



SIMULATIONS

003 Kitty Hawk
Late Afternoon





SIMULATION

003 Kitty Hawk

Late Afternoon

Siemens SWT-3.6-107

10 nm

Simulation
003 Kitty Hawk
 Late Afternoon
 Siemens SWT-3.6-107
 10 nm

GENERAL INFORMATION

Base Photograph

Photo Name: KHA_0037-UV
 Date: April 13, 2012
 Time: 6:02 PM
 GPS Coordinates¹: lat 36.067515°, long -75.690514°
 Viewpoint Elevation: 10'

Sun and Weather

Sun Angle/Azimuth: 277°
 Sun Elevation: 6°
 Lighting Angle: Front lit
 Weather Conditions: Sunny
 Visibility²: 10 mi
 Wave Height: 2'
 Period: 3 sec.

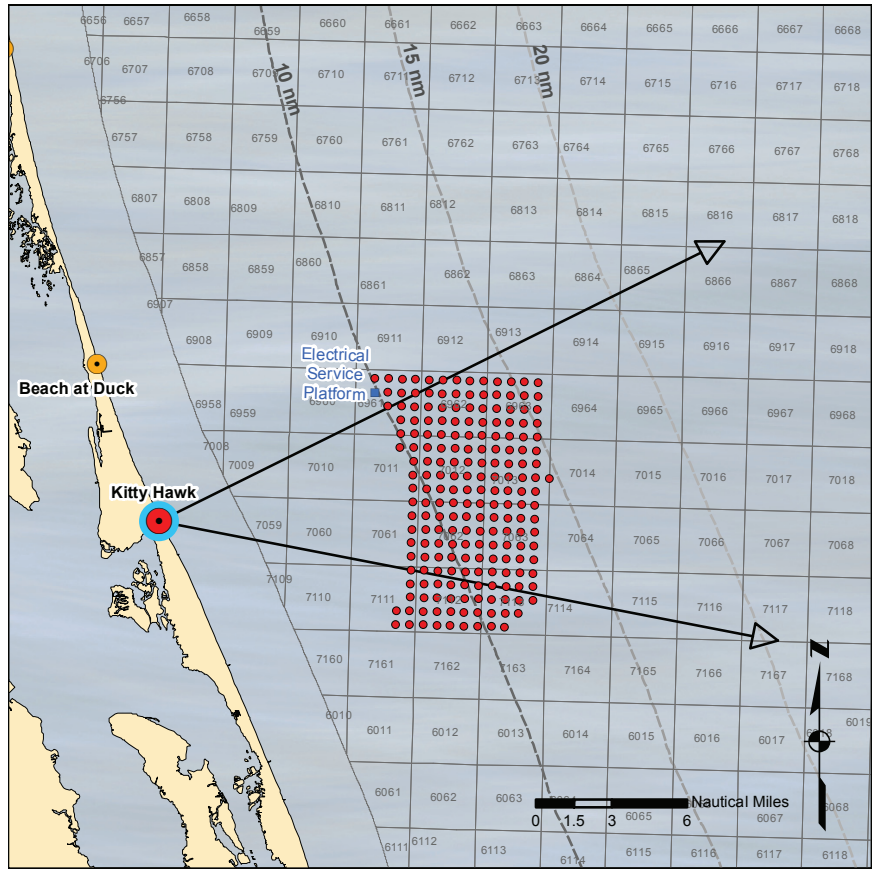
Camera

Camera Make/Model: Nikon D7000
 Sensor Dimensions: 23.6 mm X 15.6 mm
 Lens Make/Model: Nikkor DX AF-S 35 mm
 Lens Focal Length: 35 mm
 35 mm Equivalent Focal Length: 52.5 mm
 Horizontal and Vertical Angles of View:
 37.3° wide and 25.3° high
 Camera Height: 1.5 m (5')
 Camera Azimuth³: 79°

Wind Turbine Information

Number: 200
 Make and Model: Siemens SWT-3.6-107
 Height/Dimensions:
 Support Structure/Monopile Ht.: 13 m (43')
 Hub Ht. (above Monopile): 80 m (262')
 Rotor Diameter: 107 m (351')
 Total Height to Tip of Blade: 147 m (481')
 Service Platform: A bldg. 50'H X 100'W X 200' L
 elevated 50' above the water

CONTEXT MAP



VIEWING INSTRUCTIONS

The simulation is properly printed on an 11" X 17" sheet at actual size. If viewed on a computer monitor, use the highest screen resolution. The simulated image is at the proper perspective when viewed at 23.5" from the eye, or at a distance of approximately twice the image height.

