APPENDIX S
NOISE ANALYSIS

H&K Job No. 5277

Subject: **Acoustical Assessment of the Currently Planned HDD Sites for the Bluewater SPM Project (Nueces County, Aransas County and San Patricio County, Texas)**

Prepared for: **Edge Engineering & Science** (“Edge E&S”)
Project Applicant: **Bluewater Texas Terminal LLC**

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1.0 INTRODUCTION

The following report provides the results of an acoustical assessment of the currently planned horizontal directional drilling (HDD) sites for the on-shore portion of the new oil pipeline route associated with the **Bluewater SPM Project** (“Project”). The HDD construction technique (“trenchless crossing method”) is an alternative to traditional "open cut" construction and is itself an "environmental mitigative measure" for avoiding foreign pipelines, utilities and water bodies. For the reader’s information, a summary of applicable acoustical terminology in this report and description of typical metrics used to measure and regulate environmental noise is provided at the end of the report (p. 16).

The purpose of the acoustical assessment is to estimate the sound contribution at nearby noise-sensitive areas (NSAs), such as residences, schools, hospitals and recreational areas-parks, resulting from drilling operations associated with any HDD entry or HDD exit site with NSAs within 0.5 mile. If an HDD entry or exit site does not have any NSAs within 0.5 mile, it is assumed that HDD operations at the respective entry or exit site should not have a significant noise impact and a noise assessment is probably not necessary. In addition, for this Project, a Piping Plover critical habitat (located along the beach, near the Gulf of Mexico waters) will be considered a noise-sensitive area. There will also be a need to evaluated noise mitigation measures to minimize the noise impact of HDD activities if the acoustical assessment indicates that the noise attributable to HDD operations could exceed an equivalent day-night sound level (“Ldn”) of **55 dBA** [i.e., sound level guideline for HDD operations, which is normally utilized by the Federal Energy Regulatory Commission (FERC)]. This sound criterion assumes that HDD operations could be employed for a 24-hour workday. We are unaware of any sound criteria that could be applicable for the potential noise impact of a Piping Plover critical habitat.

2.0 DESCRIPTION OF PLANNED HDD SITES

Currently, there are ten (10) planned HDDs associated with the installation of the pipeline system associated with the Project, which includes the installation of dual 30-inch diameter oil transfer pipelines. The pipeline construction plan for the HDDs is to employ a drilling rig only on the "entry side/pit" of each HDD crossing, and HDD drilling operations will only occur mostly during daytime hours although HDD operations could occur during nighttime hours during "pull back" operations (defined as the "worst-case operating conditions, in which 24-hour operations are necessary). Based on the assessment, some of the HDD entry and/or exit sites have NSAs within 0.5 mile of the HDD entry/pit and HDD exit site/pit. Consequently, a noise impact assessment is provided for those HDD entry/exit sites with NSAs within 0.5 mile. Based on recent site visits by H&K, many of the planned HDD sites have NSAs within 0.5 mile of either the entry point and/or exit point of the respective HDD Crossing. Consequently, the noise impact assessment of the HDD operations will be provided for those potential Project HDD sites that have NSAs within ½ mile. For reference, **Figures 1–5** (pp. 6–10) provides an area layout-map for those HDD crossings with NSAs within 0.5 mile.

The following **Table A** summarizes the planned HDDs along the Project pipeline route and the approximate horizontal length of the HDD. **Table A** also includes the identified closest NSAs to the HDD entry or exit along with the distance/direction of the closest NSAs and observed obstructions between HDD and NSA that could provide additional attenuation of HDD noise.

Ref. No.	Brief Description and Reason for the HDD Crossing	Entry or Exit Point	Closet NSA and Type of NSA	Distance & Direction of Closest NSA	Obstructions between NSA & HDD Site	Ref. Figure in Report
#1	Water channel crossing	Entry	No NSA within ½ mile	>0.5 mile	N/A	Fig. 1 (p. 6)
		Exit	No NSA within ½ mile	>0.5 mile	N/A	Fig. 1 (p. 6)
#2	Highway 181 crossing	Entry	Residence	1,700 ft. (W)	Some foliage/trees	Fig. 1 (p. 6)
		Exit	Residence	1,650 ft. (NW)	Some foliage/trees	Not included
#3	Water channel crossing	Entry	No NSA within ½ mile	>0.5 mile	N/A	Not included
		Exit	No NSA within ½ mile	>0.5 mile	N/A	Not included
#4	Crossing of E. Stapp Ave. And other water bodies	Entry	Residences	150 ft. (W)	Minimum foliage	Fig. 2 (p. 7)
		Exit	Residence	450 ft. (SW)	Some foliage/trees	Fig. 2 (p. 7)
#5	Redfish Bay Causeway crossing	Entry	Residences	2,200 ft. (W)	Some foliage/trees	Fig. 3 (p. 8)
		Exit	Residence	150 ft. (S)	Minimum foliage	Fig. 3 (p. 8)
#6	Wetlands & water body crossing	Entry	Residences (RV Park)	700 ft. (S)	Minimum foliage	Fig. 3 (p. 8)
		Exit	Residences (RV Park)	1,100 ft. (SE)	Some foliage/trees	Fig. 3 (p. 8)
#7	Redfish Bay crossing	Entry	Residences (RV Park)	700 ft. (S)	Minimum foliage	Fig. 4 (p. 9)
		Exit	Residence	900 ft. (SE)	Some foliage/trees	Fig. 4 (p. 9)
#8	Water bodies crossing	Entry	No NSA within ½ mile	>0.5 mile	Not applicable (N/A)	Not included
		Exit	No NSA within ½ mile	>0.5 mile	Not applicable (N/A)	Not included
#9	Inner Basin Waterway crossing	Entry	Piping Plover habitat	2,450 ft. (E)	Minimum obstruction	Fig. 5 (p. 10)
		Exit	No NSA within ½ mile	>0.5 mile	Not applicable (N/A)	Fig. 5 (p. 10)
#10	Offshore pipeline to SPM	Entry	Piping Plover habitat	1,300 ft. (E)	Minimum obstruction	Fig. 5 (p. 10)

Table A: Summary of the Planned HDD Crossings for the Project along with the Distance/Direction of the Closest NSA(s) to each Respective HDD Entry/Exit Site and Other Related Information.

3.0 AMBIENT SOUND SURVEYS AND MEASUREMENT METHODOLOGY

Representative ambient sound measurements and verification of NSAs surrounding the planned HDD sites were performed by Larry Lengyel of H&K in Feb. 2019. Ambient sound levels were measured at the closest NSA(s) to the HDD sites with NSAs within ½ mile. At each sound measurement location, the ambient A-weighted (A-wt.) equivalent sound level (i.e., Leq) and unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured. The acoustical measurement system consisted of a Norsonic Model Nor140 Sound Level Meter (a Type 1 "SLM" per ANSI S1.4 & S1.11) equipped with a ½ condenser microphone with windscreen.

4.0 ACOUSTICAL ASSESSMENT AND HDD EQUIPMENT

The spreadsheet analyses (i.e., acoustical calculations) of the estimated A-wt. sound level contributed by the HDD operations during peak operating conditions associated with the potential HDD sites at the closest NSA (i.e., within ½ mile of either the HDD entry or exit site) are provided in **Tables 1–11** (pp. 11–14), and it is assumed that the HDD operations could be employed for a 24-hour workday. For those HDD sites (i.e., entry or exit location) in which the sound level guideline could be exceeded, the acoustical assessment predicts the noise contribution of HDD operations if additional noise mitigation measures are employed to minimize the noise impact at the nearby NSAs. For reference, a description of the acoustical analysis methodology and the source of sound data are provided at the end of the report (pp. 15–16) along with a brief summary of acoustical metrics and terminology associated with the report.

The following denotes the typical equipment at the HDD entry side and most of the listed equipment are 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 are 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).

The following **Table B** summarizes the estimated sound level (Ldn) of drilling operations, as calculated from estimated A-wt. sound level, at the closest NSA(s) to each respective HDD site with NSAs within ½ mile of either the HDD entry or HDD exit site. In addition, **Table B** denotes those sites in which the sound level criterion could be exceeded during the HDD operations.

Ref. No.	Reason for the HDD Crossing	Entry or Exit Point	Distance & Direction of Closest NSA	Exceed Noise Criterion	Ambient Ldn (dBA)	Calc'd Ldn due to HDD (dBA)	Ldn of HDD + Ambient (dBA)	Increase Above Ambient (dB)	Reference Table in Appendix
#2	Highway 181 crossing	Entry	1,700 ft. (W)	**No**	54.4	53.5	57.0	2.6	Table 10 (p. 14)
		Exit	1,650 ft. (NW)	**No**	54.4	42.4	54.7	0.3	Table 11 (p. 14)
#4	Crossing E. Stapp Ave.	Entry	150 ft. (W)	**Yes**	56.7	78.6	78.6	21.9	Table 8 (p. 13)
	and other water bodies	Exit	450 ft. (SW)	**No**	53.5	54.3	56.9	3.4	Table 9 (p. 13)
#5	Redfish Bay Causeway	Entry	2,200 ft. (W)	**No**	60.5	48.8	60.8	0.3	Table 6 (p. 12)
	crossing	Exit	150 ft. (S)	**Yes**	57.5	66.8	67.3	9.8	Table 7 (p. 13)
#6	Wetlands & water body	Entry	700 ft. (S)	**Yes**	61.3	62.7	65.0	3.7	Table 4 (p. 12)
	crossing	Exit	1,100 ft. (SE)	**No**	61.3	46.6	61.4	0.1	Table 5 (p. 12)
#7	Redfish Bay crossing	Entry	700 ft. (S)	**Yes**	61.3	62.7	65.0	3.7	Table 2 (p. 11)
		Exit	900 ft. (SE)	**No**	65.7	48.6	65.8	0.1	Table 3 (p. 11)
#10	Offshore pipeline to SPM	Entry	1,300 ft. (E)	**Unknown**	59.0	57.7	61.4	2.4	Table 1 (p. 11)

Table B: Summary of Est'd Sound Level Contribution (Ldn) of HDD Sites with NSAs within ½ Mile of Site(s), assuming No Additional Noise Mitigation Measures (i.e. Standard Rig Employed) and whether the Benchmark Noise Criterion could be Exceeded.

