



August 22, 2024

Cape Cod Commission
3225 Main Street
Barnstable, MA 02630

**SUBJECT: TOWERNORTH / 1185 LONG POND ROAD TELECOMMUNICATIONS FACILITY
RF ANALYSIS OF TOWER HEIGHT – VERIZON WIRELESS**

To Whom It May Concern:

This letter and the RF coverage maps attached hereto are submitted on behalf of Verizon Wireless to address the coverage impacts of lower, alternative tower heights as it relates to its wireless network in the area. The RF Report dated April 17, 2024 and included with the application includes maps labeled as Attachments A – G. For continuity, the maps included here are sequentially labeled as an extension to the initial set of attachments in that RF Report.

As noted in the RF Report, antenna height is a critical design consideration for meeting the coverage and capacity needs of the network. These specific needs along with the unique topography and land use characteristics surrounding a particular location require that each location undergo its own analysis to determine the optimal and minimum height necessary. In general, and in relation to the area topography, higher antenna height allows for better coverage over terrain obstructions located closer to the site, whereas higher heights may offer virtually no coverage improvement in many cases over terrain obstructions located in more distant areas (over 1 mile or so).

Below is a description of the six coverage maps intended to demonstrate the impact to coverage to Verizon's 700 & 2100 LTE networks with alternative antenna heights of 100' and 80' AGL, in comparison to the proposed antenna height of 120' AGL. Height comparisons are generally conducted in 20' increments to more clearly distinguish the impacts and avoid "blurring the lines" with more closely spaced heights of 10' or less.

For each frequency band, there is a layered map based on the targeted -95 dBm threshold for RSRP (Reference Signal Receive Power) discussed in the RF Report. It is important to emphasize that coverage is not uniform throughout the areas shown to be above or below this coverage threshold. LTE service will adapt the signal modulation to each user based on how "clean" the received signal is. Stronger RSRP allows for a cleaner signal, which translates into better service, and increased data rates to both the individual user and to the site itself. For this reason, maps quantifying the RSRP differences between the proposed and alternate antenna heights are also included for each frequency band. As a note for these map types, the coverage shown has been bounded by areas between -75 dBm and -115 dBm to ignore the impact of height in the very strong and very weak areas.

- **Attachment H** titled *Brenster 5 MA – 700 MHz Height Analysis (-95 dBm)* is a multi-layered coverage plot showing the extent of coverage for various tower heights at Verizon's targeted coverage threshold of -95 dBm for this area. In order from top-to-bottom, the layers show coverage from the surrounding sites in green on top, followed by the coverage of the proposed site with antenna heights of 80', 100', and 120' in gray, blue, and red, respectively. The red areas are those in which the -95 dBm threshold is met at 120' and where the lower heights of 100' and 80' would fall below that coverage threshold. The blue areas are those in which both the 120' and 100' heights would meet the targeted threshold, but 80' would fall short.
- **Attachment I** titled *Brenster 5 MA – 700 MHz LTE RSRP Delta (120' – 100', RSRP < -75 dBm and > -115 dBm)* shows the difference RSRP by comparing the proposed 120' and 100' AGL at 700 MHz. As indicated by the legend, the 120' height offers a coverage improvement of 2-4 dB in just about all directions around the site int

the central and outer extents of the site's coverage area. There are also significant pockets of 4-6 dB improvement in residential neighborhoods located to the north and east of the site.

