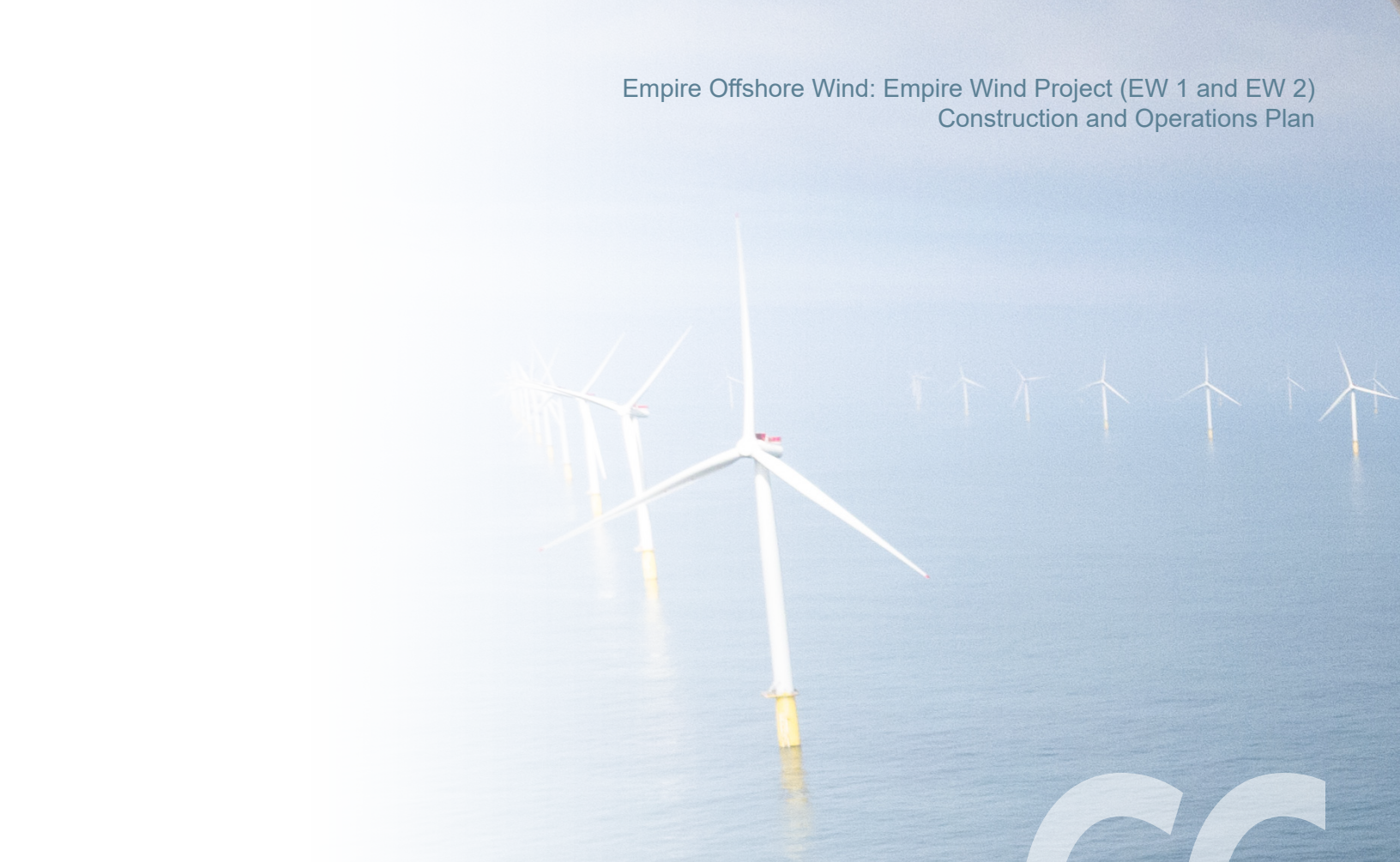
The latest revision date of Appendix CC to the Empire Offshore Wind COP is May 2022. This appendix was not revised as part of the November 2023 submittal; therefore, the date on the Appendix CC cover sheet remains as May 2022.



APPENDIX CC

Obstruction Evaluation and Airspace Analysis

Prepared for

equinor

TETRA TECH

MAY 2022

Empire Offshore Wind: Empire Wind Project (EW 1 and EW 2)

Tetra Tech, Inc.

Offshore New York City, New York

Obstruction Evaluation & Airspace Analysis

April 12, 2021

Capitol Airspace Group
capitolairspace.com
(703) 256 - 2485

Summary

Capitol Airspace conducted an obstruction evaluation and airspace analysis for Empire Offshore Wind LLC (Empire) of the Empire Offshore Wind: Empire Wind Project (EW 1 and EW 2), referred to as the Project, off the coast of New York City, New York. In support of preparing the Construction and Operations Plan (COP), the purpose for this analysis was to identify obstacle clearance surfaces established by the Federal Aviation Administration (FAA) that could limit the placement of 952-foot (ft, 290-meter [m]) above ground level (AGL) wind turbines, the maximum sized wind turbine generator under consideration as part of the COP. At the time of this analysis, individual wind turbine locations had not been identified. This analysis assessed height constraints overlying the designated Renewable Energy Lease Area OCS-A 0512 (Lease Area), an approximately 68 square mile study area (red outline, ***Figure 1***), to aid in identifying optimal wind turbine locations.

14 CFR Part 77.9 requires that all structures exceeding 200 ft (60.9 m) AGL be submitted to the FAA so that an aeronautical study can be conducted. The FAA's objective in conducting aeronautical studies is to ensure that proposed structures do not have an effect on the safety of air navigation and the efficient utilization of navigable airspace by aircraft. The end result of an aeronautical study is the issuance of a determination of 'hazard' or 'no hazard' that can be used by the proponent to obtain necessary local construction permits. It should be noted that the FAA has no control over land use in the United States and cannot enforce the findings of its studies.

Height constraints overlying the Lease Area range from 549 to 1,049 ft (167.3 to 319.7 m) above mean sea level (AMSL) and are associated with New York (N90) Terminal Radar Approach Control (TRACON) minimum vectoring altitude sectors. Proposed structures that exceed these surfaces would require an increase to minimum vectoring altitudes.

At 952 ft (290 m) AGL, wind turbines proposed in the western section of the Lease Area would exceed these surfaces and would require an increase to minimum vectoring altitude sectors. If the FAA determines that this impact would affect as few as one operation per week, it could result in determinations of hazard.

A warning area overlies the eastern section of the Lease Area. If the Navy uses this warning area regularly, it could result in military objections to proposed wind development.

This analysis did not consider electromagnetic interference on communications systems, navigation, or surveillance radar systems.

Capitol Airspace applies FAA defined rules and regulations applicable to obstacle evaluation, instrument procedures assessment and visual flight rules (VFR) operations to the best of its ability and with the intent to provide the most accurate representation of limiting airspace surfaces as possible. Capitol Airspace maintains datasets obtained from the FAA which are updated on a 56-day cycle. The results of this analysis are based on the most recent data available as of the date of this report. Limiting airspace surfaces depicted in this report are subject to change due to FAA rule changes and regular procedure amendments. Therefore, it is of the utmost importance to obtain FAA determinations of no hazard prior to making substantial financial investments in this project.

Methodology

Capitol Airspace studied the proposed Project based upon location information provided by Tetra Tech, Inc. Using this information, Capitol Airspace generated graphical overlays to determine proximity to airports (***Figure 1***), published instrument procedures, enroute airways, FAA minimum vectoring altitude and minimum instrument flight rules (IFR) altitude charts, as well as military airspace and training routes.

Capitol Airspace evaluated all 14 CFR Part 77 imaginary surfaces, published instrument approach and departure procedures, visual flight rules operations, FAA minimum vectoring altitudes, minimum IFR altitudes, and enroute operations. All formulas, headings, altitudes, bearings and coordinates used during this study were derived from the following documents and data sources:

- 14 CFR Part 77 Safe, Efficient Use, and Preservation of the Navigable Airspace;
- FAA Order 7400.2M Procedures for Handling Airspace Matters;
- FAA Order 8260.3D United States Standard for Terminal Instrument Procedures;
- FAA Order 8260.58A United States Standard for Performance Based Navigational (PBN) Instrument Procedure Design;
- Technical Operations Evaluation Desk Guide for Obstruction Evaluation/Airport Airspace Analysis (1.3.0);
- United States Government Flight Information Publication, US Terminal Procedures; and
- National Airspace System Resource Aeronautical Data.

