REVOLUTION WIND PROJECT

RADAR AND NAVIGATIONAL AID SCREENING STUDY

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INTRODUCTION

The Revolution Wind Project consists of approximately 96,321 acres of ocean (study area) off the coasts of Massachusetts and Rhode Island.[1] This report provides the results of a radar and navigational aid screening study conducted by Westslope Consulting, LLC (Westslope) for the study area using a blade-tip height of 873 feet above ground level (AGL).

This study includes the following:

- An initial analysis using the Department of Defense (DoD) Preliminary Screening Tool (PST);
- Research into other radar sites and Very High Frequency Omnidirectional Range (VOR) navigational aid sites near the study area;
- An Air Route Surveillance Radar (ARSR) and Airport Surveillance Radar (ASR) line-of-sight (LOS) analysis;
- An Early Warning Radar (EWR) LOS analysis;
- A Terminal Doppler Weather Radar (TDWR) screening analysis;
- A VOR screening analysis;
- A Next Generation Radar (NEXRAD) weather radar screening analysis; and
- A coastal High Frequency (HF) radar LOS analysis.

ANALYSIS

DoD Preliminary Screening Tool

Westslope conducted an initial analysis for Long Range Radar (LRR) and NEXRAD using the DoD PST on the Federal Aviation Administration (FAA) Obstruction Evaluation/Airport Airspace Analysis website.[2] This analysis provides a cursory indication of whether wind turbines may be within line-of-sight of one or more radar sites, and likely to affect radar performance.

The PST LRR analysis accounts for ARSR sites and ASR sites used for air defense by the DoD at the North American Aerospace Defense Command and for homeland security by the Customs and Border Protection Air and Marine Operations Center.[3] Further, the PST NEXRAD analysis accounts for DoD, FAA, and National Oceanic and Atmospheric Administration (NOAA) Weather Surveillance Radar model-88 Doppler (WSR-88D) sites.[4] The PST does not account for all DoD, Department of Homeland Security (DHS), or FAA ground-based radar sites, including Relocatable Over-the-Horizon Radar sites, tethered aerostat radar sites, or FAA TDWR sites.

[1] OCS-A 0486.shp.
[2] See http://oeaaa.faa.gov.
[3] For LRR, the PST uses a buffered line-of-sight analysis at a blade-tip height of 750 feet AGL.
[4] For NEXRAD, the PST uses a blade-tip height of 160 meters AGL (525 feet AGL).

The PST is helpful for identifying potential impacts to LRR and NEXRAD; however, the results are preliminary, as suggested by the title of the PST, and do not provide an official decision as to whether impacts are acceptable to operations.

Please note that the PST NEXRAD analysis does not account for blade-tip heights greater than 525 feet AGL, does not account for WSR-88D sites authorized to scan at elevation angles below 0.5 degrees, and does not reflect the wind farm impact zone scheme updated in 2018 by the NOAA WSR-88D Radar Operations Center (ROC). The updated scheme expands the red area, or "No Build Zone," from three to four kilometers (km) and to areas where wind turbines penetrate the third elevation angle scanned by a WSR-88D.

Based on the study area, Westslope created a single point and a four-point polygon for PST analysis purposes.

The PST single point and polygon analysis results for LRR show that the study area falls within multiple yellow areas. A yellow area indicates that impacts are likely to air defense and homeland security radar. See Figure 1, where the black rotor represents the single point, the black line represents the polygon, and the red line represents the study area.

Westslope identified the six radar sites in the PST LRR results as the Boston Airport Surveillance Radar model-9 (ASR-9), Falmouth Airport Surveillance Radar model-8 (ASR-8), Nantucket ASR-9, North Truro Air Route Surveillance Radar model-4 (ARSR-4), Providence ASR-9, and the Riverhead ARSR-4. In addition to the DoD and DHS using these radar sites for air defense and homeland security, the FAA uses these radar sites for air traffic control at multiple facilities, including the Boston Terminal Radar Approach Control (TRACON), Nantucket Air Traffic Control Tower, Boston Air Route Traffic Control Center (ARTCC), Providence TRACON, and the New York ARTCC.

For NEXRAD, the PST analysis results for the single point and the polygon show that the study area falls within a green area. A green area, or "No Impact Zone," indicates that impacts are not likely to WSR-88D operations. Please note that blue and grey areas also represent green areas in the PST NEXRAD analysis results. See Figure 2. Westslope identified the two radar sites in the PST NEXRAD analysis as the Boston WSR-88D and the Brookhaven WSR-88D.

Research conducted by Westslope shows that the lowest elevation angle scanned by the Boston WSR-88D and the Brookhaven WSR-88D is 0.5 degrees.

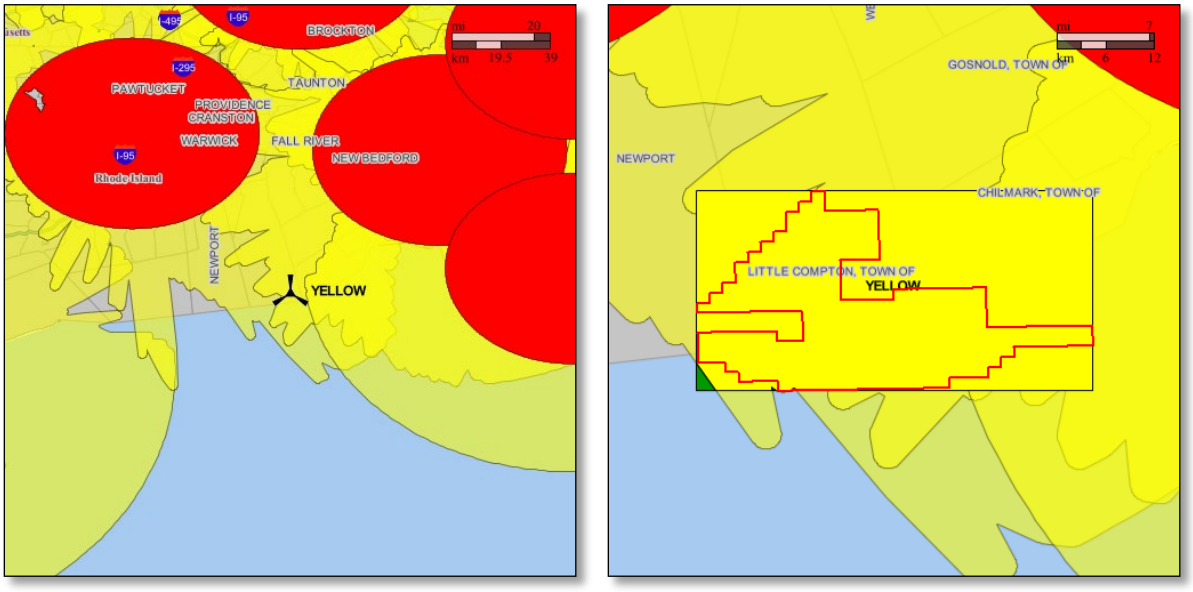

Figure 1 Long Range Radar Results for the Single Point (left) and for the Polygon (right)

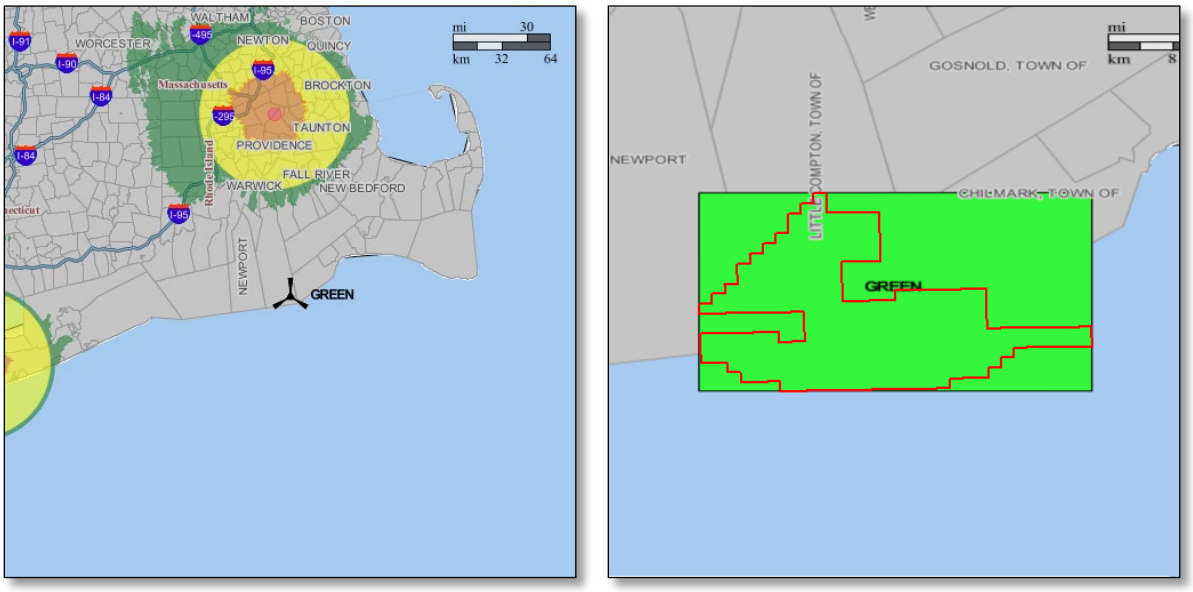

Figure 2 NEXRAD Results for the Single Point (left) and for the Polygon (right)

Other ARSR and ASR Sites

Research conducted by Westslope identified no additional ARSR or ASR sites near the study area.

Co-Located Secondary Surveillance Radar

Research conducted by Westslope identified the following secondary surveillance radar systems co-located with the ARSR and ASR systems:

- An Air Traffic Control Beacon Interrogator model-5 is co-located with the Falmouth ASR-8;
- An Air Traffic Control Beacon Interrogator model-6 is co-located with the North Truro ARSR-4 and the Riverhead ARSR-4; and
- A Mode S is co-located with the Boston ASR-9, Nantucket ASR-9, and the Providence ASR-9.

In general, secondary surveillance radar systems are less susceptible to interference from wind turbines than primary surveillance radar systems, such as the ARSR and ASR systems.

EWR Sites

Research conducted by Westslope identified one EWR site near the study area: the Cape Cod Air Force Station (AFS) EWR.

The DoD uses the Cape Cod AFS EWR for ballistic missile defense and space surveillance.

TDWR Sites

Research conducted by Westslope identified one TDWR site near the study area: the Boston TDWR.

The FAA uses this radar site for air traffic control at the Boston TRACON.

VOR Sites

Research conducted by Westslope identified the following three navigational aid sites near the study area:

- Martha's Vineyard VOR and co-located Distance Measuring Equipment (VOR/DME);
- Providence VOR/DME; and
- Sandy Point VOR/DME.

Correspondence with the FAA indicates that the Martha's Vineyard VOR/DME is a conventional VOR, and the Providence VOR/DME and the Sandy Point VOR/DME are Doppler VORs. In general, conventional VORs are more susceptible than Doppler VORs to interference from wind turbines.

HF Radar Sites

Research conducted by Westslope identified the following 13 HF radar sites near the study area:

- Amagansett HF radar;
- Block Island Long Range HF radar;
- Block Island Standard Range HF radar;
- Camp Varnum HF radar;
- Horseneck Beach State Reservation HF radar;
- Long Point Wildlife Refuge HF radar;
- Martha's Vineyard HF radar;
- Moriches HF radar;
- Martha's Vineyard Coastal Observatory (MVCO) Meteorological Mast HF radar;
- Nantucket HF radar;
- Nantucket Island HF radar;
- Nauset HF radar; and
- Squibnocket Farms HF radar.

The Amagansett HF radar, Block Island Long Range HF radar, Martha's Vineyard HF radar, Moriches HF radar, and the Nantucket Island HF radar are operated by Rutgers University. The Block Island Standard Range HF radar is operated by the University of Rhode Island. The Camp Varnum HF radar, Horseneck Beach State Reservation HF radar, Long Point Wildlife Refuge HF radar, MVCO Meteorological Mast HF radar, Nantucket HF radar, and the Squibnocket Farms HF radar are operated by the Woods Hole Oceanographic Institution. The Nauset HF radar is operated by the University of Massachusetts Dartmouth.

Various federal agencies in partnership with NOAA's Integrated Ocean Observing System (IOOS) use the ocean surface current and wave data provided by these HF radar sites in support of multiple missions.

ARSR and ASR LOS Analysis

Westslope conducted an ARSR and ASR LOS analysis using the United States Geological Survey (USGS) 10-meter National Elevation Dataset (NED). This analysis shows whether wind turbines at a blade-tip height of 873 feet AGL will be within line-of-sight of one or more ARSR and ASR sites.

Westslope conducted the LOS analysis for the following six ARSR and ASR sites:

- Boston ASR-9;
- Falmouth ASR-8;
- Nantucket ASR-9;
- North Truro ARSR-4;
- Providence ASR-9; and
- Riverhead ARSR-4.

The study area is beyond the instrumented range of the Boston ASR-9. As such, no additional analysis was considered necessary for this radar site.

