

January 9, 2012

ENVIRON Project No: 29-27143B

MEMORANDUM

To: Brett Teel, Brown and Caldwell
cc: Joel Komarek, City of Lake Oswego

From: Kristen Wallace, ENVIRON

Project Name: Lake Oswego/Tigard Water Partnership (LOTWP)

Subject: Noise Study - Lake Oswego/Tigard Water Treatment Plant

This memorandum presents the results of our noise study for the proposed Lake Oswego/Tigard Water Treatment Plant (WTP).

Project Description

The existing plant is located in West Linn, Oregon on Kenthorpe Way, approximately a quarter mile east of Highway 43. It was originally built in 1968 but has undergone a number of upgrades since then to improve its performance. The current project will upgrade the capacity of the plant from 16 to 38 million gallons per day.

The existing and proposed WTP layouts are illustrated in **Figure 1** and **Figure 2**, respectively.



Figure 1. Existing Lake Oswego WTP Layout



Figure 2. Proposed Lake Oswego/Tigard WTP Layout

The Owner provided information about the existing plant facilities and the proposed facilities as follows.

The existing WTP is operated to accommodate water usage demands. The plant is operated up to 24 hours per day when demands are high and for lesser time periods when demands are lower. Operations are generally quiet. Most noise producing equipment is housed inside buildings. There are some infrequent operations at the existing WTP that generate noise as noted below.

1. Operation of the lime storage and feed system for short periods when started and during testing
2. Periodic use of a front-end loader and dump trucks for solids drying and disposal activities
3. Testing of a small backup power generator located outside
4. Intermittent operation of roof mounted fans on the existing high service pump station
5. Automatic and periodic operation of the CO₂ storage tank compressor
6. Chemical delivery and garbage pickup service trucks include on-board mechanical equipment that generates noise while on site.

Operations 1 and 2 will not be needed for the new WTP. Operation 3 will be addressed by locating a new small generator inside a building. Operation 4 will be moved to the new finished water pump station, which will be designed with noise attenuation features. Operation 5 will be relocated to the center of the new plant facilities. Operation 6 will continue at the new WTP with provisions to avoid noise generation, as discussed later.

Similar to the existing WTP, the new WTP will be operated to accommodate water usage demands and may operate up to 24 hours per day when demands are high and for lesser time periods when demands are lower. The WTP is being designed at this time. Most noise generating equipment will be housed inside buildings with some minor equipment located outdoors. The facility will be designed to comply with applicable noise limits, and a post construction noise survey will be conducted and submitted to confirm the noise limits are met.

The Owner advised that West Linn representatives asked for this noise study to include noise measurements taken at a water treatment plant similar in nature to the proposed new WTP. The task was included in the scope of this study, and noise measurements of the Willamette River Water Treatment Plant in Wilsonville, Oregon were taken. The Willamette River Water Treatment Plant uses the same treatment processes proposed for the new WTP.

Applicable Noise Limits

The Lake Oswego/Tigard WTP is located in the city of West Linn, Oregon. Chapter 5.487 of West Linn's municipal code (WLMC 5.487) defines noises that are considered a nuisance, such as noise from dogs and amplified music. Although the City of West Linn identified quantitative noise limits in Chapter 55.100 of the Community Development Code, these quantitative standards were repealed by Ordinance No. 1604 on September 26, 2011. Therefore, the quantitative noise standards established by the Department of Environmental Quality (DEQ) in the Oregon Administrative Rules (OAR 340-035) apply to this project.

OAR 340-035-0035 regulates noise from commercial and industrial land uses near noise sensitive receivers. The applicable noise limits are shown in **Table 1**.

Table 1. Oregon Industrial and Commercial Noise Source Standards

Statistical Level	Allowable Statistical Noise Levels in Any One Hour	
	Daytime 7 AM - 10 PM	Nighttime 10 PM - 7 AM
L50	55	50
L10	60	55
L1	75	60
Source: OAR 340-035-035 The L50, L10, and L1 statistical noise descriptors are the sound levels exceeded 50%, 10%, and 1% of any 1-hour period, respectively.		

In addition to the noise source standards identified in **Table 1**, OAR 340-35-035 specifies that

1. New noise sources located on previously unused sites should not increase the ambient L10 or L50 noise levels by more than 10 dBA in any one hour at a noise sensitive receiver.

2. Impulse sounds not related to blasting will be limited to a 100 dB peak response between 7 AM and 10 PM and an 80 dB peak response between 10 PM and 7 AM.
3. Octave band noise levels will be limited by the standards identified in **Table 2**.

Table 2. Octave Band Standards for Industrial and Commercial Noise Sources

Octave Band Center Frequency (Hz)	Daytime 7 AM - 10 PM	Nighttime 10 PM - 7 AM
31.5	68	65
63	65	62
125	61	56
250	55	50
500	52	46
1000	49	43
2000	46	40
4000	43	37
8000	40	34
Source: OAR 340-035-035		

It should be noted that although West Linn repealed their quantitative noise standards, the DEQ noise standards identified above are identical to West Linn's old noise standards except for the ambient degradation rule. West Linn limited the increase over ambient levels to 5 dBA while Oregon limits the increase to 10 dBA. However, because the LOTWTP site is not currently vacant or unused, this portion of Oregon's code is not applicable.

Noise from traffic on public roads and construction activities is exempt from the Oregon noise regulations (per OAR 340-035-0035(5)). However, West Linn's nuisance code restricts construction to the periods between 7 AM to 7 PM Monday through Friday and 9 AM to 5 PM weekends and holidays (WLMC 5.487.B.4).

Sound Level Measurements

Existing Lake Oswego WTP

ENVIRON measured sounds from the existing Lake Oswego WTP over a 24-hour period starting at 5 PM November 1, 2011. ENVIRON selected five measurement locations around the plant representing proximate residential properties.

For these measurements, ENVIRON used microphones placed approximately 5 feet above ground elevation encased in acoustically neutral weather heads. The sound level meters were manufacturer-certified Type I Larson Davis 820s that were calibrated immediately prior to and following the measurements. Although the meters were unattended for the majority of the measurements, noise sources were noted during the setup and retrieval of the meters.

