PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Bull Run TREATMENT PROJECTS

Technical Memorandum

Subject:	Acoustical Analysis of the Facility Pipeline Finished Water Intertie
Project #s:	**PWB:** W02563 **Jacobs:** D3460500
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Exhibit A.65

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1.0 Introduction

This memorandum documents methods and results of an acoustical analysis conducted for the Facility Pipeline Finished Water Intertie (project). The project is located approximately 1,900 ft east of the intersection of SE Altman Rd and SE Lusted Rd, within Multnomah County and is part of a proposed new set of pipelines conveying raw water and finished water to and from a new filtration facility (the pipelines). The potential sources of noise at the project are the emergency backup generator and the valves in the subsurface vault. Other than these sources at the project, no other portion of the pipelines or associated appurtenances produce any material source of noise. This memorandum identifies applicable Multnomah County noise standards and reviews expected sound levels at sensitive receptors from operational activities associated with the project. This analysis shows the project complies with the Multnomah County noise standards.

1.1 Fundamentals of Acoustics

This section presents background material which can aid in understanding this memo. Noise is generally defined as sound that is loud, disagreeable, unexpected, or unwanted. Airborne sound results from small fluctuations of air pressure above and below atmospheric pressure as perceived by the ear. Because of the ability of the human ear to detect a wide range of sound-pressure fluctuations, sound-pressure levels are expressed in logarithmic units called decibels (dB) to avoid a very large and awkward range in numbers. The sound-pressure level in decibels is calculated by taking the log of the ratio between the actual sound pressure and the reference sound pressure (20 microPascals) squared. Because decibels are logarithmic units, ordinary arithmetic cannot be used to provide comparable sound levels. Caltrans (2015) explains "a doubling of sound energy corresponds to a 3 dB increase. In other words, when two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dB higher than one source under the same conditions. For example, if one automobile produces a sound pressure level (SPL) of 70 dB when it passes an observer, two cars passing simultaneously would not produce 140 dB—rather, they would combine to produce 73 dB."

The A-weighting network measures sound in a similar fashion to how a person perceives or hears typical environmental sounds as the A-weighting approximates the frequency response of the average young ear when listening to typical community sounds. For general environmental or community sounds (e.g., traffic), A-weighted decibels yield a strong correlation with how people perceive acceptable and unacceptable sound levels. Table 2-1 presents typical A-weighted sound levels from common activities.

Table 2-1. Typical A-weighted Sound levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	— 110 —	Rock band
Jet fly-over at 1000 feet		
	— 100 —	
Gas lawn mower at 3 feet		
	— 90 —	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	— 80 —	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	— 70 —	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	— 60 —	
		Large business office
Quiet urban daytime	— 50 —	Dishwasher next room
Quiet urban nighttime	— 40 —	Theater, large conference room (background)
Quiet suburban nighttime		
	— 30 —	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	— 20 —	
		Broadcast/recording studio
	— 10 —	
Lowest threshold of human hearing	— 0 —	Lowest threshold of human hearing

Source: Caltrans 2013.

The decrease in sound level caused by distance from any single sound source normally follows the inverse square law; that is, the sound pressure level changes in inverse proportion to the square of the distance from the sound source. In a large open area with no obstructive or reflective surfaces, it is a general rule that at distances greater than approximately the largest dimension of the noise-emitting surface, the sound pressure level from a single source of sound drops off at a rate of 6 dB with each doubling of the distance from the source. Sound energy is absorbed in the air as a function of temperature, humidity, and the frequency of the sound. This attenuation can be up to 2 dB over 1,000 feet. The drop-off rate will also vary based on terrain conditions and the presence of obstructions in the sound's propagation path. These factors are considered in the acoustical model prepared for this analysis.

All buildings provide some exterior-to-interior noise reduction even if the windows are open, when a 10 dBA reduction is expected. A typical light frame building is noted to provide an exterior-to-interior noise reduction of 20 dBA with closed sash windows or 25 dBA with closed storm windows. A masonry building with single glazed closed windows provides a reduction of 25 dBA and closed double glazed windows provides 30 dBA (FHWA 2011, cited in Caltrans 2013).