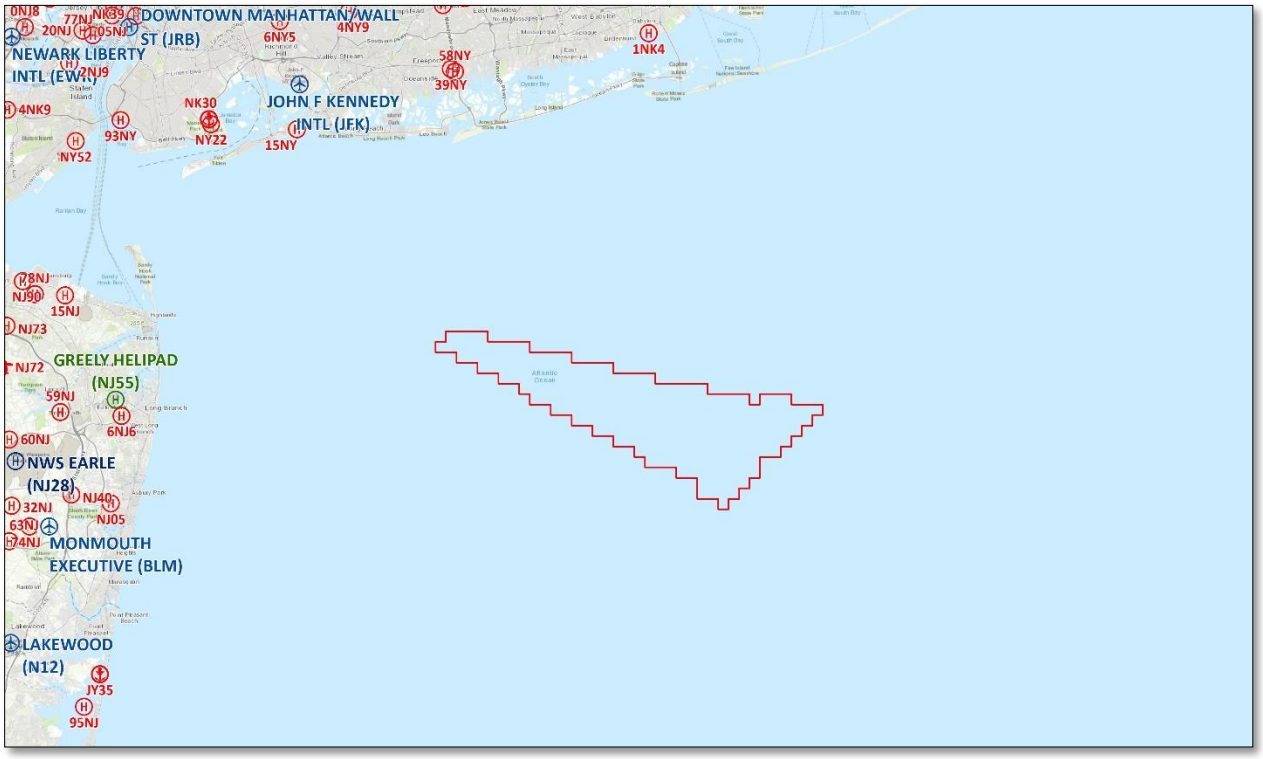


Figure 1: Public-use (blue), private-use (red), and military (green and navy blue) airports and heliports in proximity to the Project

Study Findings

Airspace Classification

The FAA establishes different volumes of airspace depending on the nature of aviation operations that will be encompassed. Airspace classification is often dictated by the volume and complexity of operations or the need to ensure certain levels of safety. Each segment of airspace may have defined rules and/or access restrictions to ensure separation or awareness of incompatible aviation operations. Depending on the type of airspace, obstacles located within or below these segments of airspace can cause a compression of airspace, increased minimum altitudes, or pose a hazard to the special operations occurring within special-use airspace.

Territorial Airspace

The FAA is authorized to conduct aeronautical studies for structures proposed within any state, territory, or possession of the United States, within the District of Columbia, or within territorial waters (pink, ***Figure 2***) surrounding the United States.[1] Wind turbines proposed in a small northwestern section of the Lease Area will be located within territorial waters and must be submitted to the FAA.[2]

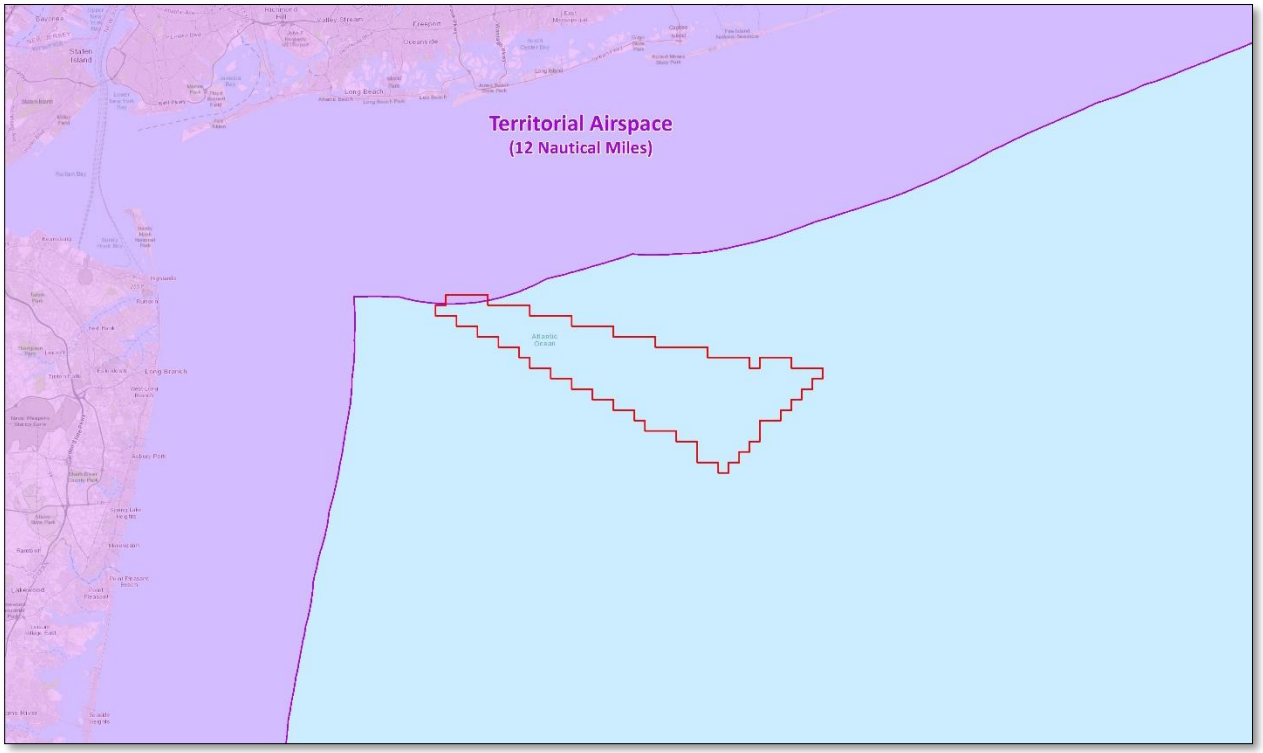


Figure 2: Territorial Airspace overlying the Project

[1] As described in FAA Order 7400.2M 5-1-4(a) "Scope"

[2] National Oceanic and Atmospheric Administration (NOAA) defines territorial waters as 12 nautical miles (22.2 kilometers) measured from the official U.S. baseline—a recognized low water line along the coast. NOAA publishes this boundary in a publicly available ***Web Map Service***.

14 CFR Part 77 Imaginary Surfaces

The FAA uses level and sloping imaginary surfaces to determine if a proposed structure is an obstruction to air navigation. Structures that are identified as obstructions are then subject to a full aeronautical study and increased scrutiny. However, exceeding a Part 77 imaginary surface does not automatically result in the issuance of a determination of hazard. Proposed structures must have airspace impacts that constitute a substantial adverse effect in order to warrant the issuance of determinations of hazard.

14 CFR Part 77.17(a)(2) and 77.19/21/23 imaginary surfaces do not overlie the Lease Area (***Figure 3***). However, at 952 ft (290 m) AGL, proposed wind turbines will exceed 77.17(a)(1) – a height of 499 ft (152 m) AGL at the site of the object – and will be identified as obstructions regardless of location.

