Visibility Analysis

380 HORACE STREET
BRIDGEPORT, CT

Prepared in June 2017 by:
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ALL-POINTS
TECHNOLOGY CORPORATION

Project Introduction

Tarpon Towers II, in support of Cellco Partnership d/b/a Verizon Wireless, is pursuing a Certificate of Environmental Compatibility and Public Need from the Connecticut Siting Council ("Council") for the development of a new wireless communications facility ("Facility") at 380 Horace Street in Bridgeport, Connecticut (the "Property"). All-Points Technology Corporation, P.C. ("APT") prepared this Visibility Analysis to evaluate the potential visual impacts associated with the proposed Facility from within a two-mile radius (the "Study Area").

Site Description and Setting

The Property is developed with a commercial building located on the east side of Horace Street within a highly urbanized area. The proposed Facility location (the "Site") lies north of the existing building at an approximate ground elevation of 62 feet Above Mean Sea Level ("AMSL"). The proposed Facility would include a 90-foot tall steel monopole designed to accommodate multiple commercial service providers and/or municipal/regional emergency services equipment. The tower would be enclosed within a 50-foot by 50-foot, gravel base, fenced equipment compound.

Land use within the immediate vicinity of the Property is primarily a mix of dense, urban commercial and residential development, with a large tract of undeveloped forested land to the east/northeast. The Route 8 transportation corridor is approximately 0.75 mile to the west. The topography within the Study Area is characterized by the Pequonnock River valley and gently rising hills to the east and west; ground elevations range from approximately 10 feet AMSL to 260 feet AMSL. The tree cover within the Study Area (consisting of mixed deciduous hardwoods with interspersed stands of conifers) occupies approximately 1,004 acres of the 8,042-acre study area (±19%).

Methodology

APT used the combination of a predictive computer model and in-field analysis to evaluate the visibility associated with the proposed Facility on both a quantitative and qualitative basis. The predictive model provides a measurable assessment of potential visibility throughout the entire Study Area including private properties and other areas inaccessible for direct observations. The in-field analyses included a balloon float and reconnaissance of the Study Area to record existing conditions, verify results of the model, inventory visible and nonvisible locations, and provide photographic documentation from publicly accessible areas. A description of the procedures used in the analysis is provided below.

Preliminary Computer Modeling

To conduct this assessment, a predictive computer model was developed specifically for this project using TerrSet, an image analysis program developed by Clark Labs at Clark University, to provide an estimation of potential visibility throughout the Study Area. The predictive model incorporates Project- and Study Area-specific data, including the site location, its ground elevation and the proposed Facility height, as well as the surrounding topography, existing vegetation, and structures (which are the primary features that can block direct lines of sight).

Information used in the model included lidar[1]-based digital elevation data and customized land use data layers developed specifically for this analysis. Lidar is a remote-sensing technology that develops elevation data in meters by measuring the time it takes for laser light to return from the surface to the instrument's sensors. The varying reflectivity of objects also means that the returns can be classified based on the characteristics of the reflected light, normally into categories such as "bare earth," "vegetation," "road," or "building." The system is also designed to capture many more data points than older radar-based systems. Thus, lidar-based digital elevation models ("DEM"s) have a much finer resolution and can also identify the different features of the landscape at the time that it was captured.

Viewshed analysis using lidar data provide a much more detailed view of the potential obstacles (especially trees and buildings), and therefore the viewshed modeling produces results with many smaller areas of visibility than those produced by using radar-based DEMs. Its precision makes lidar a superior source of data, but at present it is only available for limited areas of the state. The viewshed results are also checked against the most current aerial photographs in case significant changes (a new housing development, for example) have occurred since the time the lidar data was captured.

The lidar-based DEM created for this analysis represents topographic information for the state of Connecticut that was derived through the spatial interpolation of airborne LiDAR-based data collected in the years 2007 through 2012 and has a horizontal resolution of approximately two (2) feet. In addition, multiple land use data layers were created from the Natural Resources Conservation Service (through the USDA) aerial photography (1-meter resolution, flown in 2012) using the image processing tools. Terrset develops light reflective classes defined by statistical analysis of individual pixels, which are then grouped based on common reflective values such that distinctions can be made automatically between deciduous and coniferous tree species, as well as grassland, impervious surface areas, surface water and other distinct land use features.

