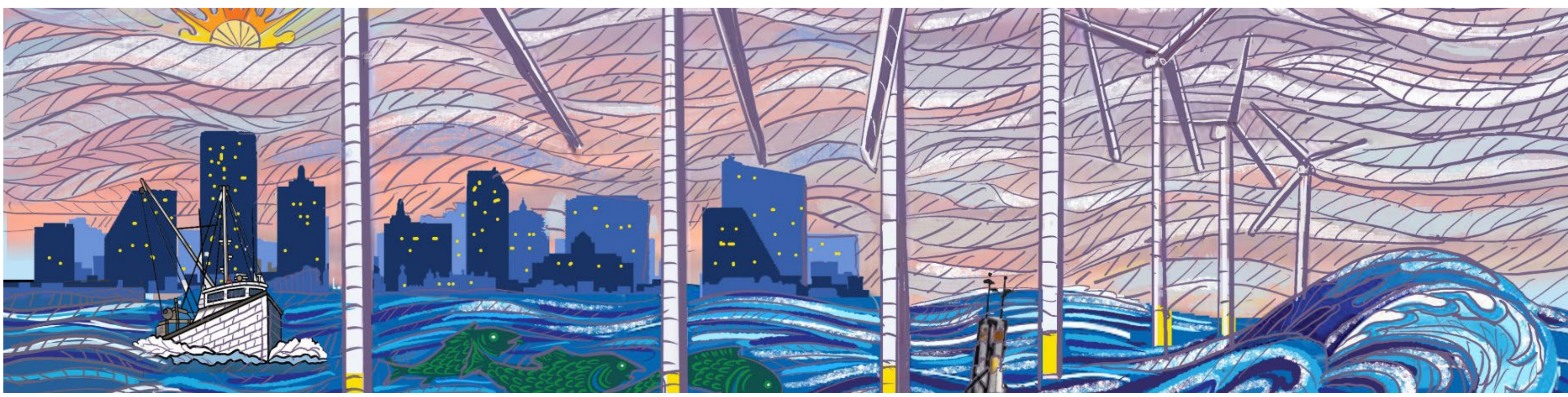

Appendix II-U

Onshore Noise Report

Note:

On March 26, 2021, Atlantic Shores Offshore Wind, LLC (Atlantic Shores) submitted a Construction and Operations Plan (COP) to BOEM for the southern portion of Lease OCS-A 0499. On June 30, 2021, the New Jersey Board of Public Utilities (NJ BPU) awarded Atlantic Shores an Offshore Renewable Energy Credit (OREC) allowance to deliver 1,509.6 megawatts (MW) of offshore renewable wind energy into the State of New Jersey. In response to this award, Atlantic Shores updated Volume 1 of the COP to divide the southern portion of Lease OCS-A 0499 into two separate and electrically distinct Projects. Project 1 will deliver renewable energy under this OREC allowance and Project 2 will be developed to support future New Jersey solicitations and power purchase agreements.

As a result of the June 30, 2021 NJ BPU OREC award, Atlantic Shores updated Volume I (Project Information) of the COP in August 2021 to reflect the two Projects. COP Volume II (Affected Environment) and applicable Appendices do not currently include this update and will be updated to reflect Projects 1 and 2 as part Atlantic Shores' December 2021 COP revision.

ATLANTIC SHORES OFFSHORE WIND

ONSHORE NOISE REPORT

Prepared for:

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February 24, 2021

TABLE OF CONTENTS

1.0	**EXECUTIVE SUMMARY**	**1-1**
2.0	**INTRODUCTION**	**2-1**
3.0	**PROJECT DESCRIPTION – ONSHORE FACILITIES**	**3-1**
3.1	Larrabee Onshore Interconnection Cable Route and Substation	3-1
3.2	Cardiff Onshore Interconnection Cable Route and Substation	3-2
4.0	**NOISE REGULATIONS**	**4-1**
4.1	Federal Regulations	4-1
4.2	New Jersey State Regulations	4-1
4.3	Local Regulations – Larrabee Onshore Interconnection Cable Route and Substation	4-2
4.4	Local Regulations – Cardiff Onshore Interconnection Cable Route and Substation	4-2
5.0	**BASELINE SOUND LEVEL MONITORING PROGRAM**	**5-1**
5.1	Proposed Larrabee Onshore Substation	5-1
5.1.1	Location L5—Randolph Road	5-1
5.1.2	Location L6—Larrabee Boulevard	5-3
5.1.3	Location L7—Arosa Hill	5-4
5.2	Proposed Cardiff Onshore Substation	5-5
5.2.1	Sound Level Measurement Locations—Preferred Substation Location	5-5
5.2.1.1	Location C1—Broadway Avenue	5-7
5.2.1.2	Location C2—Broadway Avenue	5-7
5.2.2	Sound Level Measurement Locations—Alternate Substation Location	5-8
5.2.2.1	Location C3—Washington Avenue	5-9
5.2.2.2	Location C4—Ruckreim Drive	5-10
5.3	Sound Level Measurement Instrumentation	5-11
6.0	**BASELINE SOUND LEVEL MONITORING RESULTS**	**6-1**
6.1	Data Formatting Overview	6-1
6.2	Larrabee Onshore Substation	6-2
6.2.1	Sound Level Measurement Results—Preferred & Alternate Substation Location	6-2
6.3	Cardiff Onshore Substation	6-2
6.3.1	Sound Level Measurement Results—Preferred Substation Location	6-2
6.3.2	Sound Level Measurement Results—Alternate Substation Location	6-3
7.0	**OPERATIONAL SOUND LEVELS**	**7-1**
7.1	Overview and Noise Sources	7-1
7.2	Cadna/A Sound Model and Methodology	7-2

TABLE OF CONTENTS (CONTINUED)

7.3 Proposed Larrabee Onshore Substation 7-4
7.3.1 Preferred Substation Location 7-4
7.3.1.1 Modeled Sound Power Levels 7-4
7.3.1.2 Predicted Operational Sound Levels 7-4
7.3.2 Alternate Substation Location 7-6
7.3.2.1 Modeled Sound Power Levels 7-6
7.3.2.2 Predicted Operational Sound Levels 7-7
7.4 Proposed Cardiff Onshore Substation 7-9
7.4.1 Preferred Substation Location 7-9
7.4.1.1 Modeled Sound Power Levels 7-9
7.4.1.2 Predicted Operational Sound Levels 7-9
7.4.2 Alternate Substation Location 7-11
7.4.2.1 Modeled Sound Power Levels 7-11
7.4.2.2 Predicted Operational Sound Levels 7-12
7.5 Sound Level Evaluation 7-12
7.5.1 Proposed Larrabee Onshore Substation-- Preferred Substation Location 7-12
7.5.2 Proposed Larrabee Onshore Substation—Alternate Substation Location 7-14
7.5.3 Proposed Cardiff Onshore substation -- Preferred Substation Location 7-15
7.5.4 Proposed Cardiff Onshore substation – Alternate Substation Location 7-16
7.6 Mitigation Measures 7-16

8.0 ONSHORE CONSTRUCTION NOISE 8-1
8.1 Onshore Substations 8-1
8.1.1 General Information 8-1
8.1.2 Onshore Substation Construction Sound Levels 8-2
8.1.3 Proposed Larrabee Onshore Substation Construction Sound Level Impacts 8-3
8.1.3.1 Preferred Substation Location 8-4
8.1.3.2 Alternate Substation Location 8-4
8.1.4 Proposed Cardiff Onshore Substation Construction Sound Level Impacts 8-5
8.1.4.1 Preferred Substation Location 8-5
8.1.4.2 Alternate Substation Location 8-5
8.1.5 Onshore Substation Construction Mitigation 8-6
8.2 Onshore Interconnection Cables 8-6
8.2.1 Specialty Installation Techniques – Larrabee Onshore Interconnection Cable Route 8-7
8.2.2 Specialty Installation Techniques – Cardiff Onshore Interconnection Cable Route 8-8
8.2.3 Onshore Interconnection Cables – Construction Sound Levels 8-8
8.2.4 Onshore Interconnection Cables Mitigation 8-11

TABLE OF CONTENTS (CONTINUED)

8.3 Specialty Installation Techniques – Horizontal Directional Drilling 8-11
8.3.1 HDD at the Monmouth Landfall Site 8-13
8.3.2 HDD at the Atlantic Landfall Site 8-13
8.3.3 HDD Mitigation 8-14
8.4 Construction Noise Evaluation 8-14

9.0 ONSHORE NOISE FROM OFFSHORE ACTIVITIES 9-1

10.0 CONCLUSIONS 10-1

LIST OF APPENDICES

Appendix A Certificates of Sound Level Instrument Calibration
Appendix B Acoustical Terminology and Metrics

LIST OF FIGURES

Figure 3-1 Larrabee Onshore Interconnection Cable Route and Substation 3-3
Figure 3-2 Cardiff Onshore Interconnection Cable Route and Substation 3-4

Figure 5-1 Baseline Monitoring Locations – Proposed Larrabee Onshore Substation -- Preferred and Alternate Sites 5-2
Figure 5-2 Location L5 -- Sound Level Meter 5-3
Figure 5-3 Location L6 -- Sound Level Meter 5-4
Figure 5-4 Location L7 -- Sound Level Meter 5-5
Figure 5-5 Baseline Monitoring Locations - Proposed Cardiff Onshore Substation—Preferred & Alternate Sites 5-6
Figure 5-6 Location C1 -- Sound Level Meter 5-7
Figure 5-7 Location C2 -- Sound Level Meter 5-8
Figure 5-8 Location C3 -- Sound Level Meter 5-9
Figure 5-9 Location C4 -- Sound Level Meter 5-10

Figure 7-1a Proposed Larrabee Onshore Substation Sound Level Modeling Results -- Preferred Site 7-5
Figure 7-1b Proposed Larrabee Onshore Substation Sound Level Modeling Results -- Alternate Site 7-8

LIST OF FIGURES (CONTINUED)

Figure 7-2a	Proposed Cardiff Onshore Substation Sound Level Modeling Results -- Preferred Site	7-10
Figure 7-2b	Proposed Cardiff Onshore Substation Sound Level Modeling Results -- Alternate Site	7-13
Figure 8-1	Modeled Sound Levels from HDD activity -- Monmouth Landfall Site	8-15
Figure 8-2	Modeled Sound Levels from HDD activity -- Atlantic Landfall Site	8-16

LIST OF TABLES

Table 4-1	New Jersey Sound Level Standards (dBA)	4-1
Table 5-1	GPS Coordinates – Sound Level Measurement Locations—Larrabee	5-1
Table 5-2	GPS Coordinates – Sound Level Measurement Locations—Preferred Site (Cardiff)	5-5
Table 5-3	GPS Coordinates – Sound Level Measurement Locations—Alternate Site (Cardiff)	5-8
Table 6-1	Sound Level Measurement Results—Preferred & Alternate Site (Larrabee)	6-2
Table 6-2a	Sound Level Measurement Results—Preferred Site (Cardiff)	6-3
Table 6-2b	Sound Level Measurement Results—Alternate Site (Cardiff)	6-3
Table 7-1	Onshore Substation Noise Sources - HVAC	7-1
Table 7-2	Modeled Reference Sound Power Levels – Preferred Larrabee	7-4
Table 7-3	Project-Only Sound Level Results – Preferred Larrabee	7-6
Table 7-4	Modeled Reference Sound Power Levels – Alternate Larrabee	7-6
Table 7-5	Project-Only Sound Level Results – Alternate Larrabee	7-7
Table 7-6	Modeled Reference Sound Power Levels – Preferred Cardiff	7-9
Table 7-7	Project-Only Sound Level Results – Preferred Cardiff	7-10
Table 7-8	Modeled Reference Sound Power Levels – Alternate Cardiff	7-11
Table 7-9	Project-Only Sound Level Results – Alternate Cardiff	7-12
Table 7-10	Project Sound Level Results Compared to Limits – Preferred Larrabee	7-14
Table 7-11	Project Sound Level Results Compared to Limits – Alternate Larrabee	7-15
Table 7-12	Project Sound Level Results Compared to Limits – Preferred Cardiff	7-15
Table 7-13	Project Sound Level Results Compared to Limits – Alternate Cardiff	7-16
Table 7-14	Modeled Noise Barrier Details	7-17
Table 8-1	Reference Sound Levels of Construction Equipment at 50 feet	8-3
Table 8-2	Maximum Sound Levels of Construction Phases Extrapolated to Additional Distances	8-3
Table 8-3	Maximum Sound Levels of Construction Phases Extrapolated to Preferred Larrabee Sound Monitoring Locations	8-4

LIST OF TABLES (CONTINUED)

Table 8-4	Maximum Sound Levels of Construction Phases Extrapolated to Alternate Larrabee Sound Monitoring Locations	8-4
Table 8-5	Maximum Sound Levels of Construction Phases Extrapolated to Preferred Cardiff Sound Monitoring Locations	8-5
Table 8-6	Maximum Sound Levels of Construction Phases Extrapolated to Alternate Cardiff Sound Monitoring Locations	8-5
Table 8-7	Reference Sound Levels of Construction Equipment at 50 feet	8-9
Table 8-8	Reference Sound Levels of Construction Equipment at Arbitrary Distances	8-10
Table 8-9	Reference Sound Power Levels of HDD Equipment	8-13
Table 8-10	Modeled Sound Levels from HDD activity -- Monmouth Landfall Site	8-13
Table 8-11	Modeled Sound Levels from HDD activity – Atlantic Landfall Site	8-14

1.0 EXECUTIVE SUMMARY

This Onshore Noise Report was prepared by Epsilon Associates, Inc. (Epsilon) as part of the Construction & Operations Plan (COP) for Atlantic Shores Offshore Wind, LLC. The report includes a baseline sound monitoring program that measured existing ambient sound levels in the vicinity of the proposed onshore substations, computer modeling that predicted future sound levels when the onshore substations are operational, computer modeling of construction noise, and a comparison of predicted sound levels with applicable noise criteria.

The Onshore Noise Report analyzed potential sound level impacts from both construction and operation of the onshore portions of the project. The construction analysis examined expected sound levels from onshore substation construction, typical in-street noise levels associated with underground installation of the onshore interconnection cables, and horizontal directional drilling (HDD) at the export cable landfall sites. The operational analysis examined expected sound levels from each onshore substation site anticipated for the Cardiff and Larrabee points of interconnection. Both the proposed Cardiff and Larrabee onshore substations have a preferred and an alternate site so a total of four possible onshore substation sites were analyzed. Results of the modeling were compared to the State of New Jersey Department of Environmental Protection noise regulations which limit sound levels based on the type of land use (residential, commercial, industrial) and time of day. While the NJ DEP sound level limits do not apply to construction noise, construction noise is regulated at the local level by allowing construction activity during specific hours and days of the week.

In summary, operation of the Atlantic Shores onshore substation will be designed to comply with the applicable NJ DEP residential or commercial sound level limits and will include sound level mitigation as needed. Mitigation elements under consideration include designs for the proposed converter station to included certified enclosures as well as natural barriers and landscaping around the substation at the point of interconnection. While temporary onshore construction noise may occur, Atlantic Shores is proposing to adhere to seasonal construction restrictions during the peak tourist season to minimize impacts. No onshore construction in areas near the coast, including HDD at the landfall sites, will occur during the summer (generally from Memorial to Labor Day), subject to ongoing coordination with local authorities. Additionally, the daily hours of operation for onshore construction activities, including HDD, will be developed in accordance with municipal noise ordinances. Any work that needs to extend outside allowed construction hours will be discussed with local officials and waivers will be obtained if necessary. To further minimize the effects of construction noise, Atlantic Shores will maintain strong communication and public outreach with adjacent neighbors about the time and nature of construction activities.

2.0 INTRODUCTION

Atlantic Shores Offshore Wind, LLC (Atlantic Shores) is proposing to construct an offshore wind farm within the southern portion of New Jersey Wind Energy Lease Area OCS-A 0499 located on the Outer Continental Shelf. Energy from Atlantic Shores will be delivered to shore via 230-kV to 525-kV high voltage alternating current (HVAC) or high voltage direct current (HVDC) export cables. The export cables will traverse federal and state waters to deliver energy from Atlantic Shores to landfall sites located in either Monmouth County (the "Monmouth Landfall Site") or Atlantic County (the "Atlantic Landfall Site"), New Jersey.

From the Monmouth or Atlantic Landfall Sites, new 230-kV to 525-kV HVAC or HVDC onshore interconnection cables will travel underground primarily along existing roadway, utility rights-of-way (ROWs), and/or along bike paths to up to two new onshore substation sites (one for each onshore point of interconnection [POI]), where transmission voltage will be stepped up or stepped down in preparation for interconnection with the electrical grid. Onshore interconnection cables will continue from each of the new onshore substations to proposed POIs in to the electrical grid at the existing Larrabee Substation in Howell, New Jersey (for the Monmouth Landfall Site) or the existing Cardiff Substation in Egg Harbor Township, New Jersey (for the Atlantic Landfall Site).

This Onshore Noise Report includes the following elements:

- Discussion of sound level limits and regulations
- Description of existing condition sound level measurement program
- Operational sound level modeling procedures and results
- Construction sound level modeling procedures and results
- Evaluation of modeling results to applicable regulations

3.0 PROJECT DESCRIPTION – ONSHORE FACILITIES

The Project will require up to two onshore substations (one for each onshore point of interconnection). At each onshore substation site, transmission voltage will be stepped up or stepped down in preparation for interconnection with the electrical grid. The onshore substation design and specific equipment will depend on whether the transmission cables are HVAC or HVDC.

From the Monmouth Landfall Site or Atlantic Landfall Site, onshore interconnection cables will travel underground along existing roadway or utility rights-of-way (ROWs) and/or along bike paths to proposed onshore substations. From the proposed onshore substations, onshore interconnection cables will continue to the proposed points of interconnection (POIs) at the existing Larrabee Substation in Howell Township or the existing Cardiff Substation in Egg Harbor Township for interconnection to the electrical grid. Atlantic Shores has identified a preferred and an alternate onshore substation site on each of the Cardiff and Larrabee onshore interconnection cable routes. Figure 3-1 illustrates the route for the Monmouth Landfall Site and onshore interconnection cable route, and Figure 3-2 does the same for the Atlantic Landfall Site and onshore interconnection cable route. Section 3.3 discusses the negligible onshore sound levels expected from offshore operations.

Existing noise conditions at each proposed onshore substation site are described in Sections 5 and 6.

3.1 Larrabee Onshore Interconnection Cable Route and Substation

The Larrabee Onshore Interconnection Route is an approximately 12 mile (19 kilometer [km]) underground transmission route that largely uses existing linear infrastructure corridors from the Monmouth Landfall Site to the existing Larrabee Substation POI. The transmission line begins in transition vaults at the Monmouth Landfall Site located at the New Jersey National Guard Training Center in Sea Girt, NJ.

