3.3 Noise

3.3.1 Sources of Information

Predictions of noise emissions associated with equipment to be used for the proposed project were based primarily on data provided by equipment vendors. Impacts from those emissions were determined by the authors. Sources of information included:

- Siemens Westinghouse, which provided sound level information on the gas turbines/gas turbine generators, the air inlet to the gas turbine, and the rotor air cooler
- Nooter/ Eriksen, which identified base sound levels and anticipated noise reduction from sources related to the heat recovery steam generator (HRSG), including the HRSG walls, the exhaust stack walls, and the exhaust stack tops
- The Brad Thompson Company, the local representative for GEA Power-Cooling Systems, Inc., which provided noise information for the air-cooled condenser and the cooling tower
- Black & Veatch, LLP, which identified transformer ratings, physical dimensions, and sound levels

3.3.2 Existing Conditions

3.3.2.1 Introduction to Sound Terminology

The human ear responds to a very wide range of sound intensities. The decibel scale used to describe sound is a logarithmic rating system that accounts for the large differences in audible sound intensities. The human perception of a doubling of loudness is reflected in the scale as an increase of 10 dBA (A-weighted decibel). Therefore, a 70 dBA sound level will sound twice as loud as a 60 dBA sound level to most individuals. People generally cannot detect differences of 1 dBA; under ideal listening conditions, differences of 2 or 3 dBA can be detected by some people. A 5 dBA change would be expected to be perceived under normal listening conditions. Typical sound levels of familiar noise sources and activities are presented in Table 3.3-1.

An indication of average sound levels is provided by a noise measurement known as the equivalent sound level (Leq). The Leq is the level of a constant sound that has the same sound energy as the actual fluctuating sound. It is important to always identify the time period being considered. Leq(24), for example, is the equivalent sound level for a 24-hour period. The day-night sound level (Ldn) is similar to the Leq(24) except that a 10 decibel "penalty" is added to sound levels, artificially raising nighttime noise sources between 10 p.m. and 7 a.m. to apply more stringent standards of compliance at that time.

Table 3.3-1: Common Sound Levels/Sources and Subjective Human Responses

Thresholds/ Noise Sources	Sound Level (dBA)	Subjective Evaluations	Possible Effects on Humans
Human threshold of pain Carrier jet takeoff (50 ft)	140		
Siren (100 ft) Loud rock band	130		
Jet takeoff (200 ft) Auto horn (3 ft)	120		
Chain saw Noisy snowmobile	110	Deafening	
Lawn mower (3 ft) Noisy motorcycle (50 ft)	100		Continuous exposure to levels above 70 can cause hearing loss in majority of population
Heavy truck (50 ft)	90	Very loud	
Pneumatic drill (50 ft) Busy urban street, daytime	80		
Normal automobile at 50 mph Vacuum cleaner (3 ft)	70	Loud	
Large air conditioning unit (20 ft) Conversation (3 ft)	60		Speech interference
Quiet residential area Light auto traffic (100 ft)	50	Moderate	
Library Quiet home	40		Sleep Interference
Soft whisper (15 ft)	30	Faint	
Slight rustling of leaves	20		
Broadcasting studio	10		
Threshold of human hearing	0	Very faint	

Note that both the subjective evaluations and the physiological responses are continual without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the individuals exposed to noise.

When addressing the effects of noise on people, it is necessary to consider the frequency response of the human ear. Therefore, monitoring instruments are designed to respond to frequencies within the response range of the human ear. The frequency-weighting most often used for this purpose is A-weighting, and measurements from instruments using this system are reported in A-weighted decibels or dBA. A-weighting has the effect of reducing measured levels of very low and very high frequencies, but has less filtering effect on the mid-range sound frequencies where speech and communication are important.

3.3.2.2 Noise Standards

When evaluating noise impacts, federal regulations limit the average sound level (e.g., Leq or Ldn), while state and local regulations limit the maximum sound level. The City of Sumas has adopted an environmental noise ordinance that essentially applies the same criteria as the Washington State regulations. These regulations establish limits on the levels and durations of noise crossing property boundaries. Allowable maximum sound levels depend on the land use zoning of the property supporting the source of the noise and the zoning of the receiving property (Table 3.3-2). For example, industrial zoned properties are allowed higher noise emissions than are residential or commercially zoned properties. Noise entering residential properties must be lower than some other land uses. Between the hours of 10 p.m. and 7 a.m., permissible noise levels are reduced by 10 dBA for receiving properties zoned residential.