Falmouth ASR-8

The LOS analysis results show that wind turbines in the northeastern two-thirds of the study area will be within line-of-sight of and will interfere with the Falmouth ASR-8 at a blade-tip height of 873 feet AGL. See Figure 3. The radar effects will include unwanted radar returns (clutter) resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of wind turbines within line-of-sight in the study area. Other possible radar effects include a partial loss of weather detection and false weather indications over and in the immediate vicinity of wind turbines within line-of-sight in the study area.

Nantucket ASR-9

The LOS analysis results show that wind turbines in the eastern one-half of the study area will be within line-of-sight of and will interfere with the Nantucket ASR-9 at a blade-tip height of 873 feet AGL. See Figure 4. The radar effects will include clutter resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of wind turbines within line-of-sight in the study area. Other radar effects include a partial loss of weather detection and false weather indications over and in the immediate vicinity of wind turbines within line-of-sight in the study area.

North Truro ARSR-4

The LOS analysis results show that wind turbines in the study area will not be within line-of-sight of and will not interfere with the North Truro ARSR-4 at a blade-tip height of 873 feet AGL. As a result, Westslope does not expect any radar effects at or below this blade-tip height.

Providence ASR-9

The LOS analysis results show that wind turbines in the entire study area will be within line-of-sight of and will interfere with the Providence ASR-9 at a blade-tip height of 873 feet AGL. See Figure 5. The radar effects will include clutter resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of wind turbines in the study area. Other radar effects include a partial loss of weather detection and false weather indications over and in the immediate vicinity of wind turbines in the study area.

Riverhead ARSR-4

The LOS analysis results show that wind turbines in the study area will not be within line-of-sight of and will not interfere with the Riverhead ARSR-4 at a blade-tip height of 873 feet AGL. As a result, Westslope does not expect any radar effects at or below this blade-tip height.

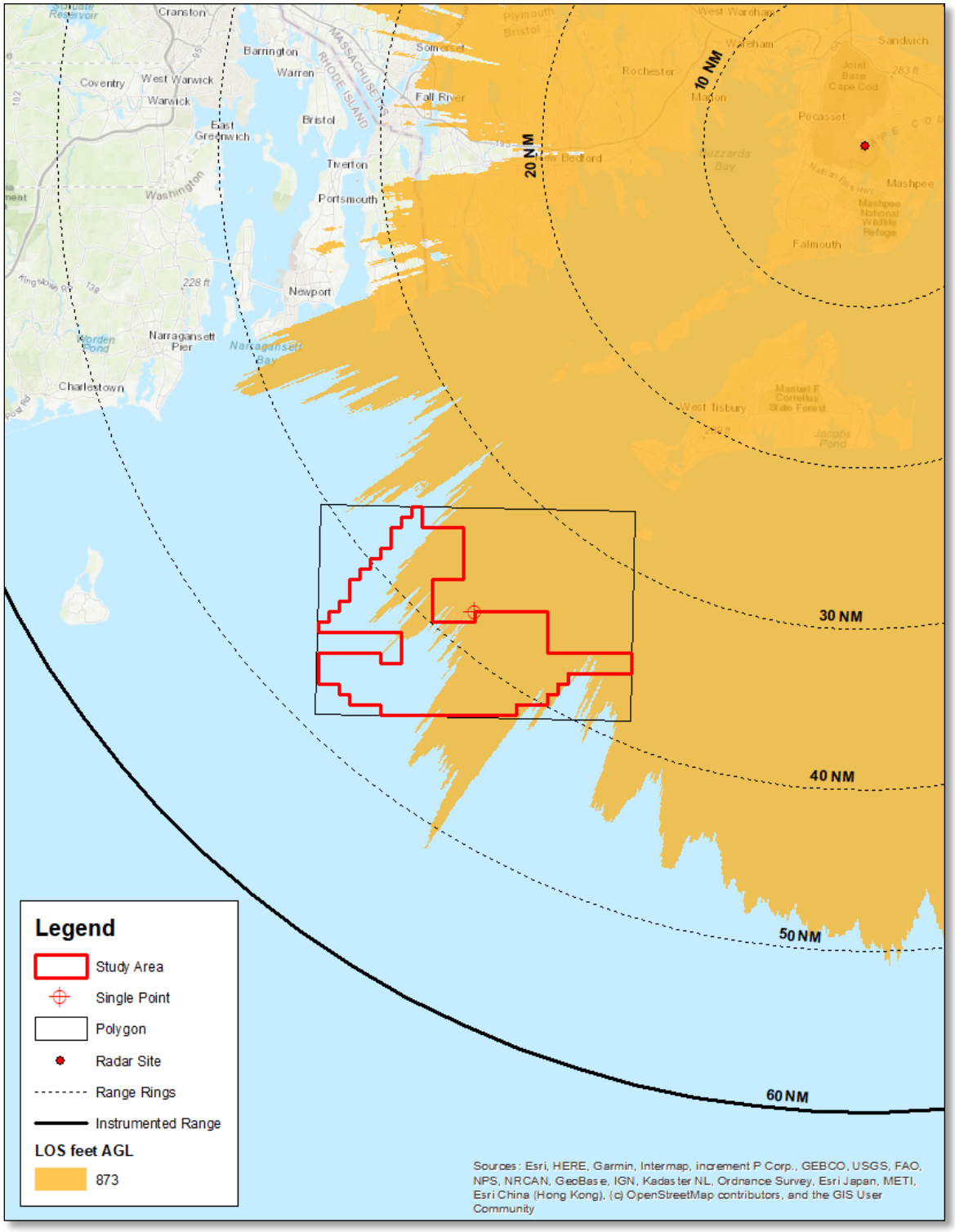

Figure 3 LOS Analysis Results for the Falmouth ASR-8 using 10-meter NED

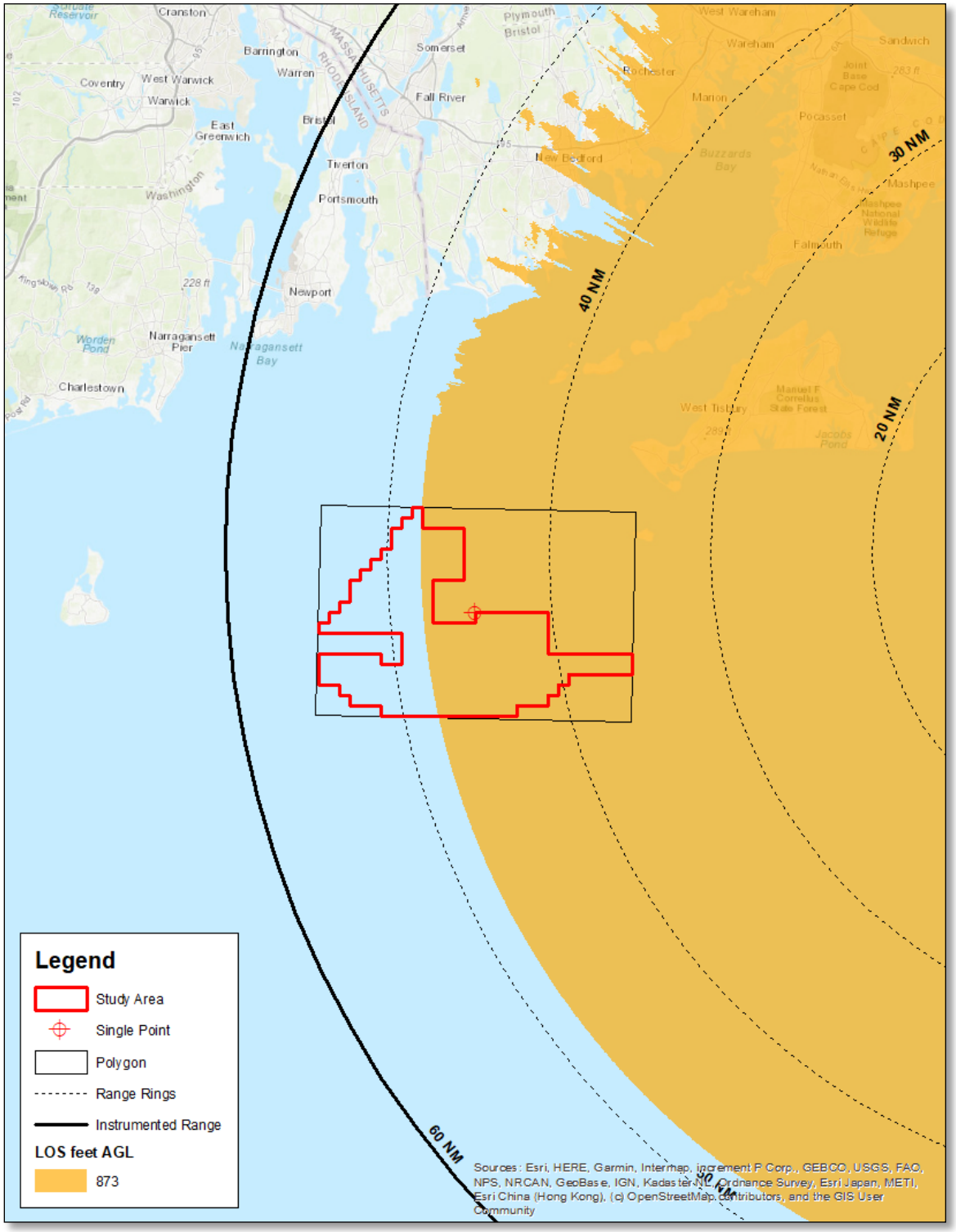

Figure 4 LOS Analysis Results for the Nantucket ASR-9 using 10-meter NED

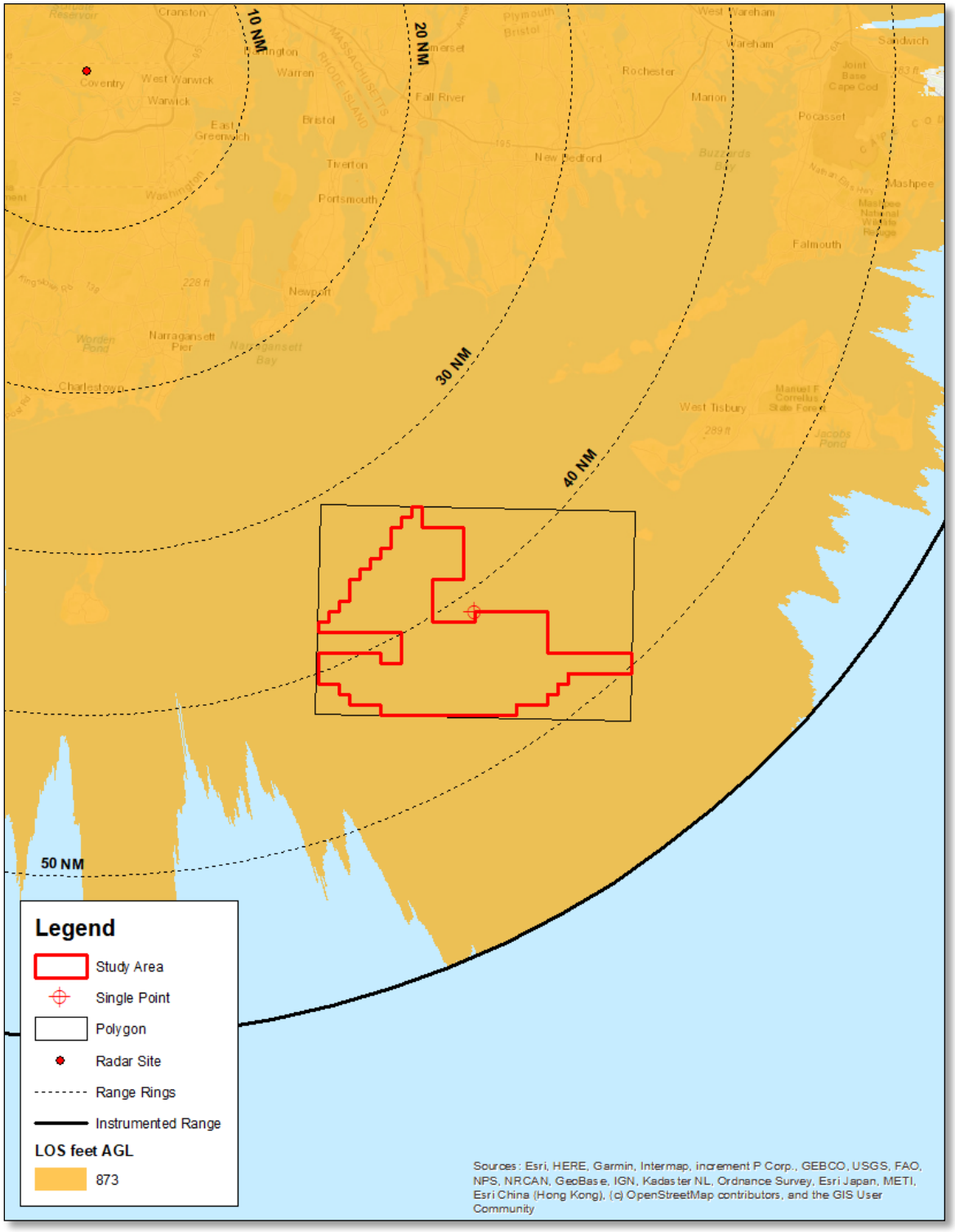

Figure 5 LOS Analysis Results for the Providence ASR-9 using 10-meter NED

EWR LOS Analysis

Westslope conducted an EWR LOS analysis for the Cape Cod AFS EWR using USGS 10-meter NED. This analysis shows whether wind turbines at a blade-tip height of 873 feet AGL will be within line-of-sight of this EWR site.