- **Attachment J** titled *Brewster 5 MA – 700 MHz LTE RSRP Delta (120' – 80', RSRP < -75 dBm and > -115 dBm)* is similar to Attachment I but compares 120' and 80' AGL antenna heights. As expected, the losses are much greater with a 40' height decrease and the analysis shows a 4 to 10+ dB loss of coverage throughout the majority of the area that would be covered by the site.
- **Attachment K** titled *Brewster 5 MA – 2100 MHz Height Analysis (-95 dBm)* is a multi-layered coverage plot, similar to Attachment H, except for Verizon's licensed 2100 MHz frequency band. The extent of coverage for this frequency band is more limited for the -95 dBm threshold. Please note that the antenna tilts were optimized in this plot to improve the coverage range compared to what is shown in Attachment B of the RF Report.
- **Attachment L** titled *Brewster 5 MA – 2100 MHz LTE RSRP Delta (120' – 100', RSRP < -75 dBm and > -115 dBm)* shows the difference in RSRP at 2100 MHz by comparing 120' to 100'. Similar to as shown in Attachment I, the more notable coverage impacts are focused to the north and east of the site in the residential areas towards the edge of coverage with losses of 2-6 dB. Please note that the areas immediately around the site that appear to be a decrease in coverage at the higher height (blue shades) are due to sharp variations in the vertical side lobes of the antenna pattern rather than due to the antenna height difference.
- **Attachment M** titled *Brewster 5 MA – 2100 MHz LTE RSRP Delta (120' – 80', RSRP < -75 dBm and > -115 dBm)* compares the 2100 MHz coverage of 120' to 80'. The losses increase to 4 to 10+ dB to many areas, and there is a much broader area that is negatively impacted by dropping down to 80'.

Any comparison of alternative antenna heights will yield some degree of differences in coverage and is why being “first to market” on a tower can be a competitive advantage for one wireless operator over others located lower on the same tower. The impact of these different heights is unique from site to site and dependent on the surrounding topography and land use. While coverage differences between antenna heights within 20' or 40' of each other can be minimal with towers on the order to 180' tall, the impacts are usually more pronounced with shorter towers since they are closer to the height of surrounding obstructions such as trees, buildings, etc.

Based on the analysis presented in the RF Report along with the additional analysis presented here, we have concluded that the proposed tower height is at the minimum to meet the specific needs of Verizon Wireless with antennas located at 120' AGL. Furthermore, while the analysis shows degraded coverage when comparing 120' to 100', the potential coverage is still substantial suggesting that the proposed tower could be of benefit for up to three operators (120', 110', and 100') should they have similar design needs as Verizon. The coverage losses seen at 80' would be a significant detriment to the majority of the areas that would be served by the proposed site.

To the extent there are questions related to Attachments H – M, we welcome any inquiries and will attempt to address them prior to or during the next scheduled meeting.

