maximum permissible environmental noise levels, presented in Table H-5. There are three EDNA designations (WAC 173-60-030), which generally correspond to residential, commercial and recreational, and industrial and agricultural uses. These are listed as follows:

- **Class A:** Lands where people reside and sleep (such as residential or recreational)
- **Class B:** Lands requiring protection against noise interference with speech (such as commercial)
- **Class C:** Lands where economic activities are of such a nature that higher noise levels are anticipated (such as industrial or agricultural)

The following noise sources or activities are exempt from the noise limits listed WAC 173-60-050:

- Sounds created by traffic on public roads
- Sounds created by warning devices (e.g., back-up alarms)
- Sounds from blasting and from construction equipment are exempt from the standards during the day (7:00 a.m. to 10:00 p.m. on weekdays, and from 9:00 a.m. to 10:00 p.m. on weekends) in rural and residential districts

Table H-5
Maximum Permissible Noise Levels

EDNA OF NOISE SOURCE	EDNA OF RECEIVING PROPERTY		
	CLASS A	CLASS B	CLASS C
Class A	55 dBA	57 dBA	60 dBA
Class B	57 dBA	60 dBA	65 dBA
Class C	60 dBA	65 dBA	70 dBA

Source: WAC 173-60-040
Note:
Between the hours of 10:00 p.m. and 7:00 a.m. these noise limits are to be reduced by 10 dBA for all Class A EDNAs. Short-term exceedance of these limits are allowed if for any hour the limit is exceeded by no more than 5 dBA for 15 minutes, 10 dBA for no more than 5 minutes, or no more than 15 dBA for no more than 1.5 minutes.

1.2.3 Lewis County Code

Section 17.142.020 of the Lewis County Code addresses general land use standards in the county. Subsection (2)(d) prohibits approval of land uses that would involve uses, activities, processes, materials, equipment, or conditions of operation that will be detrimental to any persons, property, or the general welfare by reasons of excessive production of traffic, noise, smoke, fumes, glare, or odors. Subsection (3)(c) establishes general use standards that recognize the maximum environmental noise levels established by Chapter 173-60 WAC.

Additionally, Section 17.142.200 addresses surface mining areas and prohibits development or activity that exceeds the maximum environmental noise levels established by Chapter 173-60 WAC.

1.2.4 Lewis County Comprehensive Plan

The Transportation Element of the *Lewis County Comprehensive Plan* (Lewis County 2018) contains two policies that address noise, both of which relate to aircraft noise exposure and do not apply to the Proposed Action.

1.2.5 Pacific County Code

There are portions of the potential Huckleberry Quarry site in Pacific County. Pacific County Local Board of Health Ordinance No. 9, Section 1.6(m) defines public nuisances and prohibits loud or raucous noise that unreasonably disturbs or interferes with the peace, comfort, or repose during quiet hours of 10:00 p.m. and 6:00 a.m. Sundays through Thursdays and between 12:00 a.m. and 6:00 a.m. on Fridays and Saturdays. Normal construction activity is exempt from these restrictions.

1.2.6 City of Chehalis Municipal Code and Comprehensive Plan

Section 7.04.320 of the City of Chehalis Municipal Code prohibits noise that may cause a public noise disturbance or for someone to be in possession and control of property on which a public noise disturbance occurs. The are no quantitative noise standards established in the municipal code that would apply to construction activities.

The City's code (Section 17.30) and Comprehensive Plan Land Use Element (Chapter 3) acknowledge the presence of the Chehalis-Centralia Airport as being a source of existing noise and identifying a noise level of 65 Ldn as a potential for land use restriction but states that the 65 Ldn contour lies entirely within the airport primary surface and runway safety zone and that there are no off-site requirements in relation to airport noise and land use.

2 METHODOLOGY

2.1 Study Area

The study area for assessment of noise and vibration impacts associated with construction and operation of the Flood Retention Expandable (FRE) facility includes human sensitive receptor locations surrounding the FRE facility site and along access roads associated with truck hauling of materials and supplies. It also includes areas surrounding the three potential quarry sites and the materials processing area (Figure H-2).

The study area for the assessment of noise and vibration impacts associated with construction and operation of the Airport Levee Changes includes human sensitive receptor locations surrounding the levee and along access roads that may be associated with truck hauling of materials and supplies (Figure H-2).

The study area for the assessment of noise and vibration impacts associated with the No Action Alternative and construction and operation of the Local Actions Alternative, which have no defined project sites, is assumed to be within Lewis County.

2.2 Affected Environment

The study area primarily consists of intermittent rural homes with cities, like Centralia and Chehalis, and small cities and towns along the Chehalis River. Existing noise sources include agricultural and logging activities, commercial and industrial facilities, trains, the Chehalis-Centralia Airport, and highways. Many parts of the study area are sparsely populated and have very low noise levels (Ecology 2017).

2.2.1 Sensitive Receptors and Soundscape Near FRE Facility

The closest sensitive receptors to the proposed FRE facility and quarry areas are rural residences along Wells Road, approximately 3,000 feet north of the proposed FRE facility. These receptors are identified in Figure H-3. Sensitive receptors are also located on Muller Road, approximately 4,200 feet north of the proposed FRE facility.

