

Visual Assessment

Bureau of Ocean Energy Management (BOEM): Commercial Wind Leasing and Site Assessment Activities on the Atlantic Outer Continental Shelf (OCS) Offshore North Carolina

Currituck and Brunswick Counties, North Carolina

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October 2014

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1.0 INTRODUCTION

1.1 Purpose of the Investigation

On behalf of ICF International, Inc. (ICF) and the Bureau of Ocean Energy Management (BOEM), Environmental Design & Research, Landscape Architecture, Engineering, & Environmental Services, D.P.C. (EDR) conducted photography fieldwork and prepared visual simulations in support of the Environmental Assessment (EA) for Commercial Wind Leasing Activities on the Atlantic Outer Continental Shelf (OCS) Offshore North Carolina (the Project). The potential environmental impacts of the Commercial Wind Leasing Activities are being considered by BOEM pursuant to their obligations under the National Environmental Protection Act (NEPA). This study focuses on the potential visibility and potential visual effect (from on-shore locations) of proposed built structures that may be constructed as part of the Project.

1.2 Project Location and Description

In consultation with other Federal agencies and the BOEM North Carolina Intergovernmental Renewable Energy Task Force, BOEM has identified three areas under consideration for potential offshore commercial wind energy leasing (the North Carolina Call Areas). These Call Areas include the Kitty Hawk Duck Area, the Wilmington Area, and the Wilmington West Area (see Figure 1). Each of these Call Areas includes a contiguous cluster of lease blocks and are being evaluated as potential sites for commercial wind energy lease areas. The size and distance from shore for each of these Call Areas is:

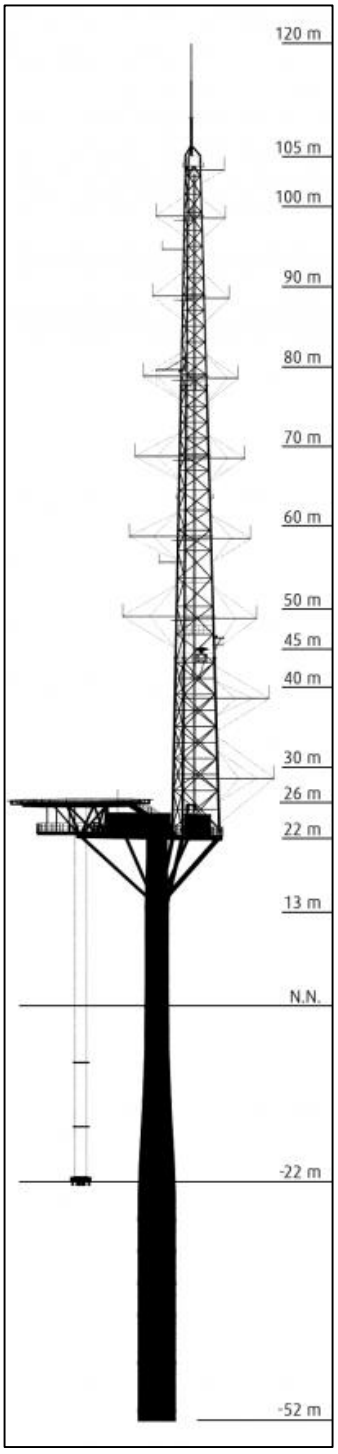
- Kitty Hawk Duck Area – 21.5 lease blocks (344 aliquots[1]), approximately 27 to 43 miles from shore.
- Wilmington Area – 25.1 lease blocks (401 aliquots), approximately 19 to 33 miles from shore.
- Wilmington West Area – 9.1 lease blocks (145 aliquots), approximately 18.5 to 32 miles from shore.

The potential structures that could be built as part of wind leasing activities include meteorological towers and buoys. It is anticipated that one meteorological tower will be erected within each Call Area. Because of the distance of each Call Area from shore, it is anticipated that buoys installed within each Call Area will not be visible from shore. Therefore, the potential visual effect of buoys is not considered in this analysis.

[1] The following definition of aliquots is provided in the GIS shapefile "Atlantic OCS aliquots" prepared by BOEM (Creed and Taylor, Undated): Aliquots are generated from full OCS blocks by sub-dividing each block into 16ths and allow for more detailed boundary delineation in offshore energy leasing. The aliquots use a letter designation in addition to their parent protraction number and OCS block number (i.e., NK-1802, 6822F). A full OCS block is 4800 x 4800 meters, while an aliquot measures 1200 x 1200 meters. Smaller, clipped aliquots are found along the Fed/State OCS boundary and along UTM zone borders. This dataset includes aliquots for 60 protractions out of the available 80 protractions in the Atlantic. The remaining 20 protractions are located on the seaward edge of the OCS. Aliquots for these protractions will be produced at a later date as needed.

The precise model and specifications of the meteorological towers that may be installed as part of the Project have also not yet been determined. However, for the purpose of presenting a conservative analysis, BOEM determined that analysis of potential visual effects should be based on the FINO 3 Meteorological Tower. The FINO 3 represents one of the tallest meteorological towers that is currently being deployed for commercial offshore wind development and therefore provides a "worst case" basis for evaluating potential visibility and visual effects.

As shown in Inset 1, the maximum height of the FINO 3 meteorological tower is 120 meters above the average sea level. The tower is built on a monopole structure that extends up to 22 meters below the water, with an additional 30 meters embedded within the sea floor. The monopole rises to a 13 by 13-meter service platform at an elevation of 22 meters above the water line. A lattice structure with numerous arms (where meteorological sensors will be located) rises from the service platform to 105 meters above the water. A Federal Aviation Administration (FAA) obstruction warning light is located at the top of the structure, and a 15-meter antennae structure extends up from that (i.e., from 105 to 120 meters above the water).



Inset 1. Elevation Diagram of FINO 3 Meteorological Tower.
Schematic diagram available at: http://www.fino3.de/en/fino3/design-of-the-fino3.

1.3 Viewpoint Selection

In accordance with standard practice in visual impact assessment (e.g., NPS, 2014), BOEM identified key viewpoints that are representative of the affected seascape and circumstances of perspective viewers of the Project. The viewpoints were selected based on consideration of the following criteria: proximity to the Call Areas, availability of open views of the ocean and horizon, high public use and visitation, historical significance and sensitivity of the sites, and inclusion of views available from both the ground and elevated vantage points. The viewpoints selected for inclusion in the visual study are shown in Figure 2 and listed in Table 1.

Table 1. Viewpoints Selected for Inclusion in Visual Analysis.

Viewpoint #	Viewpoint Name and Locations	Distance to Call Areas	Comments*
1	Currituck Beach Lighthouse (Currituck County)	~27-43 miles to Kitty Hawk Duck Area	Elevated NRHP-listed
2	Corolla Public Beach (Currituck County)	~27-43 miles to Kitty Hawk Duck Area	Shorefront
3	Sunset Beach Pier (Brunswick County)	~11.5-21 miles to Wilmington West Area ~32-56 miles to Wilmington Area	Shorefront
4	Old Baldy Lighthouse (Bald Head Island, Brunswick County)	~12-26 miles to Wilmington West Area ~19-33 miles to Wilmington Area	Elevated NRHP-listed
5	South Beach (Bald Head Island, Brunswick County)	~11.5-26 miles to Wilmington West Area ~18.5-32 miles to Wilmington Area	Shorefront

* NRHP = National Register of Historic Places.

It is worth noting that Viewpoints 1 and 2 (Currituck Beach Lighthouse and Corolla Public Beach) and Viewpoints 4 and 5 (Old Baldy Lighthouse and South Beach on Bald Head Island) are located in close proximity to one another. These pairings of nearby viewpoints were intentionally selected to allow for evaluation of the effect of viewer elevation on the potential visibility and perceived scale of the meteorological towers.

2.0 METHODOLOGY

2.1 Computer Model

EDR developed a three-dimensional (3-D) computer model of the FINO 3 Meteorological Tower based on specifications and photographs available on the manufacturer's website[2]. These data were used to construct a to-scale computer model of the meteorological tower using AutoCAD® software. The model included detail sufficient to represent the appearance and potential visibility of tower components from on-shore viewpoints. Appropriate structural materials and finishes were applied based on specifications and photographs available on the manufacturer's website. An elevation diagram of EDR's digital model of the FINO 3 Meteorological Tower (based on the manufacturer's specifications) is presented in Figure 3.

2.2 Fieldwork Methodology

At each of the five viewpoint sites, a two-person EDR crew selected an appropriate photo location, based on the availability of an open view toward the proposed Call Area (or Areas), appropriate composition and lighting, and if possible, the inclusion of distinctive foreground features that would allow recognition of the viewpoint by the public. Once the viewpoint was selected, a series of overlapping photos of the entire visible seascape was obtained at specific times throughout the day. Photos were obtained from shoreline locations (Viewpoints 2, 3, and 5) in the early morning (7:30 a.m. – 9:30 a.m.), mid-day (12:30 – 2:00 p.m.), late-afternoon (4:30 – 6:30 p.m.) and evening (after 7:15 p.m.), using a tripod-mounted camera at approximately 1.5 meters above the ground. Photos were also obtained from the publicly-accessible viewing platform at the Currituck Beach and Old Baldy lighthouses (Viewpoints 1 and 4) in the morning, mid-day and afternoon. No evening photos were obtained from these locations as they are not open to the public at that time. Due to the restricted space available on the viewing platform, photos from the lighthouses were obtained using hand-held, rather than tripod-mounted cameras.

For the shoreline viewpoints (2, 3, and 5), a Nikon D7100 digital SLR camera with a resolution of 24 mega pixels was used. The camera used for the lighthouse viewpoints (1 and 4) was a Nikon D200 with a resolution of 10 megapixels. The equivalent of a 50 mm lens setting was used for all photos. This focal length is the standard used in visual impact assessment because it most closely approximates the central cone of vision seen by the human eye (Enviros Consulting 2005), and accurately illustrates human perception of depth of field and scale in the landscape.

Nighttime photos were obtained using a range of shutter speeds to assure proper exposure of both the foreground and background at each viewpoint.

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[2] Specifications for the FINO 3 meteorological tower are available at http://www.fino3.de/en/fino3/design-of-the-fino3.

In addition, for the three shoreline viewpoints (2, 3, and 5), EDR staff obtained a panoramic series of overlapping photographs and short digital video clips at regular 15-minute intervals throughout the day. These photographs and videos will be used to prepare time lapse video simulations that illustrate changing lighting conditions throughout the day and the effect on Project visibility. These video simulations are not included as part of the Visual Assessment but will be available on the Project website.

EDR's field crew also utilized global positioning system (GPS) equipment with sub-meter accuracy to document the location of each viewpoint and foreground reference features (e.g., buildings, fences, driven stakes) visible in the photos. Precise location of these features allows accurate camera alignment during the development of visual simulations (see discussion in Section 2.3). It also assures that the resulting simulations will have a high degree of accuracy in terms of the location and perceived size of the meteorological tower relative to other landscape features in the view.

The time and location of each photo were documented on all electronic equipment (camera, GPS unit, etc.) and noted on field maps and data sheets. This information is included with the simulations presented in Appendix A.

2.3 Visual Simulation Methodology

To show anticipated visual changes associated with the proposed Project, high-resolution computer-enhanced image processing was used to create realistic photographic simulations of the completed meteorological tower(s) from each of the five selected viewpoints. The photographic simulations were developed by constructing a three-dimensional computer model of the proposed meteorological tower based on specifications obtained from the manufacturer of the FINO 3 meteorological tower (see Section 2.1) and conservative assumptions regarding the potential location of the tower relative to each viewpoint. At the time that this study was prepared, BOEM has not determined the precise location of proposed meteorological towers. For the purpose of presenting a conservative analysis, it is assumed that the proposed meteorological towers will be installed at the centerpoint of the nearest lease block within each Call Area relative to the on-shore viewpoints that were selected for the analysis. The assumed locations of the meteorological towers (for the purpose of preparing visual simulations) relative to each of the five selected viewpoints are depicted in Figure 2.

