Thinking outside the sphere

August 4, 2022

WIRELESS DRIVE TEST REPORT FOR LENOX, MASSACHUSETTS

OVERVIEW

A drive test capturing wireless coverage of the major carriers was conducted in Lenox on May 5, 2022, traversing approximately 100 miles[1] of town roads. Cell phones with special software were attached to the windshield inside a car and the route was driven. The coverage with the currently deployed technology, 4G LTE, was captured. The drive test data was divided into four quality-of-service categories as shown on the legends in the maps. The signal strength classifications include Excellent, Network Design Goal, Marginal and Poor.[2] In places that were driven but no LTE signal was detectable, a fourth color (orange) is indicated.

In the accompanying file folder are the results of the drive test in the form of a kmz file for use with GIS or Google Earth applications and a set of drive test map files for each carrier. There are 2 series of maps, one displaying overall cell coverage in town, including service from facilities inside and outside of town. The other displays what portion of the coverage, as best can be discerned, is coming from out-of-town facilities.

COVERAGE

The signal strength information can be interpreted in two ways. First, it shows coverage. Signal strengths are reported as the outdoor signal level as measured. A signal level of, say, -85 dBm (Excellent) that exists outside a building has a better chance of penetrating much of a building and still providing a good connection than a weaker signal. Signals at a level of -95 dBm might not be as effective in providing good coverage inside the entirety of a building, but might still be usable inside portions of buildings and would still be good at penetrating automobiles. Signals in the "Marginal" range are generally reliable outdoors. Signals in the "Poor" range may still be able to provide a connection, such as for phone calls, but they are more likely to be interrupted or suffer quality degradation. Each of these thresholds are not exact limits for

[1] Note that in pre-drive discussions, Roaring Brook Rd was to be included in the route. On the day of the drive test, a portion of the road was closed for construction.

[2] The signal level thresholds go from a high of -85 dBm to a low of -115 dBm. This is because the values are negative numbers.

in-building, in-vehicle and outdoor coverage, as anyone who has had to move near a building window to get a good signal can understand. The probability of a certain quality of connection diminishes with the increase in obstacles between cell site and user, such as walls, cars, and terrain. Distance from the cell site also affects signal strength.

In summary, with respect to using signal strength to estimate quality of the connection, service is likely available in smaller residential buildings in the yellow and green areas, with increasing difficulty for larger buildings in the yellow areas. Even with blue signal areas, some users may be able to use the network adequately from some locations in residences, but with much less certainty and reliability. Likewise, a person in an automobile is likely to be able to maintain a call in areas that are blue, although best service and data connectivity is obtained in the green and yellow areas. It is a sliding scale of probability and the design goal is to serve as much of a developed area with green and yellow as possible, while counting on the blue to leave the impression of service in difficult-to-reach or low-activity areas. The black areas indicate unreliable service, but a connection to the cell site is possible. It is best to be out in the open and standing still to make a call in the black areas, and data service will be minimal. Locations marked orange had no service.

CAPACITY

The other thing that the signal strength maps imply is the potential capacity of a connection. Increased capacity is available from two phenomena – more signals available and stronger signals available.

POOR SIGNAL STRENGTH WASTES CAPACITY

When the signal is strong, it is received clearly and with few errors. As the signal gets weaker, the network must send more information (redundant data bits for error correction) more slowly (like a telegraph operator striking longer dots and dashes to overcome a noisy connection) to be sure it is received well. This means that a subscriber at the cell coverage edge loads the capacity of the cell site more than a subscriber close to the cell site. This is a reason why it is important to have cell sites close to where subscribers congregate.

FEWER RADIO CHANNELS AVAILABLE AWAY FROM CELL SITES

Cell sites operate on several bands of radio frequencies.[3] Higher frequencies generally do not cover as much area as lower ones. This means that when a subscriber is near a cell site, there is more capacity available because there are more frequency bands available with good signal quality. This is another reason why it is

[3] "Frequencies" in the radio spectrum are the same as the "colors" of visible light. Bands include Cellular 850 MHz, PCS, AWS, and 700 MHz, with new bands at higher frequencies being deployed mostly in urban settings – C Band, CBRS and millimeter wave.

important to have cell sites close to where the subscribers congregate. A coverage map that shows where the signals are strongest also implies where the various frequencies of the cell site are more readily available and more capacity is available to more subscribers.