The noise environment surrounding the FRE facility study area is relatively quiet as a result of the surrounding rural/open space land uses. Natural sounds predominate in the study area, such as river flow, bird song, and wind. Commercial logging operations occur in the area. State Route 6 is more than 3,000 feet to the northwest, while local roadways such as Muller Road and Forest Road (FR) 1000 accommodate infrequent traffic, which intermittently adds to the soundscape.

2.2.2 Sensitive Receptors and Soundscape Near Airport Levee Changes

The closest sensitive receptors to the proposed Airport Levee Changes areas are multi-family residences along NW Airport Road and NW River Street, some of which are as close as 100 feet from the levee edge. In addition, the Riverside RV Park is located along NW Airport Road. Because people sleep within the RV park, it is also considered a sensitive receptor with respect to noise and vibration. These receptors are identified in Figure H-4. While there is a golf course west of the airport levee site, golf courses are generally considered to be a noise-tolerant land use where noise exposure levels of 75 dBA may be considered acceptable (OPR 2017) and are, therefore, not considered a sensitive receptor with respect to noise and vibration.

The noise environment surrounding the Airport Levee Changes study area is moderately urban and predominantly influenced by vehicle traffic on Interstate 5 (I-5) and aircraft operations at Chehalis-Centralia Airport, a general aviation airport. Based on traffic volumes published by the Washington State Department of Transportation, noise from I-5 contributes approximately 60 dBA to 65 dBA at the residences along NW Airport Road and NW River Street during the peak traffic hour (WSDOT 2017). The airport accommodates an average of 131 operations per day (AirNav 2019). The 65 Ldn noise contour for aircraft operations exists entirely within the confines of the airport site (Chehalis Municipal Code Section 17.30.020).

2.3 Studies and Reports Referenced/Used

The following studies and reports were used to evaluate noise and vibration impacts.

- *Chehalis Basin Strategy Programmatic Environmental Impact Statement* (Ecology 2017)
- *Transit Noise and Vibration Impact Assessment* (FTA 2018)
  - Provides guidance for assessing construction-related noise and vibration impacts, including identification of noise and vibration criteria for lead agencies to consider when assessing impacts under the State Environmental Policy Act (SEPA) or local regulations
  - These methods and criteria are generally applied industry-wide for large projects, regardless of whether they are transit projects
- *Roadway Construction Noise Model* (RCNM; FHWA 2006)
  - A noise prediction model generally applied industry-wide for large projects, it provides reference noise levels and usage rates for almost all construction equipment types and predicts resultant noise levels in terms of maximum noise metrics or hourly equivalent noise metrics that take into account percentage usage of equipment
- *Traffic Noise Model* (RD-77-108; FHWA 2004)
  - Predicts roadside noise levels at various distances using input variables such as vehicle trips per hour; passenger vehicle, medium truck, and heavy duty truck trip percentages; and vehicle speeds