The measurements captured the L50, L10, and L1 noise descriptors for each hour of measurement, as described above in the discussion of the State noise limits. Results of the sound level measurements (SLMs) are discussed later in this report.

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Over the 24-hour measurement period (from 5 PM November 1 to 5 PM November 2), activity levels at the treatment plant varied as follows:

- Typical Operation - The treatment plant operated in a typical manner from 5 PM to 10 PM on November 1 and from 1 PM to 5 PM on November 2.
- No Operation - The plant did not operate between 10 PM November 1 and 9 AM November 2.
- Staged Intermittent Activities - Intermittent noise generating activities were intentionally staged between 9 AM and 1 PM on November 2nd. The activities included sludge pond cleaning and stockpiling, operation and testing of the lime facilities, air conditioner operation at the CO₂ storage tank, use of high service exhaust fans on the finish water pump building, a chemical delivery off-loading, and testing of the small backup power generator.

The sound level measurement (SLM) locations and intermittent operation locations are shown in **Figure 3**.



Figure 3. SLM and WTP Equipment/Activity Locations

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Willamette River WTP

As part of this study, ENVIRON also measured sound levels near the Willamette River Water Treatment Plant (WRWTP) in Wilsonville, Oregon to try and characterize typical continuous operational sound levels of a plant expected to have equipment similar to that proposed for the updated Lake Oswego/Tigard WTP. The measurement locations are displayed in **Figure 4**.

Similar to the Lake Oswego WTP measurements, ENVIRON used microphones placed approximately 5 feet above ground elevation encased in acoustically neutral weather heads. The sound level meters were manufacturer-certified Type I Larson Davis 820s that were calibrated immediately prior to and following the measurements. Although the meters were unattended for the majority of the measurements, noise sources were noted during the setup and retrieval of the meters. Results of the sound level measurements (SLMs) are discussed later in this report.



Figure 4. SLM Locations near Willamette River Water Treatment Plant

Noise Measurement/Investigation Results

Existing Lake Oswego WTP

Long-Term Hourly Sound Level Measurements

The sound levels measured during the various operational and non-operational periods, including those hours with simulated on-site activities, are presented in the measurement summary in **Table 3**. Detailed measurement data are included in **Attachment A**. Discussions of the measured hourly levels at each of the five SLM locations are provided in more detail below the table.

Table 3. Lake Oswego WTP, Measured Existing Hourly Sound Levels (dBA)

Location	Period	L1	L10	L50
SLM1	Daytime - No Operations	56-60	48-50	45-46
	Nighttime - No Operations	43-53	41-47	38-45
	Typical Daytime Operations	52-59	47-54	43-48
	Staged Noisy Activities - 9AM to 1PM	57-65	53-64	43-63
SLM2	Daytime - No Operations	52	47	45-46
	Nighttime - No Operations	44-52	42-47	40-46
	Typical Operations	49-61	47-53	46-52
	Staged Noisy Activities - 9AM to 1PM	54-62	53-60	46-53
SLM3	Daytime - No Operations	52-63	46-48	45
	Nighttime - No Operations	43-51	41-46	39-44
	Typical Operations	48-57	46-49	45-48
	Staged Noisy Activities - 9AM to 1PM	49-72	47-63	46-52
SLM4	Daytime - No Operations	58-63	48-56	44-46
	Nighttime - No Operations	42-55	40-46	38-44
	Typical Operations	54-60	45-51	42-48
	Staged Noisy Activities - 9AM to 1PM	57-63	45-56	43-46
SLM5	Daytime - No Operations	50	45-46	43
	Nighttime - No Operations	41-50	39-44	37-43
	Typical Operations	48-55	45-52	42-47
	Staged Noisy Activities - 9AM to 1PM	52-59	51-52	41-50
OR Limits	Daytime	75	60	55
	Nighttime	60	55	50
<p>Red text identifies levels that would not comply with Oregon's nighttime noise limits, applicable between 10 PM and 7 AM. However, these levels all occurred during daytime operations, so the nighttime limits did not specifically apply.</p> <p>Grey shaded cells identify measured levels that did not comply with Oregon's daytime noise limits, applicable between 7 AM and 10 PM.</p>				

The existing Lake Oswego WTP normally operates during daytime hours, with 24-hour operation occasionally required during high demand periods. At some point in the future, the upgraded Lake Oswego/Tigard WTP will need to operate 24 hours per day as normal operation to meet increasing water demands. In this case, the upgraded Lake Oswego/Tigard WTP must meet nighttime noise limits. To estimate whether the upgraded plant will meet these limits, current noise generation at the existing plant was compared to nighttime noise limits.

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SLM1

At SLM1, measured sound levels during typical daytime operations complied with the daytime and nighttime noise limits. The measured levels of typical operations were also similar to/within the same range as the measured daytime sound levels with no operations (between 7 and 9 AM).

Sound levels during the simulated loader operations between 9 and 10 AM (removing sludge from the sludge ponds and transporting it over 400 feet to the sludge stockpile) complied with daytime noise limits. This activity occurs only during daytime hours.

Measured sound levels between 10 and 11 AM, during which the lime silo vibratory system, the lime building blower, and high service pumps and fans operated, and during which some chemical unloading occurred, indicate the daytime 60-dBA noise limit for the hourly L10 was exceeded. Review of the measured data suggests that the level in excess of the limit was due to the chemical unloading, which occurred for approximately 15 minutes of the hour between 10 and 11 AM. The other sources appear to have complied with the noise limits at SLM1.

The measured sound levels between 11 AM and noon were dominated by the chemical unloading, which occurred from approximately 10:45 to 11:45 AM. Although the CO₂ tank compressor was operated during this hour, it did not influence the measured sound levels at SLM1. Due to chemical unloading operations, both the daytime L50 limit of 55 dBA and the L10 limit of 60 dBA were exceeded during this hour. Chemical unloading only occurs during daytime hours.