Table 3.3-2: Maximum Permissible Environmental Noise Levels (dBA)

Zoning of Source	**Zoning of Receiving Property**		
	Residential	**Commercial**	**Industrial/Agricultural**
Industrial	7 a.m. to 10 p.m. – 60 10 p.m. to 7 a.m. – 50	65	70

These sound levels are maximum levels that can only be exceeded for certain periods of time: 5 dBA for no more than 15 minutes in any hour, 10 dBA for no more than 5 minutes of any hour, or 15 dBA for no more than 1.5 minutes as indicated in the City's noise ordinance. Because noise generated by the proposed plant would not vary significantly (i.e., there would not be short-term peaks), short-term exceedances were not analyzed for the project.

Traffic on public roads, aircraft, and railroad traffic are exempt from the applicable environmental noise limits. Construction activities during daytime hours are also exempt from the noise regulations.

S2GF is an industrial activity located in an industrially zoned area. The site is surrounded on all four sides by industrially zoned property. The nearest non-industrially zoned property lies south of the site and is used for farming. Agricultural land uses have the same environmental noise designation as industrial property according to the state noise regulation that pertains to Whatcom County. The nearest residentially zoned properties are located approximately 1,400 feet north of the site (north of Kneuman Road) and 2,600 feet east of the site (east of Sumas Avenue).

According to the applicable City of Sumas noise ordinance, the proposed plant (an industrial noise source) may not generate a sound level exceeding 70 dBA at industrial receiving properties. The proposed plant may not generate a sound level exceeding 60 dBA at residential receiving properties during daytime hours (7 a.m. to 10 p.m.) and 50 dBA during nighttime hours. Because the proposed plant would operate 24 hours per day, it would need to be designed and operated to meet the more stringent 50 dBA nighttime limit at residential receiving properties.

The United States Environmental Protection Agency (EPA) has no regulations governing environmental noise. The EPA has, however, conducted extensive studies to identify the effects of sound levels on public health and welfare. The EPA "Levels Document" identifies sound levels "requisite to protect the public health and welfare with an adequate margin of safety" (EPA 1974). Partly because the cost or feasibility of achieving these sound levels was not taken into consideration, these levels are guidelines, not regulations or standards. EPA specifies an Ldn of 55 dBA for outdoor areas where quiet is a basis for use. This is less strict than the 50 dBA City of Sumas nighttime limit for residential areas.

The Department of Housing and Urban Development cites a maximum outdoor day-night sound level of 65 dBA in residential areas (HUD 1980). This is also a policy and not a regulatory standard.

3.3.2.3 Existing Sound Levels

The primary sources of noise in the vicinity of the project site are traffic on State Route 9 and nearby industrial facilities. Industrial noise sources include the existing SCCLP cogeneration plant (approximately 1,000 feet south of the site), the IKO roofing plant (approximately 1,000 feet west of the site), the Ellenbaas Company (approximately 1,200 feet southeast of the site), and the Wood Stone facility (approximately 500 feet east of the site). Noise generated by truck traffic from the Desticon Transportation yard east of Bob Mitchell Avenue is also noticeable. Other sources of noise include trains, and occasional aircraft overflights. Agricultural activities occur occasionally during the cultivation and harvest seasons, however, the sound contribution from the equipment involved in such activities is usually negligible.

Sound levels were measured for a 48-hour period at three locations in the project area, from 1 p.m. September 28, 1998 until 1 p.m. September 30, 1998 (Figure 3.3-1).

The sound level meters were placed at three residential locations: 3802 Kneuman Road, 1,700 feet north-northwest of the project site; 3904 Barker Avenue, 90 feet higher in elevation and 1,600 feet directly north of the project site; and 1116 Sumas Avenue, approximately 2,600 feet from the site and at approximately the same elevation (SLM 1, 2, and 3, respectively in Figure 3.3-1).