Along the Larrabee onshore interconnection cable route, the preferred onshore substation site is located at the corner of County Road 547 (Lakewood Farmingdale Road) and Randolph Road in Howell Township (see Figure 3-1). The site is approximately 10 acres in size and is currently used for an active mulching business. The alternate onshore substation site is just south of the preferred onshore substation site along County Road 547 in Howell Township, immediately west of the existing Larrabee Substation POI (see Figure 3-1). This alternate site encompasses approximately 14.6 acres and consists of a junk yard, mixed forest, and transmission line right-of-way.

3.2 Cardiff Onshore Interconnection Cable Route and Substation

The Cardiff onshore Interconnection route is an approximately 12 mi (19 km) underground transmission route that largely uses existing linear infrastructure corridors from the Atlantic Landfall Site to the existing Cardiff Substation POI. Where the onshore transmission begins at the Atlantic Landfall Site located on Sovereign Avenue, the underground transition vault will likely be at the eastern terminus of Sovereign Avenue under a parking area adjacent to the Atlantic City boardwalk.

Along the Cardiff onshore interconnection cable route, the preferred onshore substation site is located on Shore Mall Road in Egg Harbor Township (see Figure 3-2). The site currently consists of a commercial shopping center which has been partially demolished. The preferred onshore substation is proposed to be constructed within a portion of the abandoned parking lot west of the existing shopping center. The alternate onshore substation site is also located within a commercial shopping center that is situated immediately east of U.S. Route 40 and west of the Garden State Parkway in Egg Harbor Township (see Figure 3-2). The onshore substation on this alternate site would also be constructed within a portion of the parking lot.

ATLANTIC SHORES offshore wind

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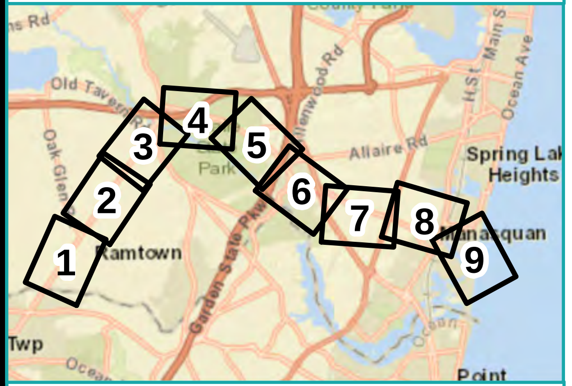


Figure 3-1, Index

Larrabee -
Onshore Interconnection Cable Route
and Substation Sites
Monmouth County, New Jersey

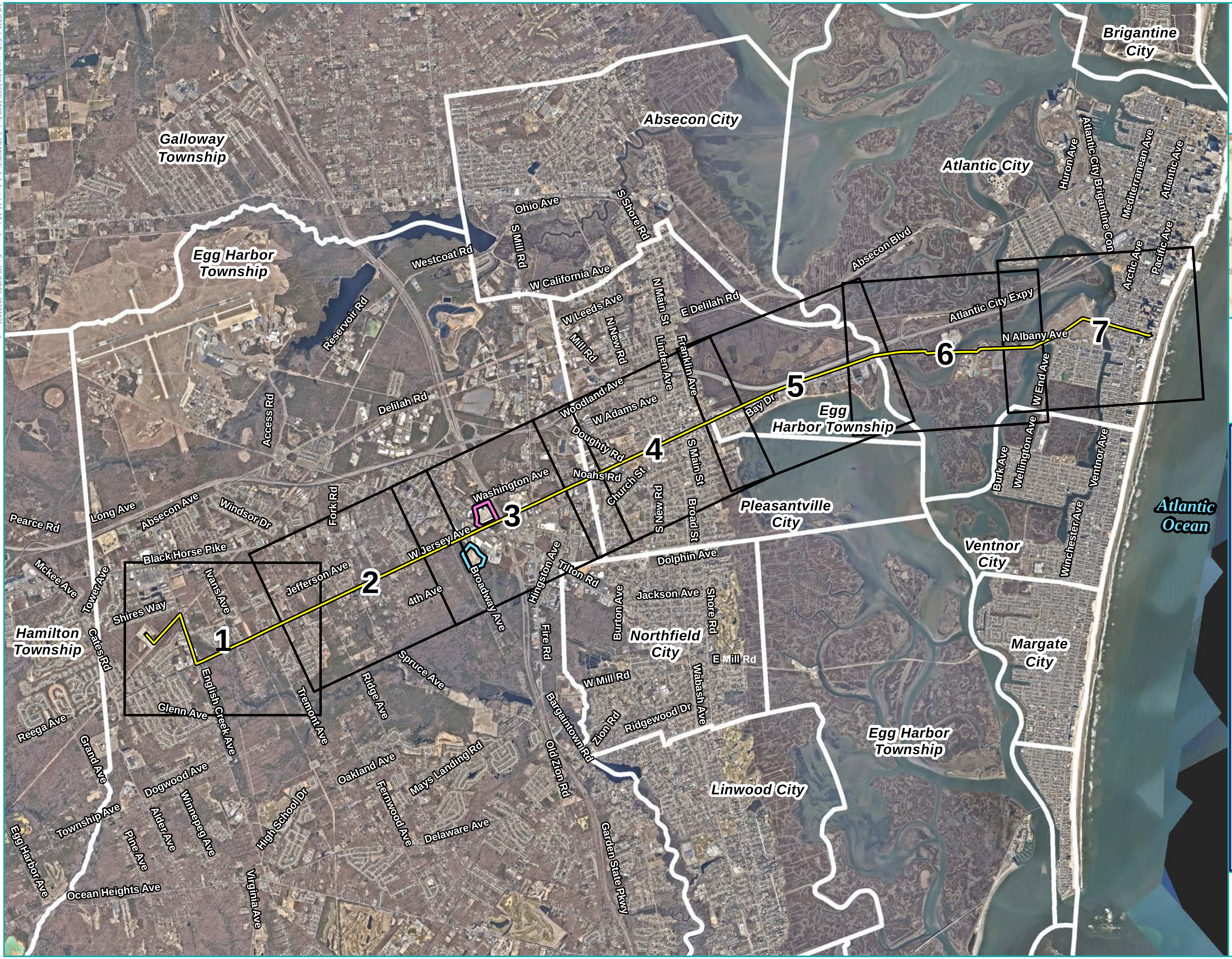
LEGEND

- Larrabee Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Proposed Onshore Substation Site (Alternative)

0 2,500 5,000 Feet

0 750 1,500 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020



ATLANTIC SHORES offshore wind

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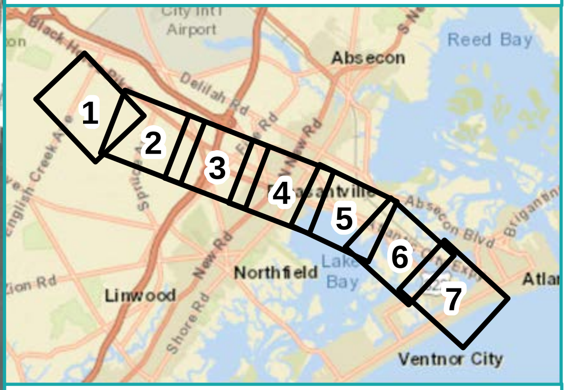

Figure 3-2, Index

Cardiff -
Onshore Interconnection Cable Route
and Substation Sites
Atlantic County, New Jersey

LEGEND

- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 2,500 5,000 Feet

0 750 1,500 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

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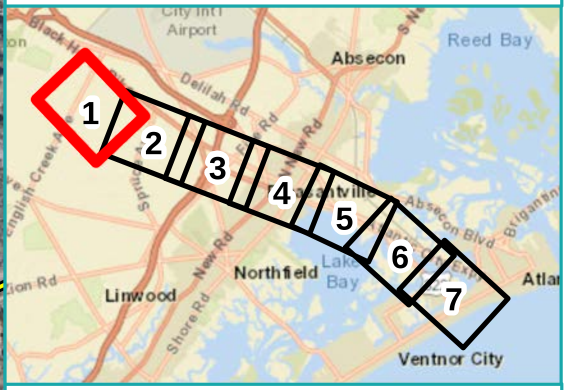


Figure 3-2, Sheet 1 of 7

Cardiff -
Onshore Interconnection Cable Route and Substation Sites
Atlantic County, New Jersey

LEGEND

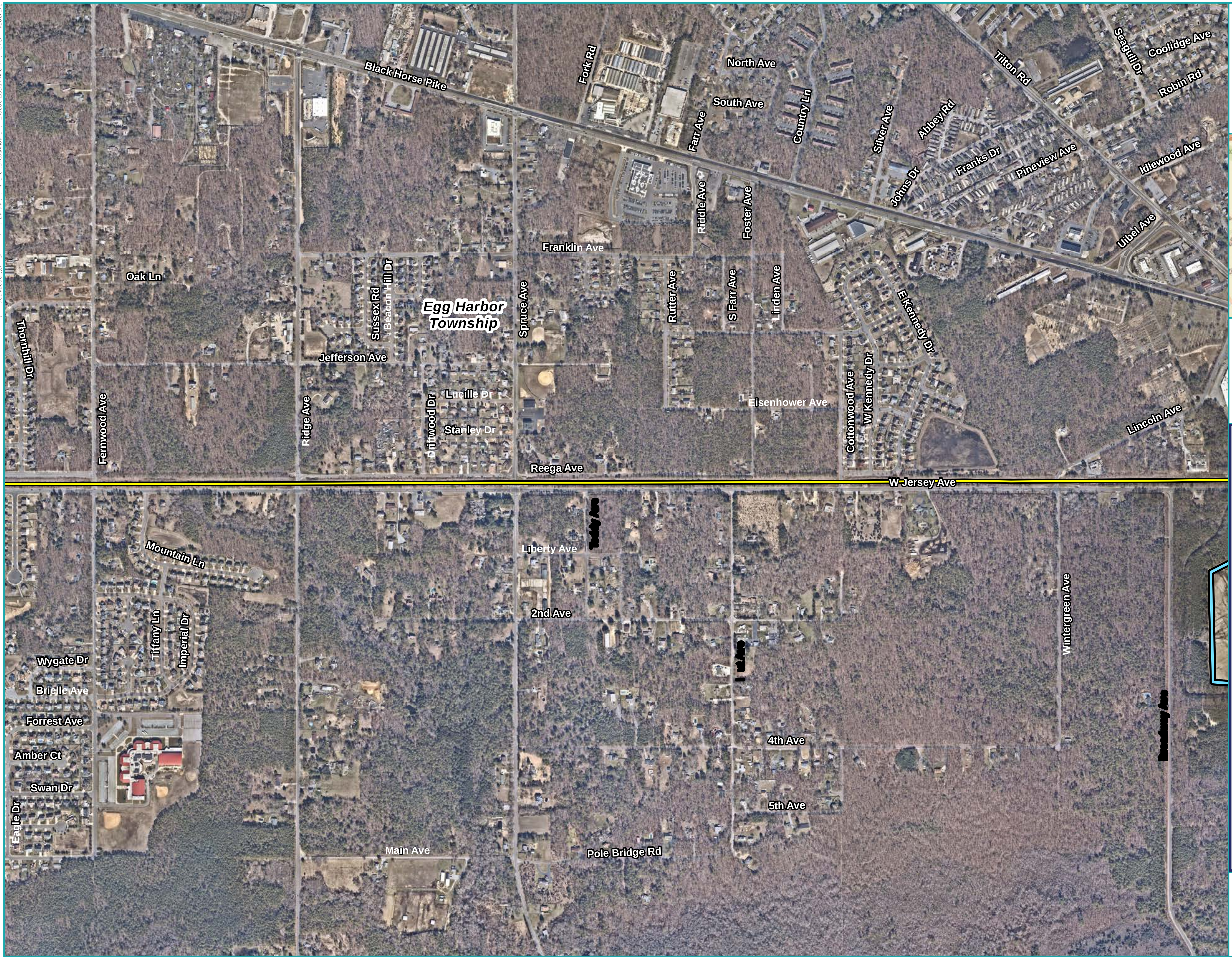
- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 200 400 800 Feet

0 120 240 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020



ATLANTIC SHORES offshore wind

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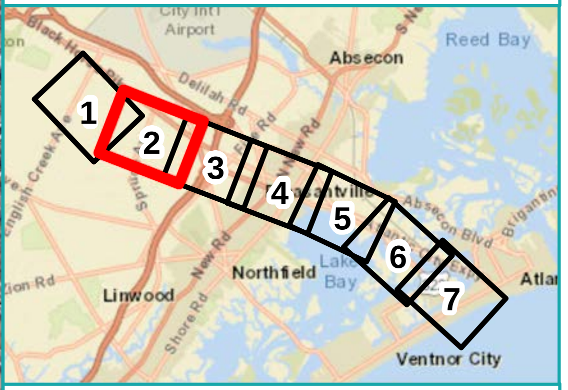

Figure 3-2, Sheet 2 of 7

Cardiff - Onshore Interconnection Cable Route and Substation Sites Atlantic County, New Jersey

LEGEND

- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 200 400 800 Feet

0 120 240 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

ATLANTIC SHORES offshore wind

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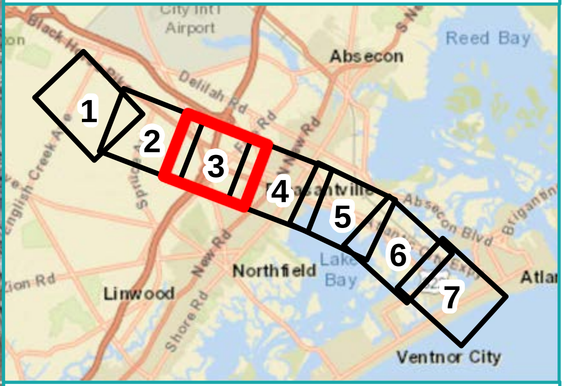

Figure 3-2, Sheet 3 of 7

Cardiff -
Onshore Interconnection Cable Route
and Substation Sites
Atlantic County, New Jersey

LEGEND

- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 200 400 800 Feet
0 120 240 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

ATLANTIC SHORES offshore wind

Epsilon ASSOCIATES INC.

Figure 3-2, Sheet 4 of 7

Cardiff -
Onshore Interconnection Cable Route
and Substation Sites
Atlantic County, New Jersey

LEGEND

- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

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ATLANTIC SHORES offshore wind

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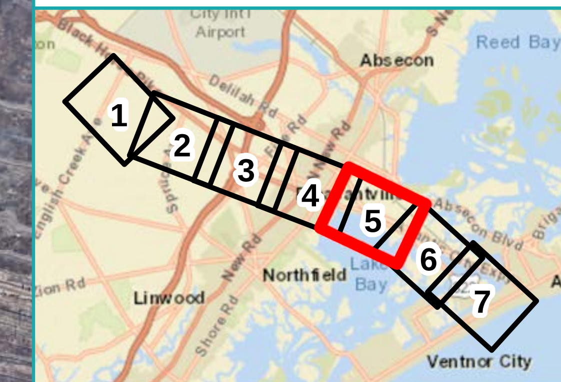

Figure 3-2, Sheet 5 of 7

Cardiff -
Onshore Interconnection Cable Route
and Substation Sites
Atlantic County, New Jersey

LEGEND

- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 200 400 800 Feet

0 120 240 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

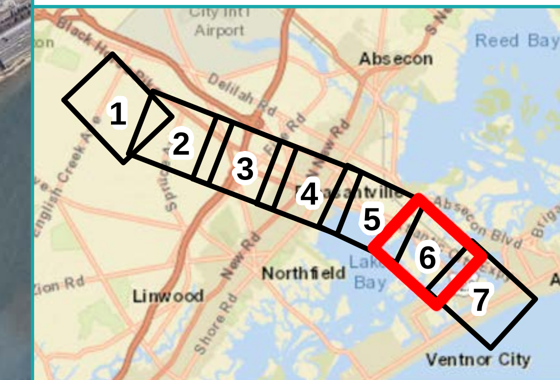

Figure 3-2, Sheet 6 of 7

Cardiff -
Onshore Interconnection Cable Route
and Substation Sites
Atlantic County, New Jersey

LEGEND

- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 200 400 800 Feet
0 120 240 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

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ATLANTIC SHORES
offshore wind

Epsilon
ASSOCIATES INC.

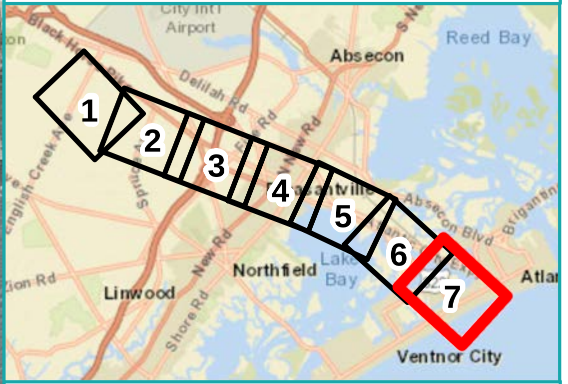

Figure 3-2, Sheet 7 of 7

Cardiff -
Onshore Interconnection Cable Route
and Substation Sites
Atlantic County, New Jersey

LEGEND

Cardiff Onshore Interconnection Cable Route

Preferred Onshore Substation Site

Alternate Onshore Substation Site

0 200 400 800 Feet

0 120 240 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

4.0 NOISE REGULATIONS

4.1 Federal Regulations

There are no federal community noise regulations applicable to operation and/or construction of onshore substations.

4.2 New Jersey State Regulations

The State of New Jersey's Noise Control Act of 1971 authorized the NJ Department of Environmental Protection (DEP) to promulgate codes, rules, and regulations relating to the control and abatement of noise. The NJ DEP promulgated noise regulations to control noise from stationary commercial and industrial sources in 1974 pursuant to the Noise Control Act of 1971 (NJ DEP 7:29). Within the noise regulations, there are established broadband (A-weighted) limits as well as octave band level limits for daytime (7:00 a.m. to 10:00 p.m.) and nighttime (10:00 p.m. to 7:00 a.m.) continuous noise sources. These limits are based on the land use categorization of the source and adjacent property, and are summarized below in Table 4-1.

The Atlantic Shores onshore substations fall under the category of "industrial facility." Based on these standards, the most stringent noise limits for off-site residences or commercial receptors due to noise from the onshore substation would be 65 dBA during the day, and 50 dBA at night. In addition, noise from impulsive (very short duration) noise sources is also regulated; impulsive noise sources occurring less than four times per hour must have levels less than 80 dBA. If they occur more often, they are considered to be continuous noise sources. However, impulsive noise is not applicable to the onshore substation. The noise from public roadways is specifically exempt from the noise level standards [7:29-1.4(a)(9)]. The sound level limits in Table 4-1 do not apply to construction noise which is regulated at the local level by allowing construction activity during specific hours and days of the week.

Table 4-1 New Jersey Sound Level Standards (dBA)

Octave Band Center Frequency	Receptor		
	Residential/Day	Residential/Night	Commercial/ All
A-weighted (dBA)	**65**	**50**	**65**
31.5 Hz	96	86	96
63 Hz	82	71	82
125 Hz	74	61	74
250 Hz	67	53	67
500 Hz	63	48	63
1000 Hz	60	45	60
2000 Hz	57	42	57
4000 Hz	55	40	55
8000 Hz	53	38	53

4.3 Local Regulations – Larrabee Onshore Interconnection Cable Route and Substation

The NJ Noise Control Act allows municipalities to adopt noise control ordinances that are more stringent than the State regulations. The sound level limits set by the NJ DEP apply statewide but the NJ DEP does not investigate noise complaints. Noise complaints are handled at the county level by the Monmouth County Health Department, Air and Noise Control Program.