Figure H-2
Noise Study Area

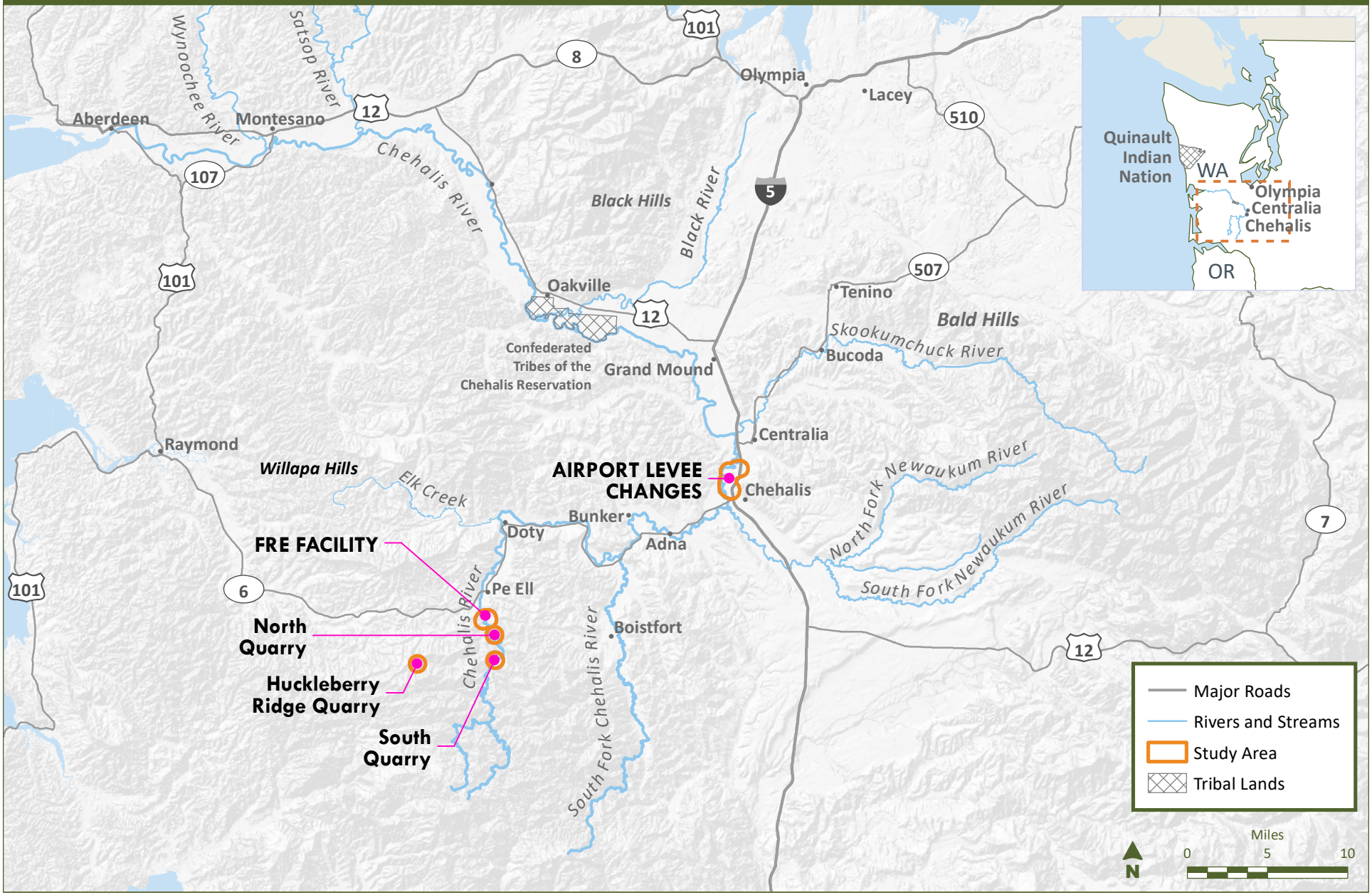


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Figure H-3
Noise-sensitive Receptors Near FRE Facility

