APPENDIX S HORIZONTAL DIRECTIONAL DRILLING (HDD) ENVIRONMENTAL SOUND LEVEL ASSESSMENT REPORT

Alaska LNG™

PROJECT HDD

ENVIRONMENTAL SOUND LEVEL ASSESSMENT REPORT

USAI-P2-SRVIB-00-000006-000

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report presents the results of an environmental sound level assessment for the three proposed Horizontal Directional Drilling (HDD) locations for the Alaska LNG Project (Project).

The purpose of this study was to provide an environmental sound level assessment for the HDD locations, which includes the following tasks:

1. Develop a model to estimate the sound level contribution level from the facility at the nearest existing Noise Sensitive Areas (NSAs) in the vicinity of the HDD construction activities.
2. Assess the far-field community sound levels at the identified NSAs for HDD construction activities.
3. Identify noise mitigation measures that could be implemented to comply with the Project environmental sound level criterion.

The acoustical modeling for the Project was conducted with a commercial noise modeling software, SoundPLAN (V7.4). Equipment sound power levels are based on data of similar capacity/type equipment to those proposed for use by Alaska LNG.

2.0 ENVIRONMENTAL SOUND CRITERIA

The regulations in 18 CFR § 157.206, sets the maximum A-weighted Nighttime Sound Level (Ln) at 55 dBA for HDD activities. No applicable local or state environmental sound regulations or ordinances have been identified.

3.0 NOISE MODELING METHODOLOGY

The procedure for estimating the total (or overall) sound pressure level at any given location is as follows:

a. The octave band sound levels for a specific in-plant source or equipment item at a specific receiver location is calculated using the octave band sound power emission levels of a sound source and applying the octave band environmental correction factors as determined by the environmental conditions (e.g. atmospheric, topographical, foliage) between that source and the receiver.

b. This calculation repeats for each source resulting in multiple octave band sound pressure level spectra at the receiver location.

c. The individual octave band sound pressure spectra for each source are then summed logarithmically on an energy basis (within each octave band) resulting is a total octave band sound pressure level spectrum accounting for the influence of all of the sound sources at the receiver location.

d. The total sound pressure level spectrum is then A-weighted and the resulting A-weighted octave band sound levels summed on an energy or logarithmic basis to obtain the final overall A-weighted sound level that can be compared to the project criteria.

Items a. through d. above repeat for each individual receiver location. Therefore, due to the complexity of determining the sound level at multiple receiver locations from multiple sound sources, it is advantageous to use a computer program incorporating standard algorithms that:

- Determine the sound level from each individual source, based on the environmental factors that separate the source from a receiver, and
- Then combines the resulting individual sound levels from many sources into a total or cumulative sound level.

The computer program utilized for this environmental noise level assessment is SoundPLAN Version 7.4 as distributed by Braunstein + Berndt GmbH. The program calculates the sound pressure level at a location utilizing the sound emission properties of the source(s) and environmental propagation factors (sound spreading due to distance, ground affects, barriers, topography, as well as, atmospheric attenuation). The program also includes a number of standardized methodologies that can be utilized to quantify the acoustic effect of these environmental factors. The specific standard employed by this program is that described in the ISO standard 9613 “Acoustics - Attenuation of sound during propagation outdoors”, part 1 and 2. These standards assumes a favourable downwind propagation condition (wind speed 1 m/s to 5 m/s at a height of 3 to 11m) as recommended in ISO standard 1996 “Acoustics - Description and measurement of environmental noise” part 2. The modeled ambient temperature was 10 degrees C and the assumed relative humidity (RH) was 70 percent. All receiver heights were 1.5 m above the local ground level (AGL).

The topography was obtained from the Project GIS library and was used to create a topological digital ground model. The ground absorption value utilized in the model was 0.6, which is representative of grasslands. No sound attenuation due to foliage was included in the assessment.

4.0 NOISE ASSESSMENT

The following denotes the typical equipment at the HDD entry side and most of the listed equipment is considered noise sources associated with the HDD operations:

- Drilling rig and engine-driven hydraulic power unit (i.e., most significant noise source);
- Engine-driven mud pump(s) and engine-driven generator set(s);
- Mud mixing/cleaning equipment and associated fluid systems shale shakers;
- Crane, backhoe, frontloader, forklift and/or truck(s);
- Frac tanks (i.e., water & drilling mud storage); engine-driven light plants (nighttime operation).

