VENICE WATER STORAGE TANK AND BOOSTER PUMP STATION

Acoustical Assessment Report – Final

Rev 2

B&V PROJECT NO. 403737

©Black & Veatch Holding Company 2020. All rights reserved.

PREPARED FOR

Venice, FL
City on the Gulf

City of Venice

3 AUGUST 2020

BLACK & VEATCH

Table of Contents

LIST OF TABLES

LIST OF FIGURES

Executive Summary

The City of Venice (City) is evaluating the post-construction environmental noise impact for the New Water Booster Pump Station (BPS) located in Venice, Florida. The BPS will include a Water Booster Pump building which houses four 75 hp water booster pumps (plus one standby), one outdoor waste-water lift station pump (plus one standby), and one 600 kW emergency diesel generator along with other non-noise related structures.

To characterize the existing acoustical environment prior to construction, Black & Veatch completed an ambient sound level survey. The survey included three measurement locations representative of the nearest residential receptors. In general, the existing ambient conditions at these locations are influenced by local and distant traffic, air traffic, and local fauna.

Local regulations and standards related to environmental sound emissions were investigated and reviewed to determine applicability to the BPS. Since the BPS is expected to operate during the daytime and nighttime hours in an industrial zone, the following criteria is a summary from the Code of Ordinances of Venice, Florida that have been used for this study, based on the surrounding properties:

(1) The BPS sound levels should not exceed 55 dBA when measured at or beyond the property boundary of the receiving residential properties to comply with nighttime noise requirements.

(2) The BPS sound levels should not exceed 80 dBA when measured at or beyond the property boundary of the receiving industrial properties.

The environmental sound emissions from the BPS have been evaluated to predict future compliance with local regulations provided by the City of Venice. The results of the assessment indicate that the BPS sound level are expected to comply with local noise regulations.

1.0 Introduction

The City of Venice (City) is evaluating the post construction environmental noise impact for the New Water Booster Pump Station (BPS) located in Venice, Florida. The BPS will include a Water Booster Pump building which houses four 75 hp water booster pumps (plus one standby), one outdoor waste water lift station pump (plus one standby) and one 600kW emergency diesel generator, associated HVAC, and other non-noise related structures.

An aerial view of the BPS, approximate property boundary[1], and nearest residential receptors are shown in Figure 1-1. This acoustical assessment has been conducted to address the following questions:

- What are the sound levels in the vicinity of the BPS site?
- What acoustical regulations, standards, and guidelines are applicable to the BPS?
- What (if any) acoustical mitigation measurements are anticipated to be necessary for the BPS to ensure compliance with the applicable noise regulations?

Figure 1-1 Venice BPS Site and Neighboring Properties

[1] Provided in Venice Water Storage Tank and Booster Pump Station Preliminary Design Report – Draft, March 19, 2020.

2.0 Regulations and Guidelines

Regulations and standards related to environmental noise were reviewed to determine applicability to the BPS. Since the site is located in Venice, Florida, the BPS is regulated by the *Code of Ordinances of Venice, Florida*. The applicable noise section is *Chapter 34, Article II – Noise Control*[2]. The BPS is currently located in PID zoning[3], which is defined as a Planned Industrial Development zone, but is planned to be rezoned to Government Use (GU). For all noise regulation purposes, this should be defined as an Industrial Land Use Category. The sections of interest have been reproduced below:

(a) No person shall operate or cause to be operated any source of sound which travels off of the property limits where the sound originates in such a manner as to create a sound level which, when measured at the property line of the receiving property, exceeds the limits set forth for the receiving land use category in the following table, more than ten percent of any measurement, which shall not be less than ten minutes, when measured on or beyond the property bounds of the receiving land use:

Table 2-1 Sound Level Regulations for Venice, Florida

Receiving Land Use Category	Time	Sound Level Limits DB(A)
Noise-sensitive	At all times	50
Residential or public space	7:00 a.m. to 10:00 p.m.	60
	10:00 p.m. to 7:00 a.m. on weekdays	55
	10:00 p.m. to 10:00 a.m. on weekends and holidays	55
Commercial or business	7:00 a.m. to 10:00 p.m.	65
	10:00 p.m. to 7:00 a.m.	60
Manufacturing, industrial or agricultural	At all times	80

(b) For any source of sound, the maximum sound level shall not exceed the sound level limits in the table in subsection (a) of this section by:

(1) Ten dB(A) from 7:00 a.m. to 10:00 p.m.

(2) Five dB(A) from 10:00 p.m. to 7:00 a.m.

(3) Ten dB(A) at all times in manufacturing, industrial or agricultural land use area. (Code 1982, § 12-39)

---

[2] Code of Ordinances City of Venice, Florida (https://library.municode.com/fl/venice/codes/code_of_ordinances?nodeId=SPAGEOR_CH34EN_ARTIINOCO_S34-36MAPESOLERELAUS) accessed on April 10, 2020.

[3] According to City Zoning Venice, Florida (https://covfl.maps.arcgis.com/apps/View/index.html?appid=fd651e28583641629e18c35d5cd594cc) accessed on April 10, 2020.

Based on zoning information, the BPS should not exceed 55 dBA along the south and farthest-west properties boundary lines (between Toscana Isles and Venetian Country Club) and should not exceed 80 dBA along the north and close-west (AJAX facility) property lines in order to comply with these regulations.

3.0 Pre-Construction Sound Levels

A sound level survey was completed to characterize the acoustical environment in the area surrounding the BPS. The section describes the results of the survey and the nature of the acoustical environment.

3.1 Survey Procedure and Conditions

The original ambient sound level survey was conducted January 13 through January 15, 2020, and additional spot check measurements for the Toscana Isles Residential Community were obtained on July 8, 2020. The survey procedure was based on relevant portions of general industry standards including, but not limited to, ANSI S1.13, ANSI S12.9, and ANSI S12.18. Sound level measurements were conducted using Type 1 and Type 2 sound level meters that met the requirements of ANSI S1.4. The sound level meters were field calibrated immediately before and after each measurement period and deviated less than 0.2 dB. All equipment had been laboratory calibrated within the last 12 months. A list of the measurement equipment utilized during the survey and copies of corresponding calibration certificates are included in Appendix A.

Meteorological conditions[4] during the ambient level survey were suitable for environmental sound level measurements. Temperatures ranged from approximately 66 to 84 °F. Average wind speeds ranged from 0 to 14 mph with occasional gusts up to 21 mph (measured at a height of 10 meters). Spot measurements for local average wind speeds at microphone height were also taken during each short-term measurement. These wind speeds ranged from 0 to 3 mph. The temperature, humidity and wind speed trends during this survey are detailed in Appendix B.

To effectively quantify and qualify the sound levels surrounding the BPS site, the ambient sound level survey included continuous sound level monitoring and short-term (attended) sound level measurements. The continuous monitor contained recording abilities and a sound level “trigger” was applied to capture any abnormally loud events and record them for further analysis. Each noise measurement location (NML) was selected to represent nearby noise-sensitive receptors. Geographic coordinates and the location of each measurement are summarized in Table 3-1 and identified on Figure 3-1.

