Revolution Wind Project

DWW Rev I, LLC

Offshore Rhode Island & Massachusetts

Obstruction Evaluation & Airspace Analysis

March 2020

Capitol Airspace Group

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Summary

Capitol Airspace conducted an obstruction evaluation and airspace analysis for the Revolution Wind project off the coasts of Rhode Island and Massachusetts. The purpose for this analysis was to identify obstacle clearance surfaces established by the Federal Aviation Administration (FAA) that could limit the placement of 873-foot above ground level (AGL) wind turbines. This analysis assessed height constraints overlying an approximately 151 square mile study area (red outline, ***Figure 1***) to aid in identifying optimal wind turbine locations.

The Bureau of Ocean Energy Management (BOEM) is responsible for regulating renewable energy activities on the outer continental shelf in accordance with 30 CFR Part 585. As part of the application process for leases, grants, and easements, BOEM may require the inclusion of an aeronautical study to determine the proposal's impact on airspace use and safety. If a project is determined to have an unacceptable impact on civil aviation or military activities, it could result in denial of the application.

14 CFR Part 77 applies to all structures within US territorial airspace. 14 CFR Part 77.9 requires that that all structures exceeding 200 feet 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 Revolution Wind project range from 500 to 549 feet above mean sea level (AMSL) and are associated with an instrument approach procedure and minimum vectoring altitude sectors. At 873 feet AGL, proposed wind turbines throughout the study area would exceed these surfaces and would require an increase to instrument approach procedure minimum altitudes and minimum vectoring altitudes. If the FAA determines that these impacts would affect as few as one operation per week, it could result in determinations of hazard.

Additionally, potential VFR routes overlie the Revolution Wind project. If the FAA determines that these routes are used an average of once per day, they could limit wind development in excess of 499 feet AGL and within two stature miles of the routes.

This study did not consider electromagnetic interference on FAA communication systems. Impact on surveillance radar systems will be addressed in a separate report.

Methodology

Capitol Airspace studied the proposed project based upon location information provided by Vanasse Hangen Brustlin, 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, and 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 (1.5.1)
- United States Government Flight Information Publication, US Terminal Procedures
- National Airspace System Resource Aeronautical Data
- National Oceanic and Atmospheric Administration Maritime Boundaries Data

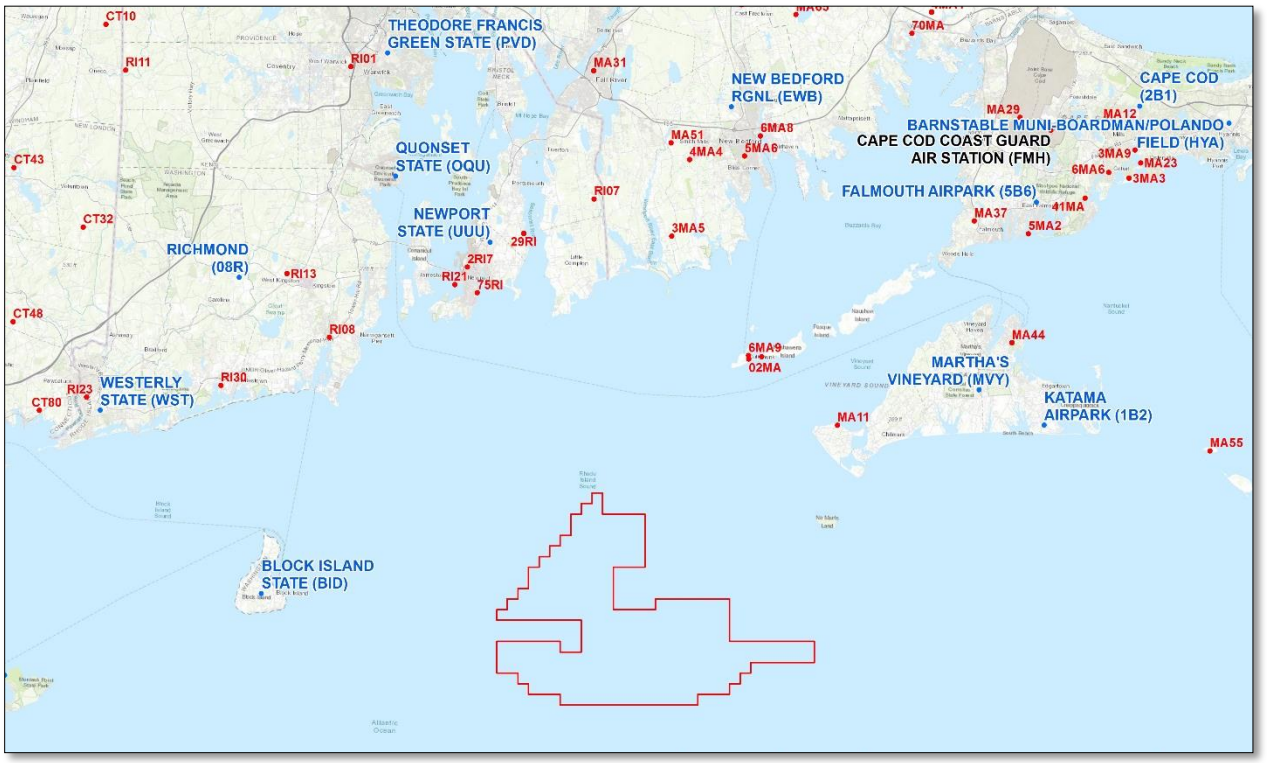


Figure 1: Public-use (blue) and private-use (red) airports in proximity to the Revolution Wind project

Study Findings

Territorial Airspace

The FAA conducts aeronautical studies for structures proposed within any state, territory, or possession of the United States, within the District of Columbia, or within territorial waters[1] surrounding the United States.[2] Although an offshore wind project may be located outside of territorial waters, BOEM may require an aeronautical study as part of the application process.

Wind turbines proposed in the northern and eastern sections of the study area will be located within territorial waters (purple, ***Figure 2***) and must be submitted to the FAA.

