

# **Wireless Market Study for the Town of New Canaan, CT**

**Prepared by**



**December 1, 2014**

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## **Executive Summary**

Centerline Solutions is pleased to present this Wireless Market Study to the Town of New Canaan Utilities Commission. This report provides the Town of New Canaan with an independent, third party, engineering technical evaluation of existing commercial wireless services in its community. It will also provide evaluations of the viability of two Approved site locations (Armory and Silver Hill Hospital) to the four major wireless service providers: AT&T, Verizon, T-Mobile and Sprint.

During the week of June 9, 2014, Centerline Solutions personnel conducted physical surveys the following sites:

1. Active sites within the Town of New Canaan
  - a. 135 Main
  - b. 39 Locust
  - c. Waveny Park
  - d. Country Club
2. Active sites outside New Canaan that provide coverage to New Canaan
  - a. Darien WT (CT)
  - b. Stamford (CT)
  - c. Pound Ridge (NY)
  - d. Vista (NY)

Centerline also conducted a drive test survey within the Town borders using a professional-quality scanning receiver and externally mounted antennas. Data collection was limited to the four major wireless service providers' primary networks:

- **AT&T:** 850 and 1900 UMTS, and 700 LTE
- **Verizon:** 850 and 1900 CDMA, and 700 LTE
- **T-Mobile:** 1900 and 2100 UMTS
- **Sprint:** 1900 CDMA

Following the in-market work, Centerline analyzed the drive test data and used it to tune radio propagation models. The tuned propagation models were used to predict a more comprehensive view of existing coverage and to predict the impact of the Approved Armory and Silver Hill Hospital site locations. Survey results, maps for collected drive test and predicted coverage data as well as engineering opinions of the data are presented in this document.

For the 4 sites in-town, here are the carriers with active service:

- **135 Main:** AT&T
- **39 Locust:** Sprint, T-Mobile, Verizon
- **Country Club:** AT&T, T-Mobile
- **Waveny Park:** AT&T, Sprint, T-Mobile, Verizon

The Town is highly residential and the dominant features of all sites were the dense, tall trees (65' – 90') in their coverage areas.

The study analyses focused on each carrier's primary voice service channel and Coverage thresholds were set for Indoor, In-Vehicle and Outdoor service. Outdoor service was used to determine the overall coverage footprint. With the growth in demand for wireless data services, coverage thresholds were also considered for different target data speeds, though as secondary to voice service.

Existing Primary coverage footprints for the operators range from 1/4 to 3/4 of the Town area with AT&T having the largest footprint and Sprint having the smallest. The table below summarizes the approximate coverage footprints in the Town for each carrier analyzed.

**Table 1: Approximate Coverage Footprints by Carrier**

Carrier	Approximate Footprint (% Area of the Town)	
	Primary Wireless Voice Service	Primary Wireless Data Service
<b>AT&amp;T</b>	67%	75%
<b>Verizon</b>	50%	67%
<b>T-Mobile</b>	50%	50%
<b>Sprint</b>	25%	25%

Adding in the Approved sites at Armory and Silver Hill Hospital fills in many of the coverage holes but AT&T still would have coverage holes E of Downtown, W of route 124 and E of route 123 along Valley Rd.

Options to mitigate these coverage gaps are:

1. Traditional Macro sites
2. Stealth Macro sites
3. Distributed Antennas Systems (DAS)
4. Small Cells

All of the 4 options are potential, viable solutions with their own benefits and tradeoffs. An ultimate solution to address coverage gaps would have to consider many issues such as budgets, zoning issues, construction logistics, community aesthetics and others. A detailed study of each problem area would be required to determine the best solution to addressing the coverage gaps identified in this report. This level of analysis is not included within the scope of this report. Centerline can, however, provide such additional support to the town upon request.

## **Project Description and Purpose**

This Project provides the Town of New Canaan with an independent, third party, engineering technical evaluation of the current state of existing commercial wireless services in its community. It will also provide evaluations of the viability of two Approved site locations (Armory and Silver Hill Hospital) to the four major wireless service providers: AT&T, Verizon, T-Mobile and Sprint.

Centerline conducted physical site surveys of cell site locations both in and adjacent to the Town of New Canaan. Centerline conducted a drive test of the area using a professional quality scanning receiver and externally mounted antennas to give a snapshot of existing wireless service coverage. This drive data was analyzed and the mapped results are provided.

The data obtained during the site surveys and drive testing was used to tune radio propagation models for each frequency band. The tuned models were used to provide broader views of existing coverage within the Town, i.e., coverage that is not constrained to public roads. The tuned propagation model was also used to estimate the coverage of proposed site locations. Drive test and predicted coverage maps as well as engineering opinions based on the data are provided.

## **Methodologies**

### **Coverage criteria**

The study focused on each carrier's primary voice service channel. With the growth in demand for wireless data services, coverage thresholds were also considered for different target data speeds, though as secondary to voice service.

Four threshold levels were selected to represent typical use cases per technology so that comparisons can be made across carriers and frequency bands:

- a. In-Building Voice/High Data Rate Service (1Mbps DL, 90% availability)
- b. In-Vehicle Voice/Moderate Data Rate Service (512kbps DL, 90% availability)
- c. Outdoor Voice/Low Data Rate Service (64kbps DL, 90% availability)
- d. Poor/No Service

Outdoor Voice service was used to determine the overall coverage footprint.

Specific signal levels by technology that correspond to the above service levels are:

- a. UMTS RSCP
  - In-Building Voice/High Data Rate Service (> -83 dBm)
  - In-Vehicle Voice/Moderate Data Rate Service (> -91 dBm)
  - Outdoor Voice/Low Data Rate Service (> -97 dBm)
  - Poor/No Service (< - 97 dBm)
- b. CDMA/EVDO Ec
  - In-Building Voice/High Data Rate Service (> -83 dBm)
  - In-Vehicle Voice/Moderate Data Rate Service (> -91 dBm)
  - Outdoor Voice/Low Data Rate Service (> -97 dBm)

- Poor/No Service ( $< -97$  dBm)
- c. LTE RSRP
  - High Data Rate Service ( $> -102$  dBm)
  - Moderate Data Rate Service ( $> -110$  dBm)
  - Low Data Rate Service ( $> -116$  dBm)
  - Poor/No Service ( $< -116$  dBm)

These service levels were chosen to 1) accommodate standard voice service thresholds and 2) choose data rates that can be compared across technologies. As the current LTE implementation is primarily a data-only service, no voice service levels were considered.