The Larrabee onshore interconnection cable route passes through four towns or boroughs including Howell Township, Wall Township, Manasquan Borough, and Sea Girt Borough. Both the preferred and alternate onshore substation sites are located in Howell Township. Relevant local noise regulations for each municipality are described below.

Howell Township. Chapter 208 Noise was adopted by the Township of Howell October 17, 2017. Howell Township adopted the same sound level limits as NJ DEP (Section 208-7). These were approved by the NJ DEP. Section 208-4.C exempts construction and demolition activities from the sound level limits. Section 208-9.C limits hours of construction to 7:00 AM-6:00 PM weekdays, and 9:00 AM-6:00 PM on weekends and federal holidays, unless such construction noise can meet the NJ DEP limits. All construction equipment shall be operated with a muffler and/or sound reduction device.

Wall Township. Ordinance No. 22-2014 adopted by the Township of Wall on October 22, 2014 amended Chapter 164 “Peace and Good Order.” Section 164-2.4.b.2(a) limits hours of construction to 7:00 AM-6:00 PM weekdays and 7:00 AM-6:00 PM on Saturday. Construction is prohibited on Sunday and legal holidays.

Manasquan Borough. Section 3-28.3.e limits hours of construction to 8:00 AM-6:00 PM weekdays and 8:00 AM-6:00 PM on Saturday. Construction is prohibited on Sunday and legal holidays.

Sea Girt Borough. Ordinance 891, Section 2 limits hours of construction to 8:00 AM-6:00 PM weekdays and 9:00 AM-5:00 PM on Saturday (Labor Day through June 30 only). Construction is prohibited on Sunday and legal holidays.

4.4 Local Regulations – Cardiff Onshore Interconnection Cable Route and Substation

The NJ Noise Control Act allows municipalities to adopt noise control ordinances that are more stringent than the State regulations. The sound level limits set by the NJ DEP apply statewide but the NJ DEP does not investigate noise complaints. Noise complaints are handled at the county level by the Atlantic County Department of Human Services, Division of Public Health, Environmental Health, Noise Control Program.

The Cardiff onshore interconnection cable route passes through three towns or cities including Egg Harbor Township, Pleasantville City, and Atlantic City. The preferred onshore substation site is located in Egg Harbor Township. The alternate onshore substation site is also located in Egg Harbor Township. Relevant local noise regulations for each municipality are described below.

Egg Harbor Township. Chapter 158 Noise was adopted by the Township of Egg Harbor April 22, 2015. Egg Harbor Township adopted the same sound level limits as NJ DEP (Section 158-7). These were approved by the NJ DEP. Section 158-4.C exempts construction and demolition activities from the sound level limits. Section 158-9.C limits hours of construction to 7:00 AM-6:00 PM weekdays, and 7:00 AM-6:00 PM on weekends and federal holidays, unless such construction noise can meet the NJ DEP limits. All construction equipment shall be operated with a muffler and/or sound reduction device.

Pleasantville City. No information on construction hours was found through a series of emails, phone calls, and a search of on-line ordinances. Specific hours of work in Pleasantville will be refined as the project gets closer to construction.

Atlantic City. Chapter 186 Noise was adopted by the City Council of Atlantic City May 11, 2011. Atlantic City adopted the same sound level limits as NJ DEP (Section 186-6). These were approved by the NJ DEP. Section 186-3.C exempts construction and demolition activities from the sound level limits. Section 186-8.C limits hours of construction to 7:00 AM-6:00 PM weekdays, and 9:00 AM-6:00 PM on weekends and federal holidays, unless such construction noise can meet the NJ DEP limits. All construction equipment shall be operated with a muffler and/or sound reduction device.

5.0 BASELINE SOUND LEVEL MONITORING PROGRAM

To characterize the existing soundscape of the Project area, an ambient (baseline) monitoring program was conducted around the proposed onshore substations in the summer of 2020. This section outlines the structure of the ambient program.

In accordance with ANSI S12.9-1992/Part 2 (R2013), the deterministic spatial sampling technique was used to select measurement locations. In other words, sound monitoring locations were selected to be representative of nearby residences in various directions from the project. Thus, the selected locations are representative of potentially impacted receptors. The program was intended to measure total ambient sound in the area which includes all noise sources.

5.1 Proposed Larrabee Onshore Substation

Both the preferred and alternate locations for the proposed Larrabee onshore substation are in Howell Township. In fact, they are next to each other abutting the existing Larrabee substation (POI). Therefore, one set of existing sound level measurements covered both locations.

Short-term attended monitoring was conducted during both daytime and nighttime hours. Daytime measurements were generally conducted between 12:45 PM and 1:45 PM while nighttime measurements were made between 12:00 AM and 2:00 AM. The sound level meter measured and stored broadband (A-weighted) and one-third octave band sound level statistics. Measurements were made for 20 minutes at each location.

Figure 5-1 shows the measurement locations. The coordinates for the sound level measurement locations are listed in Table 5-1. Each sound level monitoring location is described in the following subsections.

Table 5-1 GPS Coordinates – Sound Level Measurement Locations—Larrabee

Location	Latitude	Longitude
L5	40.1161661	-74.1927358
L6	40.1141718	-74.1985149
L7	40.1100289	-74.1929919

5.1.1 Location L5—Randolph Road

One programmable, attended sound level meter was placed across the street from #27 Randolph Road. This is a commercial building and is surrounded by other commercial buildings, and some homes to the west. The meter was placed approximately 20 feet (6 meters) south of the road and is representative of existing sound levels in the central area of the Project Site and along Randolph Road. Refer to Figure 5-2 for a photo of the monitoring setup. Sound levels at this location were

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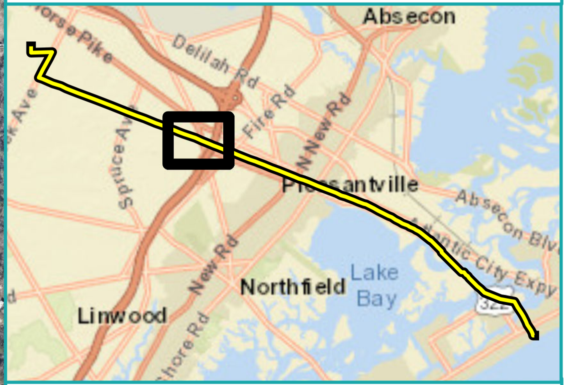

Figure 5-5

Cardiff
Preferred and Alternate Onshore Substation
Sound Monitoring Locations

LEGEND

- Sound Level Measurement Location
- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 225 450 Feet

0 65 130 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

influenced by vehicular traffic on Randolph Road, construction site machinery, vegetation rustle, insects, distant traffic, faint electrical equipment in the distance (east/southeast of the monitoring location), and sprinklers.

Daytime measurements were made at this location Wednesday August 5, 2020 beginning at 12:45 PM. Nighttime measurements were made at this location Wednesday August 5, 2020 beginning at 12:26 AM.

Figure 5-2 Location L5 -- Sound Level Meter

5.1.2 Location L6—Larrabee Boulevard

One programmable, attended sound level meter was placed on the sidewalk across the street from #18 Larrabee Boulevard. This is a residential building and is surrounded by other residences, and some commercial uses. The meter was placed approximately 7 feet (2 meters) south of the road and is representative of existing sound levels in the northern area of the Project Site and along Larrabee Boulevard. Refer to Figure 5-3 for a photo of the monitoring setup. Sound levels at this location were influenced by vehicular traffic on Larrabee Boulevard, residential activity, insects, birds, dogs, electric generator noise, and occasional aircraft.

Daytime measurements were made at this location Wednesday August 5, 2020 beginning at 1:23 PM. Nighttime measurements were made at this location Wednesday August 5, 2020 beginning at 1:05 AM.

Figure 5-3 Location L6 -- Sound Level Meter

5.1.3 Location L7—Arosa Hill

One programmable, attended sound level meter was placed on the sidewalk across the street from #40 Arosa Hill. This is a residential building and is surrounded by other residences. The meter was placed approximately 52 feet (16 meters) south of the road and is representative of existing sound levels in the southern area of the Project Site and along Arosa Hill. Refer to Figure 5-4 for a photo of the monitoring setup. Sound levels at this location were influenced by vehicular traffic on Arosa Hill and Milano Drive, electric generator noise, residential activity (including lawn mowers), insects, birds, and occasional aircraft.

Daytime measurements were made at this location Wednesday August 5, 2020 beginning at 1:20 PM. Nighttime measurements were made at this location Wednesday August 5, 2020 beginning at 1:41 AM.

Figure 5-4 Location L7 -- Sound Level Meter

5.2 Proposed Cardiff Onshore Substation

The preferred location for the proposed Cardiff onshore substation is in Egg Harbor Township. The alternate Cardiff onshore substation site is also located in Egg Harbor Township. Therefore, existing sound level measurements focused on these two locations.

Short-term attended monitoring was conducted during both daytime and nighttime hours at each location. Daytime measurements were generally conducted between 3:15 PM and 5 PM while nighttime measurements were made between 11 PM and 1:30 AM. The sound level meter measured and stored broadband (A-weighted) and one-third octave band sound level statistics. Measurements were made for 20 minutes at each location.

5.2.1 Sound Level Measurement Locations—Preferred Substation Location

Figure 5-5 shows the measurement locations for the preferred site. The coordinates for the sound level measurement locations are listed in Table 5-2. Each sound level monitoring location is described in the following subsections.

Table 5-2 GPS Coordinates – Sound Level Measurement Locations—Preferred Site (Cardiff)

Location	Latitude	Longitude
C1	39.4041508	-74.5687275
C2	39.400236	-74.5710179

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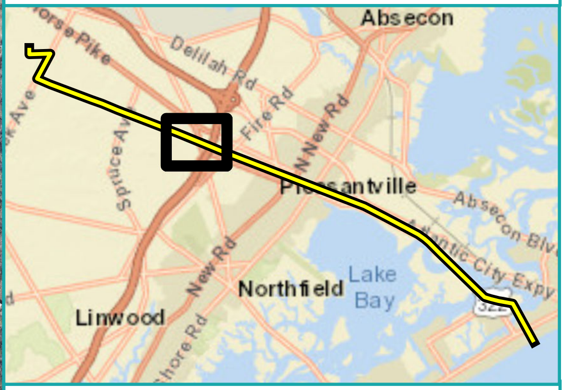

Figure 5-5

Cardiff
Preferred and Alternate Onshore Substation
Sound Monitoring Locations

LEGEND

- Sound Level Measurement Location
- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Alternate Onshore Substation Site

0 225 450 Feet
0 65 130 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

5.2.1.1 Location C1—Broadway Avenue

One programmable, attended sound level meter was placed on the side of the Broadway Ave near #6695 West Jersey Avenue. This is a residential building and is surrounded by other residences, and some commercial uses. The meter was placed approximately 13 feet (4 meters) east of the road and is representative of existing sound levels in the western area of the Project Site and along Broadway Avenue and West Jersey Avenue. Refer to Figure 5-6 for a photo of the monitoring setup. Sound levels at this location were influenced by vehicular traffic on West Jersey Avenue, vegetation rustle, wind, insects, birds, and occasional propeller planes.

Daytime measurements were made at this location Monday August 3, 2020 beginning at 3:24 PM. Nighttime measurements were made at this location Monday August 3, 2020 beginning at 11:38 PM.

Figure 5-6 Location C1 -- Sound Level Meter

5.2.1.2 Location C2—Broadway Avenue

One programmable, attended sound level meter was placed on the side of the road on Broadway Avenue. The sound level meter was in front of a residential building and is surrounded by other residences, and some commercial uses. The meter was placed approximately 16 feet (5 meters) west of the road and is representative of existing sound levels in the southwest area of the Project Site and along Broadway Avenue. Refer to Figure 5-7 for a photo of the monitoring setup. Sound levels at this location were influenced by insects, rustling vegetation, wind, birds, occasional traffic on Broadway Avenue, and distant traffic.

Daytime measurements were made at this location Monday August 3, 2020 beginning at 3:18 PM. Nighttime measurements were made at this location Monday August 3, 2020 beginning at 11:08 PM.

Figure 5-7 Location C2 -- Sound Level Meter

5.2.2 Sound Level Measurement Locations—Alternate Substation Location

Figure 5-5 shows the measurement locations for the alternate site. The coordinates for the sound level measurement locations are listed in Table 5-3. Each sound level monitoring location is described in the following subsections.

Table 5-3 GPS Coordinates – Sound Level Measurement Locations—Alternate Site (Cardiff)

Location	Latitude	Longitude
C3	39.4055295	-74.5584953
C4	39.4069199	-74.5588898

5.2.2.1 Location C3—Washington Avenue

One programmable, attended sound level meter was placed in public yard space across Martin Avenue from #6730 Washington Avenue. This is a commercial building and is surrounded by other residences, and some commercial uses. The meter was placed approximately 50 feet (15 meters) northeast of the road and is representative of existing sound levels in the southwest area of the Project Site and along Washington Avenue. Refer to Figure 5-8 for a photo of the monitoring setup. Sound levels at this location were influenced by vehicular traffic on Washington Avenue and the Garden State Parkway, rustling vegetation, a low frequency piece of equipment from the plaza across the street, dogs, insects, and birds.

Daytime measurements were made at this location Monday August 3, 2020 beginning at 4:27 PM. Nighttime measurements were made at this location Tuesday August 4, 2020 beginning at 12:21 AM.

Figure 5-8 Location C3 -- Sound Level Meter

5.2.2.2 Location C4—Ruckreim Drive

One programmable, attended sound level meter was placed on the side of the road on Ruckreim Drive. This is a residential road and is surrounded by other residences, and some commercial uses. The meter was placed approximately 26 feet (8 meters) southeast of the road and is representative of existing sound levels in the northern area of the Project Site and along Ruckreim Drive. Refer to Figure 5-9 for a photo of the monitoring setup. Sound levels at this location were influenced by vehicular traffic on Washington Avenue and the Garden State Parkway, residential activity, rustling vegetation, insects, birds, dogs, and occasional aircraft.

Daytime measurements were made at this location Monday August 3, 2020 beginning at 4:40 PM. Nighttime measurements were made at this location Tuesday August 4, 2020 beginning at 1:19 AM.

Figure 5-9 Location C4 -- Sound Level Meter

5.3 Sound Level Measurement Instrumentation

Each of the monitoring locations utilized a Larson Davis (LD) model 831[1] sound level meter (SLM) to measure A-weighted (dBA) and one-third octave bands from 6.3 Hz to 10,000 Hz. Each instrument was equipped with a LD PRM831 preamplifier and a PCB 377B20 or 377C20 half-inch microphone. Each SLM used an untreated ACO 7-inch diameter 20 ppi (pores per inch) open cell foam windscreen to reduce wind-induced noise over the microphone. Each microphone was tripod-mounted at a height of approximately five feet (1.5 meters) above ground level in accordance with ANSI S12.9-1992/Part 2 (R2013).

The LD831 meet Type 1 ANSI/ASA S1.4, ANSI S1.43-1997 (R2007), and IEC 61672 Class 1 standards for sound level meters and were calibrated and certified as accurate to standards set by the National Institute of Standards and Technology. The octave band filters for all instrumentation meet ANSI S1.11-2004 (R2009). These calibrations were conducted by an independent laboratory within 12 months of field placement and certificates of calibration are provided in Appendix A. All measurement equipment was calibrated in the field before and after the surveys with the manufacturer's acoustical calibrator which meets the standards of IEC 60942-2003 Class 1L and ANSI/ASA S1.40-2006 (R2016).

Meteorological observations were made during each sound level monitoring program using handheld instrumentation. For this project, a Kestrel 3000 was used to observe the local wind speed, relative humidity, and temperature.

1 Noise floor specified in manufacturer's manual with use of PRM831 preamplifier and 377B02 microphone for A-weighted sound pressure levels is 18 dB at a 0 dB gain and 17 at a 20 dB gain. Noise floor specified for Z-weighted sound pressure levels is 23 dB at a 0 dB gain and 21 at a 20 dB gain.

6.0 BASELINE SOUND LEVEL MONITORING RESULTS

This section discusses the results from the detailed ambient (baseline) monitoring program outlined in the previous section. Specifically, the logic for data validity and sound level results for the monitoring locations are provided.

6.1 Data Formatting Overview

Monitoring periods that experienced elevated ground-level wind speeds (greater than 5 m/s) or precipitation were excluded from the data analysis per Method #1 in ANSI S12.18-1994.

During the summer months, insect noise can dominate sound levels especially in wooded, grassy, or wet areas. This insect noise can overwhelm other sources and sometimes result in a very different sound level than if the insects were not present, such as the winter season. This seasonal noise was removed from the ambient sound level measurements using a high-frequency natural sound (HFNS) filter applied to the measured one-third octave-band data from which a broadband sound level was calculated. This technique removes all sound energy above the 1,250 Hertz frequency band which is primarily insect noise. The methodology for the filtration process is as specified in ANSI/ASA S12.100-2014 and the sound pressure levels presented in this report using this methodology are indicated as ANS-weighted levels (presented in dBA). This HFNS analysis provides an indication of what ambient sound levels may be in colder weather without the influence of insect noise. Appendix B contains a more detailed discussion of acoustic terminology used in this report.

During both the daytime and nighttime sound measurements at the preferred and alternate Larrabee onshore substation locations, there was a significant amount of electric generator noise. This noise was due to there being widespread power outages caused by Tropical Storm Isaias. The storm passed through the Atlantic Shores Project Region on Tuesday, August 4 from roughly 4:00 AM until 6:00 PM. The storm caused widespread power outages, which in turn, caused many backup generators to turn on. The storm passed through the Project Region after the sound measurements at the Cardiff onshore substation locations were completed, therefore, the storm did not affect these measurements. However, the storm passed through the Project Region before the sound measurements at the Larrabee onshore substation locations; thus, some generator noise was included in both the daytime and nighttime sound measurements at the Larrabee onshore substation locations. This generator noise is tonal in nature and not representative of “normal” existing conditions. Therefore, the generator-specific sound energy was not included in the octave band and broadband analysis presented below.

The 20-minute measured steady-state (L_{90}) and equivalent (L_{eq}) A-weighted sound levels are summarized below in Tables 6-1, 6-2a, and 6-2b for each onshore substation along with the calculated ANS-weighted L_{90} and L_{eq} sound levels. In addition to broadband sound levels, the L_{90} octave-band data are also summarized in Tables 6-1, 6-2a, and 6-2b for each onshore substation. The time in each table represents the start of the 20-minute measurement time.

6.2 Larrabee Onshore Substation

6.2.1 Sound Level Measurement Results—Preferred & Alternate Substation Location

Table 6-1 presents the measured sound levels from the Larrabee onshore preferred and alternate substation.