NOTES

- Turbine heights were adjusted to the image's horizon line, which was slightly curved due to camera lens distortion.
- The image was taken with a UV filter.
- Refraction Coefficient⁴ (k) = .075

PANORAMA



Simulation location within the panorama view (190° X 60°) from the Kitty Hawk site



VISUALIZATION STUDY FOR OFFSHORE NORTH CAROLINA
003 Kitty Hawk Simulation, Late Afternoon, Siemens SWT-3.6-107, 10 nm



SIMULATION

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15 nm

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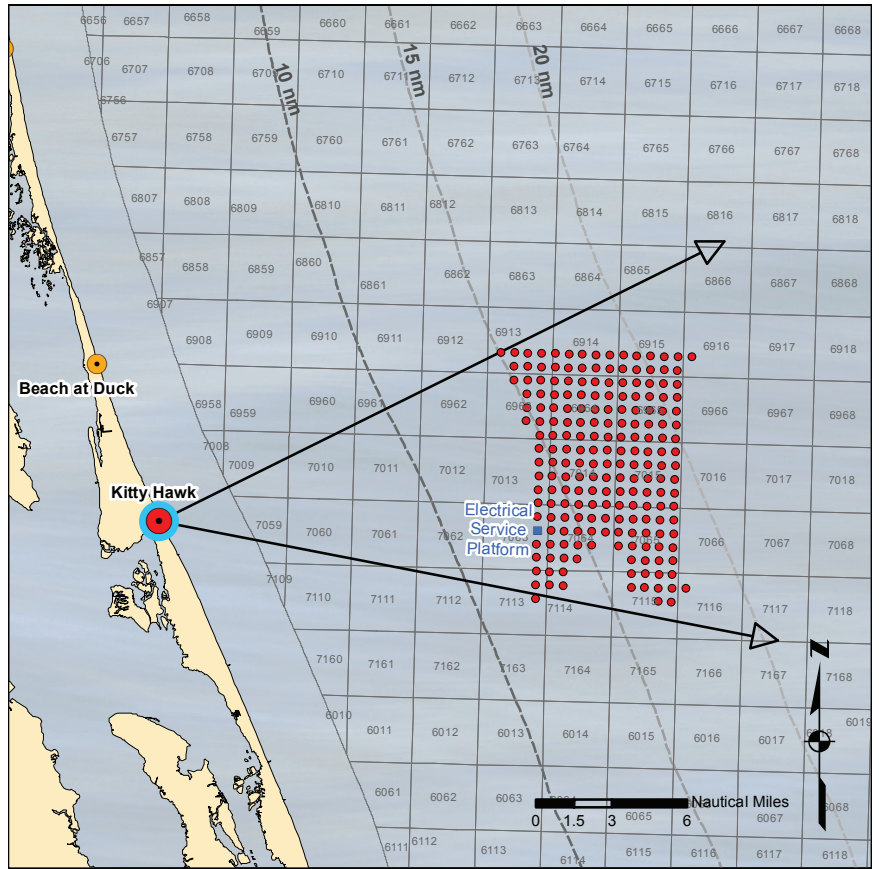
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003 Kitty Hawk Simulation, Late Afternoon, Siemens SWT-3.6-107, 15 nm



