STATE OF MINNESOTA
BEFORE THE PUBLIC UTILITIES COMMISSION

Nancy Lange	Chair
Dan Lipschultz	Commissioner
Matt Schuerger	Commissioner
Katie Sieben	Commissioner
John Tuma	Commissioner

In the Matter of the Petition of CenturyLink QC to be Regulated Pursuant to Minn. Stat. § 237.025: Competitive Market Regulation	**Docket No. P-421/AM-16-496**

AFFIDAVIT OF ADAM S. NELSON

February 23, 2017

STATE OF VIRGINIA)
) ss.
COUNTY OF FAIRFAX)

Adam S. Nelson, being duly sworn on oath, states as follows:

1. I filed my initial affidavit in this proceeding on November 21, 2016. In that affidavit I provided an assessment of wireless coverage in specific areas in the state of Minnesota. In response, the Minnesota Department of Commerce filed an Affidavit of Wes Legursky on February 9, 2017. In Mr. Legursky's affidavit, he opines that "The results of the modeling done by Mr. Nelson in this case should be viewed as an upper bound. Actual service rates to real customers over a service year are likely to be lower, not as high or higher, than described in the model.[1]"

2. I disagree with Mr. Legursky's opinion. In modeling wireless coverage, Federal Engineering, Inc. (***FE***) made several conservative assumptions to address the factors discussed in Mr. Legursky's affidavit. Furthermore, the model was limited to 800 MHz cellular coverage for two companies – AT&T Mobility (AT&T) and Verizon Wireless (Verizon). As discussed in my initial report, AT&T and Verizon hold additional licenses to provide wireless services using different frequency bands. My analysis looked solely at only one of these 15 frequency bands licensed by Verizon and/or AT&T in the State of Minnesota. [2] Therefore, it is entirely possible that both companies provide wireless voice coverage in additional locations using those additional frequency bands.[3] Furthermore, other

[1] Affidavit of Wes Legursky dated February 9, 2017 ("Legursky Affidavit"), p. 8.
[2] Affidavit of Adam Nelson, ("Nelson Affidavit") November 18, 2016, Exhibit 2, p. 6-7, § 2.3 and Table 1.
[3] Nelson Affidavit, Ex. 2, p. 20-21, § 4.3.1,

companies offer service in these areas using different frequency bands as well (for example, Sprint and T-Mobile). It is also possible that these companies offer service in locations not covered by my analysis.[4] For these reasons, I believe that ***FE***'s analysis should not be considered an "upper bound" but rather should be considered a conservative estimate of the coverage of two companies using one of several available frequency bands.

3. The remainder of this affidavit will address several comments made by Mr. Legursky.

A. Statements Regarding Absorption And Multipath

4. Mr. Legursky states that many factors affect the transmission of radio signals, including distance, absorption, and multipath.

5. Regarding absorption, Mr. Legursky describes how humid air "creates more signal loss than dry, arid air." He goes on to state that drier air, such as the type found in desert climates, would propagate better than the air found throughout Minnesota, which would tend to be more humid. In addition, Mr. Legursky states that foliage can have a dramatic effect on radio signals. While I do not dispute these claims, it is important to note that the coverage analysis model factors in a substantial amount of signal loss to account for a given environment. For example, as stated in my original affidavit, "…a point considered to be "forest land" has an additional 25 dB of signal loss incorporated into the calculations, which simulates the amount of signal loss expected when attempting to use a wireless device in a forested area...[5]"

[4] Nelson Affidavit, Ex. 2, § 4.3.2.
[5] Nelson Affidavit, Ex. 2, § 4.4, p. 21.

6. Regarding multipath, Mr. Legursky states that multipath signals can arrive at a receiver at different times (i.e. out of phase) than a direct, line-of-sight signal.[6] Mr. Legursky states that this can lead to degradation of the received signal, and hence decrease the overall performance of a wireless system. , As I stated in my original affidavit, I performed coverage modeling in accordance with recommendations and guidelines outlined in Telecommunications Systems Bulletin (TSB) 88-D, published by the Telecommunications Industry Association (TIA). In that suite of documents, coverage modeling best practices for public-safety grade wireless systems are outlined, including the use of a quantified amount of signal loss to account for multipath fading. The amount of signal loss corresponds directly to an audio quality level, referred to in the documents as Delivered Audio Quality, or DAQ. The signal losses, or fade margins, recommended in TSB-88 are often representative of the worst-case, as these guidelines are intended to be used by designers of public-safety systems, which have rigorous performance requirements. Therefore, Mr. Legursky's discussion points regarding multipath have already been accounted for in the coverage modeling I conducted.