Simulations were created by aligning each photographic viewpoint with the computer model of the proposed meteorological tower(s), and superimposing the model on the photographs using various types of software. Initially an AutoCAD® drawing is created utilizing aerial photographs and GPS data collected in the field. The two dimensional AutoCAD® data are then imported into 3D Studio Max® and three-dimensional components (cameras, existing

reference features, modeled meteorological tower, etc.) added. These data are then superimposed over photographs from each of the viewpoints, and minor camera changes (height, roll, precise lens setting) were then made, as necessary, to align all known reference points within the view. This process ensures that Project elements are shown in proportion, perspective, and proper relation to the existing landscape elements in the view. Consequently, the alignment, elevations, dimensions and locations of the proposed meteorological towers are accurate and true in their relationship to other landscape elements in the photo.

At this point, a "wire frame" model of the facility and known reference points are shown on each of the photographs. The proposed exterior color/finish of the meteorological tower is then added to the model and the appropriate sun angle simulated, based on the specific date, time and location (latitude and longitude) at which each photo was taken. This information allows the computer to accurately illustrate highlights, shading and shadows on the proposed structure. Color saturation of the meteorological towers was reduced to better match background conditions. However, no hazing or screening of the meteorological tower was applied to the simulation to further obscure visibility of the proposed structure. Consequently, the towers actually appear somewhat more visible than other background features on the horizon (see container ship in the mid-day [12:35 P.M.] simulation from Viewpoint 1).

No screening due to the curvature of the earth was shown in the simulations. For all of the viewpoints curvature of the earth would theoretically result in a substantial portion of the meteorological tower falling below the visible horizon and thus being screened from view. However, to account for the possible effects of refraction (bending of light) no screening due to curvature of the earth was assumed, and the base of the tower was placed on the horizon line. Therefore, reduction in the visibility of the meteorological tower(s) due to curvature of the earth was not illustrated in the simulations.

Both panoramic and single frame versions of the panoramic images were prepared, all of which are included in Appendix A. The panoramic images illustrate an approximately 124 degree field of view, which is generally accepted as the primary field of human view (NZILA, 2010). Each of these panoramic views were created by stitching together individual photos, each of which show a horizontal field of view in the range of 36 to 45 degrees, which is equivalent to the field of view of a standard digital 50 mm camera lens (equivalent to a 35 mm conventional camera lens setting). A single frame 50 mm simulation is also included in Appendix A for each viewpoint to allow easier viewing of the printed images (at the appropriate viewing distance), and so as not to lose detail that would be visible in reality. Showing both the panoramic and single frame simulations allows proper depiction of facility details, while showing the facility in the proper visual context and better depicting its scale in relationship to its surroundings (NPS, 2014).



Inset 2. Nighttime photograph of FAA Warning Lights.
This photograph depicts the FAA warning lights (on the distant ridgeline at the horizon) at the Fenner Wind Farm (Madison County, New York) at a distance of approximately 13 miles, which is comparable to the distance to the proposed meteorological towers from some of the viewpoints included in this analysis. Photo credit: EDR, 2014.

To prepare nighttime simulations, EDR reviewed the specification for L864 FAA obstruction warning lights. In addition, EDR obtained actual nighttime photos from the Fenner Wind Farm, an operating wind power project in central New York State, to document the appearance of the FAA warning lights at night (see Inset 2). Observations and photos were obtained from a distance of approximately 13 miles using a range of exposures (i.e., shutter speeds). These photos were then used to help simulate the correct appearance of the FAA warning lights on the proposed meteorological towers.

Computer modeling and camera alignment for the nighttime photos was prepared in the same manner described for the daytime simulations. However, manipulation of the nighttime photos (e.g., compositing foreground and background images obtained using different shutter speeds) was required in some cases to create a realistic representation of a nighttime view. Although the simulations were prepared based on the technical specifications of the meteorological tower and lights, the images were modified based on field observations and professional experience to assure that they accurately represent the appearance of the FAA warning lights at the appropriate viewing distance. The base of the towers are also anticipated to be equipped with amber navigation warning lights. However, given the distance of

the towers from shoreline viewpoints, research suggests that these lights are not likely to be visible (Sullivan, et al. 2013)

The complete set of photographic simulations developed for this Project are provided in Appendix A.

3.0 RESULTS

3.1 Fieldwork Results

Photographs were obtained from each of the five selected viewpoints during a single field visit conducted between September 21 and 25, 2014. The fieldwork was scheduled based on a forecast of clear sky conditions. However, the actual weather was highly variable and included a mix of clear, partly cloudy, and overcast days. Although not ideal, this provided a representative variety of sky/lighting conditions, and visibility of the horizon was relatively clear under all the weather conditions encountered. Information regarding the viewpoint location, and elevation, and the date on which photos were obtained at each viewpoint is summarized in Table 2.

Table 2. Viewpoint Summary Data.

Viewpoint #	Viewpoint Name	Date (2014)	Latitude	Longitude	Elevation[1]	Orientation of View
1	Currituck Beach Lighthouse	September 21 & 22	36° 22' 35.95"N	75° 49' 50.30" W	148.3'	East
2	Corolla Public Beach	September 21 & 22	36° 22' 36.6788"N	75° 49' 27.4344" W	25.2'	East
3	Sunset Beach Pier	September 23 & 24	33° 52' 0.8264"N	78° 30' 21.6520"W	10.8'	Southeast
4	Old Baldy Lighthouse	September 25	33°52' 24.6480" N	78°00' 1.3198" W	106.6'	South-southwest
5	South Beach (Bald Head Island)	September 25	33° 51' 9.8325" N	77° 59' 22.1390" W	9.4'	South-southwest

[1]Elevation is height above mean sea level with camera positioned approximately at eye level.

3.2 Visual Simulations

A total of 15 daytime simulations and three nighttime simulations of the proposed meteorological towers were prepared (total of 18 simulations from five different viewpoints). These simulations depict the potential visibility and visual effect of the proposed towers at different times of day, under different weather conditions and a full range of lighting conditions. Information on the times of day and conditions depicted in each of the simulations is summarized in Table 3.

Table 3. Simulation Summary Data.

Viewpoint #	Viewpoint Name	Time of Day[1]	Weather Conditions	Distance to Tower
1	Currituck Beach Lighthouse – Morning	9:25 a.m.	Partly Cloudy	28.2
1	Currituck Beach Lighthouse – Mid-day	12:30 p.m.	Clear	28.2
1	Currituck Beach Lighthouse – Late Afternoon	4:46 p.m.	Partly Sunny	28.2
2	Corolla Public Beach – Morning	7:43 a.m.	Partly Cloudy	27.9
2	Corolla Public Beach – Mid-day	1:43 p.m.	Clear	27.9
2	Corolla Public Beach – Late Afternoon	6:12 p.m.	Partly Sunny	27.9
2	Corolla Public Beach – Evening	8:18 p.m.	Clear	27.9
3	Sunset Beach Pier - Morning	9:18 a.m.	Overcast	13.2, 32.8

Viewpoint #	Viewpoint Name	Time of Day[1]	Weather Conditions	Distance to Tower
3	Sunset Beach Pier – Mid-day	1:12 p.m.	Broken Overcast	13.2, 32.8
3	Sunset Beach Pier – Late Afternoon	5:13 p.m.	Overcast	13.2, 32.8
3	Sunset Beach Pier – Evening	7:07 p.m.	Overcast	13.2, 32.8
4	Old Baldy Lighthouse – Early Morning	10:26 p.m.	Overcast	12.7, 19.7
4	Old Baldy Lighthouse – Mid-Day	2:52 p.m.	Overcast	12.7, 19.7
4	Old Baldy Lighthouse – Late Afternoon	5:05 p.m.	Overcast	12.7, 19.7
5	South Beach (Bald Head Island) – Morning	9:17 a.m.	Overcast	12.2, 18.3
5	South Beach (Bald Head Island) – Mid-Day	1:58 p.m.	Broken Overcast	12.2, 18.3
5	South Beach (Bald Head Island) – Afternoon	4:57 p.m.	Broken Overcast	12.2, 18.3
5	South Beach (Bald Head Island) - Evening	7:15 p.m.	Overcast	12.2, 18.3

[1]Eastern Daylight Savings Time

It is worth noting that the photographs and simulation from Old Baldy Lighthouse (Viewpoint 4) were taken from the interior of the enclosed chamber at the top of the lighthouse, through glass windows. These photos represent the only publicly-accessible view available from this lighthouse. Reflections and subtle distortion from the glass are apparent in the photographs. This accurately conveys the view that is available and is perceived by visitors to the lighthouse.

3.3 Viewing Instructions

3.3.1 Printed Simulation Viewing Instructions

The single frame simulations showing a 36-45° degree field of view (FOV) should be printed on 11 x 17 inch paper and viewed at a distance of approximately 20" from the eye (or approximately twice the image height) to assure proper perspective and perception of scale. The formula for determining the correct size of the image for a single frame simulation in relation to the distance viewed is as follows (per National Academy of Sciences, 2007; NPS, 2014; NZILA, 2010):

Distance from viewer = Width of image/[2 x tan (HFOV 1/2)]

The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are approximately 33.6 inches from the viewer, consistent with the formula presented above (BOEM, 2014: Appendix H).

3.3.2 Video Simulation Viewing Instructions

The video simulations show approximately the same 30° vertical field of view as the printed simulations, with the horizontal field of view cropped to the limits of the video. Because computer monitors come in various sizes, no single

viewing distance can be provided. To calculate the viewing distance from different monitor sizes, the following equation can be used: tan(30/2°)=(video height/2)/(viewing distance) where the video height is the vertical size of the image as displayed on the screen. When viewing the video, use the highest screen resolution possible.

3.4 Conclusions

The results of the Visual Assessment allow for the following conclusions to be made regarding the visibility and potential visual effect of the Project:

- Due to the effect of distance, the overall visibility of the meteorological towers will be relatively minimal when viewed from shoreline locations. As shown in the simulations from Viewpoint 3, at distances of approximately 12 miles the shape of the meteorological tower and its various components (monopole, platform, and lattice tower) are discernible. At greater distances, the meteorological towers appear as thin, faint, vertical lines at the horizon.

- In addition, due to the effect of distance, the perceived scale of the meteorological towers is not significantly greater when viewed from elevated vantage points (compare Simulations for Viewpoints 1 and 2 and for Viewpoints 4 and 5). For both Currituck Beach Lighthouse and Corolla Beach (Viewpoints 1 and 2) and Old Baldy Lighthouse and South Beach at Bald Head Island (Viewpoints 4 and 5), the scale of the meteorological towers appear identical regardless of whether they are being viewed from shoreline or elevated (lighthouse) vantage points. However, as described in Section 2.3, to account for the possible effects of refraction (bending of light) no screening due to the curvature of the earth was shown in the simulations. The potential screening effect of curvature of the earth would be more pronounced from shoreline locations, while this should have less of an effect on the perceived height of the structures from elevated vantage points (i.e., the lighthouses). Therefore, the simulations for the shoreline viewpoints likely overstate the potential visibility and perceived scale of the meteorological towers relative to the simulations from the adjacent lighthouse vantage points.