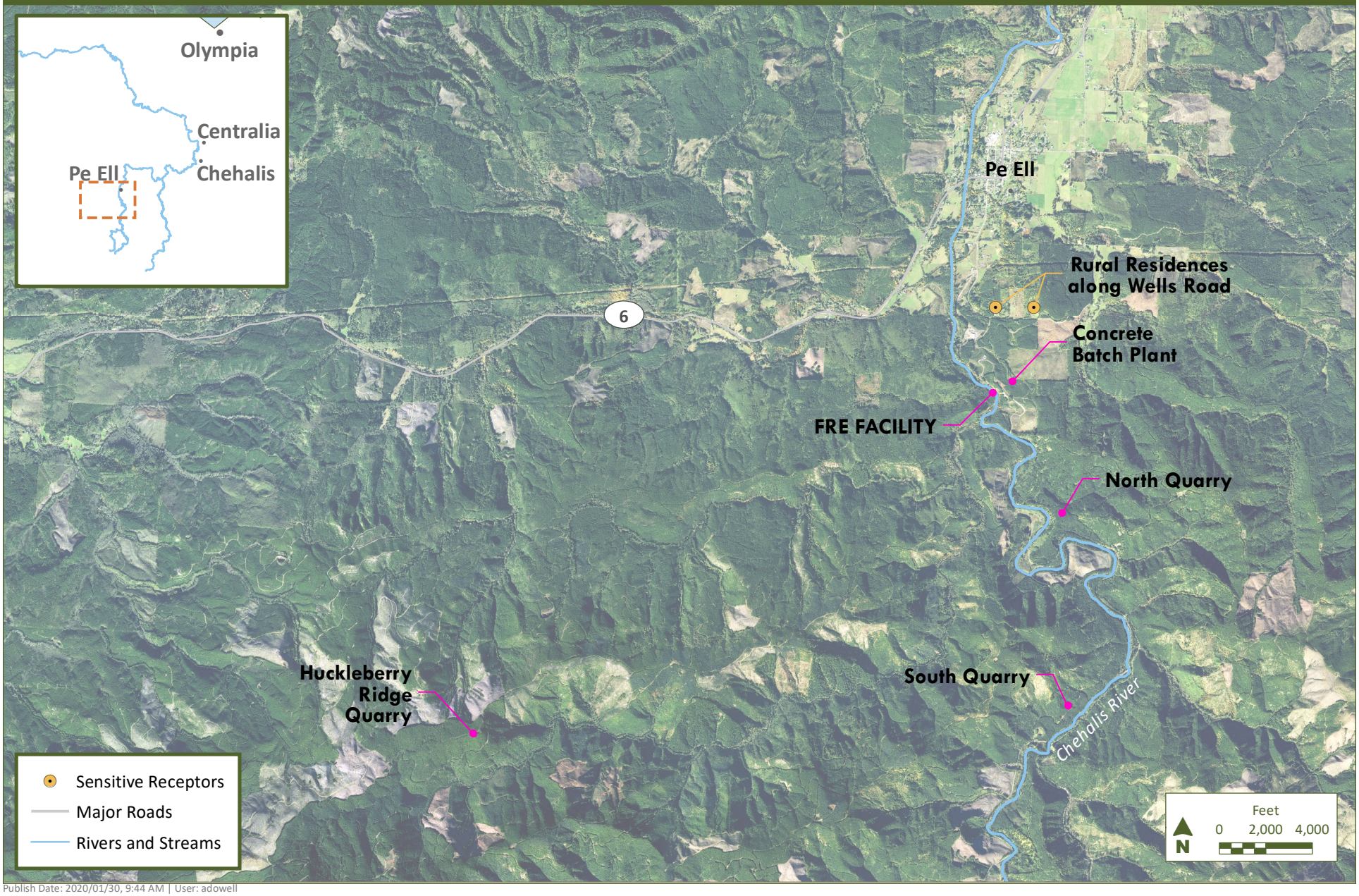

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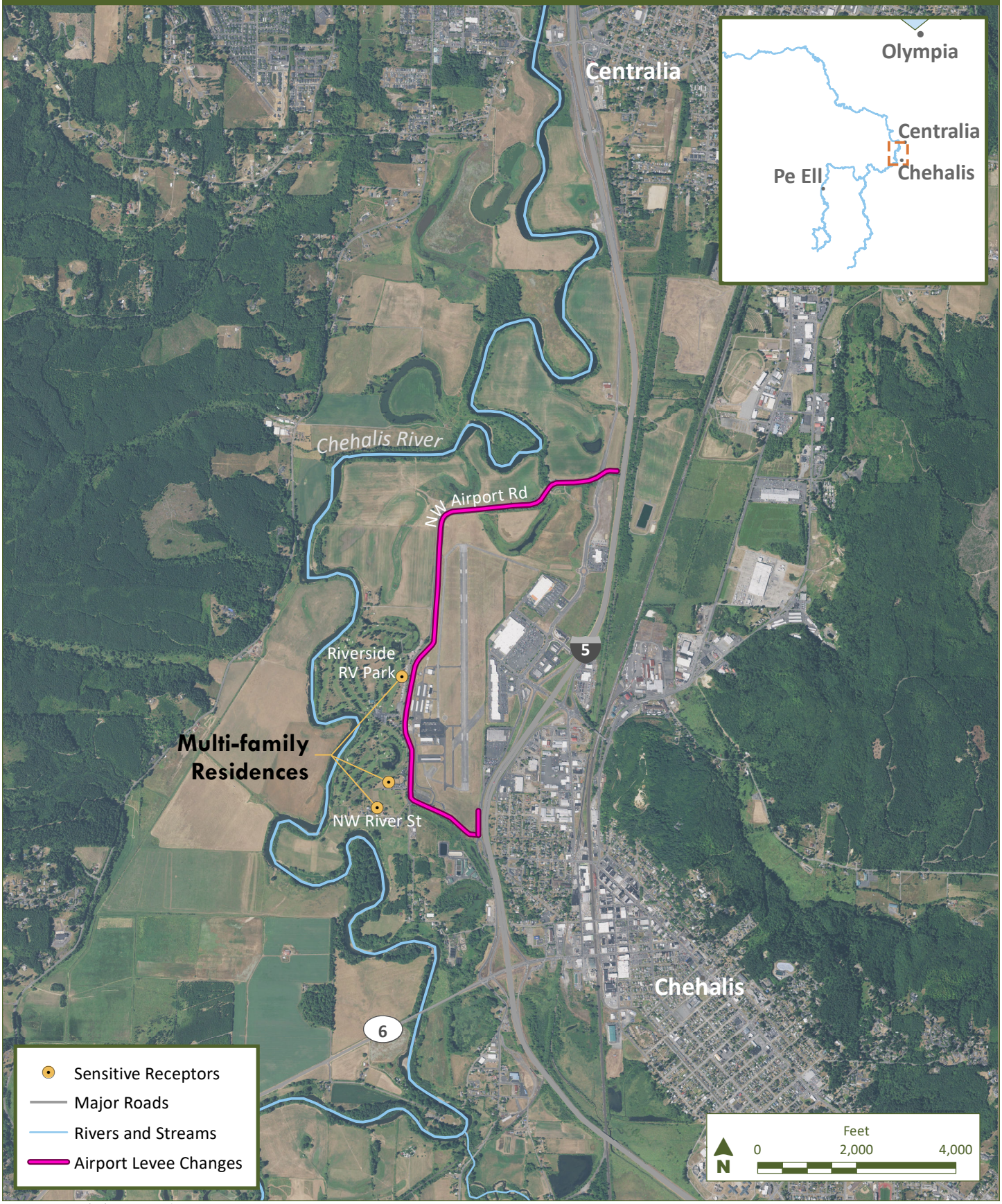
Figure H-4
Noise-sensitive Receptors Near Airport Levee Changes



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2.4 Technical Approach

This section focuses on the noise and vibration impacts on humans and the vibration impacts on structures. Potential noise impacts on aquatic wildlife and terrestrial wildlife are addressed in the *Fish Species and Habitats Discipline Report* (Anchor QEA 2020a) and the *Wildlife Species and Habitats Discipline Report* (Anchor QEA 2020b) using data points from this analysis.

2.4.1 Noise

Construction noise was assessed for the FRE facility and the Airport Levee Changes based on equipment and activities likely used for dam and levee construction. These include blasting, impact pile driving and vibratory pile driving for sheet pile installation associated with the cofferdams, as well as standard off-road equipment such as bulldozers, loaders, and off-highway trucks. Noise from truck trips on local roadways to haul materials and equipment was assessed based on an estimated number of daily (and hourly) truck trips, to be determined in conjunction with the transportation analysis.