Table 6-1 Sound Level Measurement Results—Preferred & Alternate Site (Larrabee)

Loc.	Day/ Night	Start Time	LA_{eq}	LA_{90}	ANS-LA_{eq}	ANS-LA_{90}	L_{90} Sound Pressure Level by Octave-Band Center Frequency (Hz)								
							31.5	63	125	250	500	1k	2k	4k	8k
			dBA	dBA	dBA	dBA	dB	dB	dB	dB	dB	dB	dB	dB	dB
L5	Day	12:45	71	60	70	56	69	60	54	51	54	54	53	49	38
L6	Day	13:23	61	44	60	41	51	52	45	39	38	39	34	28	24
L7	Day	13:20	53	47	51	46	51	52	51	48	43	42	39	33	25
L5	Night	00:26	56	52	49	50	43	45	43	39	37	35	46	48	37
L6	Night	01:05	52	49	40	52	46	47	44	39	35	31	44	44	39
L7	Night	01:41	53	51	46	44	47	51	50	47	41	40	46	44	39

6.3 Cardiff Onshore Substation

6.3.1 Sound Level Measurement Results—Preferred Substation Location

Table 6-2a presents the measured sound levels from the Cardiff onshore preferred substation.

Table 6-2a Sound Level Measurement Results—Preferred Site (Cardiff)

Loc.	Day/ Night	Start Time	LA_{eq}	LA_{90}	ANS-LA_{eq}	ANS-LA_{90}	L_{90} Sound Pressure Level by Octave-Band Center Frequency (Hz)								
							31.5	63	125	250	500	1k	2k	4k	8k
			dBA	dBA	dBA	dBA	dB	dB	dB	dB	dB	dB	dB	dB	dB
C1	Day	15:24	55	46	54	44	54	51	44	42	42	41	36	32	29
C2	Day	15:18	49	42	48	41	51	49	45	41	39	38	29	27	25
C1	Night	23:38	52	49	46	34	46	45	43	35	34	29	42	45	38
C2	Night	23:08	55	51	51	33	44	43	42	34	30	29	45	48	38

6.3.2 Sound Level Measurement Results—Alternate Substation Location

Table 6-2b presents the measured sound levels from the Cardiff onshore alternate substation.

Table 6-2b Sound Level Measurement Results—Alternate Site (Cardiff)

Loc.	Day/ Night	Start Time	LA_{eq}	LA_{90}	ANS-LA_{eq}	ANS-LA_{90}	L_{90} Sound Pressure Level by Octave-Band Center Frequency (Hz)								
							31.5	63	125	250	500	1k	2k	4k	8k
			dBA	dBA	dBA	dBA	dB	dB	dB	dB	dB	dB	dB	dB	dB
C3	Day	16:27	67	61	67	59	61	63	62	57	54	58	52	42	33
C4	Day	16:47	54	51	54	50	57	57	51	46	46	49	41	27	26
C3	Night	00:21	59	47	57	45	48	52	51	48	39	43	37	31	28
C4	Night	01:19	52	43	41	35	45	46	41	36	32	32	34	29	36

7.0 OPERATIONAL SOUND LEVELS

7.1 Overview and Noise Sources

The onshore substation design and specific equipment will depend on whether the onshore interconnection cables are high voltage alternating current (HVAC) or high voltage direct current (HVDC). If HVAC is used, each onshore substation will include up to four 450 MVA power transformers, four 200 MVA iron core shunt reactors, two harmonic filters, two 450 MVAr static synchronous compensators (STATCOMs), and a substation control building. If HVDC is used, each onshore substation will include one transformer system arranged in three single-phase 411 MVA transformers and a control building.

At the time of COP submission no decision has been made on the onshore interconnection cable technology. It is anticipated that the HVDC design would include equipment primarily housed indoors. The HVDC design would have additional ventilation equipment producing noise. However, based on the experience of the Project team, it is anticipated that the HVDC design would have generally lesser sound impacts on the surrounding community than HVAC technology. Therefore, only the HVAC onshore substation design has been conservatively evaluated in this report.

Table 7-1 summarizes the onshore substation components in the HVAC design along with the type or rating, quantity, and indication of whether the component is in the site yard or part of a STATCOM. Broadband sound power level ranges for each major piece of equipment were provided to Epsilon. Sound modeling was initially performed using the highest sound power level in that range to be conservative, and these sound levels are identified in Table 7-1 as the "Base Case" sound levels. Other electrical and mechanical components of the onshore substation, either in the site yard, in the STATCOMs, or contained within site buildings, are assumed to be insignificant sources of sound and were excluded from the modeling, e.g., auxiliary transformers with sound power levels that are 10 dBA lower than the quietest piece of equipment included in the model.

Table 7-1 Onshore Substation Noise Sources - HVAC

Component	Type/Rating	Qty.	Site Yard or STATCOM Component	"Base Case" Broadband Sound Power Level in dBA (per unit)
Power Transformer	450 MVA, 230/230kV	4	Site Yard	107
VSR (Iron Core)	200 MVAr	4	Site Yard	102
Harmonic Filter Reactor	Unknown	6	Site Yard	97
Harmonic Filter Capacitor	Unknown	6	Site Yard	92

Table 7-1 Onshore Substation Noise Sources – HVAC (Continued)

Component	Type/Rating	Qty.	Site Yard or STATCOM Component	"Base Case" Broadband Sound Power Level in dBA (per unit)
Harmonic Filter Resistor	Unknown	6	Site Yard	82
VSC Reactor (Air Core)	Unknown	6	STATCOM	97
DRC Step-up Transformer	400 MVA	2	STATCOM	110
Fan Bank	Unknown	6	STATCOM	102
Valve Hall HVAC Unit	Unknown	2	STATCOM	82
BARD Wall-mounted HVAC Unit	Unknown	8	STATCOM	82

7.2 Cadna/A Sound Model and Methodology

Sound level impacts from the onshore substation electrical and mechanical equipment were analyzed using Cadna/A noise calculation software[2]. This predictive software uses the ISO 9613-2 international standard for sound propagation.[3] The Cadna/A software includes a refined set of computations accounting for local topography, ground attenuation, drop-off with distance, barrier shielding, diffraction around building edges, reflection off building facades, and atmospheric absorption of sound from multiple noise sources.

Inputs and significant parameters employed in the model are described below:

- **Project Layout:** Preliminary site arrangement drawings were provided for the preferred substation sites at Larrabee and Cardiff. The location of the proposed electrical and mechanical equipment at the alternate sites was estimated by Epsilon based on the preliminary HVAC arrangements provided by Atlantic Shores.

- **Sensitive Receptors**: Sound levels were evaluated at site-specific modeling locations (discrete points) representing the closest residentially or commercially used property lines surrounding each site. The modeling locations include measurement locations presented in section 5 and additional property line receptors based on a review of aerial imagery. A total of nine receptors were modeled at the preferred and alternate Larrabee

[2] DataKustik Corporation GmbH

[3] *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation,* International Standard ISO 9613-2:1996 (International Organization for Standardization, Geneva, Switzerland, 1996).

sites, four receptors at the preferred Cardiff site, and five receptors at the alternate Cardiff site. All receptors were modeled with a height of 1.5 meters above ground level to mimic the ears of a typical standing observer.

- **Modeling Grid:** A modeling grid with 10-meter spacing was calculated in the vicinity of each proposed onshore substation site. The grids were modeled at a height of 1.5 meters above ground level for consistency with the discrete modeling points. This modeling grid allowed for the creation of sound level isolines.

- **Terrain Elevation:** Elevation contours for the modeling domain, derived from a National Elevation Dataset from Natural Resources Conservation Service at a 3-meter resolution, were directly imported into Cadna/A, which allowed for consideration of terrain shielding and differences in elevation between sources and receivers, where appropriate.

- **Source Sound Power Levels:** Broadband sound power level ranges for each major piece of equipment described in section 7.1 were provided to Epsilon. Sound modeling was initially performed using the highest sound power level in that range to be conservative ("base-case"). In some cases, and unique to each proposed onshore substation site, the sound power level of certain equipment was reduced within the model to reduce impacts at the nearest noise-sensitive property lines. Therefore, tabular summaries of the modeled reference sound power level data for each unit are provided in the subsequent sections specific to each onshore substation site. The Project is in the early design stage and octave band sound level data were not available for the equipment included in the model. Therefore, no predicted octave band sound levels were modeled.

- **Meteorological Conditions:** A temperature of 10°C (50°F) and a relative humidity of 70% were assumed in the model to minimize atmospheric attenuation in the 500 Hz and 1,000 Hz octave bands where the human ear is most sensitive. As per ISO 9613-2, the modeling assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night or equivalently downwind propagation.

- **Ground Attenuation:** Spectral ground absorption was calculated using a global G-factor of 0.5 to represent a moderately reflective surface.

- No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered in the model.

7.3 Proposed Larrabee Onshore Substation

7.3.1 Preferred Substation Location

7.3.1.1 Modeled Sound Power Levels

A tabular summary of the noise-controlled reference sound power level data for each noise source, as included in the model for the preferred Larrabee onshore substation, is presented in Table 7-2. Base-case sound levels are included in the table for reference purposes. All modeled sources were assumed to be operating simultaneously and at the sound levels shown in Table 7- 2.

Table 7-2 Modeled Reference Sound Power Levels – Preferred Larrabee

Component	Site Yard or STATCOM Component	"Base Case" Broadband Sound Power Level	Noise Controlled Broadband Sound Power Level
		dBA	dBA
Power Transformer	Site Yard	107	97
VSR (Iron Core) – 200 MVAr	Site Yard	102	92
Harmonic Filter Reactor	Site Yard	97	87
Harmonic Filter Capacitor	Site Yard	92	87
Harmonic Filter Resistor	Site Yard	82	82
VSC Reactor (Air Core)	STATCOM	97	87
DRC Step-up Transformer	STATCOM	110	97
Fan Bank	STATCOM	102	97
Valve Hall HVAC Unit	STATCOM	82	82
BARD Wall-mounted HVAC Unit	STATCOM	82	82

7.3.1.2 Predicted Operational Sound Levels

Broadband sound level results at the nine modeling receptors at the preferred onshore substation location are presented in Table 7-3. Both "base-case" and noise-controlled (i.e., proposed) results are shown. Figure 7-1a provides noise-controlled sound contours from the operation of the onshore substation. Included on the figure are the nine modeling locations and the on-site buildings included in the model. These buildings include a control building and two STATCOM buildings. The noise-controlled Project-only broadband sound levels range from 42 to 52 dBA at the nine modeling locations. The highest sound level modeled at a residential property line is 49 dBA as represented by Receptor L9 and as demonstrated by the sound results shown in Figure 7- 1a.

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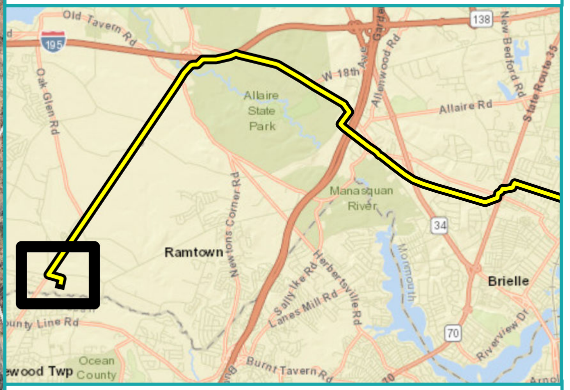

Figure 7-1a

Larrabee
Preferred Onshore Substation
Sound Level Modeling Results

LEGEND

- Modeling Receptor
- Larrabee Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Modeled On-site Buildings
- Parcel Boundary
- Township Boundary

Predicted Sound Level (dBA)

- 50
- 55
- 60
- 65

0 225 450 Feet

0 65 130 Meters

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

Table 7-3 Project-Only Sound Level Results – Preferred Larrabee

Receptor ID	Land Use	Modeled Project-Only L_{eq} Sound Level (dBA)	
		Base Case	Noise Controlled (Proposed)
L5	Commercial (Measurement Location)	68	52
L6	Residential (Measurement Location)	52	44
L7	Residential (Measurement Location)	50	42
L8	Residential	61	47
L9	Residential	67	49
L10	Residential	57	48
L11	Residential	56	47
L12	Residential	54	45
L13	Commercial	56	48

7.3.2 Alternate Substation Location

7.3.2.1 Modeled Sound Power Levels

A tabular summary of the noise-controlled reference sound power level data for each noise source, as included in the model for the alternate Larrabee onshore substation, is presented in Table 7-4. Base-case sound levels are included in the table for reference purposes. All modeled sources were assumed to be operating simultaneously at the sound levels shown in Table 7-4.

Table 7-4 Modeled Reference Sound Power Levels – Alternate Larrabee

Component	Site Yard or STATCOM Component	"Base Case" Broadband Sound Power Level	Noise Controlled Broadband Sound Power Level
		dBA	dBA
Power Transformer	Site Yard	107	92
VSR (Iron Core) – 200 MVAr	Site Yard	102	92
Harmonic Filter Reactor	Site Yard	97	87
Harmonic Filter Capacitor	Site Yard	92	82
Harmonic Filter Resistor	Site Yard	82	82
VSC Reactor (Air Core)	STATCOM	97	85
DRC Step-up Transformer	STATCOM	110	97
Fan Bank	STATCOM	102	97
Valve Hall HVAC Unit	STATCOM	82	82
BARD Wall-mounted HVAC Unit	STATCOM	82	82

7.3.2.2 Predicted Operational Sound Levels

Broadband sound level results at the nine modeling receptors at the alternate onshore substation location are presented in Table 7-5. Both "base-case" and noise-controlled (i.e., proposed) results are shown. Figure 7-1b provides noise-controlled sound contours from the operation of the onshore substation. Included on the figure are the nine modeling locations and the on-site buildings included in the model. These buildings include a control building and two STATCOM buildings. The noise-controlled Project-only broadband sound levels range from 41 to 56 dBA at the nine modeling locations. The highest sound level modeled at a residential property line is 50 dBA as represented by Receptors L10 and L12 and as demonstrated by the sound results shown in Figure 7-1b.

Table 7-5 Project-Only Sound Level Results – Alternate Larrabee

Receptor ID	Land Use	Modeled Project-Only L_{eq} Sound Level (dBA)	
		Base Case	Noise Controlled (Proposed)
L5	Commercial (Measurement Location)	58	48
L6	Residential (Measurement Location)	55	44
L7	Residential (Measurement Location)	51	41
L8	Residential	52	43
L9	Residential	56	47
L10	Residential	60	50
L11	Residential	60	49
L12	Residential	60	50
L13	Commercial	66	56

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Figure 7-1b

Larrabee Alternate Onshore Substation Sound Level Modeling Results

7.4 Proposed Cardiff Onshore Substation

7.4.1 Preferred Substation Location

7.4.1.1 Modeled Sound Power Levels

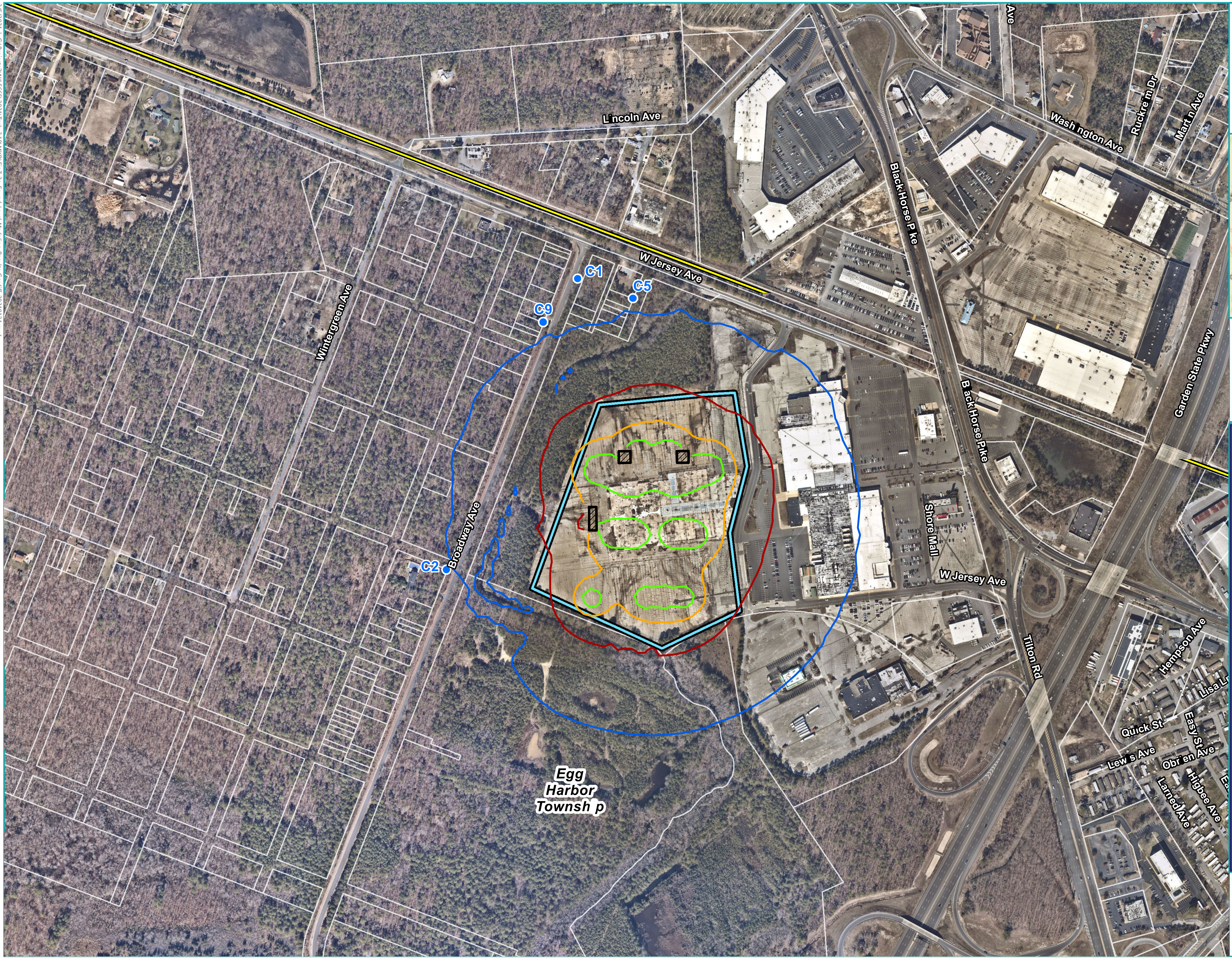
A tabular summary of the noise-controlled reference sound power level data for each noise source, as included in the model for the preferred Cardiff onshore substation, is presented in Table 7-6. Base-case sound levels are included in the table for reference purposes. All modeled sources were assumed to be operating simultaneously at the sound levels shown in Table 7-6.