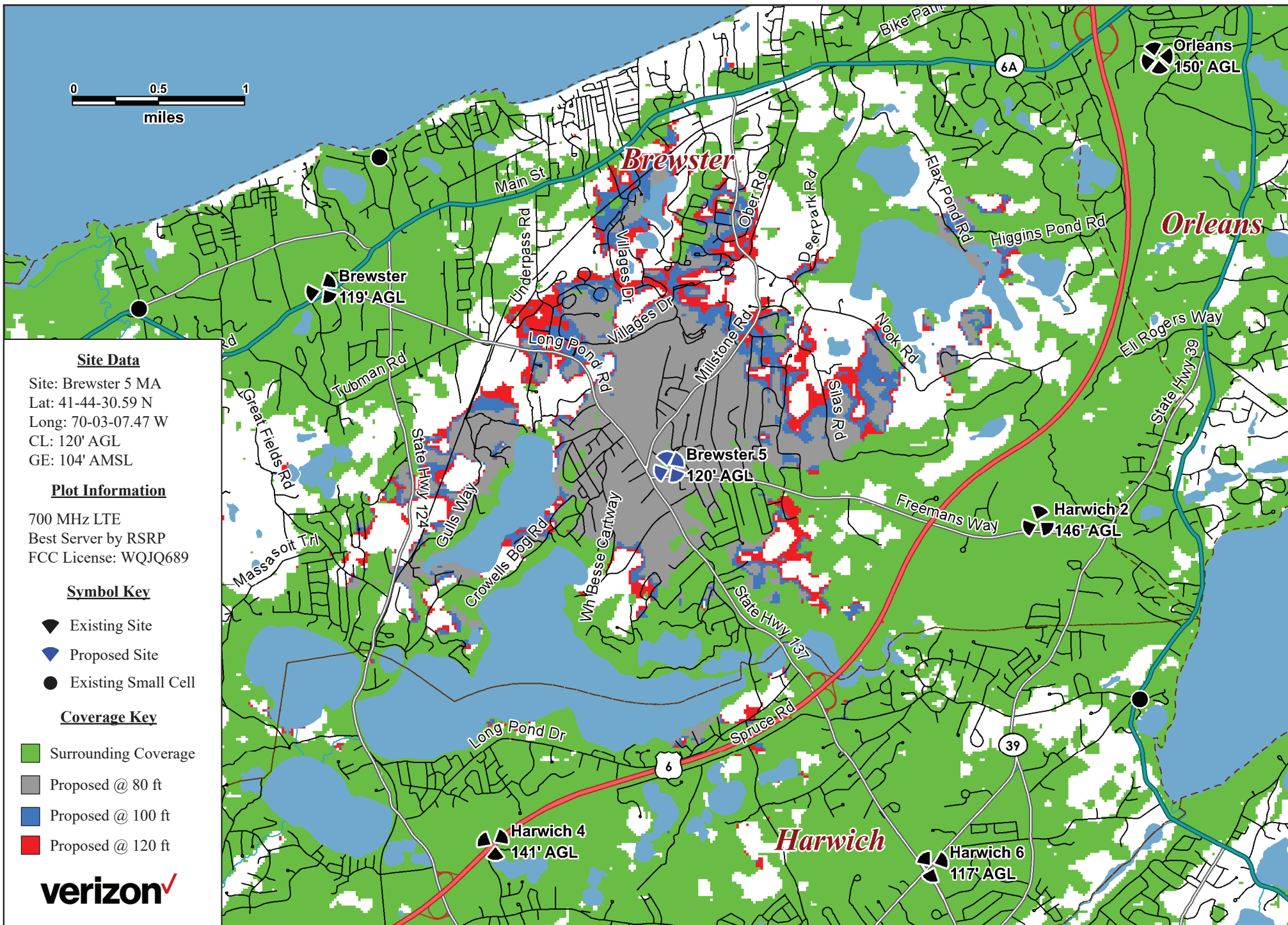
Sincerely,



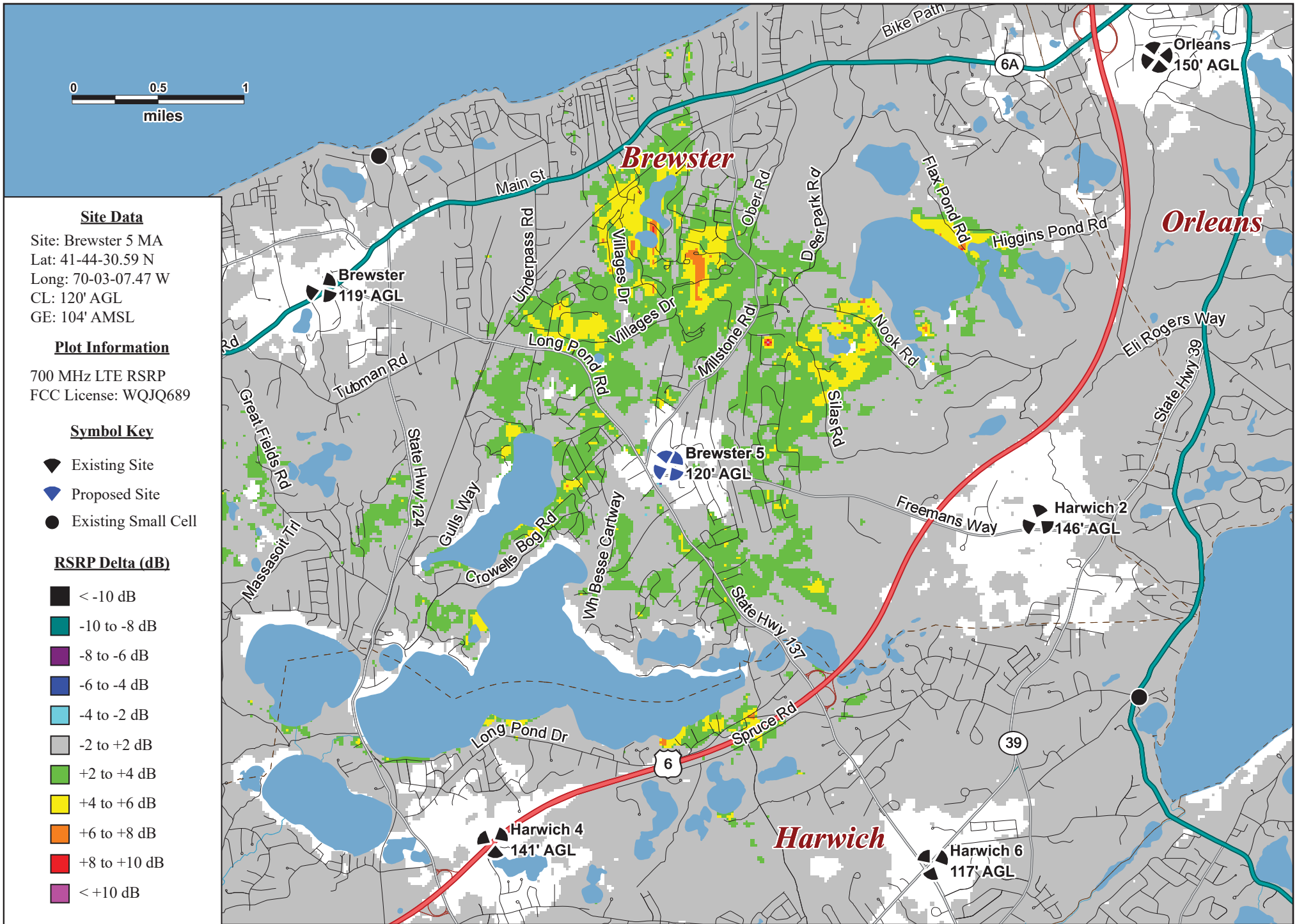
Keith Vellante
RF Engineer
C Squared Systems, LLC
Contractor to Verizon Wireless

Enclosures (6)