Measured sound levels between noon and 1 PM were influenced by operation of the emergency generator. The generator is only used during emergency power outages but must be exercised/tested approximately once per month. The testing is conducted only during daytime hours and typically lasts less than an hour. Measured levels at SLM1 during the generator exercise complied with the applicable daytime noise limits. The measured levels of generator noise during the test indicate the levels would not comply with the nighttime noise limits at SLM1, but emergency operation of the generator during a power outage would be exempt from the daytime and nighttime noise limits.

SLM2

At SLM2, measured sound levels during typical daytime operations complied with the daytime noise limits. If the plant were operated at night (i.e., between 10 PM and 7 AM), the highest measured L50 level of 52 dBA would not comply with the nighttime limit of 50 dBA. It should be noted that the measured L50 level of 52 dBA occurred between 1 and 3 PM and was not characteristic of the L50 sound levels during the other hours of "typical" operation, when it varied between 46 and 48 dBA. These data suggest that some equipment was inadvertently left on after the staged operations of intermittent sources. Given the characteristics and timing of the measured sound levels, it is possible that a pump or fan or the CO₂ tank compressor were turned on during the staged source tests and left on until sometime between 2:30 and 3 PM, and that this atypical source resulted in the elevated levels. Although the measured levels exceeded the nighttime limits at the SLM2, the additional 20 feet to the property northeast of the site would result in a level of 50 dBA due to the fans/pumps. Therefore, during typical operations the noise levels are expected to comply with both the daytime and nighttime sound levels.

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Sound levels during simulated loader operations between 9 and 10 AM (removing sludge from the sludge ponds and transporting it over 400 feet to the sludge stockpile) complied with daytime noise limits (this activity occurs only during daytime hours).

Measured sound levels between 10 and 11 AM, during which the lime silo vibrator, the lime building blower, and high service pumps and fans operated, and during which some chemical unloading occurred, complied with the daytime limits. The L₅₀, L₁₀, and L₁ levels all exceeded the nighttime noise limits of 50, 55, and 60 dBA, respectively, so these sources should not be operated at night. The most likely suspects for the noncompliance are the lime building blower and the high service pumps/fans.

The measured sound levels between 11 AM and noon included chemical unloading and operation of the CO₂ tank compressor. The measured levels complied with the daytime noise limits, but the measured L₅₀ of 53 dBA exceeded the nighttime limit of 50 dBA. As such, to stay within the nighttime noise limits, chemical delivery should be limited to daytime periods and CO₂ tank compressor operation should be curtailed to daytime operation or otherwise be modified to meet nighttime noise limits. Note: Per information provided by the Owner, the CO₂ tank will be relocated as part of the new WTP.

The measurement period between noon and 1 PM included operation of the emergency generator. However, the measured sound levels between noon and 1 PM (with the generator) and between 1 and 2 PM (without the generator) were very similar. These data indicate that operation of the generator did not affect the measured levels at SLM2.

SLM3

At SLM3, measured sound levels during typical daytime operations complied with the daytime and nighttime noise limits.

The measured L₁₀ sound level of 63 dBA during the simulated sludge pond cleaning activities between 9 and 10 AM exceeded the daytime limit of 60 dBA. The measured L₅₀ and L₁ levels complied with the daytime limits of 55 and 75 dBA, respectively. This activity is restricted to daytime hours. Note: Per information provided by the Owner, the new WTP will incorporate a replacement process for this activity housed inside a new building.

Measured sound levels between 10 and 11 AM, during which the lime silo vibrator, the lime building blower, and high service pumps and fans operated, and during which some chemical unloading occurred, indicate that the daytime noise limit of 60 dBA for the L₁₀ was exceeded (the measured level was 61 dBA). Review of the measured source data suggests the elevated level was due to the lime building blower, which was operated for approximately 15 minutes of the hour between 10 and 11 AM. The other sources appear to have complied with the noise limits at SLM3.

The measured sound levels between 11 AM and 1 PM, during which chemical unloading, operation of the CO₂ tank compressor, and testing of the emergency generator occurred, all complied with both the daytime and nighttime noise limits.

SLM4

At SLM4, measured sound levels during typical daytime operations complied with the daytime and nighttime noise limits.

The measured levels during the simulated sludge pond cleaning activities between 9 and 10 AM complied with the daytime noise limits. This activity is restricted to daytime hours.

Measured sound levels between 10 AM and 1 PM during all other staged intermittent noisier activities complied with both the daytime and stricter nighttime noise limits.

SLM5

At SLM5, the measured sound levels during both typical daytime operations and during simulated noisier operations all complied with the daytime and nighttime noise limits.

Measured sound levels between 9 AM and 1 PM during all staged intermittent noisier activities complied with both the daytime and stricter nighttime noise limits.

Short-term Measurements of Intermittent Sources

In addition to the hourly measurements, ENVIRON took short-term sound level measurements during each of the staged intermittent activities to help characterize the noise from these sources/activities. A summary of the measured levels of individual, staged, intermittent activities is provided in **Table 4**.

Table 4. Intermittent Activity Sound Levels (L50, dBA)

Activity	Level at 50 feet
Sludge Handling	58-64 (depending on location and operating parameters)
Lime Silo Vibratory System	53
Lime Building Blower	73
High Service Pumps/Fans	56
Chemical Unloading	80-84 (directional)
CO ₂ Tank Compressor	61
Emergency Generator	72-78 (directional)

Willamette River WTP

The hourly sound levels measured near the WRWTP are summarized in **Table 5**. Detailed measurement data are included in **Attachment B**.

Sound level measurements taken near the WRWTP identified L50 levels ranging from the mid 40s to low 50s dBA. Unlike the levels nearest the Lake Oswego WTP, the measured levels near the WRWTP were dominated by a water feature on the west side of the plant and a gravel pit on the east side. Noise from plant equipment and operations were identified only as secondary sources during visits to the site. Regardless, the measured sound levels (including both plant noise and water feature/gravel pit noise) easily complied with the daytime noise limit of 55 dBA at each of the measurement locations.