Table 7-6 Modeled Reference Sound Power Levels – Preferred Cardiff

Component	Site Yard or STATCOM Component	"Base Case" Broadband Sound Power Level	Noise Controlled Broadband Sound Power Level
		dBA	dBA
Power Transformer	Site Yard	107	99
VSR (Iron Core) – 200 MVAr	Site Yard	102	97
Harmonic Filter Reactor	Site Yard	97	92
Harmonic Filter Capacitor	Site Yard	92	92
Harmonic Filter Resistor	Site Yard	82	82
VSC Reactor (Air Core)	STATCOM	97	96
DRC Step-up Transformer	STATCOM	110	98
Fan Bank	STATCOM	102	97
Valve Hall HVAC Unit	STATCOM	82	82
BARD Wall-mounted HVAC Unit	STATCOM	82	82

7.4.1.2 Predicted Operational Sound Levels

Broadband sound level results at the four modeling receptors at the preferred onshore substation location are presented in Table 7-7. Both "base-case" and noise-controlled (i.e., proposed) results are shown. Figure 7-2a provides noise-controlled sound contours from the operation of the onshore substation. Included on the figure are the four modeling locations and the on-site buildings included in the model. These buildings include a control building and two STATCOM buildings. The noise-controlled Project-only broadband sound levels range from 48 to 50 dBA at the four modeling locations. The highest sound level modeled at a residential property line is 50 dBA as represented by Receptor C2 and as demonstrated by the sound results shown in Figure 7- 2a.



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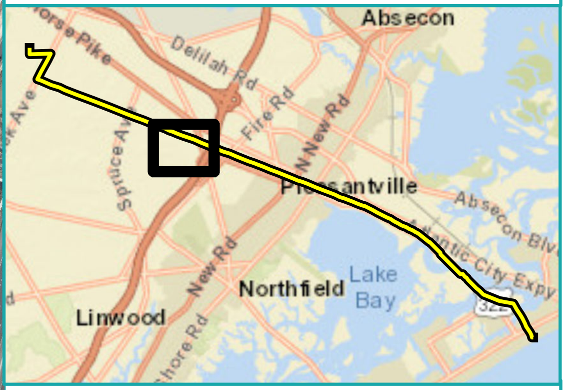


Figure 7-2a

Cardiff
Preferred Onshore Substation
Sound Level Modeling Results

LEGEND

- Modeling Receptor
- Cardiff Onshore Interconnection Cable Route
- Preferred Onshore Substation Site
- Modeled On-site Buildings
- Parcel Boundary

Predicted Sound Level (dBA)

- 50
- 55
- 60
- 65

0 225 450 Feet
0 65 130 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

Table 7-7 Project-Only Sound Level Results – Preferred Cardiff

Receptor ID	Land Use	Modeled Project-Only L_{eq} Sound Level (dBA)	
		Base Case	Noise Controlled (Proposed)
C1	Residential (Measurement Location)	55	48
C2	Residential (Measurement Location)	57	50
C5	Residential	56	49
C9	Residential	56	49

7.4.2 Alternate Substation Location

7.4.2.1 Modeled Sound Power Levels

A tabular summary of the noise-controlled reference sound power level data for each noise source, as included in the model for the alternate Cardiff onshore substation, is presented in Table 7-8. Base-case sound levels are included in the table for reference purposes. All modeled sources were assumed to be operating simultaneously at the sound levels shown in Table 7-8.

Table 7-8 Modeled Reference Sound Power Levels – Alternate Cardiff

Component	Site Yard or STATCOM Component	"Base Case" Broadband Sound Power Level	Noise Controlled Broadband Sound Power Level
		dBA	dBA
Power Transformer	Site Yard	107	95
VSR (Iron Core) – 200 MVAr	Site Yard	102	88
Harmonic Filter Reactor	Site Yard	97	97
Harmonic Filter Capacitor	Site Yard	92	92
Harmonic Filter Resistor	Site Yard	82	82
VSC Reactor (Air Core)	STATCOM	97	97
DRC Step-up Transformer	STATCOM	110	98
Fan Bank	STATCOM	102	97
Valve Hall HVAC Unit	STATCOM	82	82
BARD Wall-mounted HVAC Unit	STATCOM	82	82

7.4.2.2 Predicted Operational Sound Levels

Broadband sound level results at the five modeling receptors at the alternate onshore substation location are presented in Table 7-9. Both "base-case" and noise-controlled (i.e., proposed) results are shown. Figure 7-2b provides noise-controlled sound contours from the operation of the onshore substation. Included on the figure are the five modeling locations and the on-site buildings included in the model. These buildings include a control building and two STATCOM buildings. The noise-controlled Project-only broadband sound levels range from 42 to 51 dBA at the five modeling locations. The highest sound level modeled at a residential property line is 50 dBA as represented by Receptor C8 and as demonstrated by the sound results shown in Figure 7- 2b.

Table 7-9 Project-Only Sound Level Results – Alternate Cardiff

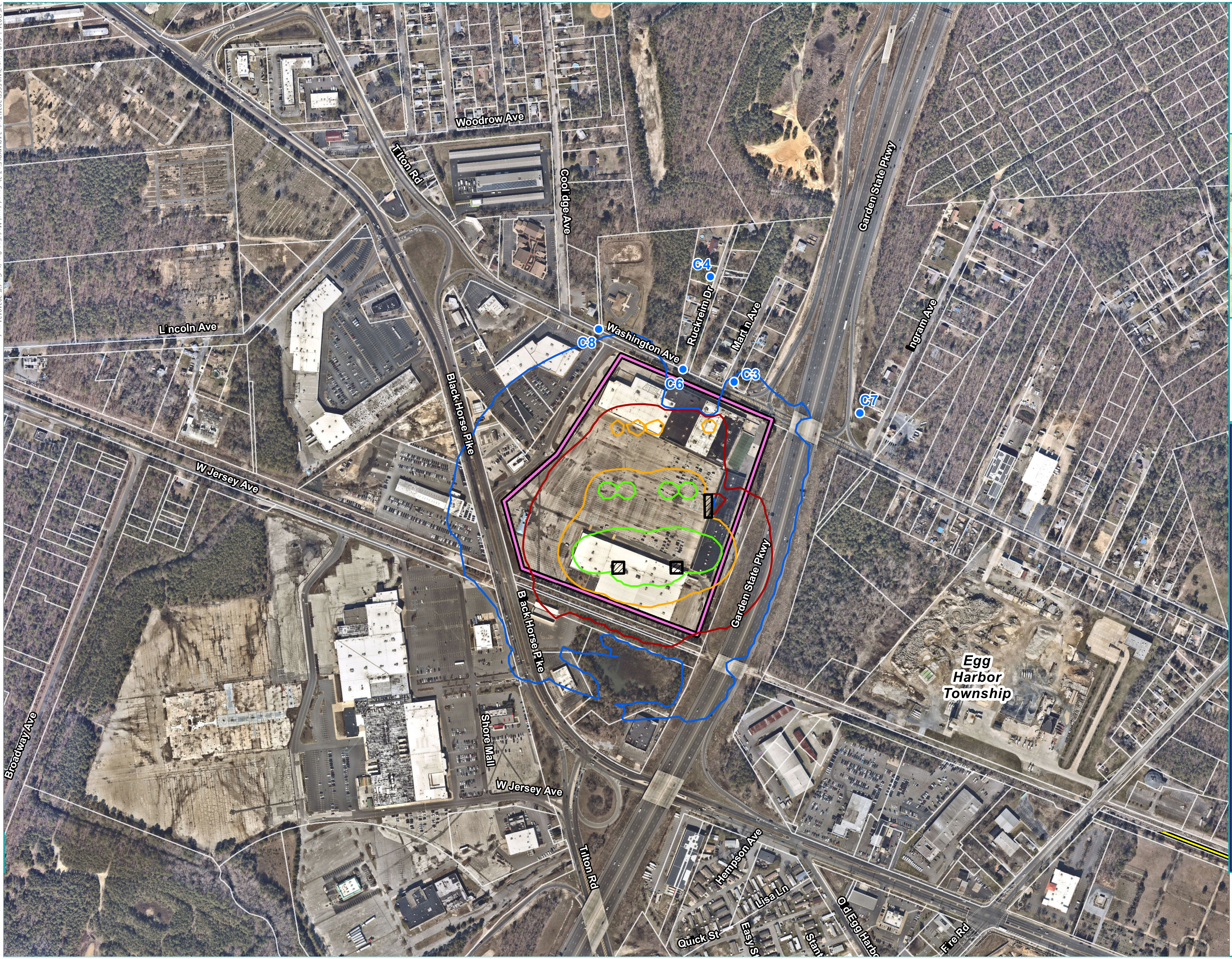
Receptor ID	Land Use	Modeled Project-Only L_{eq} Sound Level (dBA)	
		Base Case	Noise Controlled (Proposed)
C3	Commercial (Measurement Location)	60	51
C4	Residential (Measurement Location)	56	45
C6	Residential	61	48
C7	Residential	49	42
C8	Residential	58	50

7.5 Sound Level Evaluation

This section summarizes the onshore substation operational modeling results (noise-controlled) and compares them to the applicable NJ DEP daytime and nighttime A-weighted sound level limits. The onshore substation is expected to operate 24-hours per day therefore the nighttime sound level limits are the most restrictive. As noted previously, the onshore substations are in the early design stage and octave band sound level data were not available for the equipment included in the model. Therefore, octave band sound levels in the community could not be evaluated against the NJ DEP octave band limits.

7.5.1 Proposed Larrabee Onshore Substation-- Preferred Substation Location

Broadband sound level modeling results at the preferred Larrabee onshore substation location are compared to the applicable NJ DEP daytime and nighttime sound level limits. The results are presented in Table 7-10 and show compliance is expected at all locations.



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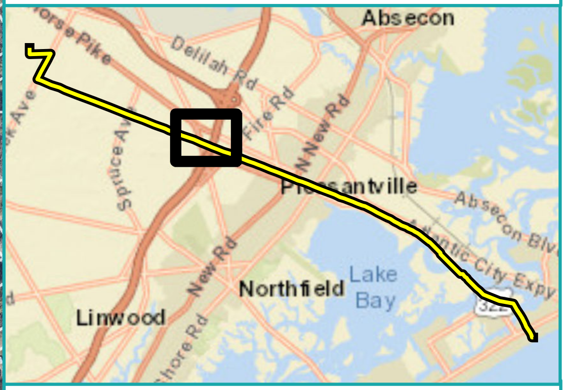


Figure 7-2b

Cardiff
Alternate Onshore Substation
Sound Level Modeling Results

LEGEND

- Modeling Receptor
- Cardiff Onshore Interconnection Cable Route
- Alternate Onshore Substation Site
- Modeled On-site Buildings
- Parcel Boundary

Predicted Sound Level (dBA)

- 50
- 55
- 60
- 65

0 225 450 Feet
0 65 130 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

Table 7-10 Project Sound Level Results Compared to Limits – Preferred Larrabee

Receptor ID	Land Use	Modeled Project-Only Sound Level	NJ DEP Sound Level Limit (Day)	NJ DEP Sound Level Limit (Night)
		dBA	dBA	dBA
L5	Commercial (Measurement Location)	52	65	65
L6	Residential (Measurement Location)	44	65	50
L7	Residential (Measurement Location)	42	65	50
L8	Residential	47	65	50
L9	Residential	49	65	50
L10	Residential	48	65	50
L11	Residential	47	65	50
L12	Residential	45	65	50
L13	Commercial	48	65	65

7.5.2 Proposed Larrabee Onshore Substation—Alternate Substation Location

Broadband sound level modeling results at the alternate Larrabee onshore substation location are compared to the applicable NJ DEP daytime and nighttime sound level limits. The results are presented in Table 7-11 and show compliance is expected at all locations.

Table 7-11 Project Sound Level Results Compared to Limits – Alternate Larrabee

Receptor ID	Land Use	Modeled Project-Only Sound Level	NJ DEP Sound Level Limit (Day)	NJ DEP Sound Level Limit (Night)
		dBA	dBA	dBA
L5	Commercial (Measurement Location)	48	65	65
L6	Residential (Measurement Location)	44	65	50
L7	Residential (Measurement Location)	41	65	50
L8	Residential	43	65	50
L9	Residential	47	65	50
L10	Residential	50	65	50
L11	Residential	49	65	50
L12	Residential	50	65	50
L13	Commercial	56	65	65

7.5.3 Proposed Cardiff Onshore substation -- Preferred Substation Location

Broadband sound level modeling results at the preferred Cardiff onshore substation location are compared to the applicable NJ DEP daytime and nighttime sound level limits. The results are presented in Table 7-12 and show compliance is expected at all locations.

Table 7-12 Project Sound Level Results Compared to Limits – Preferred Cardiff

Receptor ID	Land Use	Modeled Project-Only Sound Level	NJ DEP Sound Level Limit (Day)	NJ DEP Sound Level Limit (Night)
		dBA	dBA	dBA
C1	Residential (Measurement Location)	48	65	50
C2	Residential (Measurement Location)	50	65	50
C5	Residential	49	65	50
C9	Residential	49	65	50

7.5.4 Proposed Cardiff Onshore substation – Alternate Substation Location

Broadband sound level modeling results at the alternate Cardiff onshore substation location are compared to the applicable NJ DEP daytime and nighttime sound level limits. The results are presented in Table 7-13 and show compliance is expected at all locations.

Table 7-13 Project Sound Level Results Compared to Limits – Alternate Cardiff

Receptor ID	Land Use	Modeled Project-Only Sound Level	NJ DEP Sound Level Limit (Day)	NJ DEP Sound Level Limit (Night)
		dBA	dBA	dBA
C3	Commercial (Measurement Location)	51	65	65
C4	Residential (Measurement Location)	45	65	50
C6	Residential	48	65	50
C7	Residential	42	65	50
C8	Residential	50	65	50

7.6 Mitigation Measures

At all four proposed onshore substation sites, noise control features were needed to limit sound level impacts in the neighboring communities. In some cases, low-noise designs were utilized for certain equipment, i.e., the maximum (base case) sound power level was not used in the model. The low-noise specifications are reflected in the mitigated reference sound power data provided in Tables 7-2, 7-4, 7-6, and 7-8 for the four potential sites, respectively. These four tables list both the unmitigated ("base-case") and mitigated ("noise-controlled") sound power levels for each piece of equipment. Sound level modeling results in the previous section also include the effect of strategically placed noise barriers of various lengths at two of the four proposed onshore substation sites. The barriers are conceptual in design, and noise control features for the Project will be advanced once the final site is selected and the onshore substation layout is refined. For purposes of modeling at this stage, the barriers included in the noise models are as described in Table 7-14. The respective onshore substation sites are identified in the table. Once final onshore substation design is complete, the noise modeling will be finalized, and mitigation refined. Atlantic Shores is also considering designs for the proposed converter station to included certified enclosures as well as natural barriers and landscaping around the POI substation.

Table 7-14 Modeled Noise Barrier Details

Proposed Substation Site	Description/Approximate Location	Height (feet)	Approximate Length (feet)
Preferred Larrabee	L-shaped barrier along the northern boundary of the site on the east end	20	660
Alternate Cardiff	Straight barrier on the north end of the site	20	260

8.0 ONSHORE CONSTRUCTION NOISE

Onshore construction will be performed using standard construction equipment typical for onshore infrastructure projects such as the installation of new transmission lines. Onshore construction activities can be broken into three key components: the onshore substation, the onshore interconnection cables/duct bank, and the landfall site where the export cables transition from offshore to onshore.

Onshore substation construction will resemble typical construction at a power plant or mainland substation. Vehicles necessary for this construction can be expected to include excavators, concrete trucks, and backhoes. Typical grading equipment would be used for any clearing and grading needed at the onshore substation site, and onshore substation equipment would be delivered by large trucks and may include oversized-load deliveries. Installation of onshore substation equipment could also require the use of cranes and other support vehicles.

Installation of the onshore interconnection cables and concrete duct bank will require the use of typical construction equipment such as dump trucks, front-end loaders, concrete trucks, and excavators. The cable installation will also require construction vehicles that are more specifically designed for cable management such as winches and cable reel trucks.

The offshore-to-onshore export cable transition will be accomplished using horizontal directional drilling (HDD), a trenchless method that will avoid nearshore impacts as well as impacts directly along the shoreline. HDD, in comparison to trenching, also results in a deeper burial depth for cables in the nearshore environment, facilitating sufficient burial over the life of the Project and decreasing the likelihood that cables will become exposed over time.

Construction hours will adhere to local ordinances, and Atlantic Shores anticipates that typical construction hours will extend between 7 am and 6 pm, depending on local noise ordinances. While Atlantic Shores is not anticipating significant nighttime work, any nighttime work deemed necessary will be requested through a waiver and coordinated with the local authorities.

8.1 Onshore Substations

8.1.1 General Information

Activities involved in construction of each onshore substation will include:

- Land clearing and rough grading and fencing: Regardless of which potential onshore substation site is utilized, the entire parcel may need to be disturbed during clearing and grading. Other than the Larrabee alternate substation site, only a few trees currently exist on any given onshore substation parcel, and these will likely need to be removed.

- Trenching and excavation (for ground grid, equipment foundations, cable and conduit trenches/duct banks)

- Installation of equipment foundations
- Installation of onshore substation equipment
- Wiring and connections
- Final grading
- Commissioning
- Energization
- System testing

A crane may be used to erect equipment and poles, to set major onshore substation equipment (e.g., transformers, reactors, STATCOMs, harmonic filters, buswork, switchgear, breakers, switches, pre-fabricated buildings) onto foundations, and to move construction equipment (e.g., storage containers, offices, welders, generators, cable reels, cable pullers) around the site.

8.1.2 Onshore Substation Construction Sound Levels

At this point in the permitting phase, details of the precise quantity, location, and type of specific construction equipment are not yet known. However, a document[4] published by the U.S. Environmental Protection Agency (EPA) provides quantitative information on the five major phases of construction. These phases are shown below along with the reference sound level at 50 feet for each phase under full (maximum) operation. This reference sound level includes a specific mix of equipment typically used for the phase at construction sites in suburban residential areas and reflects an energy average sound level with all pertinent equipment present at the site. Maximum sound levels during these phases are listed in Table 8-1 at a reference distance of 50 feet. Table 8-2 lists expected sound levels at additional distances.

[4] "Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances"; U.S. Environmental Protection Agency Office of Noise Abatement and Control; prepared by Bolt, Beranek, and Newman, December 31, 1971.

Table 8-1 Reference Sound Levels of Construction Equipment at 50 feet

Phase Number	Phase Description	Max. Sound Level (dBA) at 50 feet
1	Ground Clearing	84
2	Excavation	88
3	Foundations	88
4	Erection	79
5	Finishing	84

Table 8-2 Maximum Sound Levels of Construction Phases Extrapolated to Additional Distances

Phase Number	Phase Description	Sound Level (dBA) at Distance (ft)					
		25	50	100	250	500	1000
1	Ground Clearing	90	84	78	70	64	58
2	Excavation	94	88	82	74	68	62
3	Foundations	94	88	82	74	68	62
4	Erection	85	79	73	65	59	53
5	Finishing	90	84	78	70	64	58

In general, the sound levels from construction activities will be dominated by the loudest piece of equipment operating at the time. Therefore, at any given point in the work area, the loudest piece of equipment will be the most representative of the expected sound levels in that area. Construction equipment is generally not operated continuously at maximum load but runs with significant variation in power and usage. Actual received sound levels would fluctuate, depending on the construction activity, equipment type, and separation distances between source and receiver. Other factors such as terrain and obstacles such as buildings will act to further limit the impact of construction noise levels.