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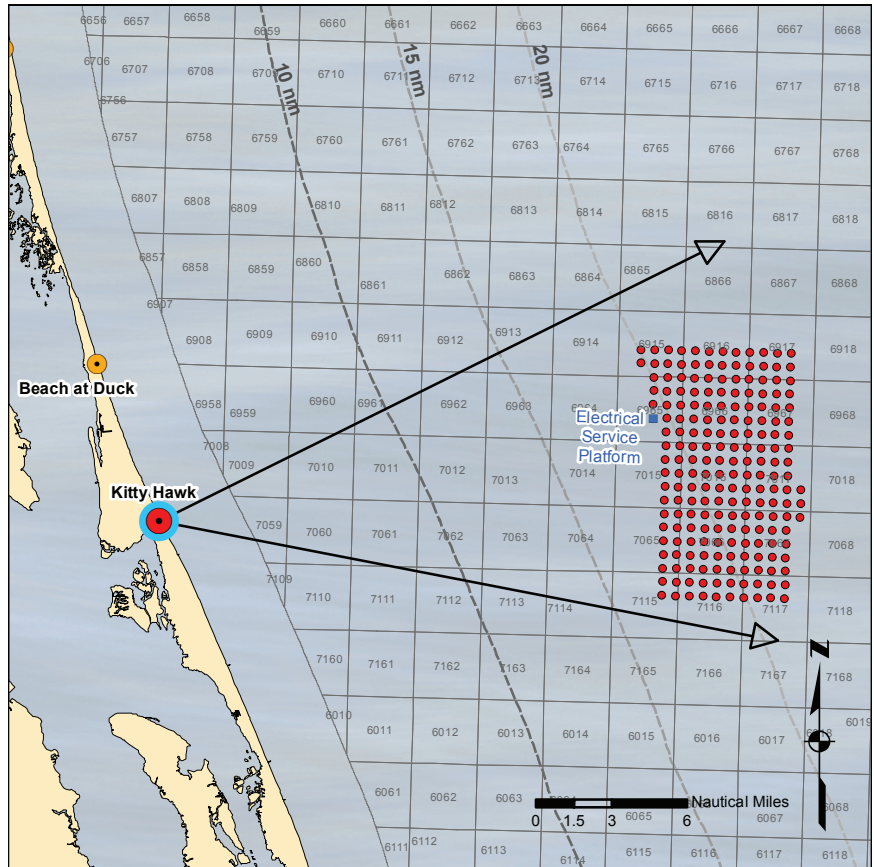
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SIMULATION

003 Kitty Hawk

Late Afternoon

Vestas V164-7.0 MW

10 nm

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 Vestas V164-7.0 MW
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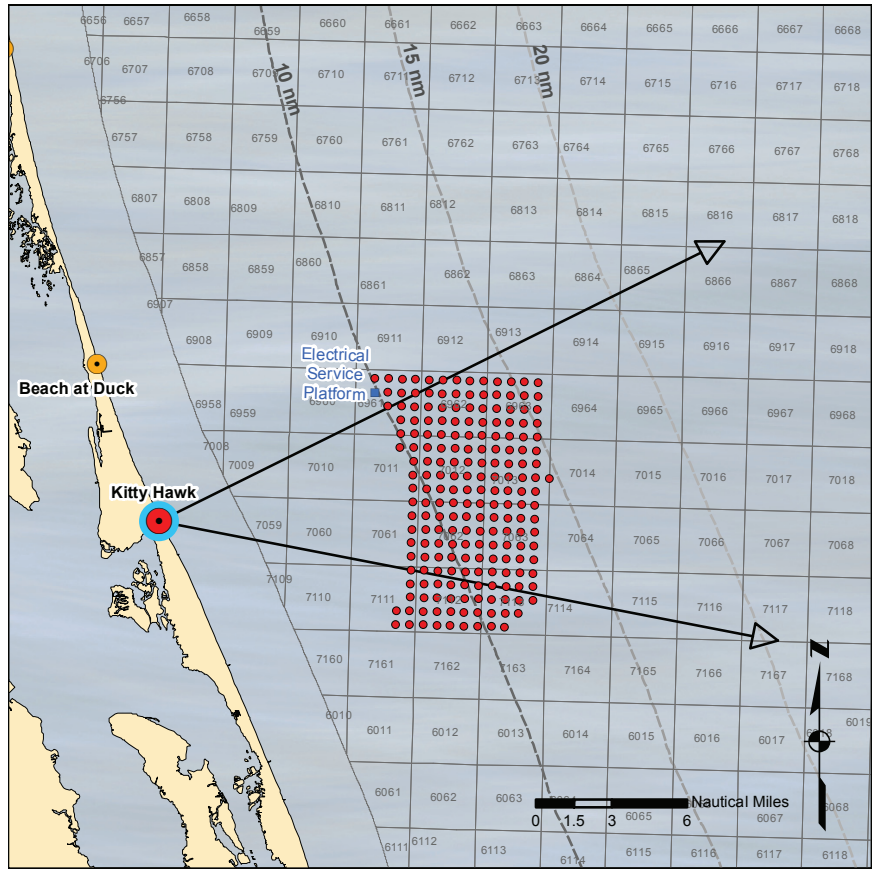
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Wind Turbine Information