Cape Cod AFS EWR

The LOS analysis results show that wind turbines in the majority of the study area will be within line-of-sight of the Cape Cod AFS EWR at a blade-tip height of 873 feet AGL. See Figure 6.

Research conducted by Westslope suggests that wind turbines in the study area within line-of-sight of the Cape Cod AFS EWR could have a significant impact on this early warning radar. [1] As such, Westslope recommends early consultation with the DoD Siting Clearinghouse.

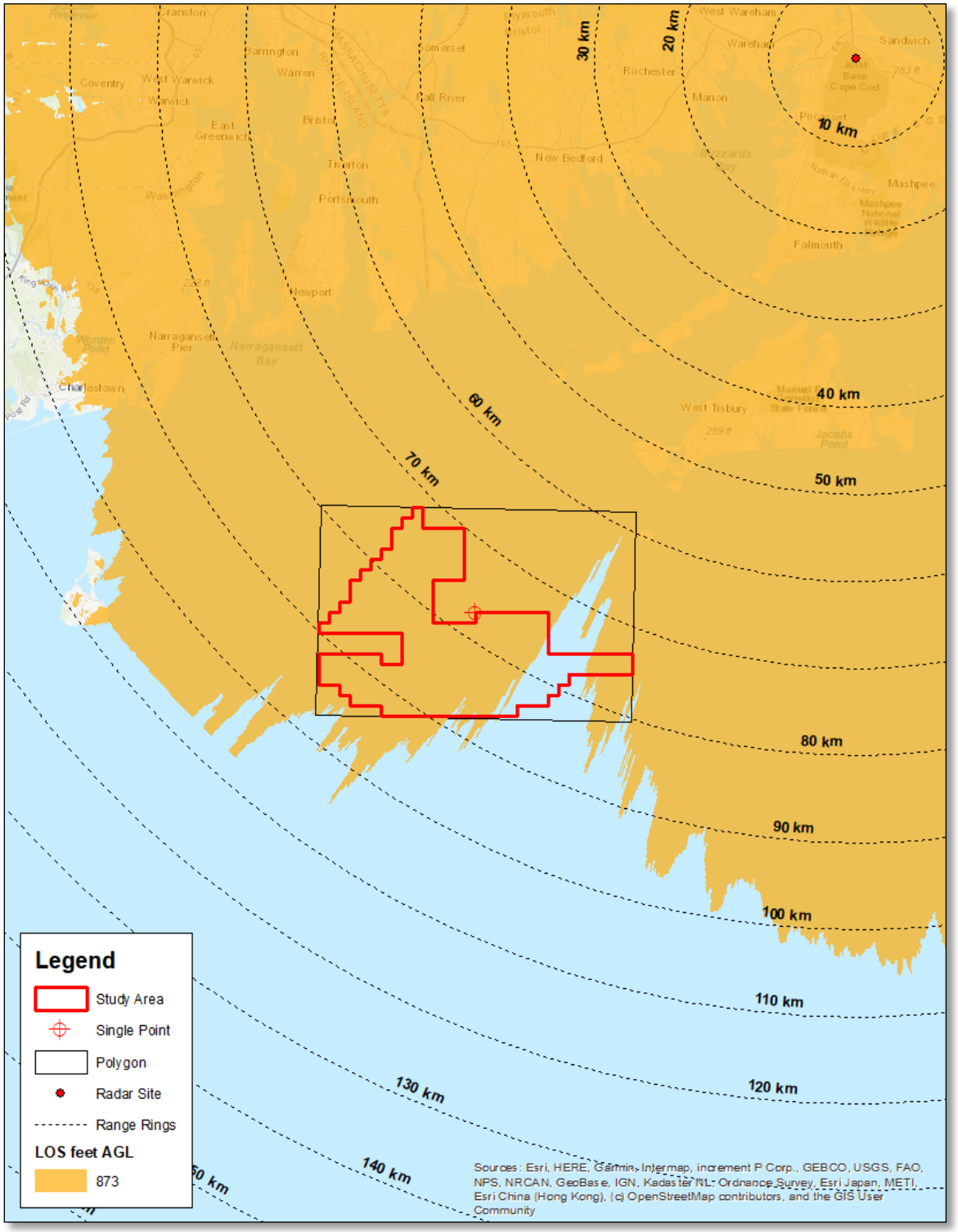

Figure 6 LOS Analysis Results for the Cape Cod AFS EWR using 10-meter NED

TDWR Screening Analysis

Westslope conducted a TDWR screening analysis for the Boston TDWR using USGS 10-meter NED. This analysis shows whether wind turbines at a blade-tip height of 873 feet AGL will be within line-of-sight of this TDWR site and determines the number of elevation angles penetrated and potentially affected.

The study area is beyond the instrumented range of the Boston TDWR. As such, no additional analysis was considered necessary for this radar site.

VOR Screening Analysis

Westslope conducted a VOR screening analysis using USGS 10-meter NED. This analysis shows whether wind turbines in the study area (1) are less than or equal to 8 nautical miles (NM) from a VOR site; (2) will subtend elevation angles greater than 0.60 degrees from the base elevation of a conventional VOR at a blade-tip height of 873 feet AGL, or 0.75 degrees for a Doppler VOR; and (3) will fall within line-of-sight of a VOR site. This screening analysis provides a cursory indication of whether wind turbines in the study area may affect VOR performance and is similar to the FAA's analysis approach for VOR sites. The same criteria will also protect for DMEs.

Westslope conducted the VOR screening analysis for the following three navigational aid sites:

- Martha's Vineyard VOR/DME;
- Providence VOR/DME; and
- Sandy Point VOR/DME.

The study area is greater than 8 NM from the Martha's Vineyard VOR/DME, Providence VOR/DME, and the Sandy Point VOR/DME. As such, no additional analysis was considered necessary for these navigational aid sites.

NEXRAD Weather Radar Screening Analysis

The PST NEXRAD analysis does not account for blade-tip heights greater than 525 feet AGL, does not account for WSR-88D sites authorized to scan at elevation angles below 0.5 degrees, and does not reflect the wind farm impact zone scheme updated in 2018 by the NOAA WSR-88D ROC. The updated scheme expands the red area, or "No Build Zone," from three to four kilometers and to areas where wind turbines penetrate the third elevation angle scanned by a WSR-88D.

Westslope conducted a NEXRAD weather radar screening analysis using USGS 10-meter NED. This analysis shows whether wind turbines at a blade-tip height of 873 feet AGL will be within line-of-sight of one or more WSR-88D sites and incorporates the updated wind farm impact zone scheme.

Westslope conducted the NEXRAD weather radar screening analysis for the following two radar sites:

- Boston WSR-88D; and
- Brookhaven WSR-88D.

Research conducted by Westslope shows that the lowest elevation angle scanned by the Boston WSR-88D and the Brookhaven WSR-88D is 0.5 degrees.

Boston WSR-88D

Westslope's NEXRAD weather radar screening analysis shows that wind turbines in the study area will not be within line-of-sight of and will not interfere with the Boston WSR-88D at a blade-tip height of 873 feet AGL. The results also show that wind turbines in the study area at a blade-tip height of 873 feet AGL will fall within a NOAA green area for this radar site. A green area, or "No Impact Zone," indicates that impacts are not likely to WSR-88D operations. See Figure 7.

Brookhaven WSR-88D

Westslope's NEXRAD weather radar screening analysis shows that wind turbines in the study area will not be within line-of-sight of and will not interfere with the Brookhaven WSR-88D at a blade-tip height of 873 feet AGL. The results also show that wind turbines in the study area at a blade-tip height of 873 feet AGL will fall within a NOAA green No Impact Zone for this radar site. See Figure 8.

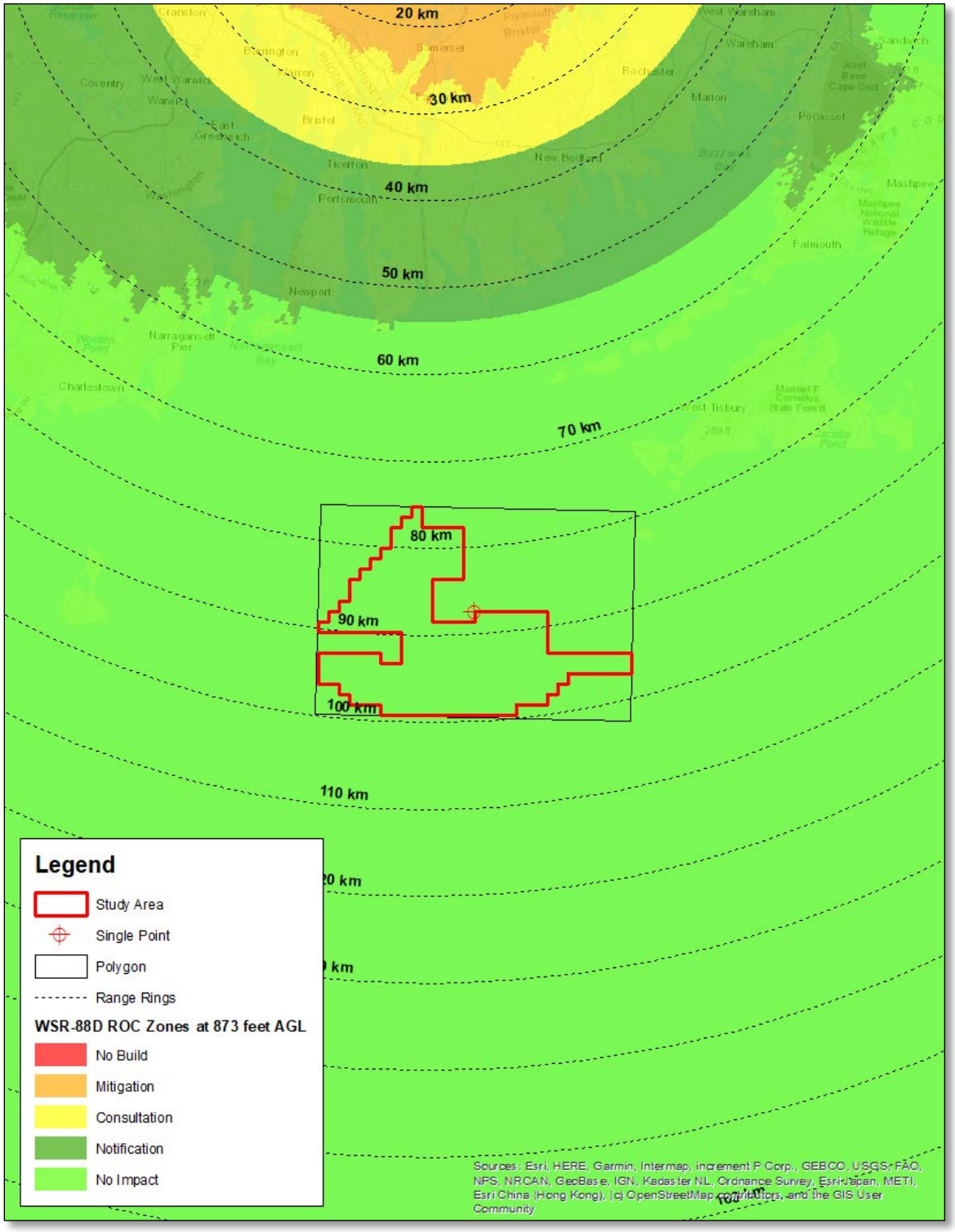

Figure 7 WSR-88D ROC Zone Results at 873 feet AGL for the Boston WSR-88D using 10-meter NED