8.1.3 Proposed Larrabee Onshore Substation Construction Sound Level Impacts

Sound levels from the construction of the onshore substation were estimated at nearby receptors. The following subsections provide estimated sound levels by construction phase for the preferred and the alternate onshore substation sites, respectively.

8.1.3.1 Preferred Substation Location

An estimate of construction sound levels by phase at the three nearby ambient sound level measurement locations presented in section 5 is provided in Table 8-3. For additional reference, residences are generally scattered around the preferred Larrabee onshore substation site. Based on a review of aerial imagery, the closest is roughly 395 feet (120.4 m) to the onshore substation location.

Table 8-3 Maximum Sound Levels of Construction Phases Extrapolated to Preferred Larrabee Sound Monitoring Locations

Location	Approx. Dist. to Perimeter (ft)	Estimated Sound Level (dBA) by Construction Phase				
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
L5	30	88	92	92	83	88
L6	1,090	57	61	61	52	57
L7	1,085	52	56	56	47	52

8.1.3.2 Alternate Substation Location

An estimate of construction sound levels by phase at the three nearby ambient sound level measurement locations presented in section 5 is provided in Table 8-4. For additional reference, residences are generally scattered around the alternate Larrabee onshore substation site. Based on a review of aerial imagery, the closest is roughly 480 feet (146.3 m) to the onshore substation location.

Table 8-4 Maximum Sound Levels of Construction Phases Extrapolated to Alternate Larrabee Sound Monitoring Locations

Location	Approx. Dist. to Perimeter (ft)	Estimated Sound Level (dBA) by Construction Phase				
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
L5	480	64	68	68	59	64
L6	635	62	66	66	57	62
L7	1045	58	62	62	53	58

8.1.4 Proposed Cardiff Onshore Substation Construction Sound Level Impacts

Sound levels from the construction of the onshore substation may be estimated at nearby receptors. The following subsections provide estimated sound levels by construction phase for the preferred and the alternate onshore substation sites, respectively.

8.1.4.1 Preferred Substation Location

An estimate of construction sound levels by phase at the two nearby ambient sound level measurement locations presented in section 5 is provided in Table 8-5. For additional reference, residences are generally scattered around the preferred Cardiff onshore substation site. Based on a review of aerial imagery, the closest is roughly 490 feet (149.4 m) to the onshore substation location.

Table 8-5 Maximum Sound Levels of Construction Phases Extrapolated to Preferred Cardiff Sound Monitoring Locations

Location	Approx. Dist. to Perimeter (ft)	Estimated Sound Level (dBA) by Construction Phase				
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
C1	575	63	67	67	58	63
C2	390	66	70	70	61	66

8.1.4.2 Alternate Substation Location

An estimate of construction sound levels by phase at the two nearby ambient sound level measurement locations presented in section 5 is provided in Table 8-6. For additional reference, residences are generally scattered around the alternate Cardiff onshore substation site. Based on a review of aerial imagery, the closest is roughly 245 feet (74.7 m) to the onshore substation location.

Table 8-6 Maximum Sound Levels of Construction Phases Extrapolated to Alternate Cardiff Sound Monitoring Locations

Location	Approx. Dist. to Perimeter (ft)	Estimated Sound Level (dBA) by Construction Phase				
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
C3	105	78	82	82	73	78
C4	505	64	68	68	59	64

8.1.5 Onshore Substation Construction Mitigation

The following measures will be considered to reduce sound levels in the community during onshore substation construction:

- Atlantic Shores will adhere to the municipal noise control ordinances established for construction in each of the cities, towns, or boroughs in which the Project's onshore POIs are located.
- Atlantic Shores will maintain strong communication and public outreach with adjacent neighbors.
- Atlantic Shores will consider replacing back-up alarms on trucks and equipment with strobes, as allowed within Occupational Safety and Health Administration regulations, to eliminate the potentially loud impulsive sound.
- Atlantic Shores will assure that equipment is functioning properly and is equipped with mufflers and other noise-reducing features.
- Implementation of quieter construction equipment and methods, as feasible, such as smaller backhoes will be used.
- Implementation of path noise control measures such as portable enclosures for small equipment (e.g., jackhammers, saws) will be used.
- Construction activities will be conducted outside of the peak tourism season (generally Memorial Day to Labor Day).

8.2 Onshore Interconnection Cables

Regardless of the type of cable, the onshore interconnection cables will be contained within a buried concrete duct bank, with individual cables residing in conduits composed of high-density polyethylene (HDPE) or Polyvinyl Chloride (PVC). Onshore interconnection cables will typically require splices every 1,640 to 3,280 ft (500 to 1,000 m). At each splice location, a concrete splice vault will be installed.

Installation of the concrete duct bank for onshore interconnection cables will typically be accomplished via open trenching, although some specialty techniques are anticipated at unique features such as busy roadways and wetlands. During typical open trenching, the trench will be up to 14.8 ft (4.5 m) wide by 11.5 ft (3.5 m) deep. Typical cover over the buried duct bank (e.g., along roadway rights-of-way [ROWs]) will be approximately 3 ft (0.9 m), though maximum coverage over the top of the cable conduits could be up to 30 ft (9 m) in some specialty installation scenarios.

Specialty installation techniques are trenchless techniques that avoid surface disturbance and hence can avoid impacts to busy roadways, wetlands, or existing developments or features. These specialty techniques primarily include:

- Horizontal directional drilling (HDD): HDD is typically used to cross beneath relatively wide features such as interstate highways and water bodies. HDD commonly involves drilling a hole in an arc under the surface feature, then enlarging that hole and pulling either a large PVC or HDPE casing or several smaller PVC or HDPE pipes (in a bundle) back through the bore hole. More detail on HDD techniques is found in Section 8.3 below.

- Pipe jacking: In this method, a casing pipe originating in a jacking shaft is driven through the soil by powerful hydraulic jacks to excavate a tunnel that leads to a receiving shaft on the opposite side of the obstacle being avoided on the surface. This method results in a flexible, structural, watertight, and finished pipeline for installation of cables.

- Jack-and-bore: This trenchless crossing technique is used to install a casing beneath the surface feature being avoided. Relative to HDD, jack-and-bore is typically used for shorter crossings (less than approximately 200 ft [61 m]), such as those under streams or highways. A jack-and-bore is performed by excavating a bore pit and a receiving pit, located on opposite sides of the obstacle. Drilling and jacking activities are initiated from the bore pit, while the steel or concrete casing is driven into the receiving pit. As a borehole is drilled, the casing is pushed into the borehole. After the casing is in place, it is cleaned and then smaller HDPE or PVC pipes are installed inside the casing.

Locations where these specialty techniques may be utilized are described below in the context of the Cardiff and Larrabee Onshore Interconnection Cable Routes.

8.2.1 Specialty Installation Techniques – Larrabee Onshore Interconnection Cable Route

Atlantic Shores will develop a Traffic Management Plan to avoid and minimize traffic impacts and will adhere to seasonal construction restrictions (generally from Memorial to Labor Day) near the coast. The use of specialty installation techniques, most likely either HDD or pipe jacking, will also avoid and minimize these impacts, particularly at the following locations:

- The Seashore New Jersey Transit Line crossing

- Route 34 overpass (while on the bike path)

- The intersection of Lakewood-Allenwood Road and County Road 524

- The Garden State Parkway crossing.

The Larrabee Onshore Interconnection Cable Route does contain a number of wetlands and waterway crossings. HDD or jack-and-bore methodologies are expected to be used to avoid impacts to these resources.

8.2.2 Specialty Installation Techniques – Cardiff Onshore Interconnection Cable Route

Atlantic Shores will develop a Traffic Management Plan to avoid and minimize traffic impacts, and will adhere to seasonal construction restrictions (generally from Memorial to Labor Day) near the shoreline. The use of specialty installation techniques, most likely either HDD or pipe jacking, will also avoid and minimize these impacts, particularly at the following locations:

- Cloverleaf at the Atlantic City High School
- A former railroad tunnel crossing the Garden State Parkway
- Route 40 crossing

8.2.3 Onshore Interconnection Cables – Construction Sound Levels

Civil construction activities related to the onshore interconnection cables will consist generally of the following five principal noise-producing phases:

- Trench excavation
- Duct bank installation
- Manhole installation
- Backfill and Compaction
- Final pavement restoration

Each of these phases will be conducted in sequence at each location; it is possible that several phases of construction will be ongoing simultaneously along various sections of the onshore interconnection cable route.

The potential for noise impacts from Project construction is a function of the specific receptors along the route as well as the equipment used and proposed hours of operation. Construction is anticipated to occur during typical work hours (7:00 AM to 6:00 PM), though in specific instances at some locations, or at the request of any given municipality, the Project may seek municipal approval to work at night. Nighttime work will be minimized and performed only on an as-needed basis, such as when crossing a busy road, and will be requested through a waiver and coordinated with each Town.

Onshore interconnection cable installation will periodically generate noise levels that are audible along the route, conductor-pulling sites, and staging and maintenance areas. Proposed construction equipment will be similar to that used during typical public works projects (e.g., road resurfacing, storm sewer installation, interconnection cable installation).

In general, sound levels from construction activities will be dominated by the loudest piece of equipment operating at the time. Therefore, at any given point along the onshore interconnection cable route, the loudest piece of equipment will be the most representative of the expected sound levels in that area. Maximum sound levels from typical equipment proposed during construction are listed in Table 8-7 at a reference distance of 50 feet (15.2 m).

Table 8-7 Reference Sound Levels of Construction Equipment at 50 feet

Equipment	Max. Sound Level (dBA) at 50 feet
Mobile Crane *(duct bank and manhole installation)*	85 (1)
Pavement Saw *(trench excavation)*	90 (1)
Asphalt Paver *(manhole installation, street restoration)*	85 (1)
Pneumatic Hammer *(trench excavation)*	85 (1)
Mounted Impact Hammer (Hoe Ram) *(trench excavation if ledge)*	90 (1)
Backhoe *(trench excavation)*	80 (1)
Dump Truck *(manhole installation, trench excavation)*	84 (1)
Generator *(cable pulling and splicing)*	82 (2)
Air Conditioning *(cable splicing)*	60 (at 3 feet) (2)

Source:

1. Thalheimer, E., "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", Noise Control Eng. Journal 48 (5), 2000 Sep-Oct.
2. US EPA, "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances", prepared by Bolt, Beranek and Newman, Report No. NTID300.1, December 31, 1971.

Construction equipment proximity to noise-sensitive land uses will vary along the proposed onshore interconnection cable route. Because sound levels from a point source drop off due to geometric divergence (hemispherical spreading) at a rate of 6 dB per doubling of distance, the reference sound levels at 50 feet (15.2 m) in Table 8-7 will decrease by 6 dBA for locations 100 feet (30.5 m) back from the edge of construction. For example, maximum backhoe sound levels at 100 feet (30.5 m) would be expected to be approximately 74 dBA. In a more urbanized area, setbacks may be only 25 feet (7.6 m) from construction activity, thus increasing the sound levels from each piece of equipment by 6 dBA. Therefore, the same backhoe at 25 feet (7.6 m) would be expected to produce a maximum sound level of 86 dBA. To reiterate, the 80 dBA is the maximum expected backhoe sound level, while typical levels would be much lower. See Table 8-8 for more examples. The distance of residences to the onshore interconnection cable route construction varies along the route. In the east, the interconnection cable route runs through dense residential areas where homes are located closer to the road. In these areas, homes may be located as close as 50 feet (15.2 m) from the road. Farther west, the residential area becomes less densely populated allowing the homes to be farther offset from the road and are, on average, located farther away from the onshore interconnection cable routes. These homes can be up to thousands of feet from construction activity.

Table 8-8 Reference Sound Levels of Construction Equipment at Arbitrary Distances

Equipment	Sound Level [dBA] at Distance [ft]					
	25	50	100	250	500	1000
Mobile Crane (duct bank and manhole installation)	91	85	79	71	65	59
Pavement Saw (trench excavation)	96	90	84	76	70	64
Asphalt Paver (manhole installation, street restoration)	91	85	79	71	65	59
Pneumatic Hammer (trench excavation)	91	85	79	71	65	59
Mounted Impact Hammer (Hoe Ram) (trench excavation if ledge)	96	90	84	76	70	64
Backhoe (trench excavation)	86	80	74	66	60	54
Dump Truck (manhole installation, trench excavation)	90	84	78	70	64	58
Generator *(cable pulling and splicing)*	88	82	76	68	62	56
Air Conditioning *(cable splicing)*	42	36	30	22	< 20	< 20

Construction equipment is generally not operated continuously at maximum load, with significant variation in power and usage. Actual received sound levels would fluctuate depending on the construction activity, equipment type, and separation distances between source and receiver. Other factors, such as terrain and obstacles such as buildings, will act to further limit the impact of construction-period noise levels.

Trench excavation and manhole installation are typically the loudest phases of construction. Under normal trenching conditions (i.e., no ledge, no excessive underground utilities), the construction crews involved in trench excavation are expected to progress at an average rate of approximately 100 feet (30.5 m) to 200 feet (61 m) per day for an average duration of approximately seven days at any one location. If rock is encountered during construction, equipment such as a hoe ram will be used, which would temporarily increase noise levels.

In general, cable pulling and splicing phases are not expected to generate significant noise. Once adjacent cable sections are installed, they will be spliced together inside the manholes. Splicing high-voltage solid-dielectric transmission cable is a complex operation; splicing activities will not be continuous but will take place over four or five extended workdays at each manhole location. The splicing operation requires a splicing van and a generator, and an air conditioning unit may be used to control the moisture content in the manhole. A portable generator will provide electrical power for the splicing van and air conditioning unit and will be muffled to minimize noise; this technique has been used successfully in locations with sensitive receptors. Typically, the splicing van will be located at one manhole access cover while the air conditioner will be located near a second manhole access cover, and the generator will be located in a convenient area that does not restrict traffic movement around the work zone.

The electric generator and truck with ventilation fans will generate some noise when manholes are occupied; however, Atlantic Shores will make every practicable effort to limit noise disturbance from this source. If necessary, mitigation measures may include use of a low-noise/muffled generator, portable sound walls (temporary noise barriers) as needed, blocking the path of generators, and working with municipalities to coordinate work schedules.

8.2.4 Onshore Interconnection Cables Mitigation

In addition to the measures described in Section 8.1.5 for the onshore substation construction, Atlantic Shores is proposing to adhere to seasonal construction restrictions for certain portions of the onshore interconnection cable routes to avoid impacts during peak usage. For the Cardiff Onshore Interconnection Cable Route between the Atlantic Landfall Site and Pleasantville, no onshore construction will occur during the summer (generally from Memorial to Labor Day), subject to ongoing coordination with local authorities. For the Larrabee Onshore Interconnection Cable Route, no summer construction will occur from the Monmouth Landfall Site, west of the Garden State Parkway, to where the route exits the bike path near Allaire State Park at Hospital Road (subject to ongoing coordination with local authorities). These restrictions will minimize disruptions and noise during the peak tourist season. To further minimize the effects of construction noise, Atlantic Shores will maintain strong communication and public outreach with adjacent neighbors.

8.3 Specialty Installation Techniques – Horizontal Directional Drilling

The offshore-to-onshore transition will be accomplished using HDD, a trenchless method that will avoid nearshore impacts as well as impacts directly along the shoreline. HDD, in comparison to trenching, also ensures a deeper burial depth for cables in the nearshore environment, decreasing the likelihood that cables will become exposed over time.

The landfall site HDD will consist of the following steps:

- Excavation of a pit at the landfall site: Each HDD path will originate or terminate in an pit excavated at the landfall site's onshore staging area. This pit will also contain drilling fluids, consisting of water and natural clay.

- Drilling of pilot hole: An approximately 12.4-inch (315-mm) pilot hole will be drilled between the pit at the onshore staging area and the offshore HDD exit/entrance location in an arcing fashion beneath the shoreline and nearshore zone. If HDD is initiated onshore, when the pilot hole exits the seabed, the contractor may use water to carry drill cuttings back to the approach pit rather than drilling fluids in order to avoid release of clay to the water column (even though bentonite is a natural substance that poses little to no risk to the marine environment).

- Reaming and conduit insertion: The drill will be equipped with a larger cutter head that will enlarge the pilot hole in preparation for insertion of an HDPE or PVC conduit. The same drill head can pull the conduit through the enlarged bore hole.

- Cable insertion: Following installation of the conduit, the export cable will be inserted into the opening at the seabed and pulled through the conduit towards shore. The end of the conduit exposed on the seabed will then be buried, possibly by divers using hand-jets.

- Disposal of drill cuttings: Drilling the HDD trajectory will produce a mixture of drill cuttings from the bore hole, water, and bentonite clay (used to lubricate and cool the drill bit). This mixture will be collected on-site and filtered to separate solids from fluids. Drill cuttings and drill fluids are typically classified as clean fill, and it is anticipated they will be disposed of at an appropriate facility such as a local landfill, a gravel pit, or other facility permitted to take such material.

- Pull-back to transition vaults: Cables installed through the HDD conduit will be pulled into onshore transition vaults, where they will be split into separate onshore cables. The transition vaults at the landfall site will be approximately 11.5 ft wide by 46 ft long by 14.8 ft deep (3.5 m wide by 14 m long by 4.5 m deep). It is anticipated that the transition vaults will also include fiber optic splice boxes.

- Site restoration: The onshore HDD staging areas will be restored to be consistent with existing conditions, while the transition vaults will be entirely underground except for at-grade manhole covers.

At this point of permitting, exact details of the HDD operation are not yet known. For example, drilling may be done either from offshore to onshore or vice versa. If drilling proceeds offshore to onshore, a temporary offshore platform (i.e., jack-up barge) may be needed to support the HDD drilling rig. In order to estimate maximum sound levels for the community, this analysis assumed the loudest portion of HDD activity was onshore. Table 8-9 presents the three loudest sources typically found in an HDD operation and their estimated sound power levels. Sound level modeling was done at both landfall sites using the same software and standards discussed in Section 7.2. A gridded set of receptors were used to generate sound level contours of the HDD operation, and sound levels at the nearest residences were also included in the modeling.

Table 8-9 Reference Sound Power Levels of HDD Equipment

Equipment	Sound Power Level (dBA)
Excavator	117
Drill rig	117
Pump	109

8.3.1 HDD at the Monmouth Landfall Site

Figure 8-1 shows the approximate location of the HDD activity for the Monmouth Landfall Site. This same figure shows the sound level contours expected from HDD activity without taking into account any mitigation. Specific mitigation measures can be provided as the design advances (see Section 8.3.3). Table 8-10 below summarizes the expected sound levels at the discrete residential receptors.