2.4.2 Vibration

Construction vibration was assessed for the FRE facility and the Airport Levee Changes based on equipment used for dam and levee construction and vibration reference levels and vibration propagation equation published by the Federal Transit Administration (FTA).

2.5 Impact Analysis

The impact analysis for noise and vibration considered the following:

- Noise impacts at the nearest sensitive land uses from off-road equipment used for construction including quarrying of rock, constructing or upgrading roads to the quarry, blasting, tunnel excavation, foundation excavation and drilling, placing roller compacted concrete, rock processing, concrete batch plant operations, and pile driving for foundations and cofferdams
- Roadway noise impacts from haul trucks importing fly ash, sand, and other materials for use in the concrete batch plant
- Construction vibration impacts at the nearest structures and at the nearest sensitive land uses from off-road equipment used for construction including quarrying of rock, blasting, rock processing, concrete batch plant operations, and pile driving for foundations and cofferdams

3 TECHNICAL ANALYSIS AND RESULTS

3.1 Overview

This section describes the probable noise and vibration impacts from the Proposed Action (Section 3.2), Local Actions Alternative (Section 3.3), and No Action Alternative (Section 3.4). This section also evaluates required permit conditions and planning document requirements that could address the impacts identified (Section 3.2.3). When probable significant adverse environmental impacts remain after considering these, the report identifies mitigation measures that could avoid, minimize, or reduce the identified impact below the level of significance (Section 3.2.4).

3.2 Proposed Action

3.2.1 Impacts from Construction

This section describes the impacts on humans from construction of a flood retention facility (referred to as an FRE facility) and associated activities including, development of a quarry to provide aggregate for the FRE facility, constructing or upgrading roads to the quarry, constructing a temporary bypass tunnel, and tree removal. It also describes the impacts from construction activities associated with the Airport Levee Changes. Noise and vibration impacts from construction on fish and wildlife are described in the *Fish Species and Habitat Discipline Report* (Anchor QEA 2020a) and the *Wildlife Species and Habitat Discipline Report* (Anchor QEA 2020b).

3.2.1.1 Direct

3.2.1.1.1 Flood Retention Expandable Facility

Noise Impacts

Construction of the FRE facility would generate noise from multiple sources, including the following:

- Off-road equipment used to construct the FRE facility
- Off-road equipment used to quarry aggregate at the quarry sites
- Noise generated by blasting at the quarry sites
- Noise generated by blasting and equipment for the proposed temporary bypass tunnel
- On-road truck trips to bring materials to the work site including sand, fly ash, and cement to the concrete batch plant
- Off-road daily truck trips to bring quarried rock to the batch plant for processing
- Noise generated by rock processing for the FRE facility structure, cofferdams, and the concrete batch plant
- Noise generated by construction equipment for the road improvements and quarry roads
- Noise generated by tree removal including operation of saws and chippers

Off-Road Equipment Noise from FRE Facility Construction

A project-specific inventory of equipment needed to construct the FRE facility was not available at the time of this analysis. To approximate equipment-related construction noise, an inventory from a dam construction project of similar size (*Sites Reservoir Project Draft Environmental Impact Report/Environmental Impact Statement*) was scaled to estimate the type of off-road equipment (Bureau of Reclamation 2017). The Sites Reservoir project included a dam of the same height as the proposed FRE facility and a slightly longer crest length, and therefore represents a conservative estimate for the construction effort for the Proposed Action. The Federal Highway Administration's (FHWA's) RCNM was used to calculate noise levels at the closest sensitive receptors. Assumed equipment included bulldozers, compactors, cranes, scrapers, and vibratory and impact pile drivers.

Off-Road Equipment Noise from Quarrying

A project-specific inventory of equipment to be used in quarrying was not available at the time of this analysis. An inventory of equipment necessary for quarrying was estimated based on an equipment inventory compiled for operations of the San Rafael rock quarry (ESA 2009). Assumed equipment included excavators, wheeled loaders, and bulldozers. The North Quarry was evaluated as it would be the closest to sensitive land uses.

Noise Generated by Blasting Activities at the Quarry, FRE Facility Foundation, and for Construction of the Temporary Bypass Tunnel

Noise from blasting activities was estimated using reference noise levels from RCNM and conservatively assumed one blast per hour. The Chehalis River Basin Flood Control Zone District (Applicant) stated that blasting for the FRE facility foundation would occur as often as one to four times per week for approximately 12 months. Blasting to construct the temporary bypass tunnel would occur one to four times a week, once or twice per day over a period of approximately 9 months with almost all blasting occurring in the interior of the tunnel. Quarry blasting is expected to occur for up to 3 years, one to four times per week during active development of the quarries.

Noise from On-Road Trucks

Noise from trucks bringing materials from off-site locations to the FRE facility site was calculated using truck trip estimates provided by the Applicant and the FHWA traffic noise model. Noise level contributions from on-road trucks were estimated for receptors along likely haul routes.