The effects of noise on people can be listed in three general categories:

- Subjective effects of annoyance, nuisance, and dissatisfaction

- Interference with activities such as speech, sleep, and learning
- Physiological effects such as startling and hearing loss

In most cases, environmental noise produces effects in the first two categories only. However, workers in industrial plants may experience noise effects in the third category. The federal Occupational Health and Safety Administration (OSHA) permissible exposure level for noise is 90 dBA for an 8-hour exposure or 105 dBA for a 1-hour exposure. No completely satisfactory way exists to measure the subjective effects of noise, or to measure the corresponding reactions of annoyance and dissatisfaction. This lack of a common standard results from the wide variation in individual thresholds of annoyance and habituation to noise.

2.0 Multnomah County Noise Regulations

The project is located in unincorporated Multnomah County. Noise limits for this area based on the time of day are established by the Sound Control Law of the Multnomah County Code (2021) (MCC). MCC 15.265. These noise limits are presented in Table 3-1. Noise sensitive units are defined as “[a]ny building or portion thereof, vehicle, boat or other structure adapted or used for the overnight accommodation of persons, including, but not limited to individual residential units, individual apartments, trailers, hospitals, and nursing homes.” MCC 15.266. The distance between the project’s operational sources of noise and the closest noise sensitive unit, the residence located to the northwest, is approximately 165 feet.

Table 3-1. Multnomah County Exterior Noise Standards

For Noise Measured at a Noise Sensitive Unit[a] at the Following Times:	Noise Limit
10 PM to 7 AM	50 dBA
7 AM to 10 PM	60 dBA

Notes:

[a] “When measured at or within the boundary of the property on which a noise sensitive unit which is not the source of the sound is located, or, within a noise sensitive unit which is not the source of the sound.”

Source: Section 15.269(A), Multnomah County Code (MCC 2021). MCC 15.269(B) applies to “sound [with] information content … such as … speech [and] musical rhythms.” The project will not produce this kind of sound.

MCC 15.270 includes the following applicable exception to the noise standards established in MCC 15.269:

