



VISIBILITY ANALYSIS

PLYMOUTH WEST RELO

33 KEEGAN ROAD

PLYMOUTH, CONNECTICUT



Prepared for:

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JANUARY 2015

Project Introduction

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 33 Keegan Road in Plymouth, Connecticut (the "Property"). At the request of Verizon Wireless, 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"). In addition to the town of Plymouth, part of the neighboring municipality of Thomaston is located in the western portion of the Study Area.

Site Description and Setting

The Property consists of an approximately 12.4-acre undeveloped wooded parcel located on the east side of Keegan Road. The area proposed for the Facility (the "Site") is located at a local high point in the west-central portion of the Property at an approximate ground elevation of 826 feet Above Mean Sea Level ("AMSL"). The proposed Facility would include a 140-foot tall steel monopole surrounded by a 50-foot by 50-foot, gravel base equipment compound. Based on discussions with the Property owner, Verizon Wireless is considering an option to camouflage the Facility as a pine tree ("monopine"). The monopine would include an approximately 7-foot high extension of faux branching to provide a conical top, bringing the total Facility height up to 147 feet above ground level ("AGL"). Antenna arrays would be concealed within faux branching affixed to the monopole.

Land use within the immediate vicinity of the Property is primarily residential, with an overhead utility corridor and large tracts of undeveloped forest. The topography within the Study Area is characterized generally by steep hills and river valleys; ground elevations range from approximately 330 feet AMSL to 990 feet AMSL. The tree cover within the Study Area (consisting of mixed deciduous hardwoods with interspersed stands of conifers) occupies approximately 4,775 acres of the 8,042-acre study area ($\pm 59\%$). The average tree canopy is estimated to be approximately 65 feet.

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

Two computer modeling tools were used to calculate those areas from which at least the top of the tower 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 tower'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 and land use data. 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, 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.

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. 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 Mattatuck Trail (approximately 0.86 mile south at its nearest point to the Site) and the Plymouth Land Trust, located approximately 0.68 mile to the north. 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 December 16, 2014 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 140 feet above ground level ("AGL") at the proposed Facility location. Weather conditions were favorable for the in-field activities, with calm winds (less than 2 miles per hour) and partly cloudy 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

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.

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.

During the balloon float and in-field activities, several trees were randomly surveyed using a hand-held infrared laser range finder and 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 measurements and comparative observations, in this case approximately 65 feet AGL. Throughout Connecticut, the tree canopy height varies from about 55 feet to in excess of 80 feet (where eastern white pine becomes a dominant component of the forest type, average tree heights may be even slightly higher). This general uniformity is most likely the result of historic state-wide clear cutting of forests for charcoal production in the late 1800s and early 1900s. Approximately 69% of Connecticut's forests are characterized as mature².

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."³

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 assist in producing the final viewshed map.

² USDA Resource Bulletin NE-160, 2004.

³ Warren, Bruce. Photography, West Publishing Company, Eagan, MN, c. 1993, (page 70).

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 programs⁴.

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 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.

⁴ 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.