The following denotes the typical equipment at the HDD exit side and most of the listed equipment is considered noise sources, noting that the noise generated at the HDD exit side is significantly lower than the noise generated at the entry side:

- Backhoe, sideboom, backhoe and/or trucks;
- Possibly one (1) engine-driven generator set and one (1) “small” engine-driven pump;
- Engine-driven light plants (used for nighttime operation).

Table 1: Sound Power Emission Levels (L_w) for Entry and Exit Locations of HDD Operations

Location	Octave Band Center Frequency - Hz									Total Sound Level (DBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Entry	118	115	112	114	112	109	108	106	98	115
Exit	110	108	105	102	100	98	95	92	88	103

Typically most of this equipment will not be in operation during the nighttime hours of 10 p.m. to 7 a.m. However, there are occasions when the termination of the drilling activity at a critical point of the drill or ream at nighttime that could result in a loss of the hole or an unsuccessful drill. In this case the equipment operation will continue throughout the nighttime hours. Our assessment assumes a worst-case scenario that all of the equipment listed above will continue in operation throughout the nighttime hours of 10 p.m. to 7 a.m.

4.1 MP 356-357 HDD SITE

Figure 1 shows the area within a mile vicinity of the MP 356-357 HDD Site. The HDD entry is located approximately 200-feet north of MP 642. The HDD exit is located approximately 900-feet south of MP 356. The nearest NSA consists of a single residential development located approximately 400 -feet southwest of the HDD exit.

The modeled sound level for operation of the HDD at the closets NSA location is:

Table 2: Modeled Sound Level Due to HDD 356-357.

Location	Distance to Entry (ft.)	Distance to Exit (ft.)	Sound Level Due to Entry (Ln, dBA)	Sound Level Due to Exit (Ln, dBA)	Total Sound Level (Ln, dBA)
NSA 2100	3,750	400	38.3	47.4	47.9

This estimated sound levels due to the maximum HDD activity during the nighttime is significantly less than the 55 dBA allowable

Figure 1 – HDD MP 356-356 Vicinity Map

4.2 MP 473-474 HDD SITE

Figure 21 shows the area within a mile vicinity of the MP 473-474 HDD Site. The HDD entry is located approximately 1,850-feet north of MP 473. The HDD exit is located approximately 1,250-feet south of MP 473. The nearest NSAs consist of multiple residential developments located 3,000-ft east of the exit point (designated NSA 02336) and six residential developments located approximately 1,600-feet N-NW of the entry point (designated NSA 02116).

The modeled sound level for operation of the HDD at the two closest NSA locations are:

Table 3: Modeled Sound Level Due to HDD 473-474.

Location	Distance to Entry (ft.)	Distance to Exit (ft.)	Sound Level Due to Entry (dBA)	Sound Level Due to Exit (dBA)	Total Sound Level (dBA)
NSA 02336	4,500	3,000	29.0	26.6	30.9
NSA 02116	1,600	1,600	45.7	20.0	45.7

This estimated sound levels due to the maximum HDD activity during the nighttime is significantly less than the 55 dBA allowable.