[4] Meteorological data from nearby airport, Venice Muni Station (per wunderground.com).

Table 3-1 Noise Measurement Locations (NML's)

Measurement Location	LAT./Long.	Location Description	Type of Monitoring
NML1	27.15201°N/82.38540°W	South property boundary between BPS and Venetian Golf and Country Club.	Continuous
NML2	27.15181°N/82.39227°W	At edge of new development in Toscana Isles Community, closest to BPS site (approx. 1300 ft from BPS PB.)	Short-term
NML3	27.15047°N/82.38653°W	North residents in Venetian Country Club community (approx. 530 ft from BPS PB)	Short-term
NML4	27.1530°N/82.3888°W	East property boundary of Toscana Isles Community.	Short-term

Figure 3-1 Noise Measurement Locations (NMLs) and Neighboring Receptor

3.2 Survey Results

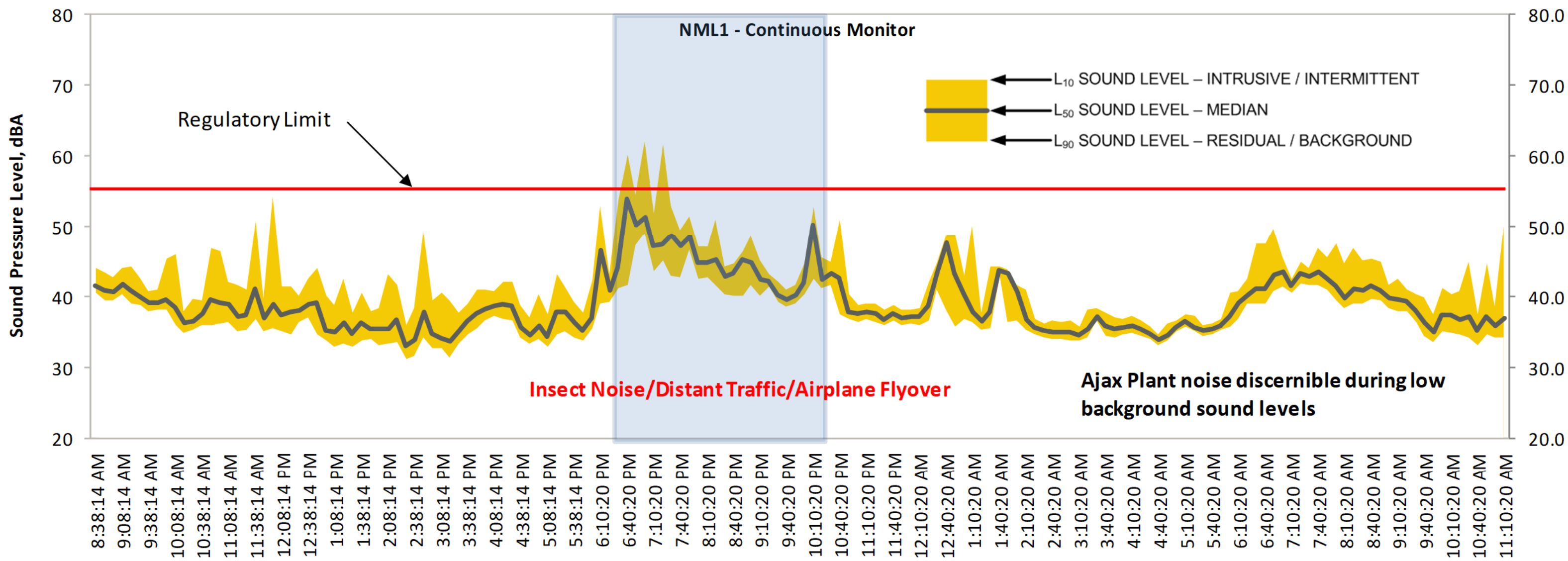
The sound level survey included continuous sound level monitoring and short-term (attended) sound level measurements. A continuous monitor was deployed at the south property boundary (NML1) to collect sound level data throughout the survey period. Short-term, 10- to 20-minutes, sound levels were also measured periodically at all locations (NML1, NML2, NML3, and NML4) to qualify the existing overall conditions and quantify the existing spectral conditions during various daytime and evening hours. Nighttime measurements were only taken at NML1, due to a lack of night access at the other two locations (NML2, NML3, and NML4). Since NML1 is the closest to the future BPS, it was decided to put the monitor with the highest resolution and audio recording capabilities at this location. The subsequent sections detail the survey results at each measurement location.

3.2.1 NML1

NML1 was selected to capture the acoustical environment experienced at the south property boundary between the BPS and the closest residential receptors. The monitor is approximately 1,000 ft from the anticipated BPS building and included continuous and short-term measurements.

The continuous and short-term monitoring results are detailed in Figure 3-2. The main noise sources were insect noise, golf cart noise (from Venetian Country Club), occasional noise from the AJAX plant, and distant traffic noise. The upper part of Figure 3-2, containing the continuous noise, a highlighted section where the sound levels increase in the late evening. These spikes were captured by the audio recording trigger and after post-processing, it was determined that this increase was due to a combination of traffic noise, increased insect noise, and an occasional airplane flyover. Even with these evening increases, the background sound levels ($L_{90(10min)}$) are still under 55 dBA during the entire measurement period. For more information on typical sound levels and acoustical terminology used in this report, please refer to Appendix C.

The bottom graph of Figure 3-2 shows the spectral equivalent sound levels (L_{eq}) over four measurement periods. The evening measurement (8:20 PM) shows the overall sound level increase and the increased high frequency noise due to the combination of sources described above.



