DATE: November 5, 2020

TO: *Steven Dahl – Skagit Aggregates, LLC*

FROM: *Drew Savas – The Greenbusch Group, Inc.*

RE: *Skagit Aggregates' Rockport Crushing Plant – Noise Study*

Transmitted by: ☐ Mail ☐ Delivery ☐ Fax ☒ E-mail

INTRODUCTION

The intent of this memorandum is to present predicted sound levels from anticipated crushing operations, compare predicted sound levels with regulatory criteria, and recommend optional mitigation for Skagit Aggregates' Rockport Crushing Plant ("site") at 50796 Cascade Highway 20, Skagit County, Washington.

SUMMARY

Predicted sound levels from crushing operations comply with Skagit County Code environmental sound level limits. The crushing plant is not anticipated to operate during nighttime hours and therefore, is not required to meet nighttime environmental sound level limits at residential-use properties.

Optional mitigation that could be implemented if Skagit Aggregates feels it is necessary to reduce sound levels is included in this memorandum.

NOMENCLATURE

Decibel, dBA

The auditory response to sound is a complex process that occurs over a wide range of frequencies and intensities. Decibel levels, or "dB," are a form of shorthand that compresses this broad range of intensities with a convenient numerical scale. The decibel scale is logarithmic. For example, using the decibel scale, a doubling or halving of energy causes the sound level to change by 3 dB; it does not double or halve the sound loudness as might be expected.

The minimum sound level variation perceptible to a human observer is generally around 3 dB. A 5-dB change is clearly perceptible, and an 8 to 10 dB change is associated with a perceived doubling or halving of loudness. The human ear has a unique response to sound pressure. It is less sensitive to those sounds falling outside the speech frequency range. Sound level meters and monitors utilize a filtering system to approximate human perception of sound. Measurements made utilizing this filtering system are referred to as "A weighted" and are called "dBA".

Table 1. A-weighted Levels of Common Sounds

Sound	Sound Level (dBA)	Approximate Relative Loudness[A]
Jet Plane @ 100 feet	130	128
Rock Music with Amplifier	120	64
Thunder, Danger of Permanent Hearing Loss	110	32
Boiler Shop, Power Mower	100	16
Orchestral Crescendo at 25 feet	90	8
Busy Street	80	4
Interior of Department Store	70	2
Ordinary Conversation at 3 feet	60	1
Quiet Car at Low Speed	50	1/2
Average Office	40	1/4
City Residence, Interior	30	1/8
Quiet Country Residence, Interior	20	1/16
Rustle of Leaves	10	1/32
Threshold of Hearing	0	1/64

[A] As compared to ordinary conversation at 3 feet.

Source: US Department of Housing and Urban Development, Aircraft Noise Impact Planning Guidelines for Local Agencies, November 1972.

Equivalent Sound Level, LA_{eq}

LA_{eq} is the A-weighted level of a constant sound having the same energy content as the actual time-varying level during a specified interval. The LA_{eq} is used to characterize complex, fluctuating sound levels with a single number. Typical intervals for LA_{eq} are hourly, daily, and annually.

Sound Power Level, PWL or L_WA (A-weighted PWL)

Sound power is the amount of energy per second generated by a source, measured in watts. The sound power level (PWL) is a decibel representation with a reference value of 1 pico-watt (pW). Sound power is independent of distance, path, or influence from any nearby surfaces.

Sound Pressure Level, SPL

Sound pressure level correlates with what is heard by the human ear. SPL is defined as the squared ratio of the sound pressure with reference to 20 µPa. Sound pressure is affected by distance, path, barriers, directivity, etc.

Percentage Sound Level, L(n)

L(n) is the sound level that is exceeded n percent of the time; for example, L08 is the level exceeded 8% of the time. L25 is the sound level exceeded 25% of the time**.**

REGULATORY CRITERIA

The proposed crushing plant and all nearby properties are within unincorporated Skagit County. Therefore, the Skagit County Code will govern sound emissions from the site.

Skagit County Code

Chapter 9.50 Noise Control of the Skagit County Code ("Code") adopts section 173-60 Maximum Environmental Noise Levels from the Washington Administrative Code ("WAC"). WAC and the Code, group multiple land use or zoning designations into three noise districts called Environmental Designations for Noise Abatement ("EDNA"). Generally, Class A EDNA includes residential zones, Class B EDNA includes commercial zones and Class C EDNA includes industrial zones. The Code does not define EDNAs by zoning, therefore EDNA classification will be based on land use as defined in WAC Section 173-60-030.