- Due to their thin profile, the meteorological towers occupy less than 1% of the visible seascape. As shown in the panoramic simulations included in Appendix A, their overall effect on the sense of openness in the seascape view is minimal.

- In general, viewer attention at shoreline locations is focused on the movement of the waves in the foreground, activity along the beach, and the sense of openness and panoramic nature of the open seascape. Because the meteorological towers are visible at the horizon and are the only vertical element(s) within the otherwise horizontal plane of the open seascape, their vertical form will attract viewer's attention. However, because

only one or two meteorological towers will be visible from any location, and due to their thin profile, the towers do not command the viewer's attention and are unlikely to be perceived as a new focal point.

- As shown in the simulations from Viewpoints 1 and 2, under clear (or sunny) conditions the meteorological towers are relatively more visible in the early morning, due to the effect of backlighting. In these circumstances the meteorological towers appear as dark vertical lines and are more pronounced against the horizon (although this is tempered by their thin profile). Under clear conditions during mid-day and afternoon conditions (when the sun is overhead or behind the viewer and the towers are generally front lit) the meteorological towers are generally less visible.

- In general, the variation in the visibility of the towers at different times of day and under different lighting conditions has less of an effect on the visibility and appearance of the towers under overcast and cloudy conditions. This is readily apparent when comparing the simulations from Viewpoints 1 and 2, which generally depict clear/sunny conditions, with the simulations from Viewpoints 3-5, which depict a range of partly cloudy, mostly cloudy, and overcast conditions. Under overcast conditions, the towers may be more visible (relative to brightly lit conditions) due to contrast against the undifferentiated, muted tone of the sky. As shown in the mid-day and afternoon simulations from Viewpoint 3 and 5 – at closer viewing distances and under cloudy or overcast conditions when the towers are front lit and/or the lighting is diffuse – the colors and red and white striped pattern of the lattice structure may be apparent, although the colors will appear muted.

- As shown in the nighttime simulations, under clear conditions the FAA warning light mounted to the top of each meteorological tower will be visible from shoreline locations. The visibility and effect of the FAA lights will be influenced by viewing distance. The nighttime simulation from Viewpoint 2 shows that at distances of approximately 28 miles, the FAA light is apparent and will likely attract viewer attention because of the absence of other immobile light sources at the horizon. However, due to the effect of distance, the FAA light is very small, relatively dull, and low to the horizon. The nighttime simulations from Viewpoints 3 and 5 illustrate the predicted appearance of the FAA warning lights at approximately 12-13 miles (Wilmington West lease area), 18 miles (Wilmington lease area from Viewpoint 5), and 32 miles (Wilmington lease area from Viewpoint 3). As illustrated in the simulations, the FAA light on the Wilmington West lease area meteorological tower is more visible and pronounced than the FAA light on the tower in the Wilmington lease area. However, even the nearer meteorological tower light has a limited effect due to its distance from the viewer. The simulations from Viewpoints 3 and 5 also depict other existing light sources on the seascape. Lighting on the Sunset Beach Pier (Viewpoint 3) and lights from a ship passing offshore (Viewpoint 5) reduce the contrast presented by the FAA lights on the meteorological towers.

As mentioned previously, for the purpose of presenting a conservative analysis, the simulations included herein were created based on the assumption that the proposed meteorological towers will be installed in the nearest lease block within each Call Area relative to each viewpoint. Therefore, each simulation shows each meteorological tower in the nearest potential location relative to the viewer. If the meteorological towers are placed closer to the center of each Call Area, then the potential visual effect of the meteorological towers will be reduced relative to what is presented in the simulations.

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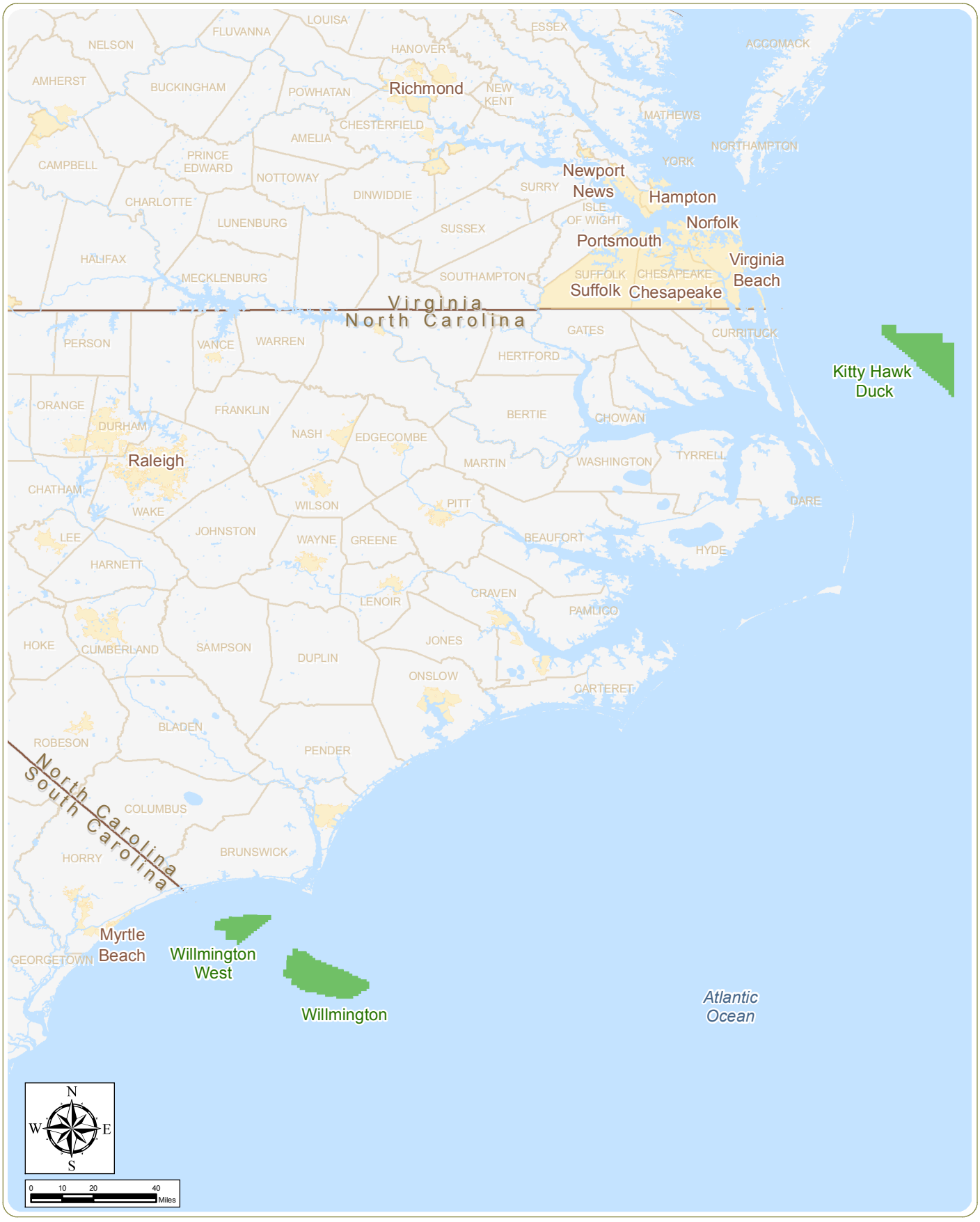
Figures



BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Figure 1: Regional Project Location

October 2014

Wind Lease Call Area

Notes: 1. Basemap: ESRI StreetMap North America, 2008.
2. This is a color graphic. Reproduction in grayscale may misrepresent the data.

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Atlantic Outer Continental Shelf, Offshore, North Carolina

Figure 2: Viewpoint Location Map

October 2014

Notes: 1. Basemap: ESRI StreetMap North America, 2008.
2. This is a color graphic. Reproduction in grayscale may misrepresent the data.

- Viewpoint
- Meteorological Tower
- Indicates which Met Tower Location(s) Apply to each Viewpoint
- Wind Lease Call Area

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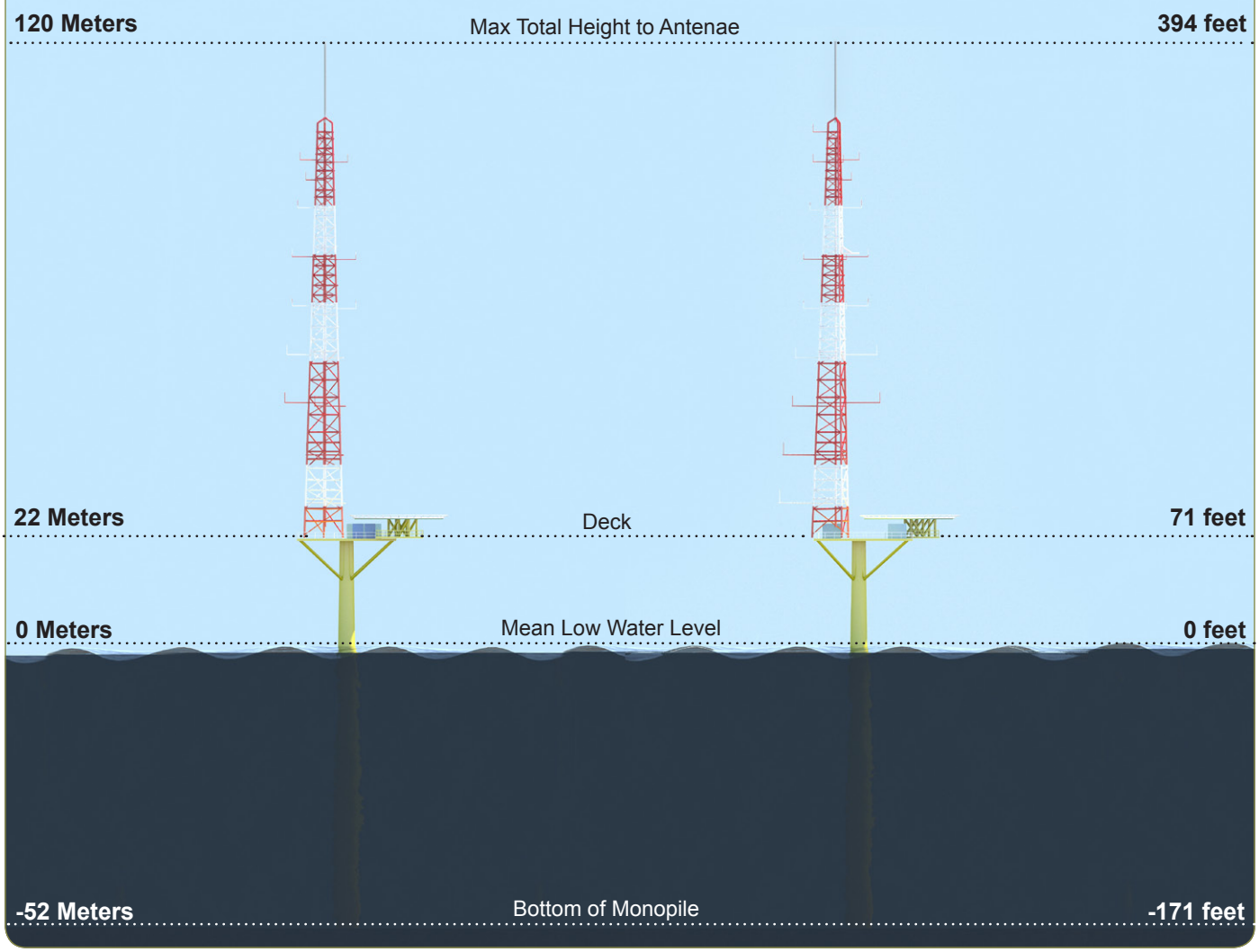
Dimensions of Proposed Meteorological Towers