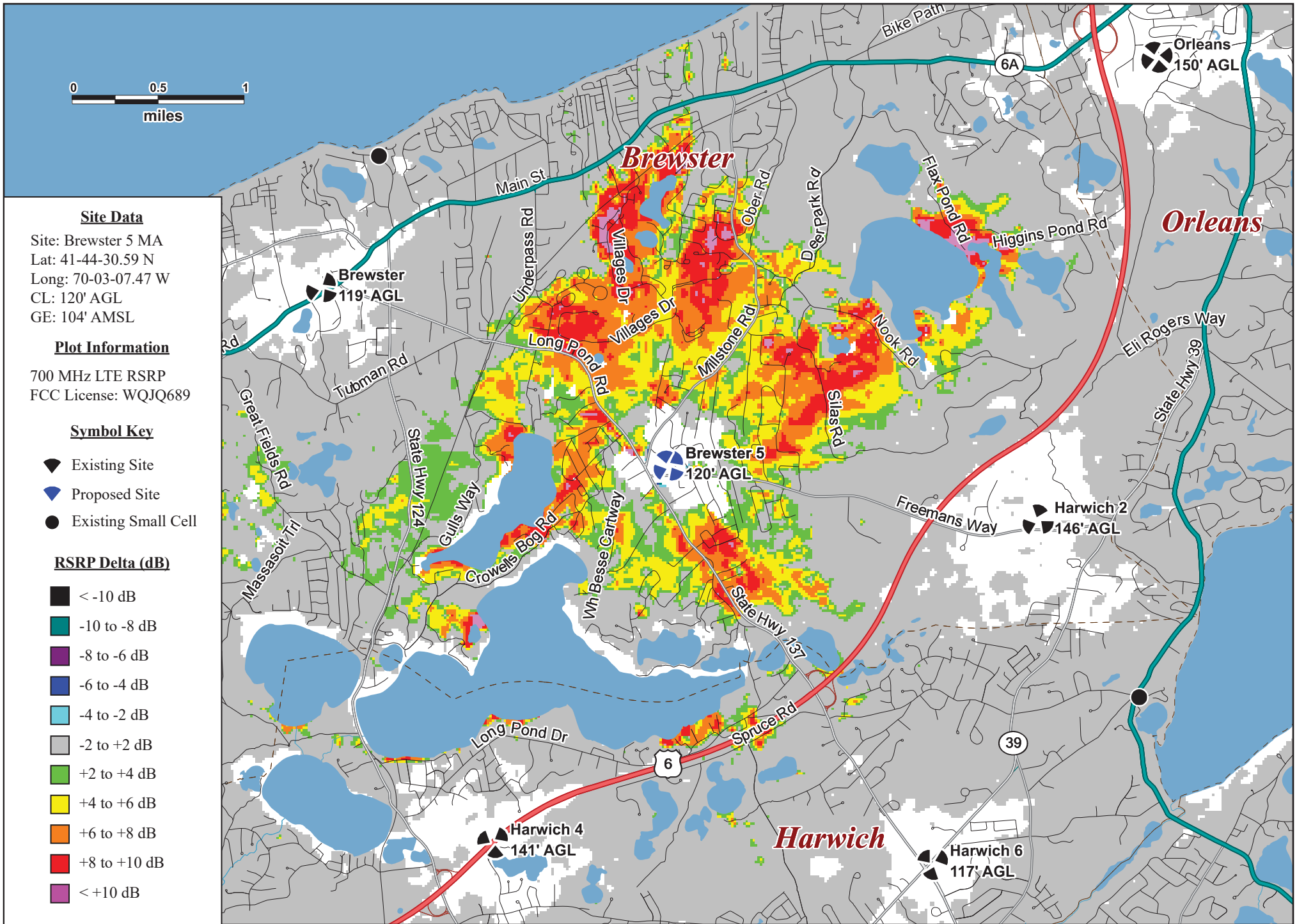
**Attachment H:
Brewster 5 MA - 700 MHz Height Analysis (-95 dBm)**