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	Park Street	Southeast	±0.89 Mile	Not Visible
2	South Street	Southeast	±0.43 Mile	Seasonal
3	South Street	Southeast	±0.30 Mile	Year-round
4	South Street	Southeast	±0.16 Mile	Year-round
5	South Street	Northeast	±0.16 Mile	Year-round
6	South Street	Northeast	±0.24 Mile	Year-round
7	South Street	Northeast	±0.29 Mile	Year-round
8	Lakeside Drive	Northeast	±0.68 Mile	Not Visible
9	West Lakeside Road at Lake Plymouth Boulevard	Northeast	±0.81 Mile	Year-round
10	Hosier Road	Northeast	±0.87 Mile	Year-round
11	Patricia Lane	Northeast	±1.26 Miles	Not Visible
12	Cedar Mountain Road	Northeast	±1.35 Miles	Not Visible
13	Prospect Street	Southeast	±0.87 Mile	Not Visible
14	Maple Avenue	Southeast	±0.63 Mile	Not Visible
15	Todd Hollow Road	Southwest	±0.59 Mile	Year-round
16	Todd Hollow Road	Southwest	±0.36 Mile	Year-round
17	Todd Hollow Road	Southwest	±0.31 Mile	Seasonal
18	Todd Hollow Road	Southwest	±0.25 Mile	Year-round
19	Todd Hollow Road	Northwest	±0.33 Mile	Year-round
20	Todd Hollow Road	Northwest	±0.43 Mile	Year-round
21	Todd Hollow Road	Northwest	±0.44 Mile	Year-round
22	Todd Hollow Road	Northwest	±0.62 Mile	Year-round
23	Scott Road	Northwest	±0.73 Mile	Seasonal
24	Keegan Road	Northwest	±0.76 Mile	Not Visible
25	Keegan Road	Northwest	±0.55 Mile	Seasonal
26	Keegan Road	North	±0.21 Mile	Year-round
27	Keegan Road	North	±0.14 Mile	Year-round
28	Knight Lane	West	±0.60 Mile	Year-round
29	Scott Road	Southwest	±0.85 Mile	Not Visible
30	Cross Road	West	±0.93 Mile	Not Visible
31	Town Hill Road	Southwest	±1.20 Miles	Not Visible
32	Town Hill Road	West	±1.36 Mile	Not Visible

Visibility Analysis Results

Results of this analysis are graphically displayed on the viewshed maps provided in the attachment at the end of this report. Areas from where the proposed Facility would be visible above the tree canopy year-round comprise a total of approximately 65 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 284± acres.

In general, year-round views of portions of the Facility appear limited to the Property and its immediate vicinity (up to ±0.25 mile) to the north and west, particularly on South Street. Year-round views extend a bit farther to the east (±0.6 mile) as demonstrated in photo locations 15, 22 and 28. A few isolated locations along the southwest shoreline of Lake Plymouth could have limited views of the top of the Facility at distances approaching 0.9 mile away (photo locations 9 and 10), although most of the views in this area would transition to seasonally when the leaves are off the deciduous trees.

The majority of views associated with the proposed Facility would occur from nearby locations east and west of the Property along three primary roads: South Street, Keegan Road and Todd Hollow Road. The relative confinement of overall views is due to a combination of the fairly rugged terrain and dense forest cover in the immediate vicinity of the Property.

No views would be achieved from portions of either the Mattatuck Trail or the Plymouth Land Trust trails system.

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 and commercial child day care center are located 107 North Street (Plymouth Center School and the TPDCC Plymouth Center B/A School Program), approximately 1.25 miles to the northwest. No views of the Facility are anticipated from this location.

LIMITATIONS

The viewshed 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 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