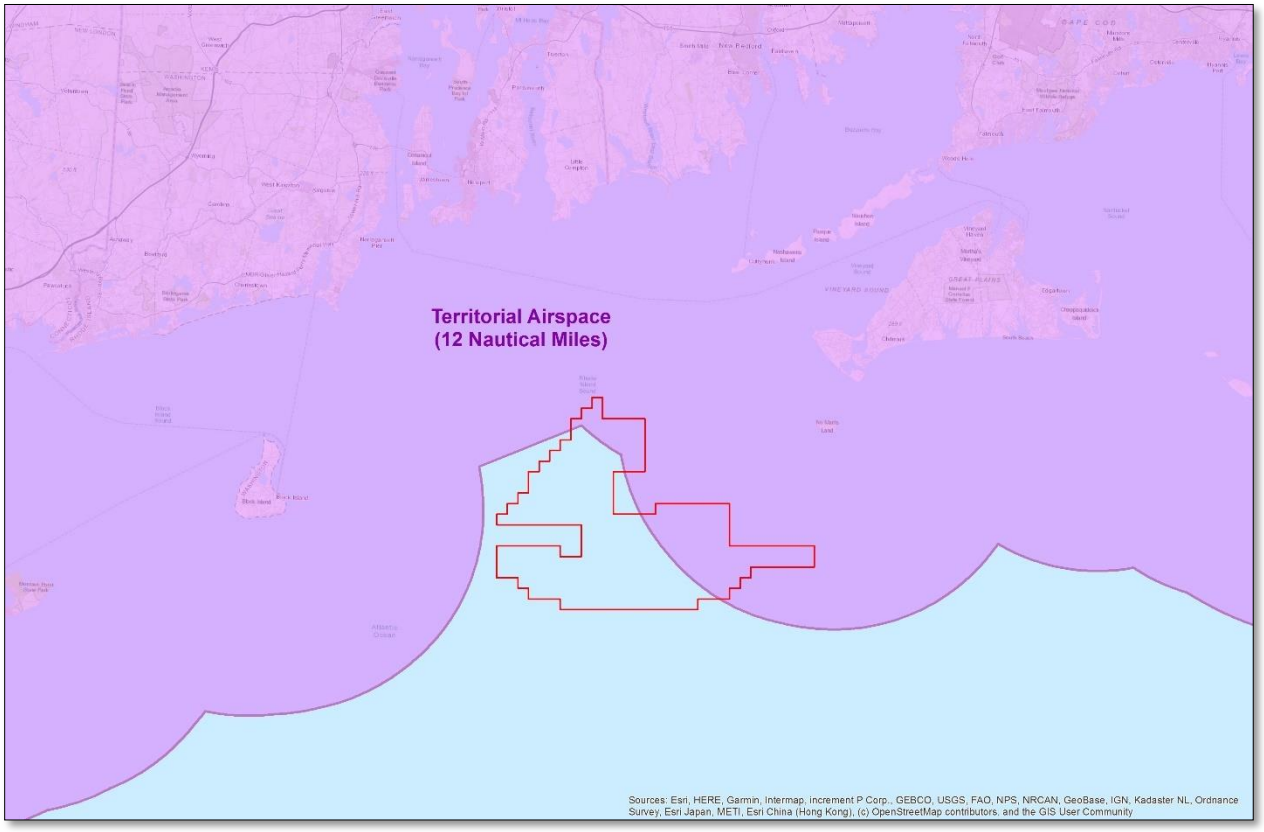


Figure 2: Territorial Airspace overlying the Revolution Wind Project

[1] The National Oceanic and Atmospheric Administration (NOAA) defines territorial waters as 12 nautical miles 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***.

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

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.

Public-use airport 14 CFR Part 77.17(a)(2) and 77.19/21/23 imaginary surfaces do not overlie the Revolution Wind project (e.g., ***Figure 3***). However, at 873 feet AGL, proposed wind turbines will exceed 77.17(a)(1) – a height of 499 feet AGL at the site of the object – and will be identified as obstructions regardless of location.

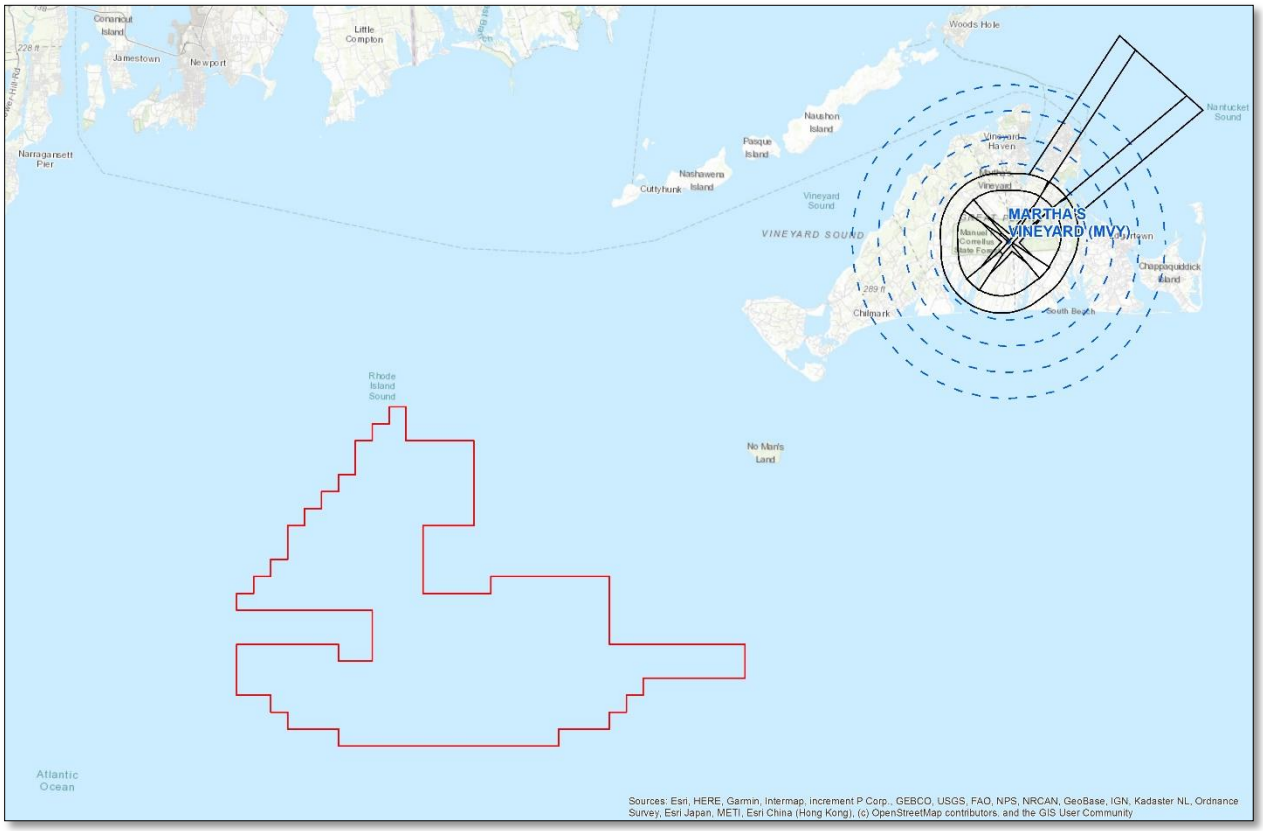


Figure 3: Martha's Vineyard (MVY) 77.17(a)(2) (dashed blue) and 77.19 imaginary surfaces (black) in proximity to the Revolution wind project

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 Revolution Wind project (e.g., ***Figure 4***). Therefore, VFR traffic pattern airspace should not limit 873-foot AGL wind turbines within the defined study area.