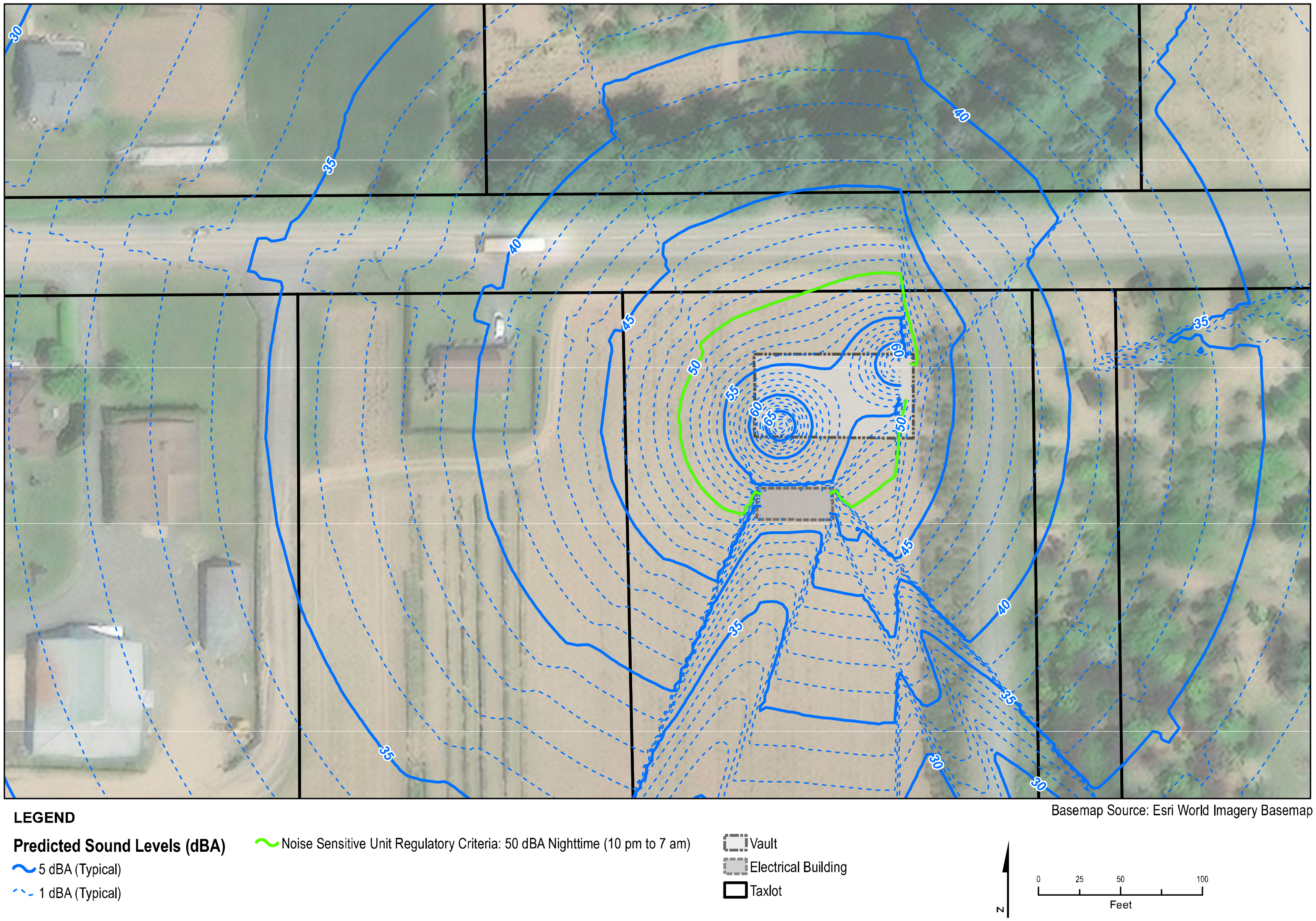
- *MCC 15.270(B): Sounds caused by emergency work, or by the ordinary and accepted use of emergency equipment, vehicles and apparatus, whether or not the work is performed by a public or private agency, upon public or private property.*

3.0 Operational Sound Levels

Sources of operational sound from the project are limited and include, most significantly, the valves which are located within an underground concrete vault. The sound level associated with these valves varies depending on the operational requirements. Vendor information indicates that each of the valves located inside the underground concrete vault does not produce sounds which exceed 85 dBA (typical threshold for hearing protection) and can be less than 65 dBA (typical sound level of a normal conversation). There are two openings in the top of the vault, one is a vent for a small fresh air supply fan (approximately 3 horsepower) and the other is a relief vent. These are sized approximately 10 square feet and 30 square feet, respectively. These openings provide a pathway for sound from within the concrete vault to be transmitted to outside. To reduce the sound transmission, silencers will be added to these openings to reduce the level of sound transmitted to the outside.

Standard acoustical engineering methods were used to predict operational sound levels for the project. The acoustical model, CADNA/A by DataKustik GmbH of Munich, Germany, is a sophisticated tool that enables one to fully model complex facilities. The sound propagation factors used in the model have been adopted from International Organization for Standardization (ISO) 9613-2 *Acoustics—Sound Attenuation During Propagation Outdoors*. Atmospheric absorption was estimated for conditions of 10 degrees Celsius and 70 percent relative humidity (conditions that favor propagation) and computed in accordance with ISO 9613-1. The model divides the proposed facility into a list of individual sound sources representing each piece of sound-emitting equipment. The equipment sound levels representing the standard performance of each project component are assigned based on data supplied by manufacturers or information found in the technical literature. Using these sound levels as a basis, the model calculates the sound pressure level that would occur at each receptor from each source after losses from distance, air absorption, and other factors are considered. The sum of all these individual levels is the total facility level at the modeling point.