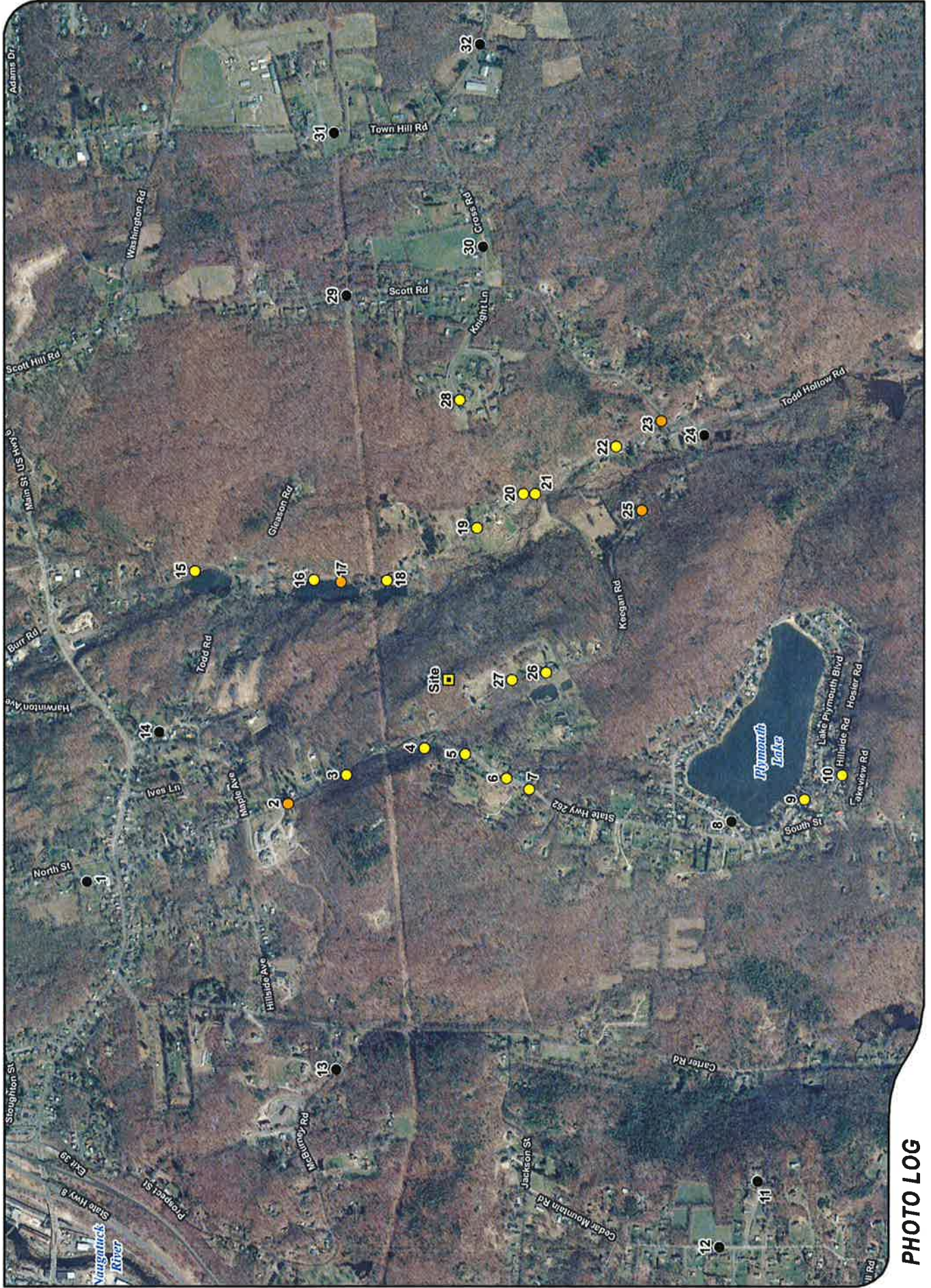
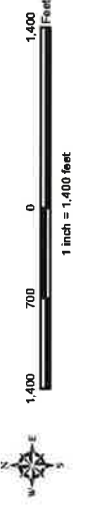


PHOTO LOG

- Legend
- Site
 - Not Visible
 - Seasonal Visibility
 - Year-Round Visibility





EXISTING

PHOTO

1

LOCATION

PARK STREET

ORIENTATION

SOUTHEAST

DISTANCE TO SITE

+/- 0.89 MILE

VISIBILITY

NOT VISIBLE





EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
2	SOUTH STREET	SOUTHEAST	+/- 0.43 MILE	SEASONAL





PROPOSED

PHOTO

2

LOCATION

SOUTH STREET

ORIENTATION

SOUTHEAST

DISTANCE TO SITE

+/- 0.43 MILE

VISIBILITY

SEASONAL



EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
3	SOUTH STREET	SOUTHEAST	+/- 0.30 MILE	YEAR ROUND



PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
3	SOUTH STREET	SOUTHEAST	+/- 0.30 MILE	YEAR ROUND