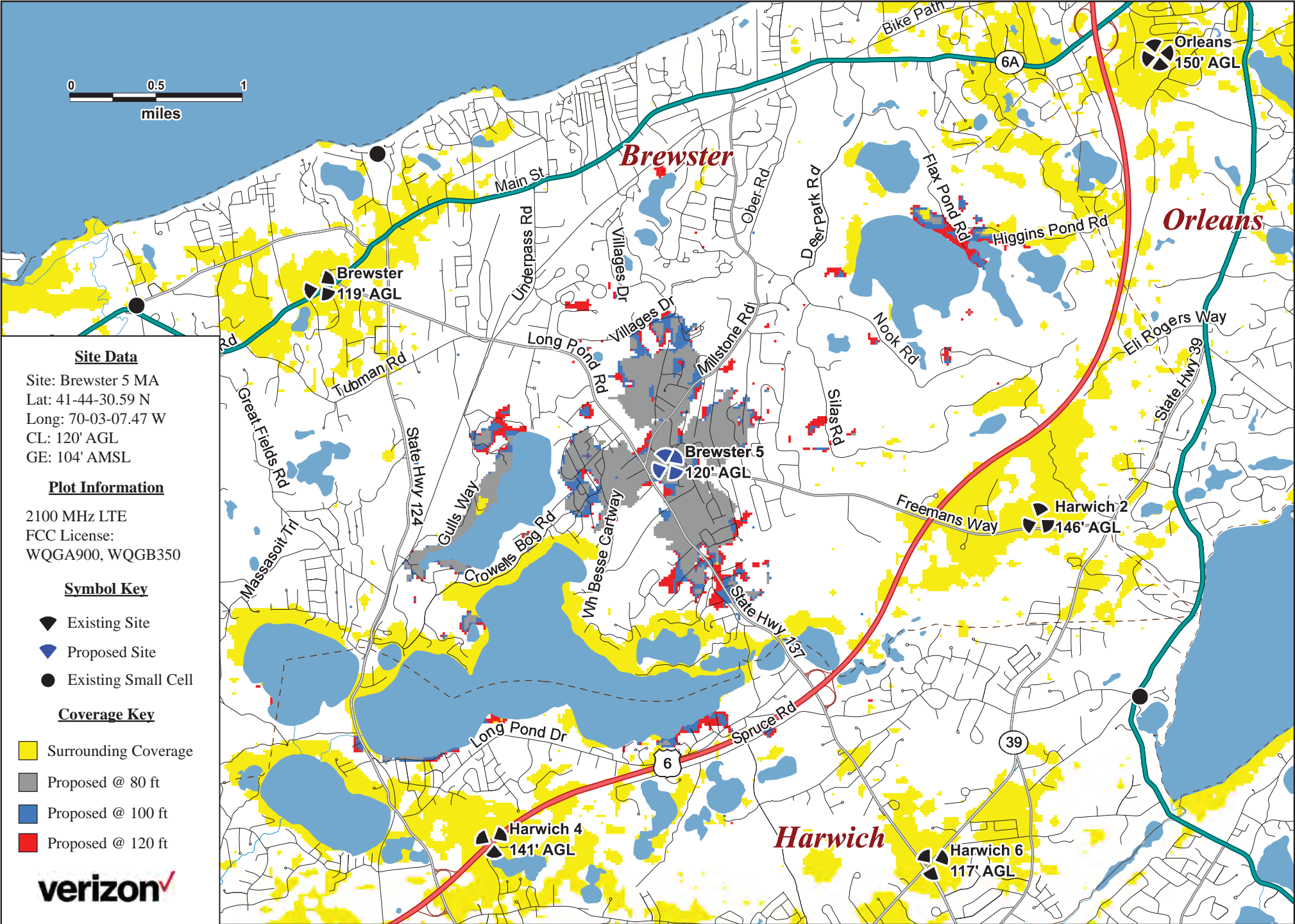
Attachment I:
Brewster 5 MA - 700 MHz LTE RSRP Delta (120' - 100', RSRP <-75 dBm and > -115 dBm)



Attachment J:
Brewster 5 MA - 700 MHz LTE RSRP Delta (120' - 80', RSRP <-75 dBm and > -115 dBm)



**Attachment K:
Brewster 5 MA - 2100 MHz Height Analysis with Existing Coverage (-95 dBm)**



Site Data

Site: Brewster 5 MA
 Lat: 41-44-30.59 N
 Long: 70-03-07.47 W
 CL: 120' AGL
 GE: 104' AMSL

