

Photographic Simulations

TRUMBULL SE 4
60 COMMERCE DRIVE
TRUMBULL, CT 06611

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Prepared for Verizon Wireless



Project Introduction

Cellco Partnership (d/b/a “Verizon Wireless”) proposes to construct and operate a wireless telecommunications facility (“Facility”) at 60 Commerce Drive in the Town of Trumbull, Fairfield County, Connecticut (identified herein as the “Host Property”). All-Points Technology Corporation, P.C. (“APT”) prepared this Visibility Analysis to evaluate views associated with the proposed Facility with a two mile radius of the proposed site location (“Study Area”).

Site Description and Setting

The Host Property is a 14± acre parcel located at the eastern end of Commerce Drive, within a large commercial/industrial complex just north of the Merritt Parkway (CT Route 15) and east of Route 8. The Trumbull Assessor’s Office identifies the Host Property as Map K09, Lot 20. The Host Property is developed with a large abandoned building (formerly occupied by Pilot Pen), parking areas and a pond. Residential development occurs to the north and east.

The proposed Facility would be located north of the largest building occupying the parcel, within an area that borders a forested block of land. The Facility would include an 80-foot tall monopole within a fence-enclosed, gravel-base 24-foot by 82-foot equipment compound, at a ground elevation of approximately 170 feet above mean sea level (“AMSL”). The compound area would also be outfitted with a 12-foot by 30-foot equipment shelter and supporting equipment.

The Study Area consists of a mix of commercial/industrial development (to the west and south), residential homes (primarily north and east), and two major transportation routes (farther to the west and south). In addition to the Town of Trumbull, the Study Area also includes parts of the neighboring municipalities of Stratford, Shelton and Bridgeport.

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 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

Two computer modeling tools are used to calculate those areas from which at least the top of the proposed Facility is estimated to be visible: IDRISI image analysis program (developed by Clark Labs, Clark University) and ArcGIS®, developed by Environmental Systems Research Institute, Inc. Project- and Study Area-specific data were incorporated into the computer model, including the Facility’s location,

height, and ground elevation, as well as the surrounding topography and existing vegetation which are two primary features that can block direct lines of sight. Information used in the model included LiDAR¹-based digital elevation data and customized land use data layers developed specifically for this analysis. The LiDAR-based Digital Elevation Model (“DEM”) represents topographic information for the state of Connecticut that was derived through the spatial interpolation of airborne LiDAR-based data collected in the year 2000 and has a horizontal resolution of ten (10) feet. In addition, multiple land use data layers were created from National Agricultural Imagery Program (USDA) aerial photography (1-foot resolution, flown in 2012) using IDRISI image processing tools. The IDRISI tools develop 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. This information is manually cross-checked with the recent USGS topographic land characteristics to quality assure the imaging analysis.

The Study Area includes a total of approximately 8,042 acres. The tree canopy within the Study Area consists mainly of mixed deciduous hardwood species interspersed with scattered stands of conifers, and occupies approximately 6,403 acres (representing nearly 80% of the Study Area). Topography within the Study Area ranges in ground elevations from approximately 20 feet AMSL to 400 feet AMSL and is generally characterized as rolling to hilly terrain.

Once the data layers were entered, image processing tools were applied and overlaid onto USGS topographic base maps and aerial photographs to achieve an estimate of locations where the Facility might be visible. First, only the topography data layer (DEM) was incorporated to evaluate potential visibility with no intervening vegetative screening. The initial omission of the forest cover data layer results in an excessive over-prediction, but provides an opportunity to identify and evaluate those areas with potentially direct sight lines toward the Facility. Eliminating the tree canopy altogether, as performed in the preliminary analysis by assigning a 1-foot height value to this data layer, exaggerates areas of visibility because it assumes unobstructed sight lines everywhere but in those locations where intervening topography rises above the height of the proposed Facility. However, using this technique not only allows for an initial identification of direct sight lines, but also to gain some insight regarding seasonal views when the leaves are not on the trees.