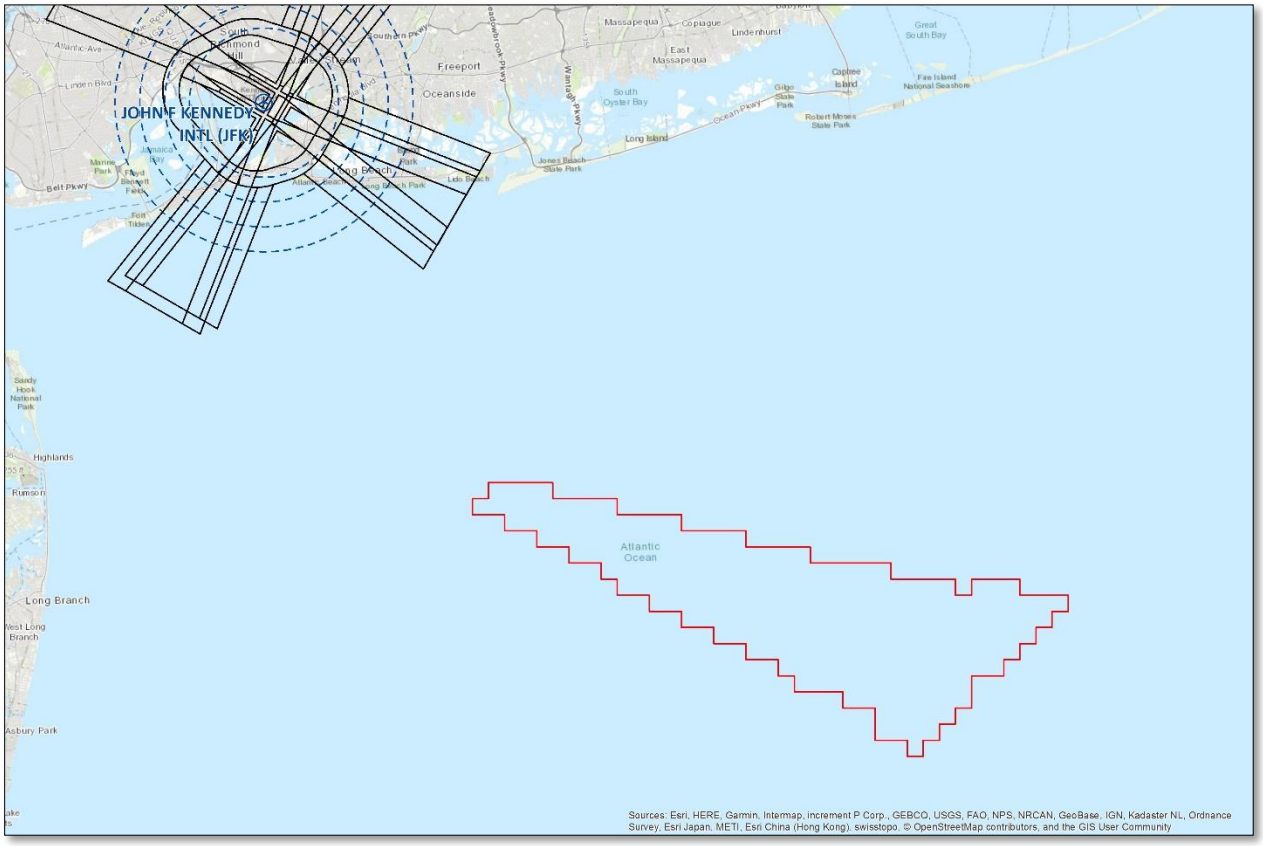


Figure 3: 77.17(a)(2) (dashed blue) and 77.19 (black) imaginary surfaces in proximity to the Project

Visual Flight Rules (VFR) Traffic Pattern Airspace

VFR traffic pattern airspace is used by pilots operating during visual meteorological conditions. The airspace dimensions are based upon the category of aircraft which, in turn, is based upon the approach speed of the aircraft. 14 CFR Part 77.17(a)(2) and 77.19 (as applied to a *visual* runway) imaginary surfaces establish the obstacle clearance surface heights within VFR traffic pattern airspace.

VFR traffic pattern airspace does not overlie the Lease Area and should not limit 952-ft (290-m) AGL wind turbines within the Lease Area (***Figure 4***).

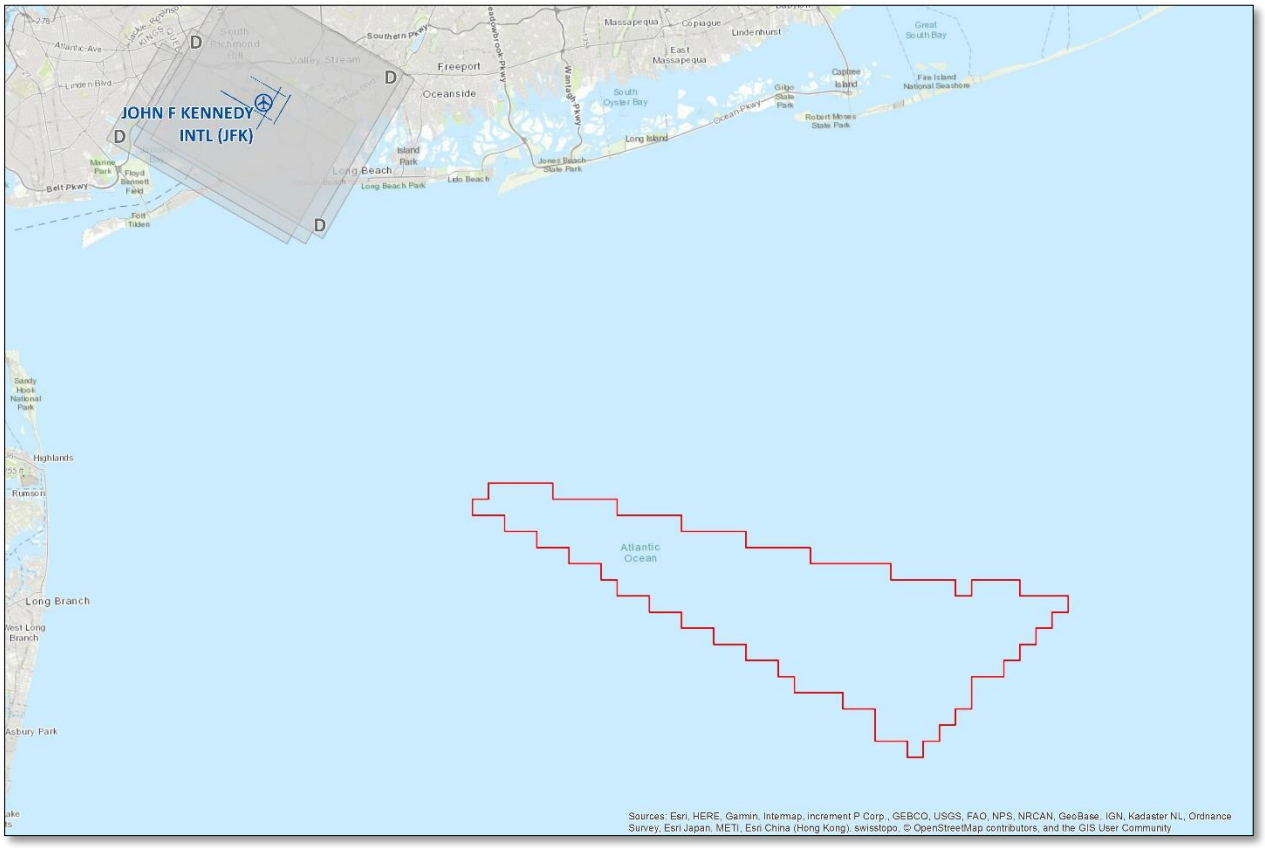


Figure 4: VFR traffic pattern airspace in proximity to the Project

Visual Flight Rules (VFR) Routes

During periods of marginal Visual Meteorological Conditions (VMC) – low cloud ceilings and one statute mile (1.6 kilometers) visibility – pilots often operate below the floor of controlled airspace. Operating under these weather conditions requires pilots to remain within one statute mile of recognizable land marks such as roads, rivers, and railroad tracks. The FAA protects for known and regularly used VFR routes by limiting structure heights within two statute miles (3.2 kilometers) of these routes to no greater than 14 CFR Part 77.17(a)(1) – a height of 499 ft (152 m) AGL at the site of the object.

The Project is located in proximity to low altitude airways that may be used as VFR routes (***Figure 5***). However, operational data describing the usage of these potential routes is not available. If the FAA determines that these potential VFR routes are flown regularly, they could limit wind development in excess of 499 ft (152 m) AGL and within two statute miles (3.2 kilometers) of these landmarks (hatched orange, ***Figure 5***).