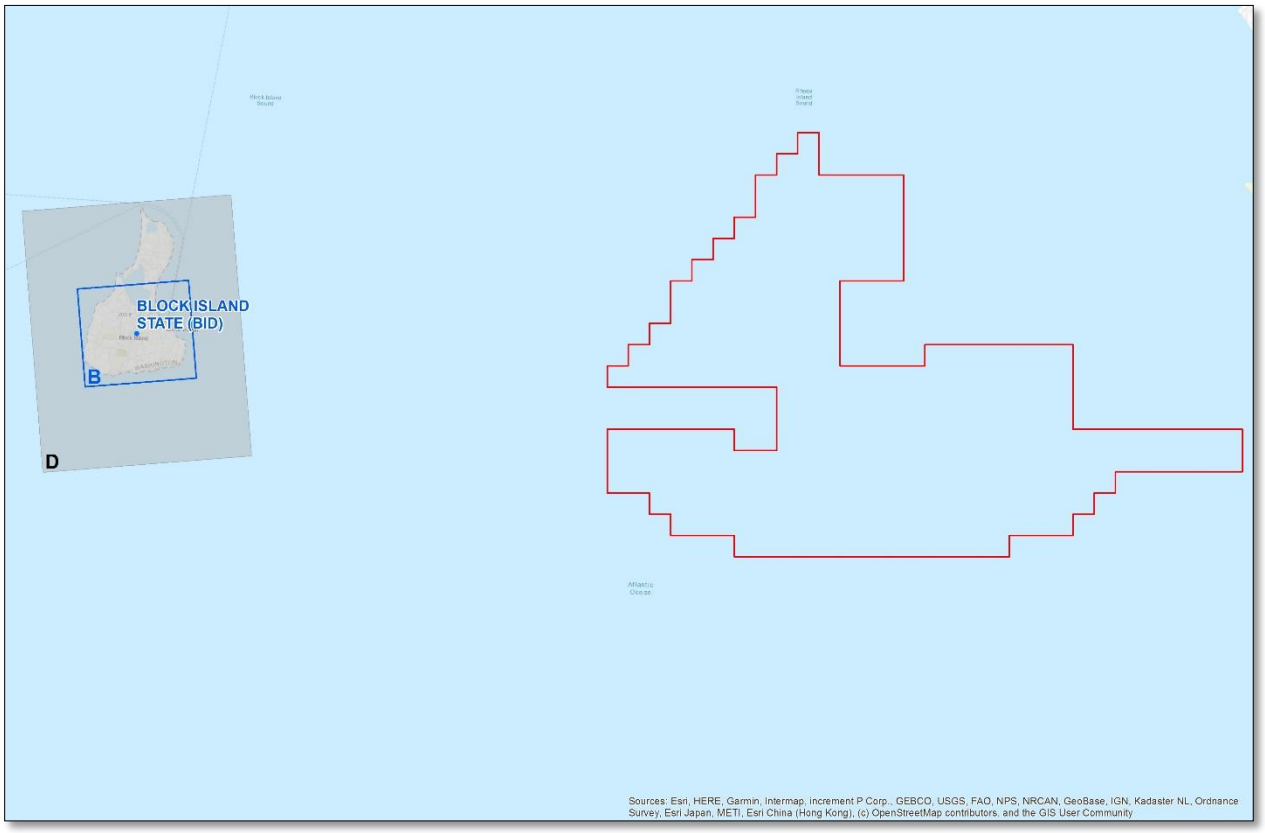


Figure 4: VFR traffic pattern airspace in proximity to the Revolution Wind project

Visual Flight Rules (VFR) Routes

During periods of marginal Visual Meteorological Conditions (VMC) – low cloud ceilings and one statute mile 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 of these routes to no greater than 14 CFR Part 77.17(a)(1) – a height of 499 feet AGL at the site of the object.

The Revolution Wind project is located in proximity to low-altitude enroute airways that may be used as VFR routes (***Figure 5***).[3] There is no database that identifies VFR routes or their utilization. However, a traffic flow analysis can be conducted to assess historical radar flight track data and identify regularly used low-level routes.[4] If the FAA determines that VFR routes are flown regularly (as few as one operation per day), they could limit wind development in excess of 499 feet AGL and within two statute miles of these landmarks (hatched orange, ***Figure 5***).

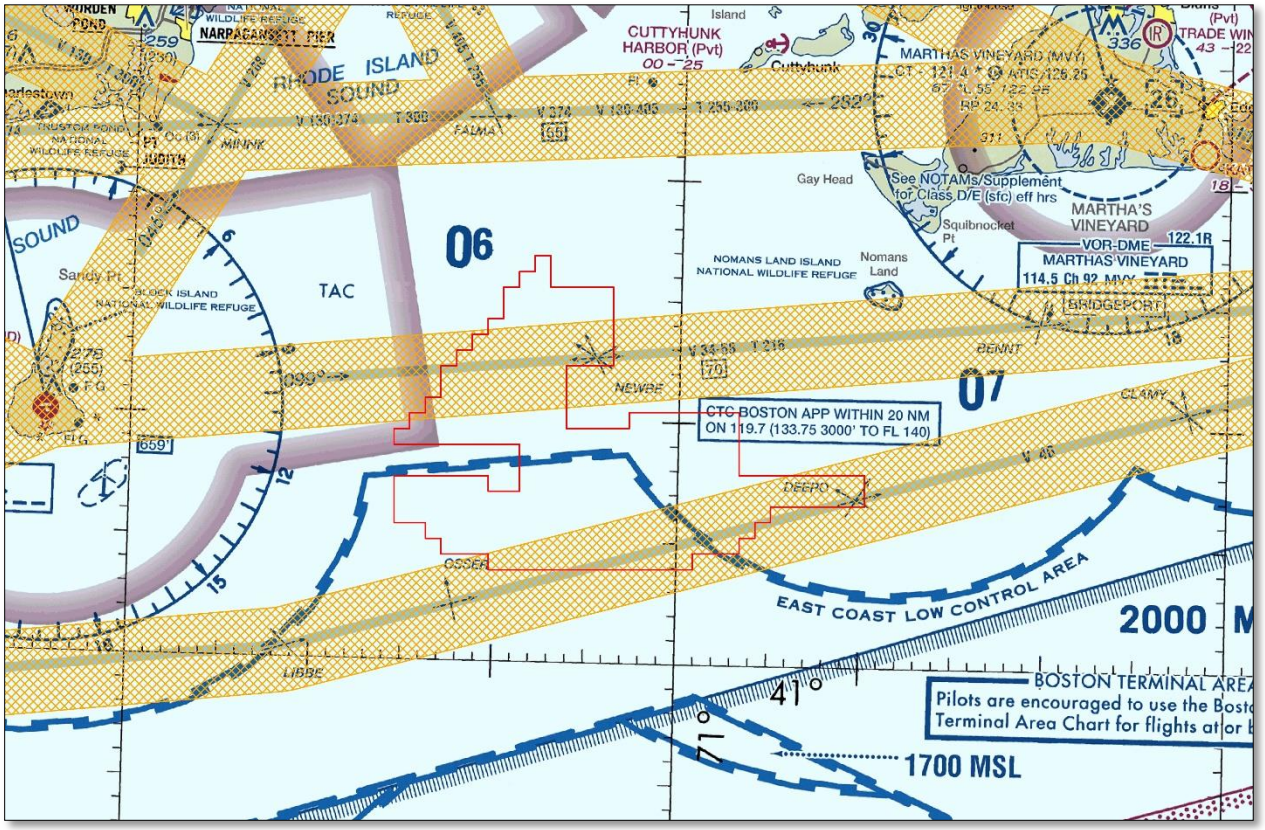


Figure 5: Potential VFR routes in proximity to the Revolution Wind project

[3] VFR traffic may use these routes at altitudes lower than the published minimum enroute altitude.

[4] Radar coverage must be adequate to detect low level VFR flights.

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 (***Figure 6***) are in excess of other lower surfaces and should not limit 873-foot AGL wind turbines within the defined study area.