TOO MANY USERS ON ONE CELL SITE

In addition to the availability of more frequency bands closer to a cell site, the other cause of a capacity crunch is simply when there are too many subscribers connecting to a site. Even a place with good signal strength can be too demanding for one cell site to handle. The first strategy to relieve capacity at a cell site is to eliminate a large number of users at the cell edge, who tend to waste capacity due to poor signal quality. If there is a commercial area, residential area or recreational area with large population that is on the fringe of cell coverage, it is a candidate for a new wireless facility. By offloading those distant users to a new cell site, the existing cell site is relieved of a disproportionate burden. A second strategy to relieve a capacity crunch on a cell site is to put in fill-in facilities at high-activity areas. They could be rooftop facilities in a busy commercial area, or "small cells" placed on utility poles, lamp posts, etc. in strategic locations.

LENOX "PRESSURE POINTS"

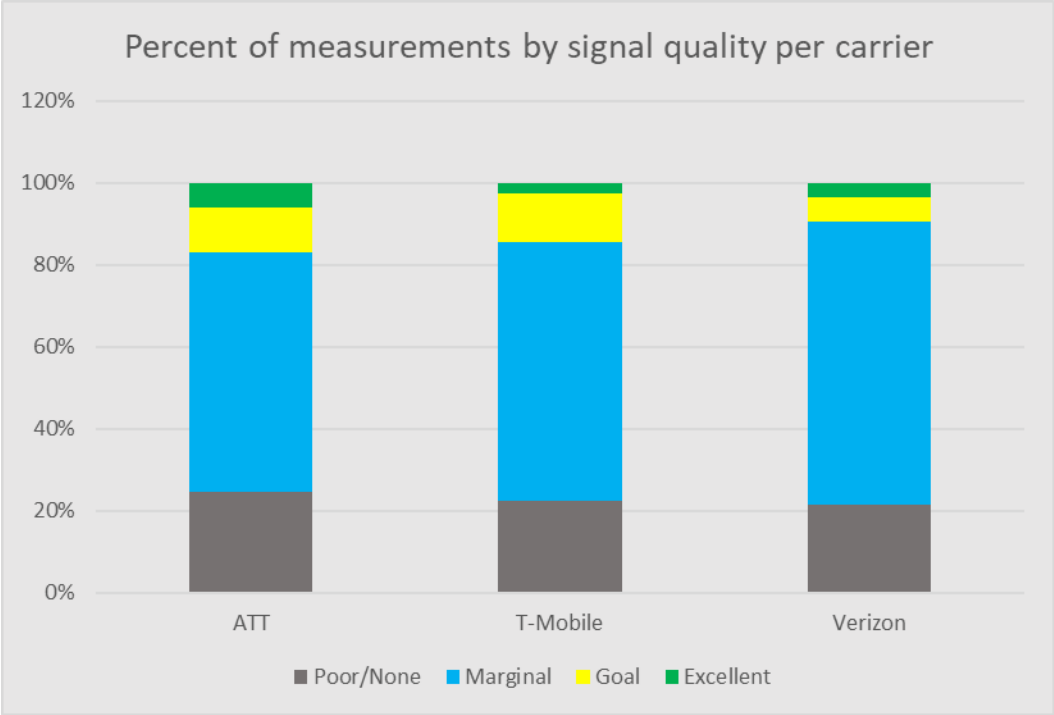
The drive test shows that along most of the roads tested, one can likely make a 911 call outdoors, standing still (includes the black on the maps). T-Mobile has a large gap near Tanglewood. Much of the town has "Marginal" service (blue) for all carriers, which is likely to support emergency calls (or any calls) in a vehicle although it might need to be stationary or the user holding the phone near a car window, provided the car stays in the blue while in motion. These are not ideal conditions, but it is reassuring that the test received LTE signals from the carriers at most places for (except the orange marks on the maps). The chart on the next page shows the proportion of measurements obtained in each category.

The existing cell tower at 90 Pittsfield Rd (Rt 7) has all three carriers on it.[4] This facility provides the dominant coverage to a large segment of Rt 7 and to the town center, as shown by comparing the coverage maps with the maps of the non-Lenox facility coverage in Lenox. The coverage in the town center and on much of Rt 7 is marginal to poor.