### Drive Test Data Collection Methodology

As the name suggests, Drive Test data is collected while driving a vehicle. For the locations driven, it provides a highly accurate measurement of Outdoor coverage which can be used to derive reasonable estimates of In-Vehicle and In-Building coverage levels for buildings that are adjacent to the driven roads. As target coverage areas move farther away from driven roads, the accuracy of derived coverage estimates decreases; this is the fundamental limitation of Drive Test data. The following collection and analysis methodology was used:

1. Conduct a Market Survey to identify the active Macro (outdoor) cell sites within and bordering the Town, to classify the sites' morphology, to identify which carriers were active at these cell sites with mature service (known to be  $> 2$  years old) and to identify the primary operating channels within each band.
2. Collect drive data using a single JDSU model E6474A Drive Test receiver system with a roof-mounted antenna for the identified carriers and channels, covering as many of the publicly accessible roads in New Canaan as possible. This system collects data from all carriers simultaneously.
3. Process and plot the collected data per major carrier per mature frequency band based on representative service criteria.

The routes driven were only able to cover approximately 80% of the total Town area.

## Propagation Prediction Methodology

Coverage prediction tools like *WIZARD* use mathematical propagation models that predict coverage levels in all areas around a site within a specified range and are not limited to public streets like Drive Testing is. These models are inherently statistical in nature and error of the predicted values at any point can be from 15dB-25dB. The accuracy of the models can be improved with empirical data collected from Drive Tests but the standard deviations of these models at any point can still be 8dB-10dB.

A 10dB variation translates to a linear power difference of 10x. What this means is that the actual power for any location could be 10 times greater or smaller than what would actually be measured. Given the high variability of these predictive models, these coverage maps should be viewed more as a guideline than an absolute.

1. Tune signal propagation models for each morphology and each frequency band using the *WIZARD* propagation modeling software tool.
2. Generate predicted coverage plots for active Macro cells per frequency band based on a representative service criteria.
3. Coverage thresholds for LTE, UMTS and CDMA/EVDO technologies were used as defined above.

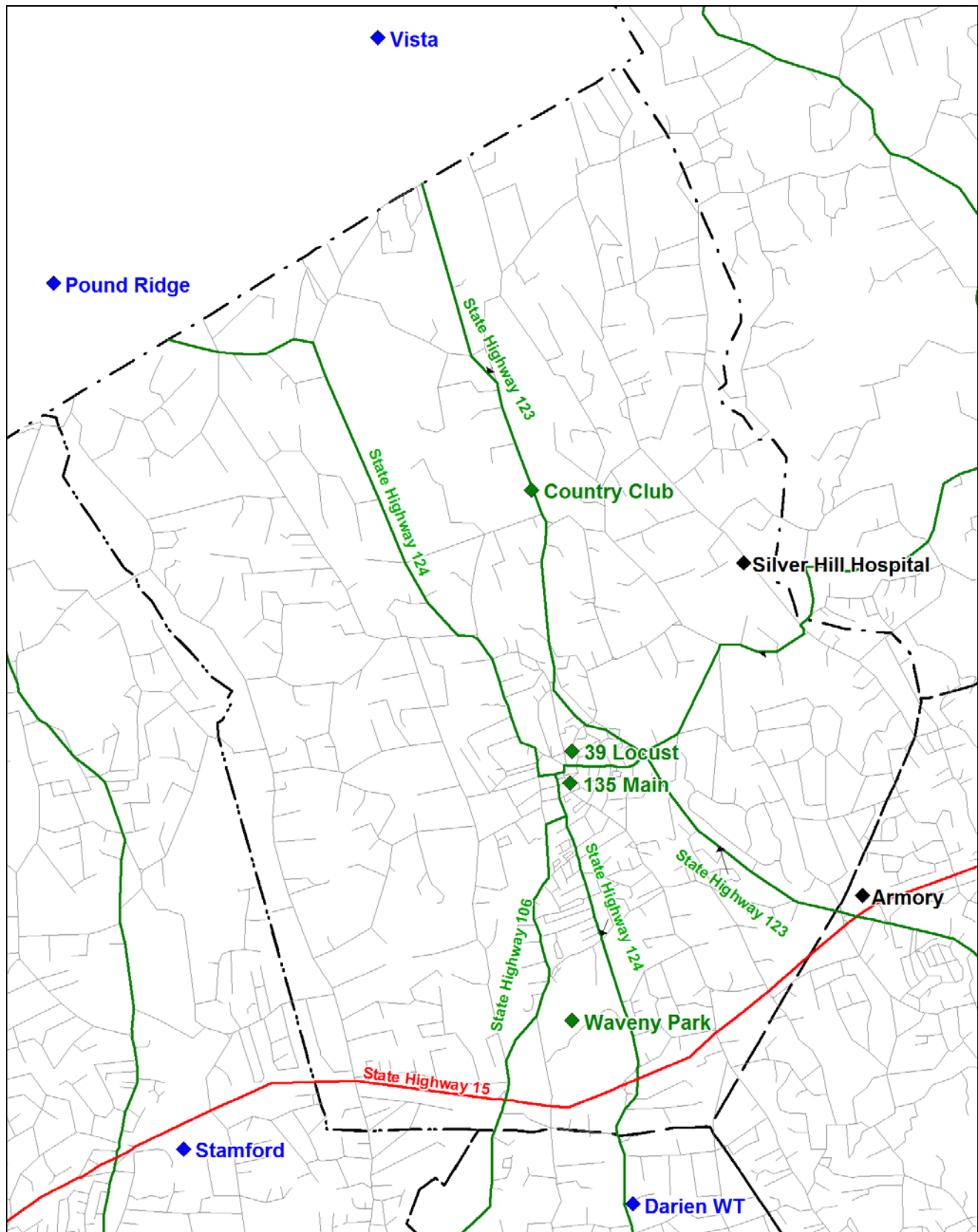
## Market Study Results

Four active Macro sites were identified within the limits of the Town of New Canaan: 135 Main, 39 Locust, Waveny Park, and Country Club. Two morphology types were defined: Urban and Suburban. Suburban is the prevalent morphology, dominated by the large, dense trees that populate the town. Urban was only used near the Downtown area. The Town is highly residential so, even though outdoor and in-vehicle voice service levels are shown on analysis plots, In-Building service will be what's desired by most customers, especially those whose primary phone is their cell phone.