In summary, the acoustical assessment indicates that the noise associated with the following HDD sites could exceed the criterion if no additional noise mitigation measures are employed: HDD #4 Entry Site, HDD #5 Exit Site, HDD #6 Entry Site and HDD #7 Entry Site.

6.0 NOISE MITIGATION MEASURES

Since the sound criterion could be exceeded if no additional mitigation measures are employed at the Project HDD entry sites, it may be necessary to develop a noise mitigation plan to reduce the noise of the HDD operations (i.e., primarily the noise of stationary HDD equipment). Reducing the noise of mobile equipment is more difficult since mobile equipment may work outside the general HDD workspace. The following summarizes noise mitigation options that could be employed primarily at the HDD entry site (i.e., HDD site with the drilling rig), noting that employing full temporary on-site enclosures for primary equipment (e.g., hydraulic power unit) may not be feasible due to equipment cooling requirements and associated costs.

- Employ a temporary noise barrier (for example, 20 to 24 ft. height) around the entry site workspace constructed of a sound-absorptive material that achieves a minimum STC 30–40 rating (e.g., barrier system designed with a septum mass layer or acoustical panel system).
- Employ residential–grade exhaust silencers on engine for any of the site HDD equipment [e.g., generators, high-pressure mud pump (H.P. mud pump) and hydraulic power unit].
- "Close-fit" noise barrier around hydraulic power unit (HPU) and engine-driven pumps by covering the sides of the equipment with a sound-absorptive material that achieves a minimum STC 30–40 rating or install HPU and H.P. mud pump in an enclosure.
- Employ a partial noise barrier around any engine jacket-water coolers.

- Install a partial barrier or partial enclosure around the mud mixing/cleaning system (e.g., sound-absorptive material that achieves a minimum STC 30–40 rating and designed for a sound transmission loss of 15 to 20 dB in the 31.5 Hz and 63 Hz O.B. SPLs).
- Relocate specific equipment (e.g., mud cleaning system and H.P. mud pump).
- Employ low-noise generators, which are designed with a factory-installed enclosure.
- As an alternative to noise mitigation, temporary housing or equivalent monetary compensation could be discussed and/or offered to the affected landowners.
- For an HDD exit site, the most practical mitigation method is to employ a temporary noise barrier at the workspace (20 to 24 ft. height barrier, between site equipment and the closest NSAs), since an exit site includes mostly mobile operating equipment.

For those HDD sites in which the sound criterion could be exceeded during drilling operations, the following **Table C** summarizes the projected sound level contribution (Ldn) of HDD operations at the closest NSA(s) for each HDD site in which additional noise mitigation measures are assumed to be employed (i.e., assumed noise mitigation measures in the noise modeling are denoted in each respective analysis spreadsheet table). Note that the potential increase above the ambient noise should be minimal if adequate noise mitigation measures are employed.

Ref. No.	HDD Crossing	Entry or Exit Point	Distance & Direction of Closest NSA	Ambient Ldn	Calc'd Ldn due to HDD	Ldn of HDD + Ambient	Increase Above Ambient	Reference Table in Appendix
#4	E. Stapp Ave. & water bodies	Entry	150 ft. (W)	56.7	54.4	58.7	2.0	Table 8 (p. 13)
#5	Redfish Bay Causeway	Exit	150 ft. (S)	57.5	53.5	58.9	1.4	Table 7 (p. 13)
#6	Wetlands & water body	Entry	700 ft. (S)	61.3	52.6	61.9	0.6	Table 4 (p. 12)
#7	Redfish Bay crossing	Entry	700 ft. (S)	61.3	52.6	61.9	0.6	Table 2 (p. 11)

Table C: Summary of Estimated Sound Contribution (Ldn) of HDD Operations at the Closest NSA assuming that Additional Noise Mitigation Measures are employed to meet the Sound Criterion.

7.0 SUMMARY AND FINAL COMMENT

The acoustical assessment indicates that the noise attributable to the drilling operations at some of the HDD entry and/or exit sites associated with the installation of the oil pipelines for the **Bluewater SPM Project** could exceed the sound level guideline of **55 dBA** (Ldn) at the closest NSA(s). As a result, feasible noise mitigation measures/options are discussed which could be implemented during drilling activity to reduce the noise at the nearby NSAs associated with the HDD operations. Consequently, if adequate noise mitigations are successfully employed, the sound level due to HDD operations at the planned HDD construction sites should not exceed **55 dBA** (Ldn) at the NSAs, which is the sound level guideline for Project HDD. After the final pipeline route has been established and the actual required HDD sites have been selected, it is anticipated that specific noise mitigation measures that will be implemented for those HDD sites that could exceed the sound criterion will be confirmed.

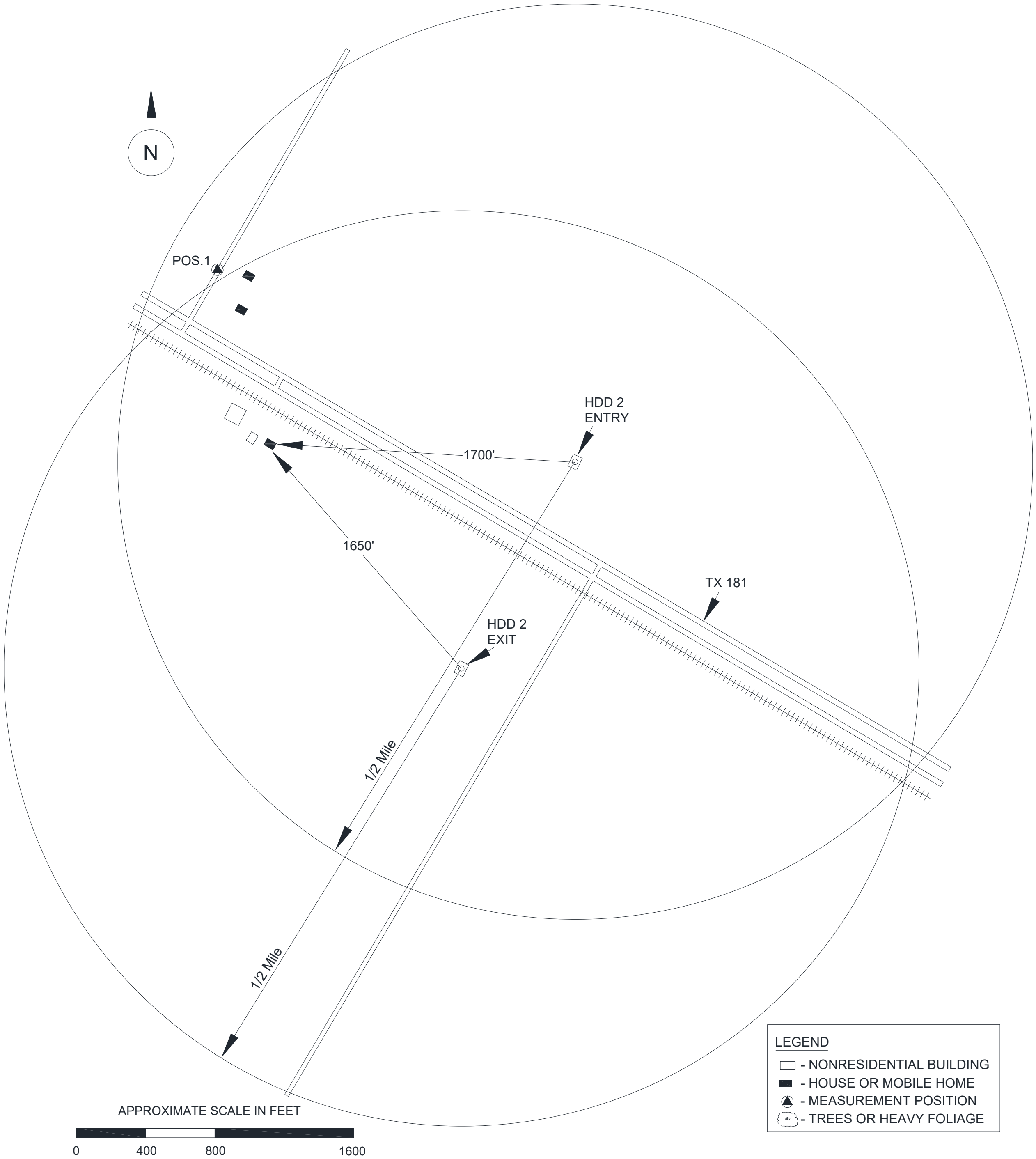

Figure 1: Bluewater SPM Project [HDD #2 (Highway 181 Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Location and the Closest NSA(s).