The sound level measurements from each of these locations are summarized in Appendix B. A review of the existing 24-hour sound levels in Appendix B indicates that existing sound levels were well within the range of sound levels considered by HUD to be appropriate for residential land uses, and only slightly higher than the levels considered acceptable by EPA guidelines. Existing sound levels at some locations may have exceeded limits established by the Sumas noise ordinance at the time of measurement.

Figure 3.3-1

The IKO roofing plant was completed after the September 1998 noise monitoring, and may have changed the existing sound environment. Although that facility is expected to comply with City noise limits, the plant has introduced additional noise to the project area. Consequently, existing sound levels may now be higher compared with those measured in September 1998 and presented in Appendix B. With a higher background sound level, the incremental increase in noise associated with other future industrial projects such as the S2GF project would be lower.

3.3.3 Environmental Impacts of Proposed Action

3.3.3.1 Construction

During the construction phase of the project, noise from construction activities would add to the noise environment in the immediate vicinity of the site. Typical sound levels associated with such activities are displayed in Table 3.3-3.

Table 3.3-3: Typical Construction Equipment Noise

Activity	Type of Equipment	Range of Noise Levels at 200 Feet (dBA)
Material Handling	Concrete Mixers Concrete Pumps Cranes	62-75 69-71 64-76
Stationary Equipment	Pumps Generators Compressors	57-59 59-70 64-75
Pile Driving	Drop Hammer Vibratory Hammer Auger Boring	69-76 54-83 65-71
Land Clearing	Bulldozer Dump	65-84 70-82
Grading	Scraper Bulldozer	68-81 65-84

Construction activities would be intermittent over the 12- to 18-month construction period and are expected to occur during normal daytime working hours and would be exempt from regulation. Based on the typical attenuation of sound over distance (6 dBA per doubling of distance from the noise source), construction noise levels in the residential area north of the project site would be approximately 20 dBA lower than those listed in Table 3.3-3.

3.3.3.2 Operation

Onsite Facilities

Noise Sources

This impact analysis is focused on the loudest noise sources, including the gas turbines, gas turbine generators, heat recovery steam generators, steam turbines, air-cooled condensers, and the cooling tower. Table 3.3-4 summarizes the predominant noise sources associated with this project.

Table 3.3-4: Summary of Significant S2GF Noise Sources

Source	# Units	Height (ft)	Approximate Sound Pressure Level at 100 ft (dBA)
Inlet Filter House	2	62	61
Gas Turbine	2	20 (building = 62)	71 (without building)
HRSG – T1&T2	2	33	62
HRSG – B1&B2	2	54	60
Stack Wall	2	75	44
Stack Exit	2	180	64
Rotor Air Cooler	2	26	64
Steam Turbine	1	20 (building = 42)	75 (without building)
Cooling Tower Fan Discharge	3	37	64
Cooling Tower Water Inlet	3	18	65
Condenser Cell	35	47	66
Steam Turbine Transformer	1	34	76 (without noise wall)
Gas Turbine Transformer	2	34	73 (without noise wall)
Station Transformer	2	30	60

Impact Assessment

Noise generated by onsite noise sources was evaluated using the Environmental Noise Model (RTA 1989). The Environmental Noise Model (ENM) is a computer program designed specifically to evaluate noise propagation in the environment. The model calculates sound levels after considering the noise reductions or enhancements caused by distance, topography, ground surfaces, and atmospheric stability and absorption.

After noise sources were identified and quantified, three-dimensional maps of the site and vicinity were created to enable the ENM to evaluate effects of distance and topography on noise attenuation. Sound power levels of proposed noise sources were assigned to the appropriate locations on the project site. The ENM was then used to construct topographic cross sections and to evaluate noise impacts in the vicinity of the site.

Because sound energy spreads as it radiates away from a source, its apparent loudness also decreases. For a single noise source, the sound level decreases at a rate of 6 dBA per doubling of distance away from the source. At a distance, the S2GF plant would act as a point source of noise. In the absence of hills or berms, distance is the primary mechanism for decreasing noise from the site.

Some of the energy in a sound wave is absorbed by the atmosphere. The amount of absorption depends on the frequency of the sound and the temperature and relative humidity of the atmosphere. Because of the more effective absorption at higher frequencies, atmospheric absorption would also tend to lower the pitch of noise generated at the site.