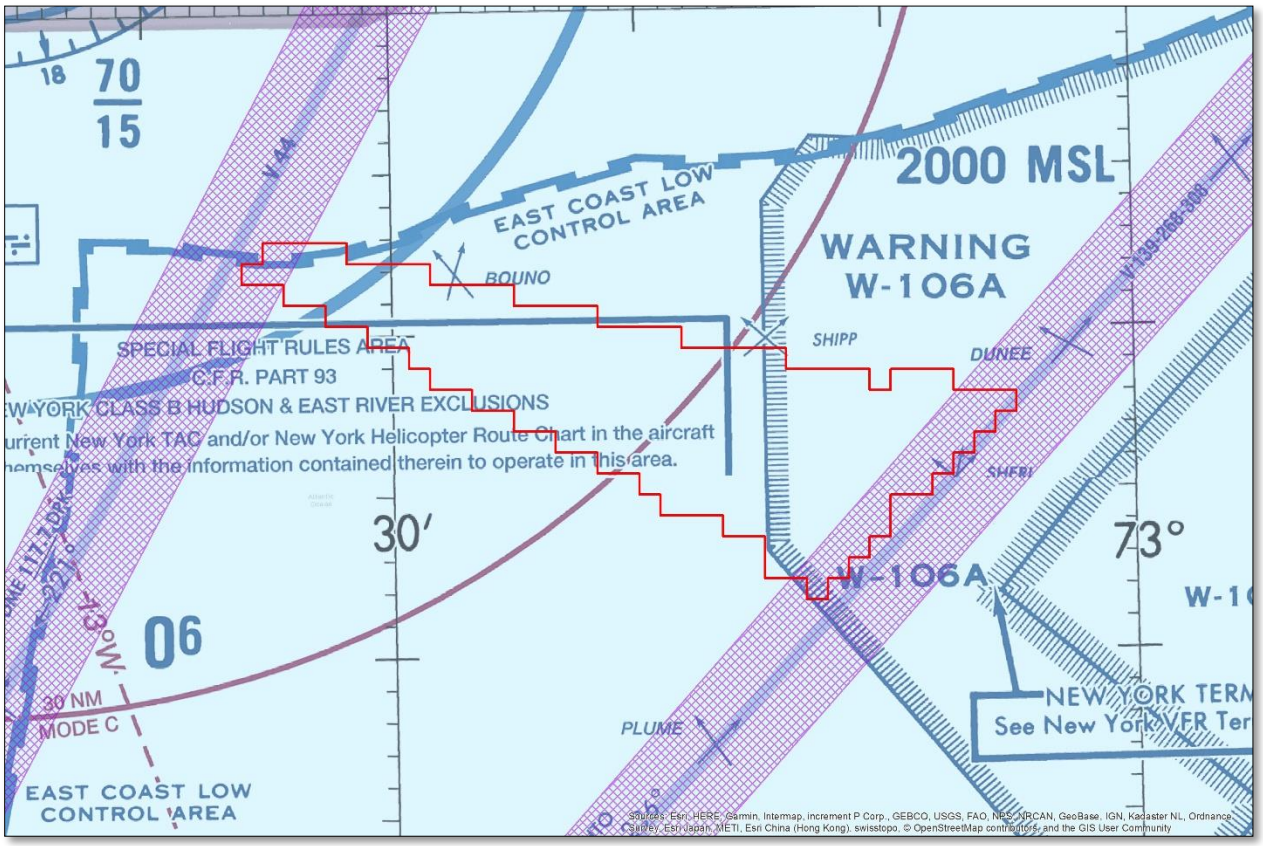


Figure 5: Potential VFR routes in proximity to the Lease Area

Instrument Departures

In order to ensure that aircraft departing during marginal weather conditions do not fly into terrain or obstacles, the FAA publishes instrument departure procedures that provide obstacle clearance to pilots as they transition between the terminal and enroute environments. These procedures contain specific routing and minimum climb gradients to ensure clearance from terrain and obstacles.

Proposed structures that exceed instrument departure procedure obstacle clearance surfaces would require an increase to instrument departure procedure minimum climb gradients. If the FAA determines that this impact would affect as few as one operation per week, it could be used as the basis for determinations of hazard.

Instrument departure procedure obstacle clearance surfaces (e.g., ***Figure 6***) are in excess of other lower surfaces and should not limit 952-ft (290-m) AGL wind turbines within the Lease Area (green area, ***Figure 6***).

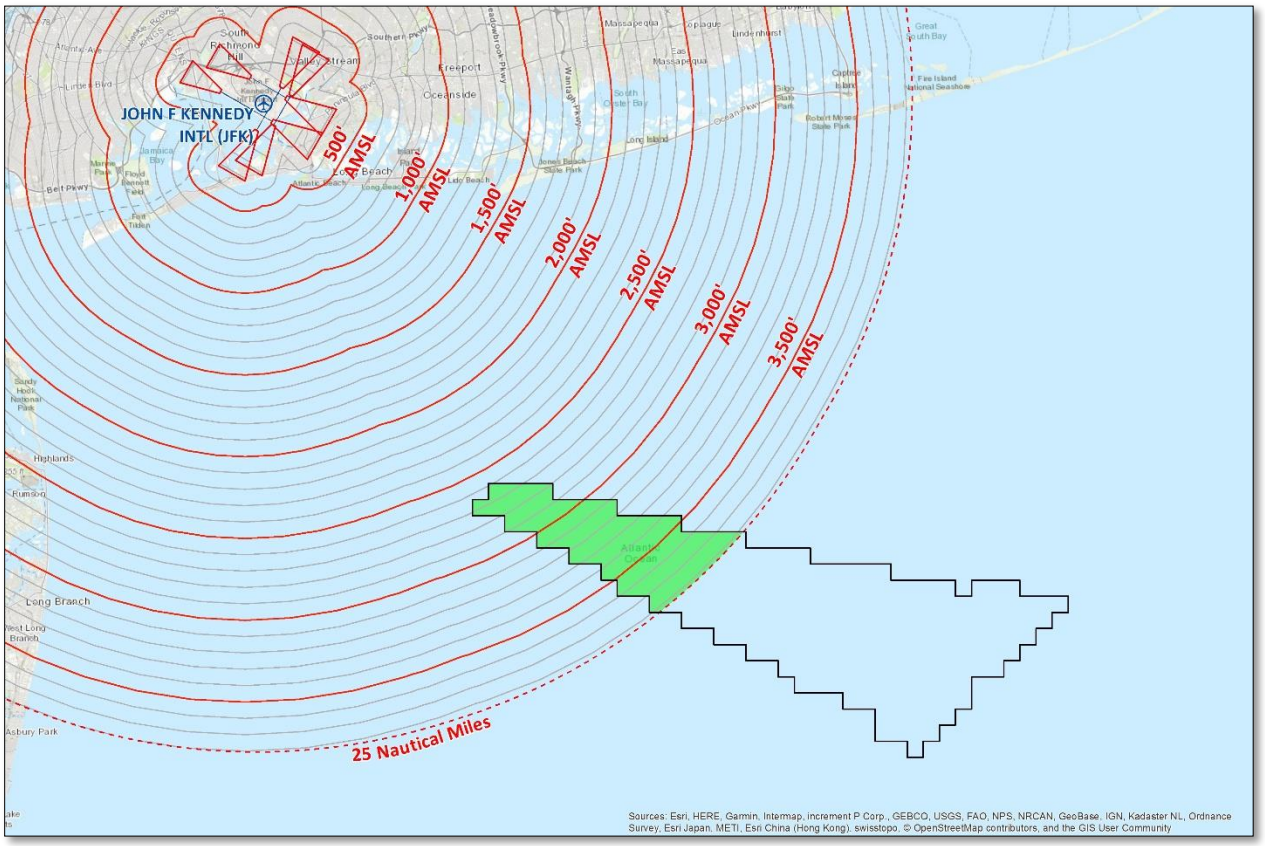


Figure 6: John F. Kennedy International Airport (JFK) obstacle departure procedure assessment

Instrument Approaches

Pilots operating during periods of reduced visibility and low cloud ceilings rely on terrestrial and satellite based navigational aids (NAVAIDS) in order to navigate from one point to another and to locate runways. The FAA publishes instrument approach procedures that provide course guidance to on-board avionics that aid the pilot in locating the runway. Capitol Airspace assessed a total of 35 published instrument approach procedures at two public-use airports in proximity to the Project:

John F. Kennedy International (JFK)
ILS or Localizer Approach to Runway 04L
ILS or Localizer Approach to Runway 04R
ILS or Localizer Approach to Runway 13L
ILS or Localizer Approach to Runway 22L
ILS or Localizer Approach to Runway 22R
ILS or Localizer Approach to Runway 31L
ILS or Localizer Approach to Runway 31R
ILS Approach to Runway 13L (CAT II)
ILS Approach to Runway 04R (CAT II & III)
ILS Approach to Runway 22L (CAT II & III)
RNAV (RNP) Z Approach to Runway 04L
RNAV (RNP) Z Approach to Runway 04R
RNAV (RNP) Z Approach to Runway 22L
RNAV (RNP) Z Approach to Runway 31L
RNAV (RNP) Z Approach to Runway 31R
RNAV (GPS) Approach to Runway 22R
RNAV (GPS) Y Approach to Runway 04L
RNAV (GPS) Y Approach to Runway 04R
RNAV (GPS) Y Approach to Runway 13R

John F. Kennedy International (JFK) (Continued)
RNAV (GPS) Y Approach to Runway 22L
RNAV (GPS) Y Approach to Runway 31L
RNAV (GPS) Y Approach to Runway 31R
VOR/DME Approach to Runway 22L
VOR or GPS Approach to Runway 13L/13R
VOR Approach to Runway 04L
VOR Approach to Runway 04R
VOR Approach to Runway 31L
Copter RNAV (GPS) 027

Republic (FRG)
ILS or Localizer Approach to Runway 14
RNAV (RNP) Z Approach to Runway 14
RNAV (GPS) Approach to Runway 01
RNAV (GPS) Approach to Runway 19
RNAV (GPS) Approach to Runway 32
RNAV (GPS) Y Approach to Runway 14
NDB Approach to Runway 01

Proposed wind turbines that exceed instrument approach procedure obstacle clearance surfaces would require an increase to their minimum altitudes. Increases to these altitudes, especially critical *decision altitudes (DA)* and *minimum descent altitudes (MDA)*, can directly impact the efficiency of instrument approach procedures. If the FAA determines this impact would affect as few as one operation per week, it could be used as the basis for determinations of hazard. [3]

Instrument approach procedure obstacle clearance surfaces (e.g., ***Figure 7***) are in excess of other lower surfaces and should not limit 952-ft (290-m) AGL wind turbines within the Lease Area (green area, ***Figure 7***).