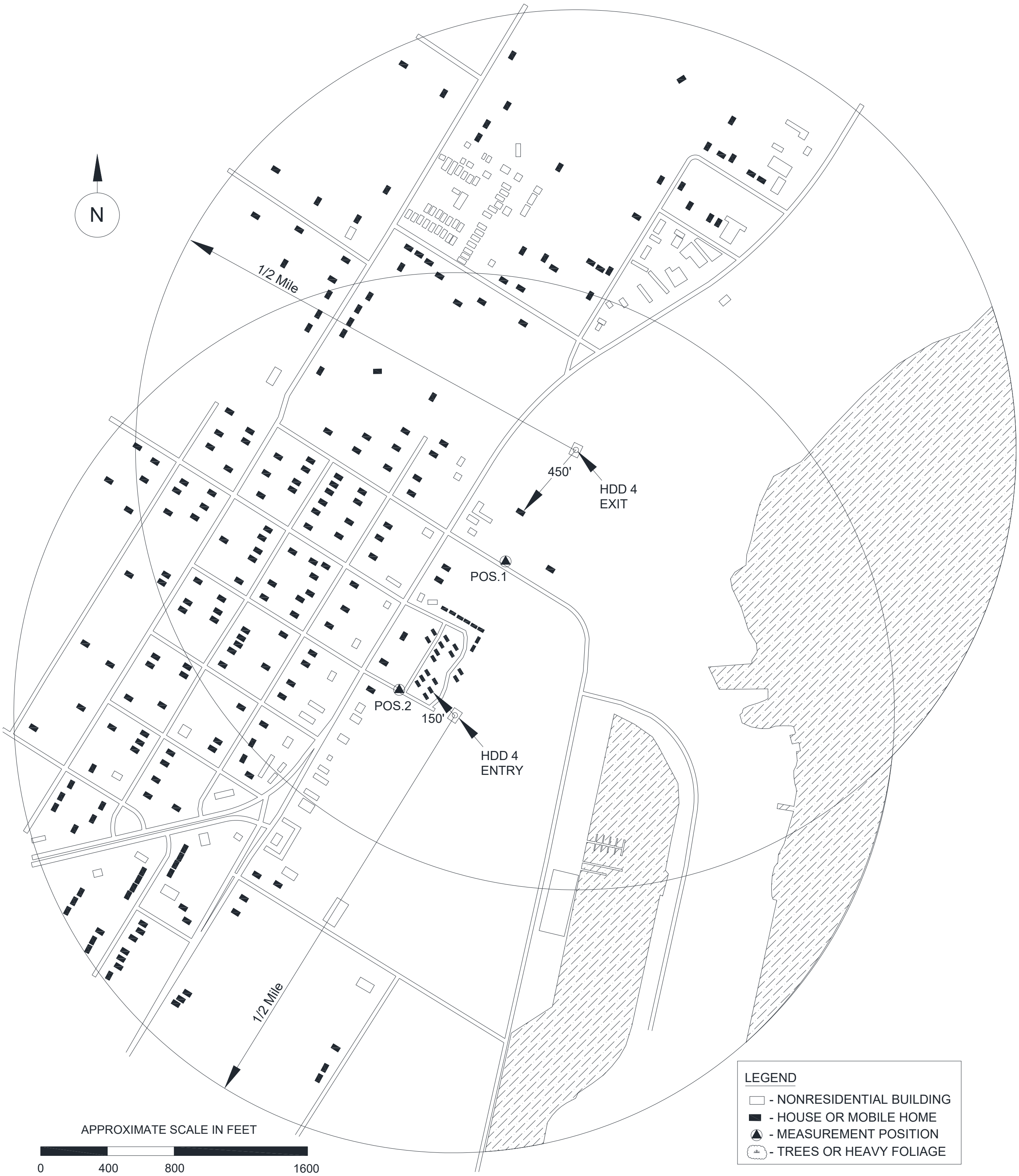

Figure 2: Bluewater SPM Project [HDD #4 (Crossing of E. Stapp Ave. & Water Bodies)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Location and the Closest NSA(s).

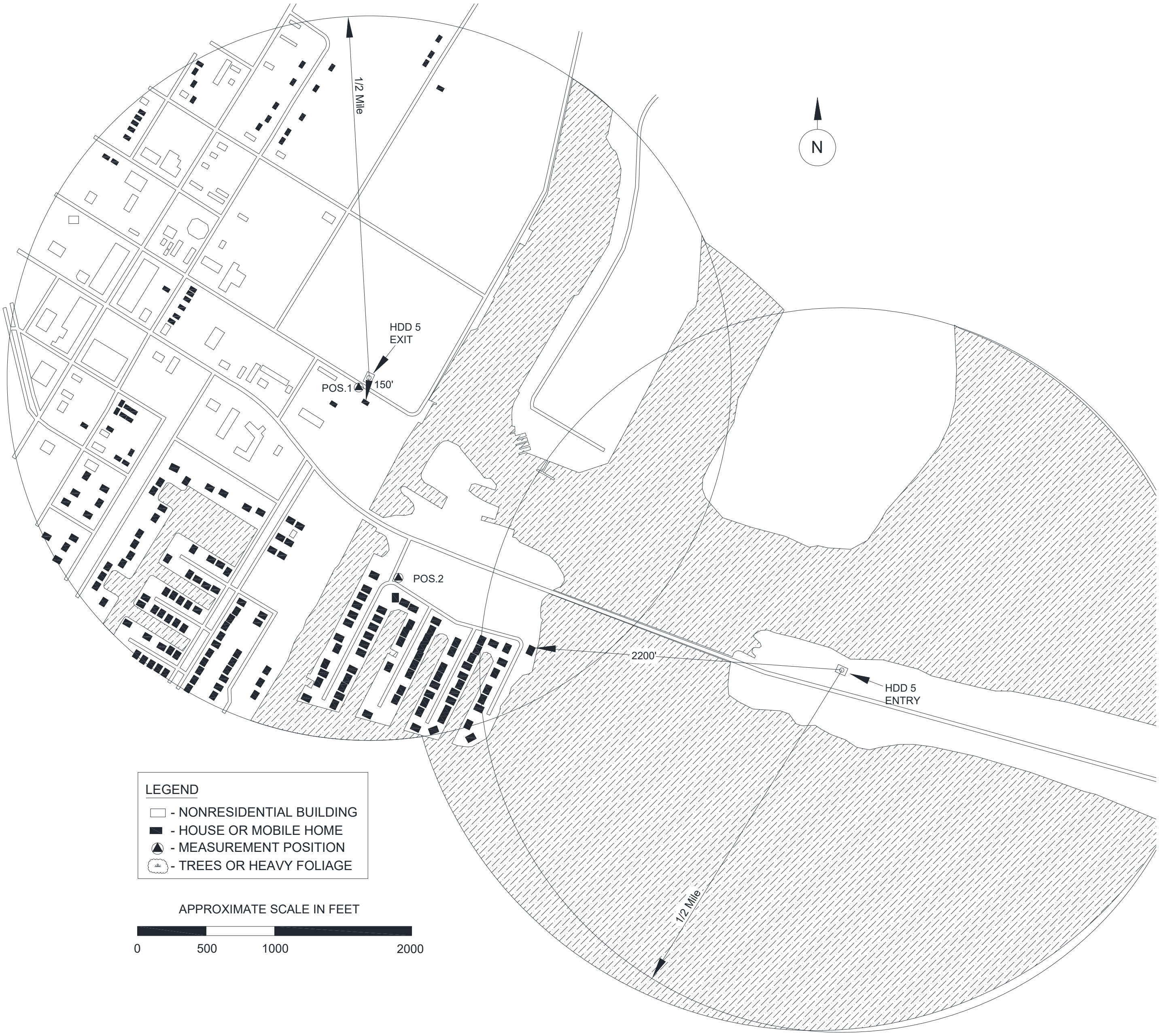

Figure 3: Bluewater SPM Project [HDD #5 (Redfish Bay Causeway Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Location and the Closest NSA(s).

Figure 4: Bluewater SPM Project [HDD #6 and HDD #7 (Wetlands-Water Body Crossing and Redfish Bay Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Location and the Closest NSA(s).