EXISTING

PHOTO

4

LOCATION

SOUTH STREET

ORIENTATION

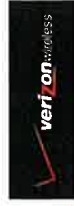
SOUTHEAST

DISTANCE TO SITE

+/- 0.16 MILE

VISIBILITY

YEAR ROUND





PROPOSED

PHOTO

4

LOCATION

SOUTH STREET

ORIENTATION

SOUTHEAST

DISTANCE TO SITE

+/- 0.16 MILE

VISIBILITY

YEAR ROUND





EXISTING

PHOTO

5

LOCATION

SOUTH STREET

ORIENTATION

NORTHEAST

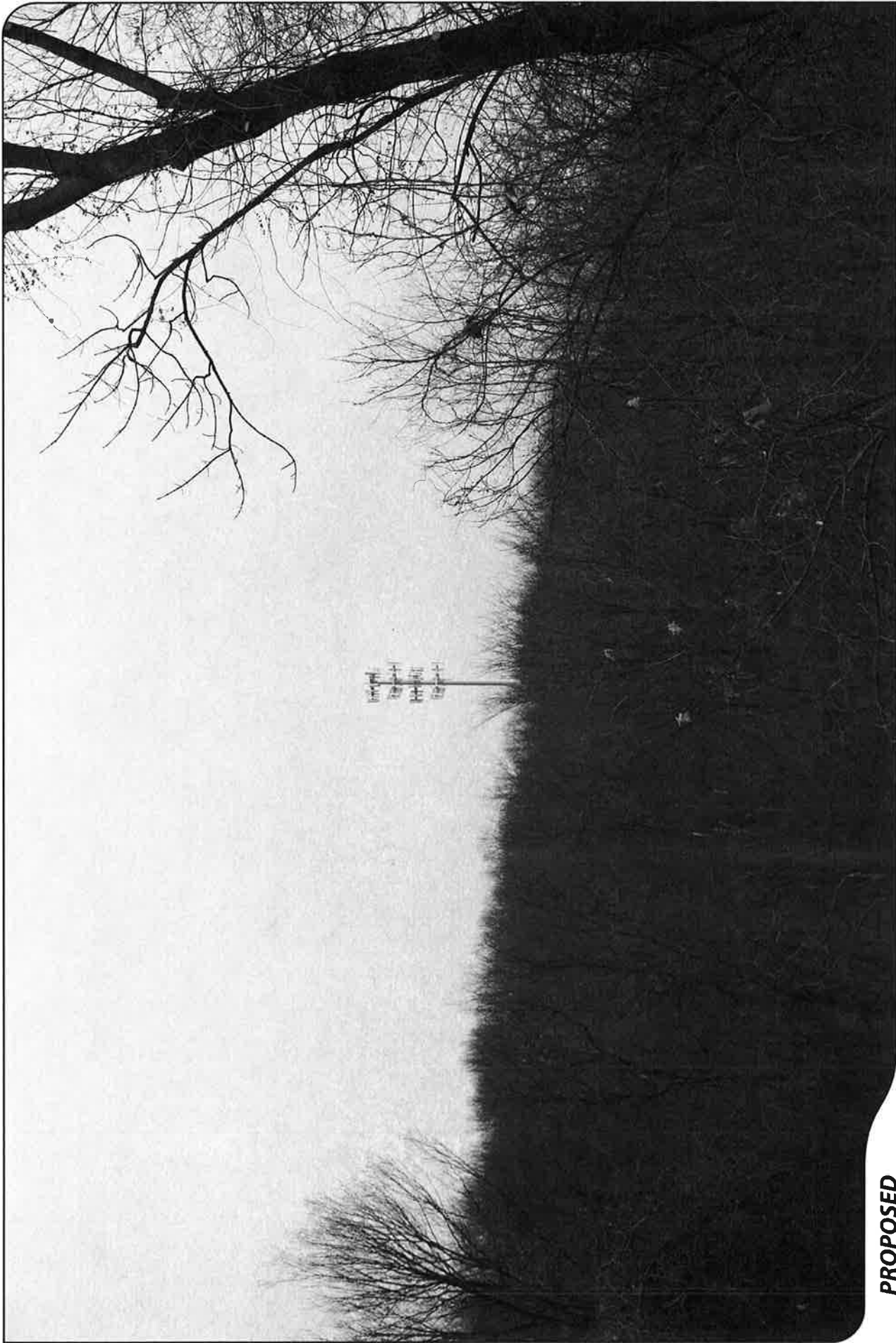
DISTANCE TO SITE

+/- 0.16 MILE

VISIBILITY

YEAR ROUND





PROPOSED

PHOTO

5

LOCATION

SOUTH STREET

ORIENTATION

NORTHEAST

DISTANCE TO SITE

+/- 0.16 MILE

VISIBILITY

YEAR ROUND





EXISTING

PHOTO

6

LOCATION

SOUTH STREET

ORIENTATION

NORTHEAST

DISTANCE TO SITE

+/- 0.24 MILE

VISIBILITY

YEAR ROUND





PROPOSED

PHOTO

6

LOCATION

SOUTH STREET

ORIENTATION

NORTHEAST

DISTANCE TO SITE

+/- 0.24 MILE

VISIBILITY

YEAR ROUND



ALL-POINTS