The measured sound levels during several hours of daytime operation at each measurement location exceeded 50 dBA, which would exceed the nighttime noise limit if they were to occur between 10 PM and 7 AM. Unfortunately, the measurements were not staffed except during setup

and retrieval of the equipment, and the primary noise sources during these hours of elevated noise were not noted. While it is likely that noise from the WRWTP alone (without influence of the water feature or gravel pit) would comply with the nighttime noise limits, it is not possible to reach a definitive conclusion regarding nighttime compliance based on the available measurement data.

Table 5. Willamette WTP, Measured Hourly Sound Levels (dBA)

Location	Period	L1	L10	L50	Dominant Source
NW	Daytime	52- 63	50- 57	49- 52	Water Feature (24-hours)
	Nighttime	51-55	49-53	48- 51	
SW	Daytime	53- 63	50- 58	48- 53	Water Feature (24-hours)
	Nighttime	50-56	48-53	46- 51	
NE	Daytime	49- 63	46- 61	44-50	Gravel Pit (when in operation)
	Nighttime	48-55	45-50	43-48	
SE	Daytime	50- 66	48- 59	46- 52	Gravel Pit (when in operation)
	Nighttime	51-56	47-53	44-50	
OR Limits	Daytime	75	60	55	
	Nighttime	60	55	50	
<p>Red text identifies levels that would not comply with the nighttime noise limits, applicable between 10 PM and 7 AM.</p> <p>Grey shaded cells identify measured levels that did not comply with the daytime noise limits, applicable between 7 AM and 10 PM.</p>					

Upgraded WTP Sound Levels and Design Considerations

The existing Lake Oswego WTP normally operates during daytime hours, with 24-hour operation occasionally required during high water demand periods. At some point in the future, the upgraded Lake Oswego/Tigard WTP will need to operate 24 hours per day as normal operation to meet increasing water demands. In this case, the upgraded Lake Oswego/Tigard WTP must meet nighttime noise limits. To estimate whether the upgraded plant will meet these limits, current noise generation at the existing Lake Oswego WTP and the WRWTP were compared to nighttime noise limits.

For the remainder of this report, the noise descriptor used for comparison to the standards is the L50. The L50 is a better descriptor for ongoing noise sources than the L10 or L1 and is typically the most difficult standard to meet. In addition, this analysis does not consider impulse noise using peak response, since impulse noises are not typically produced by treatment plant equipment or activities.

Typical Continuous Operations

The sound level measurements of typical daytime operations at the existing Lake Oswego WTP identified L50 levels ranging from the mid to high 40s dBA at most locations around the plant (**Table 3**). These levels are well below the applicable 55 dBA daytime noise limit and would also comply with the nighttime noise limit of 50 dBA, if the plant operated between 10 PM and 7 AM.

Similarly, sound level measurements taken near the WRWTP identified L50 levels ranging from the mid 40s to low 50s dBA (**Table 5**). Unlike the levels nearest the Lake Oswego WTP, the measured levels near the WRWTP were dominated by a water feature on the west side of the plant and a

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gravel pit on the east side. Noise from plant equipment and operations were identified only as secondary sources during visits to the site. Regardless, the measured sound levels (including both plant noise and water feature/gravel pit noise) easily complied with the daytime noise limit of 55 dBA at each of the measurement locations.

Because the sound levels of typical operations at the existing Lake Oswego WTP and WRWTP easily complied with the daytime noise limits at nearby locations, it is expected that the sound levels of typical operations at the updated Lake Oswego/Tigard WTP also would comply with the daytime noise limit of 55 dBA (L50).

Neither the Lake Oswego WTP nor the WRWTP operated at night during our sound level measurements. Therefore, we compared the sound levels measured during daytime operations to the nighttime noise limits to assess potential future compliance with nighttime noise limits. As indicated above, the measured sound levels of typical operations at the Lake Oswego WTP would comply with the nighttime noise limit of 50 dBA. However, near the WRWTP, the measured sound levels during several hours of operation at each measurement location exceeded 50 dBA, which would exceed the nighttime noise limit if they occurred between 10 PM and 7 AM. Unfortunately, the dominant noise sources during these hours of elevated noise were not noted, and while it is likely that noise from the WRWTP alone (without influence of the water feature or gravel pit) would comply with the nighttime noise limits, it is not possible to reach a definitive conclusion regarding nighttime compliance based on the available measurement data.

Therefore, during final design of the updated Lake Oswego/Tigard WTP, careful consideration should be given to minimizing noise from the treatment plant using some or all of the following noise mitigation techniques and practices:

- Installation of noisy equipment indoors, when feasible
- Use of appropriate noise attenuation features on buildings, including acoustical louvers on air intakes/outlets and silencers on exhaust stacks
- For equipment installed outside, use of appropriate noise attenuation features such as acoustical enclosures or barriers, pipe lagging around noisy pipes or ducts, etc.
- Selection of quieted equipment, particularly for HVAC systems

The above considerations and others will need to be incorporated into the design of the upgraded WTP facilities. With careful design and implementation of noise mitigation measures, noise levels from typical, ongoing plant operations are expected to comply with the nighttime noise limits.

Intermittent Noisy Activities/Operations

In addition to typical continuous operations, ENVIRON considered potential future sound levels associated with the intermittent on-site operations described previously. The sludge pond operations, lime silo vibratory system, and lime building blower are not expected to be required with the proposed updated Lake Oswego/Tigard WTP, so these intermittent sources were not considered further. Similarly, the existing emergency backup generator will be replaced by a smaller backup generator that will be installed indoors, and noise from this generator is not anticipated to be an issue. Finally, the existing high service pump station and roof mounted fans and the CO₂ storage tank and associated compressor will be replaced and relocated, respectively, with appropriate noise attenuation features incorporated into these plant modifications. Therefore, the only remaining

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intermittent operations of concern that will persist for the new WTP is truck mounted equipment associated with periodic chemical delivery unloading and weekly garbage pickup.