A purposely low average tree canopy height of 55 feet was subsequently incorporated into the forest data layer and added to the DEM for a second iteration of the visibility map. The model was 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 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 and tree canopy (year-round) and tree trunks (seasonally, when the leaves are off the deciduous trees). The computer model then outputs shaded areas of predicted visibility that identify locations from within the Study Area where the proposed Facility may potentially be visible. 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 individual trees, or the degradation of views that occur with distance. In addition,

¹ LiDAR is 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.

each point – or pixel - represents about one meter (3.28 feet) in area, and thus cannot predict 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 adequately modeled. Thus, modeling for seasonal variations of visibility generally over-predicts the viewshed in “leaf-off” conditions, even when incorporating conservative constraints into the model (i.e., assuming trees are simply vertical poles with no distinct branching pattern). Therefore, field verification remains a necessary component for cross-checking the model’s initial results.

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. Numerous trails systems are located within the Study Area. The Merritt Parkway is listed on the National Register of Historic Places as a Scenic Byway.

In-Field Activities

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 on January 16, 2014 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 80 feet above ground level (“AGL”) at the proposed Facility location. Weather conditions were favorable for the in-field activities, with calm winds (less than 3 miles per hour) and overcast 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 mast and 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.

During the balloon float and in-field activities, several trees were randomly surveyed using a Suunto Tandem clinometer to ascertain their heights. The heights of trees adjacent to the site were field measured to document the surrounding canopy elevation. Numerous off-site locations were also selected to obtain tree canopy heights, including along roadways, wooded lots, and high- and low-lying areas to provide for the irregularities associated with different land characteristics and uses found within the Study Area. The average canopy height was developed based on these measurements and comparative observations, in this case approximately 65 feet AGL. Information obtained during the balloon float was subsequently incorporated into the computer model to refine the visibility map.

Photographic Documentation

During the field reconnaissance, observations of the balloon were recorded and photo-documented to inventory those areas where it was and was not visible. Photographs were obtained from several vantage points to document the view towards the Facility.

At each photo location, the geographic coordinates of the camera's position were logged using global positioning system ("GPS") equipment. Photographs were taken with a Nikon D-3000 digital camera body and Nikon 18 to 135 mm zoom lens, with the lens set to 50 mm. A 50 mm focal length best approximates the relation of sizes between objects similar to what the human eye might perceive.

"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. The revised average tree canopy height data (65 feet AGL) was merged with the DEM and added to the base ground elevations of the forested areas data layer. Once the additional data was integrated into the model, APT re-calculated the visibility of the proposed Facility from within the Study Area to produce the final visibility map.

Photographic Simulations

Photographic simulations were generated to portray scaled renderings of the proposed Facility from ten (10) representative locations where the proposed Facility would be visible either on a year-round or seasonal basis. 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 programs³.

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

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.

views from all locations within a given area. From several locations, moving a few feet in any direction will result in a far different 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.

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. The simulations provide a representation of the Facility under similar settings as those encountered during the balloon float and reconnaissance. Views of the Facility can change substantially throughout the season and are dependent on environmental conditions, including (but not necessarily limited to) weather, light conditions, seasons, time of day, and the viewer 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 maps provided as attachments to this report.

View	Location	Orientation	Distance To Site	View Characteristics
1	Entrance to Pilot Pen	Northeast	±0.10 Mile	Year-round
2	Adjacent to #16 Twin Circle Drive	South	±0.12 Mile	Year-round
3	Adjacent to #41 Twin Circle Drive	Southeast	±0.17 Mile	Seasonal
4	Adjacent to #27 Twin Circle Drive	Southeast	±0.15 Mile	Seasonal
5	St. Johns Drive	Northeast	±0.38 Mile	Year-round
6	Merritt Boulevard	Northeast	±0.21 Mile	Year-round
7	Adjacent to #2771 Huntington Road	Northwest	±0.22 Mile	Seasonal
8	Adjacent to #2975 Huntington Road	Southwest	±0.09 Mile	Year-round
9	Beaver Dam Road	Southwest	±0.43 Mile	Not visible
10	Beaver Dam Road at Huntington Road Intersection	Northwest	±0.15 Mile	Seasonal
11	Host Property	Northwest	±0.12 Mile	Year-round

Visibility Analysis Results

Results of this analysis are graphically displayed on the visibility analysis maps provided in the attachment at the end of this report. The maps include a photolog that depict the photo locations.