Noise from Rock Processing for the FRE Facility Structure, Cofferdams, and the Concrete Batch Plant

A project-specific inventory of equipment to be used in rock processing was not available at the time of this analysis. To approximate equipment-related construction noise, an equipment inventory was estimated to be similar to that from a rock processing facility in Brisbane, California (ESA 2017), which included jaw crushers, cone crushers, screening equipment, and a conveyor. Noise from batch plant operations was estimated using reference noise levels from RCNM. The Applicant's construction plan states that the roller compact concrete operations would occur 20 hours per day and 7 days per week.

Under WAC 173-60-050 and Lewis County Code, noise from blasting and construction equipment is exempt during the day (7:00 a.m. to 10:00 p.m. on weekdays, and from 9:00 a.m. to 10:00 p.m. on weekends) in rural and residential areas. Outside of these times, construction activities would be required to meet noise limits.

Off-Road Equipment Noise from Construction of Roadway Improvements and Quarry Roads

The proposed quarry sites include North Quarry, South Quarry, and Huckleberry Ridge. The North Quarry site would require widening 1.9 miles of FR 1000. FR 1000G would also require widening, surfacing, and moderate improvements to the subgrade. The South Quarry site would require the same improvements described for the North Quarry with additional upgrades and widening of FR 1000 and FR 1020. The Huckleberry Ridge Quarry site would include 3.01 miles of simple improvements, 2.93 miles of moderate improvements and excavation, and 0.81 mile of complex improvements, including heavy excavation, drilling, and blasting.

A project-specific inventory of equipment needed to construct roadways was not available at the time of this analysis. To approximate equipment-related construction noise, an inventory from the Road Construction Emissions Model of the Sacramento Metropolitan Air Quality Management District was used assuming 3 miles of road widening. The model indicates that road widening equipment would include multiple excavators, crawler tractors, graders, rollers, loaders, scrapers, and compactors. Additionally, blasting was conservatively assumed to capture complex improvements.

Noise from Tree Removal

The Proposed Action would result in removal of trees in inundation areas and construction areas. However, the existing upstream area is a managed forest under private control that results in tree harvesting with or without the Proposed Action. Therefore, noise from saws and chippers engaged in tree removal would not represent a new noise source in the area and is therefore not considered as a new component in the analysis of noise predictions for the Proposed Action.

Table H-6 lists typical noise levels at a reference distance of 50 feet associated with various types of construction equipment, including the proposed aggregate crushing operations.

Table H-6
Typical Maximum Noise Levels from Construction Equipment

CONSTRUCTION EQUIPMENT/ACTIVITY	NOISE LEVEL (dBA, L_{MAX} AT 50 FEET)
Backhoe	78
Excavator	81
Compactor	83
Scraper	84
Air Compressor	78
Bulldozer	82
Crane	81
Grader	85
Paver	77
Roller	80
Front-End Loader	79
Trucks	76
Aggregate Crusher	79
Impact and Vibratory Pile Driver	101
Blasting	94

Sources: FHWA 2006; aggregate crusher processing noise level based on data from H.M. Pitt Labs 2006
Note:
These are maximum field-measured values at 50 feet as reported from multiple samples.

Table H-7 presents predicted noise levels estimated at sensitive receptor locations nearest the FRE facility site. These predicted noise levels are conservative in that they are based on a 2D model (RCNM) and do not take into account intervening topography. Additionally, the predicted noise levels are conservative in that they assume simultaneous operation of all activities and phases of construction. Noise levels from quarrying were estimated for the North Quarry, which is the closest of the three potential quarry location to human receptors. Construction noise would be well below the FTA criterion of 90 dBA for assessing impacts from daytime construction on residential land uses. Therefore, construction activities associated with the FRE facility would be a **minor** adverse impact on humans.

In addition to equipment noise, FRE facility construction would generate truck trips to bring materials from off-site locations to the FRE facility site. Trucks were assumed to access the site along 3rd Street in Pe Ell and along Muller Road to FR 1000, passing by rural residential uses. Approximately 9,200 truck trips (6,000 supply trucks and 3,200 trucks carrying logs) are predicted over the 5-year construction period, or about 1,840 truck trips per year. Lewis County estimates the current average daily traffic on Muller Road to be 370 vehicles per day. Truck trips would add approximately 8 truck trips per day to the assumed truck route. The addition of a single truck trip per hour along this route would have a negligible noise contribution to hourly noise levels in the area, and truck traffic impacts from the FRE facility site would be a **minor** adverse impact on humans.

Table H-7
Predicted Noise Level Contributions from FRE Facility Construction and Quarrying Areas at Sensitive Receptor Locations (Noise Level in DBA, Hourly, L_{eq})

ACTIVITY	RECEPTOR LOCATION	
	WELLS ROAD RESIDENCES	MULLER ROAD RESIDENCES
Construction Activities (Equipment, Pile Driving)	62.1	60.5
Quarrying (Equipment, Trucks and Blasting)	42.6	42.3
Rock Processing and Batch Plant (Equipment and Trucks)	53.4	51.8
Temporary Bypass Tunnel (Equipment and Blasting)	63.1	61.3
Road Widening (Equipment)	53.5	51.9
Acoustical Sum of All Activity	65.9	64.2
FTA Daytime Criteria for Residential Use	90	90

Sources: FHWA 2006; FTA 2018; and ESA 2019

Vibration Impacts

Construction would involve blasting and the use of equipment such as impact pile drivers and vibratory pile drivers, which can generate substantial vibration. Construction activities and quarrying activities for the FRE facility would occur more than 3,000 feet from the nearest human sensitive receptor. Drilling and blasting for the temporary bypass tunnel would occur more than 2,700 feet from the nearest human sensitive receptor.