[3] Multiple minimum safe altitude (MSA) sectors overlie the Lease Area. However, MSAs are for emergency use only and cannot be used as the basis for determinations of hazard in accordance with FAA Order 7400.2M Paragraph 6-3-9(e)(5). Therefore, height constraints associated with MSAs were not considered and are not included in the Composite Map (***Figure 13***).

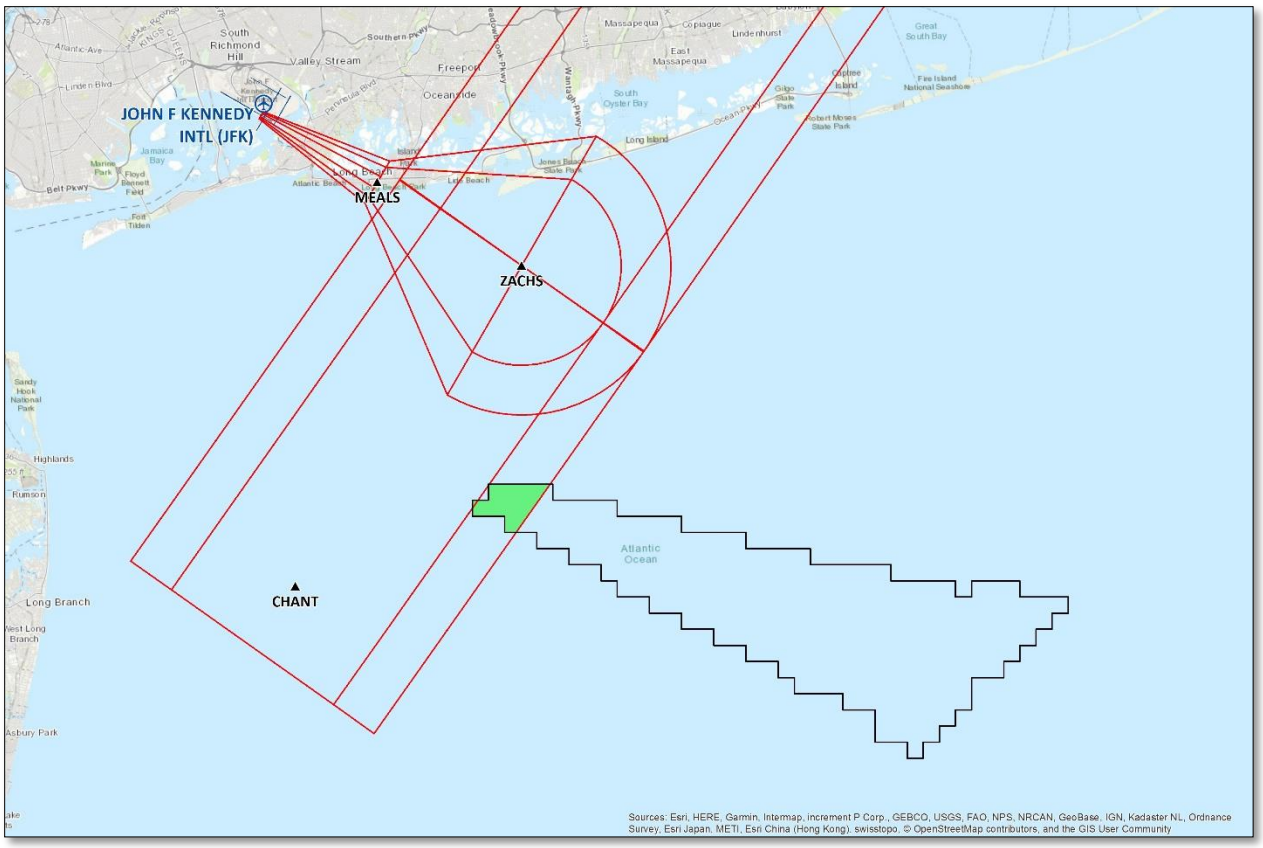


Figure 7: John F. Kennedy International Airport (JFK) ILS Approach to Runway 31L

Enroute Airways

Enroute airways provide pilots a means of navigation when flying from airport to airport and are defined by radials between VHF omni-directional ranges (VORs). The FAA publishes minimum altitudes for airways to ensure clearance from obstacles and terrain. The FAA requires that each airway have a minimum of 1,000 ft (304.8 m) of obstacle clearance in non-mountainous areas and normally 2,000 ft (609.6 m) in mountainous areas.

Proposed structures that exceed enroute airway obstacle clearance surfaces would require an increase to their minimum obstruction clearance altitudes (MOCA) and/or minimum enroute altitudes (MEA). If the FAA determines that this impact would affect as few as one operation per week, it could be used as the basis for determinations of hazard.

V44

GAMBY to *Deer Park VOR/DME (DPK)*

The MOCA is 1,600 ft (487.6 m) AMSL. The primary area obstacle clearance surface (purple outline, ***Figure 8***) is 600 ft (182.8 m) AMSL and is in excess of other lower surfaces. At 952 ft (290 m) AGL, wind turbines proposed in the western section of the Lease Area would exceed this surface and require an increase to the V44 MOCA. However, due to the Project's location beyond 22 nautical miles (40.7 kilometers) from the NAVAIDs defining V44, this surface should not be used as the sole basis for determinations of hazard.[4]

The GPS MEA is 2,500 ft (762 m) AMSL. The primary area obstacle clearance surface (purple outline, ***Figure 8***) is 1,500 ft (457.2 m) AMSL and is in excess of other lower surfaces. Additionally, this surface should not limit 952-ft (290-m) AGL wind turbines within the Lease Area (green areas, ***Figure 8***).

Other enroute airway obstacle clearance surfaces (orange outline, ***Figure 8***) are in excess of other lower surfaces and should not limit 952-ft (290-m) AGL wind turbines within the Lease Area (green areas, ***Figure 8***).

[4] In accordance with FAA Order 7400.2M Paragraph 6-3-9(d)(2), proposed structures beyond 22 nautical miles (40.7 kilometers) from an airway's supporting NAVAIDs that impact only the MOCA are not considered to have a substantial adverse effect. Therefore, height constraints associated with the V44 MOCA were not considered and are not included in the Composite Map (***Figure 13***).

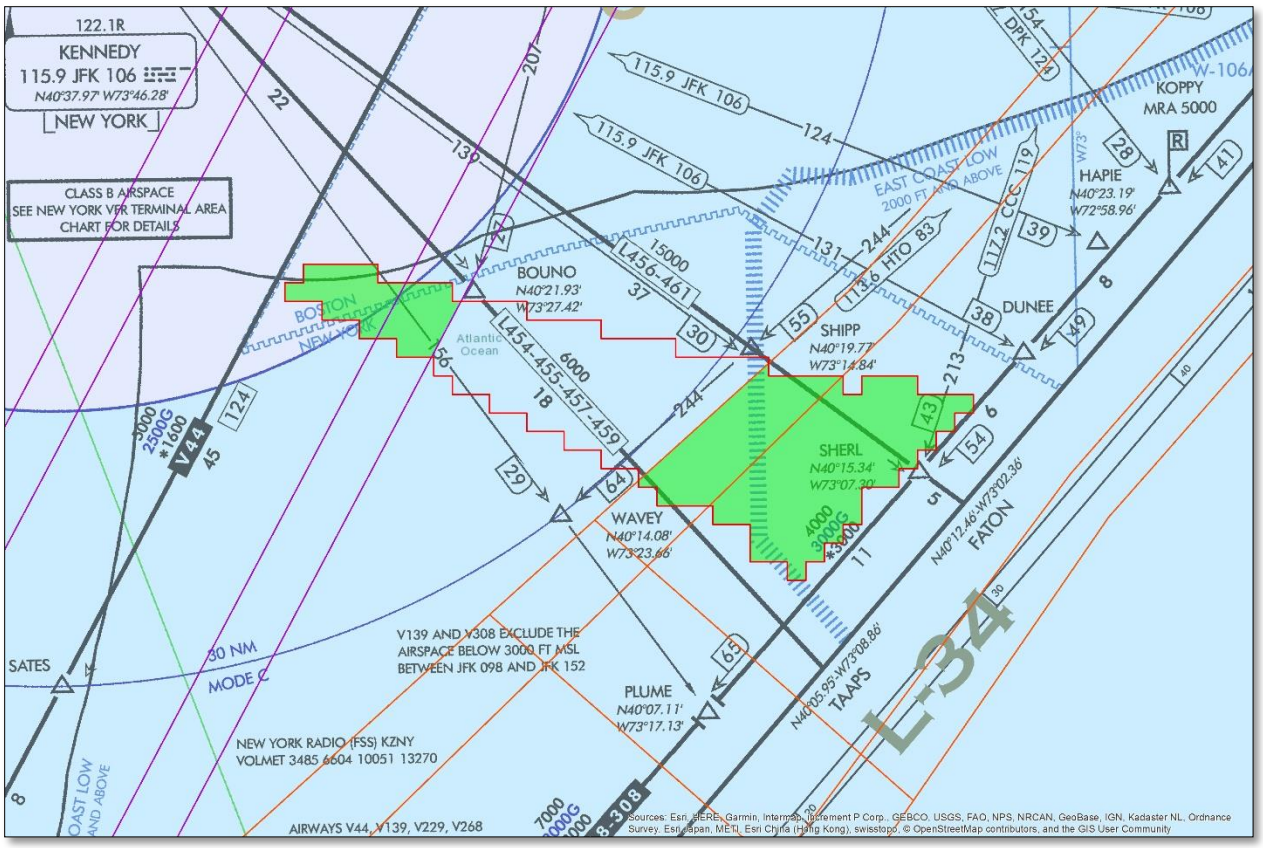


Figure 8: Low altitude enroute chart L-34 with V44 (purple outline) and V139-268-308 (orange outline) obstacle evaluation areas