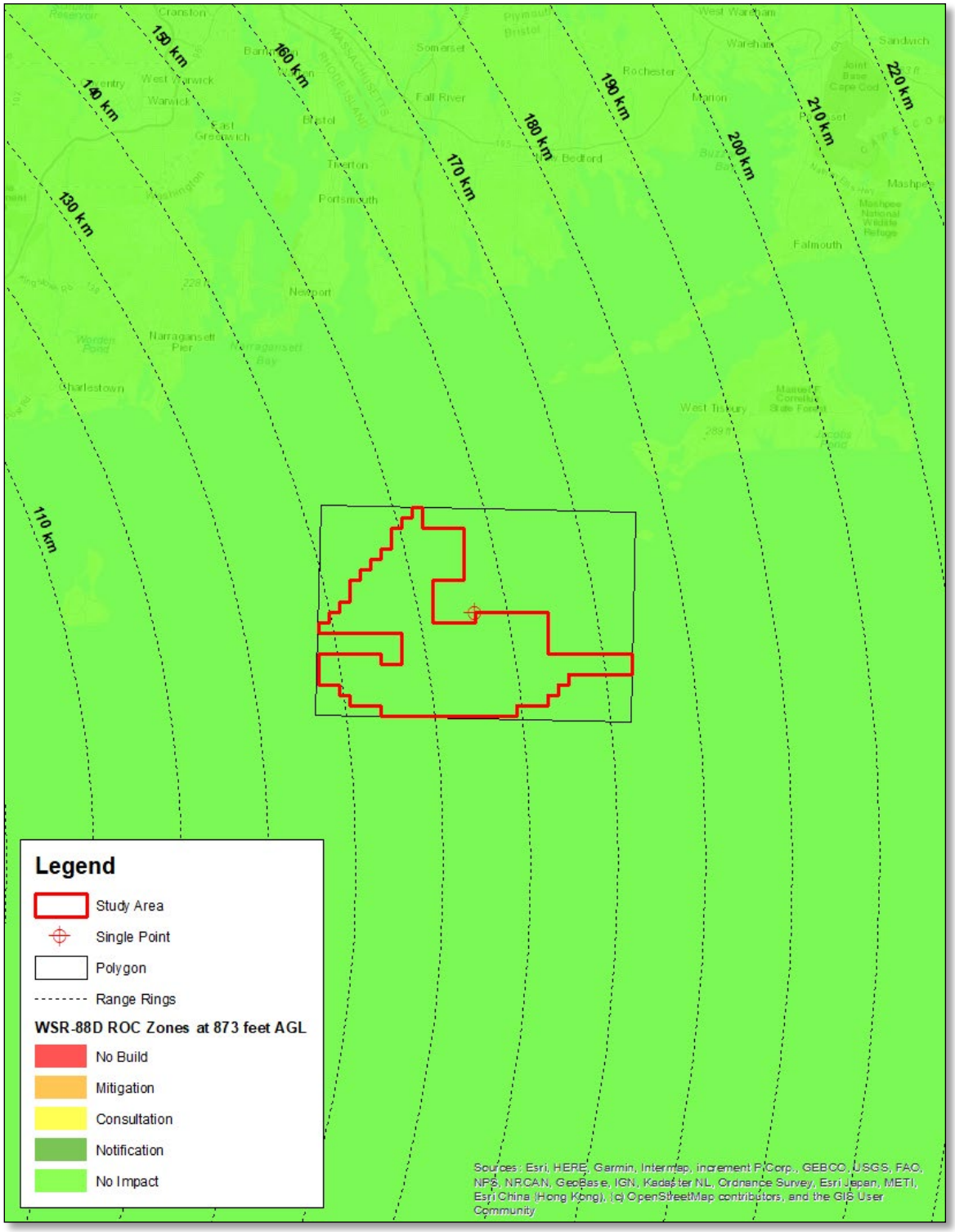

Figure 8 WSR-88D ROC Zone Results at 873 feet AGL for the Brookhaven WSR-88D using 10-meter NED

HF Radar LOS Analysis

Westslope conducted an HF radar LOS analysis using USGS 10-meter NED. This analysis shows whether wind turbines at a blade-tip height of 873 feet AGL will be within line-of-sight of one or more HF radar sites.

Westslope conducted the LOS analysis for the following 13 HF radar sites:

- Amagansett HF radar;
- Block Island Long Range HF radar;
- Block Island Standard Range HF radar;
- Camp Varnum HF radar;
- Horseneck Beach State Reservation HF radar;
- Long Point Wildlife Refuge HF radar;
- Martha's Vineyard HF radar;
- Moriches HF radar;
- MVCO Meteorological Mast HF radar;
- Nantucket HF radar;
- Nantucket Island HF radar;
- Nauset HF radar; and
- Squibnocket Farms HF radar.

Amagansett HF Radar

The LOS analysis results show that wind turbines in the western corners of the study area will be within line-of-sight of the Amagansett HF radar at a blade-tip height of 873 feet AGL. See Figure 9. The radar effects will include clutter in the vicinity of wind turbines within line-of-sight in the study area and possibly in the vicinity of wind turbines beyond line-of-sight in the study area due to the propagation of HF electromagnetic waves over the ocean surface. As a result, impacts to Amagansett HF radar operations are possible.

Block Island Long Range HF Radar

The LOS analysis results show that wind turbines in the entire study area will be within line-of-sight of the Block Island Long Range HF radar at a blade-tip height of 873 feet AGL. See Figure 10. The radar effects will include clutter in the vicinity of wind turbines in the study area. As a result, impacts to Block Island Long Range HF radar operations are possible.

Block Island Standard Range HF Radar

The LOS analysis results show that wind turbines in the western two-thirds of the study area will be within line-of-sight of the Block Island Standard Range HF radar at a blade-tip height of 873 feet AGL. See Figure 11. The radar effects will include clutter in the vicinity of wind turbines within line-of-sight in the study area. As a result, impacts to Block Island Standard Range HF radar operations are possible.

Camp Varnum HF Radar

The LOS analysis results show that wind turbines in the entire study area will be within line-of-sight of the Camp Varnum HF radar at a blade-tip height of 873 feet AGL. See Figure 12. The radar effects will include clutter in the vicinity of wind turbines in the study area. As a result, impacts to Camp Varnum HF radar operations are possible.

Horseneck Beach State Reservation HF Radar

The LOS analysis results show that wind turbines in the entire study area will be within line-of-sight of the Horseneck Beach State Reservation HF radar at a blade-tip height of 873 feet AGL. See Figure 13. The radar effects will include clutter in the vicinity of wind turbines in the study area. As a result, impacts to Horseneck Beach State Reservation HF radar operations are possible.

Long Point Wildlife Refuge HF Radar

The LOS analysis results show that wind turbines in the entire study area will be within line-of-sight of the Long Point Wildlife Refuge HF radar at a blade-tip height of 873 feet AGL. See Figure 14. The radar effects will include clutter in the vicinity of wind turbines in the study area. As a result, impacts to Long Point Wildlife Refuge HF radar operations are possible.

Martha's Vineyard HF Radar

The LOS analysis results show that wind turbines in the entire study area will be within line-of-sight of the Martha's Vineyard HF radar at a blade-tip height of 873 feet AGL. See Figure 15. The radar effects will include clutter in the vicinity of wind turbines in the study area. As a result, impacts to Martha's Vineyard HF radar operations are possible.

Moriches HF Radar

The LOS analysis results show that wind turbines in the study area will not be within line-of-sight of the Moriches HF radar at a blade-tip height of 873 feet AGL. See Figure 16. Although wind turbines in the study area will not be within line-of-sight of this radar site, radar effects are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface.

MVCO Meteorological Mast HF Radar

The LOS analysis results show that wind turbines in the eastern one-fifth of the study area will be within line-of-sight of the MVCO Meteorological Mast HF radar at a blade-tip height of 873 feet AGL. See Figure 17. The radar effects will include clutter in the vicinity of wind turbines within line-of-sight in the study area. As a result, impacts to MVCO Meteorological Mast HF radar operations are possible.

Nantucket HF Radar

The LOS analysis results show that wind turbines in the eastern one-third of the study area will be within line-of-sight of the Nantucket HF radar at a blade-tip height of 873 feet AGL. See Figure 18. The radar effects will include clutter in the vicinity of wind turbines within line-of-sight in the study area and possibly in the vicinity of wind turbines beyond line-of-sight in the study area due to the propagation of HF electromagnetic waves over the ocean surface. As a result, impacts to Nantucket HF radar operations are possible.

Nantucket Island HF Radar

The LOS analysis results show that wind turbines in the study area will not be within line-of-sight of the Nantucket Island HF radar at a blade-tip height of 873 feet AGL. See Figure 19. Although wind turbines in the study area will not be within line-of-sight of this radar site, radar effects are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface.

Nauset HF Radar

The LOS analysis results show that wind turbines in the study area will not be within line-of-sight of the Nauset HF radar at a blade-tip height of 873 feet AGL. See Figure 20. Although wind turbines in the study area will not be within line-of-sight of this radar site, radar effects are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface.

Squibnocket Farms HF Radar

The LOS analysis results show that wind turbines in the eastern one-fifth and along the northern edges of the study area will be within line-of-sight of the Squibnocket Farms HF radar at a blade-tip height of 873 feet AGL. See Figure 21. The radar effects will include clutter in the vicinity of wind turbines within line-of-sight in the study area and possibly in the vicinity of wind turbines beyond line-of-sight in the study area due to the propagation of HF electromagnetic waves over the ocean surface. As a result, impacts to Squibnocket Farms HF radar operations are possible.