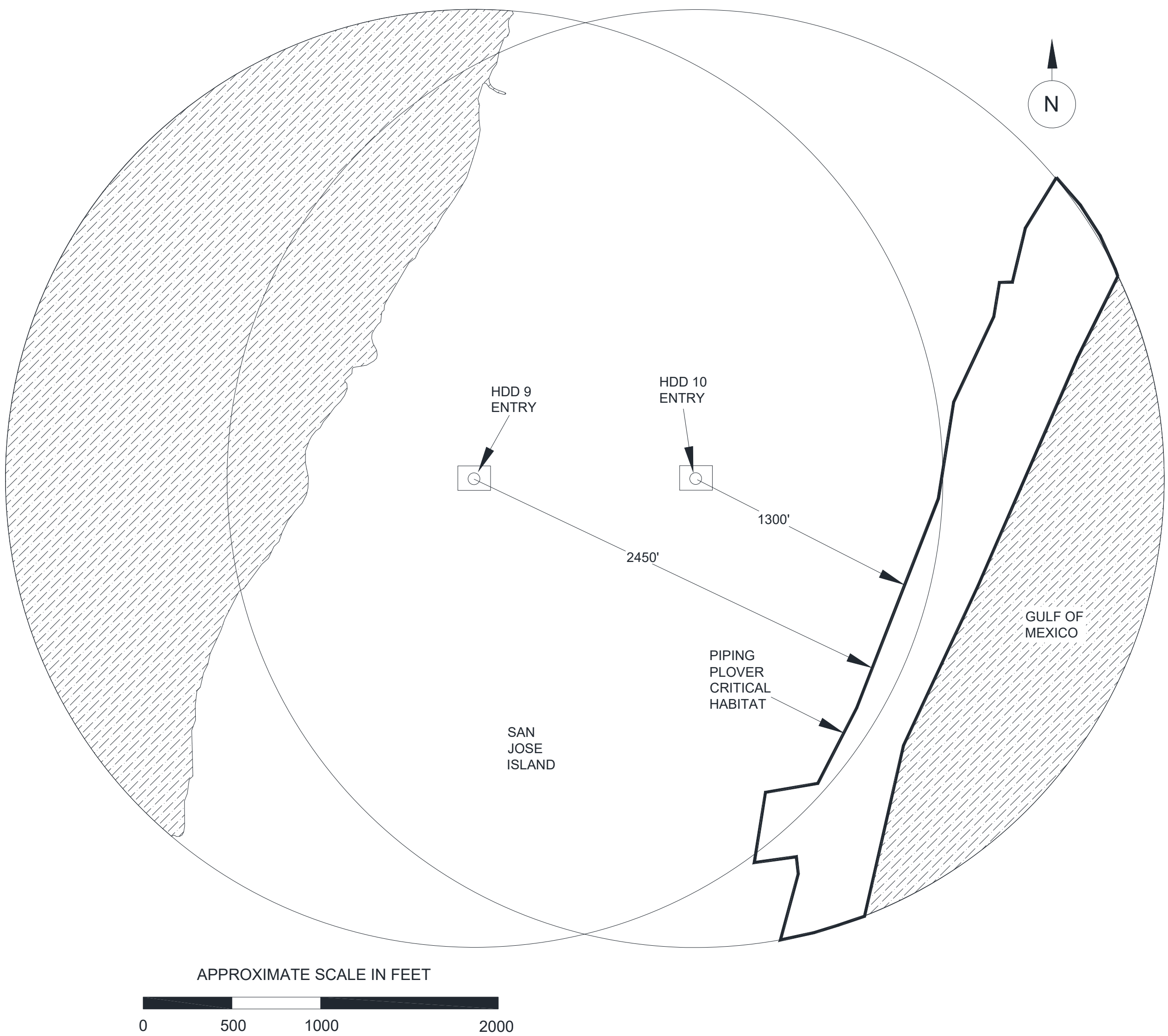

Figure 5: Bluewater SPM Project [HDD #9 and HDD #10 Entry Site (Inner Basin Waterway Crossing and Pipeline Installation to SPM)]: Area Layout showing the HDD Crossing(s), HDD Entry Locations and the Closest NSA (consisting of Piping Plover Critical Habitat).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
		Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)										
	Peak PWL of HDD Operation at an Entry Site	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	0	-1	-1	-2	-3	-3		
1300	Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60		Calc'd
1300	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-10	-18		Ldn*
Est'd Total Sound Contribution with No Additional NC		**58**	**55**	**52**	**53**	**50**	**45**	**41**	**33**	**17**	**51.3**	**57.7**
	Ambient Sound Level (Ldn) in dBA											59.0
	Sound Contribution of HDD plus Ambient Level (dBA)											61.4
	Potential Increase above the Ambient Level (dB)											2.4

Table 1: Bluewater SPM Project [HDD #10 <u>Entry Site</u>]: Estimated Sound Contribution of HDD Operations at the Nearby Critical Habitat (i.e., closest Area of Habitat located approx. 1,300 Ft. East and SE of Entry Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
		Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)										
	Peak PWL of HDD Operation at an Entry Site	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
700	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		Calc'd
700	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-6	-10		Ldn*
Est'd Total Sound Contribution with No Additional NC		**63**	**60**	**57**	**58**	**55**	**50**	**47**	**41**	**29**	**56.3**	**62.7**
	Ambient Sound Level (Ldn) in dBA											61.3
	Sound Contribution of HDD plus Ambient Level (dBA)											65.0
	Potential Increase above the Ambient Level (dB)											3.7
Attenuation due to Added Noise Mitigation Measures		-2	-3	-6	-8	-10	-12	-14	-15	-15		
Est'd Sound Level of HDD + Added Mitigation Measures		61	57	51	50	45	38	33	26	14	**46.2**	**52.6**
	Ambient Sound Level (Ldn) in dBA											61.3
	Sound Contribution of HDD plus Ambient Level (dBA)											61.9
	Potential Increase above the Ambient Level (dB)											0.6

Table 2: Bluewater SPM Project [HDD #7 <u>Entry Site</u>]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 700 Ft. South of Entry Site).
Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a 20-Ft. High Temporary Barrier between the Workspace and the Closest NSA(s).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
		Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)										
	Peak PWL of HDD Operation at an Exit Site	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
900	Hemispherical Radiation	-57	-57	-57	-57	-57	-57	-57	-57	-57		Calc'd
900	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-7	-13		Ldn*
Est'd Total Sound Contribution with No Additional NC		**53**	**51**	**48**	**44**	**40**	**36**	**31**	**23**	**14**	**42.2**	**48.6**
	Ambient Sound Level (Ldn) in dBA											65.7
	Sound Contribution of HDD plus Ambient Level (dBA)											65.8
	Potential Increase above the Ambient Level (dB)											0.1

Table 3: Bluewater SPM Project [HDD #7 <u>Exit Site</u>]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 900 Ft. SE of Exit Site).

Notes: Est'd sound power level ("PWL") of HDD operation based on field tests by H&K on similar type of rig anticipated for this pipeline system, which will be a "standard larger" type of rig. As a result, the estimated PWL values of operations at the HDD exit site should be typically 12 to 14 dB lower than PWL of operations at the HDD entry site.

*Resulting Ldn assumes "worst case" operating condition (i.e., daytime & nighttime operations), in which the Ldn is is calculated by adding 6.4 dBA to the estimated A-wt. sound level. If there are only daytime HDD operations (no nighttime operations), the resulting Ldn is approx. **2 dB lower** than the estimated A-wt. sound level.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	Calc'd Ldn*
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Site	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
700	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		
700	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-6	-10		
Est'd Total Sound Contribution with No Additional NC		**63**	**60**	**57**	**58**	**55**	**50**	**47**	**41**	**29**	**56.3**	**62.7**
			Ambient Sound Level (Ldn) in dBA									61.3
			Sound Contribution of HDD plus Ambient Level (dBA)									65.0
				Potential Increase above the Ambient Level (dB)								3.7
Attenuation due to Added Noise Mitigation Measures		-2	-3	-6	-8	-10	-12	-14	-15	-15		
Est'd Sound Level of HDD + Added Mitigation Measures		61	57	51	50	45	38	33	26	14	**46.2**	**52.6**
			Ambient Sound Level (Ldn) in dBA									61.3
			Sound Contribution of HDD plus Ambient Level (dBA)									61.9
				Potential Increase above the Ambient Level (dB)								0.6

Table 4: Bluewater SPM Project [HDD #6 Entry Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 700 Ft. South of Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a 20-Ft. High Temporary Barrier between the Workspace and the Closest NSA(s).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	Calc'd Ldn*
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Site	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
1100	Hemispherical Radiation	-59	-59	-59	-59	-59	-59	-59	-59	-59		
1100	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-9	-15		
Est'd Total Sound Contribution with No Additional NC		**51**	**49**	**46**	**42**	**39**	**34**	**28**	**20**	**9**	**40.2**	**46.6**
			Ambient Sound Level (Ldn) in dBA									61.3
			Sound Contribution of HDD plus Ambient Level (dBA)									61.4
				Potential Increase above the Ambient Level (dB)								0.1

Table 5: Bluewater SPM Project [HDD #6 Exit Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residences approx. 1,100 Ft. SE of Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	Calc'd Ldn*
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Site	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	-1	-3	-4	-5	-6	-7	-7		
2200	Hemispherical Radiation	-65	-65	-65	-65	-65	-65	-65	-65	-65		
2200	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-9	-18	-31		
Est'd Total Sound Contribution with No Additional NC		**53**	**50**	**46**	**45**	**42**	**35**	**29**	**17**	**0**	**42.4**	**48.8**
			Ambient Sound Level (Ldn) in dBA									60.5
			Sound Contribution of HDD plus Ambient Level (dBA)									60.8
				Potential Increase above the Ambient Level (dB)								0.3

Table 6: Bluewater SPM Project [HDD #5 Entry Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residences approx. 2,200 Ft. West of Entry Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Site	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	0	-1	-1	-2	-3	-3		
150	Hemispherical Radiation	-41	-41	-41	-41	-41	-41	-41	-41	-41		Calc'd
150	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-1	-2		Ldn*
Est'd Total Sound Contribution with No Additional NC		**69**	**67**	**64**	**61**	**58**	**55**	**51**	**47**	**42**	**60.4**	**66.8**
	Ambient Sound Level (Ldn) in dBA											57.5
	Sound Contribution of HDD plus Ambient Level (dBA)											67.3
	Potential Increase above the Ambient Level (dB)											9.8
Attenuation due to Added Noise Mitigation Measures		-3	-5	-8	-12	-14	-15	-16	-18	-18	-28	
Est'd Sound Level of HDD + Added Mitigation Measures		66	62	56	49	44	40	35	29	24	**47.1**	**53.5**
	Ambient Sound Level (Ldn) in dBA											57.5
	Sound Contribution of HDD plus Ambient Level (dBA)											58.9
	Potential Increase above the Ambient Level (dB)											1.4

Table 7: Bluewater SPM Project [HDD #5 Exit Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 150 Ft. South of Exit Site).
Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as 20-Ft. Barrier Between the Workspace and Closest NSA(s).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Site	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	0	-1	-1	-2	-3	-3		
150	Hemispherical Radiation	-41	-41	-41	-41	-41	-41	-41	-41	-41		Calc'd
150	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-1	-2		Ldn*
Est'd Total Sound Contribution with No Additional NC		**77**	**74**	**71**	**73**	**70**	**66**	**64**	**61**	**52**	**72.2**	**78.6**
	Ambient Sound Level (Ldn) in dBA											56.7
	Sound Contribution of HDD plus Ambient Level (dBA)											78.6
	Potential Increase above the Ambient Level (dB)											21.9
Attenuation due to Added Noise Mitigation Measures		-5	-10	-16	-22	-25	-26	-28	-30	-30		
Est'd Sound Level of HDD + Added Mitigation Measures		72	64	55	51	45	40	36	31	22	**48.0**	**54.4**
	Ambient Sound Level (Ldn) in dBA											56.7
	Sound Contribution of HDD plus Ambient Level (dBA)											58.7
	Potential Increase above the Ambient Level (dB)											2.0