The ISO 9613-2 method is based on an omnidirectional downwind condition. That is, the sound prediction algorithms assume every point at which sound level is calculated is downwind of all sound-emitting equipment simultaneously. In essence, the prediction assumes each receiver or prediction point is a "black hole" and the wind is blowing from each source and into this black hole. While this is physically impossible, it presents a conservative analysis model, and the ISO 9613-2 model has been widely and successfully used to develop acoustical models for complex facilities. Numerous agencies and regulatory bodies rely on ISO 9613-2 modeling. The ISO 9613-2 parameters used in this assessment are a receptor height of 2 meters and conservatively hard ground (G = 0, where G may vary between 0 for hard pavement or water and 1 for acoustically absorptive ground such as plowed earth). An acoustical model was developed to assess the sound level from all equipment associated with the project operations to determine the sound level at the closest noise sensitive unit (as noted above). These results are depicted in Figure 3-1. The analysis shows that project operations will be less than the nighttime limit of 50 dBA at the closest noise sensitive unit (a residential property).



Exterior noise standards (per § 15.269(A))

Noise Sensitive Unit Noise Standard:

60 dBA Daytime (7 am to 10 pm)

50 dBA Nighttime (10 pm to 7 am)

Figure 3-1
Predicted Valve Operation Sound Levels
Bull Run Finished Pipelines

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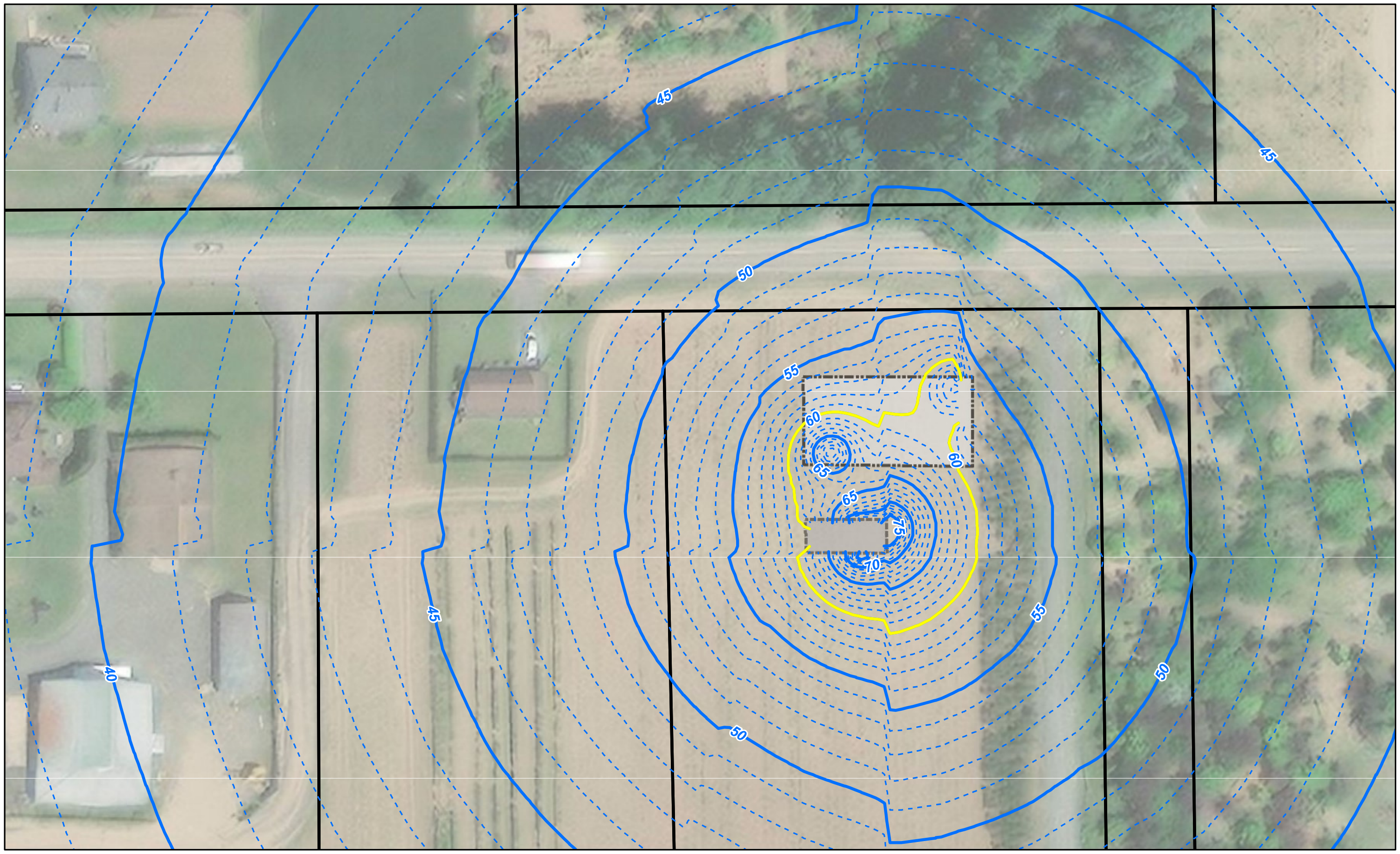
4.0 Emergency Equipment Sound Levels