With these data inputs, the model is then queried to determine where the top of the Facility can be seen from any point(s) within the Study Area, given the intervening existing topography and vegetation. The results of the preliminary analysis are depicted on the attached map and are intended to provide a representation of those areas where portions of the Facility may potentially be visible to the human eye without the aid of magnification, based on a viewer eye-height of 5 feet above the ground and the combination of intervening topography, tree canopy (year-round) and tree trunks (seasonally, when the leaves are off the deciduous

[1] Lidar (a word invented to mean "light radar") may also be referred to as LiDAR, an acronym for Light Detection and Ranging. It is a technology that utilized lasers to determine the distance to an object or surface. LiDAR is similar to radar, but incorporates laser pulses rather than sound waves. It measures the time delay between transmission and reflection of the laser pulse.

trees), and structures. The shaded areas of predicted visibility shown on the map denote locations from within the Study Area which the proposed Facility may potentially be visible year-round (in yellow) above the tree canopy and/or seasonally, through the trees (during "leaf-off" conditions; depicted in orange). The Facility however may not necessarily be visible from all locations within those shaded areas. It is important to note that the computer model cannot account for mass density, the height, diameter and branching variability of the trees, or the degradation of views that occur with distance. In addition, each point – or pixel - represents about one square meter in area, and thus is not predicting visibility from all viewpoints through all possible obstacles. Although large portions of the predicted viewshed may theoretically offer visibility of the Facility, because of these unavoidable limitations the quality of those views may not be sufficient for the human eye to recognize the tower or discriminate it from other surrounding objects. Visibility also varies seasonally with increased, albeit obstructed, views occurring during "leaf-off" conditions. Beyond the density of woodlands found within the given Study Area, each individual tree has its own unique trunk, pole timber and branching pattern characteristics that provide varying degrees of screening in leafless conditions which cannot be precisely modeled.

Once the data layers were entered, image processing tools were applied and overlaid onto digital aerial photographs to achieve an estimate of locations where the Facility might be visible. Additional data was reviewed and incorporated into the visibility analysis, including protected private and public open space, parks, recreational facilities, hiking trails, schools, and historic districts. Two trail systems occur within the Study Area, including the CT-blue blazed Housatonic Trail (approximately 0.5 mile northwest at its nearest point to the Site) and the East Coast Greenway, located approximately 1.8 miles to the south. Based on a review of publicly-available information, no designated state scenic roads exist within the Study Area.

Field Reconnaissance

To supplement and fine tune the results of the computer modeling efforts, APT completed in-field verification activities consisting of a balloon float, vehicular and pedestrian reconnaissance, and photo-documentation.

Balloon Float and Field Reconnaissance

A balloon float and field reconnaissance were conducted March 24, 2015 to evaluate the visibility associated with the proposed Facility and to obtain photographs for use in this report. The balloon float consisted of raising an approximately four-foot diameter, red helium-filled balloon tethered to a string height of 90 feet above ground level ("AGL") at the proposed Facility location. Weather conditions were favorable for the in-field activities, with calm winds (less than 5 miles per hour) and clear skies. Once the balloon was secured, APT conducted a Study Area reconnaissance by driving along the local and State roads and other publicly accessible locations to document and inventory where the balloon could be seen above/through the tree canopy. Visual observations from the reconnaissance were also used to evaluate the results of the preliminary visibility mapping and identify any discrepancies in the initial modeling.

Photographic Documentation and Simulations

During the balloon float and field reconnaissance, APT drove the public roads within the Study Area and recorded observations, including photo-documentation, of those areas where the balloon was and was not visible. Photographs were obtained from several vantage points to document the views of a proposed Facility. The geographic coordinates of the camera's position at each photo location were logged using global

positioning system ("GPS") technology. Photographs were taken with a Canon EOS 6D digital camera body and Canon EF 24 to 105 millimeter ("mm") zoom lens, with the lens set to 50 mm.

> *"The lens that most closely approximates the view of the unaided human eye is known as the normal focal-length lens. For the 35 mm camera format, which gives a 24x36 mm image, the normal focal length is about 50 mm.[2]"*

Final Visibility Mapping

Information obtained during the field reconnaissance was incorporated into the mapping data layers, including observations of the balloon float, the photo locations, areas that experienced recent land use changes and those places where the initial model was found to over-predict visibility. Once the additional data was integrated into the model, APT re-calculated the visibility of the proposed Facility from within the Study Area to assist in producing the final viewshed map.