Minimum Vectoring/IFR Altitudes

The FAA publishes minimum vectoring altitude (MVA) and minimum instrument flight rules (IFR) altitude (MIA) charts that define sectors with the lowest altitudes at which air traffic controllers can issue radar vectors to aircraft based on obstacle clearance. The FAA requires that sectors have a minimum of 1,000 ft (304.8 m) of obstacle clearance in non-mountainous areas and normally 2,000 ft (609.6 m) in mountainous areas.

Proposed structures that exceed MVA/MIA sector obstacle clearance surfaces would require an increase to the altitudes usable by air traffic control for vectoring aircraft. If the FAA determines that this impact would affect as few as one operation per week, it could result in determinations of hazard.

New York (N90) Terminal Radar Approach Control (TRACON)

FUSION 3: 1,500-ft (457.2-m) AMSL Sector

The MVA is 1,500 ft (457.2 m) AMSL. The obstacle clearance surface is 549 ft (167.3 m) AMSL (hatched purple, ***Figure 9***) and is one of the lowest height constraints overlying the western section of the Lease Area. At 952 ft (290 m) AGL, wind turbines proposed in this section would exceed this surface (red area, ***Figure 9***) and would require an increase to the MVA.

FUSION 3: 2,000-ft (609.6-m) AMSL Sector

The MVA is 2,000 ft (609.6 m) AMSL (***Figure 9***). The obstacle clearance surface is 1,049 ft (319.7 m) AMSL and is one of the lowest height constraints overlying the majority of the Lease Area. However, this surface should not limit 952-ft (290-m) AGL wind turbines within the Lease Area (green area, ***Figure 9***).

FUSION 5: 1,800-ft (548.6-m) AMSL Sector

The MVA is 1,800 ft (548.6 m) AMSL. The obstacle clearance surface is 849 ft (258.7 m) AMSL (hatched purple, ***Figure 10***) and is one of the lowest height constraints overlying the western section of the Lease Area. At 952 ft (290 m) AGL, wind turbines proposed in this section would exceed this surface (red area, ***Figure 10***) and would require an increase to the MVA.

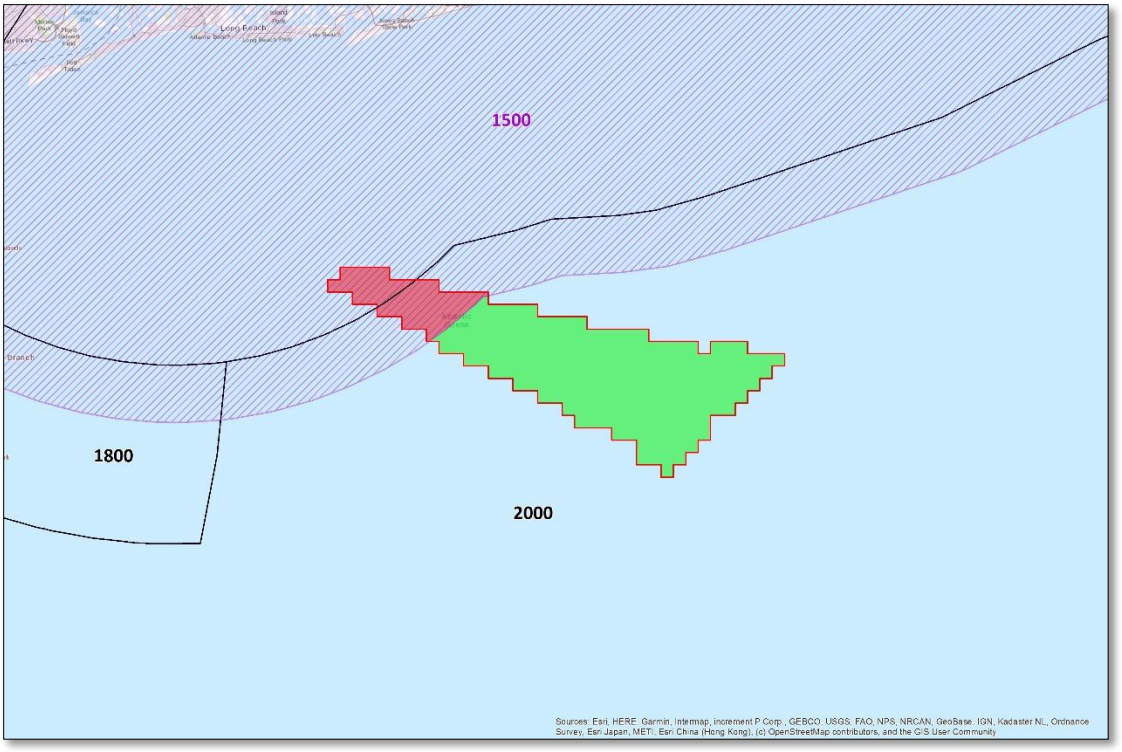


Figure 9: New York (N90) TRACON FUSION 3 MVA sectors (black) with 1,500-ft (457.2-m) AMSL Sector obstacle evaluation area (hatched purple)

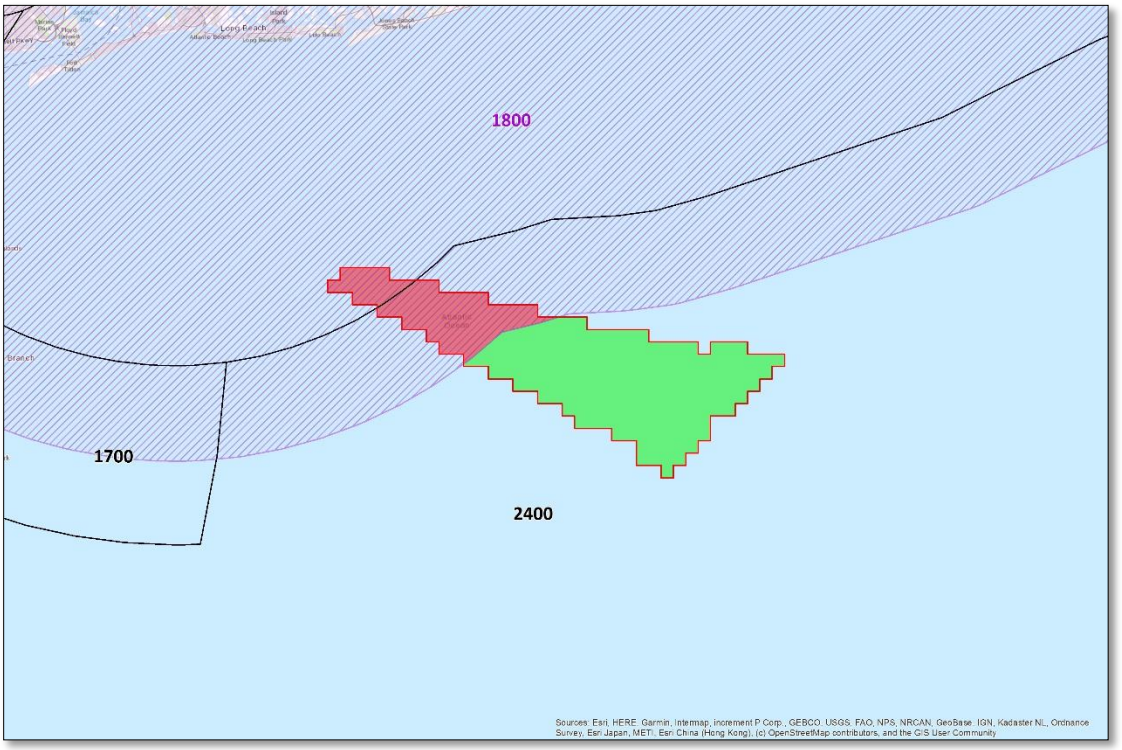


Figure 10: New York (N90) TRACON FUSION 5 MVA sectors (black) with 1,800-ft (548.6-m) AMSL Sector obstacle evaluation area (hatched purple)

Terminal and Enroute NAVAIDs

The FAA has established protection areas in order to identify proposed structures that may have a physical and/or electromagnetic effect on navigational aids (NAVAIDs). The protection area dimensions vary based on the proposed structure type as well as the NAVAID type. Proposed structures located within these areas may interfere with NAVAID services and will require further review by FAA Technical Operations. If further review determines that proposed structures would have a significant physical and/or electromagnetic effect on NAVAIDs, it could result in determinations of hazard.