Table 8: Bluewater SPM Project [HDD #4 Entry Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 150 Ft. West of Entry Site).
Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as 24-Ft. Barrier between the Workspace and Closest NSA(s); also, Enclosures for HPU and H.P. Mud Pump, and Mud System Barrier.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Site	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	-1	-2	-3	-4	-5	-6	-6		
450	Hemispherical Radiation	-51	-51	-51	-51	-51	-51	-51	-51	-51		Calc'd
450	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-4	-6		Ldn*
Est'd Total Sound Contribution with No Additional NC		**59**	**57**	**53**	**49**	**46**	**42**	**37**	**32**	**25**	**47.9**	**54.3**
	Ambient Sound Level (Ldn) in dBA											53.5
	Sound Contribution of HDD plus Ambient Level (dBA)											56.9
	Potential Increase above the Ambient Level (dB)											3.4

Table 9: Bluewater SPM Project [HDD #4 Exit Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 450 Ft. SW of Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Site	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
1700	Hemispherical Radiation	-62	-62	-62	-62	-62	-62	-62	-62	-62		Calc'd
1700	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-7	-14	-24		Ldn*
Est'd Total Sound Contribution with No Additional NC		**56**	**53**	**49**	**50**	**46**	**40**	**35**	**25**	**7**	**47.1**	**53.5**
			Ambient Sound Level (Ldn) in dBA									54.4
			Sound Contribution of HDD plus Ambient Level (dBA)									57.0
				Potential Increase above the Ambient Level (dB)								2.6

Table 10: Bluewater SPM Project [HDD #2 Entry Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 1,700 Ft. West of Entry Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Site	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Foliage, Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
1650	Hemispherical Radiation	-62	-62	-62	-62	-62	-62	-62	-62	-62		Calc'd
1650	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-7	-13	-23		Ldn*
Est'd Total Sound Contribution with No Additional NC		**48**	**46**	**43**	**38**	**35**	**30**	**22**	**12**	**0**	**36.0**	**42.4**
			Ambient Sound Level (Ldn) in dBA									54.4
			Sound Contribution of HDD plus Ambient Level (dBA)									54.7
				Potential Increase above the Ambient Level (dB)								0.3

Table 11: Bluewater SPM Project [HDD #2 Exit Site]: Estimated Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 1,650 Ft. NW of Exit Site).

Description of Acoustical Assessment Methodology and Source of Sound Data

In general, the predicted A-wt. sound level contributed by drilling operations at HDD operations at the nearby NSAs was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) during "peak" operations of HDD stationary equipment at either the HDD entry site or HDD exit site. The following summarizes the acoustical analysis procedure:

- Initially, unweighted O.B. PWLs of the HDD operations were determined from actual sound level measurements by H&K on similar type of HDD operations and equipment expected for this project. Estimated PWL values of the HDD operations were calculated from sound measurements at different distances/directions from HDD operations* (e.g., sound measurements at 100 feet, 200 feet, 400 feet and 800 feet from typical HDD equipment operations).

- Then, expected attenuation in dB per O.B. frequency due to hemispherical sound propagation (discussed in more detail below**), atmospheric sound absorption (discussed in more detail below***) and other factors (e.g., attenuation due to foliage and topography***) were subtracted from the unweighted O.B. PWLs to obtain unweighted O.B. sound pressure levels (SPLs) of HDD operations, and

- Finally, the resulting estimated total unweighted O.B. SPLs for the HDD operations, including sound attenuation effects, were logarithmically summed and corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the drilling operations at the specified distance.

*It should be noted that the estimated sound power levels of HDD operations utilized in the H&K acoustical analyses were based on measured sound level data at different distances from actual HDD construction sites, and therefore, the PWL values, for the most part, includes the effect of ground effect (e.g., ground absorption). Consequently, in our opinion, it would <u>not be appropriate</u> to strictly follow international–based standards, such as ISO 9613-2[1], when calculating the estimated A-wt. sound level at a respective receptor (i.e., NSA) via the PWL values utilized in the H&K acoustical analysis methodology.

**<u>Attenuation due to hemispherical sound propagation</u>: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the source. The following equation is the theoretical decrease of sound energy when determining the resulting O.B. SPLs of a noise source at a specific distance ("r") of a receiver from a source O.B. PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

[1]International Standard Organization (ISO) 9613-2, Dec. 15, 1996 (Publication Date): *Acoustics - Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation*

***Attenuation due to air absorption, foliage and topography: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB** per 1,000 feet for standard day conditions. Potential attenuation of foliage, based on our experience and an ISO Standard[2], the "medium-frequency" attenuation (i.e., 1000 Hz) due to forest/trees greater than 500 feet thick is approximately **10 dB**. Also, forested areas with plantings more than 100 feet deep can provide some attenuation of ground level noise sources. In addition, the topography (e.g., land contour, such as a hill or ridge) between the HDD site and the nearby NSA(s) can provide some additional attenuation of the HDD noise contribution at the respective NSA(s).

Summary of Typical Metrics and Acoustical Terminology

(1) Daytime Sound Level (L_d) & Nighttime Sound Level (L_n): L_d is the equivalent A-weighted sound level, in decibels, for a 15 hour time period, between 07:00 to 22:00 Hours (7:00 a.m. to 10:00 p.m.). L_n is the equivalent A-weighted sound level, in decibels, for a 9 hour time period, between 22:00 to 07:00 Hours (10:00 p.m. to 7:00 a.m.).

(2) Equivalent Sound Level (L_{eq}): The equivalent sound level (L_{eq}) can be considered an average sound level measured during a period of time, including any fluctuating sound levels during that period. In this report, the L_{eq} is equal to the level of a steady (in time) A-weighted sound level that would be equivalent to the sampled A-weighted sound level on an energy basis for a specified measurement interval. The concept of the measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

(3) Day-Night Average Sound Level (L_{dn}): The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and the measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. As such, the L_{dn} is not a true measure of the sound level but represents a skewed average that correlates generally with past sound surveys which attempted to relate environmental sound levels with physiological reaction and physiological effects. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, an L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured, then the L_{dn} is calculated using the following formula:

$$L_{dn} = 10\log_{10}\left(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10}\right)$$

(4) Sound Power Level (L_W or PWL): Ten times the common logarithm of the ratio of the total acoustic power radiated by a sound source to a reference power. A reference power of a picowatt or 10^{-12} watt is conventionally used.

End of Report

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[2] ISO Standard 9613-1: 1993 (E); *Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the Absorption of Sound by the Atmosphere, and Part 2: General method of calculation*

Subject: **Bluewater Project Booster and Transfer Station (Nueces County, Texas): Results of an Ambient Sound Survey and Acoustical Assessment of a new Booster Station associated with the Bluewater SPM Project**

Prepared for: **Edge Engineering & Science** ("Edge E&S")
Project Applicant: **Bluewater Texas Terminal LLC**

H&K Report No. 3866
Date of Report: March 13, 2019
H&K Job No. 5277
Submitted by: Paul D. Kiteck, P.E.**, Hoover & Keith Inc.** (H&K)

1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** (H&K) provides the results of a site ambient sound survey and acoustical assessment of a booster and transfer station (abbreviated as "booster station" or "Bluewater Booster Station") associated with the **Bluewater SPM Project** ("Project"). The purpose of the acoustical assessment is to estimate the sound contribution of the booster station during operation at the closest noise-sensitive areas (NSAs), such as residences, hospitals, schools and/or recreational areas (e.g., public parks), located within 1 mile of the booster station site, and if necessary, provide noise control measures to meet sound guidelines-criteria. The purpose of the ambient sound survey was to verify surrounding NSAs and quantify current environmental sound levels at the identified nearby NSAs.

2.0 DESCRIPTION OF THE SITE/FACILITY

Figure 1 (p. 5) provides a drawing showing the location of the new booster station along with the identified NSAs within approximately 1 mile of the booster station site, other areas of interest and the chosen sound measurement positions during the ambient sound survey. The booster station site will be located in Nueces County, Texas, just north of Port Aransas (TX), and the booster station site is considered to be located within the city limits of Port Aransas. There are only a few NSAs (primarily residences and park) within 1 mile of the booster station site, and the closest NSAs consist of the Roberts Point Park and several residences located almost 1 mile south of the booster station site.

Figure 2 (p. 6) provides a drawing showing the conceptual layout of the booster station (e.g., equipment, tanks, piping and fenceline). Currently, we understand that the booster station, which is also a crude oil transfer facility, will be designed with at least four (4) 5,500 horsepower (HP) electric motor-driven crude oil pump units that will serve two (2) crude oil pipelines (i.e., 11,000 HP per each pipeline). In addition, an electrical substation and MCC and/or Electrical Building ("EB") will be employed to serve the crude oil pumps [i.e., MCC may include a type of variable frequency drive (“VFD”)]. Also, we understand that the motors and pumps of the pump units will be enclosed inside a building (“Pump House”) to attenuate pump noise.

3.0 SOUND CRITERIA/GUIDELINES, TYPICAL METRICS AND TERMINOLOGY

3.1 Acoustical Terminology and Example of Typical Environmental Sound Levels: For the reader’s information, a summary of acoustical terminology and list of typical metrics used to measure and regulate environmental noise is provided at the end of the report (pp. 10–12). There are several metrics for quantifying and regulating environmental noise level although the most common metric used by state and municipal agencies is the A-wt. sound level (“dBA”). There are also other metrics, such as L_{eq} and day-night average sound level (“L_{dn}”), that are used to correlate human reaction to an intruding sound.