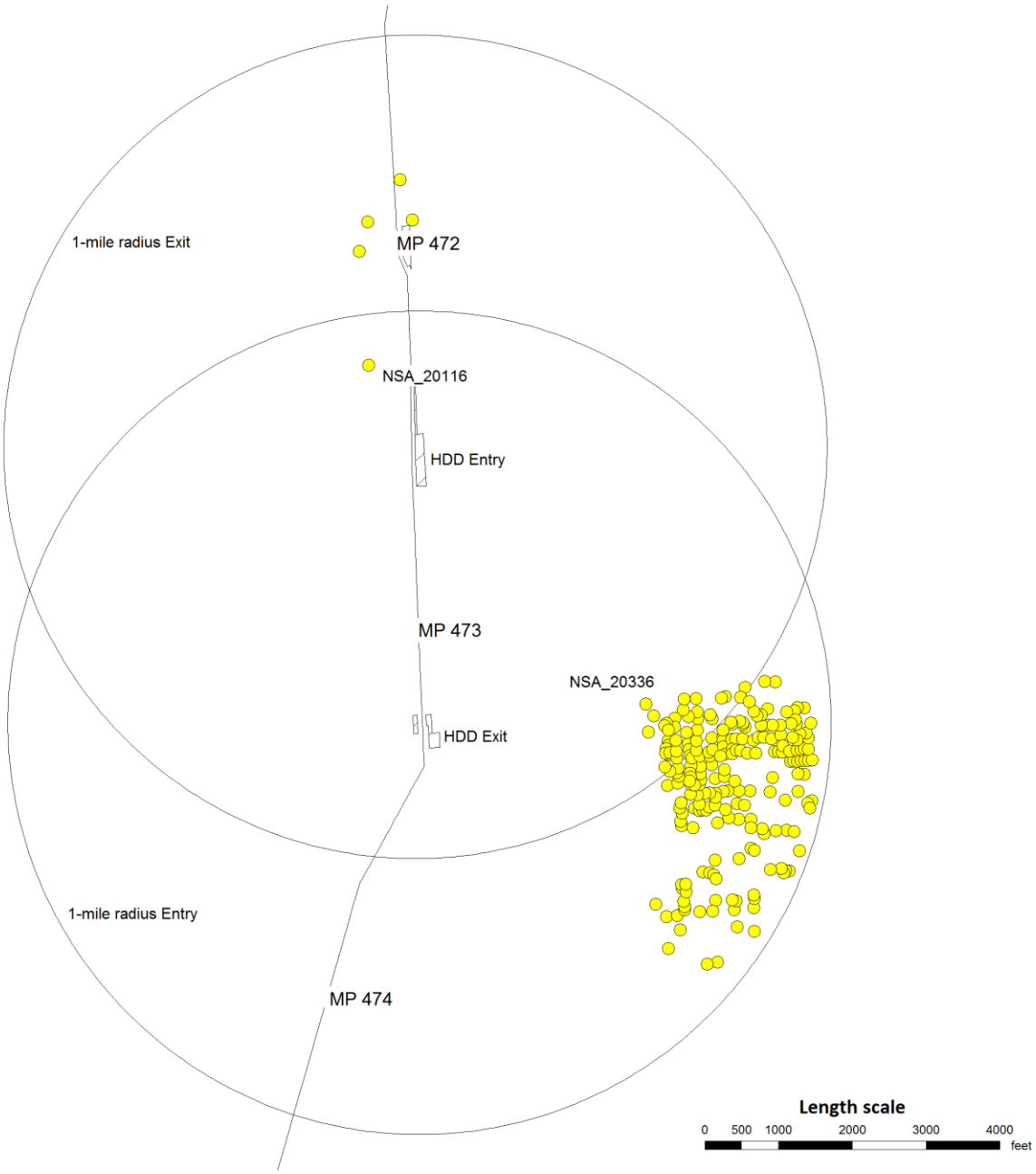

Figure 2 – HDD MP473-474 Vicinity Map

4.3 MP 641-642 HDD SITE

Figure 3 shows the area within a mile vicinity of the MP 641-642 HDD Site. The HDD entry is located approximately 500-feet southwest of MP 642. The HDD exit is located approximately 3,000-feet southwest of MP 641. The nearest NSA consists of a single residential developments located approximately 5,100-feet southeast of the HDD exit.

The modeled sound level for operation of the HDD at the closest NSA location is:

Table 4: Modeled Sound Level Due to HDD 641-642.

Location	Distance to Entry (ft.)	Distance to Exit (ft.)	Sound Level Due to Entry (dBA)	Sound Level Due to Exit (dBA)	Total Sound Level (dBA)
NSA 02007	6,900	5,100	31.0	24.1	31.8

This estimated sound levels due to the maximum HDD activity during the nighttime is significantly less than the 55 dBA allowable.

