

July 28, 2016

Mr. Patrick Brennan, Village Manager  
Village of Kenilworth  
419 Richmond Road  
Kenilworth, IL 60043

**Subject: Analysis of the Design of the Proposed Monopole at 347 Ivy Court**

Dear Mr. Brennan:

This report is in response to your letter to me of May 11, 2016 by which the Village of Kenilworth requested my services:

“... for the purpose of analyzing the design of the proposed monopole at 347 Ivy Court to determine if the design is the minimum required to provide dependable cell phone coverage, or if modifications can be made to reduce the aesthetic impact without reducing quality of service. Please provide any other recommendations you see fit.”

Upon accepting this request, I conducted a series of conference calls and email exchanges with relevant technical and administrative people connected with Kenilworth’s four cellular providers: AT&T, Sprint, T-Mobile, and Verizon. This report documents my data collection and findings.

I shall first succinctly relate my assessment of the current status of cellular communications in Kenilworth. This is followed by my assessment of alternatives to replace, and even potentially improve current cellular communications quality of service, after the planned removal of the commercial cellular antennas currently located atop the Village’s municipal water tower.

Assessment of Current Status

- (1) Three cellular providers (AT&T, Sprint, and T-Mobile) currently have macro-cells<sup>1</sup> co-located atop the Village’s water tower at a common height of 115 feet above the local ground level. The antennas comprising these macro-cells are distributed along the circumference of a 16-foot-diameter circle. (See Appendix 1 for illustrations of the existing water-tower / antenna-installation geometry, which is condensed from the July 29, 2014 structural-calculations report of Fullerton Engineering.)
- (2) Currently, Verizon does not have a macro-cell on Kenilworth’s water tower, or for that matter, anywhere in Kenilworth.

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<sup>1</sup> The term “macro-cell” describes an antenna installation wherein a cellular communications company provides coverage from a single site that is elevated above local reflective and absorptive objects such as buildings and trees. Generally, coverage is adequate within a distance of about 1 mile from such a site.

- (3) Current cellular coverage by AT&T, Sprint, T-Mobile, and Verizon (based upon data supplied by these companies for the purposes of this report):
- a) AT&T (See Appendix 2): The east (Sheridan Road) and southeast portions of Kenilworth appear to be outside of the coverage area provided by AT&T's macro-cell atop the water tower.
  - b) Sprint (See Appendix 3): Sprint did not provide a map for its existing coverage.
  - c) T-Mobile (See Appendix 4): The east (Sheridan Road) and southeast portions of Kenilworth appear to be outside of the coverage area provided by T-Mobile's macro-cell atop the water tower.
  - d) Verizon (See Appendix 5): The entirety of Kenilworth appears to be outside of Verizon's current coverage for reliable in-residence service. This is because Verizon does not have a macro-cell atop the Village's water tower. However, there is some Verizon service to Kenilworth's residents (albeit of variable reliability), especially while locally driving or walking, due to spillover of Verizon's signals from adjacent macro-cells in Wilmette and Winnetka.

### Assessment of Alternatives

#### Alternative I. The Four Cellular Providers Share a New Monopole at Kenilworth Public Works

This alternative was presented by AT&T and MasTec Network Solutions to Kenilworth's Zoning Board of Appeals on April 11, 2016. Four cellular providers would share this monopole, with their macro-cells separated vertically at radiation-center heights of 101 feet, 111 feet, 121 feet, and 132 feet. The overall monopole height would be 145 feet, excluding the thin lightning rod and vertical (omni) antenna atop the monopole. (Illustrations of the location and geometry of the proposed shared monopole are provided in Appendix 6, which is condensed from the AT&T/MasTec presentation of April 11.) For purposes of the present report, I assume that the four cellular providers sharing the new monopole would be AT&T, Sprint, T-Mobile, and Verizon.

Assessment 1: Cellular coverage in Kenilworth would be improved. Specifically, from Appendix 2, AT&T's coverage of the east (Sheridan Road) and southeast portions of Kenilworth would be strengthened. From Appendix 3, Sprint's coverage would encompass all of Kenilworth, although it's not clear that this would constitute reliable in-residence service. From Appendix 4, T-Mobile's coverage of the east (Sheridan Road) and southeast portions of Kenilworth would be strengthened. From Appendix 5, Verizon's coverage of Kenilworth would be greatly improved, but gaps would remain, especially to the southeast along the lakeshore.

Assessment 2: The overall height of the proposed monopole could be reduced. There are two options in configuring the four macro-cells sharing the proposed monopole by which the overall height of the monopole could be reduced without significantly impacting the coverage improvements summarized above. This would "reduce the aesthetic impact without reducing quality of service."

Option (a): The four macro-cells could be located individually at radiation-center heights of 90 feet, 100 feet, 110 feet, and 120 feet. This option would reduce the overall height of the monopole from 145 feet to 133 feet.