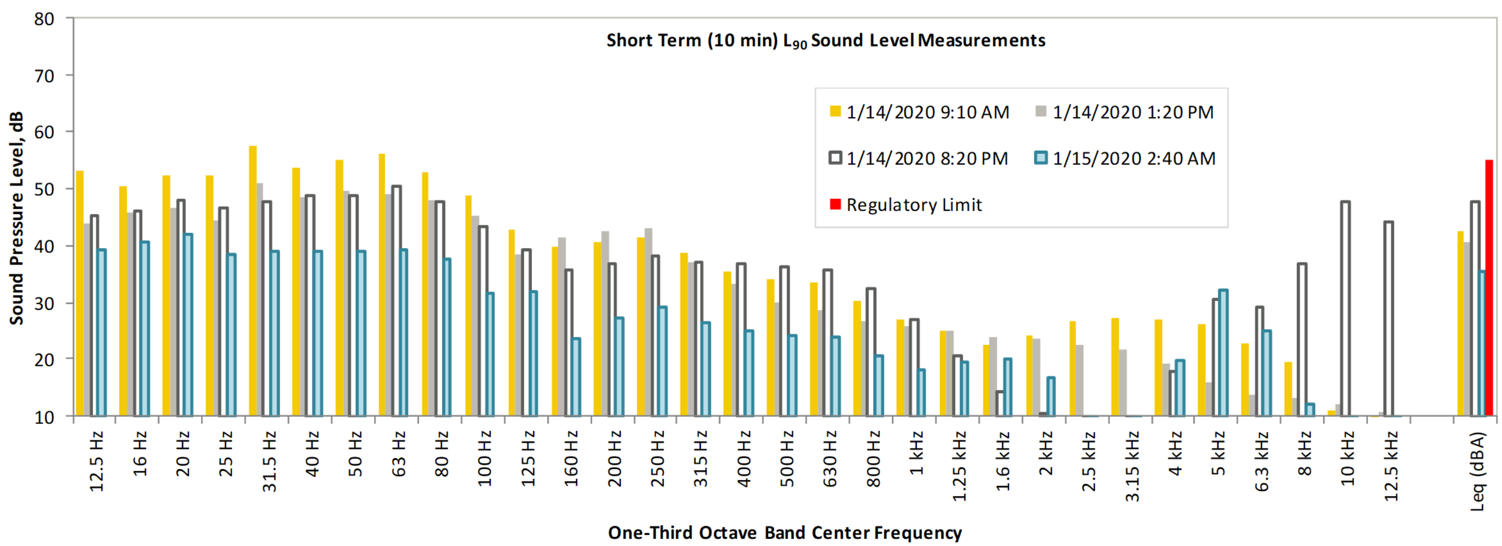


Figure 3-2 NML1 Continuous and Short-Term Measurement Data

3.2.2 NML2

NML2 was selected to capture the acoustical environment experienced by the Toscana Isles Community, located approximately 1300 ft from the BPS property boundary. The sound levels attributable to this site were mainly from local fauna (birds, insects, etc.), occasional (distant) airplane flyovers, construction noise, and local community activity. The AJAX plant was not audible from this measurement location. This site only included short-term measurements and the measurement was paused during abnormal activity (e.g. car passing close by, impulsive noise, residents talking, etc.).

Figure 3-3 shows the short-term measurements from NML2. As seen in the graph, the low frequency noise decreases in the evening due to a decrease in active construction noise in the later afternoon/evening hours. All three measurements resulted in equivalent sound levels (L_{eq}) of less than 55 dBA, with a higher level of 48 dBA occurring during rush hour and peak construction activity.

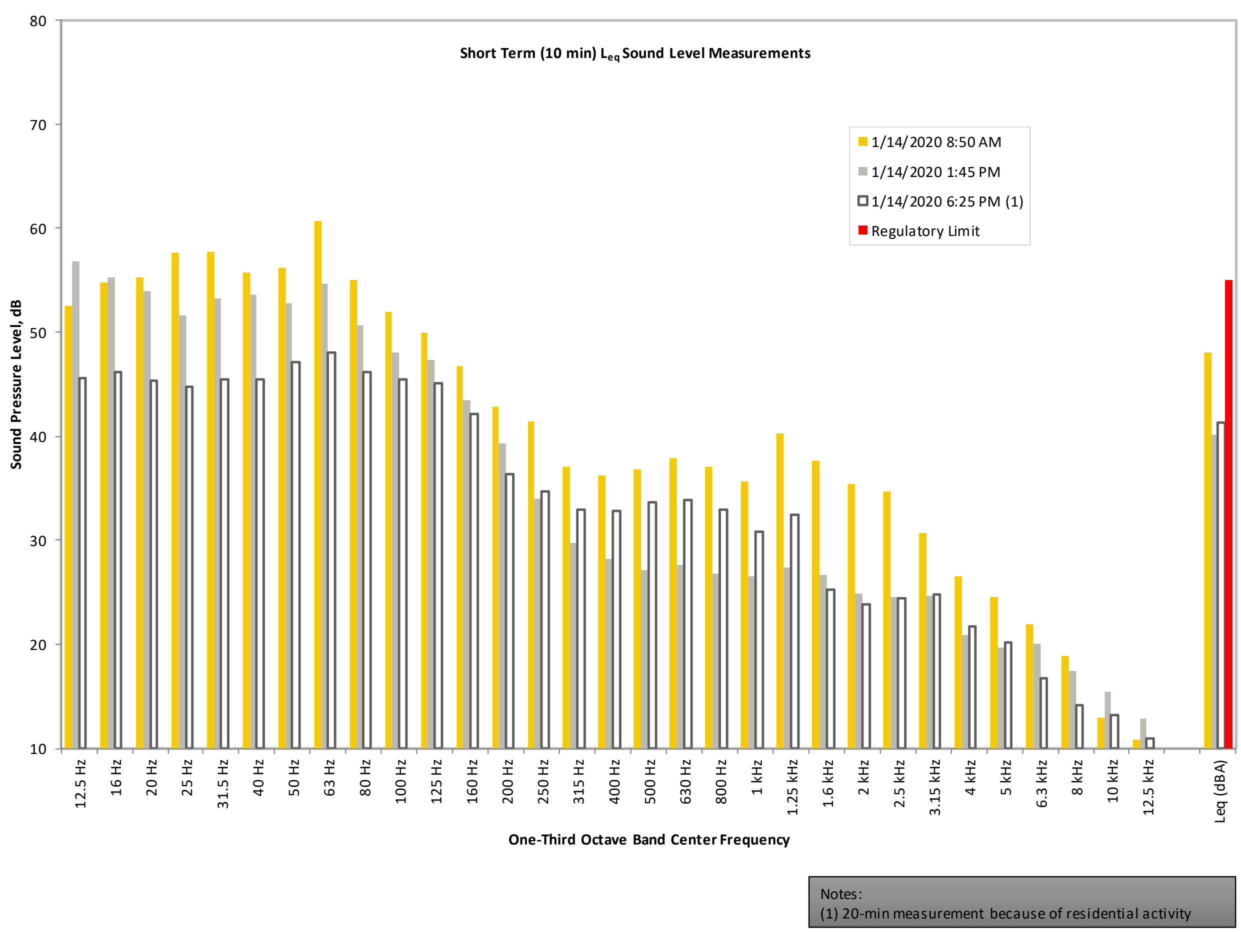


Figure 3-3 NML2 Short Term Measurement Data

3.2.3 NML3

NML3 was selected to capture the acoustical environment experienced by the Venetian Golf and Country Club community, located approximately 530 ft from the BPS property boundary. The sound levels attributable to this site were mainly from local fauna (birds, insects, etc.), occasional (distant) airplane flyovers, and local community activity. The AJAX plant was not audible from this location. This site only included short-term monitoring and the monitor was paused during abnormal activity (e.g. car passing close by, impulsive noise, residents talking, etc.).

Figure 3-4 shows the short-term measurements from NML3. All three measurements resulted in equivalent sound levels (L_{eq}) of less than 55 dBA, with a higher level of 47 dBA occurring in the morning hours.