TECHNOLOGY CORPORATION





EXISTING

PHOTO

7

LOCATION

SOUTH STREET

ORIENTATION

NORTHEAST

DISTANCE TO SITE

+/- 0.29 MILE

VISIBILITY

YEAR ROUND



PROPOSED

PHOTO

7

LOCATION

SOUTH STREET

ORIENTATION

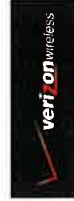
NORTHEAST

DISTANCE TO SITE

+/- 0.29 MILE

VISIBILITY

YEAR ROUND





EXISTING

PHOTO

8

LOCATION

LAKESIDE DRIVE

ORIENTATION

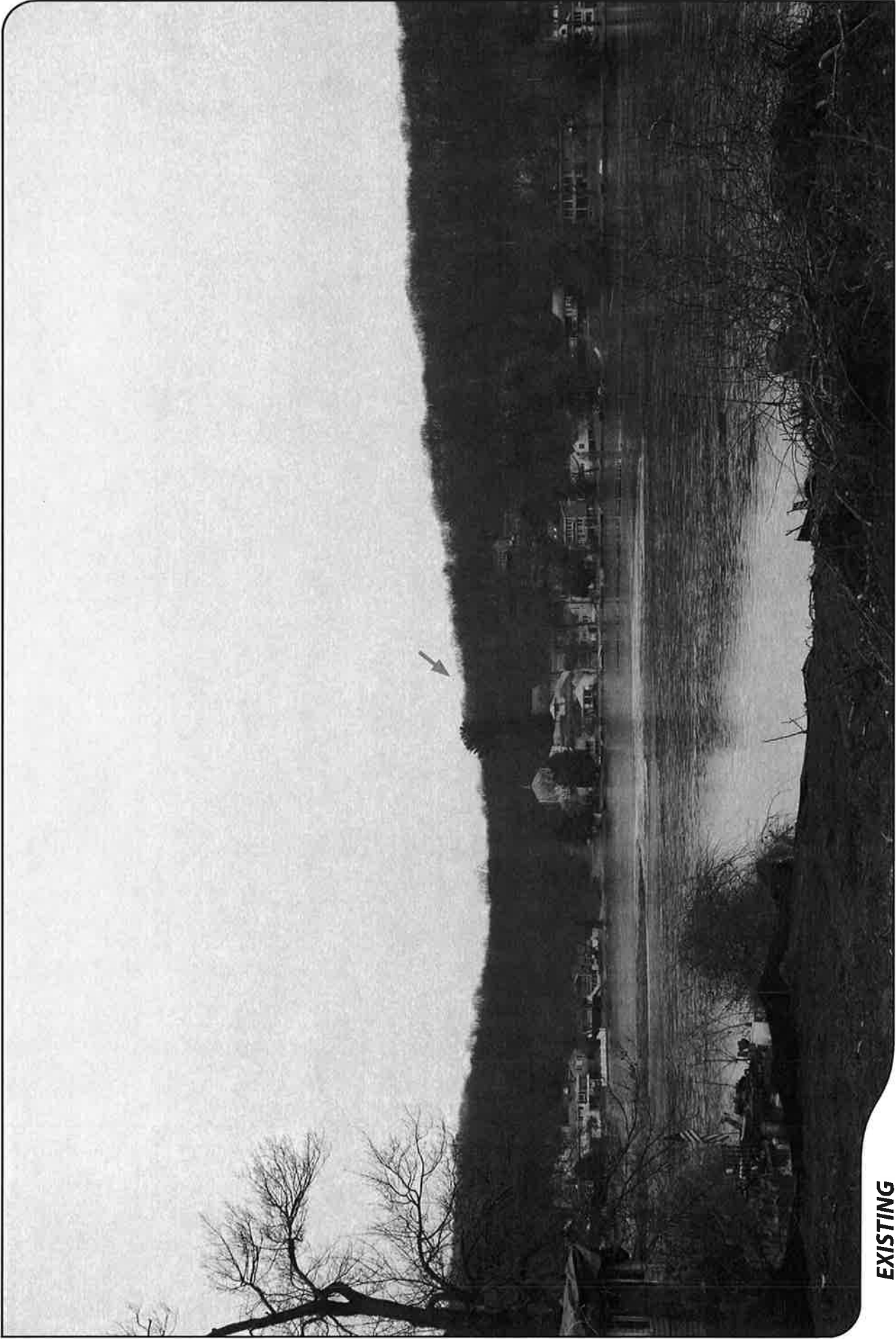
NORTHEAST

DISTANCE TO SITE

+/- 0.68 MILE

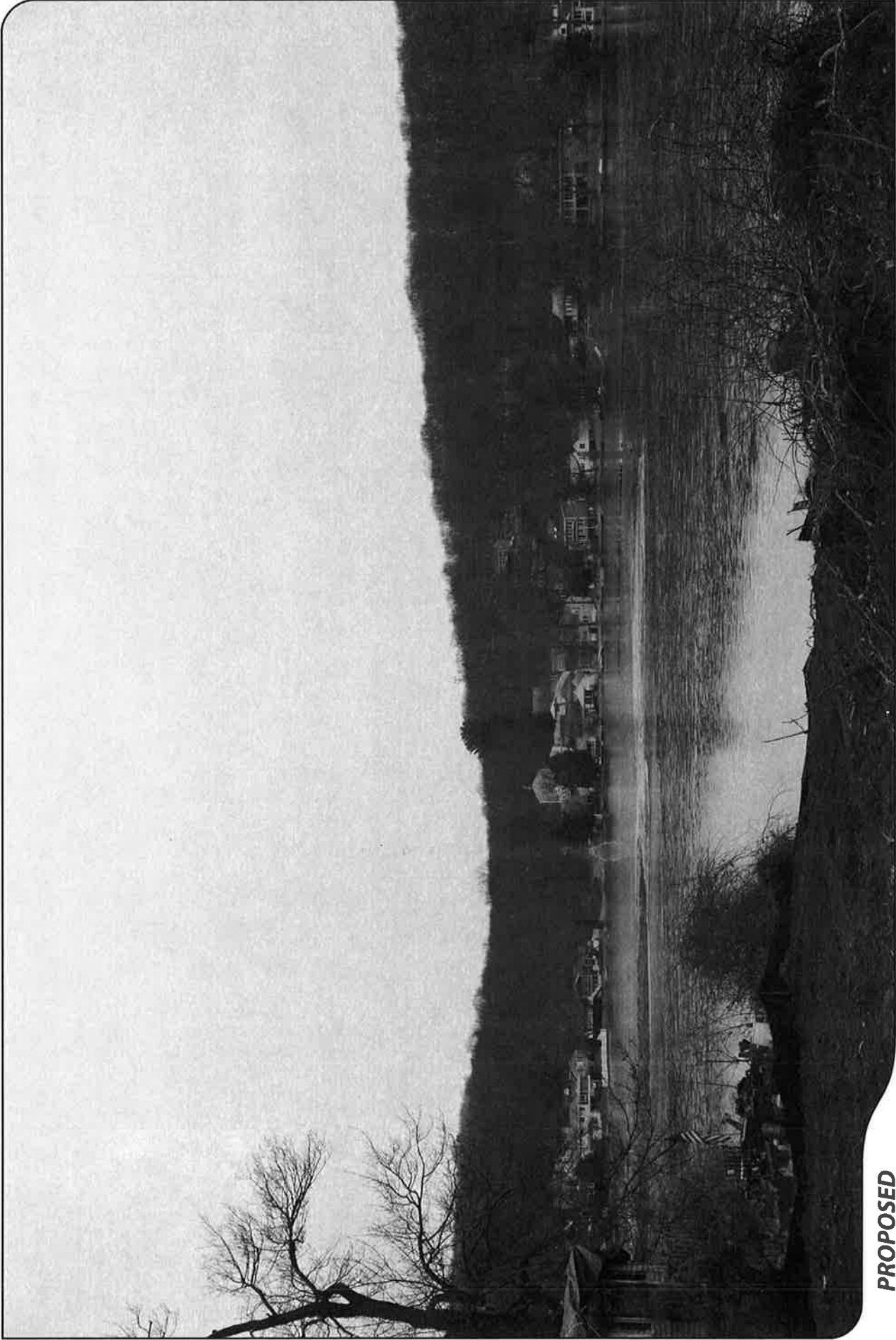
VISIBILITY

NOT VISIBLE



EXISTING

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
9	WEST LAKESIDE ROAD AT LAKE PLYMOUTH BOULEVARD	NORTHEAST	+/- 0.81 MILE	YEAR ROUND



PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
9	WEST LAKESIDE ROAD AT LAKE PLYMOUTH BOULEVARD	NORTHEAST	+/- 0.81 MILE	YEAR ROUND



EXISTING

PHOTO

10

LOCATION

HOSIER ROAD