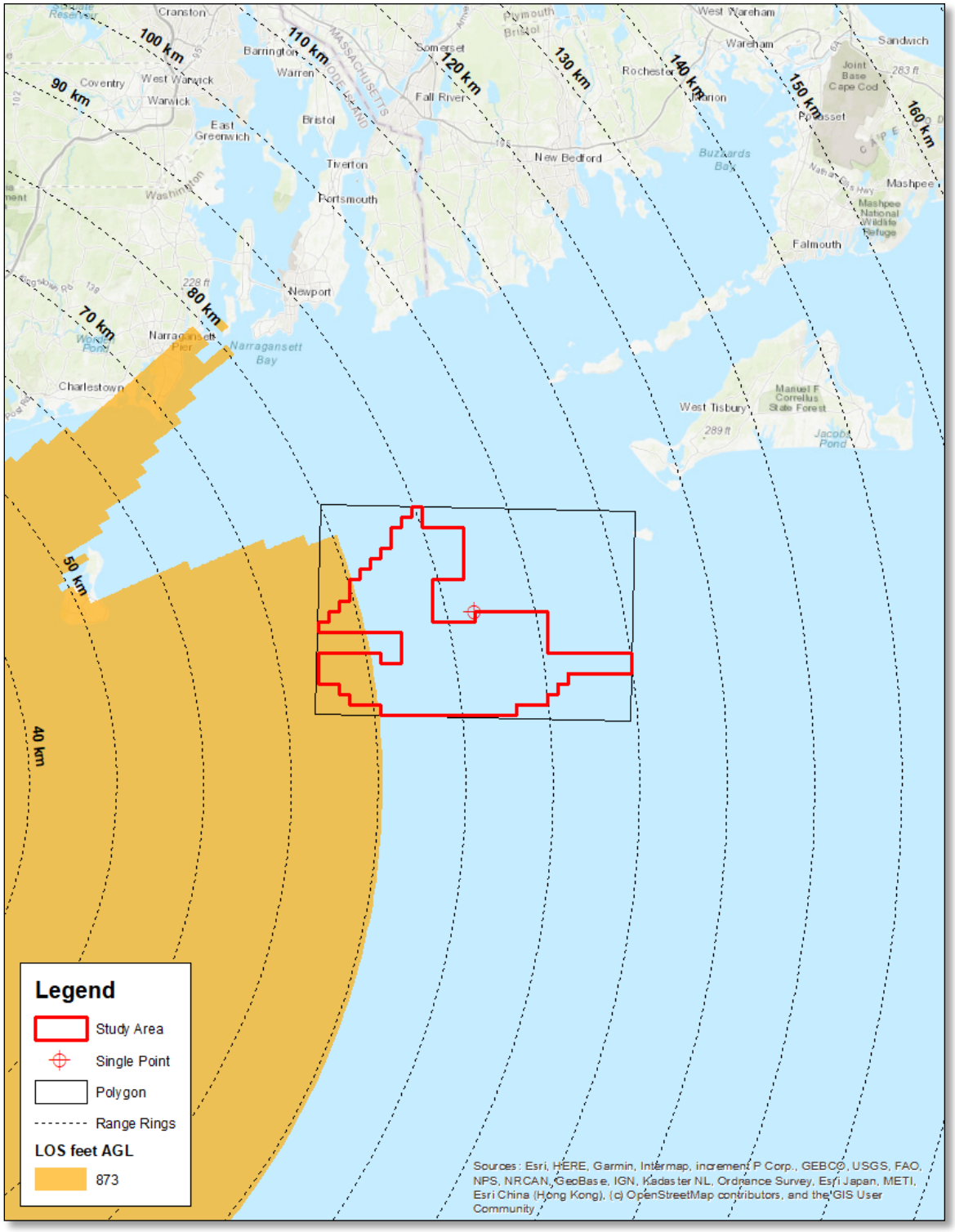

Figure 9 LOS Analysis Results for the Amagansett HF Radar using 10-meter NED

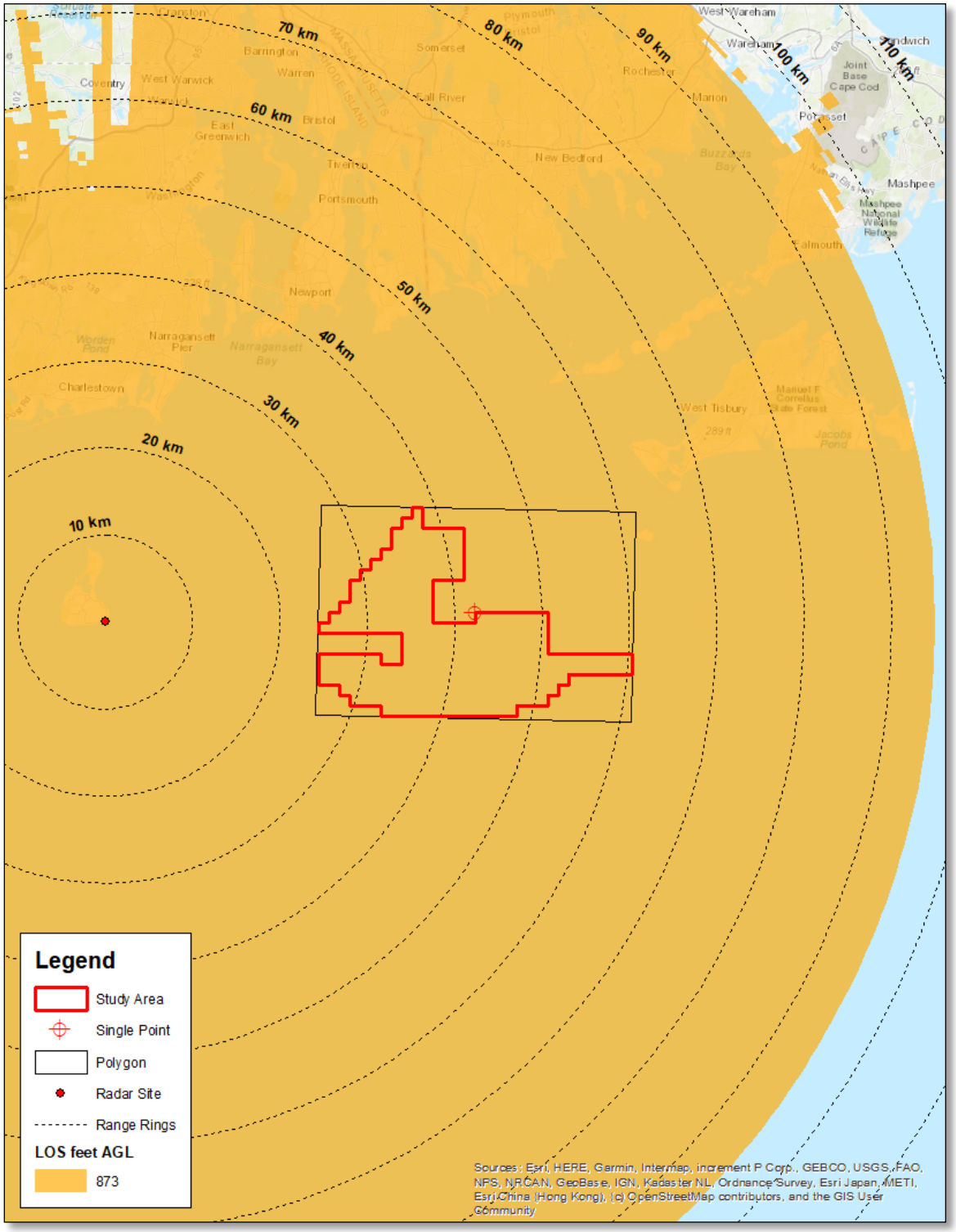

Figure 10 LOS Analysis Results for the Block Island Long Range HF Radar using 10-meter NED

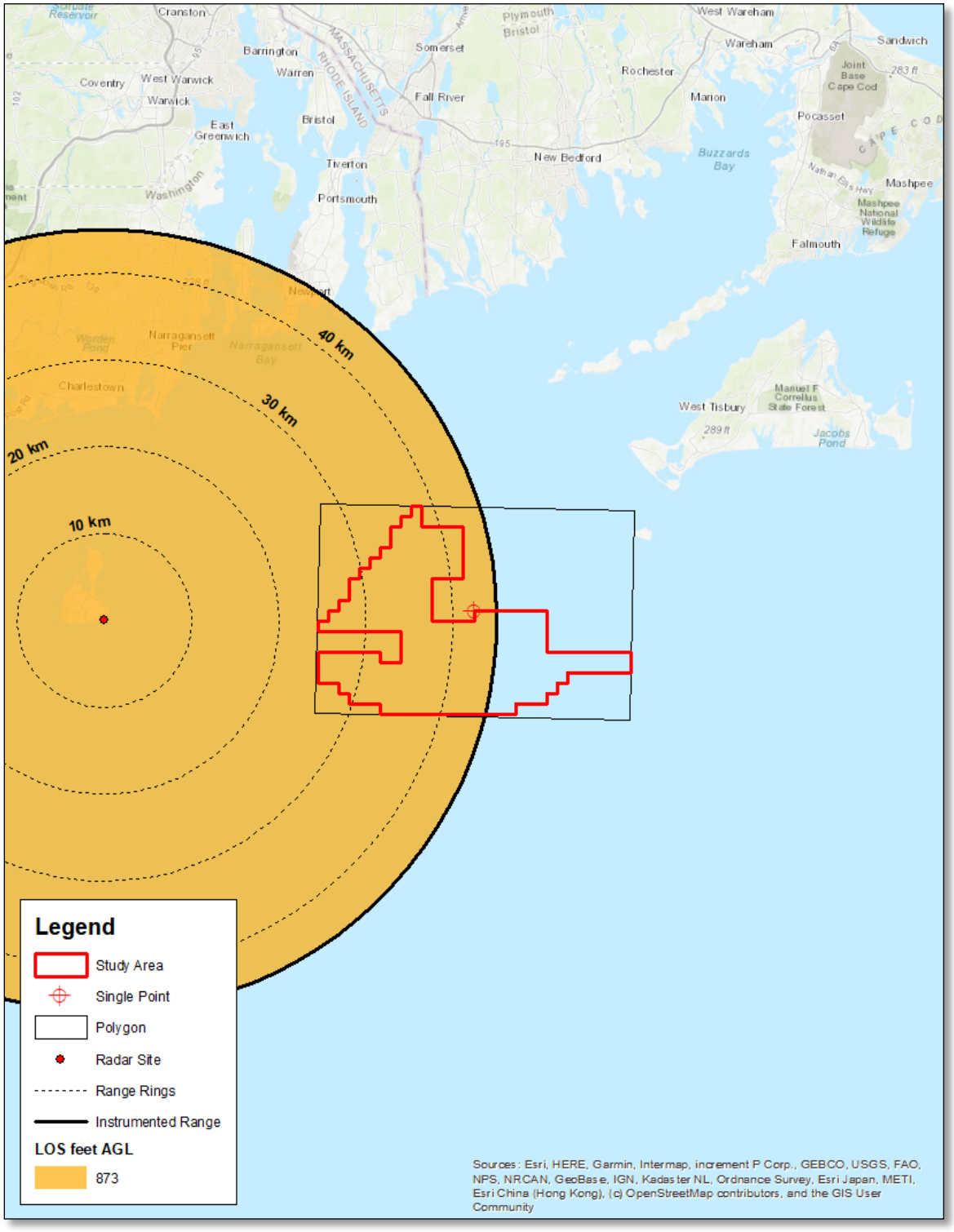

Figure 11 LOS Analysis Results for the Block Island Standard Range HF Radar using 10-meter NED

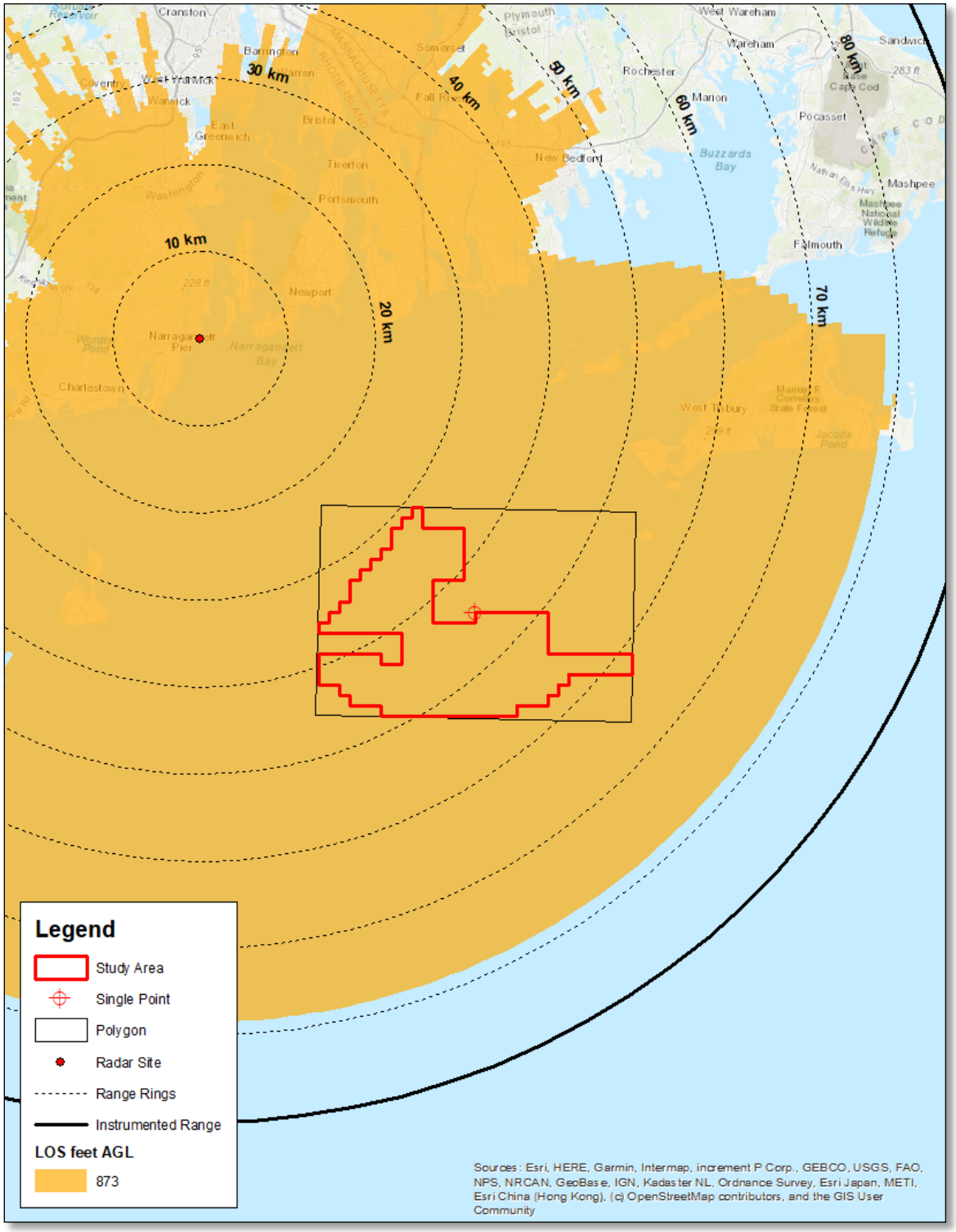

Figure 12 LOS Analysis Results for the Camp Varnum HF Radar using 10-meter NED

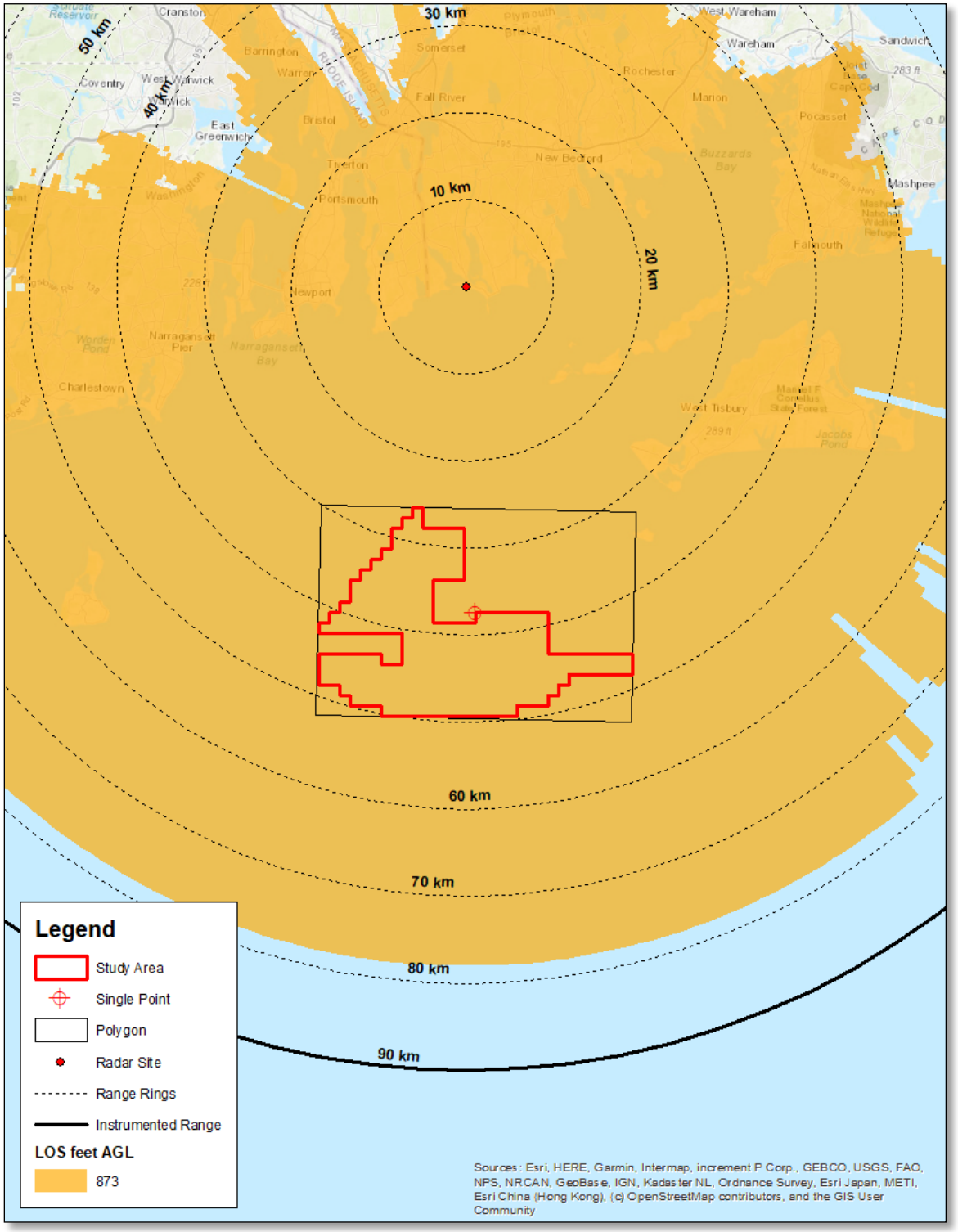

Figure 13 LOS Analysis Results for the Horseneck Beach State Reservation HF Radar using 10-meter NED