Vibration levels at the nearest receptors from pile driving and drilling were estimated using reference vibration levels published by FTA, and attenuating that vibration based on the distance between the pile installation activity or quarry and the nearest receptor. Predicted vibration levels are listed in Table H-8 and are well below FTA thresholds for disturbance to residential uses. Therefore, the vibration from FRE facility construction activities would be a **minor** adverse impact on humans.

Table H-8
Predicted Vibration Levels from FRE Facility Construction and Quarrying Activities at Sensitive Receptor Locations

EQUIPMENT/ACTIVITY	PREDICTED VdB			FTA DAYTIME CRITERIA FOR RESIDENTIAL USE
	AT 25 FEET (REFERENCE)	AT 3,000 FEET	AT 3,600 FEET	
Jack Hammer	79	17	14	80
Large Bulldozer	87	24	22	80
Loaded Trucks	86	24	21	80
Impact Pile Driver	104	42	39	72
Vibratory Pile Driver	102	40	37	72
Caisson Drilling	87	24	22	80
Vibratory Roller	94	31	29	80

Source: FTA 2018

Vibration would also be generated at the quarry sites, primarily from blasting as well as at the temporary bypass tunnel from blasting and drilling. Basic forms of energy are released when explosives react: gas energy and shock energy. Shock energy is the pressure that is transmitted outward from the borehole into the rock, causing microfractures to form and propagate outward for a short distance. Gas energy is the pressure that is exerted on the borehole walls by the expanding gases after a chemical reaction has been completed. These gases fracture the rock, and this causes the majority of rock breakage in quarry blasting. Energy from a blast that is not used for rock breakage is wasted in the form of ground vibration and airblast.

All quarry locations are in remote wilderness areas, distant from structures or sensitive land uses. The North Quarry would be closest to an existing structure or human receptor, at a distance of over 6,000 feet. Blast vibrations are a function of several variables besides distance, primarily the weight of explosives per delay. This variable can be controlled by the blasting contractor to ensure that blasting activities do not result in either structural damage or human annoyance. The Oregon Department of Transportation estimates that if a structure is 1,320 feet away (0.25 mile) and the PPV at that receptor is limited to 0.5 inch per second to avoid structural damage, then the maximum weight of explosives that can be detonated is approximately 2,300 pounds per delay period (ODOT 2000). Given the substantial distance between the potential quarry areas and existing structures and sensitive receptors, as well as the ability for contractors to adjust the pounds per delay of specific blasting events, vibration from proposed quarry blasting would be a **minor** adverse impact on humans.

Similarly, for blasting associated with the temporary bypass tunnel, the nearest human receptor would be approximately 2,700 feet to the north. Given the substantial distance between the proposed temporary bypass tunnel and existing structures and sensitive human receptors, as well as the ability for contractors to adjust the pounds per delay of specific blasting events, vibration from proposed temporary bypass tunnel blasting would be a **minor** adverse impact on humans.

3.2.1.1.2 Airport Levee Changes

Noise Impacts

Off-Road Equipment Noise from Levee Construction

A project-specific inventory of equipment needed to construct the Airport Levee Changes was not available at the time of this analysis. To approximate equipment-related construction noise, an inventory from another levee repair construction project was used to estimate off-road equipment noise generation (DWR 2019). The RCNM model was used to calculate noise levels at the closest sensitive receptors. Assumed equipment included two excavators, a compactor, a crane, a grader, and a loader.

Table H-9 presents predicted noise levels estimated at sensitive receptor locations nearest the project site using RCNM. Construction noise would be below the FTA criterion of 90 dBA for assessing impacts from daytime construction on residential land uses. Therefore, construction activities associated with construction of the Airport Levee Changes would be a **minor** adverse impact on humans

In addition to equipment noise, levee construction would generate truck trips to bring materials from off-site locations to the levee site. Trucks were assumed to access the site from I-5 along NW Airport Road, passing by residential uses and an RV park. Approximately 22,900 trucks trips are predicted over a 1-year project construction period. These truck trips would add approximately 88 truck trips per day to the assumed truck route. The City of Chehalis estimates the current average daily traffic on NW Airport Road to be 6,560 vehicles per day. The addition of nine truck trips per hour along this route would contribute 55 dBA to hourly traffic levels on this roadway where, as discussed in Section 2.2.2, the residences along NW Airport Road are currently exposed to noise levels of 60 dBA to 65 dBA from traffic on I-5 (an increase of 1 dBA or less). Therefore, the contribution of additional haul truck trips would be a modest noise contribution to hourly noise levels in the area, and truck traffic impacts from the airport levee site would be a **minor** adverse impact on humans.