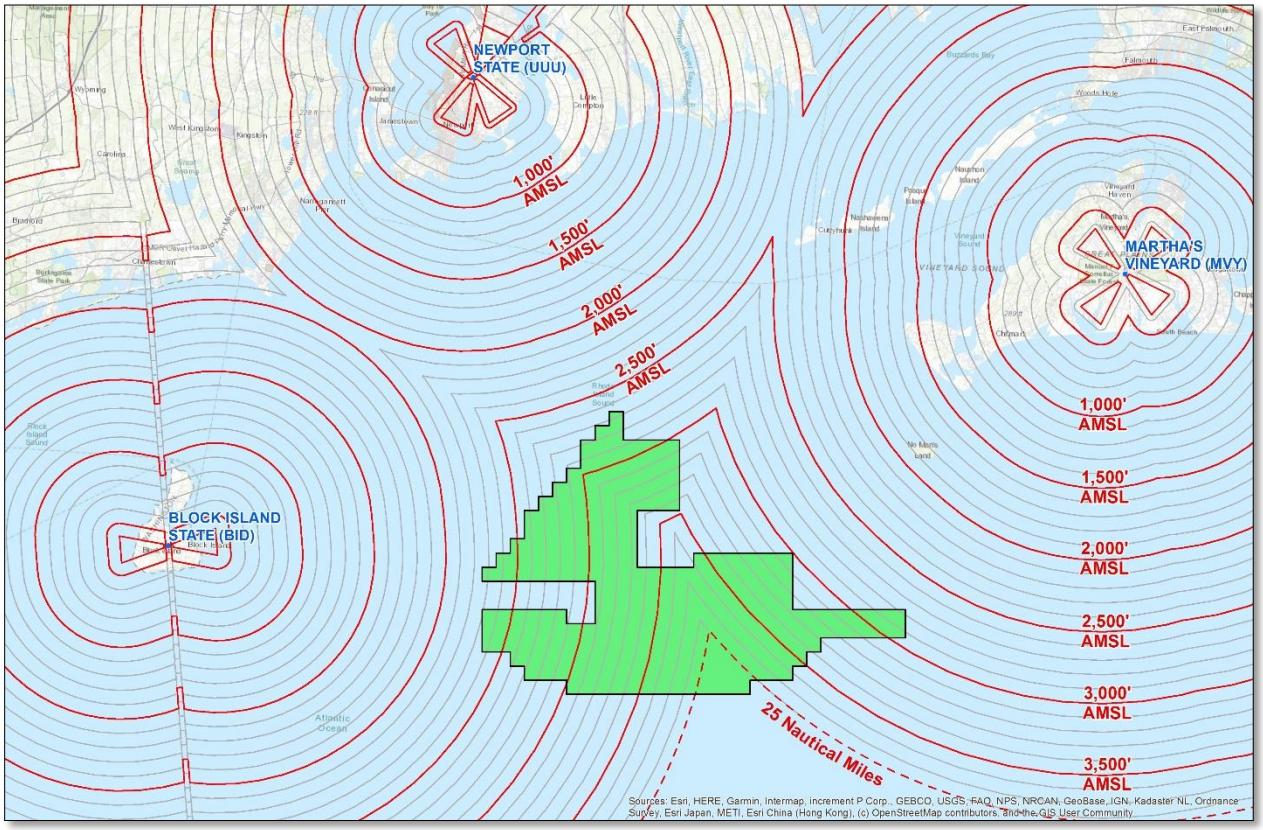


Figure 6: Block Island Airport (BID), Newport State Airport (UUU), and Martha's Vineyard Airport (MVY) obstacle departure procedure assessment

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 41 published instrument approach procedures at seven public-use airports in proximity to the Revolution Wind project[5]:

[5] Capitol Airspace assessed instrument approach procedures within 30 nautical miles (NM) of the study area. Although approach surfaces – including Terminal Arrival Areas (TAA), feeder segments, and initial segments – from airports further than 30 NM may overlie the study area, the obstacle clearance surfaces present a lower risk to projects than the surfaces identified in this report. Therefore, height constraints associated with instrument approach surfaces for airports beyond 30 NM were not considered and are not included in the Composite Map (***Figure 12***).

Block Island State (BID)
RNAV (GPS) Approach to Runway 10
RNAV (GPS) Approach to Runway 28
VOR/DME Approach to Runway 10
VOR Approach to Runway 28

Martha's Vineyard (MVY)
ILS or Localizer Approach to Runway 24
RNAV (GPS) Approach to Runway 06
RNAV (GPS) Approach to Runway 15
RNAV (GPS) Approach to Runway 24
RNAV (GPS) Approach to Runway 33
VOR Approach to Runway 06

New Bedford Regional (EWB)
ILS or Localizer Approach to Runway 05
RNAV (GPS) Approach to Runway 05
RNAV (GPS) Approach to Runway 14
RNAV (GPS) Approach to Runway 23
RNAV (GPS) Approach to Runway 32
Localizer Backcourse Approach to Runway 23

Quonset State (OQU)
ILS or Localizer Approach to Runway 16
RNAV (GPS) Approach to Runway 16
RNAV (GPS) Approach to Runway 34
VOR Approach to Runway 34
VOR- A Circling Approach

Newport State (UUU)
RNAV (GPS) Approach to Runway 16
Localizer Approach to Runway 22
VOR/DME Approach to Runway 16

Westerly State (WST)
RNAV (GPS) Approach to Runway 07
Localizer Approach to Runway 07

Theodore Francis Green State (PVD)
ILS or Localizer Approach to Runway 05
ILS or Localizer Approach to Runway 23
ILS or Localizer Approach to Runway 34
ILS Approach to Runway 23 (SA CAT I &II)
ILS Approach to Runway 05 (CAT II & III)
RNAV (RNP)-Z Approach to Runway 23
RNAV (GPS) Approach to Runway 05
RNAV (GPS) Approach to Runway 16
RNAV (GPS) Approach to Runway 34
RNAV (GPS)-Y Approach to Runway 23
VOR/DME Approach to Runway 16
VOR/DME Approach to Runway 23
VOR Approach to Runway 05
VOR-Y Approach to Runway 34
VOR-Z Approach to Runway 34

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. [6]

[6] Multiple minimum safe altitudes (MSA) overlie the Revolution Wind project. However, in accordance with FAA Order 7400.2M Paragraph 6-3-9(e)(5), MSAs are for emergency use only and cannot be used as the basis for determinations of hazard. Therefore, height constraints associated with MSAs were not considered and are not included in the Composite Map (***Figure 12***).

Block Island State (BID)

VOR Approach to Runway 28

The procedure turn completion altitude is 1,500 feet AMSL. The primary area obstacle clearance surface (red outline, ***Figure 7***) is 500 feet AMSL and is the lowest surface overlying the western section of the study area (red area, ***Figure 7***). At 873 feet AGL, wind turbines in the western section of the study area will exceed this surface and would require an increase to the procedure turn completion altitude. However, it is possible the FAA would increase the procedure turn completion altitude in order to accommodate wind development up to 873 feet AGL. This mitigation option is subject to FAA approval.