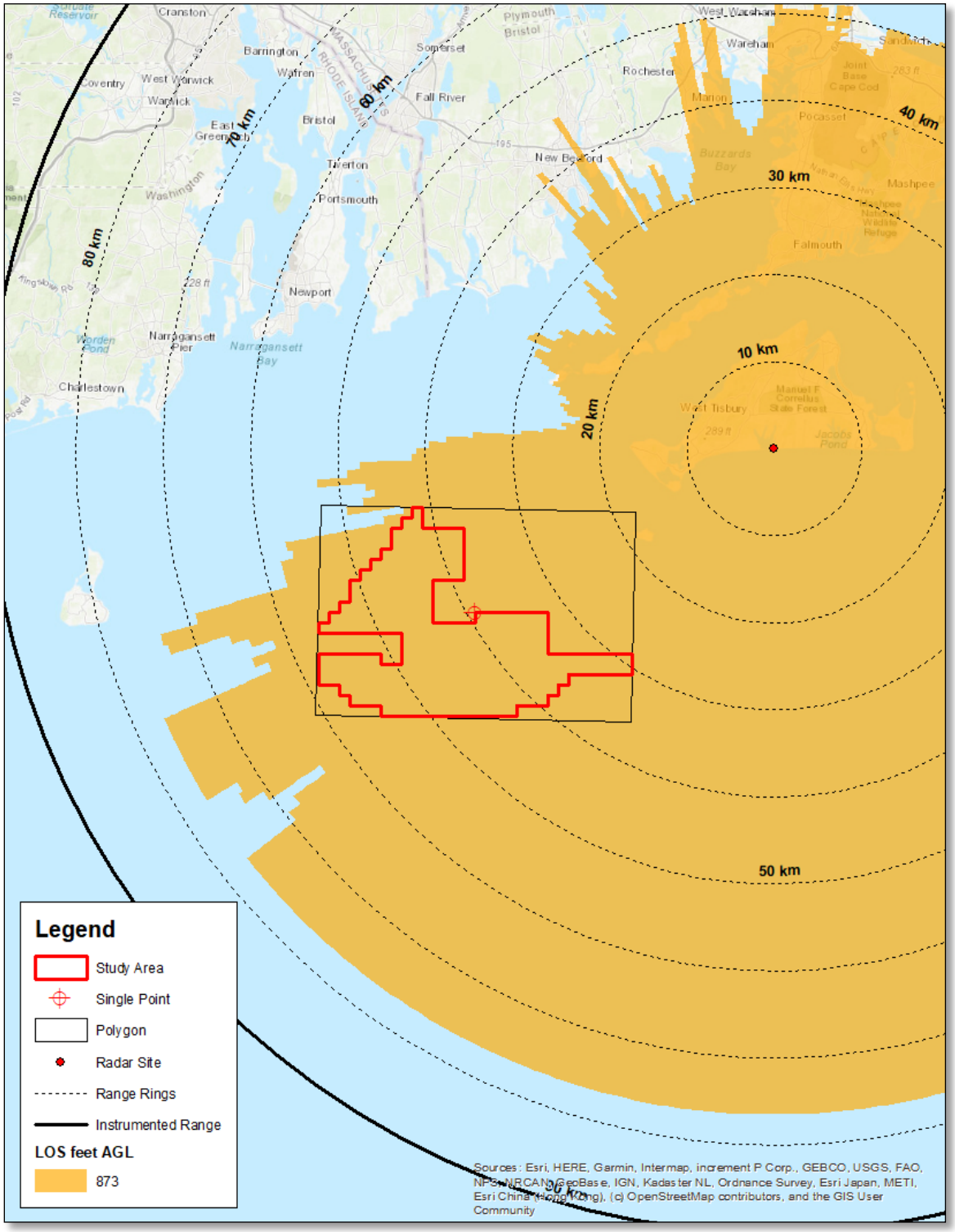

Figure 14 LOS Analysis Results for the Long Point Wildlife Refuge HF Radar using 10-meter NED

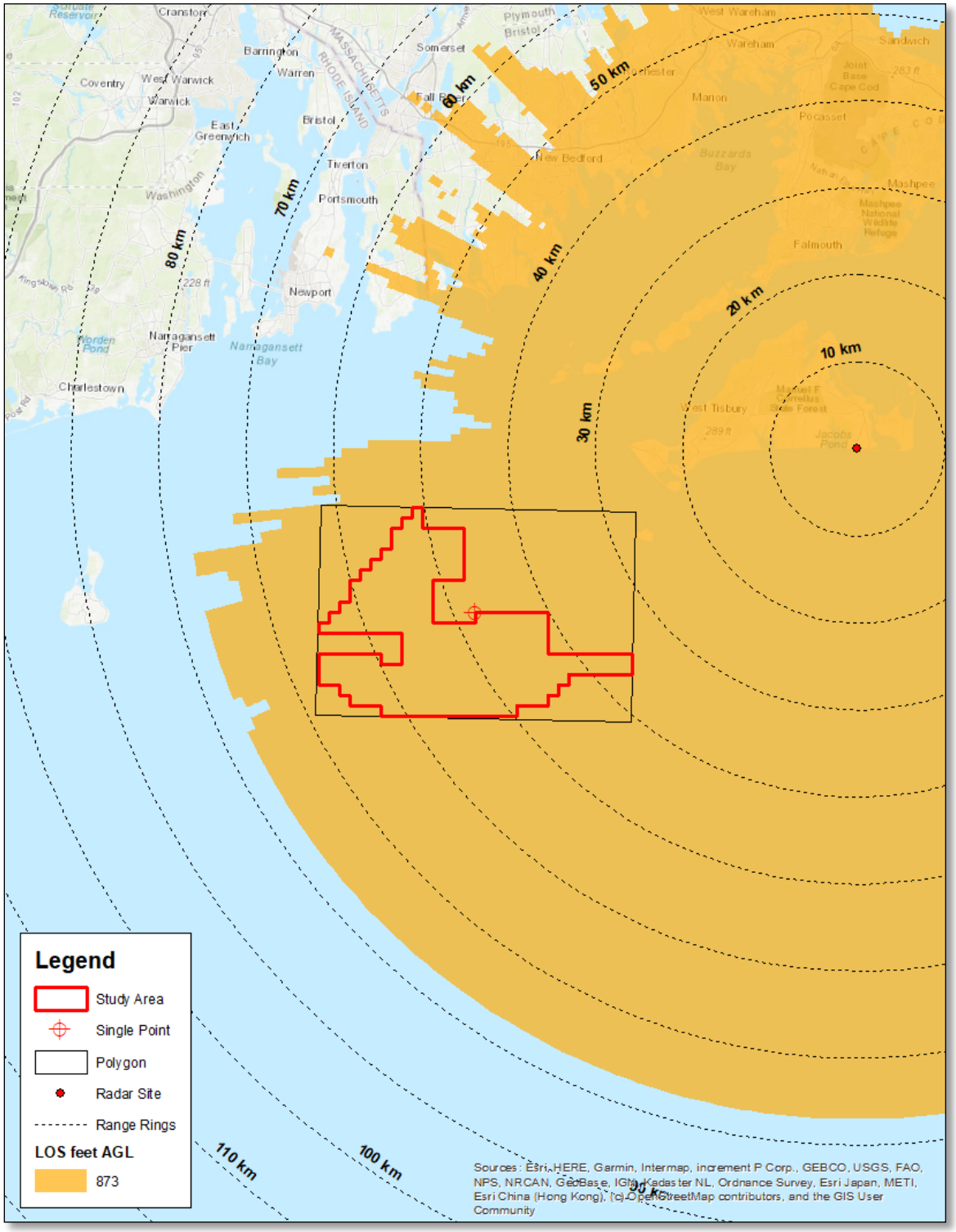

Figure 15 LOS Analysis Results for the Martha's Vineyard HF Radar using 10-meter NED