A stand-by diesel generator is included in the project and would be available in the event of a utility outage emergency. The generator is located within a concrete block building separate from and south of the vault. The generator will be infrequently operated during the day, for short durations, to assure continued proper operability. This testing would occur during the daytime consistent with maintenance and reliability needs, typically 4-hours a month. The generator's exhaust pipe will include a muffler and the air inlets and air outlets of the building will include acoustical silencers to ensure sound attenuation during generator testing complying with the County's noise code during testing. An acoustical model was developed to assess the sound level of the project operations with the emergency generator operating to determine the sound level at the closest noise sensitive unit (noted above). These results are depicted in Figure 4-1. The analysis shows that the infrequent testing of the generator combined with the operations of the project will be less than the daytime limit of 60 dBA at the closest noise sensitive unit (a residential property). Therefore, as testing of the generator will only occur during the daytime, the project will comply with Multnomah County noise requirements while the generator is tested.



Basemap Source: Esri World Imagery Basemap

Exterior noise standards (per § 15.269(A))

Noise Sensitive Unit Noise Standard:

60 dBA Daytime (7 am to 10 pm)

50 dBA Nighttime (10 pm to 7 am)

Exemptions (per § 15.270):

Section 15.270(B): Sounds caused by emergency work, or by the ordinary and accepted use of emergency equipment, vehicles and apparatus, whether or not the work is performed by a public or private agency, upon public or

LEGEND

Predicted Sound Levels (dBA)

5 dBA (Typical)

1 dBA (Typical)

Noise Sensitive Unit Regulatory Criteria: 60 dBA Daytime (7 am to 10 pm)

Vault

Electrical Building

Taxlot

N

0 25 50 100

Feet

Figure 4-1
Predicted Operational Sound Levels
During Generator Testing
Bull Run Finished Pipelines

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5.0 Conclusions

This analysis shows the project complies with the Multnomah County noise standards. Operation of the valves in the subsurface vault will comply with the applicable requirements during both the day and nighttime hours with the proposed systems installed.

It is noted that noise associated with the use of the generator during emergency times is exempt from the noise standard per MCC 15.270(B). Nonetheless, evaluation of the current design shows that compliance during infrequent, daytime testing is achieved with silenced air inlets and outlets as well as an exhaust muffler, each of which are a part of the project design. Therefore, the project will also comply with Multnomah County noise standards while the generator is tested.

6.0 References

California Department of Transportation. 2013. Transportation and Construction Vibration Guidance Manual.

California Department of Transportation. 2015. Annotated Noise Study Report (NSR). Noise Report Template. April.

Multnomah County. 2022. Multnomah County Code, Oregon. Updated with ordinances through May 20, 2022.