ORIENTATION

NORTHEAST

DISTANCE TO SITE

+/- 0.87 MILE

VISIBILITY

YEAR ROUND



PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
10	HOSIER ROAD	NORTHEAST	+/- 0.87 MILE	YEAR ROUND





EXISTING

PHOTO

11

LOCATION

PATRICIA LANE

ORIENTATION

NORTHEAST

DISTANCE TO SITE

+/- 1.26 MILES

VISIBILITY

NOT VISIBLE



EXISTING

PHOTO

12

LOCATION

CEDAR MOUNTAIN ROAD

ORIENTATION

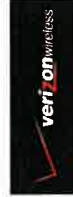
NORTHEAST

DISTANCE TO SITE

+/- 1.35 MILES

VISIBILITY

NOT VISIBLE





EXISTING

PHOTO

13

LOCATION

PROSPECT STREET

ORIENTATION

SOUTHEAST

DISTANCE TO SITE

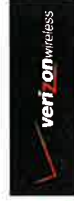
+/- 0.87 MILE

VISIBILITY

NOT VISIBLE



ALL-POINTS
TECHNOLOGY CORPORATION





EXISTING

PHOTO

14

LOCATION

MAPLE AVENUE

ORIENTATION

SOUTHEAST

DISTANCE TO SITE

+/- 0.63 MILE

VISIBILITY

NOT VISIBLE



EXISTING

PHOTO

15