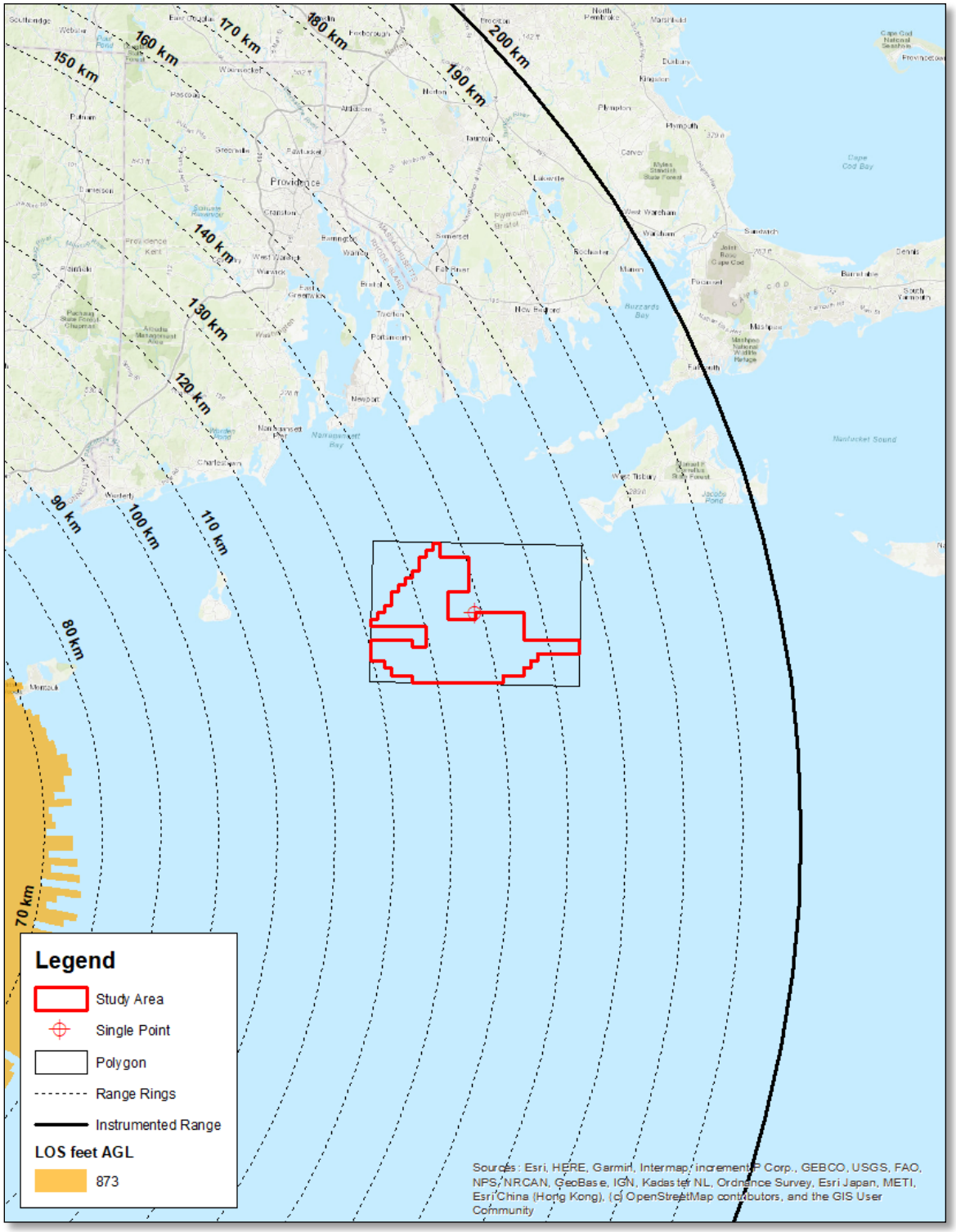

Figure 16 LOS Analysis Results for the Moriches HF Radar using 10-meter NED

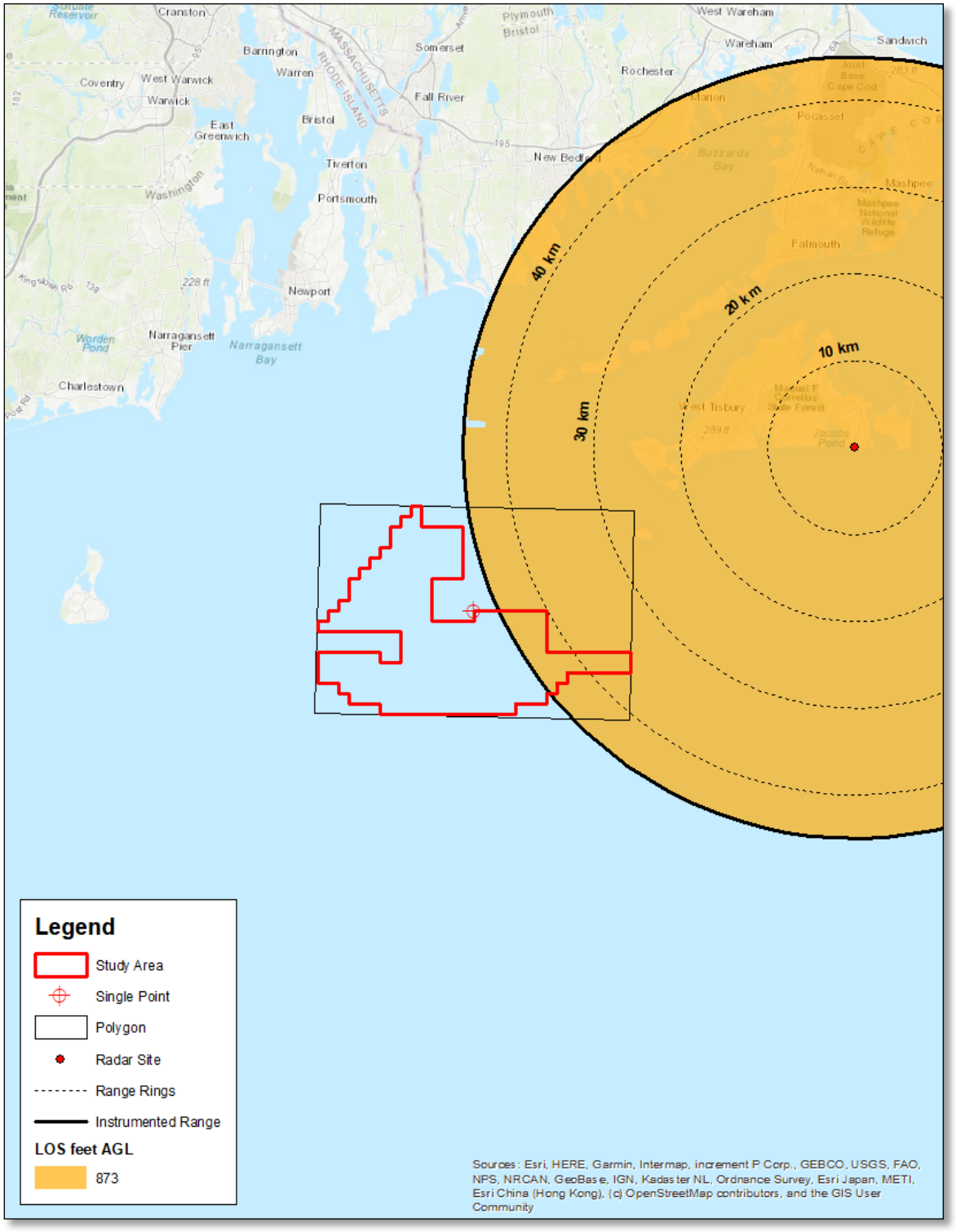

Figure 17 LOS Analysis Results for the MVCO Meteorological Mast HF Radar using 10-meter NED

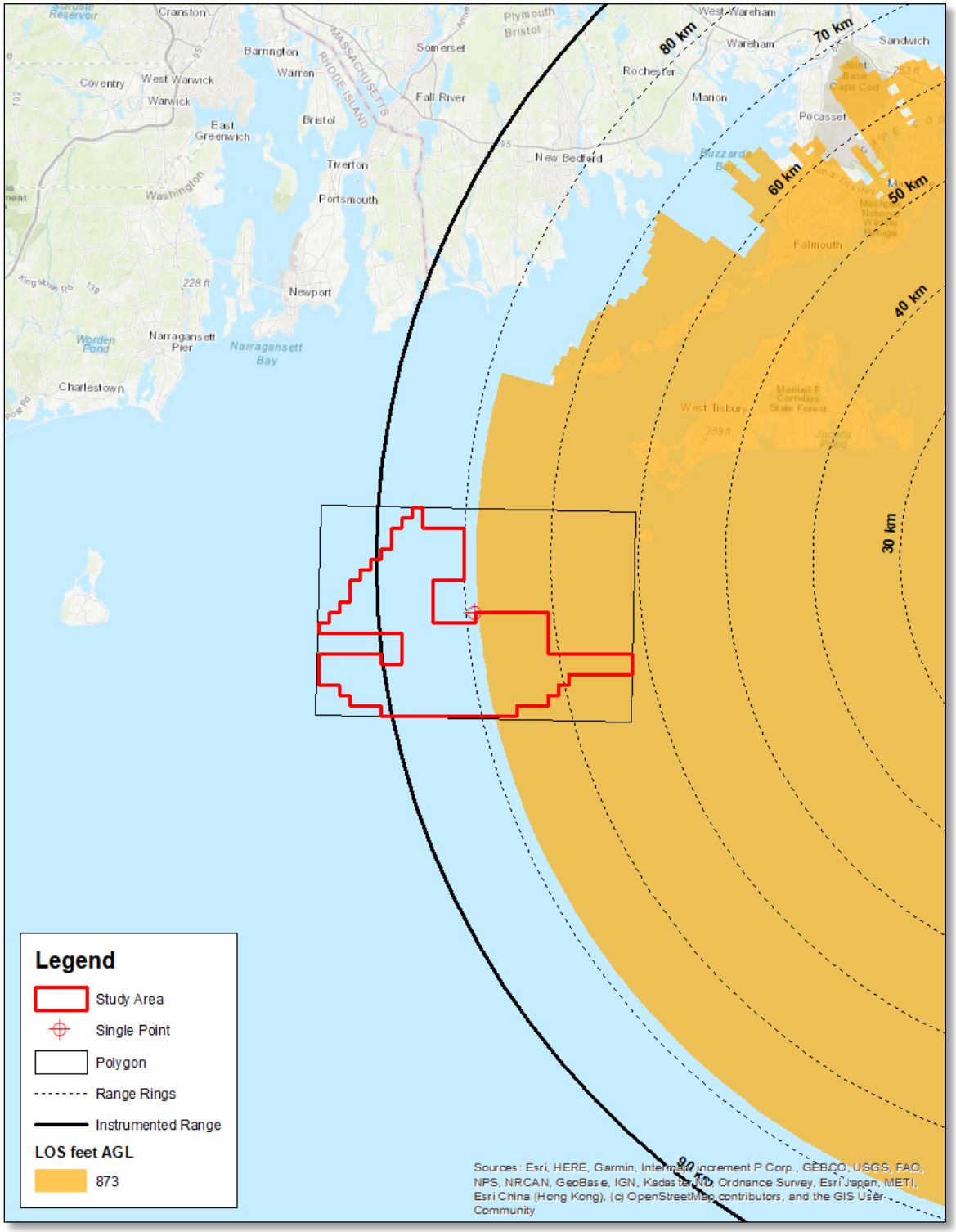

Figure 18 LOS Analysis Results for the Nantucket HF Radar using 10-meter NED

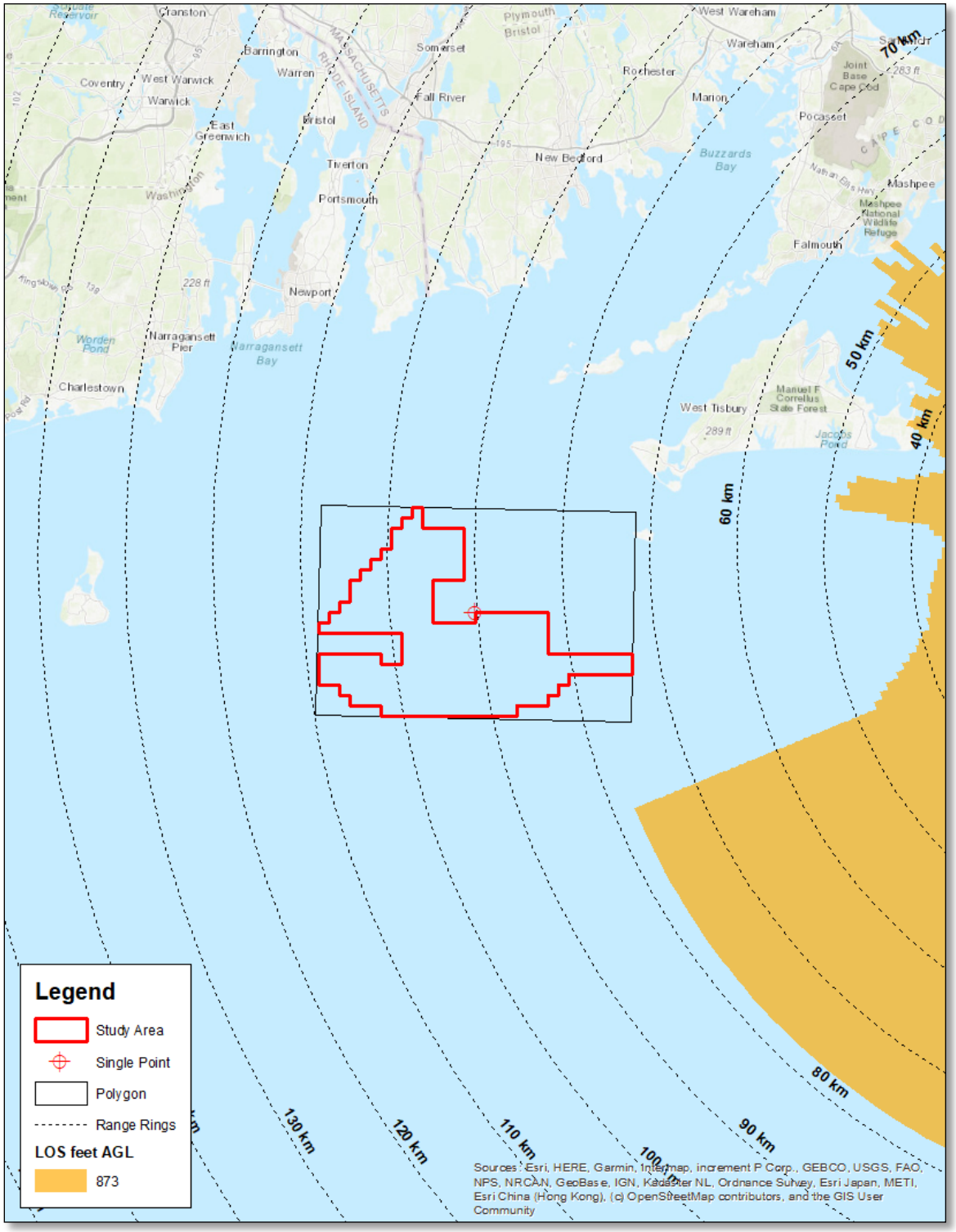

Figure 19 LOS Analysis Results for the Nantucket Island HF Radar using 10-meter NED