Table 8-10 Modeled Sound Levels from HDD activity -- Monmouth Landfall Site

Receptor	Sound Level (dBA)
10 2nd Ave	63
45 Beachfront	58
9 Sea Girt Ave	55
1001 Ocean Ave	49

8.3.2 HDD at the Atlantic Landfall Site

Figure 8-2 shows the approximate location of the HDD activity for the Atlantic Landfall Site. This same figure shows the sound level contours expected from HDD activity without taking into account any mitigation. Specific mitigation measures can be provided as the design advances (see Section 8.3.3). Table 8-11 below summarizes the expected sound levels at the discrete residential receptors.

Table 8-11 Modeled Sound Levels from HDD activity – Atlantic Landfall Site

Receptor	Sound Level (dBA)
1 N Sovereign Ave	62
28 N Sovereign Ave	59
1 N Montpelier Ave	62
24 N Montpelier Ave	59

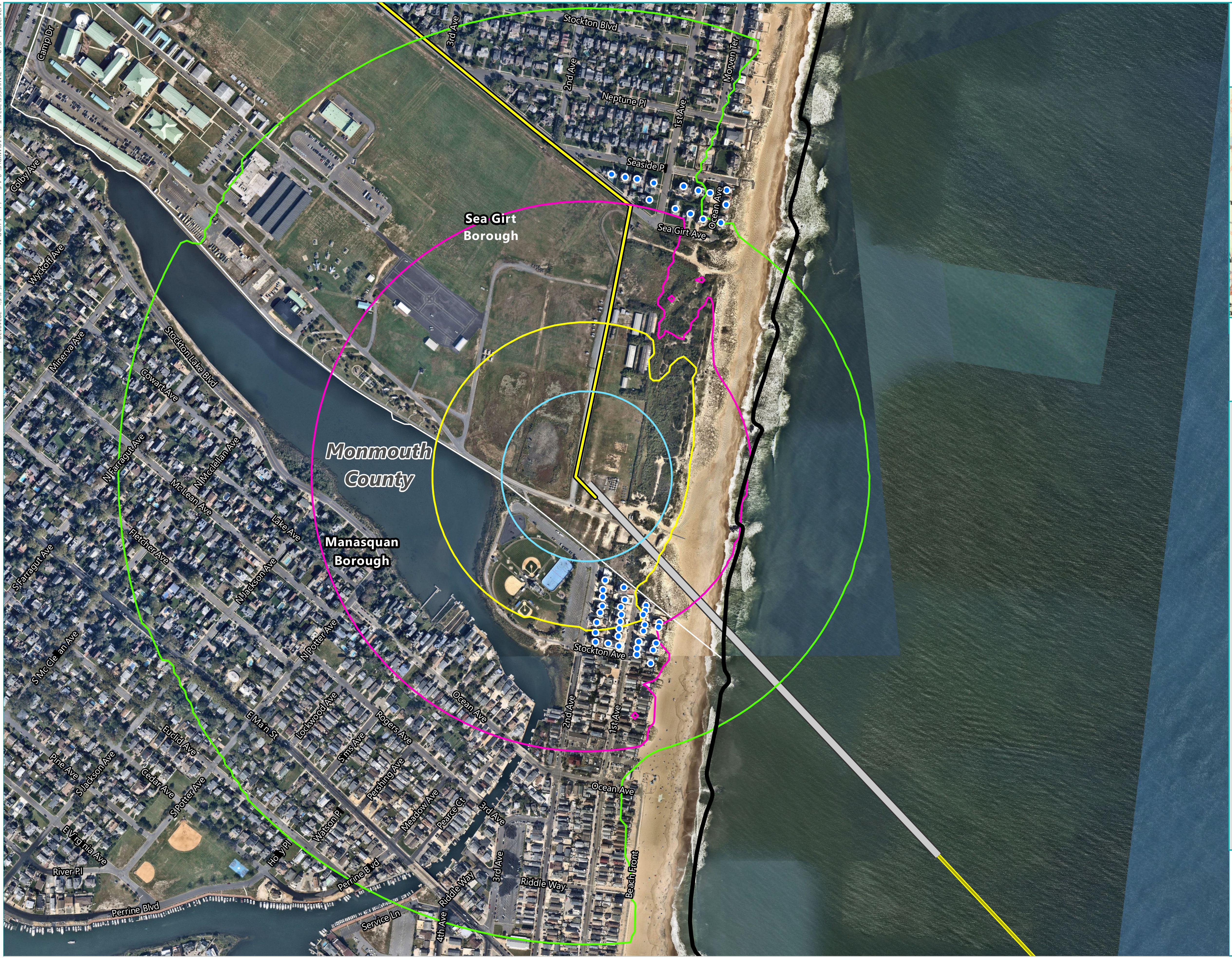
8.3.3 HDD Mitigation

Based on local permit requirements, Atlantic Shores expects that HDD activity will be seasonally restricted from Memorial to Labor Day. Atlantic Shores will work with municipal officials to finalize the construction schedule and hours, but the proposed HDD schedule is generally from 7:00 AM to 6:00 PM on Monday through Saturday (some municipalities do not allow work to start until 8:00 AM). Certain activities, such as conduit pull-in, cannot stop once they are started, so work may need to continue around the clock. Any work that needs to extend outside allowed construction hours will be discussed with local officials along with any necessary waivers.

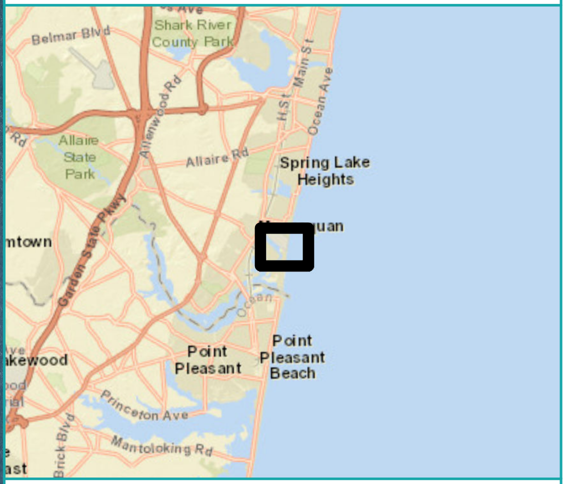
To further minimize the effects of HDD construction noise, Atlantic Shores will maintain strong communication and public outreach with adjacent neighbors. If necessary, mitigation measures may include use of a low-noise/muffled generator, portable sound walls (temporary noise barriers) as needed, blocking the path of equipment, and working with municipalities to coordinate work schedules.

8.4 Construction Noise Evaluation

While intermittent increases in noise levels are expected during construction activities, Atlantic Shores will make every reasonable effort to minimize noise impacts from construction. Specific mitigation measures for each onshore construction activity that may generate temporary noise are provided in Sections 8.1.5, 8.2.4, and 8.3.3. There are no quantitative construction noise limits in any of the municipalities along the onshore interconnection cable routes. Atlantic Shores will be guided by the hours of construction allowed in each municipality.



ATLANTIC SHORES offshore wind



0 125 250 500 Feet

0 30 60 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, October 2020

LEGEND

- Residential Buildings
- Export Cable Alignments
- Horizontal Direcitonal Drilling (HDD)
- Larrabee Onshore Interconnection Cable Route
- Municipality
- Counties

Predicted Sound Level (dBA)

- 50
- 55
- 60
- 65

Figure 8-1

Sound Levels During HDD – Monmouth Landfall Site

Figure 8-2

Sound Levels During HDD – Atlantic Landfall Site

9.0 ONSHORE NOISE FROM OFFSHORE ACTIVITIES

There will be sound generated from activities in the Atlantic Shores Offshore Project Area. However, at its closest point, the wind energy generation facility is approximately 8.7 miles (7.6 nautical miles [nm]) from the New Jersey shoreline. Therefore, onshore noise from offshore activities will be negligible. Two examples of these activities are briefly described below.

Mariner Radio Activated Sound Signals (MRASS) will be located on corner towers/significant peripheral structures and perimeter structures of the wind farm. The MRASS are required to have an audible range of 2 nm but they may be louder. No sound level modeling was done for these sources due to their distance. It is possible that the MRASS may be heard on land under certain circumstances but they would only be activated at certain times and thus any effect would be limited.

With respect to noise from operational wind turbine generators (WTGs), sounds of different frequencies are emitted by WTGs as they operate, related to both the aerodynamics of the turbine blades as they rotate and the mechanical sounds of the internal mechanism of the turbine. Noise levels near the turbine are clearly audible but sound levels diminish rapidly with distance. At a distance of 1,000 ft (~300 m), the sound pressure is on the order of 50 dBA, a level lower than normal conversation.[5] In this case, operational noise from the offshore WTGs will not be audible onshore.

[5] Wind Turbine-Related Noise: Current Knowledge and Research Needs. New York State Energy Research and Development Authority (NYSERDA), NYSERDA Report 13-14, June 2013.

10.0 CONCLUSIONS

A sound level impact assessment was conducted for the Atlantic Shores onshore substations, onshore interconnection cable routes, and horizontal directional drilling activity associated with the Larrabee and Cardiff POIs. The onshore substation analysis was done to determine compliance with the NJ DEP sound level regulations. An existing condition sound level measurement program was completed in the area around each proposed onshore substation site. Many of the monitoring locations measured existing sound levels above the NJ DEP sound level limits.

Operational sound levels from the proposed onshore substations were evaluated at four sites:

- Larrabee preferred onshore substation site
- Larrabee alternate onshore substation site
- Cardiff preferred onshore substation site
- Cardiff alternate onshore substation site

The onshore substation design and specific equipment will depend on whether the onshore interconnection cables are HVAC or HVDC. At this stage of permitting, no decision has been made on the onshore interconnection cable technology. However, it is anticipated that the HVDC design would have generally lesser sound impacts on the surrounding community than HVAC technology. Therefore, only the HVAC onshore substation design was evaluated in this report. Modeled sound levels around the onshore substation sites showed all nearby land-use would be in compliance with their respective residential or commercial A-weighted sound limits with some sound level mitigation. Since the onshore substations are in the early design stage, no octave band sound level data were available for the equipment included in the model. Therefore, octave band data will be evaluated in the future when specific equipment types are identified and Atlantic Shores will apply design criteria or mitigation measures as needed to meet the NJ DEP octave band limits.

At this early stage of design, no equipment-specific sound level data were available so worst-case approximations of potential sound power levels of each piece of equipment were assumed. The modeling results showed that some combination of quieter equipment and/or barrier walls may be needed at all four potential onshore substation sites in order to meet the NJ DEP sound limits. The results of this modeling may be used to inform the onshore substation design and equipment procurement.

There will also be temporary noise from construction of the onshore substation, onshore interconnection cables, and horizontal directional drilling. While the NJ DEP does not regulate construction noise, construction activity is controlled at the local level by limiting work to certain times of the day and days of the week. A possible mix of construction equipment for in-street onshore interconnection cable route work, onshore substation work, and the landfall sites was used to calculate worst-case expected construction sound levels at various distances from the activity. Since there are no quantitative limits on noise from construction, these sound levels are provided for informational purposes only. Atlantic Shores anticipates that construction hours will typically adhere to local ordinances to minimize potential effects of construction noise, and Atlantic Shores will work with municipal officials to finalize the construction schedule and hours.

In conclusion, operation of the Atlantic Shores onshore substation will be designed to comply with the NJ DEP sound level limits and will include sound level mitigation as needed. While temporary onshore construction noise may occur, Atlantic Shores is proposing to adhere to seasonal construction restrictions during the peak tourist season to minimize impacts. No onshore construction in areas near the coast, including HDD at the landfall sites, will occur during the summer (generally from Memorial to Labor Day), subject to ongoing coordination with local authorities. Additionally, the daily hours of operation for onshore construction activities, including HDD, will be developed in accordance with municipal noise ordinances. Any work that needs to extend outside allowed construction hours will be discussed with local officials and waivers will be obtained if necessary. To further minimize the effects of construction noise, Atlantic Shores will maintain strong communication and public outreach with adjacent neighbors about the time and nature of construction activities.

Appendix A

Certificates of Sound Level Instrument Calibration

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.45008

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **7/15/2020** *Cal Due:* **7/15/2021**		
Model:	**CAL200**	*Status:*	**Received**	**Sent**
Manufacturer:	**Larson Davis**	*In tolerance:*	**X**	**X**
Serial number:	**2853**	*Out of tolerance:*		
Class (IEC 60942):	**1**	*See comments:*		
Barometer type:		*Contains non-accredited tests:* __Yes _X_ No		
Barometer s/n:				
Customer:	**Epsilon Associates, Inc.**	*Address:*	**3 Mill & Main Place, Suite 250, Maynard, MA 01754**	
Tel/Fax:	**978-461-6235 / choyt@epsilonassociates.com**			

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, 2019	Scantek, Inc./ NVLAP	Oct 31, 2020
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 22, 2019	ACR Env. / A2LA	Oct 22, 2020
HM30-Thommen	Meteo Station	1040170/39633	Oct 24, 2019	ACR Env./ A2LA	Oct 24, 2020
140-Norsonic	Real Time Analyzer	1406423	Oct 31, 2019	Scantek / NVLAP	Oct 31, 2020
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Oct 23, 2019	Scantek, Inc. / NVLAP	Oct 23, 2020
1203-Norsonic	Preamplifier	14059	March 3, 2020	Scantek, Inc./ NVLAP	March 3, 2021

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:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D. Gallagher
Date	7/15/2020	Date	7/17/2020

Document stored as: Y:\Calibration Lab\Cal 2020\LDCAL200_2853_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES[1] FROM STANDARDS REFERENCED IN PROCEDURES:	MET[2]	NOT MET	COMMENTS
Manufacturer specifications			
Manufacturer specifications: Sound pressure level	X		
Manufacturer specifications: Frequency	X		
Manufacturer specifications: Total harmonic distortion	X		
Current standards			
ANSI S1.40:2006 B.3 / IEC 60942: 2003 B.2 - Preliminary inspection	X		
ANSI S1.40:2006 B.4.4 / IEC 60942: 2003 B.3.4 - Sound pressure level	X		
ANSI S1.40:2006 A.5.4 / IEC 60942: 2003 A.4.4 - Sound pressure level stability	-	-	
ANSI S1.40:2006 B.4.5 / IEC 60942: 2003 B.3.5 - Frequency	X		
ANSI S1.40:2006 B.4.6 / IEC 60942: 2003 B.3.6 - Total harmonic distortion	X		

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 The tests marked with (*) are not covered by the current NVLAP accreditation.

Main measured parameters [3]:

Measured[4]/Acceptable[5] Tone frequency (Hz):	Measured[4]/Acceptable[5] Total Harmonic Distortion (%):	Measured [4]/Acceptable Level[5] (dB):
1000.30 ± 1.0/1000.0 ± 10.0	0.37 ± 0.10/ < 3	93.96 ± 0.13/94.0 ± 0.4
1000.29 ± 1.0/1000.0 ± 10.0	0.37 ± 0.10/ < 3	113.89 ± 0.12/114.0 ± 0.4

3 The stated level is valid at measurement conditions.

4 The above expanded uncertainties for frequency and distortion are calculated with a coverage factor k=2; for level k=2.00

5 Acceptable parameters values are from the current standards

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.2 ± 1.0	100.48 ± 0.000	40.7 ± 2.0

Tests made with following attachments to instrument:

Calibrator ½" Adaptor Type:	
Other:	

Adjustments: Unit was not adjusted.
Comments: The instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Measured Data: in Acoustical Calibrator Test Report # 45008 of two pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

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.45009

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **7/15/2020**	*Cal Due:* **7/15/2021**
Model:	**CAL200**	*Status:*	
Manufacturer:	**Larson Davis**		
Serial number:	**7146**		
Class (IEC 60942):	**1**		
Barometer type:			
Barometer s/n:			

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

Contains non-accredited tests: __**Yes** _**X**_ **No**

Customer: **Epsilon Associates, Inc.**
Tel/Fax: **978-461-6235 /**
choyt@epsilonassociates.com

Address: **3 Mill & Main Place, Suite 250,**
Maynard, MA 01754

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, 2019	Scantek, Inc./ NVLAP	Oct 31, 2020
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 22, 2019	ACR Env. / A2LA	Oct 22, 2020
HM30-Thommen	Meteo Station	1040170/39633	Oct 24, 2019	ACR Env./ A2LA	Oct 24, 2020
140-Norsonic	Real Time Analyzer	1406423	Oct 31, 2019	Scantek / NVLAP	Oct 31, 2020
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Oct 23, 2019	Scantek, Inc. / NVLAP	Oct 23, 2020
1203-Norsonic	Preamplifier	14059	March 3, 2020	Scantek, Inc./ NVLAP	March 3, 2021

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:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D Gallagher
Date	7/15/2020	Date	7/17/2020

Document stored as: Y:\Calibration Lab\Cal 2020\LDCAL200_7146_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES[1] FROM STANDARDS REFERENCED IN PROCEDURES:	MET[2]	NOT MET	COMMENTS
Manufacturer specifications			
Manufacturer specifications: Sound pressure level	X		
Manufacturer specifications: Frequency	X		
Manufacturer specifications: Total harmonic distortion	X		
Current standards			
ANSI S1.40:2006 B.3 / IEC 60942: 2003 B.2 - Preliminary inspection	X		
ANSI S1.40:2006 B.4.4 / IEC 60942: 2003 B.3.4 - Sound pressure level	X		
ANSI S1.40:2006 A.5.4 / IEC 60942: 2003 A.4.4 - Sound pressure level stability	-	-	
ANSI S1.40:2006 B.4.5 / IEC 60942: 2003 B.3.5 - Frequency	X		
ANSI S1.40:2006 B.4.6 / IEC 60942: 2003 B.3.6 - Total harmonic distortion	X		

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 The tests marked with (*) are not covered by the current NVLAP accreditation.