Option (b): Two macro-cells could share a radiation-center height of 100 feet on the monopole, and the other two macro-cells could share a radiation-center height of 110 feet.<sup>2</sup> This would reduce the overall height of the monopole from 145 feet to 123 feet.

#### Alternative II. The Four Cellular Providers Distribute Mini-Cells Throughout Kenilworth

During my conference calls with AT&T, Sprint, T-Mobile, and Verizon, I asked each company whether it would be possible to replace (or even improve upon) their existing cellular coverage by distributing a network of “mini-cells” throughout Kenilworth.<sup>3</sup> This would avoid the need to build the proposed monopole at Kenilworth Public Works.

AT&T response: As shown in Appendix 2, 9 mini-cells could be located to approximately replicate AT&T’s current coverage. Typical mini-cells could be mounted on streetlight poles and utility poles. Assessment: Local coverage gaps would exist between the 9 mini-cells. Some residents would have reliable in-home coverage, but others would not. Additional mini-cells would be needed to extend service to the lakeshore (Sheridan Road) vicinity and the southeast.

Sprint response: Currently, there are no Sprint mini-cell sites in service anywhere in the U.S., but Sprint is experimenting with such a system in Minnesota. When asked to provide a photo of one of its mini-cell test sites, the following response was emailed: “Sprint does not have the ability to do mini cell sites so we don’t want to provide a photo of something that we cannot use.”

T-Mobile response: As shown in Appendix 4, 37 low-power mini-cells could be located to provide “strong coverage” to Kenilworth.” These mini-cells would be comparable in appearance to those installed by AT&T. Assessment: While no coverage map was provided for this case, the planned location of the 37 mini-cells appears to be sufficiently comprehensive to provide all Kenilworth residents with satisfactory in-residence coverage. Radio frequency (RF) exposure levels to residents would be orders-of-magnitude below the Government standard.

Verizon response: As shown in Appendix 5, 17 mini-cells could be located to approximately cover Kenilworth. These mini-cells would be comparable in appearance to those installed by AT&T. Assessment: Local coverage gaps would exist between the 17 mini-cells. Some residents would have reliable in-home coverage, but others would not. Quoting a Verizon engineer, “Generally, you don’t get all of them (the mini-cells) at the desired locations which leaves coverage holes in the area.”

Overall assessment: For AT&T, T-Mobile, and Verizon, reliable coverage everywhere in Kenilworth via a network of mini-cells would require something like T-Mobile’s siting plan. This would imply the installation of a total of approximately 120 mini-cells on streetlight poles and utility poles. Sprint’s inability to “do mini cell sites” would still require it to operate a macro-cell on a tall monopole.

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<sup>2</sup> Note that, currently, *three* macro-cells successfully share the top of Kenilworth’s water tower at the same height (see Appendix 1), thereby proving that co-locating macro-cells at the same height is technically feasible. Upon scaling the water-tower antenna configuration to the monopole, the antennas comprising each pair of macro-cells on the monopole could be distributed along the circumference of an 11-foot-diameter circle centered at the monopole.

<sup>3</sup> The term “mini-cell” describes an antenna installation wherein a cellular communications company provides local coverage from a small antenna mounted on a streetlight pole or utility pole. Generally, coverage is adequate within a distance of a small fraction of a mile from such a site, depending upon the local construction and tree foliage.

Bottom-Line Conclusions

1. Sprint's inability to "do mini cell sites" effectively rules out this option unless Sprint's current macro-cell could remain atop Kenilworth's water tower. The other three companies could then distribute their mini-cells within the Village as appropriate to provide reliable in-residence coverage to all of their customers.

In this case, however, there would remain the issue of the visual impact of siting numerous mini-cells. Assuming that T-Mobile's proposed siting of a regular grid of low-power mini-cells also applies to AT&T and Verizon (in order to provide seamless in-residence coverage everywhere in Kenilworth), there could eventually be lightpole-mounted mini-cells situated at most street intersections within the Village.

2. The cellular coverage of AT&T, T-Mobile, and Verizon in Kenilworth would generally be improved by co-locating their macro-cells on the proposed monopole. Improvements would be most pronounced in the vicinity of the lakeshore (Sheridan Road).

Any potential change in Sprint's coverage cannot be evaluated without Sprint providing details of its existing coverage and furthermore better defining its capability to provide in-residence coverage with a macro-cell operating on the proposed monopole.

3. Depending upon how the four macro-cells are distributed vertically along the proposed monopole, the overall height of the monopole could be reduced by as much as 22 feet without significantly impacting the anticipated coverage of any of the four companies.

I would be pleased to discuss my findings in any venue that you feel appropriate.

Sincerely,



Allen Taflove, Professor

cc: Nadim Badran