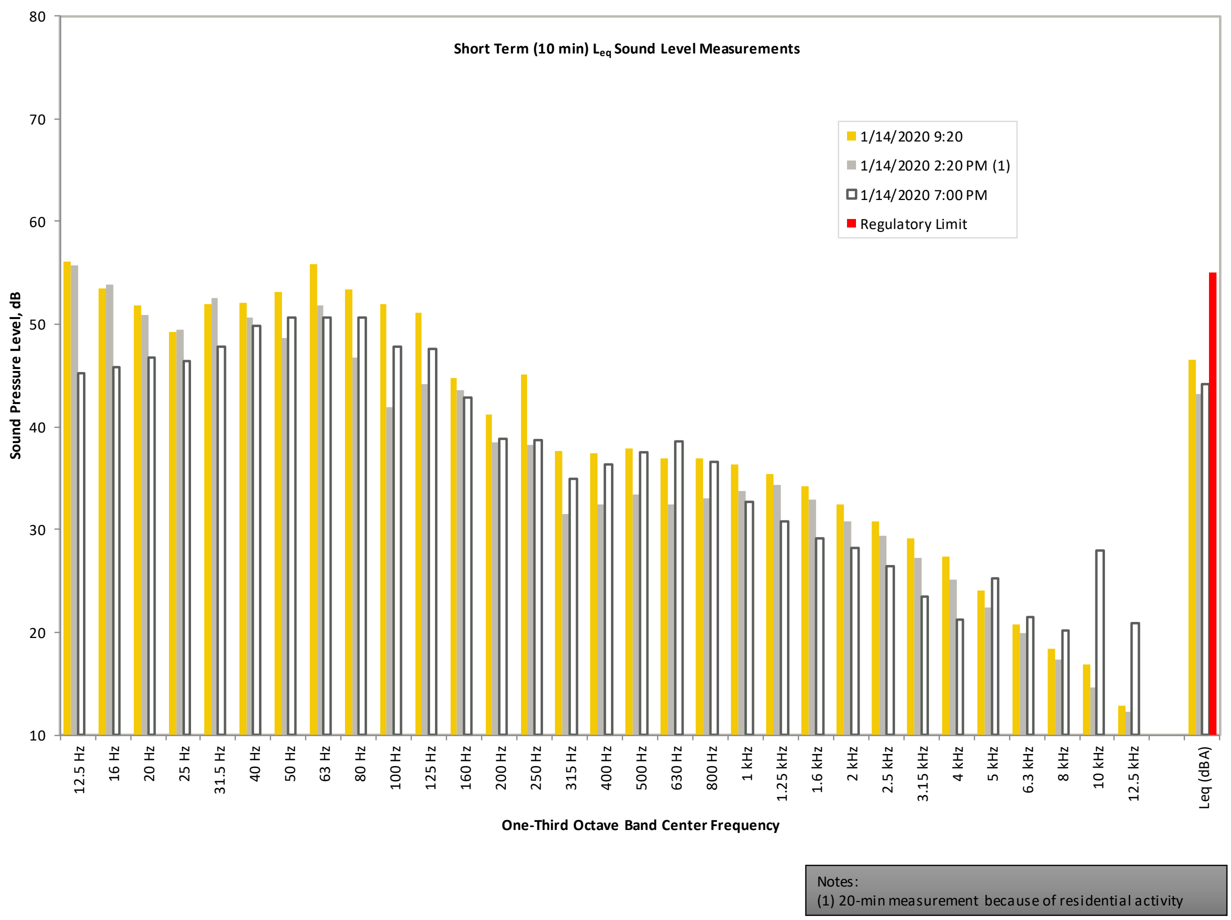


Figure 3-4 NML3 Short Term Measurement Data

3.2.4 NML4

Additional short-term measurements were obtained to provide a closer measurement to the Toscana Isles Community eastern property boundary that was inaccessible due to construction at the time of the original ambient survey. The sound levels attributable to this location were construction noise and local community activity, similar to NML2, as well as occasional traffic noise, rustling from trees due to wind, and some perceptible noise from the AJAX plant to the north. An 8 ft tall privacy wall has been constructed between the Toscana Isles Community and the BPS property boundaries. This is shown in Figure 3-5.

Table 3-2 shows the equivalent sound levels (L_{eq}) for the spot checks, compared to the L_{eq} from NML2. As shown in the table, the spot checks appear to be higher than the original measurements from NML2, which is attributed to a couple of sources: increased community activity and higher wind causing nearby trees to rustle. During the morning measurement there was no wind, and the only attributable noise source was construction noise. During the afternoon and evening measurements, the wind speed was higher than previous measurements and this location was closer to the property boundary berm which included more trees. This location was also closer to the access road to the north and included some low traffic along Gene Green Rd, along with additional noise from the AJAX plant. The combination of all these factors led to an increase in sound levels from NML2 to NML4. Even on a calm day, NML4 is expected to be slightly higher than NML2 because of its proximity to the AJAX plant and these extra noise sources.

Table 3-2 NML2 and NML4 Comparison

Approximate Time	NML2 L_{eq}	NML4 L_{eq}	Level Difference and Reasoning
Morning (8:00 am to 10:00 am)	48 dBA	48 dBA	0 dB (no wind)
Afternoon (1:00 pm to 3:00 pm)	40 dBA	49 dBA	9 dBA (proximity to AJAX, traffic noise, and wind in trees)
Evening (6:00 pm to 8:00 pm)	41 dBA	49 dBA	8 dBA (proximity to AJAX, traffic noise, and wind in trees)