Number: 200
 Make and Model: Vestas V164-7.0 MW
 Height/Dimensions:
 Support Structure/Monopile Ht.: 13 m (43')
 Hub Ht. (above Monopile): 105 m (344')
 Rotor Diameter: 164 m (538')
 Total Height to Tip of Blade: 200 m (656')
 Service Platform: A bldg. 50'H X 100'W X 200'L.
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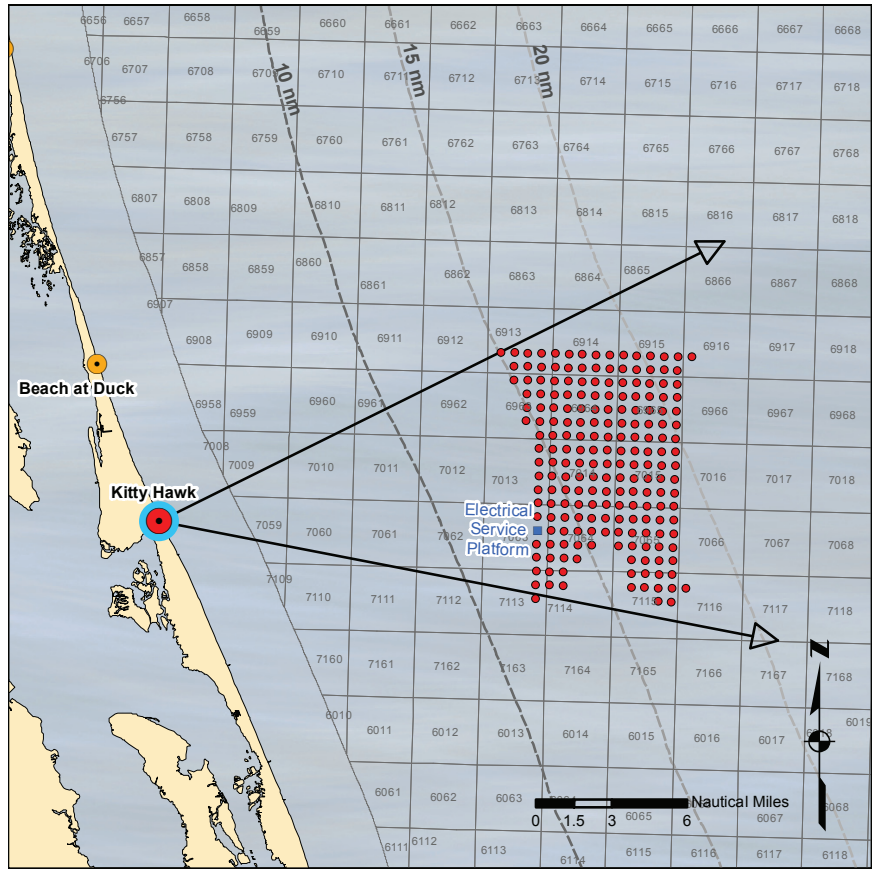
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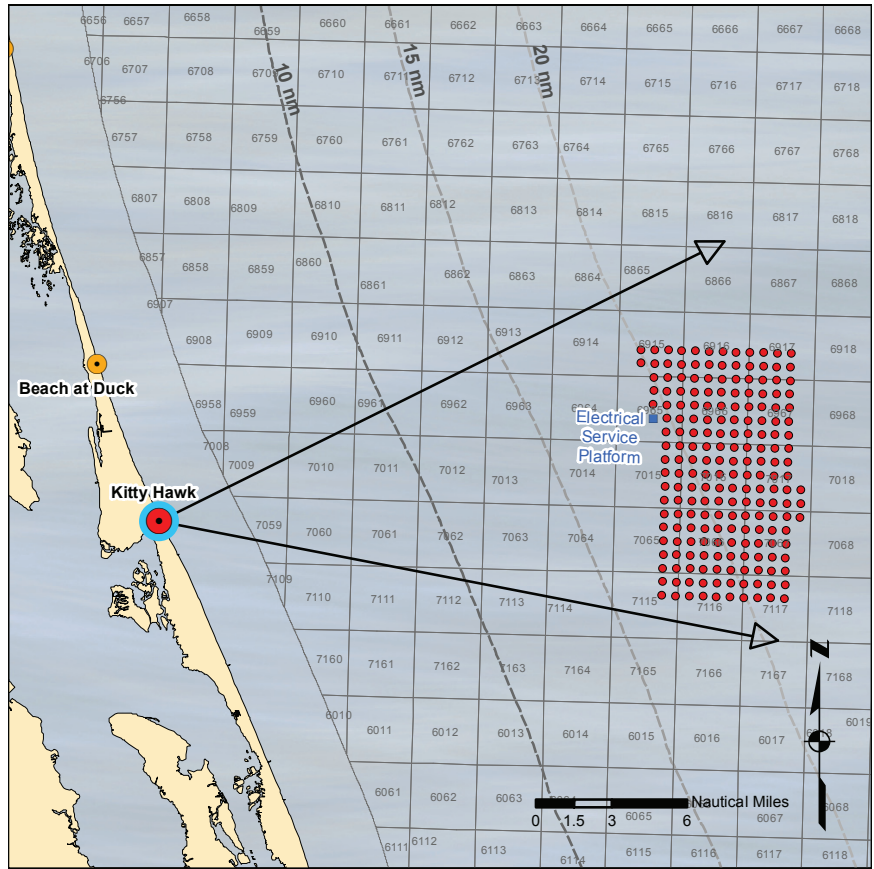
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Simulation location within the panorama view (190° X 60°) from the Kitty Hawk site