NAVAID protection areas do not overlie the Lease Area (***Figure 11***). As a result, it is unlikely that proposed wind turbines would have a physical or electromagnetic effect on terminal or enroute NAVAIDs.

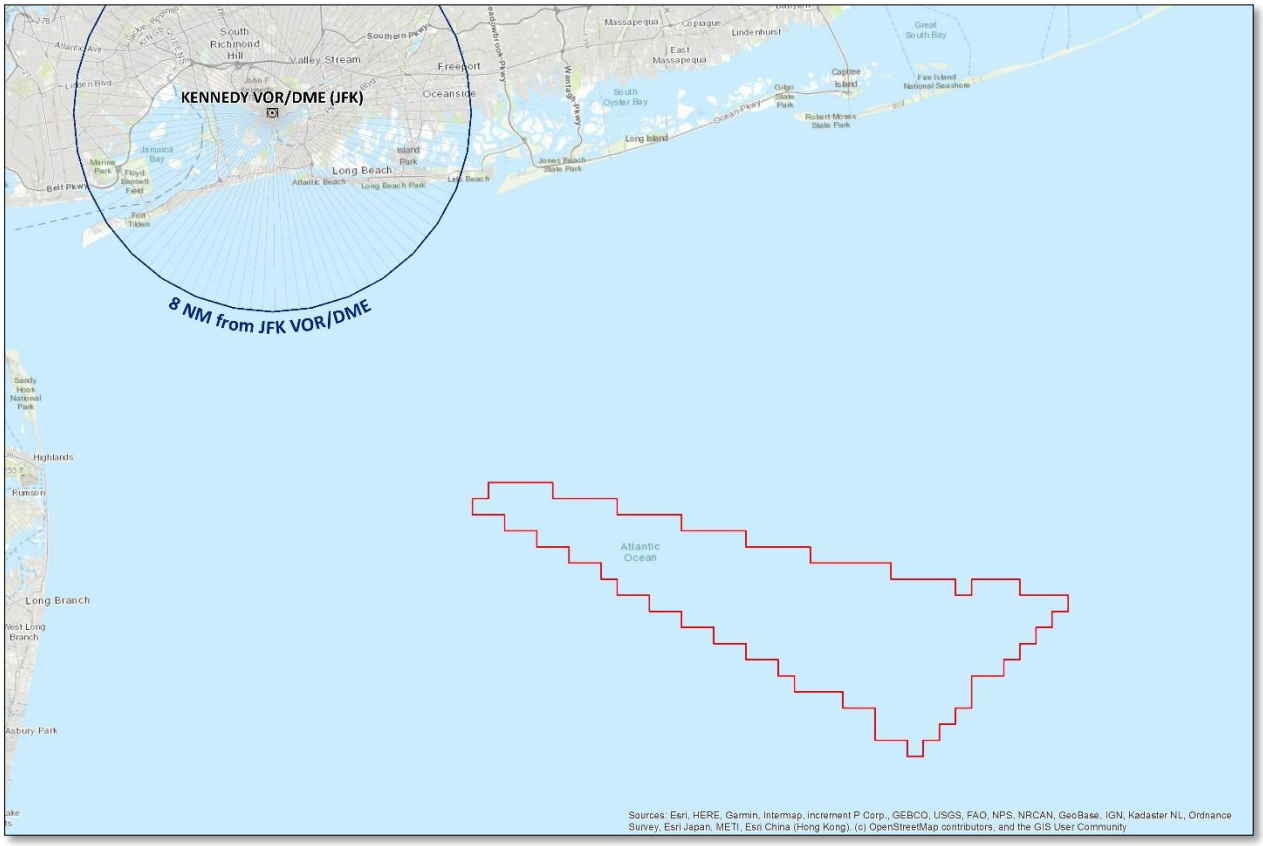


Figure 11: Kennedy VOR/DME (JFK) screening surface in proximity to the Project

Military Airspace and Training Routes

Although the FAA does not consider impact on military airspace or training routes, they will notify the military of proposed structures located within these segments of airspace. Impact on these segments of airspace can result in military objections to the proposed development. If the planned development area is located on federal land, impact on military airspace or training routes may result in the denial of permits by the Bureau of Land Management.

Military airspace overlying the Lease Area (***Figure 12***) includes the following.

U.S. Navy, Fleet Area Control and Surveillance Facility

Airspace	*Minimum Altitude*
W-106A	Surface to 3,000 ft (914.4 m) AMSL

Due to the low floor altitude associated with this segment of airspace, it is possible that wind development could have an impact on its operations. If the Navy uses this warning area regularly, it could result in military objections to proposed wind development in the eastern section of the Lease Area.

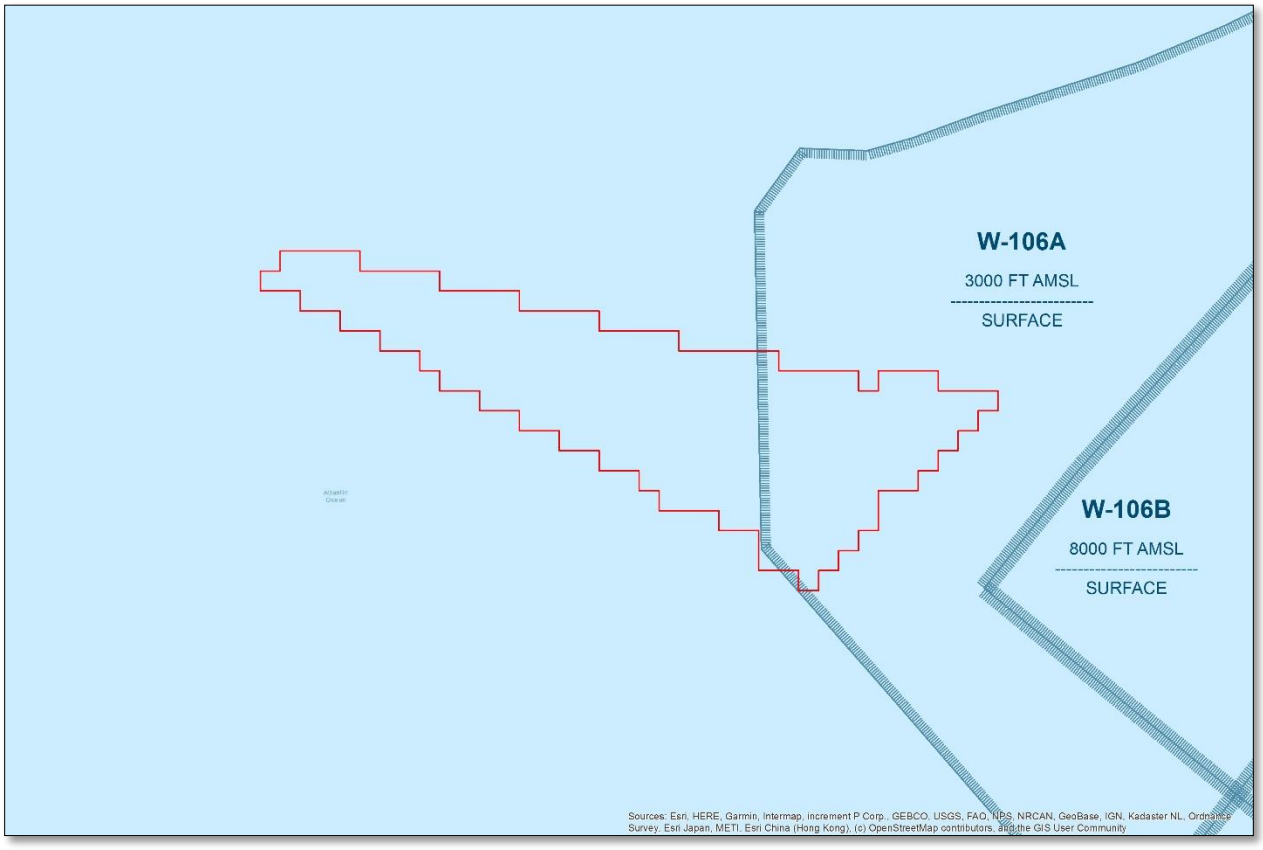


Figure 12: Military airspace overlying the Lease Area

Conclusion

At 952 ft (290 m) AGL, proposed wind turbines will exceed 77.17(a)(1) – a height of 499 ft (152 m) AGL at the site of the object – and will be identified as obstructions. However, heights in excess of 499 ft (152 m) AGL are feasible provided proposed wind turbines do not exceed FAA obstacle clearance surfaces.