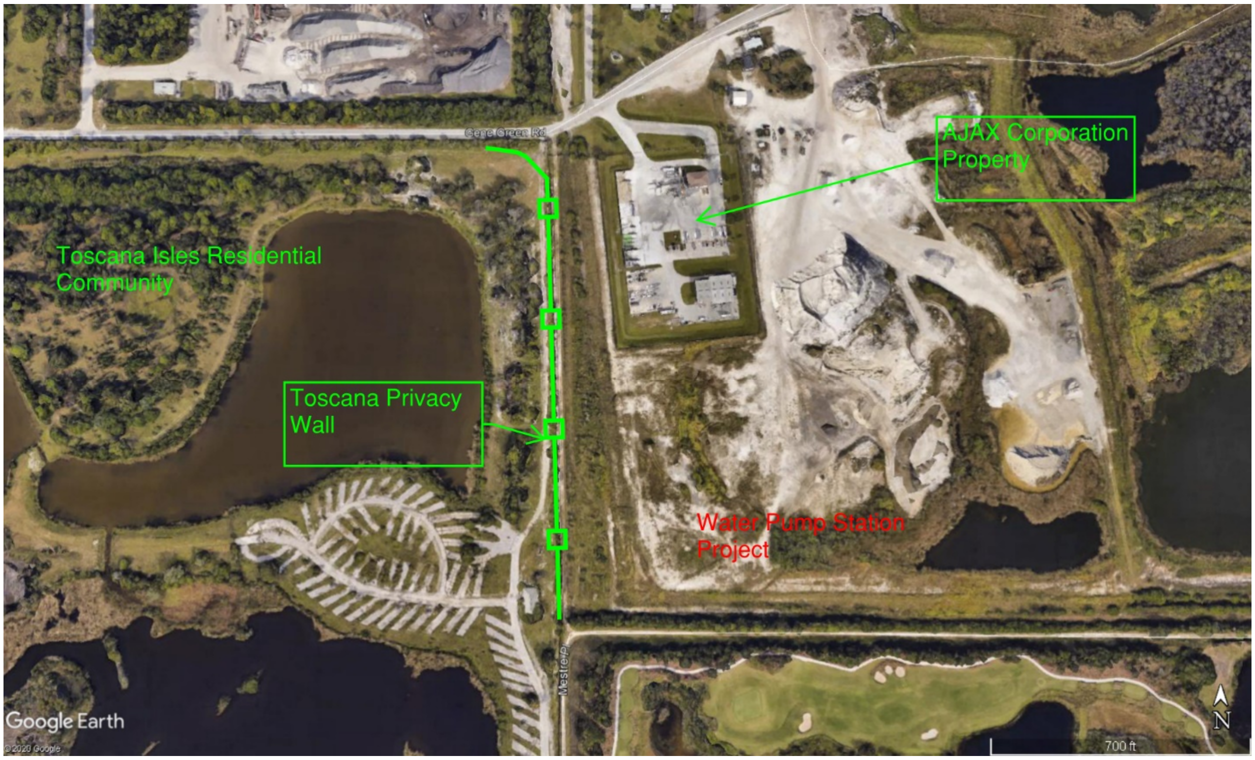


Figure 3-5 Toscana Isles Community Privacy Wall

4.0 BPS Noise Emission Modeling

4.1 Outdoor Calculation Methodology

Outdoor far-field sound levels were predicted in accordance with ISO 9613 (Ref. 3) using Cadna/A software from DataKustik™ (version 2020 MR 1). Ground surrounding the BPS Site is assumed to be mixed (“G” = 0.7), with pavement and water assumed to be hard (“G” = 0.0). Historical wind data have also been incorporated into to the model to account for typical wind speeds/directions that occur at the project site. Source octave-band sound levels and directivity are input into the acoustical model to determine far-field A-weighted sound levels. Sound levels are predicted over a 10 m x 10 m spaced grid at 1.5 m above the ground, as well as for specific receptor locations. Local topography, buildings, and structures are also included in the model. An overall site layout is shown in Figure 4-1 below. To be conservative, the privacy wall on the east boundary of Toscana Isles Community has not been included in the model.

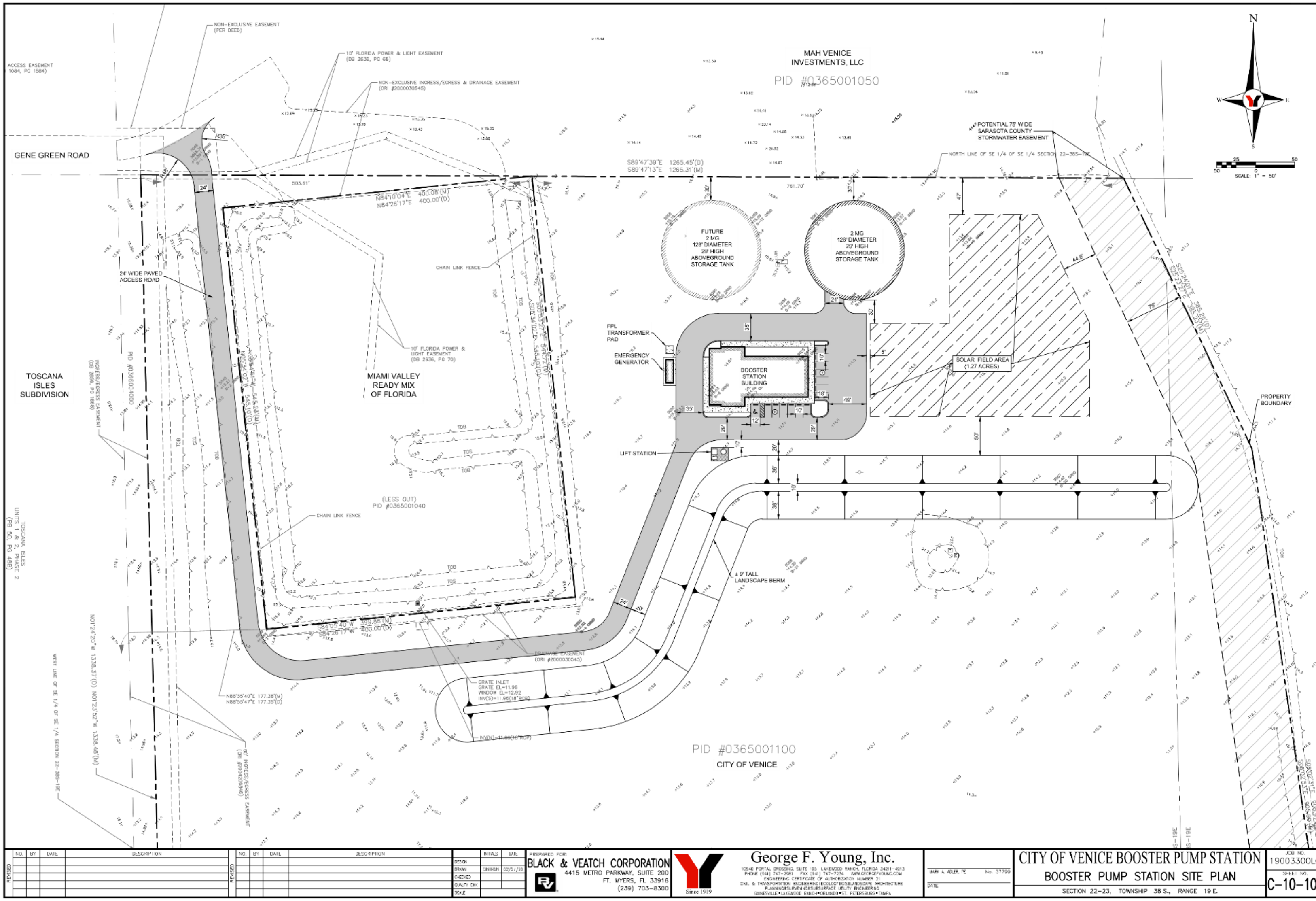


Figure 4-1 Venice BPS Site Layout

4.2 Equipment Sound Levels

Table 4-1 includes all expected equipment and assumed sound power levels (L_w) or sound pressure levels at a specified distance (L_p). All equipment sound levels have not been confirmed with suppliers, as they are all conservative estimates. Please note that any deviations from the proposed site arrangement or the sound levels outlined herein may affect the modeling results presented later. Therefore, the levels shown in Table 4-1 should be included in equipment specifications.