Plot Information

2100 MHz LTE
 FCC License:
 WQGA900, WQGB350

Symbol Key

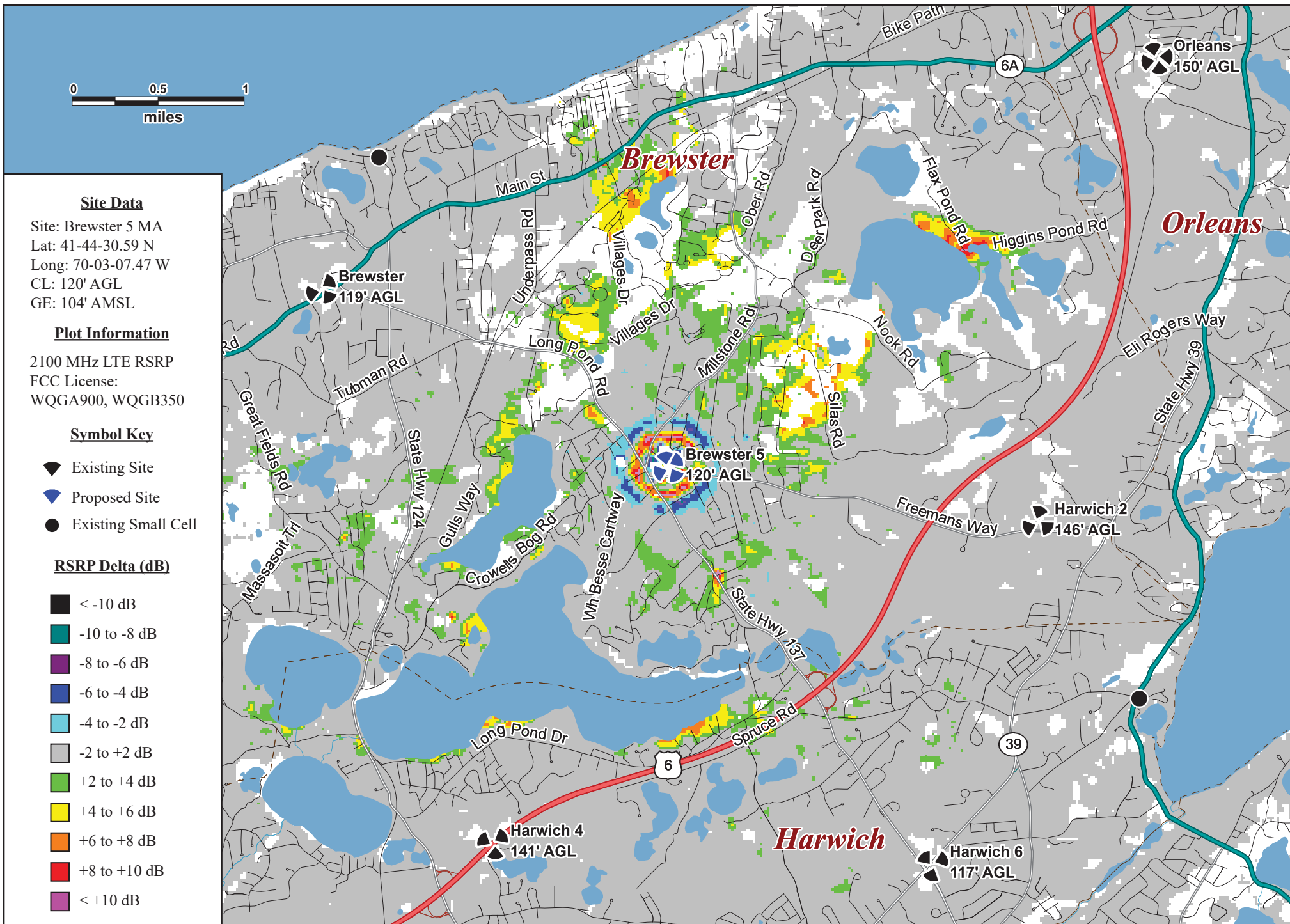
- ◆ Existing Site
- ◆ Proposed Site
- Existing Small Cell

Coverage Key

- Surrounding Coverage
- Proposed @ 80 ft
- Proposed @ 100 ft
- Proposed @ 120 ft



Attachment L:
Brewster 5 MA - 2100 MHz LTE RSRP Delta (120' - 100', RSRP <-75 dBm and > -115 dBm)



Attachment M:
Brewster 5 MA - 2100 MHz LTE RSRP Delta (120' - 80', RSRP <-75 dBm and > -115 dBm)