BOEM Commercial Wind Leasing and Site Assessment
Atlantic Outer Continental Shelf, Offshore, North Carolina
Figure 3: Digital Model of Proposed Meteorological Towers
October 2014

Note:
All dimensions rounded to the nearest whole number

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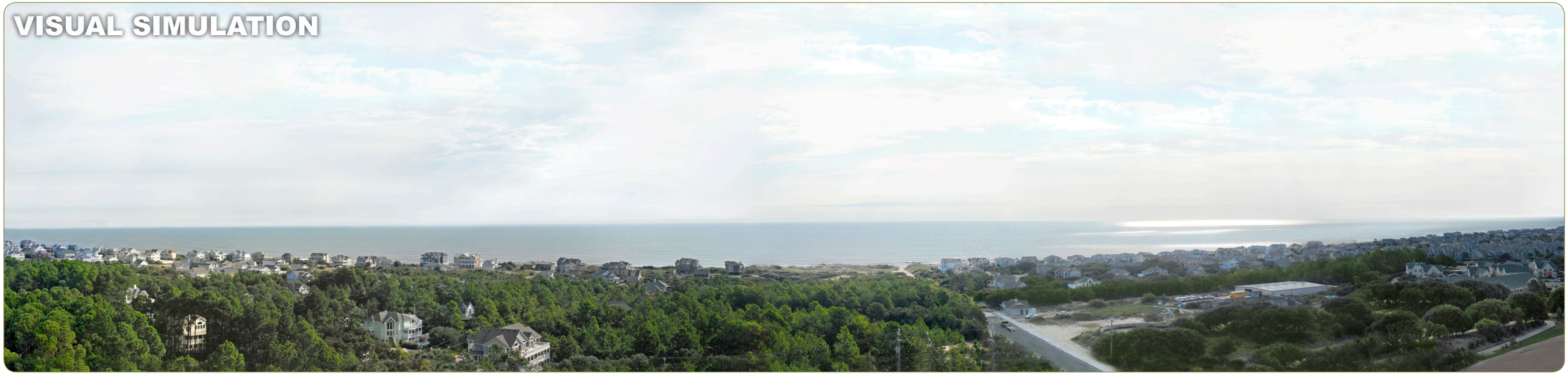
www.edrdpc.com

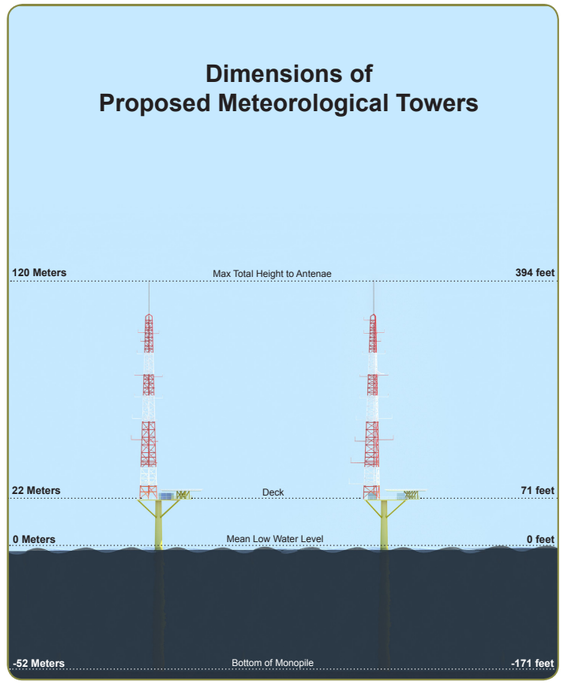
Appendix A:
Visual Simulations



Panoramic Simulation, Early Morning, 9:25 AM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....1
Viewpoint Name:.....Currituck Beach Light House
Latitude:.....36° 22’ 35.8674” N
Longitude:.....75° 49’ 49.8609” W
Viewer Elevation Above Sea Level:.....148.277’

SIMULATION INFORMATION

Wind Lease Area:.....Kitty Hawk Duck
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....394’
Distance to Meteorological Tower:.....28.23 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/22/14
Time of Photograph:.....9:25AM
Weather Condition:.....Partly Cloudy
Camera Model:.....Nikon D200
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:.....87.2° East

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 1: Currituck Beach Lighthouse, Currituck County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

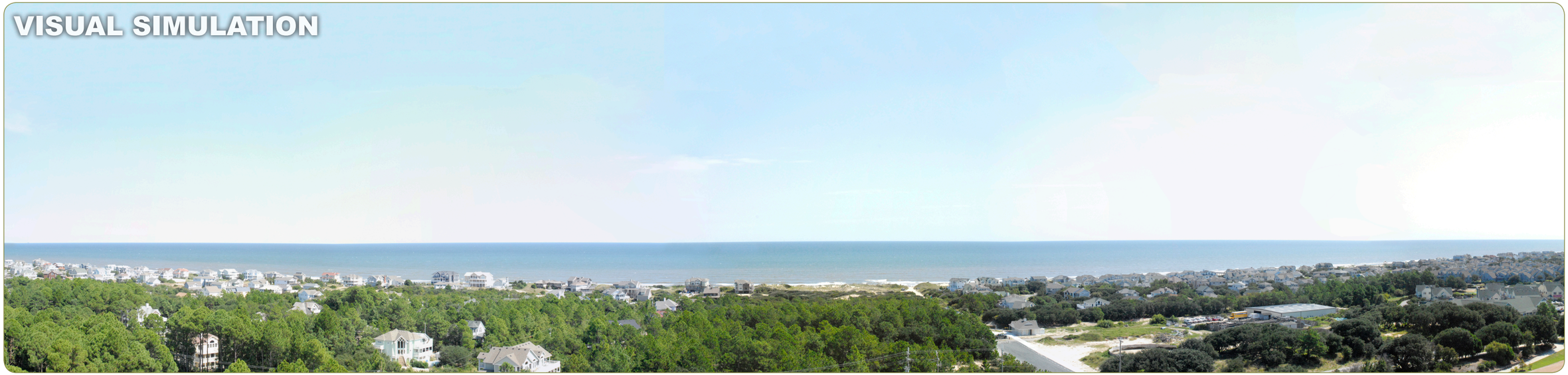
Viewpoint 1 : Currituck Beach Lighthouse, Currituck County, North Carolina
35mm Visual Simulation, Early Morning, 9:25AM, View of Kitty Hawk - Duck Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Kitty Hawk - Duck Lease Area

Meteorological Tower

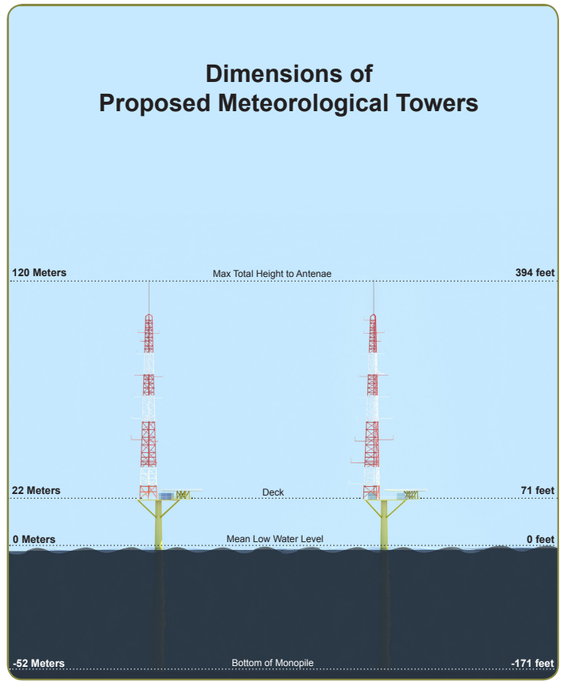
VISUAL SIMULATION



Panoramic Simulation, Mid-day, 12:30 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....1
Viewpoint Name:.....Currituck Beach Light House
Latitude:.....36° 22’ 35.8674” N
Longitude:.....75° 49’ 49.8609” W
Viewer Elevation Above Sea Level:.....148.277’

SIMULATION INFORMATION

Wind Lease Area:.....Kitty Hawk Duck
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....394’
Distance to Meteorological Tower:.....28.23 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/22/14
Time of Photograph:.....12:30PM
Weather Condition:.....Partly Cloudy
Camera Model:.....Nikon D200
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:.....87.2° East

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 1: Currituck Beach Lighthouse, Currituck County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 1 : Currituck Beach Lighthouse, Currituck County, North Carolina
35mm Visual Simulation, Mid-day, 12:30PM, View of Kitty Hawk - Duck Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Kitty Hawk - Duck Lease Area

Meteorological Tower

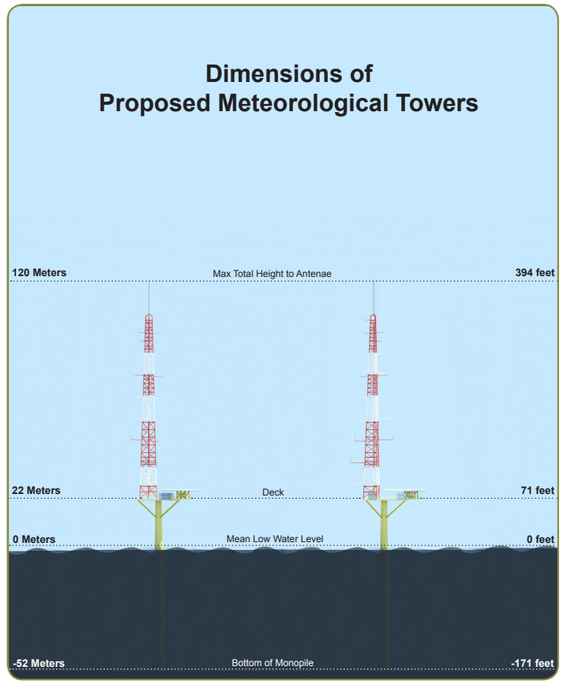
VISUAL SIMULATION



Panoramic Simulation, Late Afternoon, 4:46 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....1
Viewpoint Name:.....Currituck Beach Light House
Latitude:.....36° 22’ 35.8674” N
Longitude:.....75° 49’ 49.8609” W
Viewer Elevation Above Sea Level:.....148.277’

SIMULATION INFORMATION

Wind Lease Area:.....Kitty Hawk Duck
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....394’
Distance to Meteorological Tower:.....28.23 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/21/14
Time of Photograph:.....4:46PM
Weather Condition:.....Partly Clear
Camera Model:.....Nikon D200
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:.....87.2° East

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 1: Currituck Beach Lighthouse, Currituck County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 1 : Currituck Beach Lighthouse, Currituck County, North Carolina
35mm Visual Simulation, Late Afternoon, 4:46PM, View of Kitty Hawk - Duck Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