The southeast corner of town, generally described as the area from Housatonic St southerly to the Lee boundary, is a likely target for new facilities. This is an area with a concentration of streets and development that is largely served by out-of-town facilities to a level of coverage that is not up to design standards. As noted above, the fact that this area is of substantial size, with substantial street penetration and development, and coupled with the less-than-stellar signal levels, suggests this area could be a drain on the

[4] AT&T, T-Mobile, and Verizon. Sprint was absorbed by T-Mobile. Dish Networks is the new 4th carrier and will be expanding its national footprint in the coming years.

capacity of cell sites outside the town. To increase capacity of existing cell sites outside town and provide a higher quality of service to this area, the southeast part of town is a likely location to target a new facility.



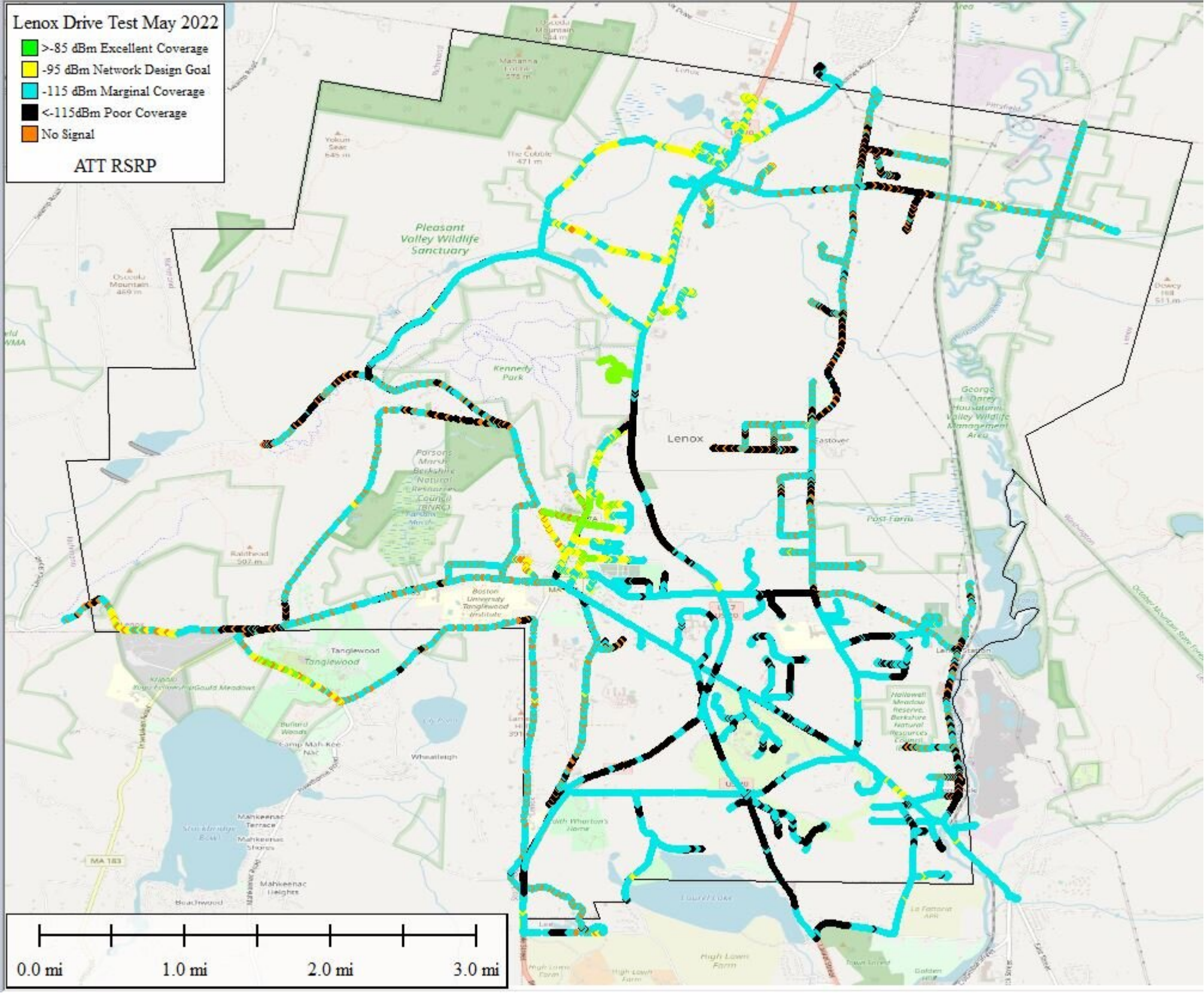
The Tanglewood area is poorly served by T-Mobile and partially served by AT&T and Verizon. AT&T and Verizon appear to have facilities in Stockbridge, southwest of Tanglewood, providing some good coverage along West Hawthorne Rd and perhaps into the lawn and music shed area. Verizon has a small cell on a utility pole on West St (Rt 183) in Lenox to buttress service on the Lenox side of the town line. With the large concentration of seasonal activity in this area, no doubt this is a challenging area for the carriers to address. Tanglewood is largely in Stockbridge, so the pressure point favors a solution in Stockbridge. The traffic generated on Rt 183 in Lenox could be a target for new coverage as well. Verizon seems to have addressed this at least in part with its small cell.