Noise from chemical unloading activities, if conducted similarly to existing operations, could greatly exceed the daytime noise limit of 55 dBA at the nearest property boundaries. However, use of "plant air" (i.e., compressors installed inside a plant building) in lieu of truck-mounted compressors to provide the air needed to transfer the materials would likely eliminate much of the noise associated with chemical unloading and allow this activity to meet the daytime noise limits at all property boundaries. Chemical unloading is restricted to daytime hours only.

Given the above, the design considerations for intermittent noisy activities should include the following:

- Installation of backup generator indoors
- Use of "plant" air for chemical unloading operations

Conclusions/Recommendations

Sound levels measured during typical continuous operations at the existing Lake Oswego WTP complied with both the daytime and nighttime noise limits. Similarly, measured sound levels near the WRWTP easily complied with the daytime noise limit of 55 dBA (L50) at each of the measurement locations. Therefore, it is expected that the upgraded Lake Oswego/Tigard WTP will comply with all daytime noise limits. However, the measured sound levels of the existing Lake Oswego WTP and the WRWTP do not enable a definitive conclusion that noise from continuous, typical operations at the updated Lake Oswego/Tigard WTP would comply with the nighttime noise limit of 50 dBA. Therefore, design of the updated Lake Oswego/Tigard WTP should include consideration of noise attenuation measures for all exterior equipment/activities and for any air intake or outlet louvers or exhaust louvers/stacks.

With the proposed updated Lake Oswego/Tigard WTP, most of the existing exterior noise-producing intermittent activities will be eliminated or are expected to be far enough from neighboring properties to comply with both the daytime and nighttime noise limits.

This noise study considers noise levels associated with the existing Lake Oswego WTP and the existing Willamette River WTP. Appropriate noise mitigation features need to be considered during the design of the new Lake Oswego/Tigard WTP facilities. A post construction noise survey is typically provided to verify that noise limits have been satisfied. ENVIRON is available to perform post construction noise survey confirmations.

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ATTACHMENT A

24-Hour Sound Level Measurement Details

Lake Oswego Water Treatment Plant

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SLM1						
Date	Time	Leq	L1	L10	L50	L90
1-Nov	17:00:00	49.4	58.7	51.8	47.2	45.6
1-Nov	18:00:00	49.2	56.9	49.6	48.2	47.1
1-Nov	19:00:00	48.3	55.3	49.2	47.4	46.3
1-Nov	20:00:00	48.1	56.7	48.7	46.6	45.1
1-Nov	21:00:00	46.3	51.7	47.7	45.6	43.9
1-Nov	22:00:00	44.4	48.3	46	43.9	42.2
1-Nov	23:00:00	44.3	52	45.7	42.8	41.2
2-Nov	0:00:00	41.4	46	43	40.8	38.9
2-Nov	1:00:00	39.2	42.7	40.9	39	37.2
2-Nov	2:00:00	40.9	49.9	41.4	38.4	36.3
2-Nov	3:00:00	41.5	48.4	43.1	40.1	38
2-Nov	4:00:00	41.9	48.2	43	40.8	39
2-Nov	5:00:00	44.1	47.4	45.4	43.8	41.7
2-Nov	6:00:00	45.8	52.6	46.9	45.2	43.2
2-Nov	7:00:00	47	56	47.5	45.3	44.1
2-Nov	8:00:00	49.2	59.7	50.2	45.8	44.4
2-Nov	9:00:00	51.7	62.9	53	43.9	39.6
2-Nov	10:00:00	59.1	64.8	63.8	42.7	40.4
2-Nov	11:00:00	61.9	65	64	63.2	47.9
2-Nov	12:00:00	51.9	57	53.6	52.2	45.6
2-Nov	13:00:00	50.5	57.1	53.6	45.4	41.7
2-Nov	14:00:00	45.2	55.2	46.5	43	40.3
2-Nov	15:00:00	47.1	56.9	48.1	45.4	43.8
2-Nov	16:00:00	49.2	58.5	49.4	47.7	46.2
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

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SLM2						
Date	Time	Leq	L1	L10	L50	L90
1-Nov	17:00:00	48.6	57.7	49.3	46.9	45.4
1-Nov	18:00:00	48.5	53.4	48.9	47.9	47.1
1-Nov	19:00:00	48	54.4	49	47.4	46.3
1-Nov	20:00:00	48	55.2	48.6	47	45.7
1-Nov	21:00:00	46.1	49.1	47	45.9	45.1
1-Nov	22:00:00	44.6	48	45.9	44.2	42.6
1-Nov	23:00:00	44.4	51.3	45.7	43.4	42.2
2-Nov	0:00:00	41.9	45	43.2	41.8	40.5
2-Nov	1:00:00	40.9	43.5	42	40.6	39.5
2-Nov	2:00:00	41.7	49.6	42.5	40.3	39.2
2-Nov	3:00:00	42.1	47.9	43.3	41.3	40
2-Nov	4:00:00	42	45.4	43.5	41.7	40.3
2-Nov	5:00:00	44	46	45.3	43.9	42.4
2-Nov	6:00:00	46.1	51.6	47.3	45.6	43.7
2-Nov	7:00:00	46.2	51.9	46.9	45.6	44.5
2-Nov	8:00:00	46	51.9	46.9	45.4	44.3
2-Nov	9:00:00	51.9	61.9	53.4	45.9	41.8
2-Nov	10:00:00	55.3	60.7	59.5	51.4	48.2
2-Nov	11:00:00	53.4	56	54.9	52.9	51.4
2-Nov	12:00:00	52.5	54.3	53	52.4	51.4
2-Nov	13:00:00	52.4	54.8	53	52.4	51.4
2-Nov	14:00:00	51	53.8	52.7	51.5	46
2-Nov	15:00:00	50.7	61.3	52.1	47.2	45.4
2-Nov	16:00:00	49.3	56.8	50	48.3	47.2
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