3.2 Federal Sound Requirements for FERC Project, as a Sound Guideline: The Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) typically requires that the sound level contribution of a new compressor station (e.g., booster station) at an nearby NSAs not exceed an day-night average A-weighted (A-wt.) sound level (“dBA”) of **55 dBA** (i.e., L_{dn}). Although we understand that this Project is not under the FERC jurisdiction, this FERC sound level requirement could be utilized as a sound guideline, noting that no applicable state and/or local noise regulations (i.e., respective townships, county or cities) have been identified.

3.3 County and/or Township Noise Regulations: No applicable county noise regulations have been identified. There are “nuisance-type” noise regulations in the Port Aransas Code of Ordinances (i.e., Chapter 10 – Health and Sanitation; Article IV. – Noise), stating “Any unreasonably loud, disturbing, unnecessary noise which causes material distress, discomfort or injury to persons of ordinary sensibilities in the immediate vicinity thereof is hereby declared to be a nuisance and is prohibited” (Sec. 10-51. – Nuisance declared and prohibited).

3.4 Discussion of Noise Impact of a new Booster Station: This section provides a proposed “noise level guideline” that could be utilized to determine the potential noise impact at any NSA due to the construction and operation of a booster station. If an intruding noise (e.g., noise generated by the booster station) causes less than a **3 dB** increase in the background sound level (i.e., ambient sound level) at the surrounding NSAs (i.e., defined as “potential noise increase”), the booster station noise should be barely perceivable by the human ear and should have minimum impact on the acoustical environment. If an intruding noise causes an increase in the overall sound level of between **4 dB** and **6 dB**, the noise of the booster station may be audible by the human ear but should still have minimum impact on the acoustical environment and should not be considered a “nuisance”.

4.0 AMBIENT SOUND SURVEY/DATA AND SOUND MEASUREMENT METHODOLOGY

Ambient sound measurements and verification of NSAs were performed by Larry Lengyel of H&K during the daytime of Feb. 5, 2019. Ambient sound levels were measured near the identified closest NSAs to the booster station site. At each sound measurement location, the ambient A-wt. equivalent sound level (L_{eq}) and related unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured. The acoustical measurement system consisted of a Norsonic Model Nor140 Sound Level Meter (a Type 1 SLM per ANSI S1.4 & S1.11) equipped with a microphone covered with a windscreen. The SLM was calibrated with a mic calibrator (calibrated within 1 year of the tests).

For reference, **Table 1** (p. 7) shows the measured ambient daytime L_{eq} (L_d) near the closest NSAs along with the averaged measured L_d since more than one test sample was taken at the reported sound measurement positions during the sound tests. **Table 1** also includes the resulting ambient L_{dn} at the closest NSAs (as calculated from the measured ambient L_d). Meteorological conditions that occurred during the sound tests are summarized in **Table 2** (p. 7). Measured ambient L_d and related unweighted daytime O.B. SPLs at the reported measurement positions are provided in **Table 3** (p. 7).

5.0 ACOUSTICAL ASSESSMENT, SUMMARY AND FINAL COMMENT

The noise assessment considers the noise produced by all equipment that could contribute to the noise generated by the booster station, based on the assumed preliminary design. A description of the analysis methodology is provided toward the end of the report (p. 9). The predicted sound contribution of booster station was performed at the closest residence (i.e., NSA #1 and NSA #2) since the sound contribution of the booster station at more distant NSAs should be lower than the estimated sound contribution at these identified closest NSAs. For the noise assessment, the following equipment were considered significant and potential noise sources:

- Noise of electric motor-driven crude oil pumps (current acoustical analysis will assume that the pumps will not be covered with a type of enclosure-building).
- Noise associated with electrical substation and the MCC (may include a VFD), which included noise generated by the MCC/VFD air exhaust system and wall-mounted AC units.
- Noise radiated from the aboveground piping associated with the pumps.

Table 4 (p. 8) shows the spreadsheet calculation of the estimated A-wt. sound level and unweighted O.B. SPLs contributed by at NSA #1 (i.e., Roberts Point Park) for standard day propagating conditions (i.e., no wind, 60 deg. F, 70% R.H.). In addition, **Table 4** includes estimated <u>total</u> cumulative sound level at NSA #1 (i.e., sound level of the booster station plus the ambient sound level), and the estimated potential increase in the existing ambient sound level at NSA #1 during operation of the booster station.

Table 5 (p. 8) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the booster station at NSA #2 (i.e., residences along Port Street) based on the estimated booster station sound level contribution in **Table 4**. In addition, **Table 5** includes estimated total cumulative sound level at NSA #2 (i.e., sound level of booster station plus the ambient sound level) and the estimated potential increase in the ambient sound level at NSA #2.

6.0 SUMMARY OF ACOUSTICAL ASSESSMENT RESULTS AND FINAL COMMENT

The following **Table A** summarizes the measured noise environment via the recent ambient sound survey, the estimated sound contribution of the booster station at the closest NSAs and the estimated total sound level of the booster station during along with the potential increase in the existing sound level at the closest NSAs during operation of the booster. The results in this table are defined as the "Noise Quality Analysis".

Identified nearby NSAs and Type of NSA	Distance & Direction of NSA to Station Site Center	Ambient A-Wt. Sound Level (Ld)	Estimated A-Wt. Sound Level of the Booster Station	Estimated A-Wt. Sound Level of Booster Station plus Ambient Sound Level	Potential Noise Increase
NSA #1 (Park)	4,400 feet (S)	51.2 dBA	35.6 dBA (Ldn of 42.0 dBA)	51.3 dBA	0.1 dB
NSA #2 (Residences)	5,000 feet (SSW)	44.9 dBA	34.1 dBA (Ldn of 40.5 dBA)	45.2 dBA	0.3 dB

Table A: Noise Quality Analysis for the new Booster Station associated with the Bluewater SPM Project

The results of the acoustical assessment of the Bluewater SPM Project Booster Station indicates the following:

- Sound level contribution of the booster station during operation should be significantly lower than an L_{dn} of **55 dBA** at the surrounding NSAs, which is considered a sound level guideline for this type of facility, as related to current federal (FERC) sound requirements.

- Potential noise increases in the ambient sound level due to the booster station during operation should be less than **3 dB** at the nearby NSAs (i.e., park and residences). Consequently, the noise of the booster station during operation may be audible, at times, by the human ear but should have minimum impact on the surrounding acoustical environment but the noise of the booster station should not be a nuisance in the community or other surrounding park(s) and recreational areas.

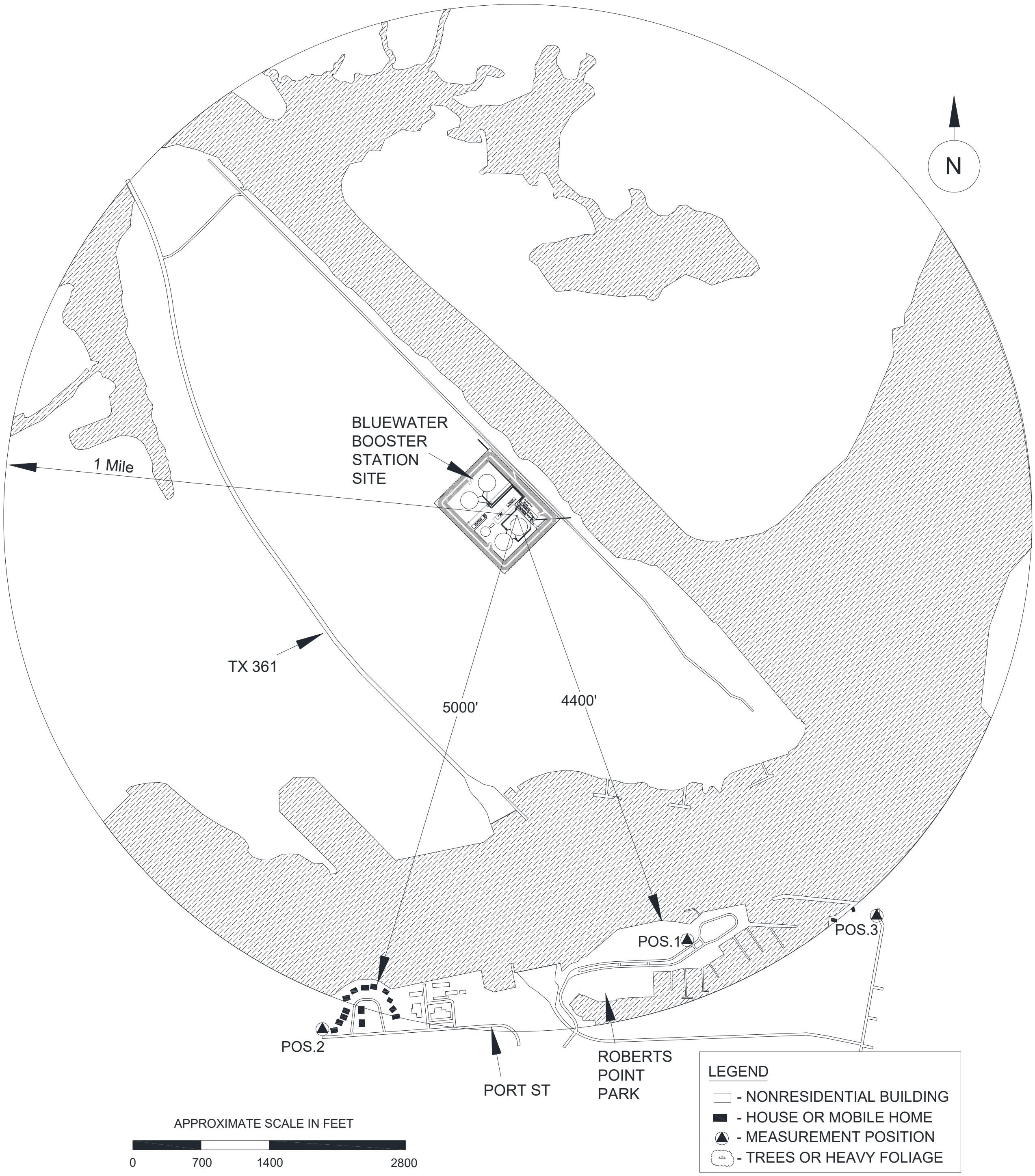


Figure 1: Bluewater Project Booster Station for Bluewater SPM Project: Area Layout/Map showing the Planned Site of Booster Station, NSAs within approximately 1 Mile of the Booster Station Site and Chosen Sound Measurement Positions near the Closest NSAs.