The center of town has an AT&T facility in a steeple, and we understand there has been other carrier interest in putting facilities on building rooftops to serve the center of town. Just as is the case with the steeple installation of AT&T, putting other carriers' facilities in visually acceptable locations near the center of town will provide the best coverage to the most people without resorting to a new cell tower.

CONCLUSIONS

Lenox has one cell tower. The town is primarily served from cell sites outside the town. The two most likely areas of potential wireless facility development are the center of town and the southeast portion of town between Housatonic Street and the Lee line.

David Maxson, WCP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-95 dBm Network Design Goal
-115 dBm Marginal Coverage
<-115dBm Poor Coverage
No Signal
ATT RSRP
Pleasant Valley Wildlife Sanctuary
Kennedy Park
Lenox
Tanglewood
Wheatleigh
Mahkeenac Terrace
Mahkeenac Shores
Mahkeenac Heights
Beachwood
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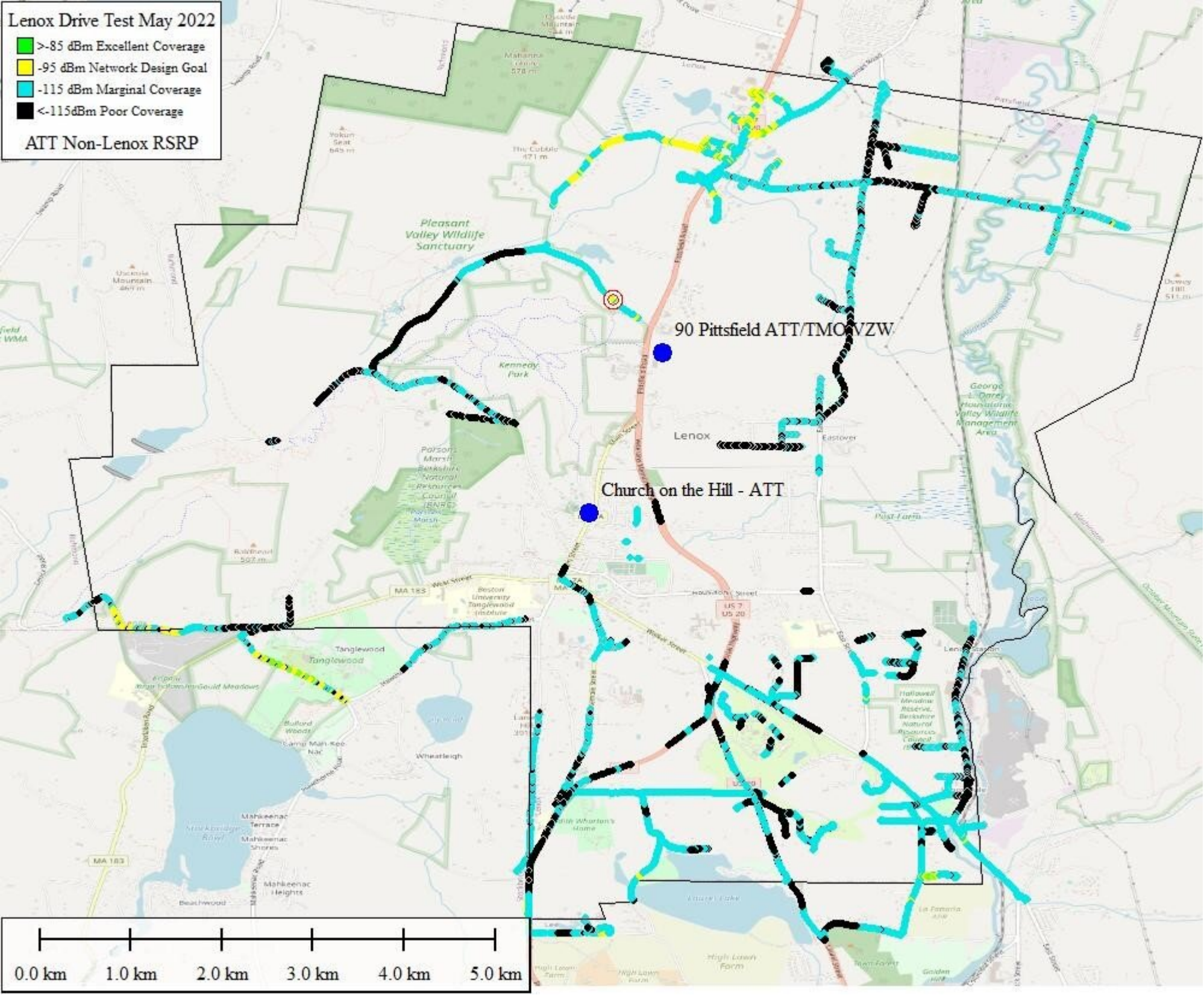
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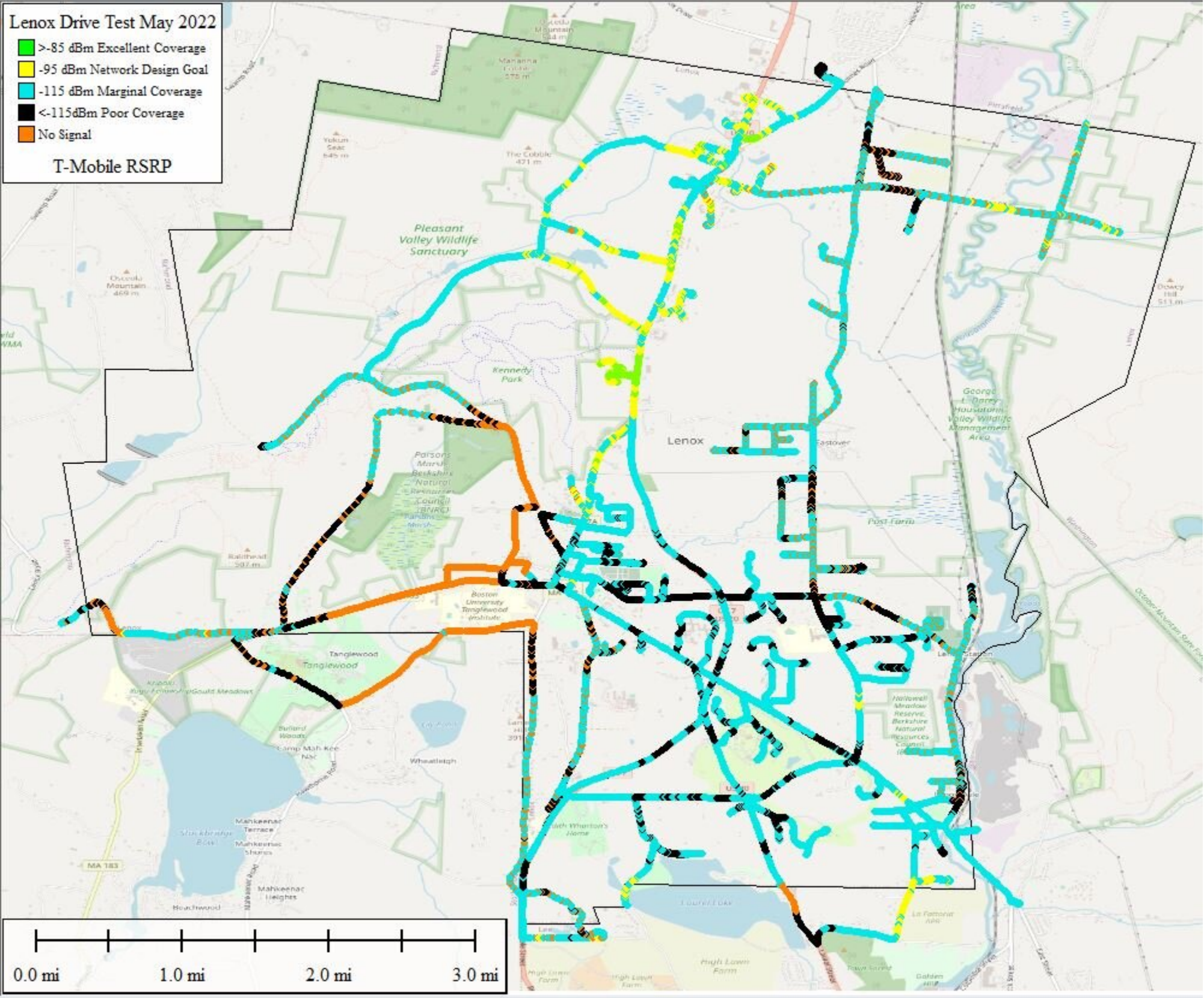