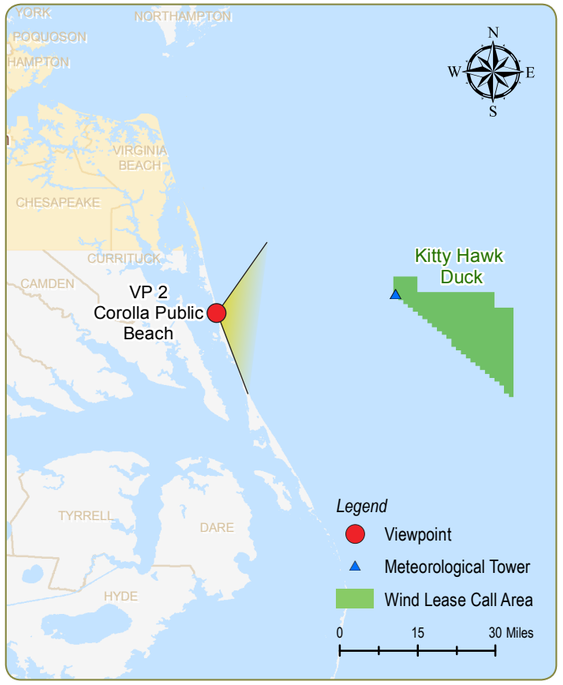
Kitty Hawk - Duck Lease Area

Meteorological Tower

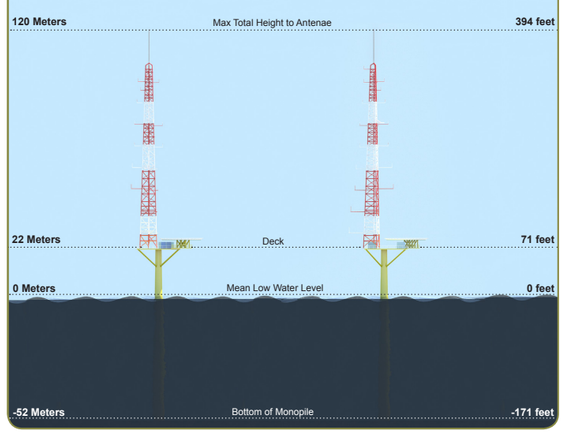
VISUAL SIMULATION



Panoramic Simulation, Early Morning, 7:43 AM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....2
Viewpoint Name:.....Corolla Public Beach
Latitude:..... 36° 22’ 36.6788” N
Longitude:.....75° 49’ 27.4344” W
Viewer Elevation Above Sea Level:.....26.78’

SIMULATION INFORMATION

Wind Lease Area:.....Kitty Hawk Duck
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....394’
Distance to Meteorological Tower:.....27.88 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/22/14
Time of Photograph:.....7:43AM
Weather Condition:.....Partly Cloudy
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:.....87.2° East

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 2: Corolla Public Beach, Currituck County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Viewpoint 2 : Corolla Public Beach, Currituck County, North Carolina
35mm Visual Simulation, Early Morning, 7:43AM, View of Kitty Hawk - Duck Meteorological Tower.

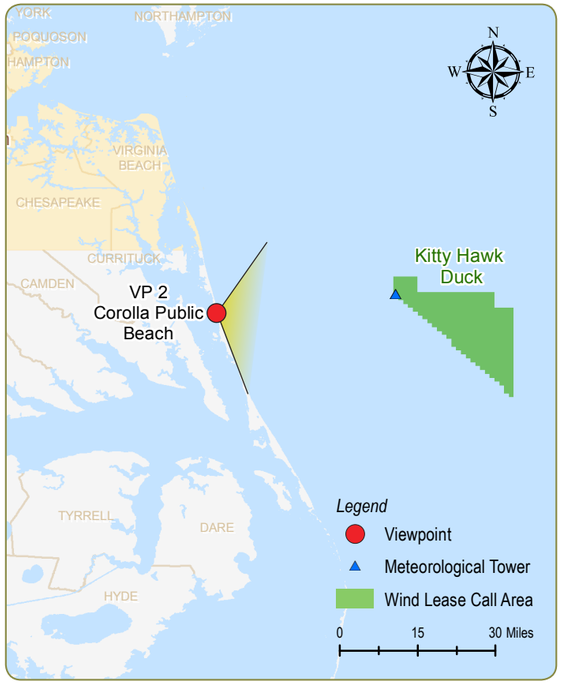
Kitty Hawk - Duck Lease Area

Meteorological Tower

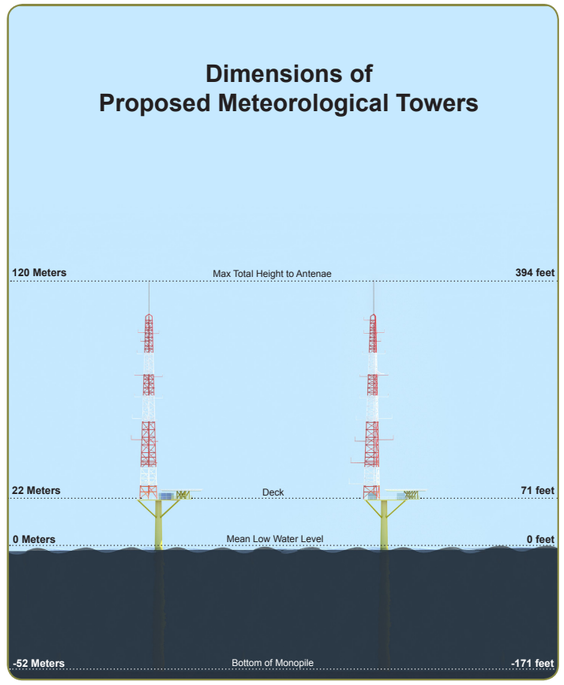
VISUAL SIMULATION



Panoramic Simulation, Mid-day, 1:43 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....2
Viewpoint Name:.....Corolla Public Beach
Latitude:..... 36° 22’ 36.6788” N
Longitude:.....75° 49’ 27.4344” W
Viewer Elevation Above Sea Level:.....26.78’

SIMULATION INFORMATION

Wind Lease Area:.....Kitty Hawk Duck
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....394’
Distance to Meteorological Tower:.....27.88 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/21/14
Time of Photograph:.....1:43PM
Weather Condition:.....Clear Skies
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:.....87.2° East

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 2: Corolla Public Beach, Currituck County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 2 : Corolla Public Beach, Currituck County, North Carolina
35mm Visual Simulation, Mid-day, 1:43PM, View of Kitty Hawk - Duck Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

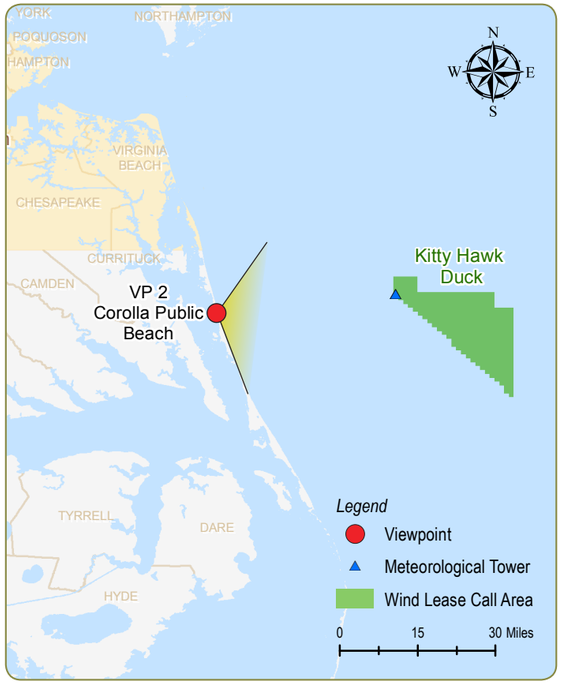
Kitty Hawk - Duck Lease Area

Meteorological Tower

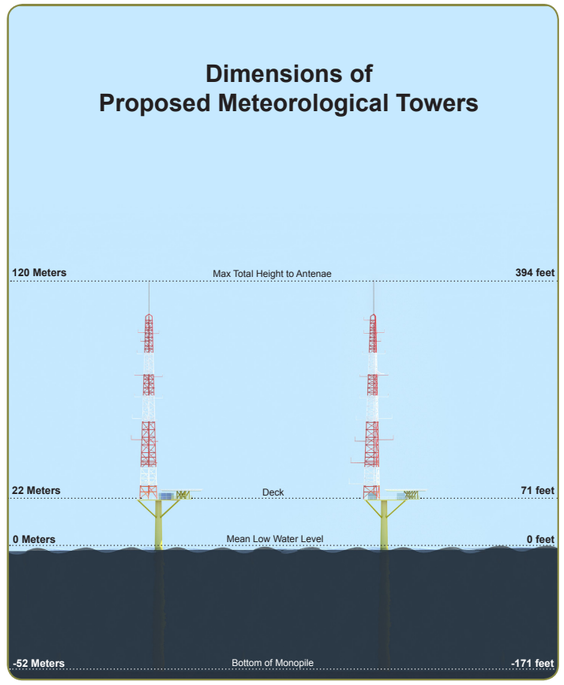
VISUAL SIMULATION



Panoramic Simulation, Late Afternoon, 6:12 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....2
Viewpoint Name:.....Corolla Public Beach
Latitude:..... 36° 22’ 36.6788” N
Longitude:.....75° 49’ 27.4344” W
Viewer Elevation Above Sea Level:.....26.78’

SIMULATION INFORMATION

Wind Lease Area:.....Kitty Hawk Duck
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Distance to Meteorological Tower:.....27.88 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/21/14
Time of Photograph:.....6:12PM
Weather Condition:.....Clear Skies
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:.....87.2° East

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 2: Corolla Public Beach, Currituck County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Viewpoint 2 : Corolla Public Beach, Currituck County, North Carolina
35mm Visual Simulation, Late Afternoon, 6:12PM, View of Kitty Hawk - Duck Meteorological Tower.

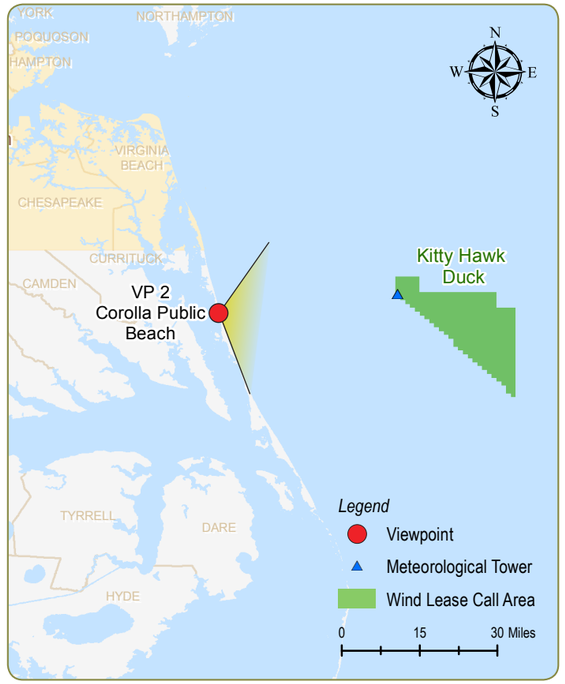
Kitty Hawk - Duck Lease Area

▼ Meteorological Tower

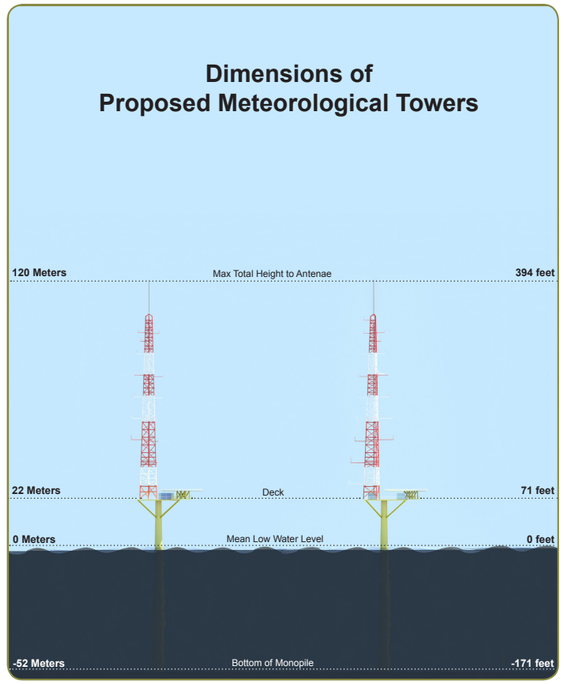
VISUAL SIMULATION



Panoramic Simulation, Night, 8:27 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....2
Viewpoint Name:.....Corolla Public Beach
Latitude:..... 36° 22’ 36.6788” N
Longitude:.....75° 49’ 27.4344” W
Viewer Elevation Above Sea Level:.....26.78’

SIMULATION INFORMATION

Wind Lease Area:.....Kitty Hawk Duck
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Distance to Meteorological Tower:.....27.88 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/21/14
Time of Photograph:.....8:27PM
Weather Condition:.....Cloudy
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:.....87.2° East

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 2: Corolla Public Beach, Currituck County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 2 : Corolla Public Beach, Currituck County, North Carolina
35mm Visual Simulation, Night, 8:27PM, View of Kitty Hawk - Duck Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering &
Environmental Services, D.P.C.