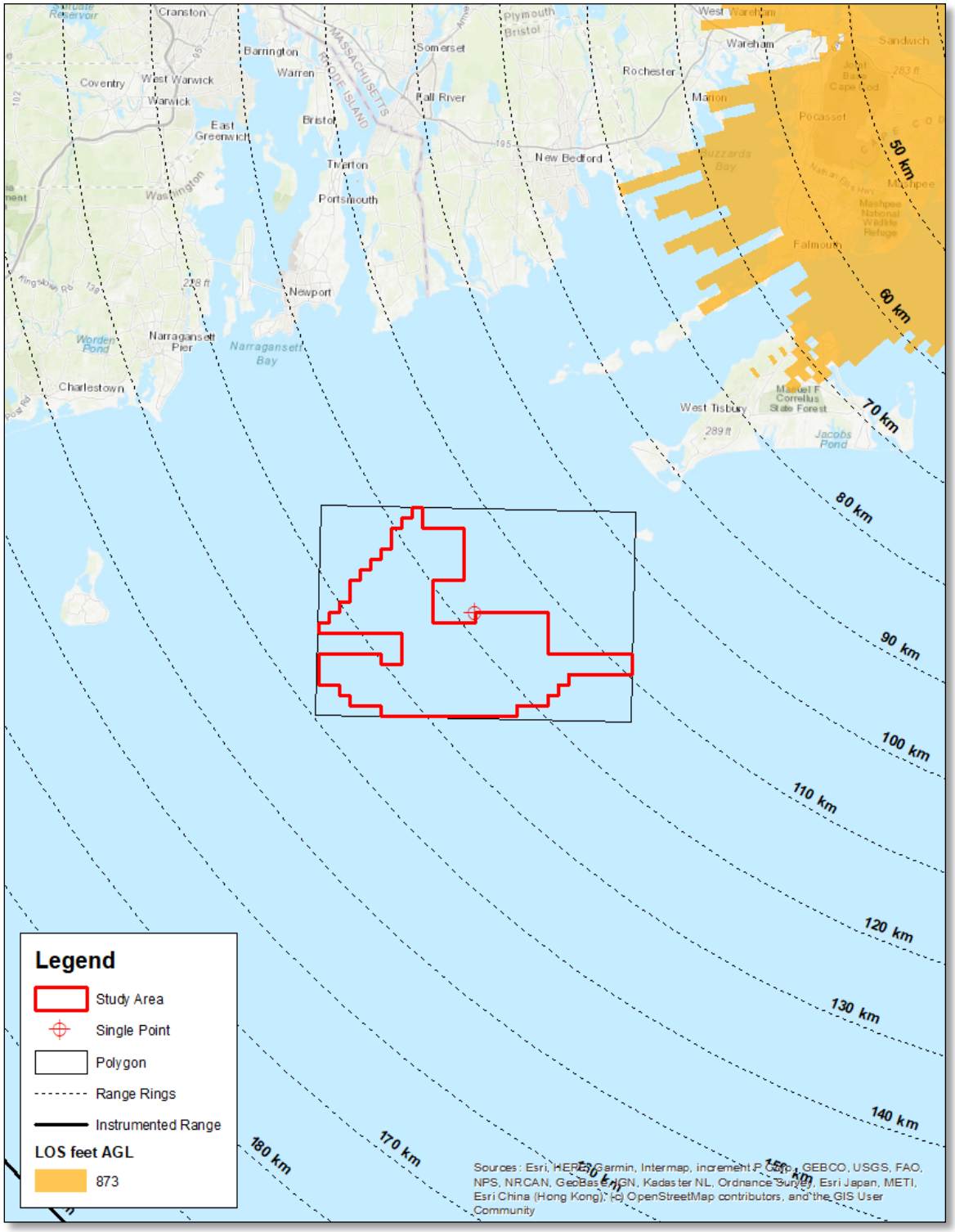

Figure 20 LOS Analysis Results for the Nauset HF Radar using 10-meter NED

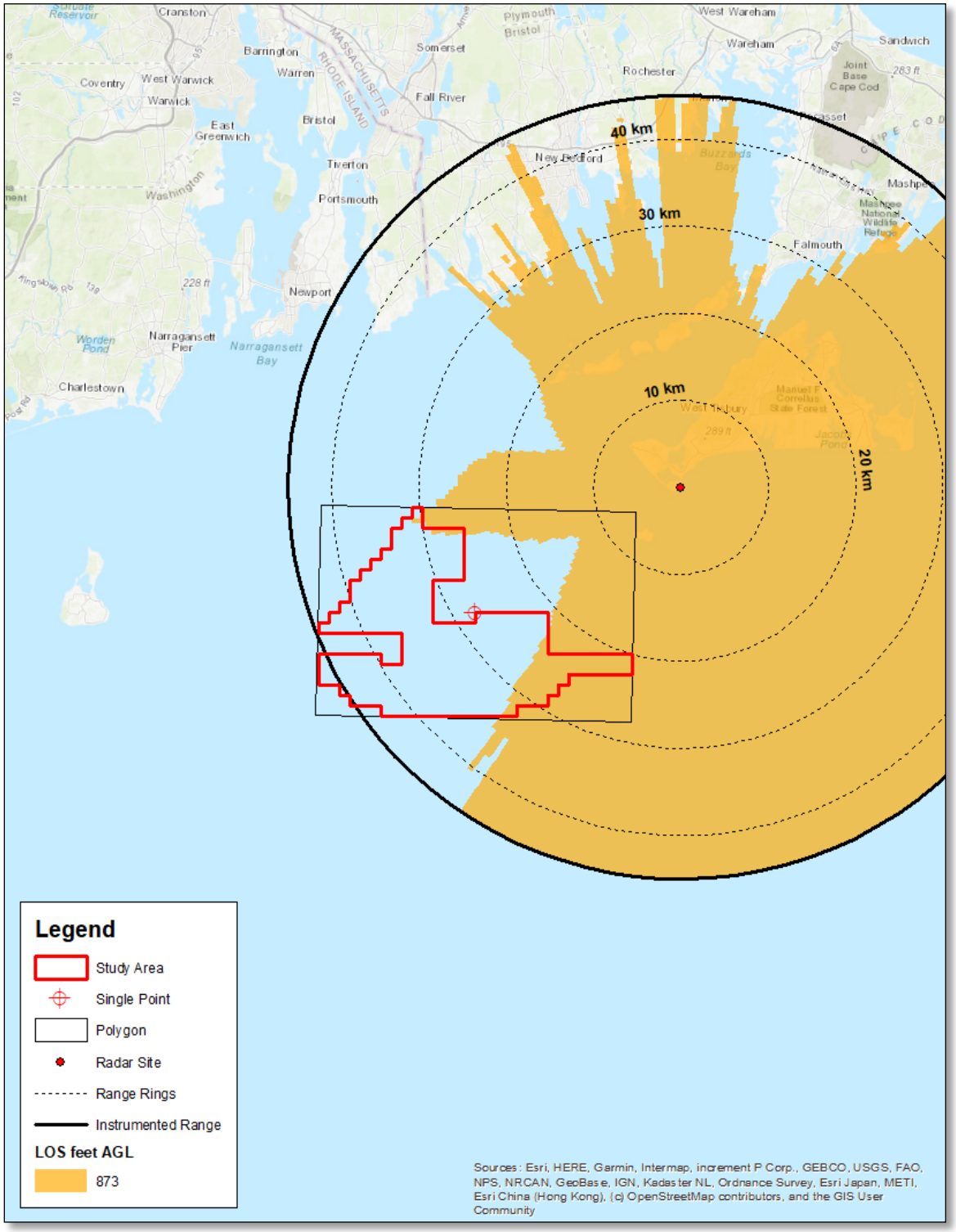

Figure 21 LOS Analysis Results for the Squibnocket Farms HF Radar using 10-meter NED

CONCLUSIONS

The DoD PST analysis results for the study area indicate the following:

- Impacts to air defense and homeland security radar are likely; and
- Impacts to WSR-88D weather radar are not likely.

Westslope identified the six radar sites in the PST analysis results for Long Range Radar as the Boston ASR-9, Falmouth ASR-8, Nantucket ASR-9, North Truro ARSR-4, Providence ASR-9, and the Riverhead ARSR-4. Further, Westslope identified the two radar sites in the PST analysis results for NEXRAD as the Boston WSR-88D and the Brookhaven WSR-88D.

Research conducted by Westslope identified no additional ARSR or ASR sites near the study area.

Westslope conducted an ARSR and ASR LOS analysis for the following six ARSR and ASR sites:

- Boston ASR-9;
- Falmouth ASR-8;
- Nantucket ASR-9;
- North Truro ARSR-4;
- Providence ASR-9; and
- Riverhead ARSR-4.

The study area is beyond the instrumented range of the Boston ASR-9. As such, no additional analysis was considered necessary for this radar site.

The ARSR and ASR LOS analyses conducted by Westslope show the following:

- For the Falmouth ASR-8, wind turbines in the northeastern two-thirds of the study area will be within line-of-sight of and will interfere with this radar site at a blade-tip height of 873 feet AGL.
- For the Nantucket ASR-9, wind turbines in the eastern one-half of the study area will be within line-of-sight of and will interfere with this radar site at a blade-tip height of 873 feet AGL.
- For the Providence ASR-9, wind turbines in the entire study area will be within line-of-sight of and will interfere with this radar site at a blade-tip height of 873 feet AGL.
- For the North Truro ARSR-4 and the Riverhead ARSR-4, wind turbines in the study area will not be within line-of-sight of and will not interfere with these radar sites at a blade-tip height of 873 feet AGL.

For the Falmouth ASR-8, Nantucket ASR-9, and the Providence ASR-9, without mitigation, the radar effects due to clutter will include a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of wind turbines within line-of-sight in the study area. Other radar effects include a partial loss of weather detection and false weather indications over and in the

immediate vicinity of wind turbines within line-of-sight in the study area. Please note that radar effects do not always translate into operational impacts. Because wind turbines will be within line-of-sight of these radar sites, Westslope expects that the DoD and FAA will have concerns with wind turbines within line-of-sight in the study area at a blade-tip height of 873 feet AGL based on electromagnetic interference to air navigation facilities. The FAA's aeronautical study process and the DoD Siting Clearinghouse process will provide an official decision as to whether impacts are acceptable to operations. Although possible, Westslope does not expect that the DHS will have concerns with wind turbines within line-of-sight in the study area at a blade-tip height of 873 feet AGL based on impacts to these radar sites.

Westslope does not expect that wind turbines in the study area will affect the secondary surveillance radar co-located with the Falmouth ASR-8, Nantucket ASR-9, or the Providence ASR-9.

Westslope's EWR LOS analysis for the Cape Cod AFS EWR shows that wind turbines in the majority of the study area will be within line-of-sight of this radar site and could have a significant impact on this early warning radar at a blade-tip height of 873 feet AGL.

For the Cape Cod AFS EWR, Westslope recommends early consultation with the DoD Siting Clearinghouse. Because wind turbines will be within line-of-sight of this radar site, it is possible that the DoD will have concerns with wind turbines within line-of-sight in the study area based on electromagnetic interference to a ballistic missile defense and space surveillance facility.

Westslope's TDWR screening analysis for the Boston TDWR shows that the study area is beyond the instrumented range of this radar site. As such, no additional analysis was considered necessary for this radar site.

Westslope conducted a VOR screening analysis for the following three navigational aid sites:

- Martha's Vineyard VOR/DME;
- Providence VOR/DME; and
- Sandy Point VOR/DME.

Westslope's VOR screening analysis for the Martha's Vineyard VOR/DME, Providence VOR/DME, and the Sandy Point VOR/DME shows that the study area is greater than 8 NM from these navigational aid sites. Although possible, Westslope does not expect that the FAA will have concerns with wind turbines in the study area at a blade-tip height of 873 feet AGL based on impacts to these navigational aid sites.

Westslope conducted a NEXRAD weather radar screening analysis for the following two radar sites:

- Boston WSR-88D; and
- Brookhaven WSR-88D.

Westslope's NEXRAD weather radar screening analysis for the Boston WSR-88D and the Brookhaven WSR-88D shows that wind turbines in the study area will not be within line-of-sight of and will not interfere with these radar sites at a blade-tip height of 873 feet AGL. The results also show that wind turbines in the study area at a blade-tip height of 873 feet AGL will fall within a NOAA green No Impact Zone for these radar sites.

Westslope conducted an HF radar LOS analysis for the following 13 radar sites:

- Amagansett HF radar;
- Block Island Long Range HF radar;
- Block Island Standard Range HF radar;
- Camp Varnum HF radar;
- Horseneck Beach State Reservation HF radar;
- Long Point Wildlife Refuge HF radar;
- Martha's Vineyard HF radar;
- Moriches HF radar;
- MVCO Meteorological Mast HF radar;
- Nantucket HF radar;
- Nantucket Island HF radar;
- Nauset HF radar; and
- Squibnocket Farms HF radar.

The HF radar LOS analyses conducted by Westslope show the following:

- For the Amagansett HF radar, wind turbines in the western corners of the study area will be within line-of-sight of this radar site at a blade-tip height of 873 feet AGL.
- For the Block Island Long Range HF radar, Camp Varnum HF radar, Horseneck Beach State Reservation HF radar, Long Point Wildlife Refuge HF radar, and the Martha's Vineyard HF radar, wind turbines in the entire study area will be within line-of-sight of these radar sites at a blade-tip height of 873 feet AGL.
- For the Block Island Standard Range HF radar, wind turbines in the western two-thirds of the study area will be within line-of-sight of this radar site at a blade-tip height of 873 feet AGL.
- For the MVCO Meteorological Mast HF radar, wind turbines in the eastern one-fifth of the study area will be within line-of-sight of this radar site at a blade-tip height of 873 feet AGL.
- For the Nantucket HF radar, wind turbines in the eastern one-third of the study area will be within line-of-sight of this radar site at a blade-tip height of 873 feet AGL.

- For the Squibnocket Farms HF radar, wind turbines in the eastern one-fifth and along the northern edges of the study area will be within line-of-sight of this radar site at a blade-tip height of 873 feet AGL.
- For the Moriches HF radar, Nantucket Island HF radar, and the Nauset HF radar, wind turbines in the study area will not be within line-of-sight of these radar sites at a blade-tip height of 873 feet AGL. Although wind turbines in the study area will not be within line-of-sight of these radar sites, radar effects are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface.

For the Amagansett HF radar, Block Island Long Range HF radar, Block Island Standard Range HF radar, Camp Varnum HF radar, Horseneck Beach State Reservation HF radar, Long Point Wildlife Refuge HF radar, Martha's Vineyard HF radar, MVCO Meteorological Mast HF radar, Nantucket HF radar, and the Squibnocket Farms HF radar, without mitigation, the radar effects will include clutter in the vicinity of wind turbines within line-of-sight in the study area and possibly in the vicinity of wind turbines beyond line-of-sight in the study area due to the propagation of HF electromagnetic waves over the ocean surface. Because wind turbines will be within line-of-sight of these radar sites, Westslope expects that multiple federal agencies in partnership with NOAA's IOOS may have concerns with wind turbines within line-of-sight in the study area at a blade-tip height of 873 feet AGL based on potential interference to these HF radar sites.

Westslope recommends that the study area be submitted to the DoD Siting Clearinghouse for an informal review and to the National Telecommunications Information Administration (NTIA) for a detailed review. The NTIA is essentially a clearinghouse for other federal agencies, including the National Oceanic and Atmospheric Administration. Additionally, Westslope recommends consultation with NOAA's IOOS Program Office.

If you have any questions regarding this analysis, please contact Geoff Blackman at (405) 816-2604 or via email at gnblackman@westslopeconsulting.com.

REFERENCES

[1] DoD, Missile Defense Agency, "*Wind Turbine Analysis for Cape Cod Air Force Station Early Warning Radar and Beale Air Force Base Upgraded Early Warning Radar*," Spring 2007.