Main measured parameters [3]:

Measured[4]/Acceptable[5] Tone frequency (Hz):	Measured[4]/Acceptable[5] Total Harmonic Distortion (%):	Measured [4]/Acceptable Level[5] (dB):
1000.14 ± 1.0/1000.0 ± 10.0	0.36 ± 0.10/ < 3	93.86 ± 0.12/94.0 ± 0.4
1000.11 ± 1.0/1000.0 ± 10.0	0.43 ± 0.10/ < 3	113.85 ± 0.12/114.0 ± 0.4

3 The stated level is valid at measurement conditions.

4 The above expanded uncertainties for frequency and distortion are calculated with a coverage factor k=2; for level k=2.00

5 Acceptable parameters values are from the current standards

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.1 ± 1.0	100.47 ± 0.000	40.2 ± 2.0

Tests made with following attachments to instrument:

Calibrator ½" Adaptor Type:	
Other:	

Adjustments: Unit was not adjusted.
Comments: The instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Measured Data: in Acoustical Calibrator Test Report # 45009 of two pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
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Scantek, Inc.
CALIBRATION LABORATORY

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ACCREDITED by NVLAP (an ILAC MRA signatory)

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CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.44212

Instrument:	**Sound Level Meter**	*Date Calibrated:* **1/16/2020**	*Cal Due:* **1/16/2021**
Model:	**831**	*Status:*	**Received** / **Sent**
Manufacturer:	**Larson Davis**	*In tolerance:*	X / X
Serial number:	**0003751**	*Out of tolerance:*	
Tested with:	**Microphone 377C20 s/n 162996** **Preamplifier PRM831 s/n 029562**	*See comments:*	
		Contains non-accredited tests:	__Yes X No
Type (class):	**1**	*Calibration service:*	__ Basic X Standard
Customer:	**Epsilon Associates, Inc.**	*Address:*	**3 Mill & Main Place, Suite 250, Maynard, MA 01754**
Tel/Fax:	**978-461-6235 / choyt@epsilonassociates.com**		

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, 2019	Scantek, Inc./ NVLAP	Oct 31, 2020
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 22, 2019	ACR Env. / A2LA	Oct 22, 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 (%)
23.5	100.28	51.3

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D. Gallagher
Date	1/16/2020	Date	1/16/2020

Document stored Y:\Calibration Lab\SLM 2020\LD831_0003751_M1.doc

Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES [1] FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT[2,3]	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
INDICATION AT THE CALIBRATION CHECK FREQUENCY - IEC61672-3 ED.2 CLAUSE 10	Passed	0.15
SELF-GENERATED NOISE - IEC 61672-3 ED.2 CLAUSE 11	Passed	0.30
FREQUENCY WEIGHTINGS: A NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.20
FREQUENCY WEIGHTINGS: C NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.20
FREQUENCY WEIGHTINGS: Z NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.20
FREQUENCY AND TIME WEIGHTINGS AT 1 KHZ IEC 61672-3 ED.2.0 CLAUSE 14	Passed	0.20
LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE - IEC 61672-3 ED.2 CLAUSE 16	Passed	0.25
LEVEL LINEARITY INCLUDING THE LEVEL RANGE CONTROL - IEC 61672-3 ED.2.0 CLAUSE 17	Passed	0.25
TONEBURST RESPONSE - IEC 61672-3 ED.2.0 CLAUSE 18	Passed	0.30
PEAK C SOUND LEVEL - IEC 61672-3 ED.2.0 CLAUSE 19	Passed	0.35
OVERLOAD INDICATION - IEC 61672-3 ED.2.0 CLAUSE 20	Passed	0.25
HIGH LEVEL STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 21	Passed	0.10
LONG TERM STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 15	Passed	0.10
FILTER TEST 1/1OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/3OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
COMBINED ELECTRICAL AND ACOUSTICAL TEST - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	See test report

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Comments: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2, to demonstrate that the model of sound level meter fully conforms to the requirements in the IEC 61672-2, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Tests made with the following attachments to the instrument:

Microphone: PCB Piezotronics 377C20 s/n 162996 for acoustical test
Preamplifier: Larson Davis PRM831 s/n 029562 for all tests
Other: line adaptor ADP005 (18pF) for electrical tests
Accompanying acoustical calibrator: Larson Davis CAL200 s/n 13676
Windscreen: none

Measured Data: in Test Report # 44212 of 9 + 1 pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA
Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

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.44213

Instrument:	**Microphone**	*Date Calibrated:* **1/15/2020**	*Cal Due:* **1/15/2021**
Model:	**377C20**		
Manufacturer:	**PCB Piezotronics**		
Serial number:	**162996**		
Composed of:			

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

Contains non-accredited tests: __**Yes** _X_ **No**

Customer: **Epsilon Associates, Inc.**

Tel/Fax: **978-461-6235/choyt@epsilonassociates.com**

Address: **3 Mill & Main Place, Suite 250, Maynard, MA 01754**

Tested in accordance with the following procedures and standards:
Calibration of Measurement Microphones, Scantek, Inc., Rev. 2/25/2015

Instrumentation used for calibration: N-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, 2019	Scantek, Inc./ NVLAP	Oct 31, 2020
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 22, 2019	ACR Env. / A2LA	Oct 22, 2020
HM30-Thommen	Meteo Station	1040170/39633	Oct 24, 2019	ACR Env./ A2LA	Oct 24, 2020
PC Program 1017 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1253-Norsonic	Calibrator	28326	Oct 23, 2019	Scantek, Inc./ NVLAP	Oct 23, 2020
1203-Norsonic	Preamplifier	14059	Feb 28, 2019	Scantek, Inc./ NVLAP	Feb 28, 2020
4180-Brüel&Kjær	Microphone	2246115	Oct 1, 2019	DPLA / DANAK	Oct 1, 2021

Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D. Gallagher
Date	1/15/2020	Date	1/16/2020

Document stored as: Y:\Calibration Lab\Mic 2020\PCB377C20_162996_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES / METHODS[1] FROM PROCEDURES		MET[2,3]	NOT MET	NOT TESTED	MEASUREMENT EXPANDED UNCERTAINTY (coverage factor 2)
Open circuit sensitivity (insert voltage method, 250 Hz)		X			See below
Frequency response	Actuator response	X			63 – 200Hz: 0.3 dB 200 – 8000 Hz: 0.2 dB 8 – 10 kHz: 0.5 dB 10 – 20 kHz: 0.7 dB 20 – 50 kHz: 0.9 dB 50 – 100 kHz: 1.2 dB
	FF/Diffuse field responses	X			63 – 200Hz: 0.3 dB 200 – 4000 Hz: 0.2 dB 4 – 10 kHz: 0.6 dB 10 – 20 kHz: 0.9 dB 20 – 50 kHz: 2.2 dB 50 – 100 kHz: 4.4 dB
	Scantek, Inc. acoustical method			X	31.5 – 125 Hz: 0.16 dB 250, 1000 Hz: 0.12 dB 2 – 8 kHz: 0.8 dB 12.5 – 16 kHz: 2.4 dB

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Results are normalized to the reference conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Note: The free field/diffuse field characteristics were calculated based on the measured actuator response and adjustment coefficients as provided by the manufacturer. The uncertainties reported for these characteristics may include assumed uncertainty components for the adjustment coefficients.

Comments:	The instrument was tested and met all specifications found in the referenced procedures.

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.2 ± 1.1	100.43 ± 0.020	57.5 ± 2.7

Main measured parameters:

Tone frequency (Hz)	Measured[4]/Acceptable Open circuit sensitivity (dB re 1V/Pa)	Sensitivity (mV/Pa)
250	-26.44 ± 0.12/ -26.0 ±1.5	47.67

4 The reported expanded uncertainty is calculated with a coverage factor k=2.00

Tests made with following attachments to instrument and auxiliary devices:

Protection grid mounted for sensitivity measurements
Actuator type: G.R.A.S. RA0014

Measured Data: Found on Microphone Test Report # 44213 of one page.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA
Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

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.43718

Instrument:	**Sound Level Meter**	*Date Calibrated:* **10/1/2019**	*Cal Due:*		
Model:	**831**	*Status:*	**Received**	**Sent**	
Manufacturer:	**Larson Davis**	*In tolerance:*	**X**	**X**	
Serial number:	**0003753**	*Out of tolerance:*			
Tested with:	**Microphone 377B20 s/n 142956** **Preamplifier PRM831 s/n 029564**	*See comments:*			
		Contains non-accredited tests: __Yes **X** No			
Type (class):	**1**	*Calibration service:* __ Basic **X** Standard			
Customer:	**Epsilon Associates, Inc.**	*Address:*	**3 Mill & Main Place, Suite 250** **Maynard, MA 01754**		
Tel/Fax:	**978-461-6235 / 978-897-0099**				

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, 2020	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	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	100.50	54.4

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature		Signature	Steven E Marshall
Date	10/1/19	Date	10/1/2019

Document stored Z:\Calibration Lab\SLM 2019\LD831_0003753_M1.doc

Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES [1] FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT[2,3]	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
INDICATION AT THE CALIBRATION CHECK FREQUENCY - IEC61672-3 ED.2 CLAUSE 10	Passed	0.15
SELF-GENERATED NOISE - IEC 61672-3 ED.2 CLAUSE 11	Passed	0.3
FREQUENCY WEIGHTINGS: A NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: C NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: Z NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY AND TIME WEIGHTINGS AT 1 KHZ IEC 61672-3 ED.2.0 CLAUSE 14	Passed	0.2
LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE - IEC 61672-3 ED.2 CLAUSE 16	Passed	0.25
LEVEL LINEARITY INCLUDING THE LEVEL RANGE CONTROL - IEC 61672-3 ED.2.0 CLAUSE 17	Passed	0.25
TONEBURST RESPONSE - IEC 61672-3 ED.2.0 CLAUSE 18	Passed	0.3
PEAK C SOUND LEVEL - IEC 61672-3 ED.2.0 CLAUSE 19	Passed	0.35
OVERLOAD INDICATION - IEC 61672-3 ED.2.0 CLAUSE 20	Passed	0.25
HIGH LEVEL STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 21	Passed	0.1
LONG TERM STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 15	Passed	0.1
FILTER TEST 1/1OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/3OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
COMBINED ELECTRICAL AND ACOUSTICAL TEST - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	See test report

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Comments: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2, to demonstrate that the model of sound level meter fully conforms to the requirements in the IEC 61672-2, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Tests made with the following attachments to the instrument:

Microphone: PCB Piezotronics 377B20 s/n 142956 for acoustical test
Preamplifier: Larson Davis PRM831 s/n 029564 for all tests
Other: line adaptor ADP005 (18pF) for electrical tests
Accompanying acoustical calibrator: Larson Davis CAL200 s/n 7147
Windscreen: none

Measured Data: in Test Report # 43718 of 9+1 pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
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CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.43719

Instrument:	**Microphone**	*Date Calibrated:* **9/30/2019**	*Cal Due:*		
Model:	**377B20**	*Status:*	**Received**	**Sent**	
Manufacturer:	**PCB Piezotronics**	*In tolerance:*	**X**	**X**	
Serial number:	**142956**	*Out of tolerance:*			
Composed of:		*See comments:*			
		Contains non-accredited tests: __Yes _X_ No			
Customer:	**Epsilon Associates, Inc.**	*Address:*	**3 Mill & Main Place, Suite 250,**		
Tel/Fax:	**978-461-6235/978-897-0099**		**Maynard, MA 01754**		

Tested in accordance with the following procedures and standards:
Calibration of Measurement Microphones, Scantek, Inc., Rev. 2/25/2015

Instrumentation used for calibration: N-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, 2020	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	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 1017 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1253-Norsonic	Calibrator	28326	Nov 11, 2018	Scantek, Inc./ NVLAP	Nov 11, 2019
1203-Norsonic	Preamplifier	21270	Aug 5, 2019	Scantek, Inc./ NVLAP	Aug 5, 2020
4180-Brüel&Kjær	Microphone	2246115	Oct 24, 2017	DANAK / DPLA	Oct 24, 2019

Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature	Jeremy Gotwalt	Signature	Steven E. Marshall
Date	9/30/19	Date	10/1/2019

Document stored as: Z:\Calibration Lab\Mic 2019\PCB377B20_142956_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES / METHODS[1] FROM PROCEDURES		MET[2,3]	NOT MET	NOT TESTED	MEASUREMENT EXPANDED UNCERTAINTY (coverage factor 2)
Open circuit sensitivity (insert voltage method, 250 Hz)		X			See below
Frequency response	Actuator response	X			63 – 200Hz: 0.3 dB 200 – 8000 Hz: 0.2 dB 8 – 10 kHz: 0.5 dB 10 – 20 kHz: 0.7 dB 20 – 50 kHz: 0.9 dB 50 – 100 kHz: 1.2 dB
	FF/Diffuse field responses	X			63 – 200Hz: 0.3 dB 200 – 4000 Hz: 0.2 dB 4 – 10 kHz: 0.6 dB 10 – 20 kHz: 0.9 dB 20 – 50 kHz: 2.2 dB 50 – 100 kHz: 4.4 dB
	Scantek, Inc. acoustical method			X	31.5 – 125 Hz: 0.16 dB 250, 1000 Hz: 0.12 dB 2 – 8 kHz: 0.8 dB 12.5 – 16 kHz: 2.4 dB

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Results are normalized to the reference conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Note: The free field/diffuse field characteristics were calculated based on the measured actuator response and adjustment coefficients as provided by the manufacturer. The uncertainties reported for these characteristics may include assumed uncertainty components for the adjustment coefficients.

Comments:	The instrument was tested and met all specifications found in the referenced procedures.

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
21.5 ± 1.0	100.94 ± 0.020	67.5 ± 2.0

Main measured parameters:

Tone frequency (Hz)	Measured[4]/Acceptable Open circuit sensitivity (dB re 1V/Pa)	Sensitivity (mV/Pa)
250	-26.89 ± 0.12/ -26.0 ±1.5	45.23

4 The reported expanded uncertainty is calculated with a coverage factor k=2.00

Tests made with following attachments to instrument and auxiliary devices:

Protection grid mounted for sensitivity measurements
Actuator type: G.R.A.S. RA0014

Measured Data: Found on Microphone Test Report # 43719 of one page.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA
Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Appendix B

Acoustical Terminology and Metrics

The unit of sound pressure is the decibel (dB). The decibel scale is logarithmic to accommodate the large dynamics of sound intensities to which the human ear is subjected. An inherent property of the logarithmic decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total is a 3-decibel increase (or 53 dB), not an arithmetic doubling to 100 dB. The human ear does not perceive changes in the sound pressure level as equal changes in loudness. Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics:

- 1 dBA is the practically achievable limit of the accuracy of sound measurement systems and corresponds to an approximate 10 percent variation in sound pressure. A 1 dBA increase or decrease is a non-perceptible change in sound.

- 3 dBA increase or decrease is a doubling (or halving) of acoustic energy and it corresponds to the threshold of perceptibility of change. In practice, a 3 dBA change in environmental sound is at the margin of perceptibility to the average person[6].

- 5 dBA increase or decrease is described as a perceptible change in sound level and is a discernible change in an outdoor environment.

- 10 dBA increase or decrease is a tenfold increase or decrease in acoustic energy, but is perceived as a doubling or halving in sound (i.e., the average person will judge a 10 dBA change in sound level to be twice or half as loud)[7].

Environmental sound is typically composed of acoustic energy across a wide range of frequencies, referred to as the frequency spectra; however, the human ear does not interpret the sound level from each frequency as equally loud. To compensate for the physical response of the human ear, the A-weighting filter is commonly used for describing environmental sound levels. The A-weighting filters the frequency spectrum of sound levels to correspond to the frequency response of the human ear (attenuating low and high frequency energy similar to the way people hear sound). Sound levels that are A-weighted to reflect human response are presented as “dBA”. The A-weighted sound level is the most widely accepted descriptor for community noise assessments. Unweighted sound levels are referred to as linear decibels, and given in units of “dB” or “dBZ”.

[6] 2009 ASHRAE Handbook – Fundamentals, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA, 2009.

[7] Procedures for the Computation of Loudness of Steady Sounds, American National Standard, ANSI S3.4-2007, Annex A, NY.

Sound levels can be measured and presented in various formats. The most common sound metric used in community sound surveys is the equivalent sound level (L_{eq}). The L_{eq} level is the energy averaged, A-weighted sound pressure level that occurs over a given time period, i.e., the steady, continuous sound level which has the same acoustic energy as the time-varying sound levels over the same time period. The L_{eq} has been shown to provide both an effective and uniform method for comparing time-varying sound levels and is routinely employed.

Statistical levels help further characterize the sound environment. The percentile sound levels ($L_{\%}$) indicate the sound level exceeded for that percentage of the measurement period. The L_{90} level is commonly referred to as the residual sound level as it excludes short-term intrusive noise events so it is effective in defining the quietest periods. The L_{90} is the statistical level that is the level exceeded during 90 percent of the measurement period. In comparison, the L_{10} is referred to as the intrusive level and is the sound level that is exceeded for 10 percent of the time during the measurement.

The L_{max} is the maximum sound level over a given time period. The L_{max} is typically due to discrete, identifiable events such as an airplane overflight, car or truck pass by, or a dog bark for example.

The noise metrics defined are broadband (i.e., inclusive of sound across the entire audible frequency spectrum). In addition to broadband, sound level data typically includes an analysis of the various frequency components of the sound spectrum to determine the potential for tonal characteristics and for use in identifying candidate noise mitigation measures. The unit of frequency is Hertz (Hz), measuring the cycles per second of the sound pressure waves, and typically the frequency analysis is presented in octave bands established by standard (ANSI S1.11, 1986).

A few additional terms are defined below.

ANS-weighted - A high-frequency natural sound (HFNS) filter applied to the measured one-third octave-band data to remove seasonal noise like insects. This technique removes all sound energy above the 1,250 Hertz frequency band. The methodology for the filtration process is specified in ANSI/ASA S12.100-2014 and the sound pressure levels presented using this methodology are indicated as ANS-weighted levels (presented in dBA).

G - The portion of ground that is considered porous as defined under ISO 9613-2. This is used as part of the ground attenuation calculation between the source and receiver. For example, a G-factor of 0.5 corresponds to “mixed ground” consisting of half hard and half porous ground cover. A G-factor of zero (0) corresponds to “hard ground” consisting of surfaces with low porosity including water, and a G of 1 represents all porous ground.

Infrasound - Sound in the frequencies below 20 Hz.

ISO 9613-2 - An international standard which specifies an engineering method for calculating the attenuation of sound during outdoor propagation in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound level under meteorological conditions favorable to propagation from sources of known sound emission, and is used throughout the United States and the world.

L_{DN} - the day-night average sound level, sometimes abbreviated as DNL, presented in dBA. The DNL is the 24-hour average sound level obtained by the logarithmic average of the average daytime sound level (L_D) and the average nighttime sound level (L_N) that incorporates a 10-decibel "penalty" to each nighttime-hour sound level. This penalty accounts for the greater sensitivity to sound events during nighttime hours. The L_D and L_N are both calculated using hourly equivalent sound levels ($L_{eq(h)}$). The Environmental Protection Agency defines daytime as the 15 hours from 7:00 AM-10:00 PM and nighttime as the 9 hours from 10:00 PM-7:00 AM.

Low frequency- Sound contained in the frequencies from 20 Hz to 200 Hz.

Octave bands - The International Standards Organization (ISO) has agreed upon "preferred" frequency bands for sound measurement and by agreement the octave band is the widest band for frequency analysis. The upper frequency limit of the octave band is approximately twice the lower frequency limit and each band is identified by its geometric mean called the band center frequency. The octave band center frequencies typically used for sound level analyses are 31.5, 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz. When more detailed information about a noise is required, standardized one-third octave band analysis may be used.

Weighting - The sound level meter used to measure noise is a standardized instrument.[8] It contains "weighting networks" to adjust the frequency response of the instrument to approximate that of the human ear under various conditions. One network is the A-weighting network, which most closely approximates how the human ear responds to sound as a function of frequency, and is the accepted scale used for community sound level measurements. Sounds are frequently reported as detected with the A-weighting network of the sound level meter in dBA. A-weighted sound levels emphasize middle frequencies (i.e., middle pitched—around 1,000 Hertz sounds), and de-emphasize lower and higher frequencies. The C-weighting network has a nearly flat response for frequencies between 63 Hz and 4000 Hz and is noted as dBC.

[8] *American National Standard Specification for Sound Level Meters*, ANSI S1.4-1983, published by the Standards Secretariat of the Acoustical Society of America, Melville, NY.