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SLM3						
Date	Time	Leq	L1	L10	L50	L90
1-Nov	17:00:00	48.1	56.8	48.7	47	45.5
1-Nov	18:00:00	48.1	52.2	48.7	47.5	46.3
1-Nov	19:00:00	46.9	52.8	47.8	46.3	45.2
1-Nov	20:00:00	47.2	55.7	47.9	45.8	44.3
1-Nov	21:00:00	44.9	48	46.2	44.7	43.3
1-Nov	22:00:00	43.1	46.9	44.7	42.7	41.2
1-Nov	23:00:00	43.4	50.3	45.1	42.4	40.6
2-Nov	0:00:00	40.7	44.3	42.5	40.5	38.7
2-Nov	1:00:00	39.3	42.7	40.8	39	37.5
2-Nov	2:00:00	40	48.5	40.9	38.5	37.1
2-Nov	3:00:00	41.1	46.9	42.4	40.1	38.3
2-Nov	4:00:00	42.2	45.9	42.9	40.7	39.1
2-Nov	5:00:00	42.7	45	43.9	42.6	41.1
2-Nov	6:00:00	44.8	51.1	45.9	44.3	42.5
2-Nov	7:00:00	45.1	51.6	45.9	44.5	43.4
2-Nov	8:00:00	55.4	62.6	47.9	44.9	43.9
2-Nov	9:00:00	60.7	72.1	63	51.7	40.6
2-Nov	10:00:00	56.8	61.9	60.6	46.3	42.4
2-Nov	11:00:00	47.7	51.1	49	47.5	46
2-Nov	12:00:00	46.5	49.1	47.4	46.3	45.3
2-Nov	13:00:00	46.2	50.2	46.9	45.7	44.4
2-Nov	14:00:00	45.5	50.4	46.7	45.1	44
2-Nov	15:00:00	46.6	52.1	48.3	45.9	44.1
2-Nov	16:00:00	47.7	51.2	48.7	47.4	46.1
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

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SLM4						
Date	Time	Leq	L1	L10	L50	L90
1-Nov	17:00:00	49.7	60.2	51.3	46.6	45
1-Nov	18:00:00	49.6	59.6	50.7	47.2	46
1-Nov	19:00:00	47.7	56.7	48.6	46.2	44.8
1-Nov	20:00:00	47.5	57	48.3	45.5	43.8
1-Nov	21:00:00	45.9	53.8	46.6	44.5	42.8
1-Nov	22:00:00	43.9	51.2	44.8	42.7	40.9
1-Nov	23:00:00	43.4	51.9	44.8	41.9	40.1
2-Nov	0:00:00	40.8	44.7	41.9	39.8	37.9
2-Nov	1:00:00	38.4	42	40	38	36.4
2-Nov	2:00:00	39.9	49.8	40.7	37.7	35.7
2-Nov	3:00:00	40.8	47.6	42.4	39.6	37.4
2-Nov	4:00:00	42	50.1	42.5	40.1	38.2
2-Nov	5:00:00	42.6	45	43.8	42.5	40.5
2-Nov	6:00:00	45.6	55.2	46	44.1	42.2
2-Nov	7:00:00	46.9	57.7	47.6	44.1	43.1
2-Nov	8:00:00	52.4	63.4	55.6	45.6	42.7
2-Nov	9:00:00	52.1	62.9	56	46.1	38.9
2-Nov	10:00:00	47.1	59.5	46.2	43	40.4
2-Nov	11:00:00	47.3	57.4	47.9	45.4	43.9
2-Nov	12:00:00	46.3	57.4	46	43.3	42.1
2-Nov	13:00:00	45.8	57.3	45.3	42.9	40.7
2-Nov	14:00:00	47.1	58.7	48	42.4	39.3
2-Nov	15:00:00	49.5	59.9	50	44.9	42.7
2-Nov	16:00:00	49.9	59.4	51	47.6	45.8
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

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SLM5						
Date	Time	Leq	L1	L10	L50	L90
1-Nov	17:00:00	46.1	54.4	46.8	45.2	43.5
1-Nov	18:00:00	46.7	51.8	47.3	46.1	45
1-Nov	19:00:00	45.7	51.9	46.6	45	44.1
1-Nov	20:00:00	46.1	54.6	46.5	44.6	43.1
1-Nov	21:00:00	44.1	47.8	45.8	43.6	42
1-Nov	22:00:00	42.4	46	44.2	41.8	40.1
1-Nov	23:00:00	41.9	50	43.4	40.8	39.2
2-Nov	0:00:00	39.4	43.2	41	39.1	37.2
2-Nov	1:00:00	37.7	41.2	39.1	37.4	35.9
2-Nov	2:00:00	38.4	47.4	39	36.8	35.2
2-Nov	3:00:00	39.4	45.8	41	38.4	36.6
2-Nov	4:00:00	39.4	43.2	40.9	39.1	37.6
2-Nov	5:00:00	41.4	43.9	42.8	41.4	39.4
2-Nov	6:00:00	43	49	44.3	42.5	40.9
2-Nov	7:00:00	43.5	50.4	44.7	42.7	41.4
2-Nov	8:00:00	44.6	49.8	46.2	43.3	41.6
2-Nov	9:00:00	49.6	59.2	52.3	42.8	38.2
2-Nov	10:00:00	46.8	51.8	50.8	40.9	38.8
2-Nov	11:00:00	49.4	52.1	51.2	50.2	44.6
2-Nov	12:00:00	49.8	52.9	51.6	50.3	43.1
2-Nov	13:00:00	48.7	53.6	52.3	42.9	40.2
2-Nov	14:00:00	43.1	51.8	44.6	41.5	39.1
2-Nov	15:00:00	44.6	50.3	46.4	44	42.3
2-Nov	16:00:00	47.6	50.8	47.9	46.6	45
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