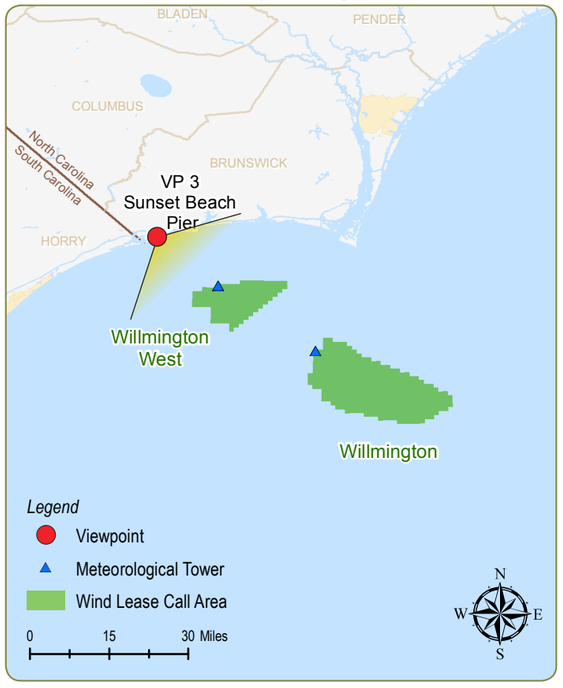
Wilmington & Wilmington West Lease Areas

Meteorological Towers

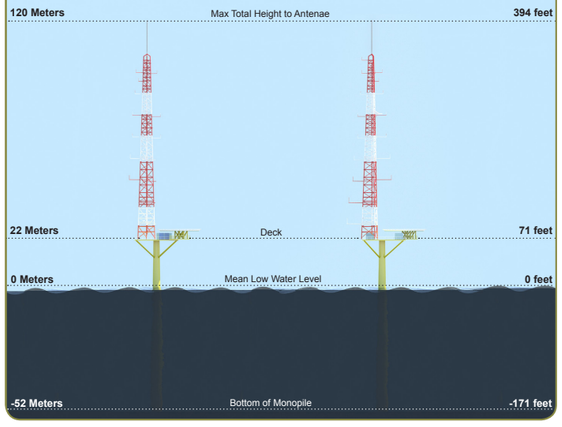
VISUAL SIMULATION



Panoramic Simulation, Early Morning, 9:18 AM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....3
Viewpoint Name:.....Sunset Beach Pier
Latitude:.....33° 52’ 0.8072” N
Longitude:.....78° 30’ 21.6515” W
Viewer Elevation Above Sea Level:.....12.82’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:.....13.16 & 33.81 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/23/14
Time of Photograph:.....9:18AM
Weather Condition:.....Overcast
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....134.1° Southeast

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 3: Sunset Beach Pier, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 3 : Sunset Beach Pier, Brunswick County, North Carolina
35mm Visual Simulation, Early Morning, 9:18AM, View of Wilmington & Wilmington West Meteorological Towers.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

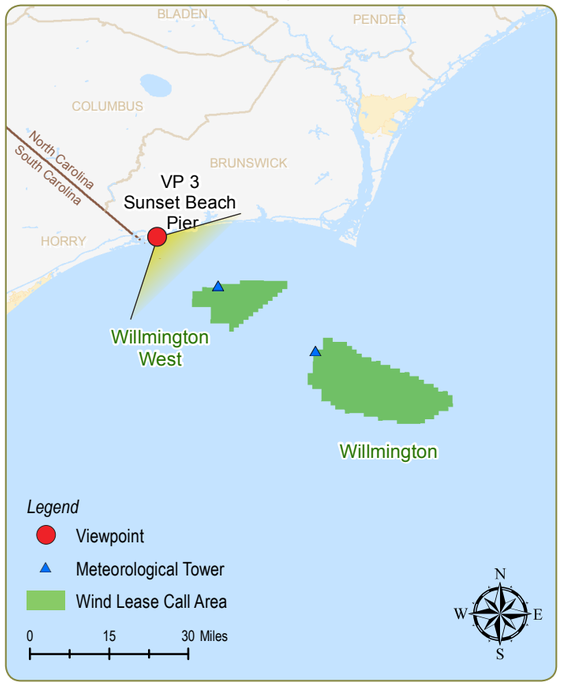
Wilmington & Wilmington West Lease Areas

Meteorological Towers

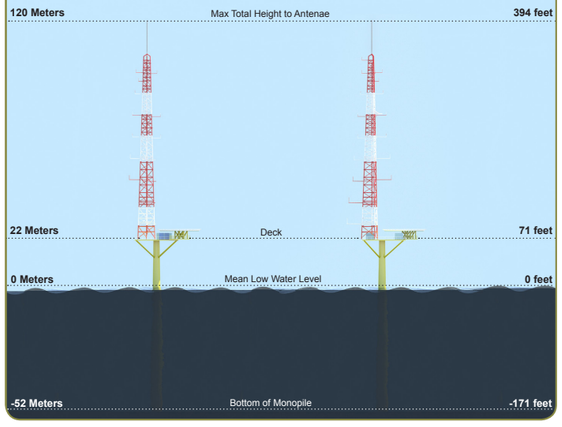
VISUAL SIMULATION



Panoramic Simulation, Mid-day, 1:12 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....3
Viewpoint Name:.....Sunset Beach Pier
Latitude:.....33° 52’ 0.8072” N
Longitude:.....78° 30’ 21.6515” W
Viewer Elevation Above Sea Level:.....12.82’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:.....13.16 & 33.81 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/24/14
Time of Photograph:.....1:12PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....134.1° Southeast

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 3: Sunset Beach Pier, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 3 : Sunset Beach Pier, Brunswick County, North Carolina
35mm Visual Simulation, Mid-day, 1:12PM, View of Wilmington & Wilmington West Meteorological Towers.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

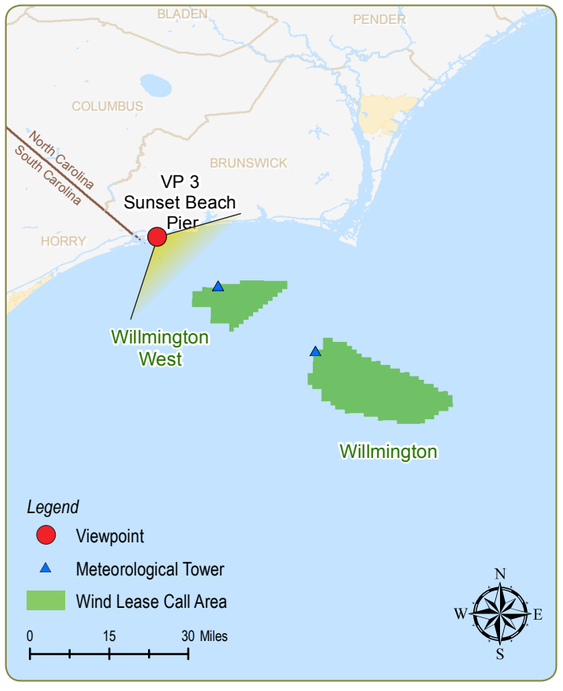
Wilmington & Wilmington West Lease Areas

Meteorological Towers

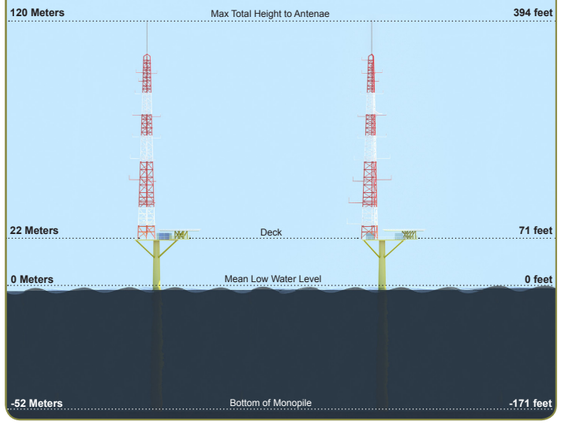
VISUAL SIMULATION



Panoramic Simulation, Late Afternoon, 5:13 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....3
Viewpoint Name:.....Sunset Beach Pier
Latitude:.....33° 52’ 0.8072” N
Longitude:.....78° 30’ 21.6515” W
Viewer Elevation Above Sea Level:.....12.82’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:.....13.16 & 33.81 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/23/14
Time of Photograph:.....5:13PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....134.1° Southeast

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 3: Sunset Beach Pier, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 3 : Sunset Beach Pier, Brunswick County, North Carolina
35mm Visual Simulation, Late Afternoon, 5:13PM, View of Wilmington & Wilmington West Meteorological Towers.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

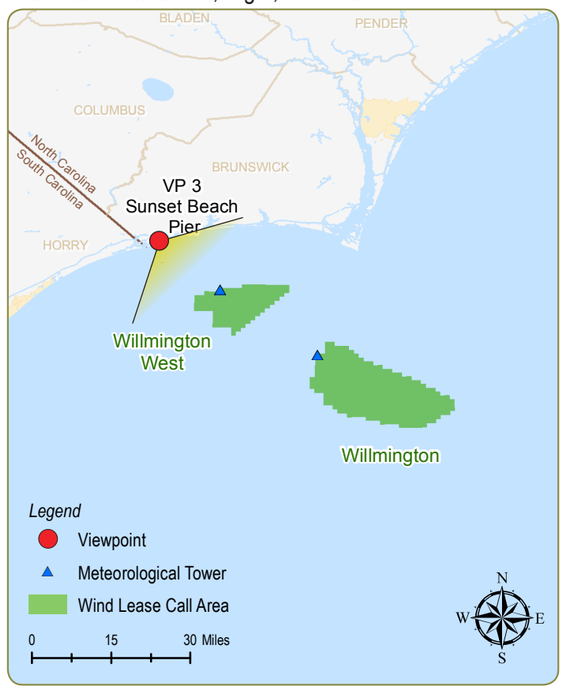
Wilmington & Wilmington West Lease Areas