Maximum permissible environmental sound levels are defined by Chapter 9.50.040(1) of the Code which adopts WAC Section 173-60-040). These sound level limits are based on the EDNA the sound source originates within (EDNA of Sound Source) and in which EDNA the sound is received (EDNA of Receiving Property). A summary of the applicable sound level limits can be found in Table 2.

Table 2. Maximum Permissible Environmental Noise Levels, L_{25}

EDNA of Sound 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: Chapter 9.50.040(1) Skagit County Code, Section 173-60-040 Washington Administrative Code

At any hour of the day or night the applicable noise limitations may be exceeded for any receiving property by no more than:

- 5 dBA for a total of 15 minutes in any one-hour period; or
- 10 dBA for a total of 5 minutes in any one-hour period; or
- 15 dBA for a total of 1.5 minutes in any one-hour period.

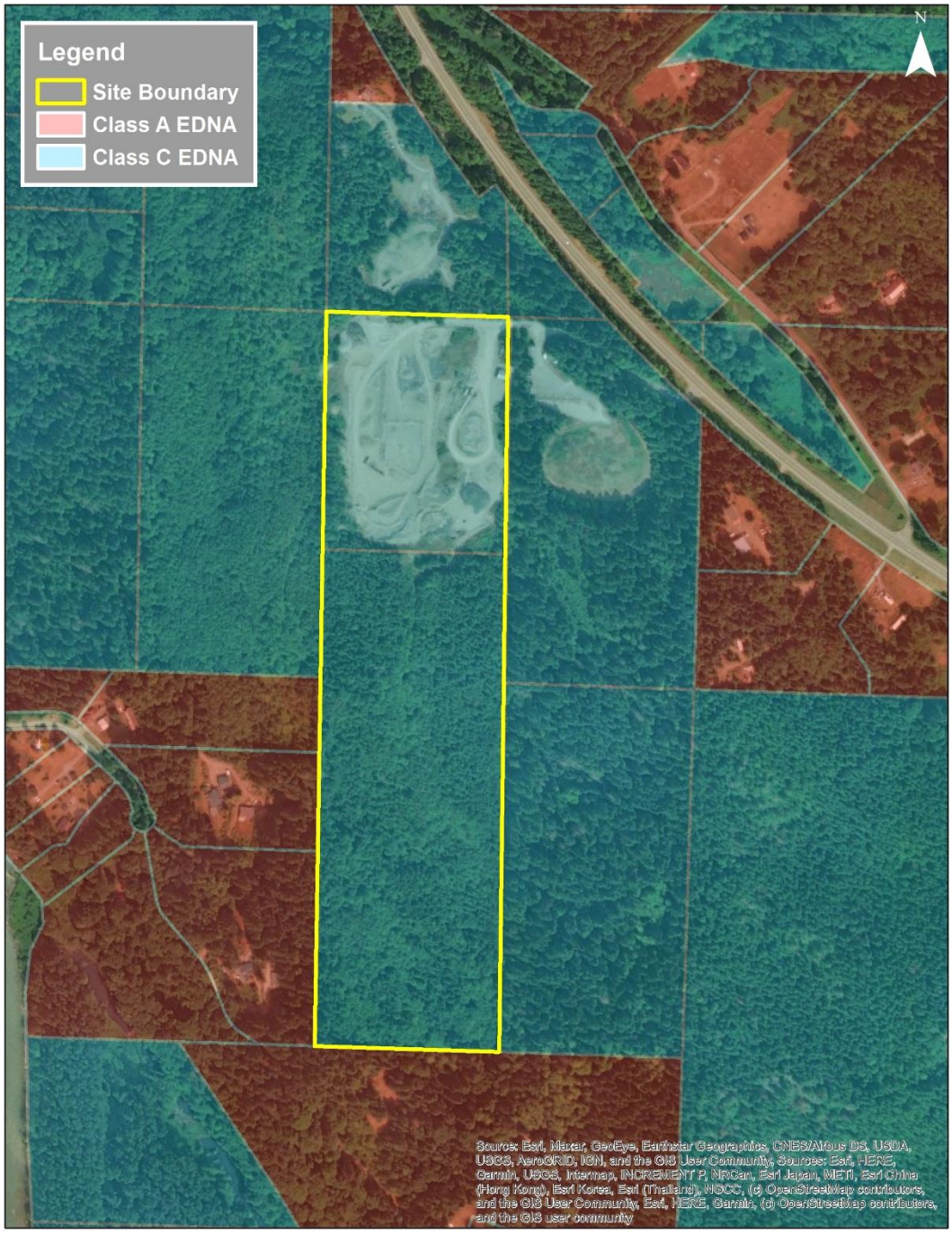
Modifications to the environmental sound level limits set forth in Table 2 are also outlined in Section 173-60-040 of the WAC. These modifications are for certain times of day and classification of receiving properties. These modifications to the environmental sound level limits include a 10 dBA reduction during the nighttime hours between the hours of 10 PM and 7 AM when the receiving property is within Class A EDNAs.