Table 4-1 Equipment Sound Levels

Equipment	QTY	Location	Sound Levels
Booster Pumps	4 (3 initial + 1 future)	Inside BPS Bldg	89 dBA L_p @ 3 ft $^{(1)}$
Emergency Generator	1	Outside BPS Bldg	75 dBA L_p @ 23ft $^{(1)}$
Waste Water LS Pump	1	Outside BPS Bldg	55 dBA L_p @ 3 ft $^{(1)}$
Condenser Units	3	Outside BPS Bldg	96 dBA L_w $^{(2)}$
Building HVAC Vents (fan-powered)	3	At BPS Bldg Wall	78 dBA L_p @ 3 ft $^{(1)}$

Notes:
(1) L_p when measured in accordance with ANSI/ASME PTC 36.
(2) L_w when determined in accordance with ARI 270/370.

4.3 Results

Even though the emergency generator is not expected to operate often, it will have to be tested periodically and is not exempt from the noise regulations. Therefore, it has been included in the acoustical model as a constant source for a conservative result.

Based on the local regulations discussed in Section 2.0, the sound levels from the BPS should not exceed 55 dBA along the south and west property lines since they abut to residential receptors, or 80 dBA along the north and northwest boundary since they are shared with industrial receptors. Figure 4-2 shows the results from the acoustical model. The predicted sound levels indicate that the BPS is not expected to exceed the property boundary regulatory sound level limit anywhere at this site and, based on the ambient sound levels presented in Section 3.2, the BPS sound levels are expected to be consistent with the existing environment. Table 4-2 below shows the predicted sound levels at surrounding property boundaries along with applicable regulatory limits.

Table 4-2 Predicted Sound Levels at Community Boundaries

Boundary	Expected Sound Levels	Regulatory Limit
Toscana Isles (west)	39 to 51 dBA	55 dBA
Venetian (south)	34 to 41 dBA	55 dBA
Industrial neighbors (north)	41 to 57 dBA	80 dBA

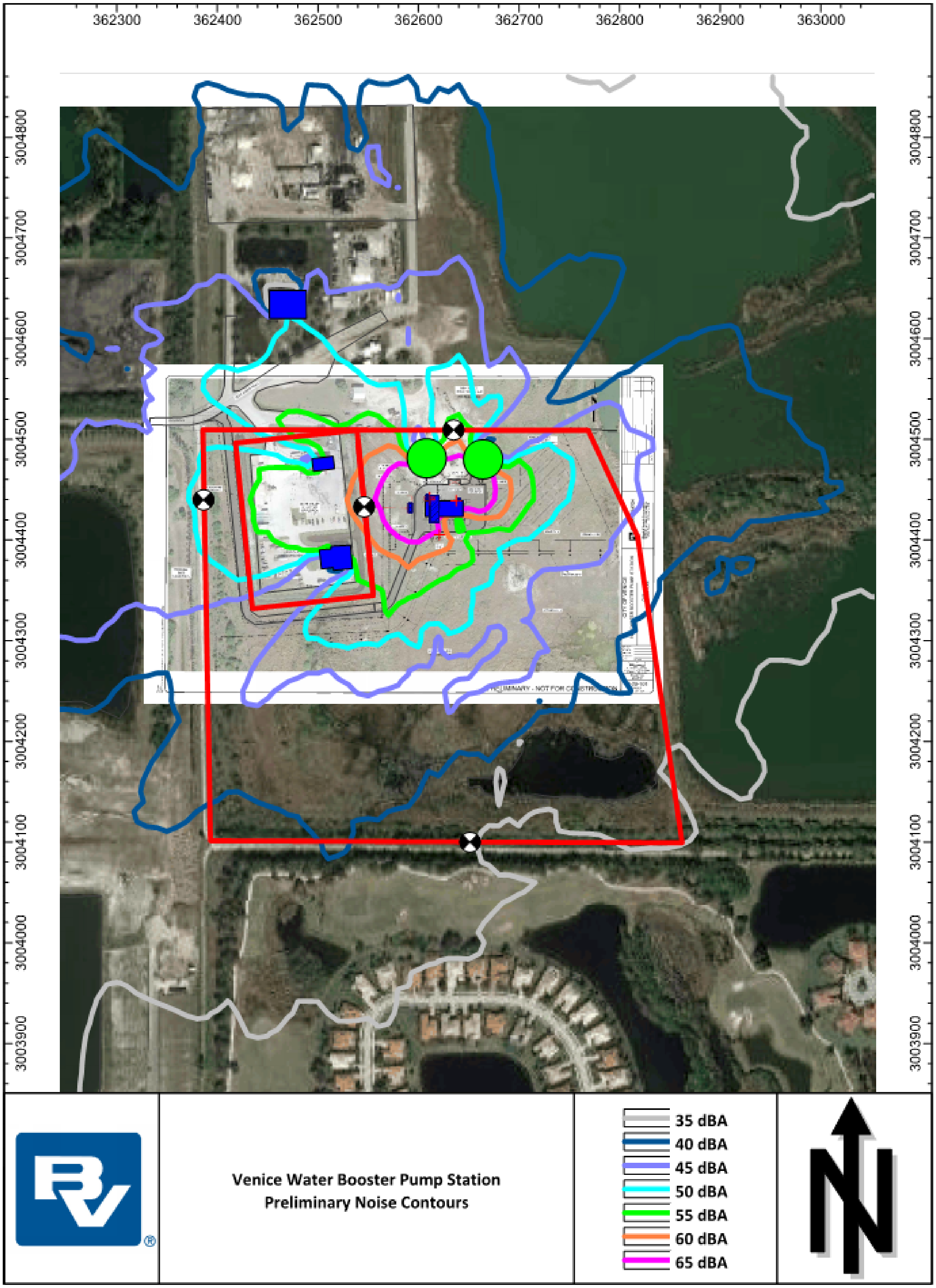


Figure 4-2 Venice BPS Site Layout

Appendix A. Ambient Survey Test Equipment

Table A-1 Ambient Survey Test Equipment

Model	Serial Number	Last Calibration Date
Larson Davis Model 831	10354	31 December 2019
Rion Model NA27	01191119	9 August 2019
Rion NC-73 Acoustical Calibrator	10527795	6 August 2019

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.44069

Instrument: **Sound Level Meter**
Model: **831**
Manufacturer: **Larson Davis**
Serial number: **10354**
Tested with: **Microphone 377B02 s/n 171505**
Preamplifier PRM2103 s/n 001343
Type (class): **1**
Customer: **Black & Veatch**
Tel/Fax: **913-458-9265 / 913-458-7823**

Date Calibrated: **12/31/2019** *Cal Due:* **12/31/2020**

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Calibration service: __ Basic X Standard
Address: **11401 Lamar Avenue**
Overland Park, KS 66211

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31061	Jul 31, 2019	Scantek, Inc./ NVLAP	Jul 31, 2020
DS-360-SRS	Function Generator	61646	Sep 7, 2018	ACR Env./ A2LA	Sep 7, 2020
34401A-Agilent Technologies	Digital Voltmeter	MY47022043	Sep 16, 2019	ACR Env./ A2LA	Sep 16, 2020
HM30-Thommen	Meteo Station	1040170/39633	Oct 24, 2019	ACR Env./ A2LA	Oct 24, 2020
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Oct 23, 2019	Scantek, Inc./ NVLAP	Oct 23, 2020