Four sites outside the perimeter of the Town were identified that provide coverage inside the Town limits: Darien Water Tower (CT), Stamford (CT), Pound Ridge (NY) and Vista (NY).

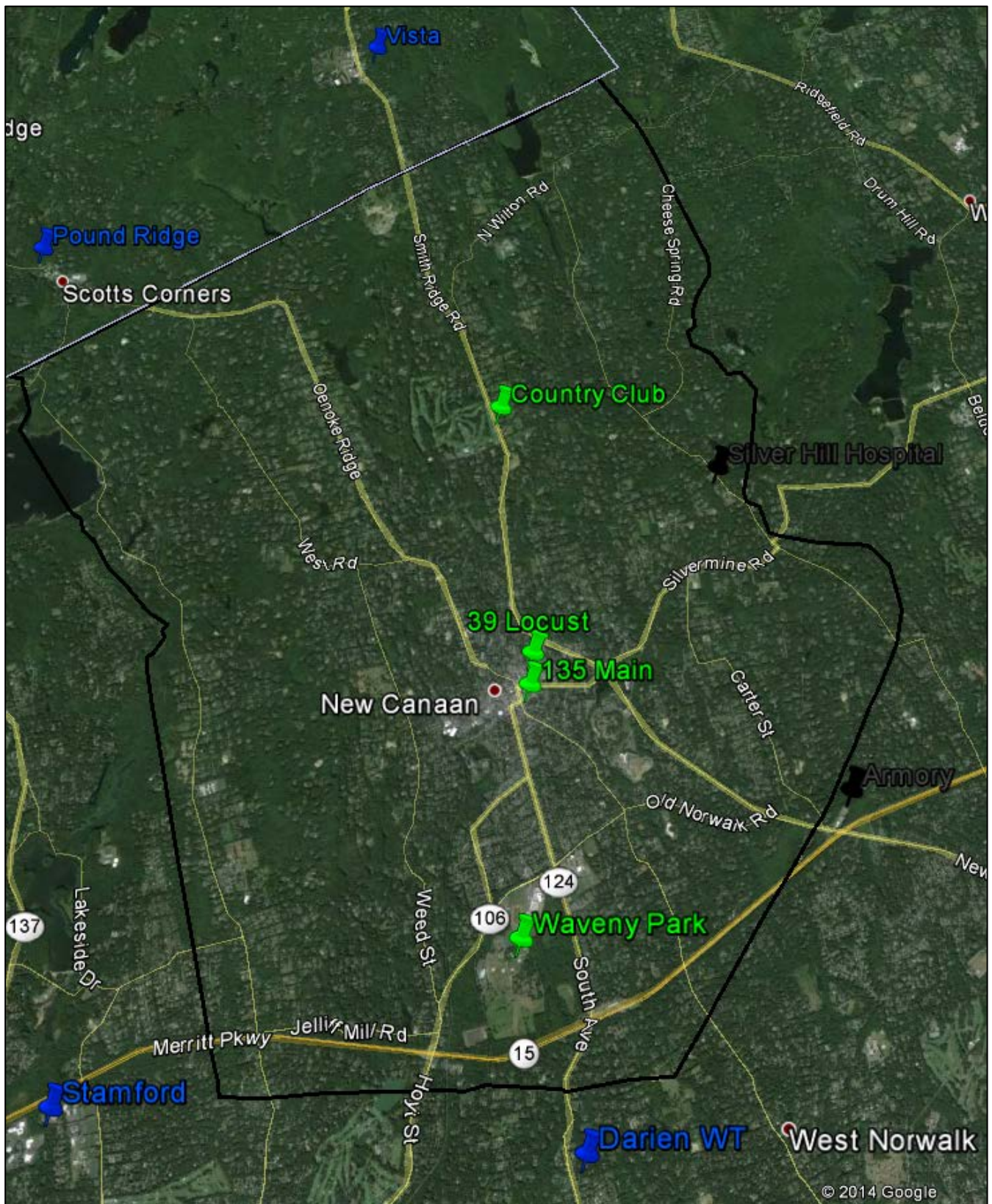
These site locations are displayed on the following two pages: one in a street map format, the other in Google Earth <sup>TM</sup> format.