Given the constant nature of crushing operations, hourly L_{EQ} predictions are used to approximate L_{25} sound levels. Sound level limits are enforced anywhere on the receiving property.

The Site is a Class C EDNA, and nearby properties are either Class A, or Class C. Sounds from the Site will be limited to 60 dBA L_{25} at Class A properties and 70 dBA L_{25} at Class C properties.

The Site and many adjacent parcels are Class C EDNA due to their industrial use or undeveloped state. Adjacent parcels southwest of the site fall under Class A EDNA as they are residential use. Figure 1 provides a graphical representation of EDNAs near the proposed crushing plant**.**

Figure 1. Project Location and Nearby EDNAs



Source: Skagit County GIS.

ACOUSTICAL MODEL

The primary tool used for the sound level analysis and prediction was the 3-D computer noise modeling software environment, Cadna/A. Cadna/A utilizes the CADNA (Control of Accuracy and Debugging for Numerical Applications) computation engine developed by the Pierre et Marie Curie University of Paris. The model used for this project utilized the International Organization for Standardization 9613 Part II algorithms, implemented in the Cadna/A software, which accounted for the effects of distance, topography, and surface reflections on sound levels predicted for modeled activities.

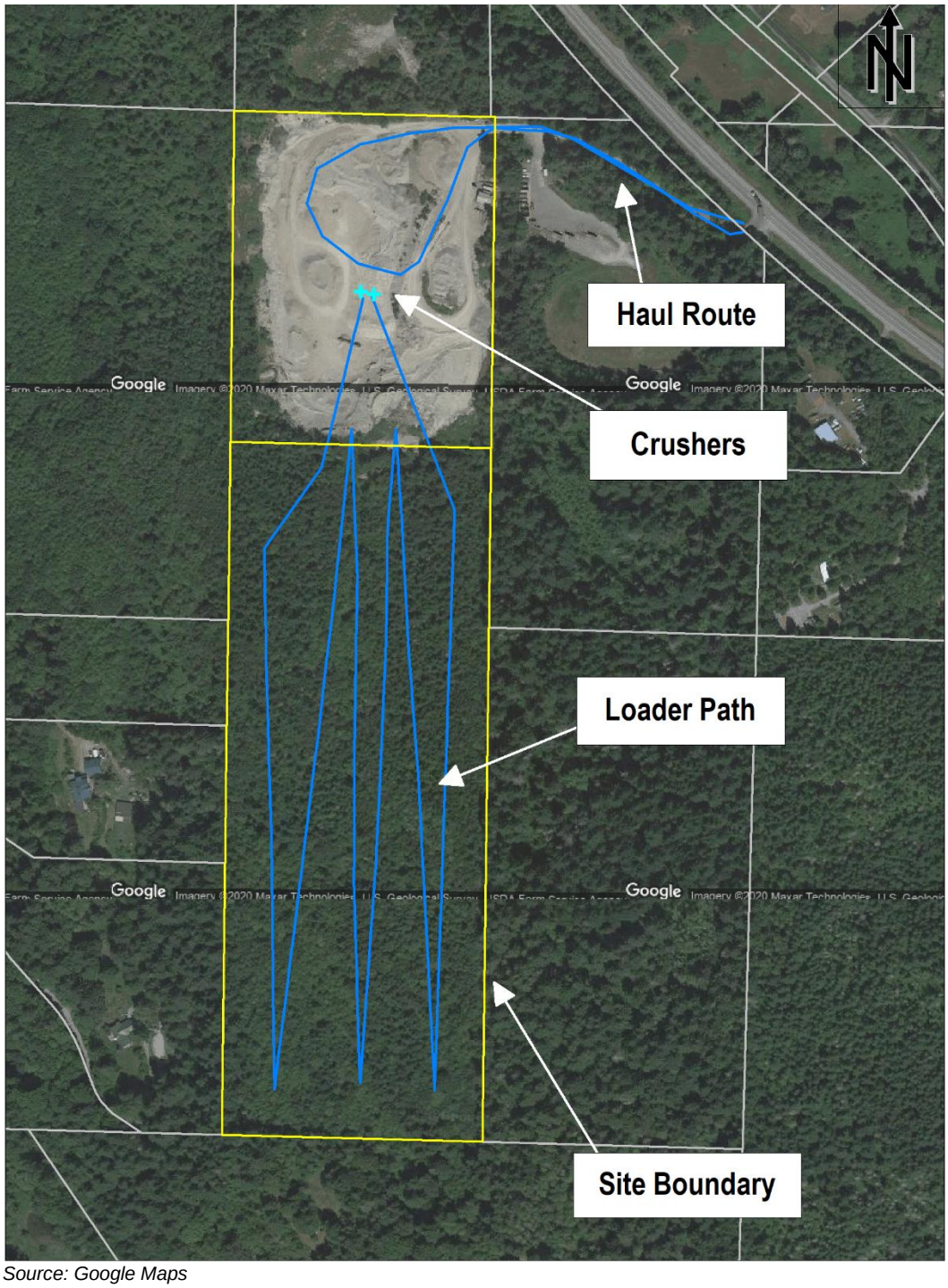
The future topography of the site was determined from drawings and information provided by Skagit Aggregates, LLC and Jepson & Associates. Existing topography, property lines, and land use were determined from Skagit County Geographic Information System (GIS) records and Google Maps. Sound power levels for the crushing equipment and the loader were provided by the manufacturers. Sounds from crushing will depend on what is being crushed, therefore a 3 dB safety margin was included for crushing equipment. Sound power levels for the haul trucks are based on measurements performed by Wyle Laboratories for the Transportation Research Board.

Table 3. Equipment Sound Power Levels, L_WA