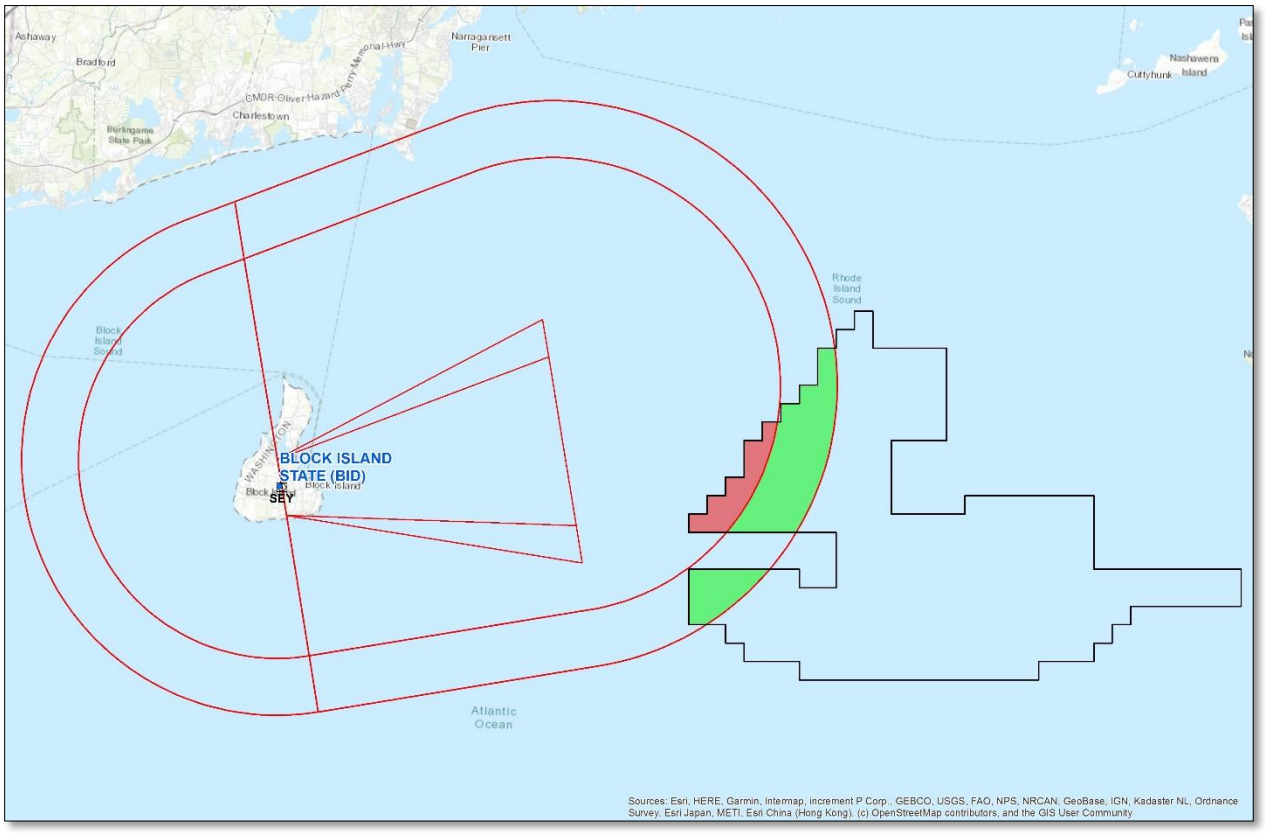


Figure 7: Block Island State (BID) VOR Approach to Runway 28 (red outline)

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 feet of obstacle clearance in non-mountainous areas and normally 2,000 feet of obstacle clearance 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.

Low altitude enroute airway obstacle clearance surfaces (e.g., ***Figure 8***) are in excess of other lower surfaces and should not limit 873-foot AGL wind turbines within the defined study area.

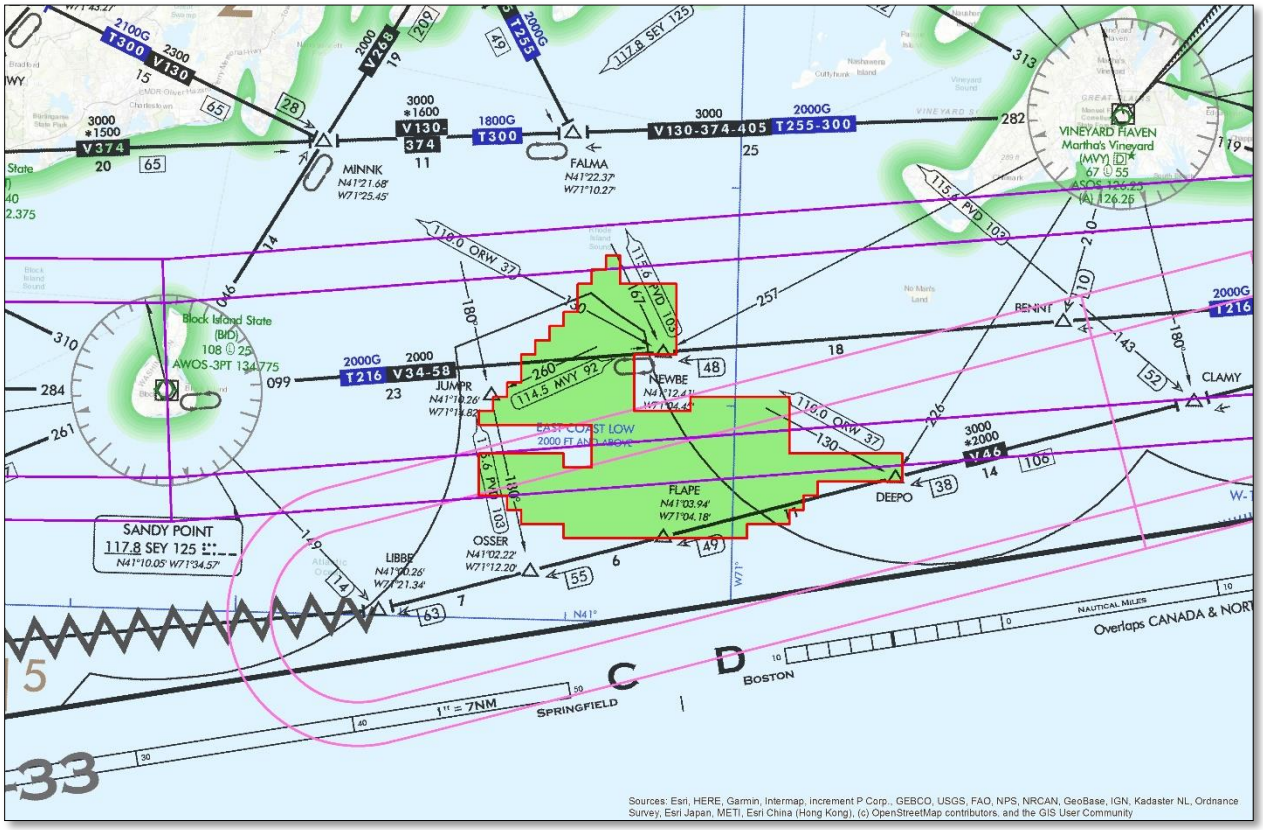


Figure 8: Low altitude enroute chart L-33 with V46 (pink) and T216-V34-V58 (purple) obstacle evaluation areas

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 feet of obstacle clearance in non-mountainous areas and normally 2,000 feet of obstacle clearance 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.