Photographic Simulations

Photographic simulations were generated to portray scaled renderings of the proposed Facility from representative locations where the proposed Facility would be visible on a year-round basis. The simulations depict a monopole as well as the option for a monopine. Using field data, site plan information and 3-dimension (3D) modeling software, spatially referenced models of the site area and Facility were generated and merged. The geographic coordinates obtained in the field for the photograph locations were incorporated into the model to produce virtual camera positions within the spatial 3D model. Photo simulations were then created using a combination of renderings generated in the 3D model and photo-rendering software programs[3].

For presentation purposes in this report, the photographs were taken with a 50 mm focal length and produced in an approximate 7-inch by 10.5-inch format. When viewing in this format size, we believe it is important to provide the largest representational image while maintaining an accurate relation of sizes between objects within the frame of the photograph.

Photo-documentation of the balloon float and photo-simulations of the proposed Facility are presented in the attachment at the end of this report. The balloon float photos provide visual reference points for the approximate height and location of the proposed Facility relative to the scene. The photo-simulations are intended to provide the reader with a general understanding of the different views that might be achieved of the Facility. It is important to consider that the publicly-accessible locations selected are typically representative of a "worst case" scenario. They were chosen to present unobstructed view lines (wherever possible), are static in nature and do not necessarily fairly characterize the prevailing views from all locations within a given area. From several locations, moving a few feet in any direction will result in a far different

[2] Warren, Bruce. Photography, West Publishing Company, Eagan, MN, c. 1993, (page 70).

[3] As a final step, the accuracy and scale of select simulations are tested against photographs of similar existing facilities with recorded camera position, focal length, photo location, and tower location.

perspective of the Facility than what is presented in the photographs. In several cases, a view of the Facility may be limited to the immediate area of the specific photo location.

Photograph Locations

The table below summarizes characteristics of the photographs and simulations presented in the attachment to this report including a description of each location, view orientation, the distance from where the photo was taken relative to the proposed Facility and the general characteristics of that view. The photo locations are depicted on the visibility analysis map provided as an attachment to this report.

View	Location	Orientation	Distance to Site	View Characteristics
1	Pennsylvania Avenue	Southeast	±0.35 Mile	Seasonal
2	Texas Avenue	Southeast	±0.24 Mile	Seasonal
3	Nelson Terrace and East Main Street	Southeast	±0.24 Mile	Seasonal
4	Alpine Street	Southeast	±0.14 Mile	Year-round
5	Foster Square	Southeast	±0.09 Mile	Year-round
6	Kingsbury Road	East	±0.08 Mile	Year-round
7	Berkeley Place	East	±0.11 Mile	Year-round
8	York Street at Horace Street	North	±0.12 Mile	Year-round
9	Asylum Street	West	±0.25 Mile	Seasonal
10	Goddard Avenue	North	±0.20 Mile	Year-round
11	Horace Street at Kent Street	North	±0.23 Mile	Year-round
12	Lakeview Cemetery	Northeast	±1.35 Miles	Not Visible

Visibility Analysis Results

Results of this analysis are graphically displayed on the viewshed map provided in the attachment at the end of this report. Areas from where the proposed Facility would be visible year-round comprise a total of approximately 41 acres. When the leaves are off the trees, seasonal views through intervening tree trunks and branches are anticipated to occur over some locations within an area of 40± additional acres.

In general, year-round views of portions of the Facility appear limited to the Property and its immediate vicinity (within ±0.25 mile). Near-range views (within ± 0.10 mile) of the proposed Facility offer an opportunity to see a majority of the length of the monopole. With few exceptions, views from distances beyond ± 0.10 mile are limited to upper portions of the monopole.

No views would extend portions of either the Housatonic Trail (approximately or the East Coast Greenway.

The overall visibility of the proposed Facility is the results of a combination of the relatively short height of the tower and the urban nature of the Study Area, which is dominated by multi-story structures and existing utility infrastructure.

Proximity to Schools And Commercial Child Day Care Centers

No schools or commercial child day care centers are located within 250 feet of the Property. The nearest school (Beardsley School) is located at 2010 East Main Street, nearly 0.5 mile to the southwest. The nearest commercial child day care center (Heavenly Blessings Christian Academy) is located approximately 0.25 mile to the southwest. No views of the Facility are anticipated from either of these locations.