In general, the combination of the relatively low height of the Facility, rolling terrain and mature forest results in minimizing the overall visibility throughout the Study Area, limiting views to select areas within 0.5 mile or less of the Host Property. Areas from where the proposed Facility would be visible above the tree canopy year-round comprise a total of approximately 61 acres. When the leaves are off the trees, seasonal views through intervening tree trunks and branches are anticipated to occur over an

additional 144± acres. Being located within a commercial/industrial park setting, numerous potential visual receptors are other business tenants (photograph locations 1, 5 and 6 for example).

The Host Property is separated from residential areas to the north, and to a lesser degree eastward, by mature stands of mostly deciduous trees that serve to effectively obstruct direct lines of sight, even during those months of year when there is no foliage. Locations to the north are buffered by a dense tract of woods 500± feet in width (see photographs 3 and 4 as examples). Seasonal views are heavily screened by the intervening trees. To the east, six abutting residential parcels along Huntington Road have a narrower tree buffer (about 50 to 100 feet wide) separating them from the Host Property's parking lot. However, several of the intervening trees are conifers which assist in breaking up direct lines of sight throughout the year. Photo locations 7, 8 and 10 provide representative examples of those views. Once beyond the immediate vicinity of the Host Property, views diminish rapidly. No views would be achieved from along the Merritt Parkway, which lies approximately 0.6 mile to the south.

The visibility maps 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 65 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 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.

Proximity to Schools And Commercial Child Day Care Centers

No schools or commercial child day care centers are located within 250 feet of the Host Property. The nearest school is Bunnell High School, located at One Bulldog Avenue in Stratford, approximately 1.44 miles to the southwest. The nearest commercial child day care center is Huntington Point Child Development Center, located at 1079 Bridgeport Avenue in Shelton, approximately 0.83 mile to the north. No views of the Facility are anticipated from either of these locations.

ATTACHMENTS



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
1	ENTRANCE TO PILOT PEN PROPERTY	NORTHEAST	+/- 0.10 MILE	YEAR ROUND



SIMULATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
1	ENTRANCE TO PILOT PEN PROPERTY	NORTHEAST	+/- 0.10 MILE	YEAR ROUND



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
2	ADJACENT TO #16 TWIN CIRCLE DRIVE	SOUTH	+/- 0.12 MILE	YEAR ROUND



SIMULATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
2	ADJACENT TO #16 TWIN CIRCLE DRIVE	SOUTH	+/- 0.12 MILE	YEAR ROUND



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
3	ADJACENT TO #41 TWIN CIRCLE DRIVE	SOUTHEAST	+/- 0.17 MILE	SEASONAL



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
4	ADJACENT TO #27 TWIN CIRCLE DRIVE	SOUTHEAST	+/- 0.15 MILE	SEASONAL



SIMULATION

PHOTO

4

LOCATION

ADJACENT TO #27 TWIN CIRCLE DRIVE

ORIENTATION

SOUTHEAST

DISTANCE TO SITE

+/- 0.15 MILE

VISIBILITY

SEASONAL



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
5	ST. JOHNS DRIVE	NORTHEAST	+/- 0.38 MILE	YEAR ROUND



SIMULATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
5	ST. JOHNS DRIVE	NORTHEAST	+/- 0.38 MILE	YEAR ROUND



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
6	MERRITT BOULEVARD	NORTHEAST	+/- 0.21 MILE	YEAR ROUND



SIMULATION

PHOTO

6

LOCATION

MERRITT BOULEVARD

ORIENTATION

NORTHEAST

DISTANCE TO SITE

+/- 0.21 MILE

VISIBILITY

YEAR ROUND



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
7	ADJACENT TO #2771 HUNTINGTON ROAD	NORTHWEST	+/- 0.22 MILE	SEASONAL



SIMULATION

PHOTO

7

LOCATION

ADJACENT TO #2771 HUNTINGTON ROAD

ORIENTATION

NORTHWEST

DISTANCE TO SITE

+/- 0.22 MILE

VISIBILITY

SEASONAL



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
8	ADJACENT TO #2975 HUNTINGTON ROAD	SOUTHWEST	+/- 0.09 MILE	YEAR ROUND