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
22.6	99.38	35.2

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature		Signature	Steven E Marshall
Date	12/31/19	Date	01/02/2020

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
Document stored Z:\Calibration Lab\SLM 2019\LD831_10354_M1.doc

Page 1 of 2

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.43345

Instrument: **Sound Level Meter**
Model: **NA27**
Manufacturer: **Rion**
Serial number: **01191119**
Tested with: **Microphone UC53 s/n 99858**
Preamplifier NH20 s/n 94641
Type (class): **1**
Customer: **Black & Veatch**
Tel/Fax: **913-458-8283 / 913-458-7823**

Date Calibrated: **8/9/2019** *Cal Due:* **8/9/2020**

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Calibration service: __ Basic X Standard
Address: **11401 Lamar Avenue**
Overland Park, KS 66211

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2018	Scantek, Inc./ NVLAP	Oct 31, 2019
DS-360-SRS	Function Generator	33584	Oct 24, 2017	ACR Env./ A2LA	Oct 24, 2019
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 1, 2018	ACR Env. / A2LA	Oct 1, 2019
HM30-Thommen	Meteo Station	1040170/39633	Nov 13, 2018	ACR Env./ A2LA	Nov 13, 2019
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Nov 11, 2018	Scantek, Inc./ NVLAP	Nov 11, 2019

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
22.8	99.47	53.2

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	Steven E. Marshall
Signature	Lydon Dawkins	Signature	Steven E Marshall
Date	8/9/2019	Date	8/9/2019

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
Document stored Z:\Calibration Lab\SLM 2019\RIONA27_01991119_M1.doc

Page 1 of 2

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.43343

Instrument: **Acoustical Calibrator**
Model: **NC-73**
Manufacturer: **Rion**
Serial number: **10527795**
Class (IEC 60942): **2**
Barometer type:
Barometer s/n:
Customer: **Black & Veatch**
Tel/Fax: **913-458-8283 / 913-458-7823**

Date Calibrated: **8/6/2019** *Cal Due:* **8/6/2020**

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Address: **11401 Lamar Avenue**
Overland Park, KS 66211

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2018	Scantek, Inc / NVLAP	Oct 31, 2019
DS-360-SRS	Function Generator	33584	Oct 24, 2017	ACR Env./ A2LA	Oct 24, 2019
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 1, 2018	ACR Env. / A2LA	Oct 1, 2019
HM30-Thommen	Meteo Station	1040170/39633	Nov 13, 2018	ACR Env./ A2LA	Nov 13, 2019
140-Norsonic	Real Time Analyzer	1406423	Nov 3, 2018	Scantek / NVLAP	Nov 3, 2019
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Nov 11, 2018	Scantek, Inc. / NVLAP	Nov 11, 2019
1203-Norsonic	Preamplifier	14059	Feb 28, 2019	Scantek, Inc./ NVLAP	Feb 28, 2020

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	Steven E. Marshall
Signature	Lydon Dawkins	Signature	Steven E Marshall
Date	8/6/2019	Date	8/9/2019

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
Document stored as: Z:\Calibration Lab\Cal 2019\RIONNC73_10527795_M1.doc