INFORMATION PAGE FOOTNOTES

¹GPS Coordinates

Location coordinates as used in WindPRO to register the wireframe diagram to the photograph. Due to slight errors and lens distortion, these values may differ at the fourth significant digit as obtained from a handheld GPS device at the time the photographs were taken and as shown on the Project Location Map.

²Visibility

Visibility is obtained from the closest airport weather station (see chart at right). The chart shows which weather station was used for each site. Visibility is measured up to ten statute miles.

³Camera Azimuth

Camera azimuth was obtained using a magnetic compass at the time of photography. However magnetic anomalies in the study area make some of these measurements unreliable. The camera azimuth reported here is for true north and reflects the bearing used to register the wind turbines to the photograph in WindPRO.

⁴Refraction Coefficient

The correction for refraction comes from Technical Appendix F Earth Curvature and Refraction of Light, in the report *Visual Representation of Windfarms Good Practice Guidance*, prepared for Scottish Natural Heritage (h+m 2006). The coefficient of refraction k is commonly defined as the ratio between the radius of the earth and the radius of the light in the line of sight between an object and the observer (Hirt 2010). The value reported here is half this value, but it is multiplied by two in the Technical Appendix's equation.

ABBREVIATIONS

nm	nautical miles
mi	statute miles
mm	millimeters
m	meters
sec.	seconds
'	feet
"	inches
°	degrees
lat	latitude
long	longitude

REFERENCES

h+m and envision. 2006. Visual Representation of Windfarms Good Practice Guidance. Scottish Natural Heritage.

Hirt C., Guillaume S., Wisbar A., Bürki B. and Sternberg, H. 2010. Monitoring of the refraction coefficient of the lower atmosphere using a controlled set-up of simultaneous reciprocal vertical angle measurements. *Journal of Geophysical Research*, 115, D21102, doi:10.1029/2010JD014067

Closest Airport Weather Station to Sites

Site	Weather Station Location NC
001 Corolla Lighthouse	Kill Devil Hills
002 Beach at Duck	Kill Devil Hills
003 Kitty Hawk	Kill Devil Hills
004 Coquina Beach	Kill Devil Hills
005 Bodie Island Lighthouse	Hatteras
006 Cape Hatteras Lighthouse	Hatteras
007 Lighthouse Beach	Hatteras
008 Ocracoke Beach	Hatteras
009 Portsmouth Life Saving Station Tower	Hatteras
010 Long Point Camps	Hatteras
011 Great Island Camps	Beaufort
012 Cape Lookout Lighthouse	Beaufort
013 Cape Point	Beaufort
014 Atlantic Beach	Beaufort
015 Bald Head Island	Southport
016 Oak Island	Southport
017 Holden Beach	Southport
018 Sunset Beach	Southport