SIMULATION

PHOTO

8

LOCATION

ADJACENT TO #2975 HUNTINGTON ROAD

ORIENTATION

SOUTHWEST

DISTANCE TO SITE

+/- 0.09 MILE

VISIBILITY

YEAR ROUND



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
9	BEAVER DAM ROAD	SOUTHWEST	+/- 0.43 MILE	NOT VISIBLE



DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
10	BEAVER DAM ROAD AT INTERSECTION WITH HUNTINGTON ROAD	NORTHWEST	+/- 0.15 MILE	SEASONAL



SIMULATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
10	BEAVER DAM ROAD AT INTERSECTION WITH HUNTINGTON ROAD	NORTHWEST	+/- 0.15 MILE	SEASONAL



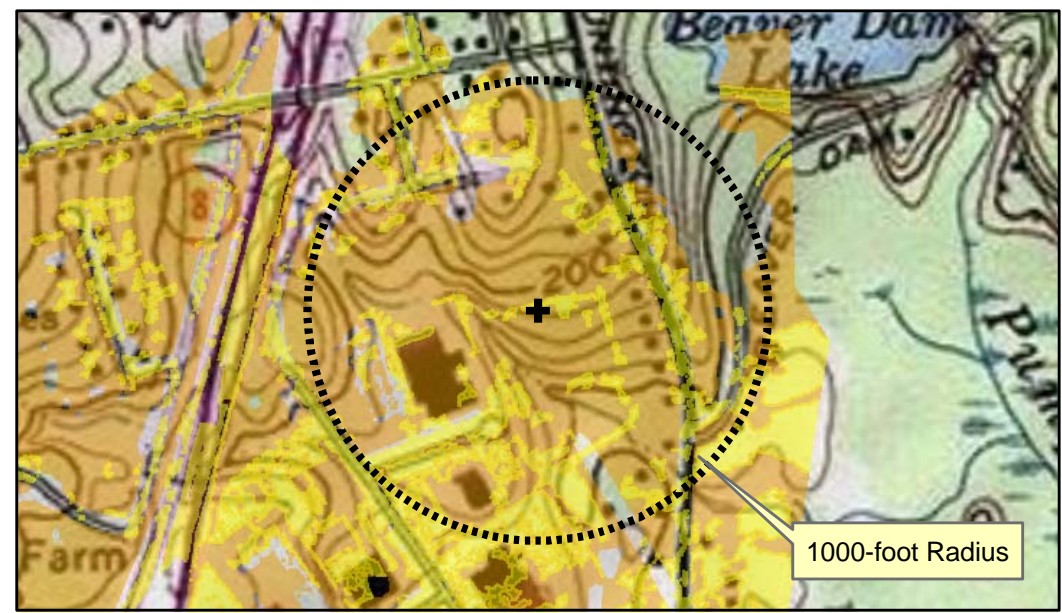
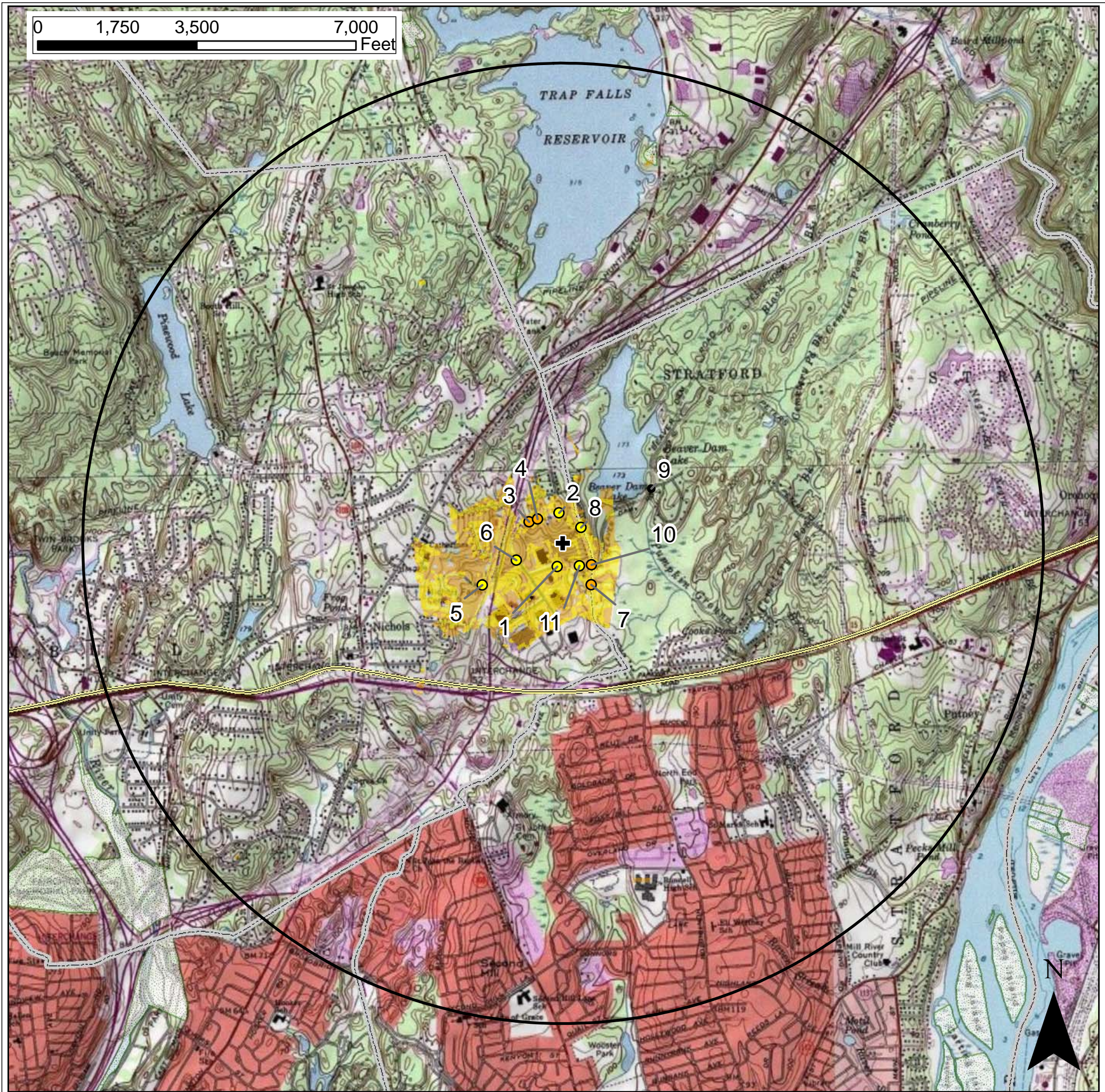
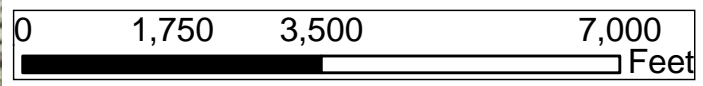
DOCUMENTATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
11	HOST PROPERTY	NORTHWEST	+/- 0.12 MILE	YEAR ROUND