Providence (PVD) Terminal Radar Approach Control (TRACON)

Sector C (Multiple Charts)

The MVA is 1,500 feet AMSL. The obstacle clearance surface is 549 feet AMSL (hatched purple, ***Figure 9***) and is the lowest height constraint overlying the majority of the study area. At 873 feet AGL, wind turbines throughout the entire study area would exceed this surface (red area, ***Figure 9***), and would require an increase to the MVA.

Boston (A90) Consolidated TRACON

Sector II (Fusion 3) & Sector KK (Fusion 5)

The MVA is 1,500 feet AMSL. The obstacle clearance surface is 549 feet AMSL and is the lowest height constraint overlying the majority of the study area. At 873 feet AGL, wind turbines throughout the entire study area would exceed this surface (red area, ***Figure 9***), and would require an increase to the MVA.

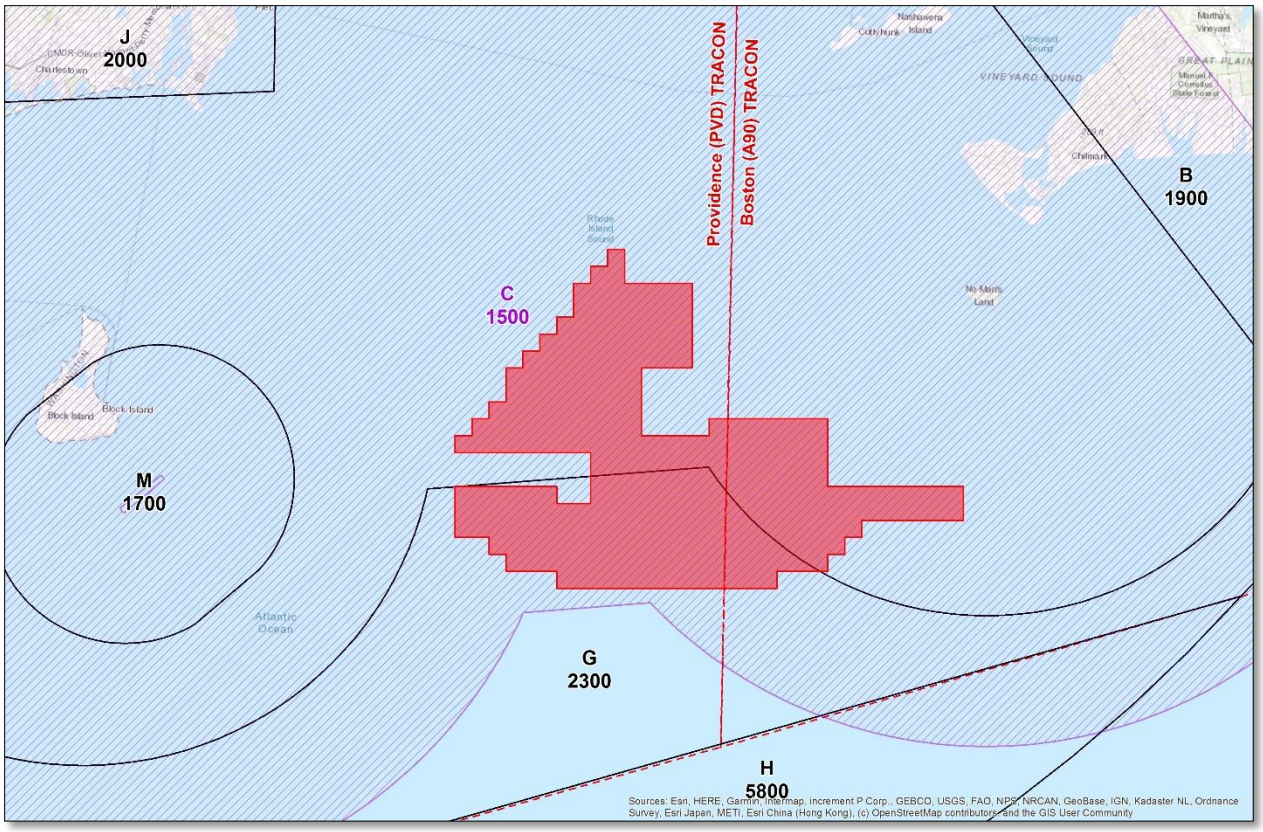


Figure 9: Providence (PVD) TRACON Fusion 5 MVA sectors (black) with Sector C obstacle evaluation area (hatched purple)

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 Revolution Wind project (e.g., ***Figure 10***). As a result, it is unlikely that proposed wind turbines would have a physical or electromagnetic effect on terminal or enroute NAVAIDs.

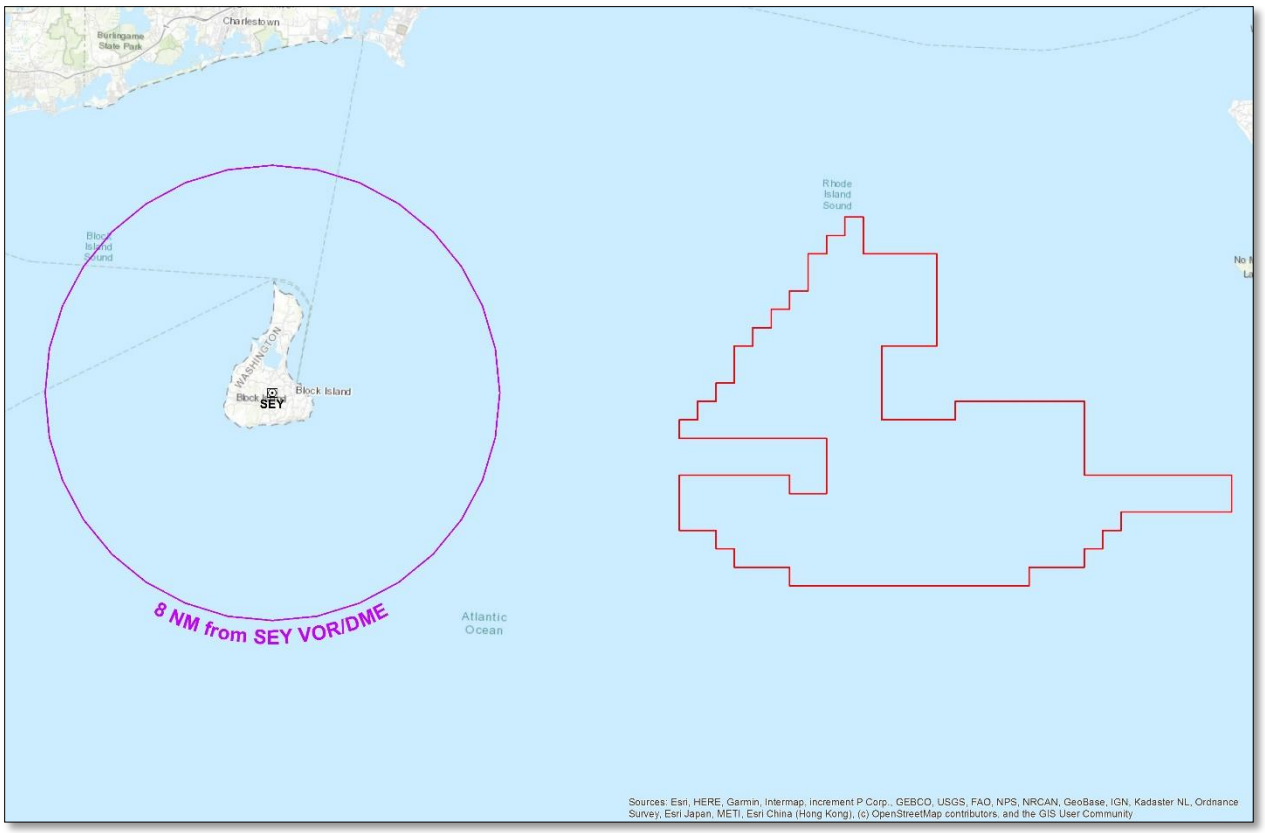


Figure 10: Sandy Point VOR/DME (SEY) screening surface and the Revolution Wind project

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 and training routes do not overlie the Revolution Wind project (e.g., ***Figure 11***). As a result, it is unlikely that the military will object to proposed wind development based on proximity to these segments of airspace.