LOCATION

TODD HOLLOW ROAD

ORIENTATION

SOUTHWEST

DISTANCE TO SITE

+/- 0.59 MILE

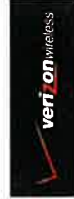
VISIBILITY

YEAR ROUND

15
16
17
18



ALL-POINTS
TECHNOLOGY CORPORATION





PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
15	TODD HOLLOW ROAD	SOUTHWEST	+/- 0.59 MILE	YEAR ROUND



EXISTING

PHOTO

16

LOCATION

TODD HOLLOW ROAD

ORIENTATION

SOUTHWEST

DISTANCE TO SITE

+/- 0.36 MILE

VISIBILITY

YEAR ROUND





PROPOSED

PHOTO	LOCATION	ORIENTATION	DISTANCE TO SITE	VISIBILITY
16	TODD HOLLOW ROAD	SOUTHWEST	+/- 0.36 MILE	YEAR ROUND



EXISTING

PHOTO

17

LOCATION

TODD HOLLOW ROAD

ORIENTATION

SOUTHWEST

DISTANCE TO SITE

+/- 0.31 MILE

VISIBILITY

SEASONAL



ALL-POINTS
TECHNOLOGY CORPORATION





PROPOSED

PHOTO

17

LOCATION

TODD HOLLOW ROAD

ORIENTATION

SOUTHWEST

DISTANCE TO SITE

+/- 0.31 MILE

VISIBILITY

SEASONAL