Meteorological Towers

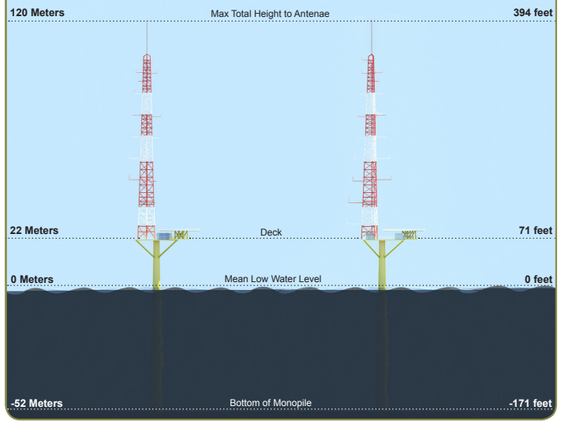
VISUAL SIMULATION



Panoramic Simulation, Night, 7:07 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....3
Viewpoint Name:.....Sunset Beach Pier
Latitude:.....33° 52’ 0.8072” N
Longitude:.....78° 30’ 21.6515” W
Viewer Elevation Above Sea Level:.....12.82’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:.....13.16 & 33.81 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/23/14
Time of Photograph:.....7:07PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D 7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....134.1° Southeast

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 3: Sunset Beach Pier, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 3 : Sunset Beach Pier, Brunswick County, North Carolina
35mm Visual Simulation, Night, 7:07PM, View of Wilmington & Wilmington West Meteorological Towers.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Wilmington Lease Area

Meteorological Tower

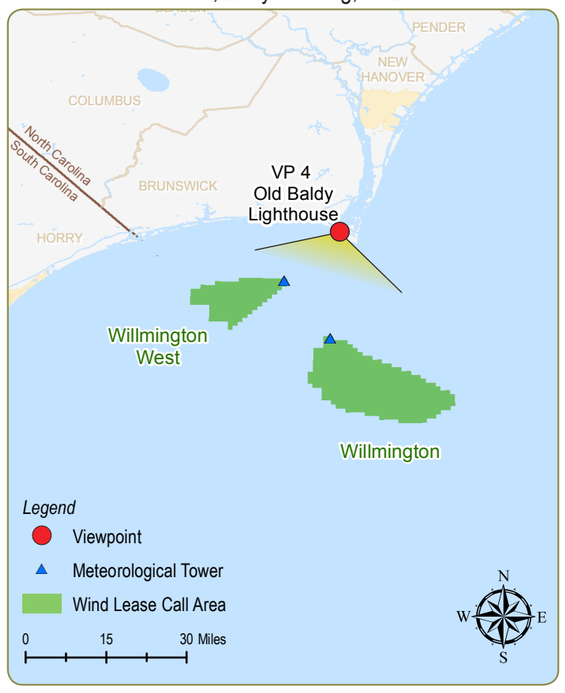
Wilmington West Lease Area

Meteorological Tower

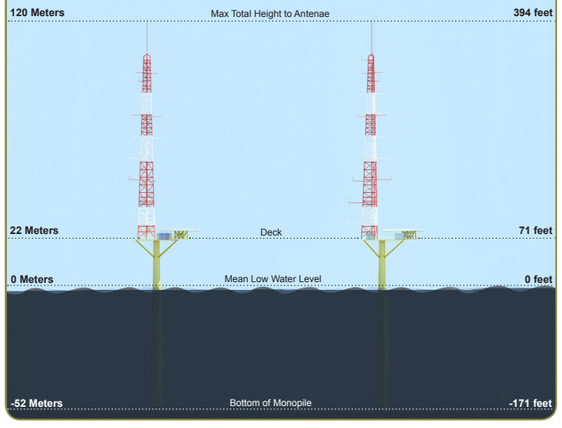


Panoramic Simulation, Early Morning, 10:26 AM

Note: View through glass observation window results in some unavoidable glare and reflection.



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....4
Viewpoint Name:.....Old Baldy Lighthouse
Latitude:..... 33° 52’ 24.6585” N
Longitude:..... 78° 00’ 1.2903” W
Viewer Elevation Above Sea Level:.....108.55’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:.....12.67 & 19.65 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/25/14
Time of Photograph:.....10:26AM
Weather Condition:.....Overcast
Camera Model:.....Nikon D200
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....205.56° Southwest

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 4: Old Baldy Lighthouse, Bald Head Island, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Viewpoint 4A : Old Baldy Lighthouse , Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Early Morning, 10:26AM, View of Wilmington West Meteorological Tower.

VISUAL SIMULATION

Viewpoint 4B : Old Baldy Lighthouse , Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Early Morning, 10:26AM, View of Wilmington Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Wilmington Lease Area

Meteorological Tower

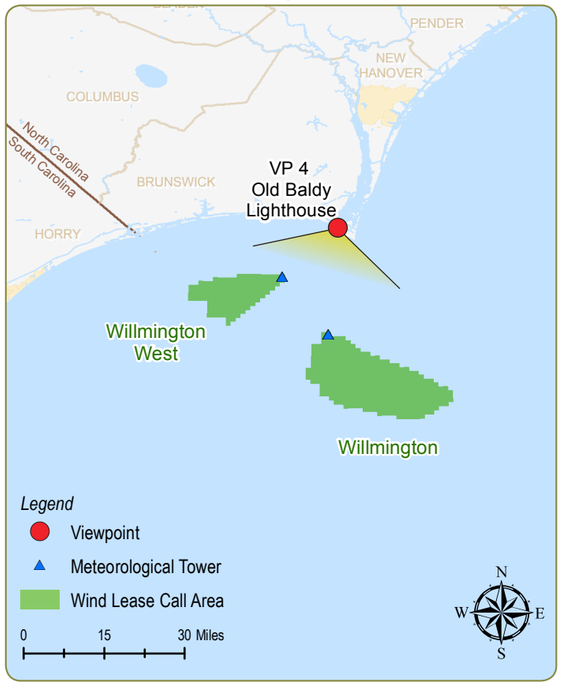
Wilmington West Lease Area

Meteorological Tower

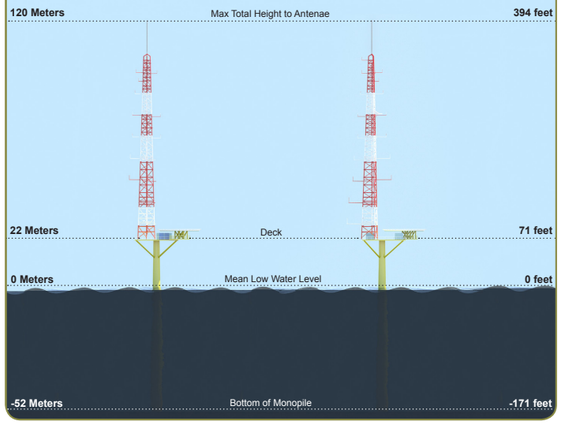


Panoramic Simulation, Mid-day, 2:52 PM

Note: View through glass observation window results in some unavoidable glare and reflection.



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....4
Viewpoint Name:.....Old Baldy Lighthouse
Latitude:..... 33° 52’ 24.6585” N
Longitude:..... 78° 00’ 1.2903” W
Viewer Elevation Above Sea Level:.....108.55’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:.....12.67 & 19.65 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/25/14
Time of Photograph:.....2:52PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D200
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....205.56° Southwest

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 4: Old Baldy Lighthouse, Bald Head Island, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 4A : Old Baldy Lighthouse , Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Mid-day, 2:52PM, View of Wilmington West Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering &
Environmental Services, D.P.C.

VISUAL SIMULATION

Viewpoint 4B : Old Baldy Lighthouse , Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Mid-day, 2:52PM, View of Wilmington Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Wilmington Lease Area

Meteorological Tower

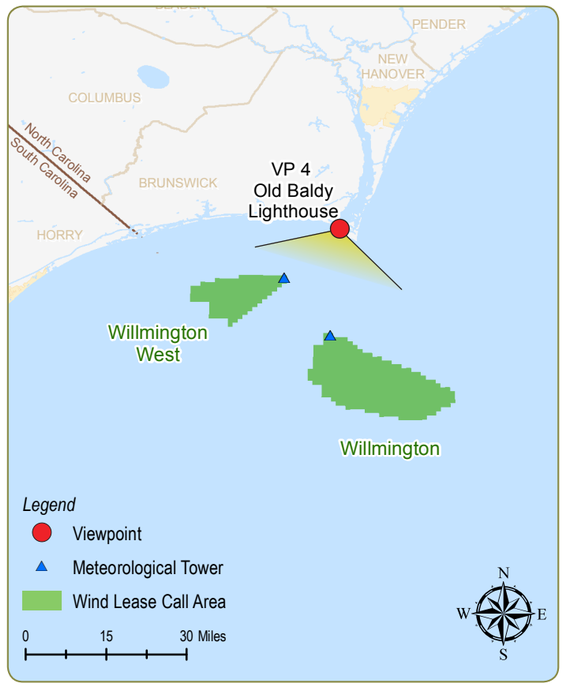
Wilmington West Lease Area

Meteorological Tower

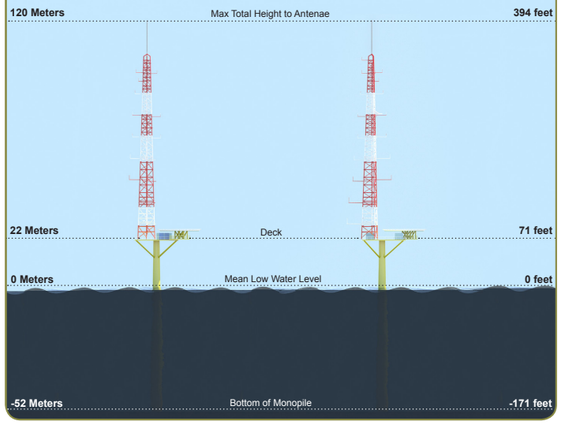


Panoramic Simulation, Late Afternoon, 5:05 PM

Note: View through glass observation window results in some unavoidable glare and reflection.



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....4
Viewpoint Name:.....Old Baldy Lighthouse
Latitude:..... 33° 52’ 24.6585” N
Longitude:..... 78° 00’ 1.2903” W
Viewer Elevation Above Sea Level:.....108.55’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:.....12.67 & 19.65 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/25/14
Time of Photograph:.....5:05PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D200
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....205.56° Southwest

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 4: Old Baldy Lighthouse, Bald Head Island, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 4A : Old Baldy Lighthouse , Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Late Afternoon, 5:05PM, View of Wilmington West Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

VISUAL SIMULATION

Viewpoint 4B : Old Baldy Lighthouse , Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Late Afternoon, 5:05PM, View of Wilmington Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Wilmington Lease Area

Meteorological Tower

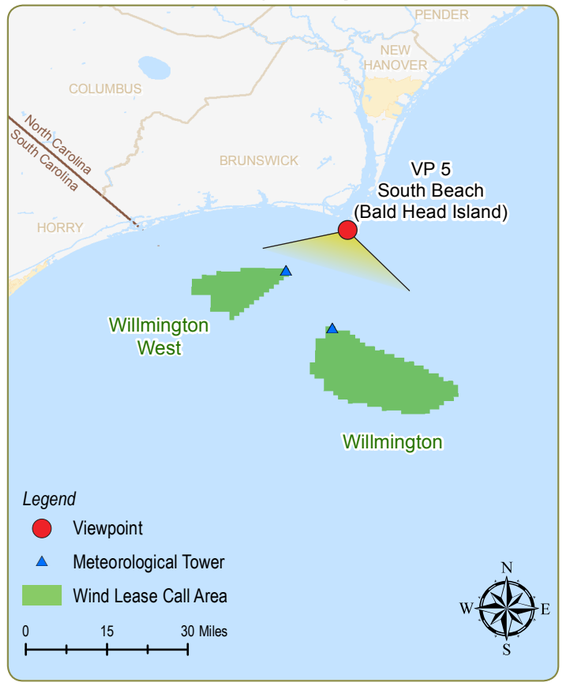
Wilmington West Lease Area

Meteorological Tower

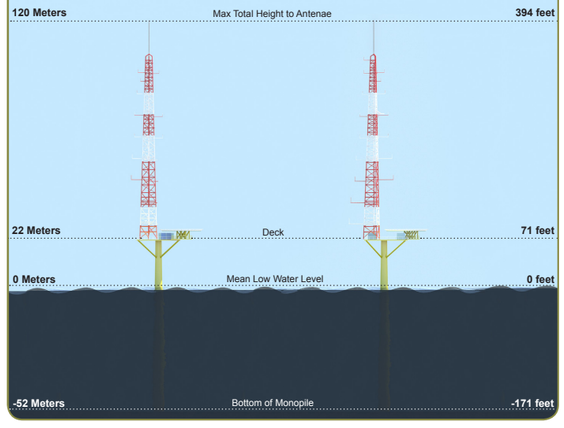
VISUAL SIMULATION



Panoramic Simulation, Early Morning, 9:17 AM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....5
Viewpoint Name:.....South Beach
Latitude:.....33° 51’ 9.8325” N
Longitude:.....77° 59’ 22.1390” W
Viewer Elevation Above Sea Level:.....11.408’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:....12.2 & 18.3 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/25/14
Time of Photograph:.....9:17AM
Weather Condition:.....Overcast
Camera Model:.....Nikon D7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....206.31° Southwest