Equipment	Sound Power Level	Safety Margin	Modeled Sound Power Level
Caterpillar 980G Loader	111	0	111
Terex Finlay J-1160 Jaw Crusher	116	3	119
Terex Finlay C-1540 Cone Crusher	111	3	114
Truck ID038 Haul Truck	113	0	113

The crushers are anticipated to be in the center of the north end of the site. To conservatively model the crushers, they were placed at an elevation of approximately 545 feet. This elevation is relatively high compared to other potential crusher locations, which reduces the acoustic shielding provided by nearby hills or excavated berms. Sounds originating from the crushers will likely be lower at nearby parcels if the crushers are placed at lower elevations on the site. The loader will travel around the site as required to move material. The following figure shows crusher locations, a potential loader path, and a potential haul route.

Figure 2. Modeled Equipment Locations and Paths



Source: Google Maps

ANALYSIS AND MITIGATION

Crushing Operations

The crushing plant will operate between the daytime hours of 7 AM and 6 PM. Therefore, the nighttime 10 dB reduction in sound level limits at Class A EDNAs will not apply.

Sound levels from crushing operations were predicted by the acoustical model using the equipment listed in Table 3. Predicted sound levels were then compared with the environmental sound level limits in Table 2 to assess whether the crushing plant complies with Code. It was determined that crushing operations are predicted to comply with sound level limits at all nearby properties without mitigation. Predicted sound levels do not include existing or future ambient noise sources, or any other noise source not included in Table 3.

Table 4 provides predicted sound levels at all adjacent parcels and most nearby parcels. The predicted sound levels in Table 4 are at the anticipated loudest location within each parcel, not at dwelling units. The loudest point on a parcel is often at the property line that is closest to a noise source. Figure 3 shows the location of each parcel listed in Table 4.