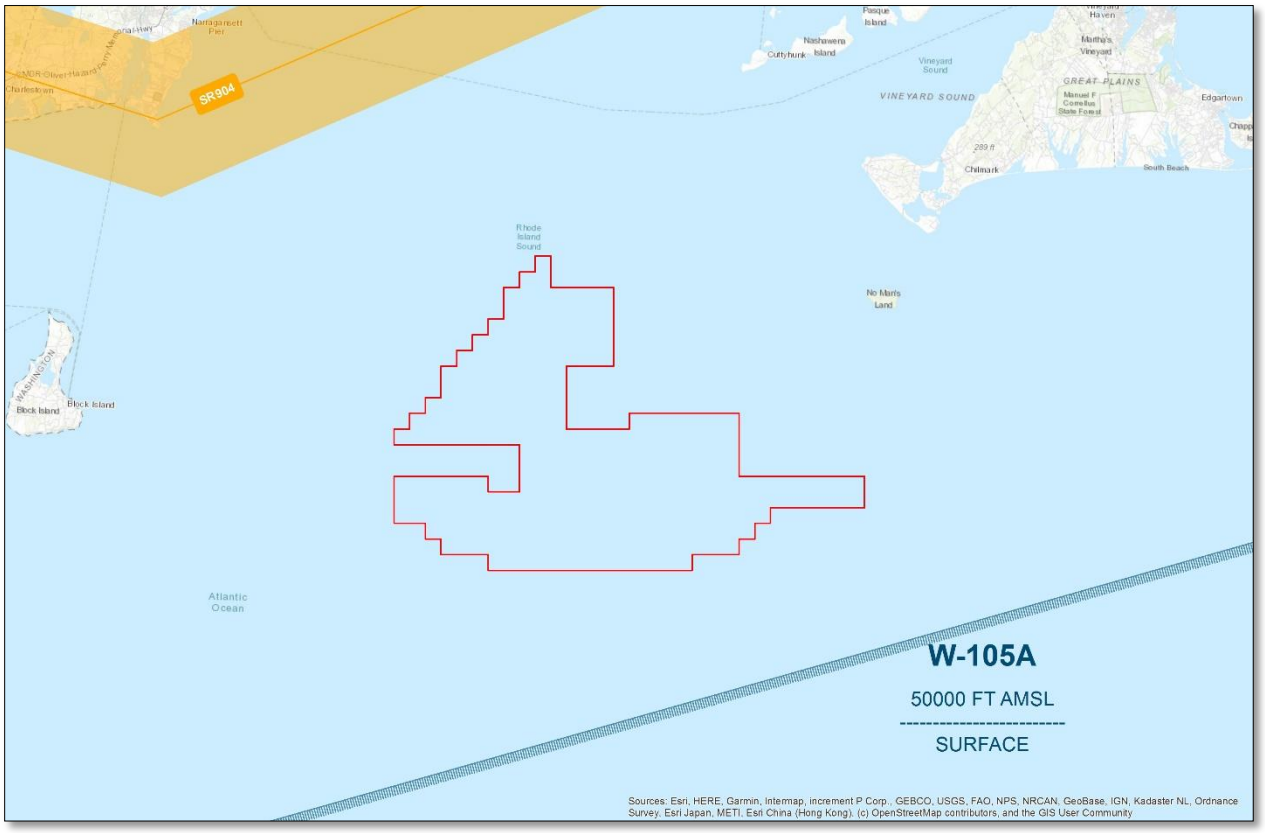


Figure 11: Military airspace and training routes in proximity to the Revolution Wind project

Conclusion

At 873 feet AGL, proposed wind turbines will exceed 14 CFR Part 77.17(a)(1) – a height of 499 feet above ground level at the site of the object – and will be identified as obstructions regardless of their location. However, heights in excess of 499 feet AGL are feasible provided proposed wind turbines do not exceed FAA obstacle clearance surfaces.

The lowest obstacle clearance surfaces overlying the Revolution Wind project range from 500 to 549 feet AMSL (***Figure 12***) and are associated with an instrument approach procedure (***Figure 7***) and multiple minimum vectoring altitude sectors (***Figure 9***). These surfaces could limit 873-foot AGL wind turbines throughout the study area (red area, ***Figure 13***).

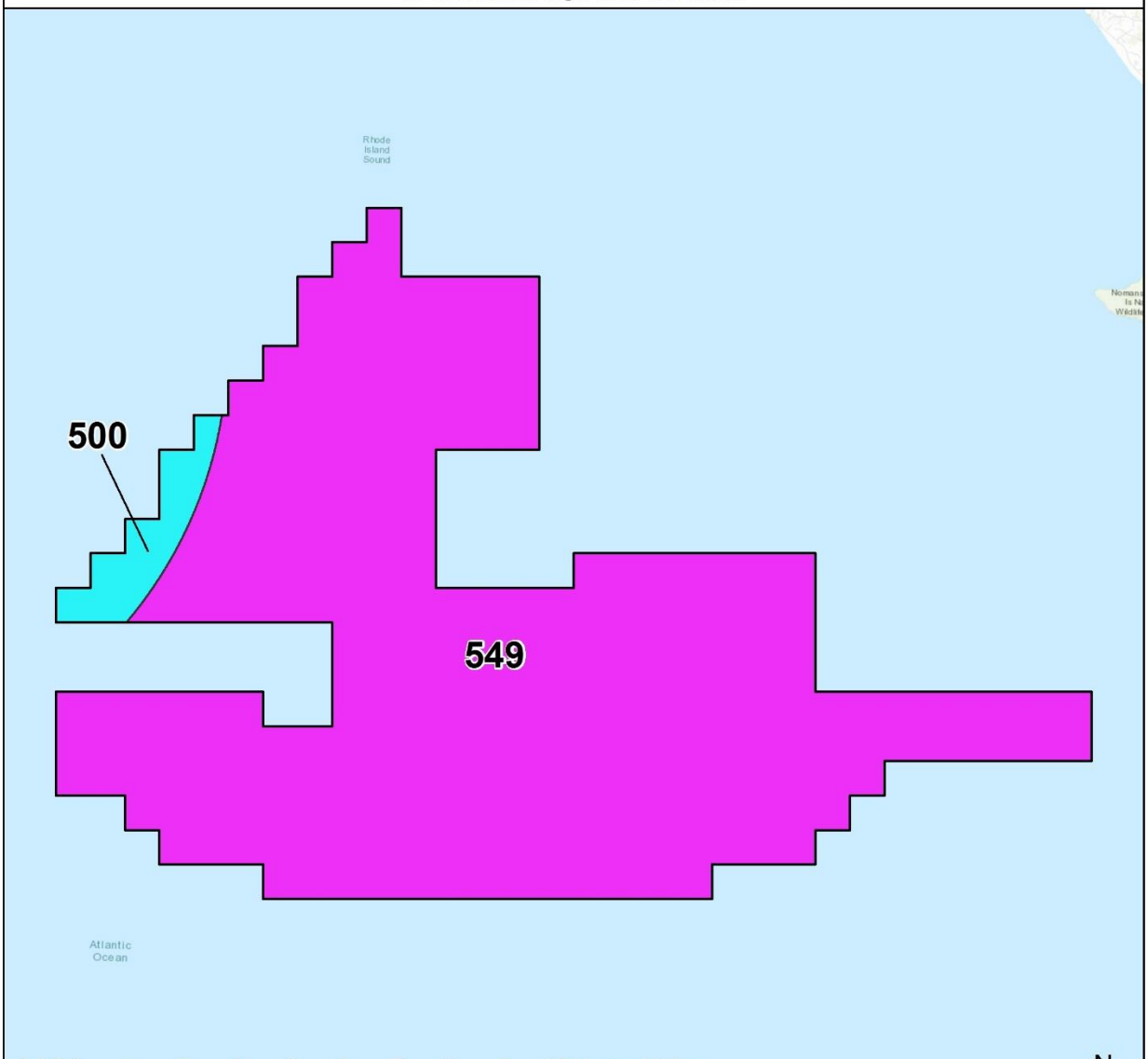
At 873 feet AGL, proposed wind turbines in the western section of the study area will exceed the Block Island State Airport (BID) VOR Approach to Runway 28 procedure turn obstacle clearance surface (red area, ***Figure 7***) and would require an increase to the procedure turn completion altitude. However, it is possible that the FAA would increase this altitude in order to accommodate 873-foot AGL wind turbines. This mitigation option is subject to FAA approval.