**Figure 1: Map of the Town of New Canaan, CT**





**Figure 2: Google Earth™ View of the Town of New Canaan, CT**



**Table 2: Site Survey Data**

Site Name	Latitude	Longitude	Morphology	Band	AT&T	Verizon	T-Mobile	Sprint
<b>135 Main</b>	41.1462	-73.4916	Urban	700	LTE			
				850	UMTS-B			
				PCS	UMTS			
				AWS				
<b>39 Locust</b>	41.1490	-73.4914	Urban	700		LTE		
				850		CDMA-A		
				PCS		CDMA/EVDO	UMTS	CDMA/EVDO
				AWS			UMTS/LTE	
<b>Waveny Park</b>	41.1245	-73.4913	Suburban	700	LTE	LTE		
				850	UMTS-B	CDMA-A		
				PCS	UMTS	CDMA/EVDO	UMTS	CDMA/EVDO
				AWS			UMTS/LTE	
<b>Country Club</b>	41.1728	-73.4962	Suburban	700	LTE			
				850	UMTS-B			
				PCS	UMTS		GSM**	
				AWS				
<b>Darien WT</b>	41.1077	-73.4839	Suburban	700	LTE	LTE		
				850	UMTS-B	CDMA-A		
				PCS	UMTS	CDMA/EVDO	UMTS	CDMA/EVDO?
				AWS			UMTS/LTE	
<b>Stamford</b>	41.1127	-73.5383	Suburban	700	LTE	LTE		
				850	UMTS-B	CDMA-A		
				PCS	UMTS	CDMA/EVDO	UMTS	CDMA/EVDO?
				AWS			UMTS/LTE	
<b>Pound Ridge</b>	41.1918	-73.5541	Suburban	700	LTE			
				850	UMTS-A			
				PCS	UMTS		UMTS	
				AWS			UMTS/LTE	
<b>Vista</b>	41.2141	-73.5149	Suburban	700	LTE	LTE		
				850	UMTS-A	CDMA-B		
				PCS	UMTS	CDMA/EVDO		CDMA/EVDO
				AWS				

\*\* The Site Survey indicated that T-Mobile is only operating 1900MHz GSM service at this site; this 2G technology was not within the scope of this study.

Full survey data will be provided separately.

As the table shows, AT&T and Verizon license opposite sides of the 850MHz Band in CT and NY. AT&T uses the “A” band in NY and the “B” in CT; Verizon has the opposite bands. It was necessary to measure both bands for both service providers and combine the results to get a complete view of their 850 MHz coverage.

All carriers have active sites in the Downtown area; AT&T at 135 Main, the others at 39 Locust. All carriers are active on the south side in Waveny Park. The Connecticut site database says both AT&T and T-Mobile are active at Country Club but the Survey indicated that T-Mobile is only operating 1900MHz GSM service here. This 2G technology was not considered within the scope of this study and no Drive Test data was collected for 2G. However, as T-Mobile could potentially upgrade the Country Club site to UMTS technology, we considered this site active for purposes of 1900 MHz coverage predictions and analysis.

All sites have dense, tall trees (65' – 90') in their coverage areas, and most antennas are above tree height. Higher frequencies have shorter signal propagation ranges than lower bands and the dense foliage reduces distances even further in these bands. Both Downtown sites have fewer trees in their area but the antennas are below tree height which will significantly reduce propagation in all bands.

Drive test data was collected for AT&T, Sprint, T-Mobile, and Verizon. A primary reference channel was identified for each carrier, frequency band and technology in order to the system to lock onto the correct signals and consistently measure received levels across the entire Town. However, the team was not able to identify a common primary reference channel across all sites for the Sprint or Verizon 1900 MHz bands so the collected drive test data only partially represents their 1900 MHz coverage. It's impossible to know how much data was missed but 50% is a rough estimate. The two approved (but not active) sites, Armory and Silver Hill Hospital, are noted in the plots for reference.

Radio prediction models were calibrated using empirical data from the Drive Test collection for all bands. Typical cell radii for each band, morphology and coverage band as predicted for New Canaan in the radio propagation tool are provided in the table below.

**Table 3: Typical Predicted Cell Radii in New Canaan**

Frequency	Suburban			Urban		
	In-Bldg	In-Vehicle	Outdoor	In-Bldg	In-Vehicle	Outdoor
700 MHz	1.0 mi	1.3 mi	1.6 mi	0.7 mi	0.8 mi	1.0 mi
850 MHz	0.9 mi	1.2 mi	1.4 mi	0.6 mi	0.7 mi	0.9 mi
1900 MHz	0.8 mi	1.0 mi	1.2 mi	0.5 mi	0.6 mi	0.8 mi
2100 MHz	0.7 mi	0.9 mi	1.1 mi	0.4 mi	0.5 mi	0.7 mi

As expected, the radii for Urban models is significantly smaller than Suburban models due to the antennas being below tree height. Also, as expected, the radii for 1900 MHz and 2100 MHz bands are significantly smaller than for 700 MHz and 850 MHz due to the higher frequency and the impact of the dense foliage.

## AT&T Results Overview

AT&T has 3 active sites in New Canaan (Country Club, 135 Main and Waveny Park) as well as 4 active periphery sites that provide coverage inside New Canaan's borders (Darien WT, Stamford, Pound Ridge and Vista).

AT&T provides primary voice service over UMTS technology in the 850 MHz band and primary high-speed data service over LTE technology in the 700 MHz band. The 850 MHz band can provide secondary data service and the 1900 MHz band provides extra capacity for both voice and data users through UMTS technology.

### *AT&T Drive Test Results*

Coverage in the 700 MHz band is strong, covering about 90% of the routes driven. With approximately 80% of the Town area driven, this equates to 75% total area covered. The perimeter sites provide some coverage on the north and south boundaries. Notable holes are W of route 124, and E of 123 along Valley Rd. These holes appear to be due to terrain features.

Coverage in the 850 MHz band is noticeably worse than the 700 MHz coverage. Approximately 2/3 of the Town receives 850 MHz signals with notable gaps appearing SE of Downtown and N of the Country Club. These holes can be attributed the weaker UMTS technology link budget as well as terrain features.

The PCS (1900 MHz) band only provides coverage in about 1/3 of the Town. The combination of dense foliage and the reduced signal propagation of higher frequencies accounts for this more limited result. Coverage from 135 Main St is restricted because the antennas are below tree height.

The AT&T Drive Test data maps are provided on the following pages. The colored dots represent collected signal strength measurements along the drive routes. The legend for each indicates the meaning of each color.