B. Statement Regarding Evaluated Towers

7. Mr. Legursky stated that "…CenturyLink has used the model to estimate the cellular coverage in 32 of its wire centers based upon the locations of existing towers…[7]" This statement is not accurate. When discussing the analysis presented in my affidavit, it is important to note that existing *towers* were not the focus, but rather existing *licensed 800 MHz transmitters* for AT&T Mobility and Verizon Wireless within and/or near the 32 wire

[6] Legursky Affidavit, pp. 3-4.
[7] Legursky Affidavit, p. 5.

centers, as documented in the Federal Communications Commission's (FCC) Universal Licensing System (ULS) database. As stated in my original affidavit, there may in fact be *more towers* in the wire centers that are providing wireless voice service beyond those considered in the analysis – again demonstrating the likely conservative nature of the analysis. It is simply not possible to verify all tower locations based on publicly available information, such as the FCC ULS database, since the carriers are licensed in other frequency bands by regions not specific sites.

C. Statements Regarding The Random Distribution Method

8. When describing the modeling process, Mr. Legurksy states that, "Random points are generated for wire centers.[8]" It is important to note that the random distribution occurs within each *census block* within each wire center – not simply within each wire center. Thus, the population is not randomly distributed evenly throughout the entirety of each wire center, but rather throughout each individual census block within each wire center. This tends to keep areas of dense population and areas of sparse population consistent between multiple passes of the random distribution.

9. Figure 1 demonstrates an example of randomly distributed points: in this case, the Bemidji wire center is shown (outlined in black), along with each census block (outlined in yellow), and its randomly distributed population (red dots). There are 1357 census blocks that intersect the Bemidji wire center, with population in those blocks varying from zero to 672. As a random distribution pass is performed, each census block retains its individual

[8] Legursky Affidavit, p. 5.

population count, but they are randomly distributed throughout the area of each census block. As the map shows, many of the census blocks with higher population are focused on the central portion of the wire center, and blocks with sparse population are near the wire center's borders. It is important to note that this pattern will occur in every random distribution pass, as each census block retains its population.