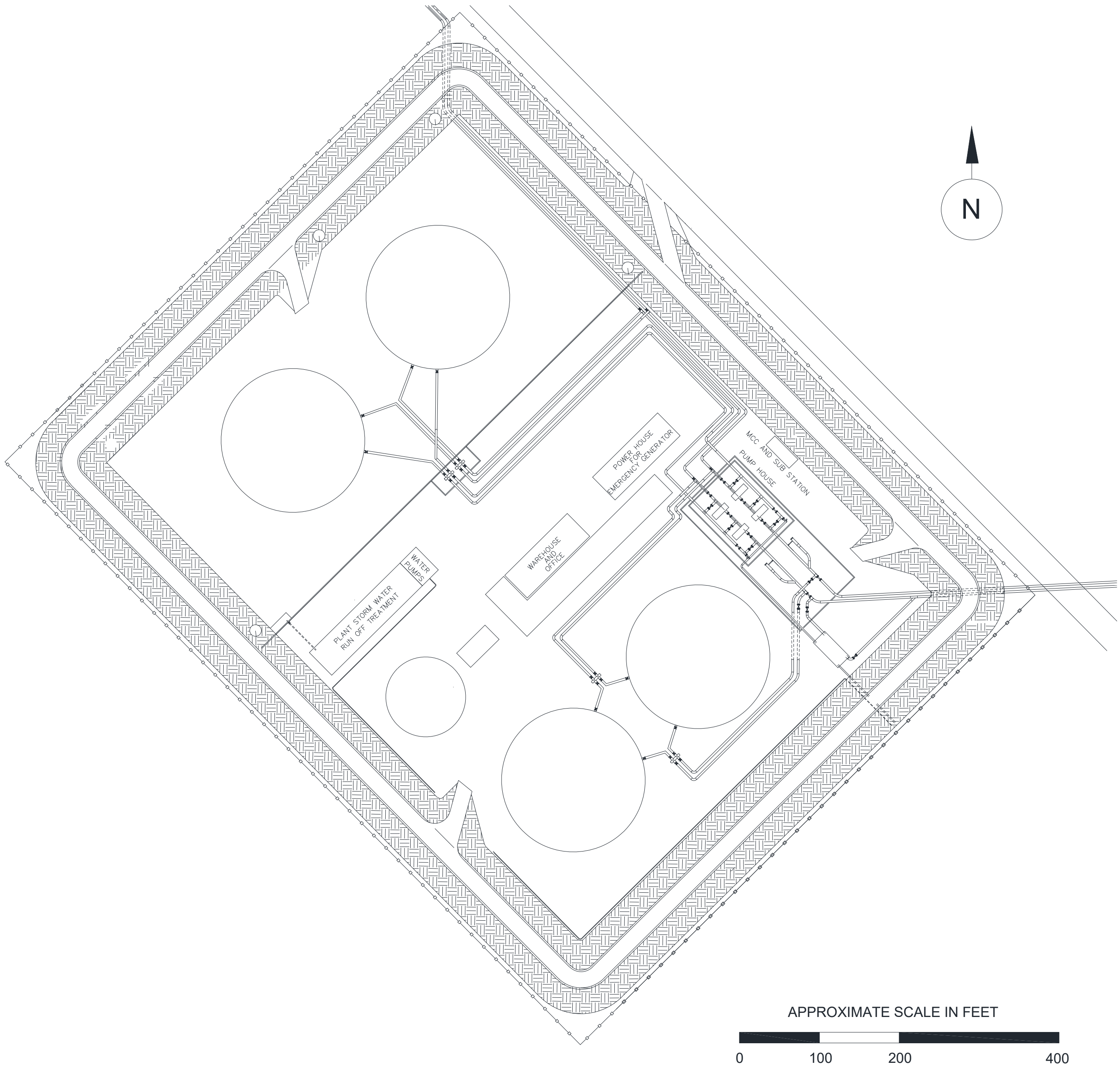


Figure 2: Bluewater Project Booster Station for Bluewater SPM Project: Drawing showing a Conceptual Layout (Plot Plan) of the Booster Station.

Measurement Set		Meas'd/Calc'd A-Wt. Levels (dBA)				
Meas. Pos. & NSA	Time/Date of Test	Day-time Leq(Ld)	Avg'd of Ld	Night time Leq(Ln)	Calc'd Ldn Note (1)	Notes/Observations
Pos. 1 (NSA #1) Roberts Point Park 4,400 ft. south of the Booster Station Site	3:41 PM (2/5/19) 3:43 PM (2/5/19) 3:44 PM (2/5/19)	49.6 52.4 51.5	**51.2**	Not Meas'd	**57.6** Note (1)	Primary noise during test: Wind, distant traffic, birds, distant ferry, and distant people.
Pos. 2 (NSA #2) Residences (Port St) 5,000 ft. SSW of the Booster Station Site	4:02 PM (2/5/19) 4:02 PM (2/5/19) 4:02 PM (2/5/19)	44.4 45.4 45.0	**44.9**	Not Meas'd	**51.3** Note (1)	Primary noise during test: distant traffic, wind, waves, and distant airplane.

Table 1: Bluewater SPM Project Booster Station: Summary of Ambient Daytime Sound Levels (Ld) at the closest NSAs, as Measured on Feb. 5, 2019, along with Resulting Ambient Ldn.

Note (1): Ldn calculated by adding 6.4 dB to the measured Ld. If both the Ld and Ln are measured and/or estimated, the Ldn is calculated using the following formula:

$$L_{dn} = 10 \log_{10}\left(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10}\right)$$

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	Time Frame/Date of Tests	(°F)	(%)	Direction	Speed	Wind	Sky Conditions
Pos. 1 & 2	3:00 PM to 5:00 PM (2/5/19)	72	93	from WNW	3 mph	8 mph	Foggy, Overcast

Table 2: Bluewater SPM Project Booster Station: Summary of the Meteorological Conditions during the Sound Survey on Feb. 5, 2019.

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Frequency (in Hz)									A-Wt.
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000	Level
Pos. 1 (NSA #1)	3:41 PM (2/5/19)	67.0	64.9	59.7	49.3	45.0	42.8	38.9	33.3	25.2	49.6
Roberts Point Park	3:43 PM (2/5/19)	70.1	67.3	65.1	49.4	45.1	43.3	40.1	40.8	30.0	52.4
4,400 ft. south of the	3:44 PM (2/5/19)	69.4	66.4	64.4	48.7	43.5	42.0	40.6	39.1	26.0	51.5
Booster Station Site	**Avg. A-Wt. & SPL**	**68.8**	**66.2**	**63.1**	**49.1**	**44.5**	**42.7**	**39.9**	**37.7**	**27.1**	**51.2**
Pos. 2 (NSA #2)	4:02 PM (2/5/19)	69.1	60.0	53.4	43.5	40.8	38.1	32.9	28.1	23.9	44.4
Residences (Port St)	4:02 PM (2/5/19)	59.9	58.4	53.5	45.3	42.6	39.8	33.9	28.4	22.7	45.4
5,000 ft. SSW of the	4:02 PM (2/5/19)	61.6	58.9	54.3	44.7	41.9	38.7	33.3	27.9	23.3	45.0
Booster Station Site	**Avg. A-Wt. & SPL**	**63.5**	**59.1**	**53.7**	**44.5**	**41.8**	**38.9**	**33.4**	**28.1**	**23.3**	**44.9**

Table 3: Bluewater SPM Project Booster Station: Measured Ambient A-Wt. Sound Level (Ld) and Unweighted Octave-Band ("O.B.") SPLs at the NSAs, as Measured on Feb. 5, 2019.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level
		31.5	63	125	250	500	1000	2000	4000	8000	
1)	PWL of Unenclosed Motor-Driven Pumps	102	105	110	112	108	106	104	102	98	112
	Atten. of Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding, Foliage or Ground Effect)	0	0	0	0	0	0	-1	-2	-3	
4400	Hemispherical Radiation	-71	-71	-71	-71	-71	-71	-71	-71	-71	
4400	Atm. Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-3	-7	-13	-33	-60	
4400	Source Sound Level Contribution	31	34	39	40	34	29	19	0	0	36
2)	PWL of Electrical Equipment (VFD/Switchgear)	85	90	98	95	90	85	80	75	72	92
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding, Foliage or Ground Effect)	0	0	0	0	0	0	-1	-2	-3	
4400	Hemispherical Radiation	-71	-71	-71	-71	-71	-71	-71	-71	-71	
4400	Atm. Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-3	-7	-13	-33	-60	
4400	Source Sound Level Contribution	14	19	27	23	16	8	0	0	0	18
3)	PWL of Outdoor Aboveground Piping	80	85	80	78	70	68	62	55	50	74
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0	
	Misc. Atten. (Shielding, Foliage or Ground Effect)	0	0	0	0	0	0	-1	-2	-3	
4400	Hemispherical Radiation	-71	-71	-71	-71	-71	-71	-71	-71	-71	
4400	Atm. Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-3	-7	-13	-33	-60	
4400	Source Sound Level Contribution	9	14	9	5	0	0	0	0	0	7
Est'd Total Sound Contribution of Station at NSA #1		**31**	**34**	**39**	**40**	**34**	**29**	**19**	**0**	**0**	**35.6**