LIMITATIONS

The viewshed map presented in the attachment to this report depict areas where the proposed Facility may potentially be visible to the human eye without the aid of magnification based on a viewer eye-height of 5 feet above the ground and intervening topography and an assumed tree canopy height of 60 feet. This analysis may not necessarily account for all visible locations, as it is based on the combination of computer modeling, incorporating 2012 aerial photographs, and in-field observations from publicly-accessible locations. No access to private properties was provided to APT personnel. This analysis does not claim to depict the only areas, or all locations, where visibility may occur; it is intended to provide a representation of those areas where the Facility is likely to be seen.

The simulations provide a representation of the Facility under similar settings as those encountered during the balloon floats and reconnaissance. Views of the Facility can change throughout the seasons and the time of day, and are dependent on weather and other atmospheric conditions (e.g., haze, fog, clouds); the location, angle and intensity of the sun; and the specific viewer location. Weather conditions on the day of the balloon float included partly cloudy skies and the photo-simulations presented in this report provide an accurate portrayal of the Facility during comparable conditions.

ATTACHMENTS

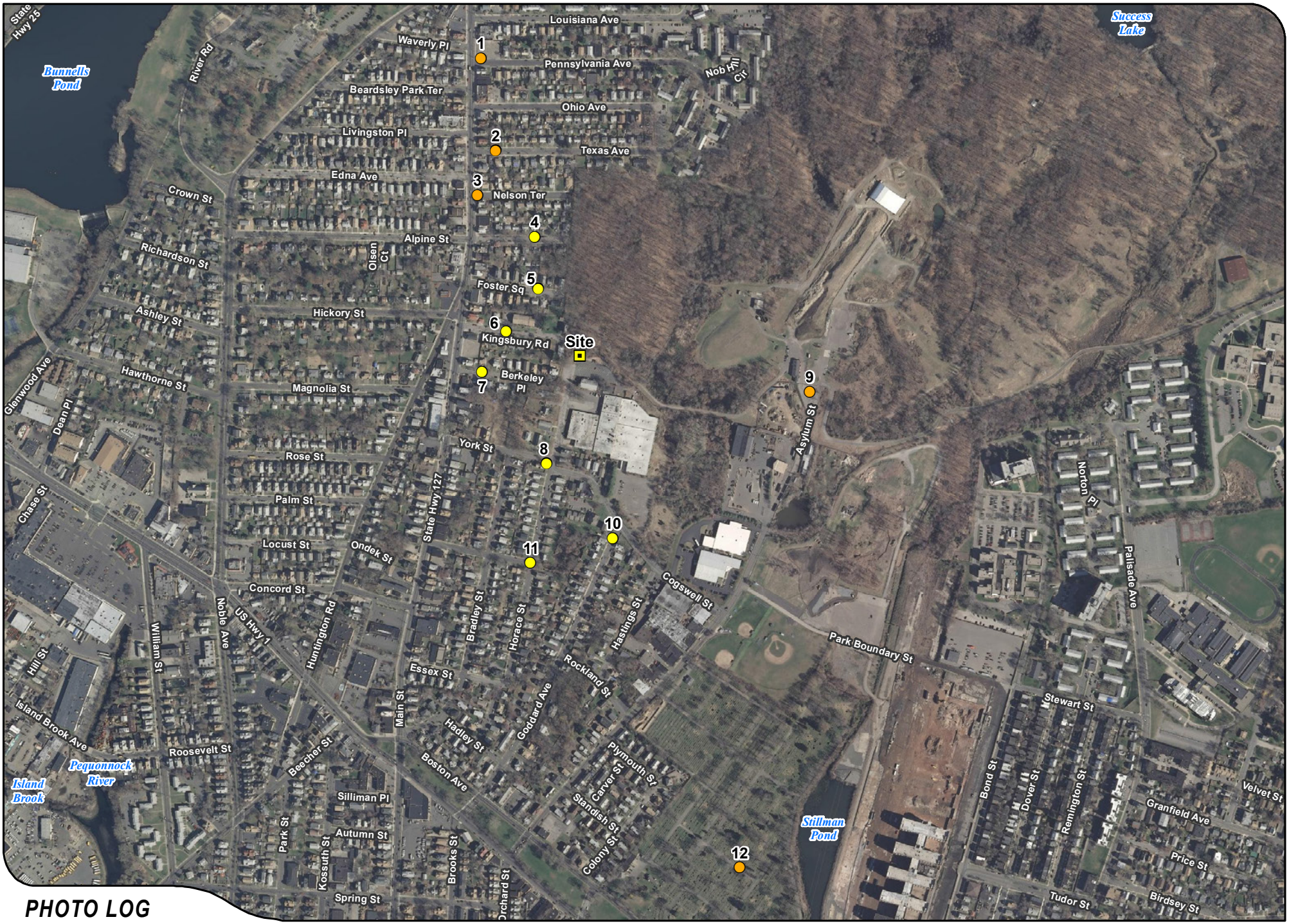

PHOTO LOG

Legend

Site ● Seasonal Visibility ● Year Round Visibility

700 350 0 700 Feet

1 inch = 700 feet

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EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
1	**PENNSYLVANIA AVENUE**	**SOUTHEAST**	**+/- 0.35 MILE**	**SEASONAL**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
1	**PENNSYLVANIA AVENUE**	**SOUTHEAST**	**+/- 0.35 MILE**	**SEASONAL**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
2	**TEXAS AVENUE**	**SOUTHEAST**	**+/- 0.24 MILE**	**SEASONAL**

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PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
2	**TEXAS AVENUE**	**SOUTHEAST**	**+/- 0.24 MILE**	**SEASONAL**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