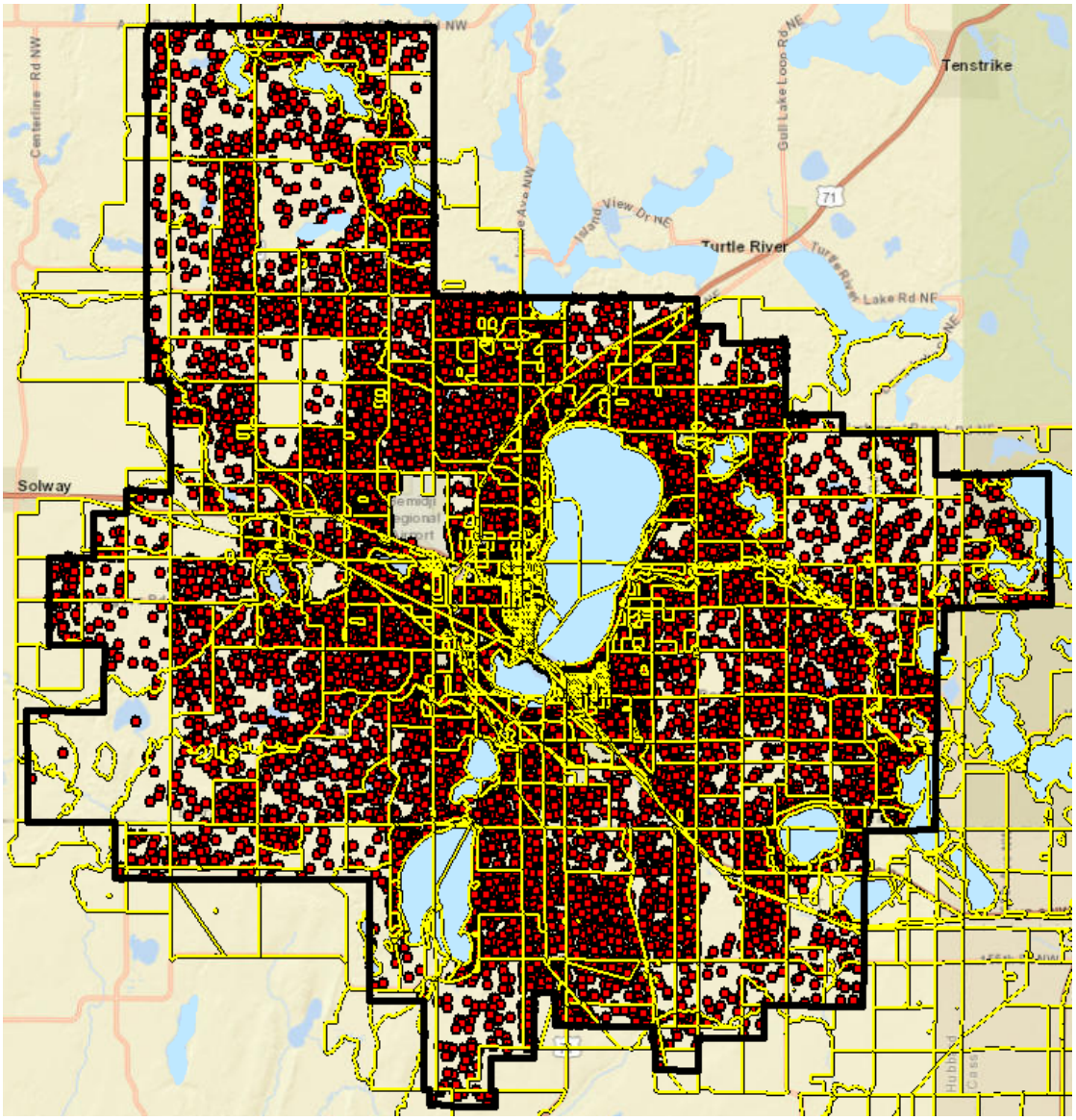

Figure 1 – Census Blocks and Randomly Distributed

Population within the Bemidji Wire Center

10. Regarding indoor vs. outdoor coverage, Mr. Legursky presents two hypothetical examples of potential differences between indoor and outdoor coverage percentages. In the first case, the difference is slight (80% indoor vs. 90% outdoor), and in the second case, the difference is substantial (40% indoor vs. 90% outdoor). Based on this, Mr. Legursky assigns a large amount of responsibility for these discrepancies to the random point distribution method used to perform the initial analysis, stating that, "This result occurs because of the location of the randomly generated points selected.[9]"

11. Mr. Legursky's statement is not accurate. While the random point distribution method can certainly yield different coverage percentages over multiple passes, the discrepancies between indoor and outdoor coverage percentages are more a factor of the actual coverage footprints in each wire center, and less about the random point distribution method. To demonstrate this, the following table shows the differences seen when performing multiple passes of the random point distribution method in the same two wire centers that Mr. Legursky cites in his affidavit (Bemidji and Cook). For each pass, the population is randomly distributed amongst all census blocks that are wholly or partially contained within the two wire centers. For reference, the rows titled "First Pass" are the same coverage amounts that were published in Mr. Nelson's original affidavit. The "Second Pass"

[9] Legursky Affidavit, pp. 3-4.

and "Third Pass" rows show coverage amounts that resulted from two newly-performed passes of the random distribution method.

12. As the table shows, the largest difference between the three passes was 1.5%, as seen when evaluating the indoor coverage of the first and third passes of the Cook wire center. The negligible differences seen in multiple passes of the random point distribution method likely occur because the random distribution occurs within individual census blocks, as opposed to the entire wire center. Based on this analysis, Mr. Legursky's concern that the random point distribution method may be unpredictable and/or widely variable is unfounded.

Table 1 – Population Coverage Percentages Over Multiple Pass Of The Random Distribution Method

Wire Center	Total Population (via Random Distribution in Census Blocks)	Outdoor		Inside Residential Structures	
		Covered Population	% of Population Covered	Covered Population	% of Population Covered
BEMIDJI – First Pass	30637	30104	98.3%	28142	91.9%
BEMIDJI – Second Pass	30630	30120	98.3%	28162	91.9%
BEMIDJI – Third Pass	30643	30095	98.2%	28199	92.0%
COOK – First Pass	2394	1081	45.2%	190	7.9%
COOK – Second Pass	2420	1081	44.7%	219	9.0%
COOK – Third Pass	2400	1064	44.3%	226	9.4%

D. The Real-World Example

13. Mr. Legursky presents a real-world example of an area of poor coverage, stating that wireless performance at his vacation home in Wisconsin suffers from call origination and quality issues. Mr. Legursky states that these problems occur even though "All three carrier coverage maps on their websites indicate that this area is well covered."

14. Mr. Legursky's example is not relevant to my analysis which does not reference, in any way, coverage maps posted by wireless carriers on their websites. I limited my assessment to transmitters licensed by AT&T Mobility and Verizon Wireless through the FCC, which must legally operate based on technical restrictions imposed on the licenses.

CONCLUSION

The concerns Mr. Legursky raises in his affidavit regarding absorption/multipath issues, environmental losses, and unpredictability of random point distributions have been fully addressed in my analysis. All the afore-mentioned concerns were accounted for in my coverage modeling methodology, which in some cases can present a conservative estimate of performance of the 800 MHz wireless voice coverage, without regard to additional wireless voice coverage that may be provided in the 14 frequency bands licensed by AT&T and/or Verizon, and without regard to services offered by other providers Therefore, I disagree with Mr. Legursky's claim that "The results of the modeling done by Mr. Nelson in this case should be viewed as an upper bound." To the contrary, the analysis I have presented should be considered a potentially conservative estimate of coverage.

Adam S. Nelson

Subscribed and sworn to before me this 23 day of February, 2017.

Shawn E Dickerson
Commonwealth of Virginia
Notary Public
Commission No. 7242475
My Commission Expires 7/31/2018

Shawn E Dickerson
Notary Public

My Commission Expires:

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