Figure 3: AT&T 850 UMTS Drive Test

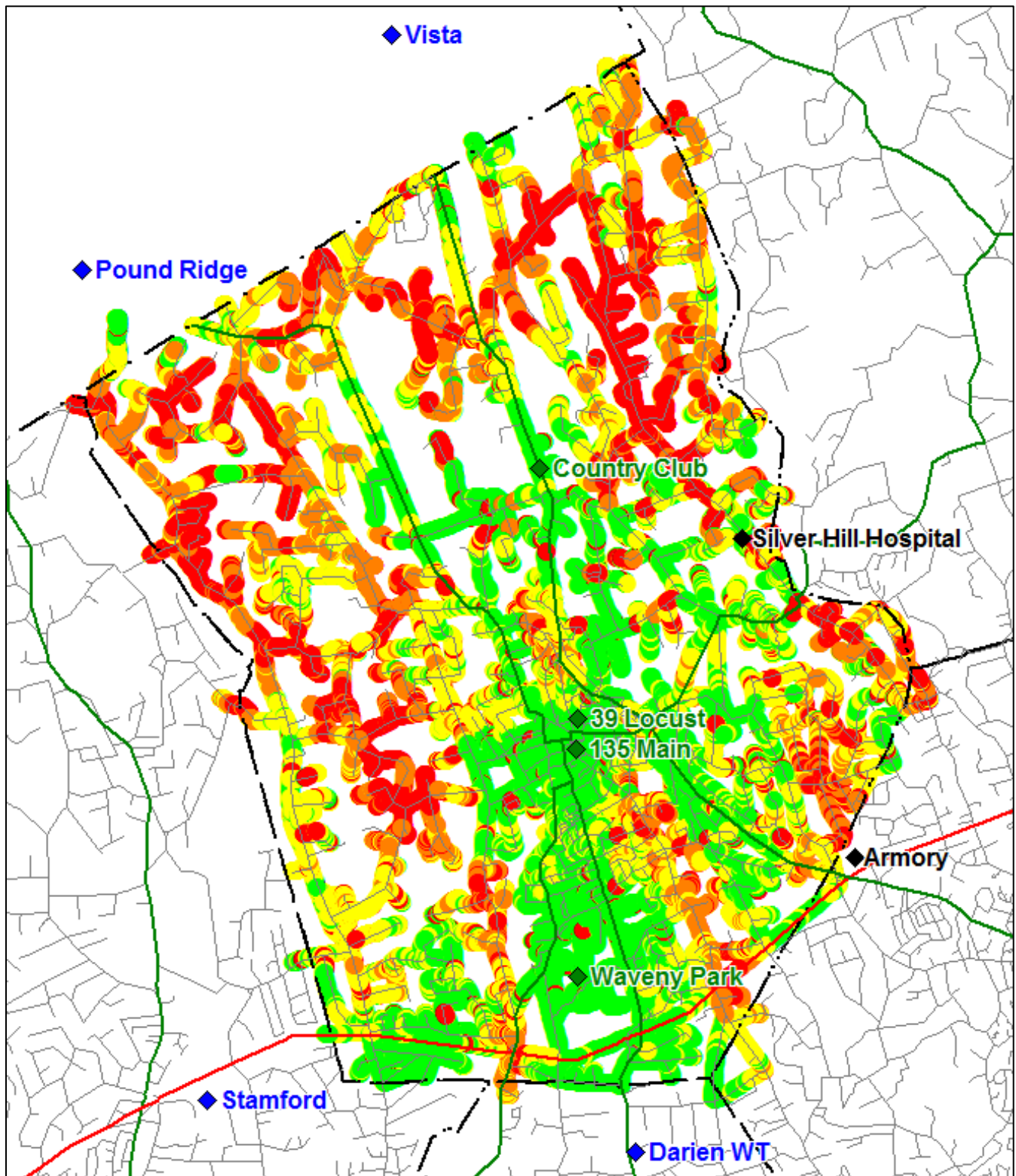


Figure 4: AT&T 700 LTE Drive Test

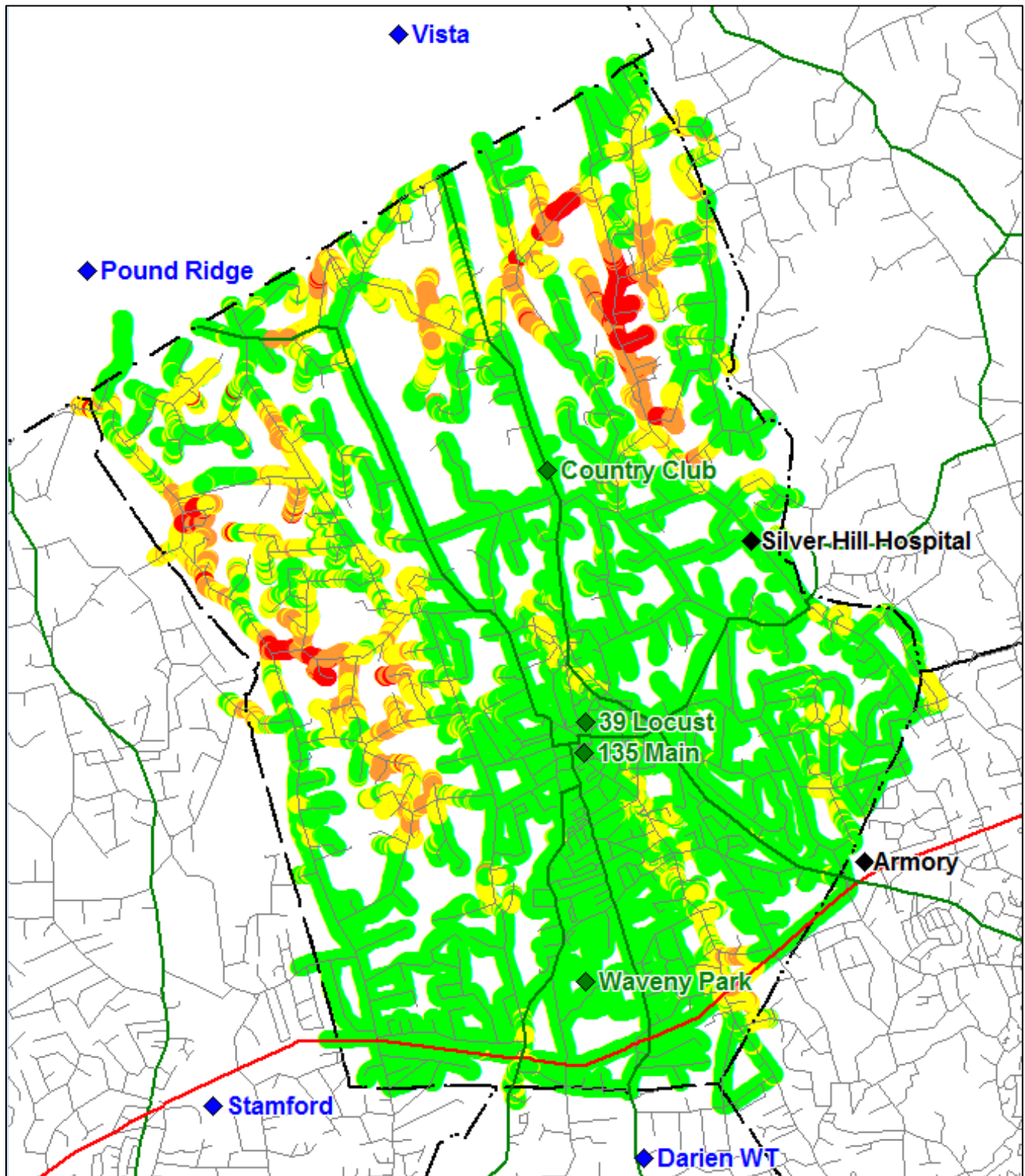
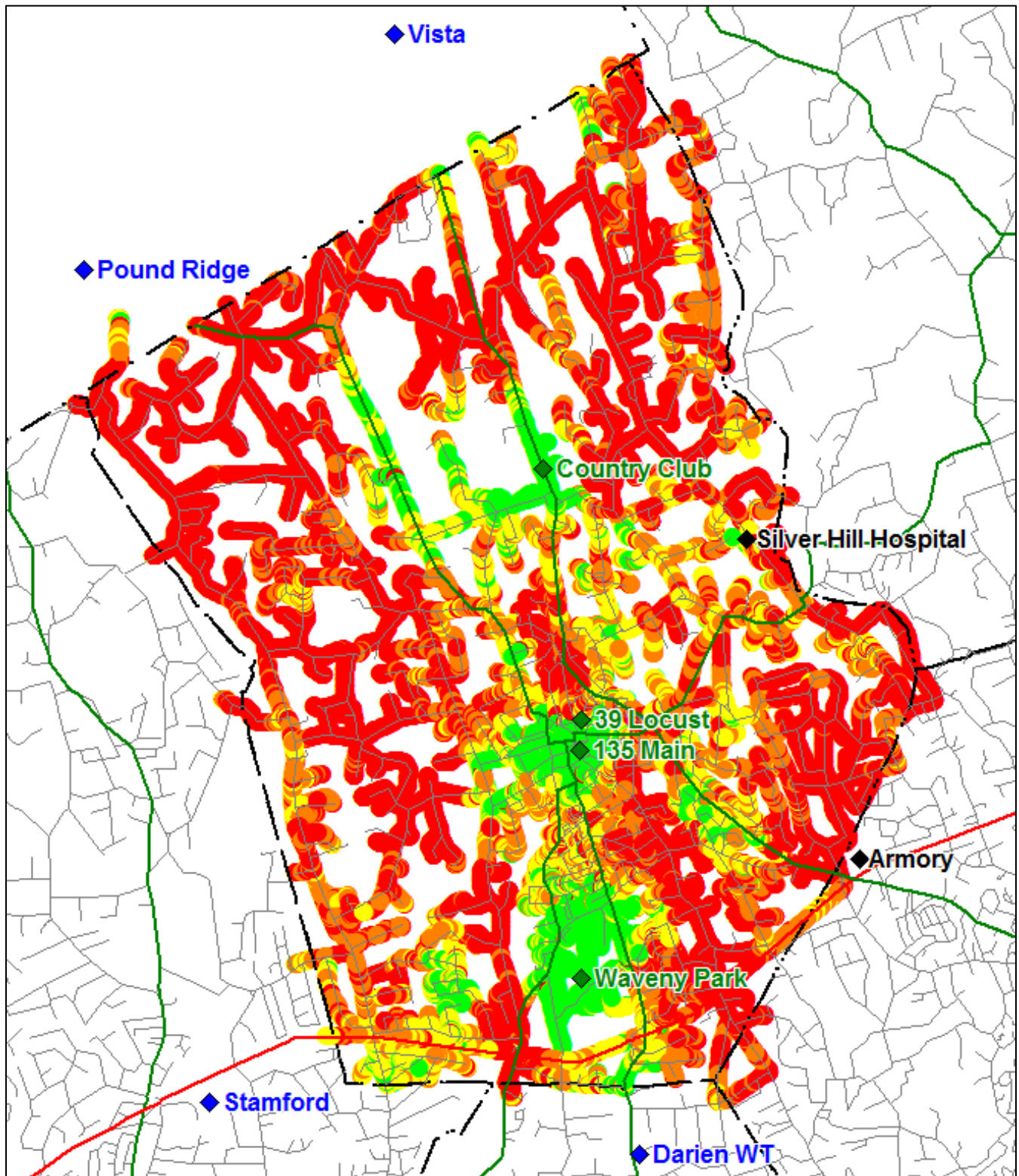


Figure 5: AT&T 1900 UMTS Drive Test



### *AT&T Coverage Prediction Results*

The 700 MHz band, as expected from the above Drive Test results, has the best coverage, with a footprint of about 3/4 of the Town. Notable gaps are W of route 124, E of Downtown and NE of 123 along Valley Rd. Coverage from 135 Main is restricted because the antennas are below tree height. The other gaps are primarily due to terrain features.

Coverage at 850 MHz is less than 700 MHz, about 2/3 of the Town. The gaps W of route 124 and E of 123 along Valley Rd are more pronounced. These increased gaps are due to the slightly higher frequency and the weaker Link Budget of UMTS vs LTE technology.