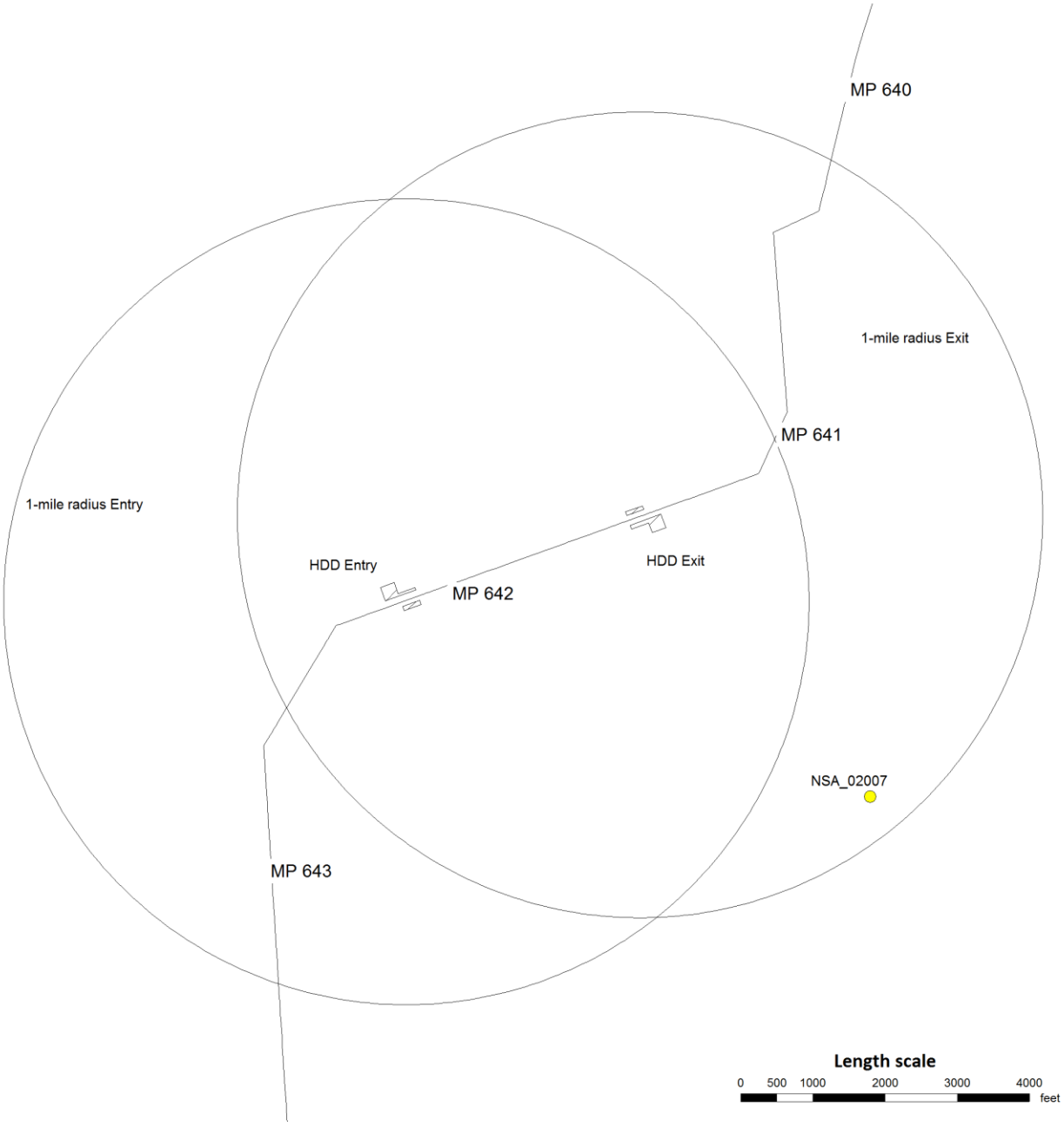

Figure 3 – HDD MP641-642 Vicinity Map

5.0 CONCLUSION

The analysis, as presented above, indicates that with the HDD construction activities will be able to comply with the FERC environmental sound level criterion with a reasonable degree of certainty.

6.0 TERMS AND ABBREVIATIONS

Term	Definition
AGL	Above the local ground level.
L_{eq}	The A-weighted equivalent continuous sound pressure level
L_n	Average nighttime (22:00 to 07:00 hrs.) equivalent sound pressure level
NSA	Noise Sensitive Area
SPL (L_p)	Sound pressure level
PWL (L_w)	Sound power level
FERC	Federal Energy Regulatory Commissions

7.0 REFERENCES

ID Number	Reference Title
18 CFR 157.206	FERC Regulations on Noise (L_n 55 dB(A) at the nearest NSA's)
ISO 9613-1	Part 1 - Calculation of the Absorption of Sound by the Atmosphere
ISO 9613-2	Part 2 - Acoustics-attenuation of Sound During Propagation Outdoors
ISO 1996-2	Part 2 - Acquisition of data pertinent to land use
USAI-P1-SRVIB-00-000001-000	**Baseline Noise Level Report – MGP May/August 2015 Field Survey**