Sound Level Measurement Locations – Lake Oswego Water Treatment Plant



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ATTACHMENT B

24-Hour Sound Level Measurement Details

Willamette River Water Treatment Plant

NW - Northwest of Plant						
Noise environment dominated by water feature. Other sources included alarms at gravel operation and small aircraft.						
Date	Time	Leq	L1	L10	L50	L90
31-Oct	15:00:00	50.8	58.9	50.6	49.1	48.2
31-Oct	16:00:00	54	62.9	57.3	51.5	48.1
31-Oct	17:00:00	51.1	56.3	52.4	50.7	49.5
31-Oct	18:00:00	50.4	53.9	51.5	50.2	49.2
31-Oct	19:00:00	49.8	52	50.8	49.7	48.6
31-Oct	20:00:00	49.7	52.5	50.9	49.5	48.3
31-Oct	21:00:00	50.7	60.6	50.2	49.2	48.2
31-Oct	22:00:00	51.1	54.4	52.8	50.9	49.3
31-Oct	23:00:00	49.9	53.9	51.9	49.3	48.1
1-Nov	0:00:00	49.8	54.2	51.6	49.2	47.7
1-Nov	1:00:00	48.3	50.9	49.5	48	47.1
1-Nov	2:00:00	48.2	51.1	49.4	47.8	47.1
1-Nov	3:00:00	48.5	51	49.7	48.3	47.2
1-Nov	4:00:00	49.1	52	50.4	48.8	47.6
1-Nov	5:00:00	50.9	54	52.1	50.6	49.3
1-Nov	6:00:00	51.4	55.3	52.7	51.1	50
1-Nov	7:00:00	52.8	57.5	53.8	52.3	51
1-Nov	8:00:00	52.5	55.8	53.8	52.3	51.1
1-Nov	9:00:00	50.9	55.9	52.7	50.2	48.5
1-Nov	10:00:00	49.4	52.9	50	48.9	48.2
1-Nov	11:00:00	50.9	55.2	51.8	50.5	49.4
1-Nov	12:00:00	50.6	54.2	51.7	50.2	49.2
1-Nov	13:00:00	49.9	53.4	50.9	49.7	48.7
1-Nov	14:00:00	50.6	58.5	51.3	49.6	49
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

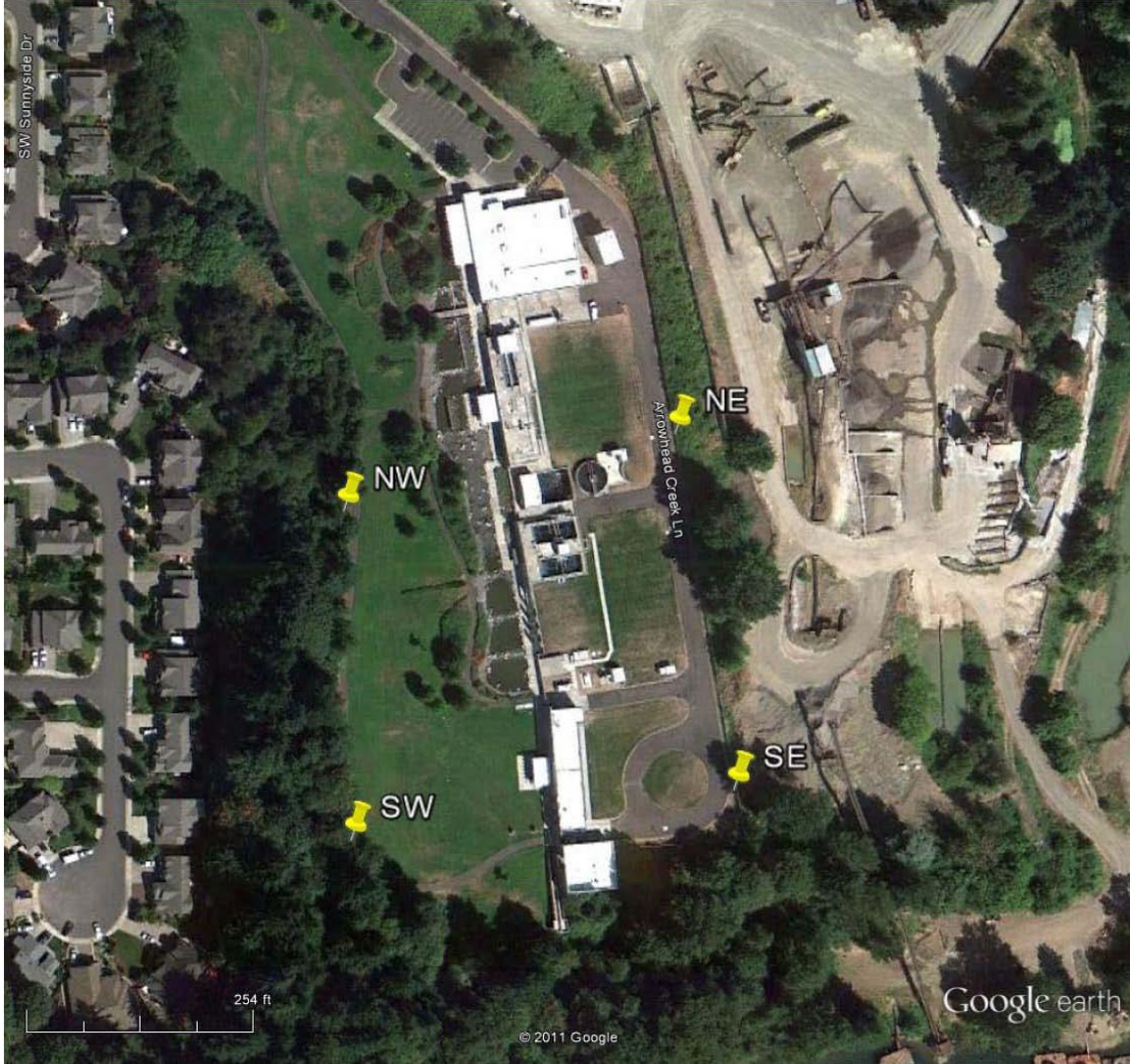
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Noise Study - Lake Oswego/Tigard Water Treatment Plant
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SW - Southwest of Plant						
Noise environment dominated by water feature, although to a lesser extent than at the NW location. Other sources included small aircraft.						
Date	Time	Leq	L1	L10	L50	L90
31-Oct	15:00:00	50.7	60.2	50.6	47.5	46.1
31-Oct	16:00:00	54.1	62.8	57.9	51.5	47.3
31-Oct	17:00:00	51.3	56	52.6	50.9	49.7
31-Oct	18:00:00	50.9	54.8	52.2	50.6	49.3
31-Oct	19:00:00	50	52.8	51.4	49.7	47.9
31-Oct	20:00:00	49.5	52.9	51.3	49.2	47.1
31-Oct	21:00:00	50.5	61.3	49.9	48.2	47.1
31-Oct	22:00:00	50.5	54.2	52.7	50	48.1
31-Oct	23:00:00	48.9	52.9	51	48.2	46.5
1-Nov	0:00:00	48.3	52.8	50.4	47.6	45.4
1-Nov	1:00:00	46.4	49.6	47.9	46.1	44.3
1-Nov	2:00:00	46.2	50.4	47.9	45.8	44.2
1-Nov	3:00:00	47.1	50.8	48.8	46.7	44.9
1-Nov	4:00:00	47.6	50.7	49	47.3	45.9
1-Nov	5:00:00	50.1	53.4	51.6	49.8	48.2
1-Nov	6:00:00	51.3	55.9	53	50.8	49.2
1-Nov	7:00:00	53.2	57.8	54.4	52.6	51.1
1-Nov	8:00:00	51.6	55	52.9	51.4	50.2
1-Nov	9:00:00	50	55.4	52.1	49.3	46.4
1-Nov	10:00:00	48.4	54.4	49.7	47.5	46.2
1-Nov	11:00:00	50.8	56.8	52.7	49.9	48
1-Nov	12:00:00	50.7	54.8	52.7	50.1	48.4
1-Nov	13:00:00	49.6	53.7	51.1	49.3	47.6
1-Nov	14:00:00	50.6	59.3	51.9	49.2	48.1
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