SIMULATION

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
11	HOST PROPERTY	NORTHWEST	+/- 0.12 MILE	YEAR ROUND



Visibility Analysis – Topo Base
 Proposed Wireless Telecommunications Facility
 Trumbull SE 4
 60 Commerce Drive, Trumbull, CT

Proposed facility height is 80 feet AGL.
 Existing tree canopy height estimated as 65 feet.
 Study area encompasses a two-mile radius and includes 8,042 acres of land.

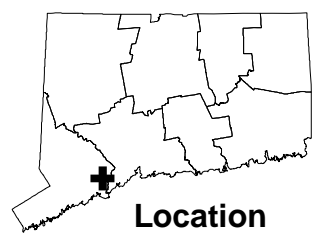
Map compiled 02/09/2014

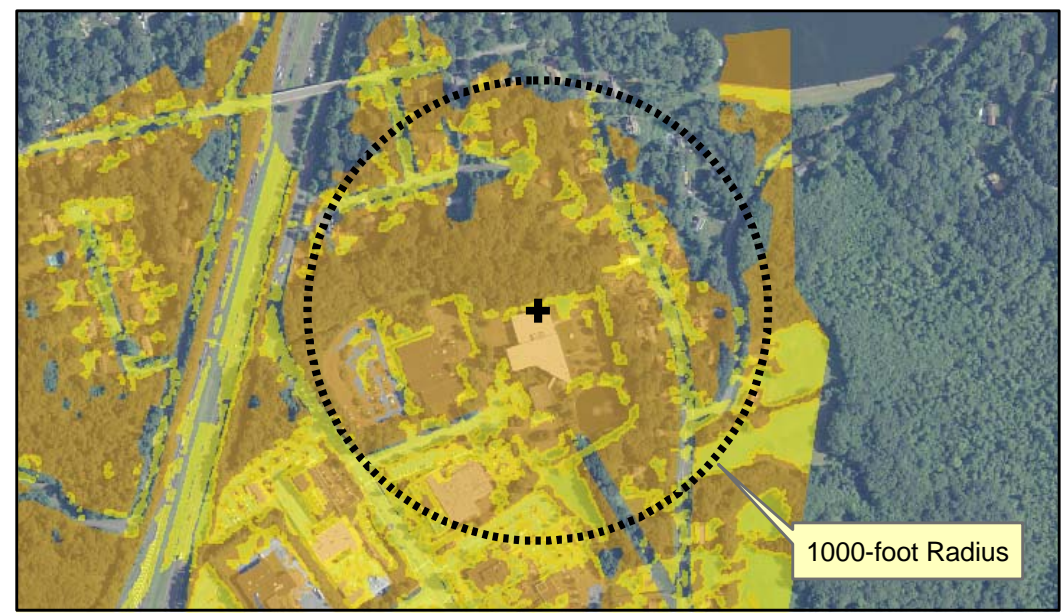
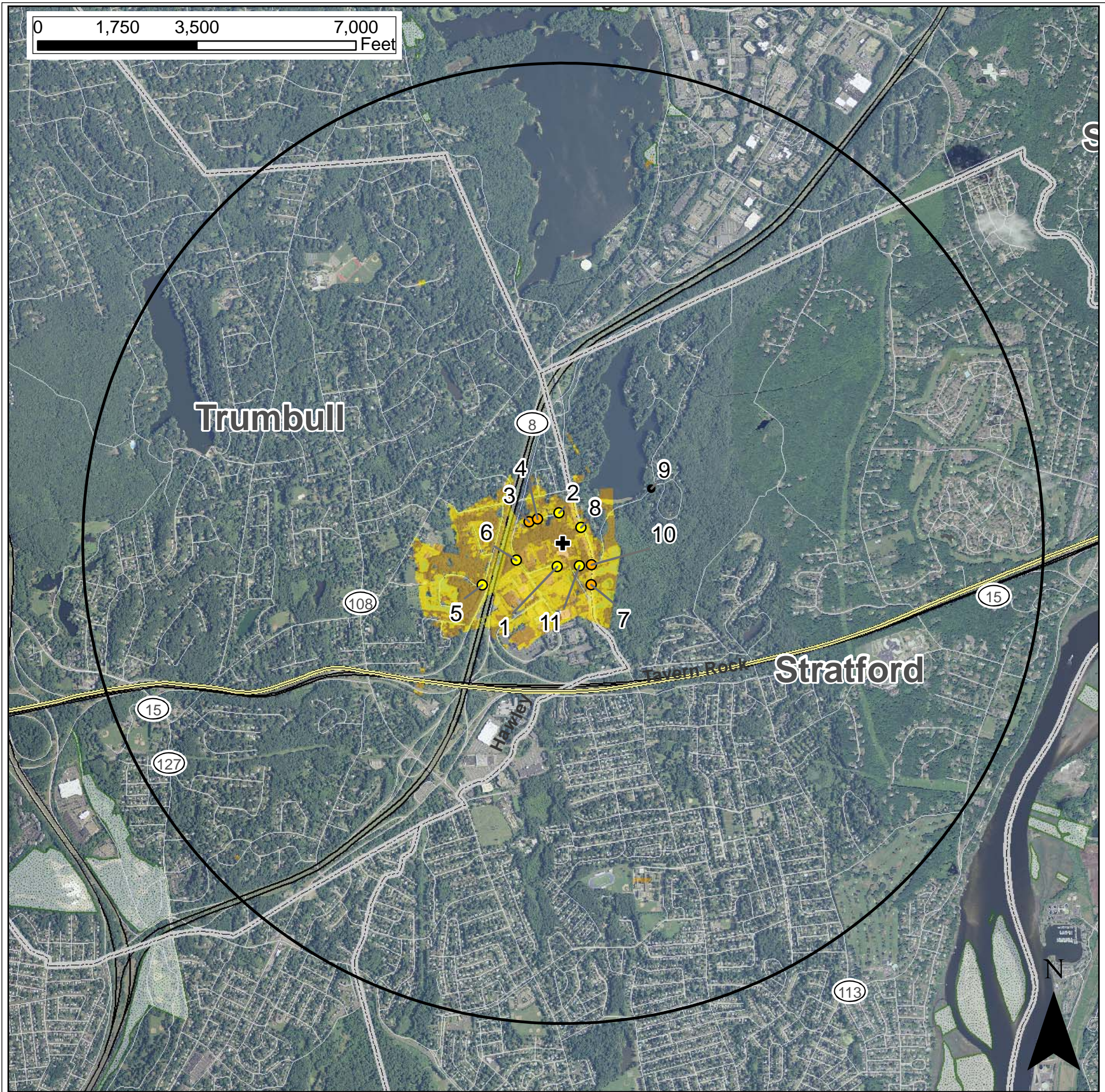
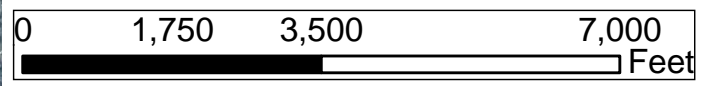
Map information field verified by APT on 01/16/2014.