Table H-9
Predicted Noise Level Contributions from Airport Levee Changes Construction at Sensitive Receptor Locations

RECEPTOR LOCATION	NOISE LEVEL (dBA, HOURLY, L_{EQ})	
	CONSTRUCTION EQUIPMENT	FTA DAYTIME CRITERIA FOR RESIDENTIAL USE
NW Airport Road Residences	78.9	90
Riverside RV Park	78.9	90

Sources: ESA 2019; FTA 2018

Vibration Impacts

Construction would involve the use of equipment such as bulldozers, which can generate a modest amount of vibration. Construction activities for the airport levee would occur up to 100 feet from the nearest sensitive human receptor potentially affected by localized vibration. Vibration levels at the nearest receptors from bulldozer and loaded truck operations were estimated using reference vibration levels published by the FTA, and attenuating that vibration based on the distance between the levee and the nearest receptor. Predicted vibration levels are listed in Table H-10 and are below FTA thresholds for disturbance to residential uses. Therefore, the vibration from airport levee construction activities would be a **minor** adverse impact on humans.

Table H-10
Predicted Vibration Levels from Airport Levee Changes at Sensitive Receptor Locations

EQUIPMENT/ACTIVITY	PREDICTED VdB		FTA CRITERIA FOR RESIDENTIAL USE
	AT 25 FEET (REFERENCE)	AT RECEPTOR (100 FEET)	
Large Bulldozer	87	69	80
Loaded Trucks	86	68	80

Source: FTA 2018

3.2.1.2 Indirect

3.2.1.2.1 Flood Retention Expandable Facility

No indirect impacts on noise or vibration impacts from the construction of the FRE facility are anticipated.

3.2.1.2.2 Airport Levee Changes

No indirect impacts on noise or vibration impacts from the construction of the Airport Levee Changes are anticipated.

3.2.2 Impacts from Operation

This section describes the noise and vibration impacts on humans from operation of the FRE facility and Airport Levee Changes. Noise and vibration impacts on fish and wildlife are described in the *Fish Species and Habitat Discipline Report* and the *Wildlife Species and Habitat Discipline Report*.

3.2.2.1 Direct

3.2.2.1.1 Flood Retention Expandable Facility

Once constructed, the FRE facility would not generate noise or vibration. While some vehicle trips would be generated for regular maintenance and operation of the FRE facility, these trips would result in negligible roadway noise with **no adverse impact**.

3.2.2.1.2 Airport Levee Changes

Once constructed, the airport levee would not generate noise or vibration. While some vehicle trips would be generated for regular inspections of the levee, these trips would result in negligible roadway noise with **no adverse impact**.

3.2.2.2 Indirect

3.2.2.2.1 Flood Retention Expandable Facility

No indirect impacts on noise or vibration associated with operation of the FRE facility are anticipated.

3.2.2.2.2 Airport Levee Changes

No indirect impacts on noise or vibration associated with operation of the Airport Levee Changes are anticipated.

3.2.3 Required Permits

The following licenses/permits would be required for the Proposed Action:

- Washington State Explosives License, issued by the Washington State Department of Labor and Industries
  - Blasting with explosives requires a license to abate potential hazards, including noise
  - Licensing includes passing a written test and fingerprinting of all users
- Federal Explosives License/Permit, issued by the Bureau of Alcohol, Tobacco, and Firearms

Both state and federal licenses would be required to be obtained by the contractor prior to procuring explosives.

3.2.4 Proposed Mitigation Measures

All adverse noise and vibration impacts identified previously would be **minor**. No mitigation is proposed.

3.2.5 Significant and Unavoidable Adverse Environmental Impacts

Compliance with laws and implementation of the measures described previously would reduce impacts on noise and vibration. There would be **no significant and unavoidable** adverse environmental impacts on noise and vibration.

3.3 Local Actions Alternative

3.3.1 Impacts from Construction

This section analyzes the potential impacts from construction of local actions such as strategic floodproofing (elevating buildings, building berms or floodwalls), floodplain storage improvement (placing wood in rivers, restoring riparian areas, reforesting floodplain areas), and channel migration protection (placement of wood in rivers).

3.3.1.1 Direct

Of the six local action measures identified under this alternative, three elements could result in the need for construction activities. First, floodproofing existing structures could involve localized construction projects for buildings within the floodplains. This activity would likely occur sporadically, as funding mechanisms become available and would reasonably be expected to result in brief, localized construction noise and vibration distributed over an extended period of time.

Likewise, floodplain storage improvements and channel migration protection would also be expected to result in sporadic, localized construction activity over an extended period of time and, therefore, result in negligible, isolated noise and vibration impacts. Consequently, construction activities under the Local Actions Alternative would be a **minor** adverse impact with respect to noise and vibration.

3.3.1.2 Indirect

No indirect impacts on noise or vibration associated with construction of the Local Actions Alternative are anticipated.

3.3.2 Impacts from Operation

This section analyzes the potential impacts from operation and implementation of local actions, such as adopting higher development and construction standards, strategic floodproofing, buy-out of at-risk properties or structures, floodplain storage improvement, channel migration protection, and early flood warning systems.

3.3.2.1 Direct

No direct impacts on noise or vibration associated with operation of the Local Actions Alternative are anticipated.

3.3.2.2 Indirect

No indirect impacts on noise or vibration associated with operation of the Local Actions Alternative are anticipated.

3.4 No Action Alternative

Under the No Action Alternative, impacts on noise and vibration from the construction or operation of the Proposed Action would not occur. No new noise or vibration impacts are expected under the No Action alternative.

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