SE - Southeast of Plant						
Noise environment dominated by gravel operation. A slight hum is audible from the treatment plant.						
Date	Time	Leq	L1	L10	L50	L90
31-Oct	15:00:00	48.8	54.9	50.6	47	45.5
31-Oct	16:00:00	55.5	66	59.4	50.2	45.6
31-Oct	17:00:00	49.2	55.5	50	48.5	47.2
31-Oct	18:00:00	48	54	49.7	47.3	45.8
31-Oct	19:00:00	47	50.7	48.6	46.8	44.6
31-Oct	20:00:00	47	50.3	48.4	46.7	45.3
31-Oct	21:00:00	49.6	61.2	48.7	46.4	45.1
31-Oct	22:00:00	49	53	51.3	48.5	45.3
31-Oct	23:00:00	46.5	51.6	48.8	45.7	43.7
1-Nov	0:00:00	45.9	51.2	48.5	44.9	42.5
1-Nov	1:00:00	45.1	51.3	47.5	44	41.5
1-Nov	2:00:00	44.8	50.9	47.3	43.7	41.4
1-Nov	3:00:00	45.9	50.7	48.2	45.2	42.5
1-Nov	4:00:00	46.5	51	48.8	45.7	43.5
1-Nov	5:00:00	50.8	55.6	52.8	50.3	48.1
1-Nov	6:00:00	50.3	55.3	52.1	49.7	47.8
1-Nov	7:00:00	51.9	57.4	52.9	51	49.5
1-Nov	8:00:00	52.3	56	53.8	51.9	50.4
1-Nov	9:00:00	49.8	55.8	52.5	48.8	45.9
1-Nov	10:00:00	50.1	57.1	52.9	48.1	45.4
1-Nov	11:00:00	53.1	60	55.5	50.8	47.9
1-Nov	12:00:00	51.5	56.7	54.7	49.7	47.1
1-Nov	13:00:00	50.7	56.9	53	49.7	48.1
1-Nov	14:00:00	53.5	64.4	55.5	50.6	48.5
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

NE - Northeast of Plant						
Noise environment dominated by gravel operation. Low level pump noise is audible from plant.						
Date	Time	Leq	L1	L10	L50	L90
31-Oct	15:00:00	49.2	55.5	50.1	47.9	47
31-Oct	16:00:00	52.5	62.7	56.1	48.5	45.6
31-Oct	17:00:00	47.4	55.2	47.9	46.4	45.3
31-Oct	18:00:00	46.8	52.7	47.9	46.1	45.2
31-Oct	19:00:00	45.4	49.9	46.7	45.1	43.6
31-Oct	20:00:00	44.7	48.7	45.8	44.4	43.3
31-Oct	21:00:00	48.5	59.8	45.5	43.8	42.9
31-Oct	22:00:00	45.4	48.8	46.8	45	43.4
31-Oct	23:00:00	43.9	48.9	45.3	43.2	42.2
1-Nov	0:00:00	43.8	47.9	45.6	43.3	41.7
1-Nov	1:00:00	43.5	47.8	45.3	42.9	41.5
1-Nov	2:00:00	43.3	47.9	45.2	42.7	41.3
1-Nov	3:00:00	43.8	47.7	45.7	43.5	42.1
1-Nov	4:00:00	44.7	48.9	46.9	44.2	42.4
1-Nov	5:00:00	48	51.7	49.8	47.7	46
1-Nov	6:00:00	48.1	55.1	49.4	47.5	46.2
1-Nov	7:00:00	49	56	50.3	47.9	46.6
1-Nov	8:00:00	51	57.1	52.7	50.2	48.5
1-Nov	9:00:00	50	57	51.8	48.8	47.2
1-Nov	10:00:00	51.2	59.6	53.3	47.6	45.8
1-Nov	11:00:00	55.1	62.3	60.1	50.1	48.2
1-Nov	12:00:00	55.5	62.7	60.8	49.4	46.9
1-Nov	13:00:00	50.6	59.4	52.3	48.4	47.2
1-Nov	14:00:00	52.4	61.6	55.9	48.8	47.1
Noise Limit		NA	75	60	55	NA
		NA	60	55	50	NA

Sound Level Measurement Locations – Willamette River Water Treatment Plant



Google earth