3	**NELSON TERRACE AT EAST MAIN STREET**	**SOUTHEAST**	**+/- 0.24 MILE**	**SEASONAL**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
3	**NELSON TERRACE AT EAST MAIN STREET**	**SOUTHEAST**	**+/- 0.24 MILE**	**SEASONAL**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
4	**ALPINE STREET**	**SOUTHEAST**	**+/- 0.14 MILE**	**YEAR ROUND**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
4	**ALPINE STREET**	**SOUTHEAST**	**+/- 0.14 MILE**	**YEAR ROUND**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
5	**FOSTER SQUARE**	**SOUTHEAST**	**+/- 0.09 MILE**	**YEAR ROUND**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
5	**FOSTER SQUARE**	**SOUTHEAST**	**+/- 0.09 MILE**	**YEAR ROUND**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
6	**KINGSBURY ROAD**	**EAST**	**+/- 0.08 MILE**	**YEAR ROUND**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
6	**KINGSBURY ROAD**	**EAST**	**+/- 0.08 MILE**	**YEAR ROUND**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
7	**BERKELEY PLACE**	**EAST**	**+/- 0.11 MILE**	**YEAR ROUND**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
7	**BERKELEY PLACE**	**EAST**	**+/- 0.11 MILE**	**YEAR ROUND**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
8	**YORK STREET AT HORACE STREET**	**NORTH**	**+/- 0.12 MILE**	**YEAR ROUND**

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PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
8	**YORK STREET AT HORACE STREET**	**NORTH**	**+/- 0.12 MILE**	**YEAR ROUND**

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EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
9	**ASYLUM STREET**	**WEST**	**+/- 0.25 MILE**	**SEASONAL**

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PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
9	**ASYLUM STREET**	**WEST**	**+/- 0.25 MILE**	**SEASONAL**

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EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
10	**GODDARD AVENUE**	**NORTH**	**+/- 0.20 MILE**	**YEAR ROUND**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
10	**GODDARD AVENUE**	**NORTH**	**+/- 0.20 MILE**	**YEAR ROUND**

EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
11	**HORACE STREET AT KENT STREET**	**NORTH**	**+/- 0.23 MILE**	**YEAR ROUND**