Ambient A-Wt. Sound Level via Sound Survey	**51.2**
Sound Level of Station plus Ambient A-Wt. Sound Level	51.3
Potential Increase above Ambient Sound Level (dB)	0.1

Table 4: Bluewater SPM Project Booster Station: Est'd Sound Contribution of the Booster Station at NSA #1 (i.e., Roberts Point Park located 4,400 Ft. South of Booster Station Site) due to the Operation of the Station Motor-Driven Pumps. Included is the Potential Increase in the Existing Ambient Sound Level after Installation of the Booster Station.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level
		31.5	63	125	250	500	1000	2000	4000	8000	
	A-Wt. & SPLs of Station at 4,400 Ft. (RE: Table 4)	31	34	39	40	34	29	19	0	0	35.6
5000	Hemisph Radiation [20*log(5000/4400) = 1.1 dB]	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	
5000	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-8	
Est'd Total Sound Contribution of Station at NSA #2		**30**	**33**	**38**	**38**	**33**	**27**	**16**	**0**	**0**	**34.1**

Ambient A-Wt. Sound Level via Sound Survey	**44.9**
Sound Level of Station plus Ambient A-Wt. Sound Level	45.2
Potential Increase above Ambient Sound Level (dB)	0.3

Table 5: Bluewater SPM Project Booster Station: Est'd Sound Contribution of the Booster Station at NSA #2 (i.e., Residences located 5,000 Ft. SSW of the Booster Station Site) due to the Operation of the Station Motor-Driven Pumps. Included is the Potential Increase in the Existing Ambient Sound Level after Installation of the Booster Station.

Description of Acoustical Assessment Methodology and Source of Sound Data

In general, the predicted sound level contributed by the booster station was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) for the booster station with similar operating conditions and equipment anticipated for this specific booster station. The following summarizes the acoustical analysis procedure:

- Initially, unweighted O.B. PWL values of the significant noise sources were determined from equipment manufacturer's sound data and/or actual sound measurements performed by H&K at similar type of booster station).

- Then, expected noise reduction ("NR") or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by structures and/or topography can influence the sound level contributed at the NSAs, sound shielding due to structures or site topography were included in the acoustical analysis, if appropriate. The sound attenuation effect due to foliage was also considered in the acoustical analysis, if appropriate.

- Finally, the resulting estimated unweighted O.B. SPLs for all noise sources associated with the booster station (with any noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the booster station at the closest NSA. The predicted sound contribution of the booster station at the closest NSA was utilized to estimate the noise contribution at the other nearby NSAs that are more distant that the closest NSA.

*<u>Attenuation due to hemispherical sound propagation</u>: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the sound source. The following equation is the theoretical decrease of sound energy when determining the resulting SPL values of a noise source at a specific distance ("r") of a receiver from the estimated PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

<u>Attenuation due to air absorption</u>: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F and 70% R.H.).

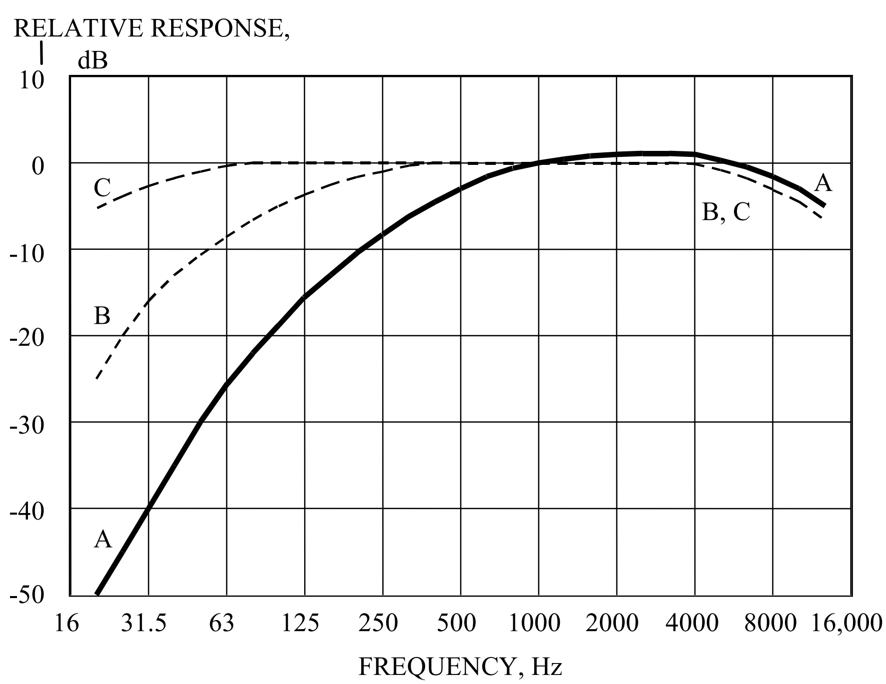
Summary of Typical Metrics and Acoustical Terminology

(1) Decibel ("dB"): A unit for expressing the relative power level difference between acoustical or electrical signals. It is ten times the common logarithm of the ratio of two related quantities that are proportional to power. When adding dB or dBA values, the values must be added logarithmically. For example, the logarithmic addition of **35 dB** plus **35 dB** is **38 dB**.

(2) A-Weighted Sound Level ("dBA"): The A-wt. sound level is a single-figure sound rating, expressed in decibels (Re 20 μPa), which correlates to the human perception of the loudness of sound. The dBA level is commonly used to measure industrial and environmental noise since it is easy to measure and provides a reasonable indication of the human annoyance value of the noise. The dBA measurement is not a good descriptor of a noise consisting of strong low-frequency components or for a noise with tonal components.

The A-weighted curve approximates the response of the average ear at sound levels of 20 to 50 decibels. The following are the relative response of A-weighted filter per octave band frequency, and a graph/curve is provided that shows a graphical representation of the A-wt. filter response per frequency (in Hz).

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	16,000 Hz
-39.4 dB	-26.2 dB	-16.1 dB	-8.6 dB	-3.2 dB	0 dB	+1.2 dB	+1.0 dB	-1.1 dB	-6.6 dB



(3) Human Perception of Change in Sound Level

- A **3-dB** change of sound level is barely perceivable by the human ear
- A **5- or 6-dB** change of sound level is noticeable
- If sound level increases by **10 dB**, it appears as if the sound intensity has doubled.

(4) Background or Ambient Noise: The total noise produced by all other sources associated with a given environment in the vicinity of a specific source of interest, and includes any Residual Noise.

(5) Sound Pressure Level (“L_p or SPL”): Ten times the common logarithm to the base 10 of the ratio of the mean square sound pressure to the square of a reference pressure. Therefore, the sound pressure level is equal to 20 times the common logarithm of the ratio of the sound pressure to a reference pressure (20 micropascals or 0.0002 microbar).

(6) Octave Band SPL: Sound is typically measured in frequency ranges (e.g., high-pitched sound, low-pitched sound, etc.) that provides more meaningful sound data regarding the sound character of the noise. When measuring two noise sources for comparison, it is better to measure the spectrum of each noise, such as in octave band SPL frequency ranges. Then, the relative loudness of two sounds can be compared frequency range by frequency range. As an illustration, two noise sources can have the same dBA rating and yet sound completely different. For example, a high-pitched sound concentrated at a frequency of 2000 Hz could have the same dBA rating as a much louder low-frequency sound concentrated at 50 Hz.

(7) Daytime Sound Level (“L_d”) & Nighttime Sound Level (“L_n”): L_d is the equivalent A-weighted sound level, in decibels, for a 15-hour time period, between 07:00 to 22:00 Hours (7:00 a.m. to 10:00 p.m.). L_n is the equivalent A-weighted sound level, in decibels, for a 9-hour time period, between 22:00 to 07:00 Hours (10:00 p.m. to 7:00 a.m.).

(8) Equivalent Sound Level (“L_{eq}”): The equivalent sound level (L_{eq}) can be considered an average sound level measured during a period of time, including any fluctuating sound levels during that period. In this report, the L_{eq} is equal to the level of a steady (in time) A-weighted sound level that would be equivalent to the sampled A-weighted sound level on an energy basis for a specified measurement interval. The concept of the measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

(9) L-Percent Sound Levels: The L percent levels (e.g., L_{50}, L_{90} & L_{10}) refer to the A-wt. sound levels that are exceeded for 90, 50 and 10 percent of the time, respectively, during a measurement period. For example, the 90-percentile exceeded sound level, designated to as L_{90}, is the A-wt. sound levels that are exceeded for 90 percent of the time and is considered the typical lowest anticipated sound levels. The range between the L_{10} and L_{90} values usually provides a good indication of the variability of the sound levels during the period of measurement.

(10) Sound Level Meter ("SLM"): An instrument used to measure sound pressure level, sound level, octave-band SPL, or peak sound pressure level, separately or in any combinations thereof. The measured weighted SPL (i.e., A-Wt. Sound Level or dBA) is obtained by the use of a SLM having a standard frequency-filter for attenuating part of the sound spectrum.

(11) Sound Power Level ("L_W or PWL"): Ten times the common logarithm of the ratio of the total acoustic power radiated by a sound source to a reference power. A reference power of a picowatt or 10^{-12} watt is conventionally used.

(12) Day-Night Average Sound Level (L_{dn}): The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and the measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. As such, the L_{dn} is not a true measure of the sound level but represents a skewed average that correlates generally with past sound surveys which attempted to relate environmental sound levels with physiological reaction and physiological effects. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, an L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured, then the L_{dn} is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

End of Report

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