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**
- Not Visible
- Seasonal Views
- Year-round Views
- Predicted Seasonal Visibility (144 Ac.)
- Predicted Year-Round Visibility (61 Ac.)
- Towns
- 2-Mile Study Area
- Open Space
- Scenic Roads





Visibility Analysis – Aerial Base
 Proposed Wireless Telecommunications Facility
 Trumbull SE 4
 60 Commerce Drive, Trumbull, CT

Proposed facility height is 80 feet AGL.
 Existing tree canopy height estimated as 65 feet.
 Study area encompasses a two-mile radius and includes 8,042 acres of land.

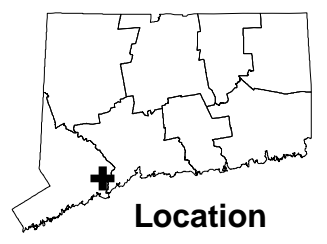
Map compiled 02/09/2014

Map information field verified by APT on 01/16/2014.

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**
- Not Visible
- Seasonal Views
- Year-round Views
- Orange Box Predicted Seasonal Visibility (144 Ac.)
- Yellow Box Predicted Year-Round Visibility (61 Ac.)
- White Box Towns
- Black Box 2-Mile Study Area
- Green Dotted Box Open Space
- Yellow Double Line Scenic Roads



DOCUMENTATION

SOURCES CONSULTED FOR VISIBILITY ANALYSIS MAPS 60 Commerce Drive Trumbull, Connecticut

Physical Geography / Background Data

Center for Land Use Education and Research, University of Connecticut (<http://clear.uconn.edu>)

*Land Use / Land Cover (2006)

*Coniferous and Deciduous Forest (2006)

*LiDAR data – topography (2000)

United States Geological Survey

*USGS topographic quadrangle maps – Bridgeport, Long Hill, Ansonia, and Milford (1984)

National Resource Conservation Service

*NAIP aerial photography (2012)

Heritage Consultants

^State Scenic Highways (based on Department of Transportation data, updated monthly)

^Municipal Scenic Roads (by website, phone and/or email/fax - current)

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 Book West – The Guide to the Blue-Blazed Hiking Trails of 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.

LIMITATIONS

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 and an assumed tree canopy height of 65 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 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.