The surfaces over which sound waves travel affect the amount of sound at a distant receptor in a complex manner. Hard surfaces such as asphalt can reflect energy and increase the sound level at distant receptors. A soft surface would be expected to absorb sound energy. In addition, the surface can produce a reflected wave that interferes with the direct sound wave and actually reduces the sound level expected due to distance. These interactions are commonly referred to as “ground effects.” In addition to surface qualities, the magnitude of the ground effect depends on the height of the source and receiver and the frequency of the sound. In the project area, most of the ground is “soft” and therefore tends to absorb rather than reflect sound.

If a wall or hillside obstructs the line-of-sight between a noise source and receiver, the sound waves must bend (or refract) around the obstruction in order to reach the receiver. Because the project area is relatively flat, there is little natural topography that would serve as a noise barrier. However, structures on the site would reduce noise from some onsite noise sources because they would block the line-of-sight from those sources to offsite locations. For example, the steam turbine generator building and the gas turbine building would block sound from some of the smaller noise sources at the plant.

Sound propagation through the atmosphere is also affected by wind and by temperature change with height. With a temperature inversion, temperatures at the ground surface are lower than the temperatures aloft and the atmosphere is said to be stable. This causes sound waves to bend back toward the ground, which reduces distance attenuation. Sound traveling downwind also bends downward.

The ENM was used to estimate sound levels attributable to S2GF noise sources under two meteorological scenarios. The first scenario reflects a “neutral” atmospheric stability (-1^{o}C/100 meters of elevation) and represents a typical daytime scenario. This condition can also occur at night, especially when there is wind. The second scenario evaluated was a stable atmospheric condition ($+2^{o}$C/100 meters of elevation), commonly referred to as an inversion condition. Stable conditions occur frequently at night, and sometimes last well into the day in fall and winter months.

Predicted Sound Levels at Residential Receiving Properties

Sound levels resulting from the project were estimated at three receptors in the residential area north of Kneuman Road and one receptor representative of the nearest residential area east of the site (Receptors R1, R2, R3, and R4 in Figure 3.3-1). Receptors R1 and R3 were located on Moe's Hill and R2 was located at the base of Moe's Hill. Receptor R4 was located approximately 2,600 feet east of the site in the nearest residentially zoned area of Sumas.

Table 3.3-5 identifies calculated sound levels at the nearest residential receiving properties. Table 3.3-5 indicates that under stable atmospheric conditions, predicted sound levels are equal to or slightly lower than the City's 50 dBA night limit for industrial noise sources affecting residential receivers, and at least 10 dBA lower than the daytime noise limit. Under neutral atmospheric conditions, estimated sound levels are 2 to 6 dBA less than the nighttime limit and at least 12 dBA less than the daytime noise limit. In addition, estimated sound levels attributable to the proposed facility are within EPA's 55 dBA guideline for residential properties and much less than HUD's 65 dBA impact criterion.

Table 3.3-5: Calculated Sound Levels, Residential Receiving Properties

Receptor	Neutral Atmosphere	Stable Atmosphere
R1. Hilltop residence to northeast	48	50
R2. Residence to north nearer base of hill	47	50
R3. Hilltop residence to northwest	44	48
R4. Nearest residential zone to east	47	49
Night standard for residential zones	**50**	**50**
Day standard for residential zones	**60**	**60**

Predicted Sound Levels at Adjacent Properties

In addition to residential receivers, sound levels were also calculated at the nearest industrial receiving properties. Receptors were placed on the site's northern, southern, and western property lines and are represented by Receptors N, S and W, respectively, in Figure 3.3-1.

The applicant is currently negotiating with the Port of Bellingham to purchase the vacant property between the site and Bob Mitchell Avenue, east of the site. Two sets of receptors were evaluated: those locations along the existing property line (designated as

E1a through E4a in Figure 3.3-1), and those along Bob Mitchell Avenue (designated as E1b through E4b in Figure 3.3-1).