Table 4. Predicted Operational Sound Levels and Compliance with Skagit County Code

Receiving Property	EDNA	Predicted Sound Level, L_{EQ} [A]	Daytime Sound Level Limit, L_{25} [B]	Exceeds Code?
Parcel 1	Class C	73 dBA	Easement - No sound level limit	No
Parcel 2	Class C	63 dBA	70 dBA	No
Parcel 3	Class A	60 dBA	60 dBA	No
Parcel 4	Class A	51 dBA	60 dBA	No
Parcel 5	Class C	50 dBA	70 dBA	No
Parcel 6	Class A	48 dBA	60 dBA	No
Parcel 7	Class A	41 dBA	60 dBA	No
Parcel 8	Class A	40 dBA	60 dBA	No
Parcel 9	Class A	40 dBA	60 dBA	No
Parcel 10	Class A	48 dBA	60 dBA	No
Parcel 11	Class A	56 dBA	60 dBA	No
Parcel 12	Class A	59 dBA	60 dBA	No
Parcel 13	Class A	60 dBA	60 dBA	No
Parcel 14	Class A	60 dBA	60 dBA	No
Parcel 15	Class C	68 dBA	70 dBA	No
Parcel 16	Class C	64 dBA	70 dBA	No
Parcel 17	Class C	66 dBA	70 dBA	No
Parcel 18	Class A	44 dBA	60 dBA	No
Parcel 19	Class A	49 dBA	60 dBA	No
Parcel 20	Class C	50 dBA	70 dBA	No
Parcel 21	Class A	52 dBA	60 dBA	No
Parcel 22	Class A	53 dBA	60 dBA	No
Parcel 23	Class A	52 dBA	60 dBA	No
Parcel 24	Class A	51 dBA	60 dBA	No
Parcel 25	Class A	26 dBA	60 dBA	No

[A] Expected loudest point on parcel.
[B] Skagit County Code Daytime Sound Level Limits from EDNA C.