Page 1 of 2

Figure A-1 Sound Equipment Calibration Certificates

Appendix B. Ambient Survey Meteorological Conditions

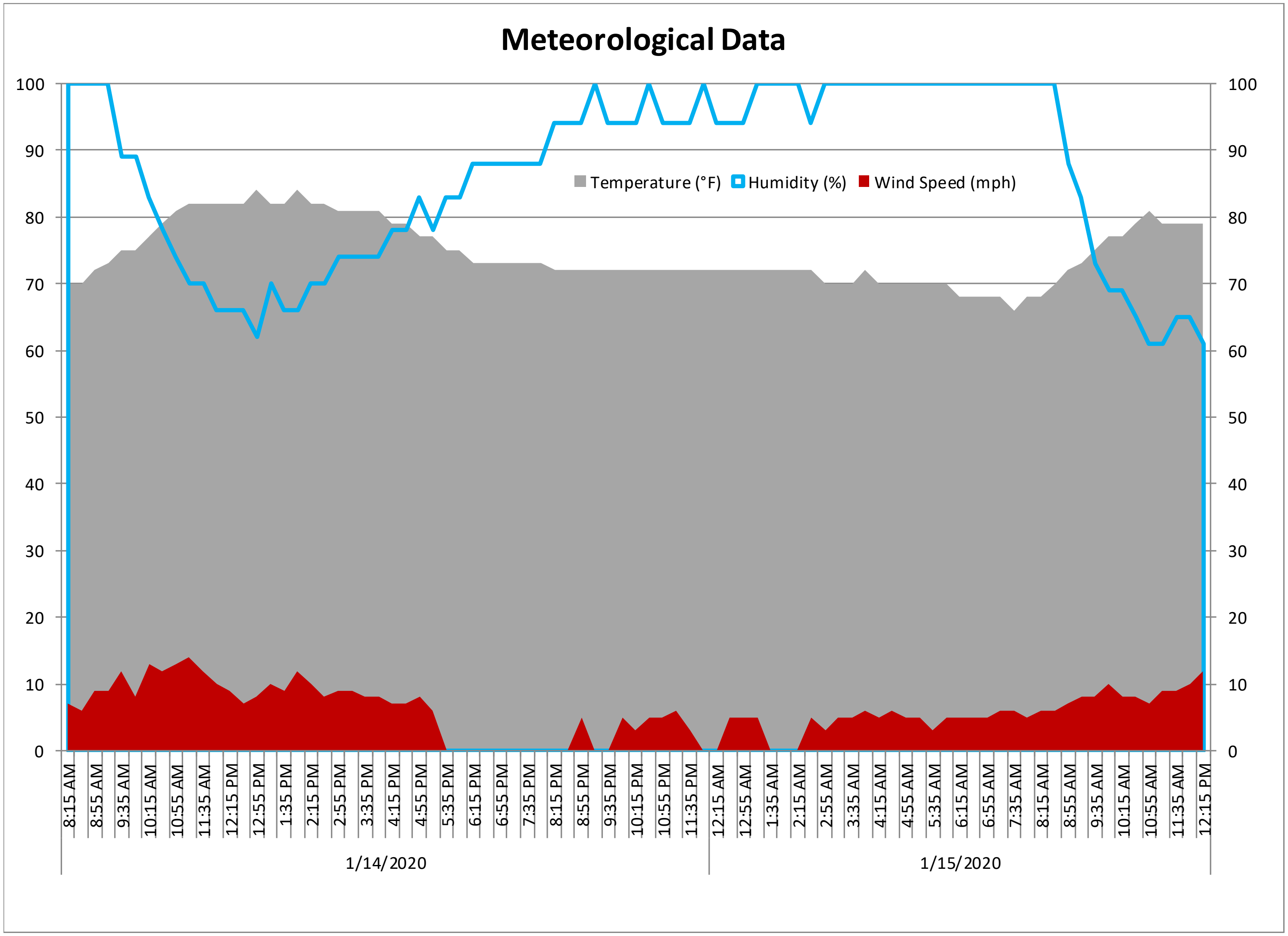


Figure B-1 Ambient Survey Meteorological Conditions

Appendix C. Acoustical Terminology

C.1 Sound Energy

Sound is generated by the propagation of energy in the form of pressure waves. Being a wave phenomenon, sound is characterized by amplitude (sound level) and frequency (pitch). Sound amplitude is measured in decibels, dB. The decibel is the logarithmic ratio of a sound pressure to a reference sound pressure. Typically, 0 dB corresponds to the threshold of human hearing. A 3 dB change in a continuous broadband noise is generally considered "just barely perceptible" to the average listener. A 5 dB change is generally considered "clearly noticeable" and a 10 dB change is generally considered a doubling (or halving) of the apparent loudness (Bies and C.H. Hansen, Engineering Noise Control, 2009). For reference, the sound pressure levels and subjective loudness associated with common noise sources are shown in Table C-1.

Table C-1 Typical Sound Pressure Levels Associated with Common Noise Sources

SOUND PRESSURE LEVEL, DBA	SUBJECTIVE EVALUATION	COMMON OUTDOOR ENVIRONMENT OR SOURCE	COMMON INDOOR ENVIRONMENT OR SOURCE
140	Deafening	Jet aircraft at 75 ft	
130	Threshold of pain	Jet aircraft during takeoff at a distance of 300 ft	
120	Threshold of feeling	Elevated Train	Hard rock band
110	Extremely loud	Jet flyover at 1000 ft	Inside propeller plane
100	Very loud	Power mower, motorcycle at 25 ft, auto horn at 10 ft	
90	Very loud	Propeller plane flyover at 1000 ft, noisy urban street	Full symphony or band, food blender, noisy factory
80	Moderately loud	Diesel truck (40 mph) at 50 ft	Inside auto at high speed, garbage disposal, dishwasher
70	Loud	B-757 cabin during flight	Close conversation, vacuum cleaner, electric typewriter
60	Moderate	Air-conditioner condenser at 15 ft, near highway traffic	General office
50	Quiet		Private office
40	Quiet	Farm field with light breeze, birdcalls	Soft stereo music in residence
30	Very quiet	Quiet residential neighborhood	Bedroom, average residence (without TV and stereo)
20	Just audible		Human breathing
10	Threshold of hearing		
0			

Frequency is measured in hertz, Hz (cycles per second). Most sound sources (except those with pure tones) contain sound energy over a wide range of frequencies. In order to analyze sound energy over the range of frequencies, the sound energy is typically divided into sections called octave bands. Octave bands are identified by their center frequencies including 31.5, 63, 125, 250, 500 1000, 2000, 4000, and 8000 Hz. For more detailed analyses, narrow bands such as ⅓-octave bands or 1/12-octave bands are employed. The sum of the sound energy in all of the octave bands for a source represents the overall sound level of the source.

The normal human ear can hear frequencies ranging from 20 Hz to 20,000 Hz. At typical sound pressure levels, the human ear is more sensitive to sounds in the middle and high frequencies (1,000 to 8,000 Hz) than sounds in the low frequencies. Various weighting networks have been developed to simulate the frequency response of the human ear. The A-weighting network was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighting network emphasizes sounds in the middle to high frequencies and de-emphasizes sounds in the low frequencies. Most sound level instruments can apply these weighting networks automatically. Any sound level to which the A-weighting network has been applied is expressed in A-weighted decibels, dBA. To characterize sound that contains relatively more low frequency energy—and to approximate the ear's response to relatively high sound levels—the C weighting network was developed. C weighting places more equal emphasis on low and high frequencies relative to A-weighting. Any sound level to which the C-weighting network has been applied is expressed in C-weighted decibels, dBC.

C.2 Sound Level Metrics

Noise in the environment is constantly fluctuating, such as when a car drives by, a dog barks, or a plane passes overhead. Therefore, noise metrics have been developed to quantify fluctuating environmental noise levels. These metrics include the equivalent-continuous sound level and the exceedance sound levels.

The equivalent-continuous sound level, Leq, is used to represent the equivalent sound pressure level over a specified time period. The Leq metric is the sound level of a steady-state sound that has the same (equivalent) total energy as the time-varying sound of interest, taken over a specified time period and covering a specified set of conditions. Thus, Leq is a single-value level that expresses the time-averaged total energy of a widely varying or fluctuating sound level.

The exceedance sound level, Lx, is the sound level exceeded "x" percent of the sampling period and is referred to as a statistical sound level. The most common Lx values are L90, L50, and L10. L90 is the sound level exceeded 90 percent of the sampling period. The L90 sound level represents the sound level without the influence of loud, transient noise sources and is therefore often referred to as the residual or background sound level (ANSI S12.9, Quantities and Procedures for Description and Measurement of Environmental Sound, 2003). The L50 sound level is the sound level exceeded 50 percent of the sampling period or the median sound level. The L10 sound level is the sound level exceeded 10 percent of the sampling period. The L10 sound level represents the occasional louder noises and is often referred to as the intrusive sound level. As previously discussed, the L90 environmental sound level typically represents the background (residual) sound level.

The variation between the L90, L50, and L10 sound levels can provide an indication of the variability of the acoustical environment. If the acoustical environment is perfectly steady, all values are identical. A large variation between the values indicates the environment experiences highly fluctuating sound levels. For instance, measurements near a roadway with frequent passing vehicles may cause a large variation in the statistical sound levels.

C.3 Typical Community Sound Levels

Typical background (residual) sound levels in various types of communities are outlined in Table C-2 for reference. However, it is important to remember that each community is unique with regard to the sources of noise that contribute to the background sound levels.

Table C-2 Typical Daytime Background Sound Levels in Various Types of Communities

Type of Community	Typical Daytime Background Sound Pressure Level, DBA
Very Quiet Rural Areas	31 to 35
Quiet Suburban Residential	36 to 40
Normal Suburban Residential	41 to 45
Urban Residential	46 to 50
Noisy Urban Residential	51 to 55
Very Noisy Urban Residential	56 to 60
Adjacent Freeway or Major Airport	n/a
Source: Adapted by Black & Veatch from *Community Noise*, by the U.S. Environmental Protection Agency, (December 1971).	

C.4 Sound Level Metrics

Human response to sound is highly individualized. Annoyance is the most common issue regarding community noise. The percentage of people claiming to be annoyed by noise will generally increase as environmental sound levels increase. However, many other factors will also influence people's response to noise. These factors can include the character of the noise, the variability of the sound level, the presence of tones or impulses, and the time of day of the occurrence. Additionally, non-acoustical factors, such as the person's opinion of the noise source, the ability to adapt to the noise, the attitude towards the noise and those associated with it, and the predictability of the noise can also influence people's response. Response to noise varies widely from one person to another and with any particular noise, individual responses will range from "highly annoyed" to "not annoyed".