Calculated sound levels at industrial property line receptors are shown in Table 3.3-6. Calculated sound levels would meet the City's noise limit for industrial sources affecting Class C (industrial) noise receiving properties. The highest sound levels are along the eastern property line, where the maximum predicted sound level just meets the 70 dBA limit under stable atmospheric conditions and is nearly at the standard under neutral atmospheric conditions. If the adjacent property east of the site is purchased from the Port of Bellingham, estimated sound levels would range from 60 to 62 dBA and would meet the standard. An alternative to purchasing the property would be the construction of noise walls in key locations.

Table 3.3-6: Calculated Sound Levels, Industrial Receiving Properties

Receptor	Neutral Atmosphere	Stable Atmosphere
N. North property line	57	58
E1a. East property line	67	67
E1b. East, Bob Mitchell Road	60	61
E2a. East property line	68	68
E2b. East, Bob Mitchell Road	61	62
E3a. East property line	69	70
E3b. East, Bob Mitchell Road	61	62
E4a. East property line	64	65
E4b. East, Bob Mitchell Road	59	60
S. South property line	64	65
W. West property line	60	61
Noise limit for industrial zones	**70**	**70**

Offsite Facilities

No noise impacts are anticipated with the construction or operation of a natural gas pipeline, water or wastewater lines, or electric transmission lines**.**

3.3.4 Environmental Impacts of No Action

Under the No Action Alternative, the site would not be developed for an electrical generating station. It is likely that at some future time the site would be developed with another industrial facility that would be subject to the same industrial noise limits.

3.3.5 Mitigation Measures

Noise levels would be measured at startup of the facility, and equipment suppliers would be required to retrofit equipment if necessary to meet the performance specifications. Although the ENM modeling does not indicate it would be necessary, additional noise walls and other forms of mitigation could be employed to meet standards based on the monitored noise levels at startup.

Although legal noise standards are not expected to be exceeded, it is recommended that the applicant expend all efforts to minimize noise sources in the design, equipment selection, construction and operation stages of the facility to assure compliance with all applicable national, state and local noise guidelines, standards and ordinances.

3.3.6 Cumulative Impacts

Assessing the cumulative impacts due to the proposed project is complicated by the fact that background sound levels vary from hour to hour. To a lesser extent, sound levels related to the project would also vary at distant receptors due to changes in local meteorology. Short-term fluctuations in source and background sound levels make short-term cumulative effects highly variable. At residences with a direct line-of-sight to the facility (particularly those on Moe's Hill), there would be times when background sound levels are low and noise from the facility would be audible. There would also be times when the facility is barely audible.

The effects of variable background sound levels and project-related noise can be reduced by assessing daily average conditions. Table 3.3-7 shows 24-hour Leq and Ldn measurements at three residential locations in September 1998. Table 3.3-7 also shows the predicted sound levels attributable to the proposed project under neutral and stable atmospheric conditions. The cumulative sound levels are estimated by logarithmically adding the calculated sound level attributable to the proposed project to the measured sound levels.

Table 3.3-7: Cumulative Sound Levels

	Neutral Atmosphere			Stable Atmosphere		
	SLM1 (R2)	**SLM2 (R1)**	**SLM3 (R4)**	**SLM1 (R2)**	**SLM2 (R1)**	**SLM3 (R4)**
Existing Leq (24)	54.5	52.5	51.7	54.5	52.5	51.7
S2GF Leq (24)	48.0	47.0	47.0	50.0	50.0	49.0
Combined	55.4	53.5	53.0	55.8	54.4	53.6
Increase	0.9	1.1	1.3	1.3	2.0	1.9
Existing Ldn	56.5	54.8	54.6	56.5	54.8	54.6
S2GF Ldn	54.4	53.4	53.4	56.4	56.4	55.4
Combined	58.6	57.2	57.1	59.5	58.7	58.0
Increase	2.1	2.4	2.4	3.0	3.9	3.4

Table 3.3-7 indicates that the noise contributions from the proposed project are generally less than existing levels, but that Ldn impacts attributable to the project are comparable to or slightly higher than existing levels under stable atmospheric conditions. The incremental increase in 24-hour average sound levels would be 1 to 2 dBA at these residential receiving properties. The increase in Ldn at these properties would be 2 to 4 dBA.

3.3.7 Significant Unavoidable Adverse Impacts

With proper design and operation of the proposed facility, potential significant adverse impacts can be satisfactorily mitigated.