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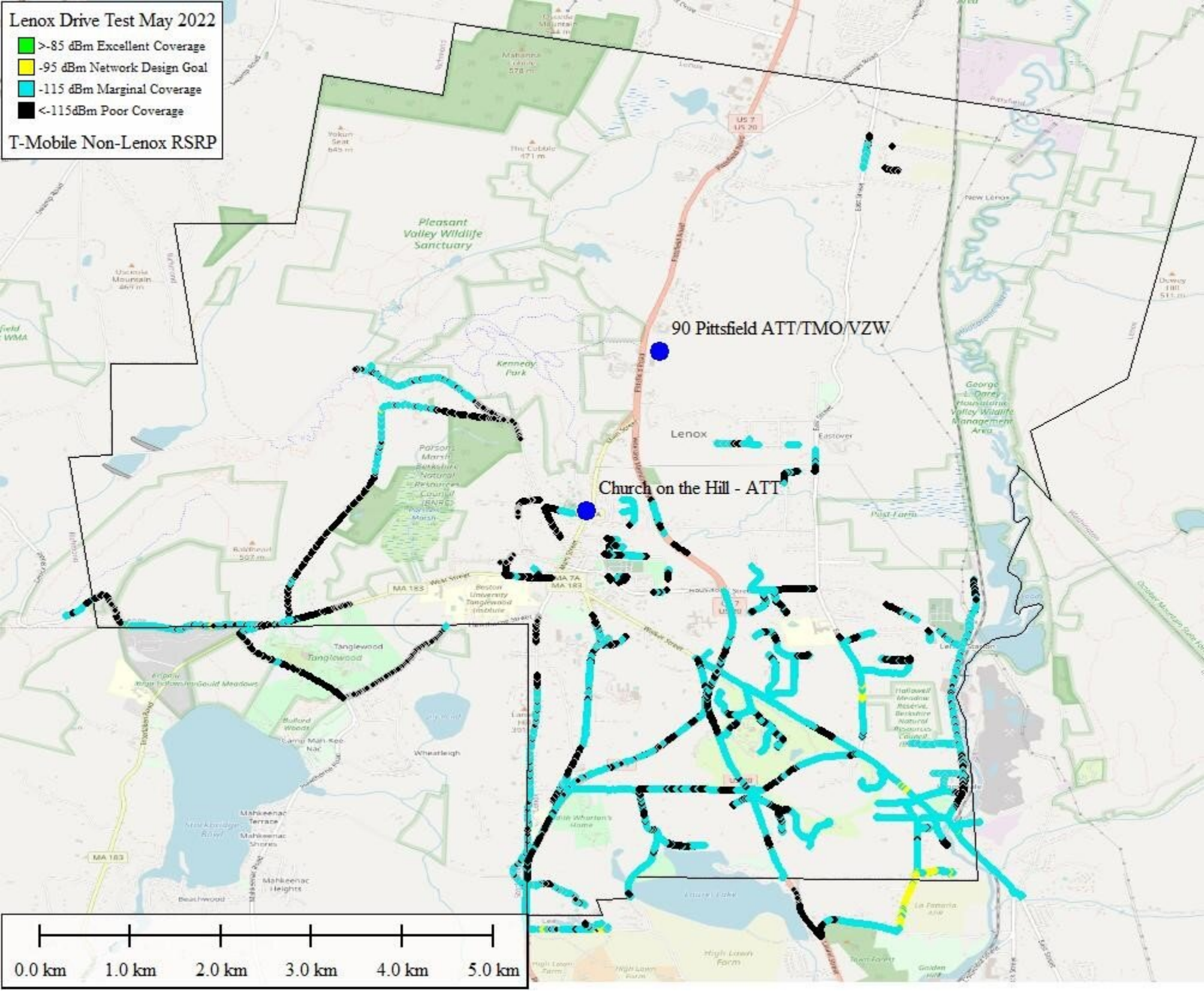
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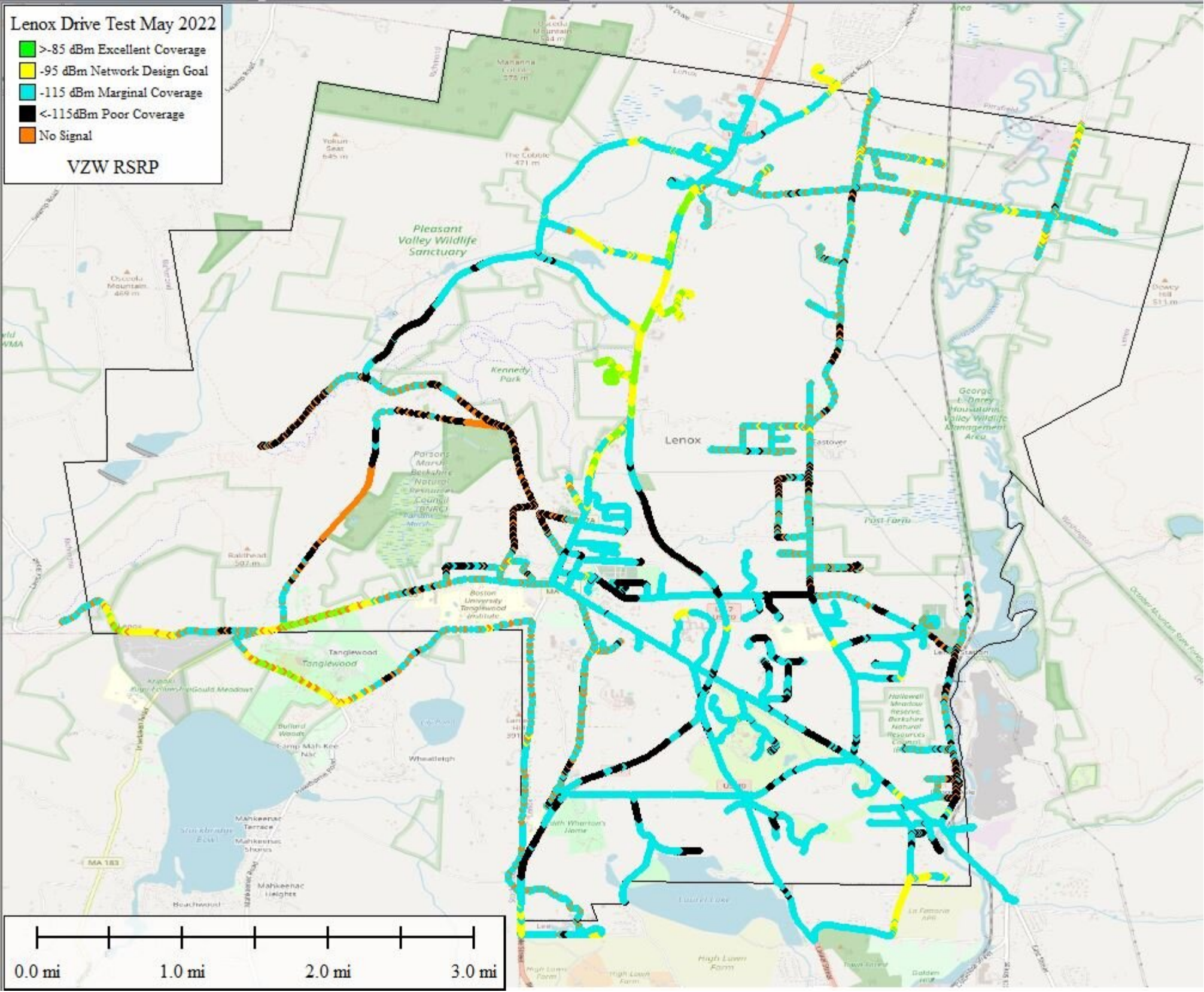
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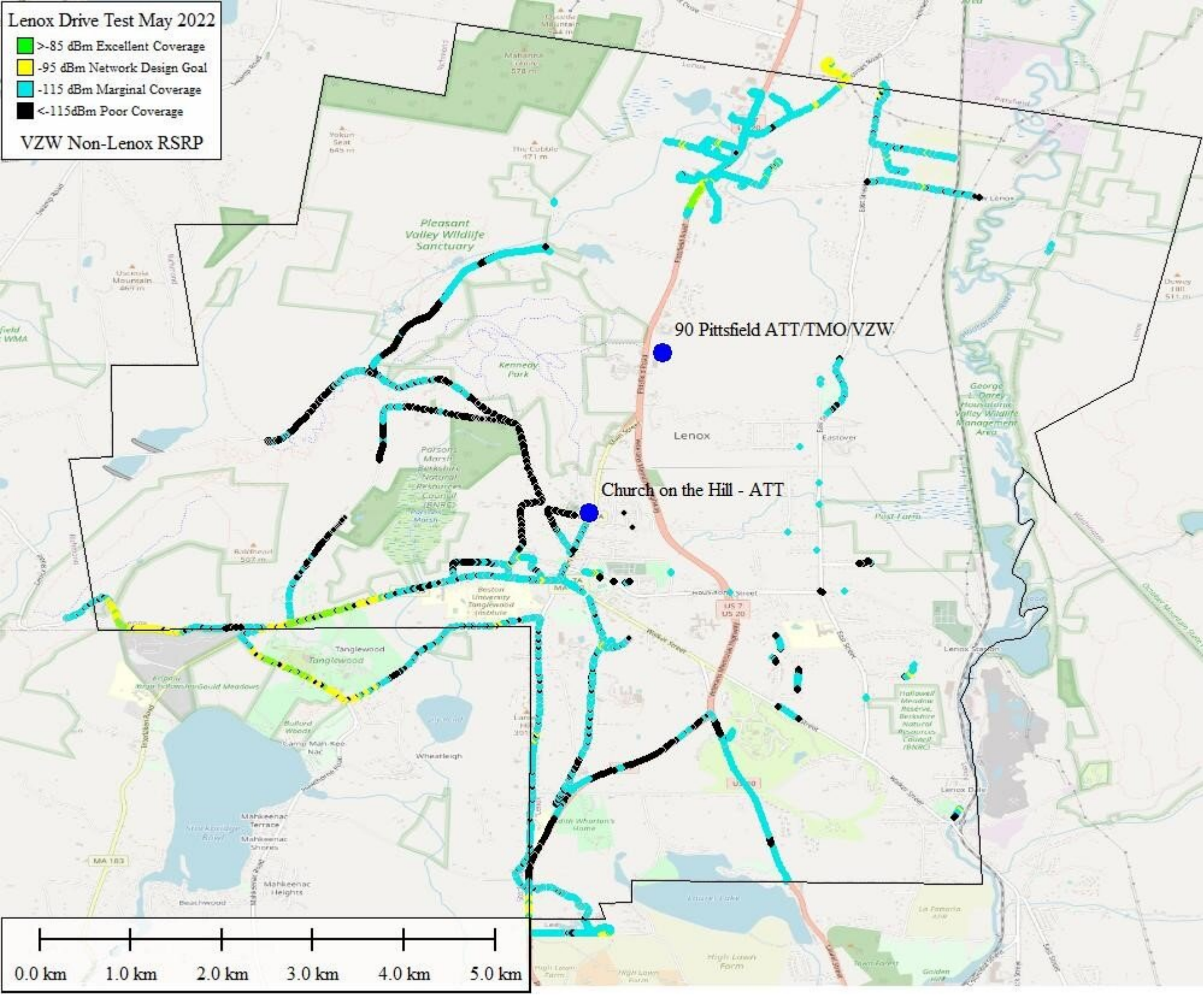
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