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 5: South Beach, Bald Head Island, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 5A : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Early Morning, 9:17AM, View of Wilmington West Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

VISUAL SIMULATION

Viewpoint 5B : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Early Morning, 9:17AM, View of Wilmington Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Wilmington Lease Area

Meteorological Tower

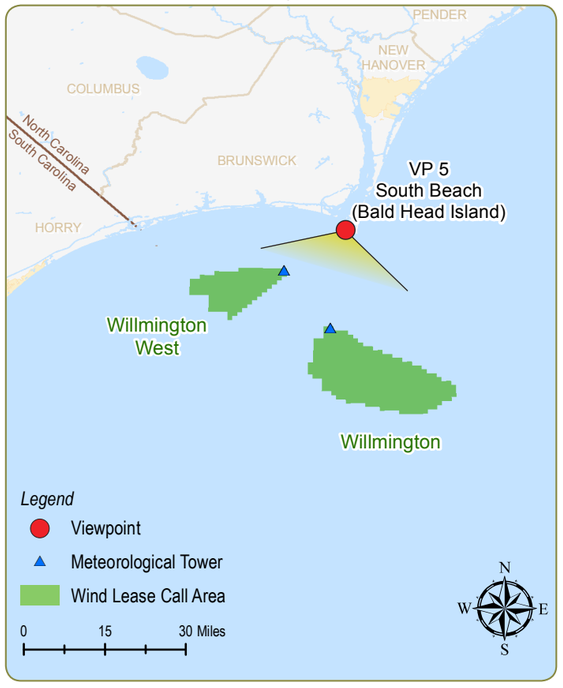
Wilmington West Lease Area

Meteorological Tower

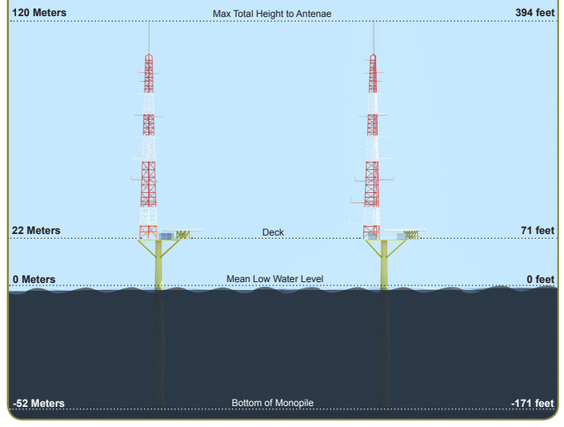
VISUAL SIMULATION



Panoramic Simulation, Mid-day, 1:59 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....5
Viewpoint Name:.....South Beach
Latitude:.....33° 51’ 9.8325” N
Longitude:.....77° 59’ 22.1390” W
Viewer Elevation Above Sea Level:.....11.408’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:....12.2 & 18.3 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/25/14
Time of Photograph:.....1:59PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....206.31° Southwest

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 5: South Beach, Bald Head Island, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 5A : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Mid-day, 1:59PM, View of Wilmington West Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

VISUAL SIMULATION

Viewpoint 5B : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Mid-day, 1:59PM, View of Wilmington Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Wilmington Lease Area

Meteorological Tower

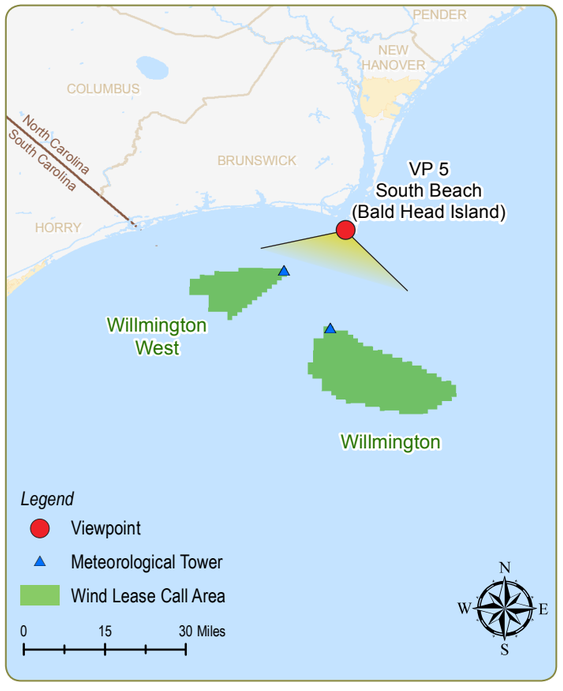
Wilmington West Lease Area

Meteorological Tower

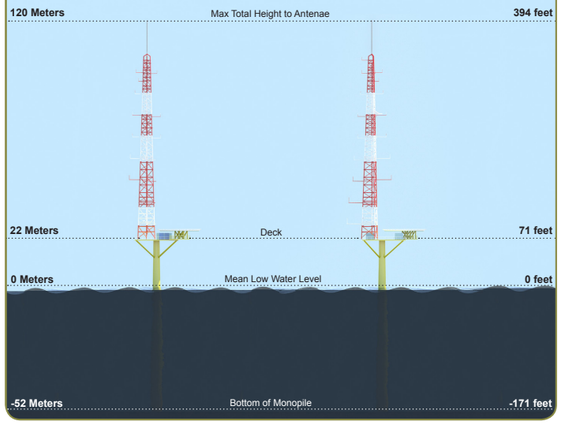
VISUAL SIMULATION



Panoramic Simulation, Late Afternoon, 4:57 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....5
Viewpoint Name:.....South Beach
Latitude:.....33° 51’ 9.8325” N
Longitude:.....77° 59’ 22.1390” W
Viewer Elevation Above Sea Level:.....11.408’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:....12.2 & 18.3 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/25/14
Time of Photograph:.....4:57PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....206.31° Southwest

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 5: South Beach, Bald Head Island, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 5A : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Late Afternoon, 4:57PM, View of Wilmington West Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

VISUAL SIMULATION

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

Viewpoint 5B : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Late Afternoon, 4:57PM, View of Wilmington Meteorological Tower.

Wilmington Lease Area

Meteorological Tower

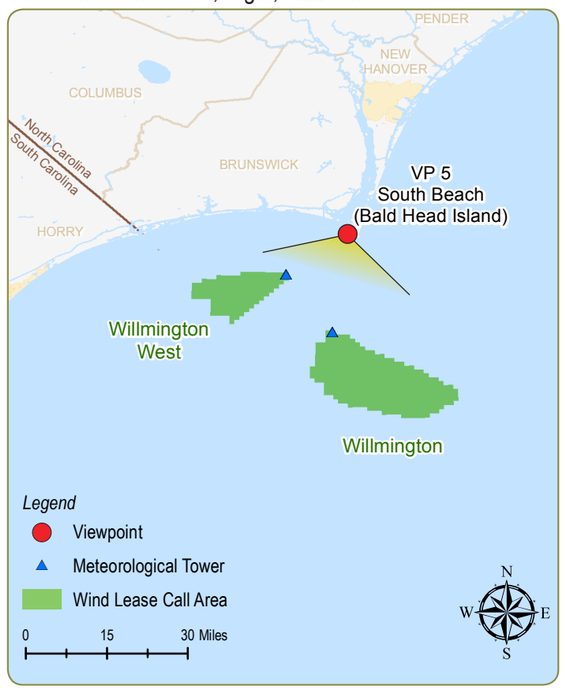
Wilmington West Lease Area

Meteorological Tower

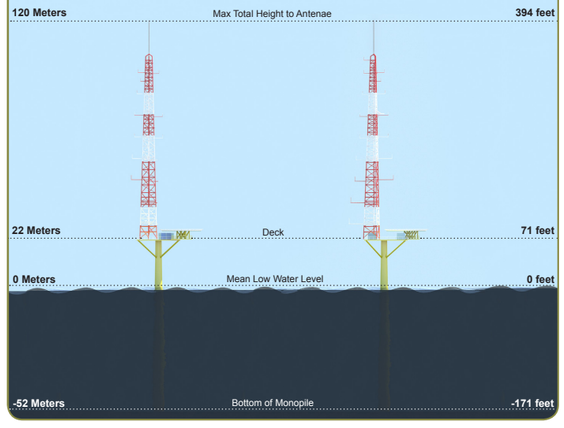
VISUAL SIMULATION



Panoramic Simulation, Night, 7:22 PM



Dimensions of Proposed Meteorological Towers



VIEWPOINT INFORMATION

Viewpoint #:.....5
Viewpoint Name:.....South Beach
Latitude:.....33° 51’ 9.8325” N
Longitude:.....77° 59’ 22.1390” W
Viewer Elevation Above Sea Level:.....11.408’

SIMULATION INFORMATION

Wind Lease Area:.....Wilmington & Wilmington West
Meteorological Tower Model:.....FINO 3
Maximum Tower Height Above MLWL:.....349’
Dist. to Meteorological Towers:....12.2 & 18.3 Miles

PHOTOGRAPH INFORMATION

Date of Photograph:.....9/25/14
Time of Photograph:.....7:22PM
Weather Condition:.....Overcast
Camera Model:.....Nikon D7100
Digital Focal Length:.....Stitched 35mm Images
35mm Focal Length Equivalent:.....50mm
Horizontal Field of View:.....124°
Vertical Field of View:.....30°
Camera Bearing at Center of View:....206.31° Southwest

VIEWING INSTRUCTIONS: The panoramic simulations show an approximately 30° vertical field of view and a 124° horizontal field of view. For full scale viewing, these panoramic images should be printed at a vertical height of 18 inches and a horizontal length of 76 inches. At this size, the images should be mounted on a curved board and viewed so that all portions of the image are 33.6” inches from the viewer.

BOEM Commercial Wind Leasing and Site Assessment

Atlantic Outer Continental Shelf, Offshore, North Carolina

Appendix A: Visual Simulations

Viewpoint 5: South Beach, Bald Head Island, Brunswick County, North Carolina

Prepared for: ICF INTERNATIONAL

Prepared by: edr

October 2014

VISUAL SIMULATION

Viewpoint 5A : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Night; 7:22PM, View of Wilmington West Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.

VISUAL SIMULATION

Viewpoint 5B : South Beach, Bald Head Island, Brunswick County, North Carolina
35mm Visual Simulation, Night, 7:22PM, View of Wilmington Meteorological Tower.

Environmental Design & Research
Landscape Architecture, Engineering & Environmental Services, D.P.C.