At 873 feet AGL, proposed wind turbines throughout the entire study area (red area, ***Figure 9***) would require an increase to Providence (PVD) TRACON and Boston (A90) Consolidated TRACON MVAs. If the FAA determines that this impact would affect as few as one operation per week, it could result in determinations of hazard.

Additionally, low altitude enroute airways T216/V34-58 and V46 overlie the Revolution Wind project. VFR traffic may use these routes at altitudes lower than the published MEA. If the FAA determines that these potential VFR routes are flown as little as an average of once per day, they could limit wind development in excess of 499 feet AGL and within two stature miles of these routes.

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

Proposed structures that exceed 14 CFR Part 77.17(a)(1) - a height of 499 feet AGL at the site of the object - will be identified as obstructions regardless of location.



Obstacle Clearance Surface

Height - AMSL Feet

High : 549

Low : 500

All heights above mean sea level (AMSL)

Revolution Wind Project
Composite Height Constraint Map

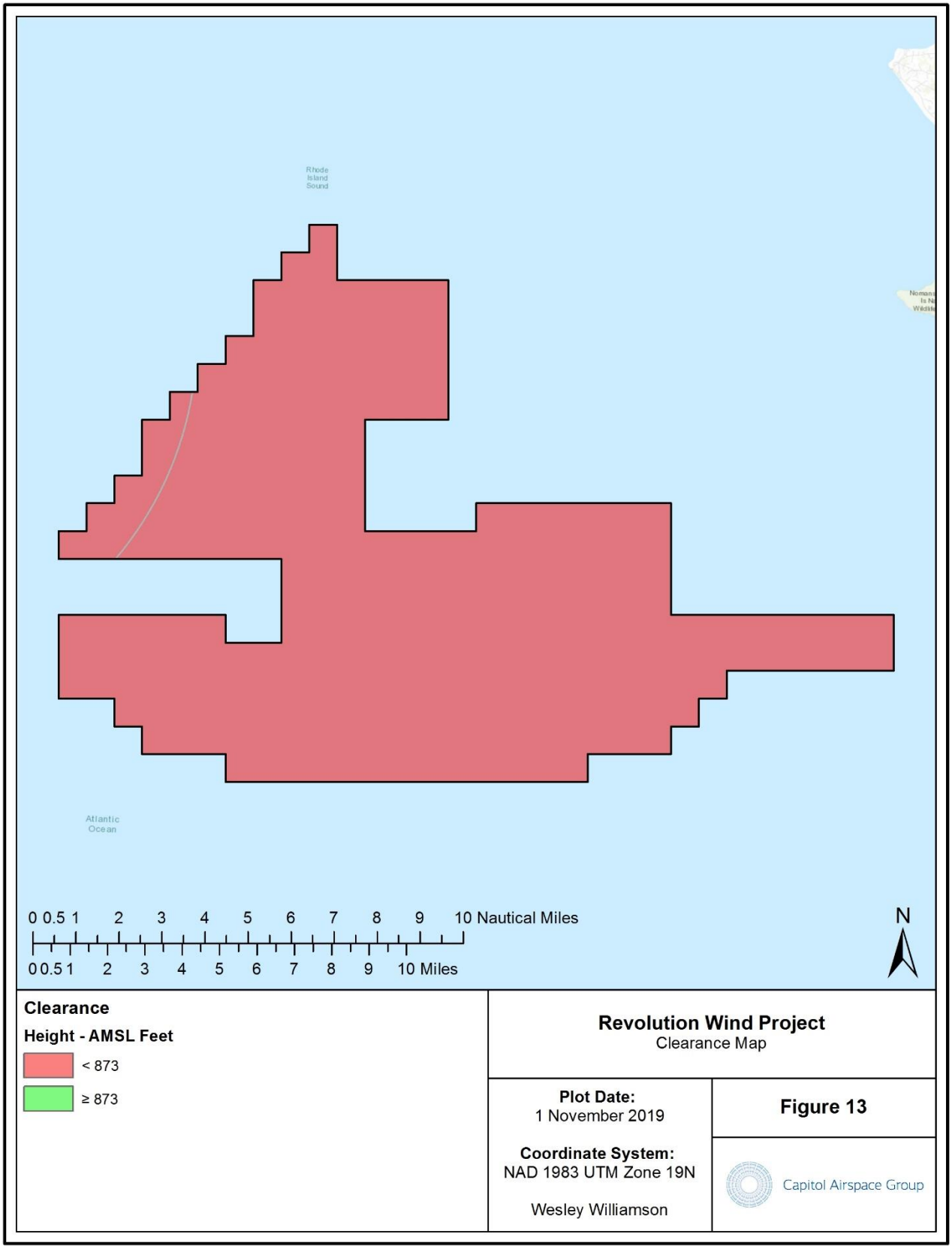
Plot Date:
25 September 2019

Figure 12

Coordinate System:
NAD 1983 UTM Zone 19N

Wesley Williamson

Capitol Airspace Group


Rhode Island Sound
Atlantic Ocean
0 0.5 1 2 3 4 5 6 7 8 9 10 Nautical Miles
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Clearance
Height - AMSL Feet
< 873
≥ 873
Revolution Wind Project
Clearance Map
Plot Date:
1 November 2019
Coordinate System:
NAD 1983 UTM Zone 19N
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Figure 13
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