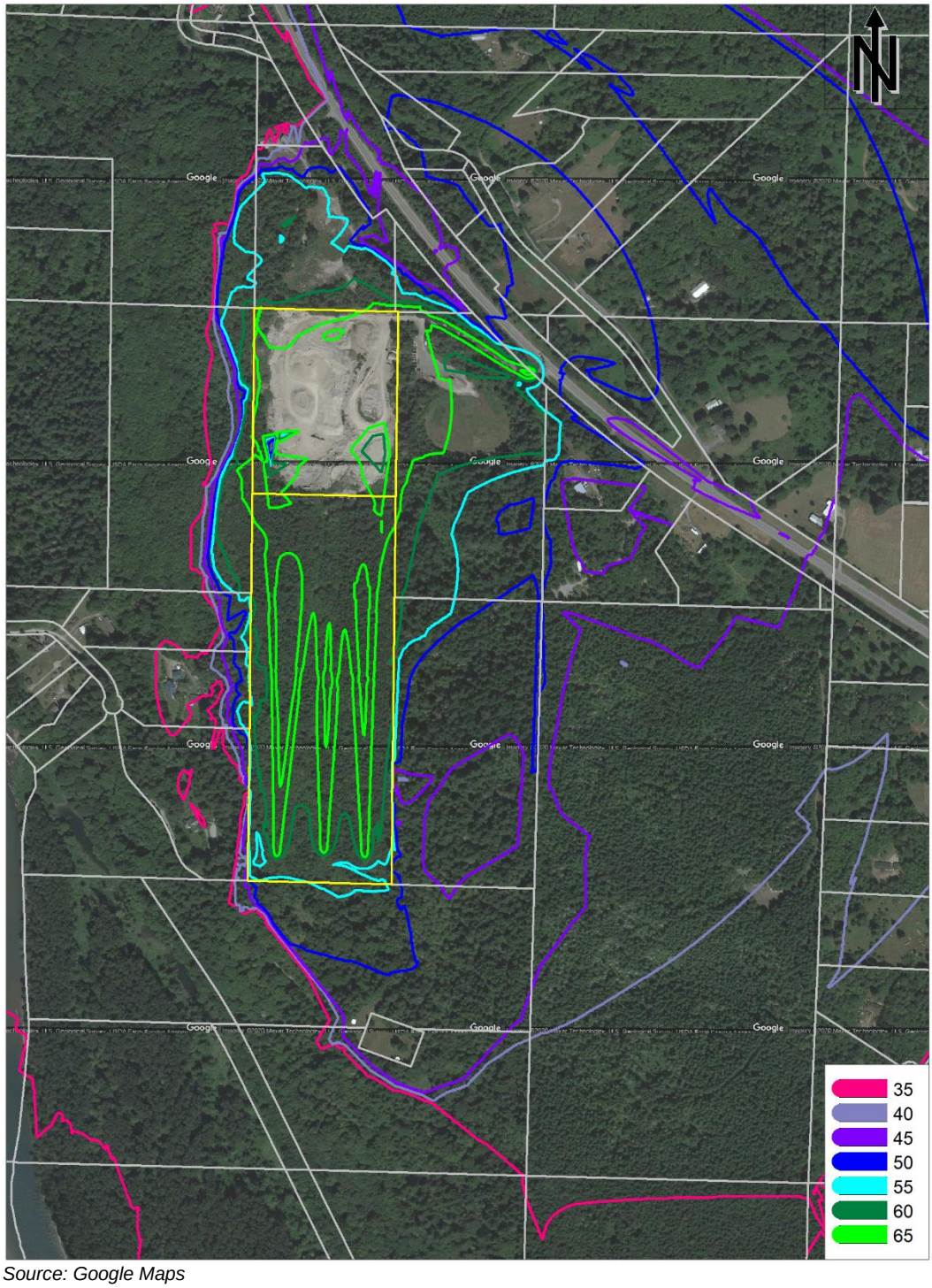
Figure 3. Parcel Number and Location

Source: Google Maps

In addition to the predicted sound levels provided in Table 4, predicted sound level contours 5 feet above grade are shown in the following figure. Sound level contours are similar to elevation contours where a line represents a single elevation. Except with sound level contours, a single line represents a single sound level. The color of the line must be

compared with the legend to determine the sound level each line represents. Sound levels between colored lines can be interpolated as an approximation.

Figure 4. Sound Level Contours, L_{EQ}(H) dBA



Source: Google Maps

Optional Mitigation

Mitigation may be implemented if Skagit Aggregates feels it is appropriate. There are three feasible methods to reduce sounds at nearby properties; reduce the amount of sound equipment is producing, reduce the amount of time equipment operates, and use shielding to reduce the amount of noise that reaches nearby properties.

Reducing the amount of noise a piece of equipment produces can be difficult. However, there are some steps that can be taken including:

- Replacing tonal backup alarm with broadband backup alarms, or ambient sensing broadband backup alarms, if safety requirements and regulations can be met,
- Placing a lining or soft material on, or in, areas that have items dropped into them, and
- Ensuring all exhaust silencers are fitted properly and are in good working order.

Reducing the amount of time or changing the time of day equipment operates can reduce complaints from residential properties.

- Phasing equipment startups so that multiple pieces of equipment are not starting at the same time. This is especially important during cold starts,
- Reducing the amount of idle time. This is especially important for equipment that utilizes high idle engine speeds,
- Starting and running loud equipment during times of the day when ambient sounds are higher, or nearby properties are less sensitive to noise, and
- Reducing the amount of time equipment operates.

Shielding noise from reaching noise sensitive properties can be an effective method to reduce noise complaints. There are many ways to shield noise, a few methods include:

- Placing loud equipment at lower elevations so excavated walls act as noise barriers,
- Placing equipment so it does not have line-of-sight to noise sensitive properties, and
- Building noise walls around loud equipment. Typical adequate construction is two sheets of ¾" marine-grade plywood. Noise walls are most effective when very close to the noise source or the receiver of noise. Sound is capable of diffracting, a process of bending around edges. Therefore, it is often necessary to build a wall higher than what is required to just break line-of-sight between a noise source and noise sensitive areas.

CONCLUSION

Sounds originating from the crushing operation are expected to comply with Skagit County Code daytime maximum permissible sound levels at all receiving properties. The crushing plant is expected to only operate during the daytime hours of 7 AM through 6 PM and therefore, is not required to comply with nighttime maximum permissible sound levels. If Skagit Aggregates feels it is necessary to reduce sound levels, the optional mitigation measures included in the memorandum could be implemented.