The lowest obstacle clearance surfaces overlying the Lease Area range from 549 to 1,049 ft (167.3 to 319.7 m) AMSL (***Figure 13***) and are associated with New York (N90) TRACON MVA sectors (***Figure 9*** & ***Figure 10***). Proposed structures that exceed these surfaces would require an increase to minimum vectoring altitudes.

At 952 ft (290 m) AGL, wind turbines proposed in the western section of the Lease Area (red area, ***Figure 14***) would exceed MVA obstacle clearance surfaces and require an increase to minimum vectoring altitudes. If the FAA determines that this impact would affect as few as one operation per week, it could result in determinations of hazard.

Warning area W-106A overlies the eastern section of the Lease Area (***Figure 12***). Due to the low floor altitude associated with this segment of airspace, wind development could have an impact on its operations. If the Navy uses this warning area regularly, it could result in military objections to proposed wind development.

The AGL Clearance Map (***Figure 14***) is based on USGS National Elevation Dataset (NED) 1/3 Arc Second data which has a vertical accuracy of 1.89 meters root-mean-square error (RMSE). Therefore, the AGL Clearance Map should only be used for general planning purposes and not exact structure siting. In order to avoid determinations of hazard, proposed structure heights should adhere to the height constraints depicted in the Composite Map (***Figure 13***).

If you have any questions regarding the findings of this study, please contact ***Joe Anderson*** or ***Dan Underwood*** at (703) 256-2485.

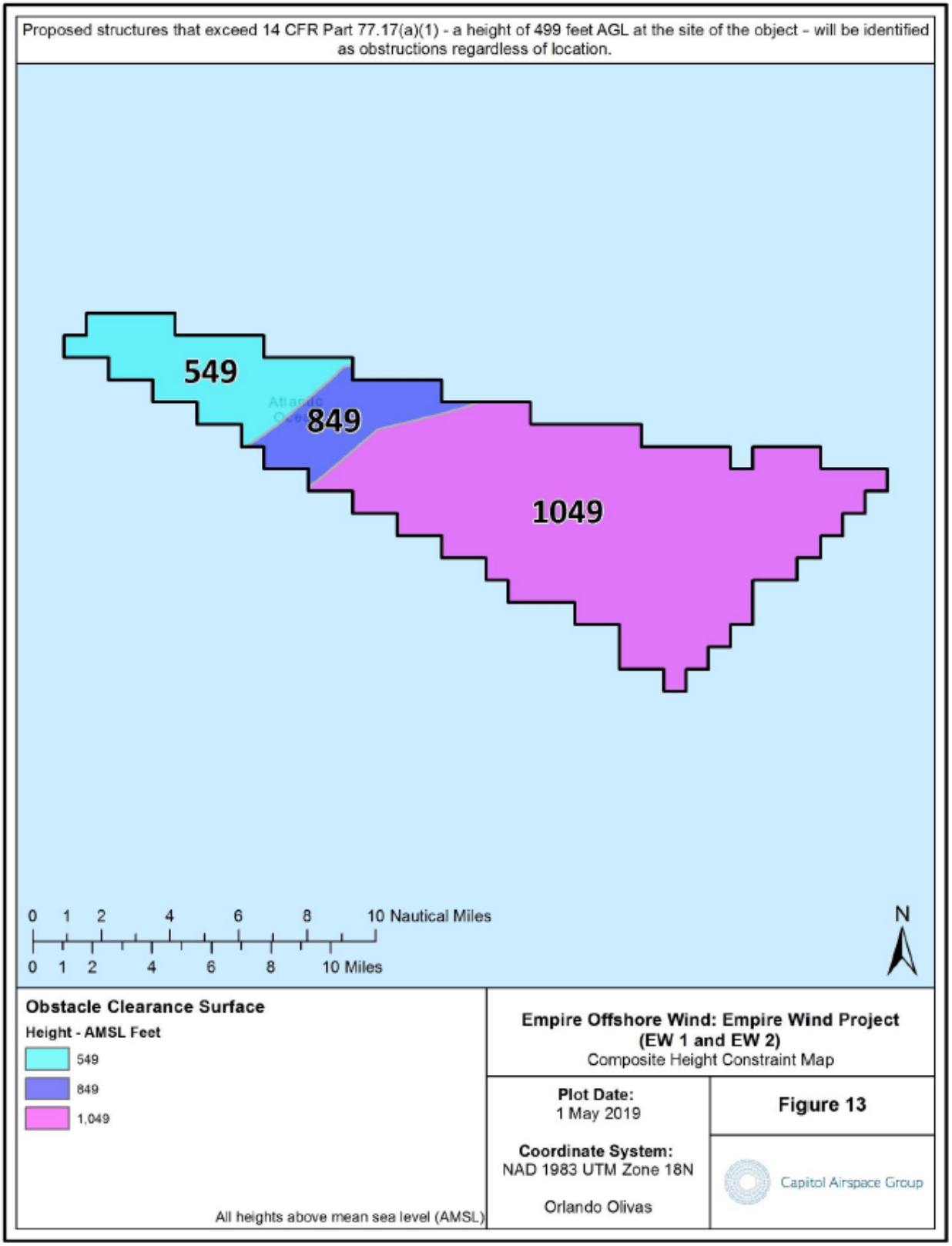


Figure 13: Composite Height Constraint Map

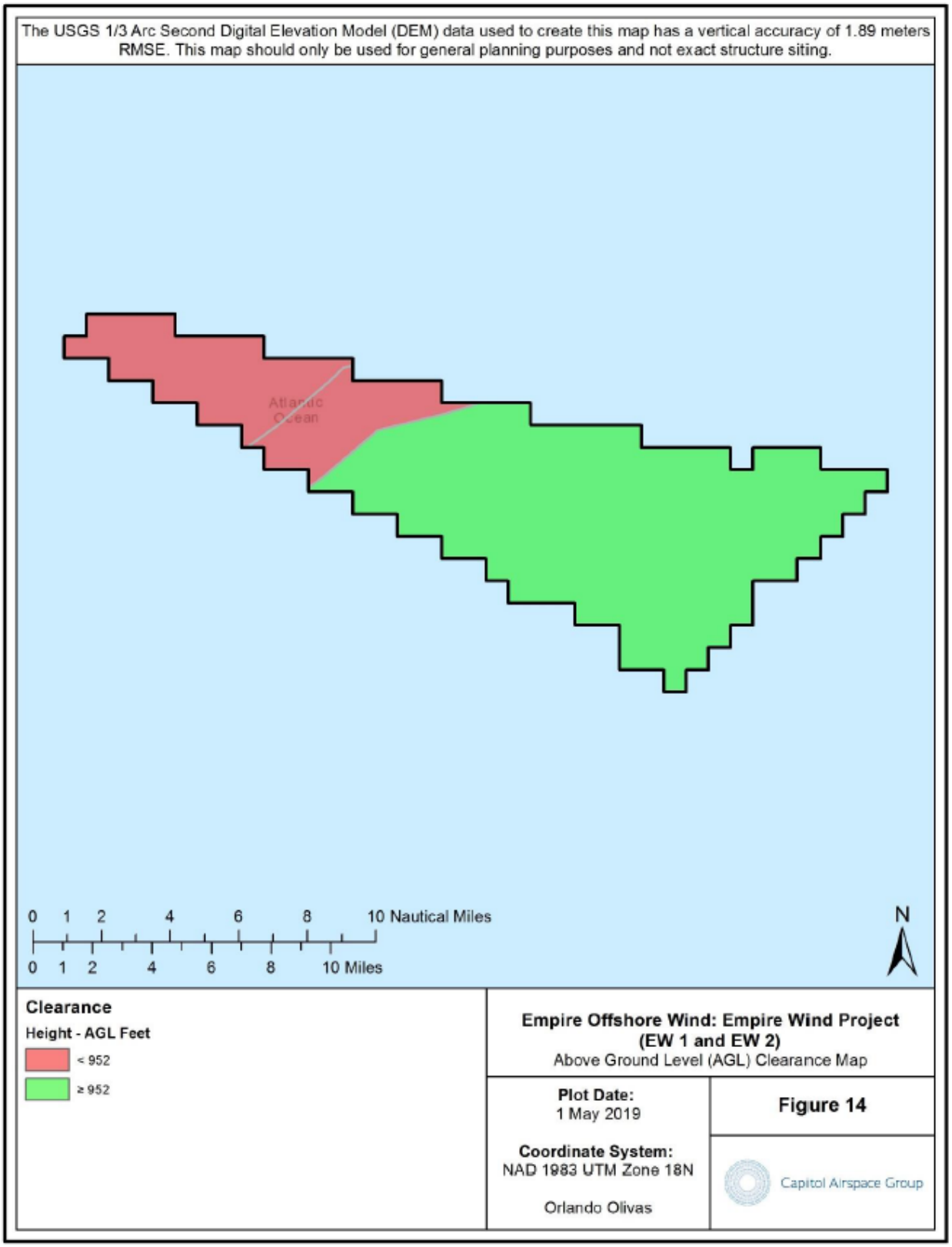


Figure 14: AGL Clearance Map