PROPOSED

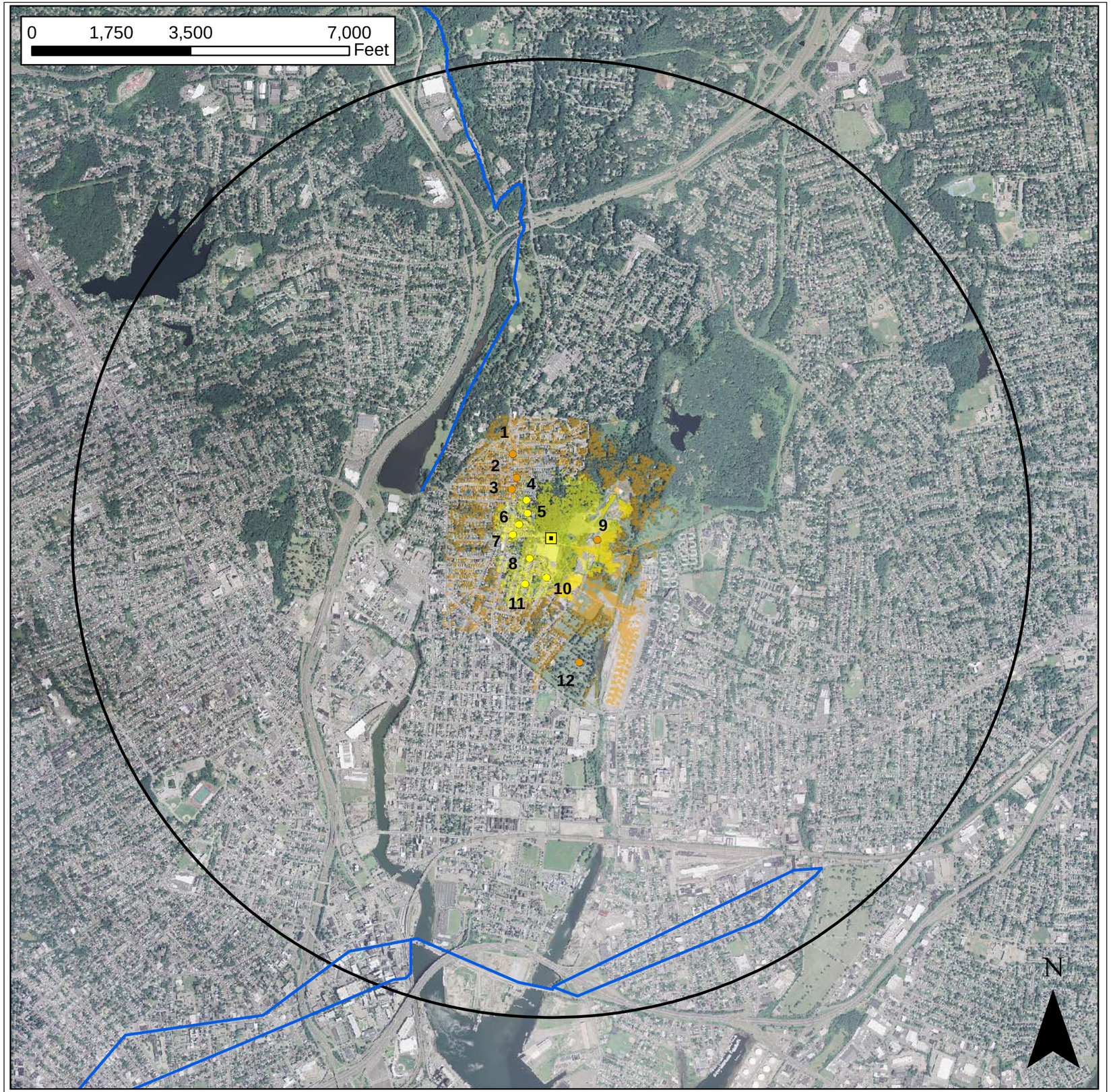
PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
11	**HORACE STREET AT KENT STREET**	**NORTH**	**+/- 0.23 MILE**	**YEAR ROUND**

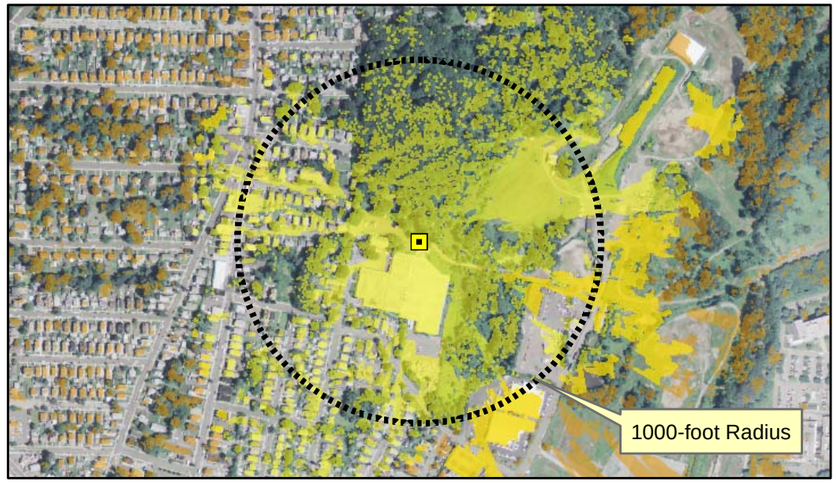
EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
12	**LAKEVIEW CEMETERY**	**NORTHWEST**	**+/- 0.57 MILE**	**SEASONAL**

PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
12	**LAKEVIEW CEMETERY**	**NORTHWEST**	**+/- 0.57 MILE**	**SEASONAL**





Viewshed Map – Aerial Base

Proposed Wireless Telecommunications Facility
380 Horace Street, Bridgeport, CT

Proposed facility height is 90 feet AGL.
Forest canopy height is derived from LiDAR data.
Study area encompasses a two-mile radius and includes 8,042 acres of land.

Map compiled 5/11/2015

Map information field verified by APT on 3/24/2015.

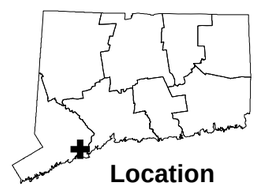
Only those resources located within the extent of the map are depicted. For a complete list of data sources consulted for this analysis, please refer to the Documentation Page.

Legend

- Proposed Tower

Photo Locations

- Seasonal Views
- Year-round Views
- Trails
- Predicted Seasonal Visibility (40 Acres)
- Predicted Year-Round Visibility (41 Acres)
- Towns
- 2-Mile Study Area



Location

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DOCUMENTATION

SOURCES CONSULTED FOR VIEWSHED MAPS
380 Horace Street
Bridgeport, Connecticut

Physical Geography / Background Data

- Digital elevation model (DEM) derived from 0.64-meter USGS lidar data obtained from NOAA
- Forest areas are generated with TerrSet (Clark University) image processing from the lidar data and 2012 NRCS/NAIP digital orthophotos with 1-foot pixel resolution
- Municipal Open Space, State Recreation Areas, Trails, County Recreation Areas, and Town Boundary data obtained from CT DEEP and the towns

United States Geological Survey
*USGS topographic quadrangle maps – Bridgeport (1984)
Department of Transportation data
^State Scenic Highways (updated monthly)
Heritage Consultants
^Municipal Scenic Roads

Cultural Resources

Heritage Consultants
^National Register
^ Local Survey Data

Dedicated Open Space & Recreation Areas

Connecticut Department of Energy and Environmental Protection (DEEP)
*DEEP Property (May 2007)
*Federal Open Space (1997)
*Municipal and Private Open Space (1997)
*DEEP Boat Launches (1994)
Connecticut Forest & Parks Association
^Connecticut Walk Books East & West –
The Guide to the Blue-Blazed Hiking Trails of Eastern Connecticut Western Connecticut, 19th Edition, 2006.

Other

^ConnDOT Scenic Strips (based on Department of Transportation data)

*Available to the public in GIS-compatible format (some require fees)
^ Data not available to general public in GIS format. Reviewed independently and, where applicable, GIS data later prepared specifically for this Study Area.

NOTE Not all the sources listed above appear on the Viewshed Maps. Only those features within the scale of the graphic are shown.

LIMITATIONS

Viewshed analysis conducted using Clark University's TerrSet. The visibility analysis map(s) presented in this report depict areas where the proposed Facility may potentially be visible to the human eye without the aid of magnification based on a viewer eye-height of 5 feet above the ground and intervening topography, tree canopy and structures. This analysis may not necessarily account for all visible locations, as it is based on the combination of computer modeling, incorporating the lidar DEM, 2012 digital aerial photographs, and in-field observations from publicly-accessible locations. No access to private properties beyond the host Property was provided to APT personnel. This analysis does not claim to depict the only areas, or all locations, where visibility may occur; it is intended to provide a representation of those areas where the Facility is likely to be seen.

The photo-simulations in this report are provided for visual representation only. Actual visibility depends on various environmental conditions, including (but not necessarily limited to) weather, season, time of day, and viewer location.