The two NY sites, Pound Ridge and Vista, provide some coverage on the fringes of Town but their positions outside the town border in thickly forested areas provide little benefit to the Town itself. By factoring in the "Approved" sites at the Armory and Silver Hill Hospital, many of the coverage holes NE and SE of Downtown are addressed. These sites will not address, however, the noticeable gaps E of Downtown N of Rte 106 and NE of Rte 123; these gaps are likely caused by the dense foliage.

As expected, coverage degrades significantly at 1900 MHz due to the higher frequency band and foliage effects.

The AT&T Predicted Coverage maps are provided on the following pages.



Figure 6: AT&T Active Sites – 850 MHz Predicted Coverage

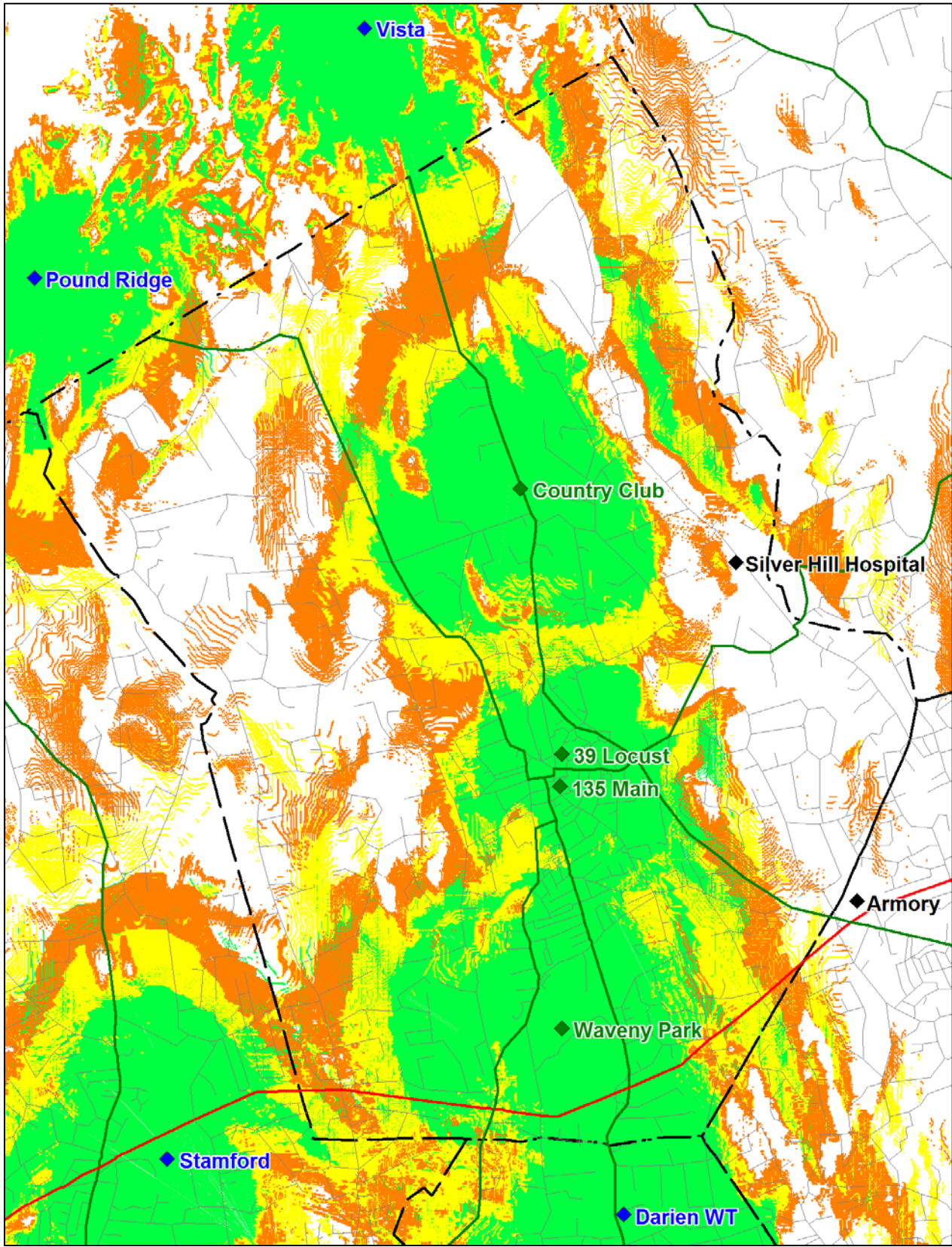
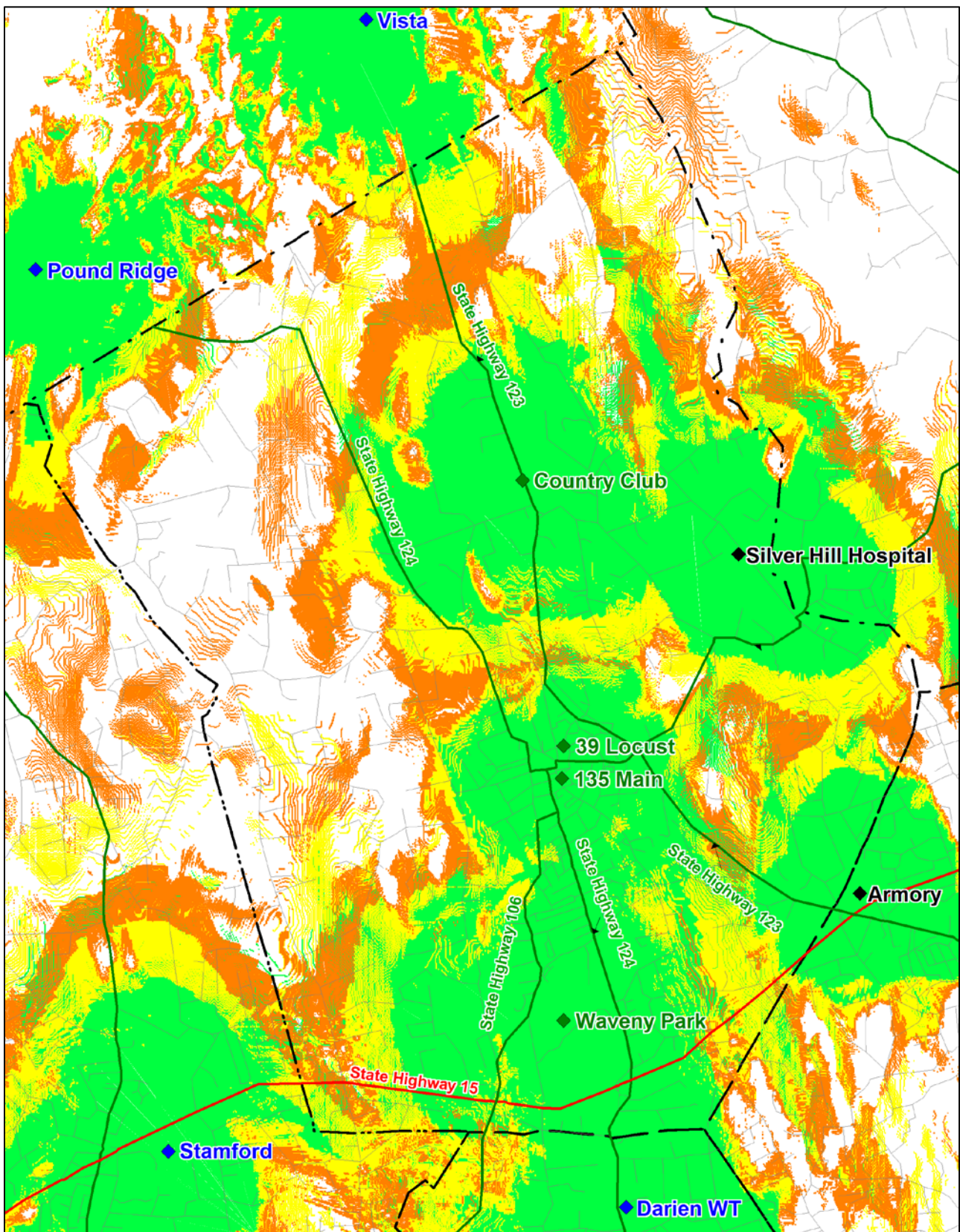
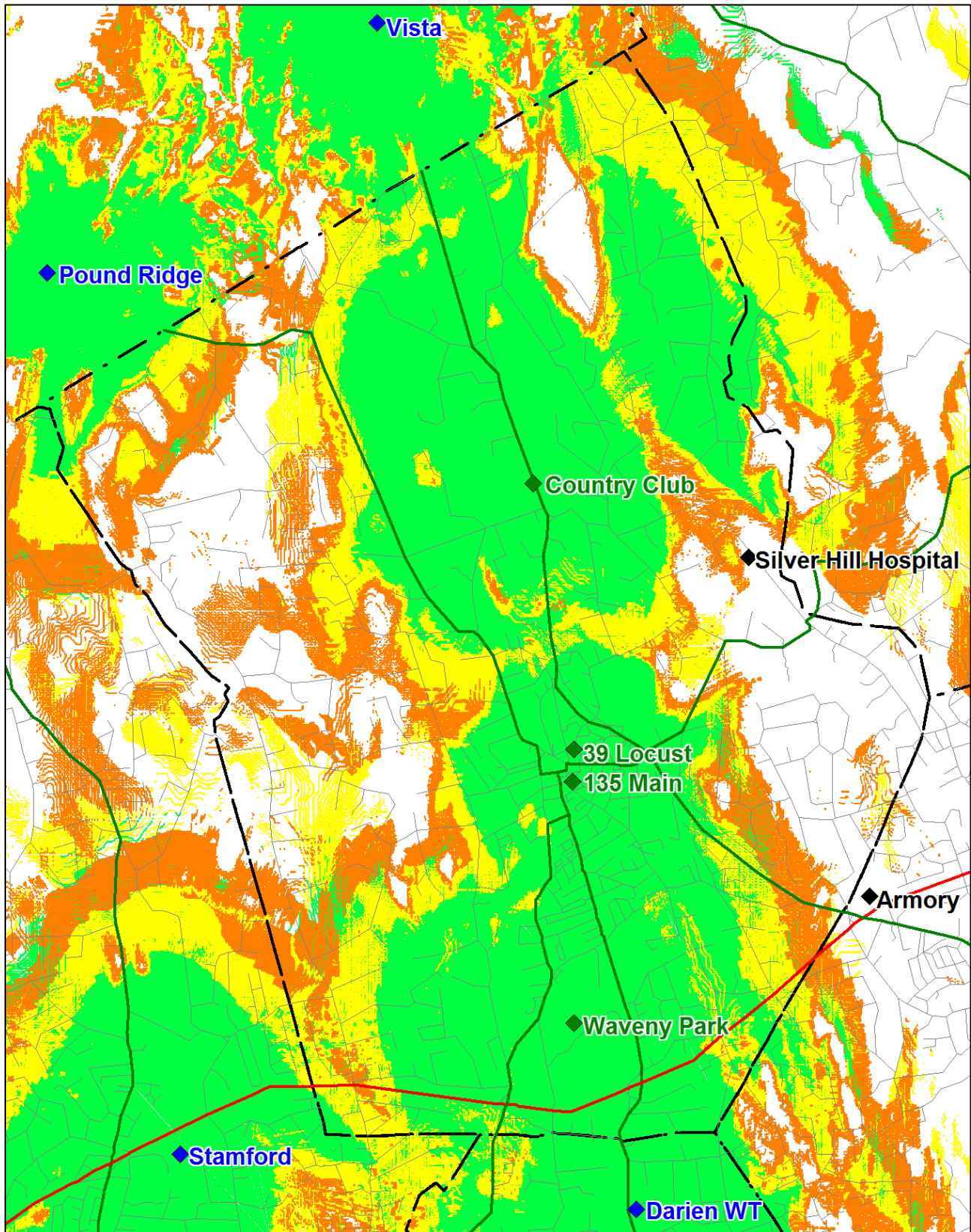


Figure 7: AT&T Active & Approved Sites – 850 MHz Predicted Coverage

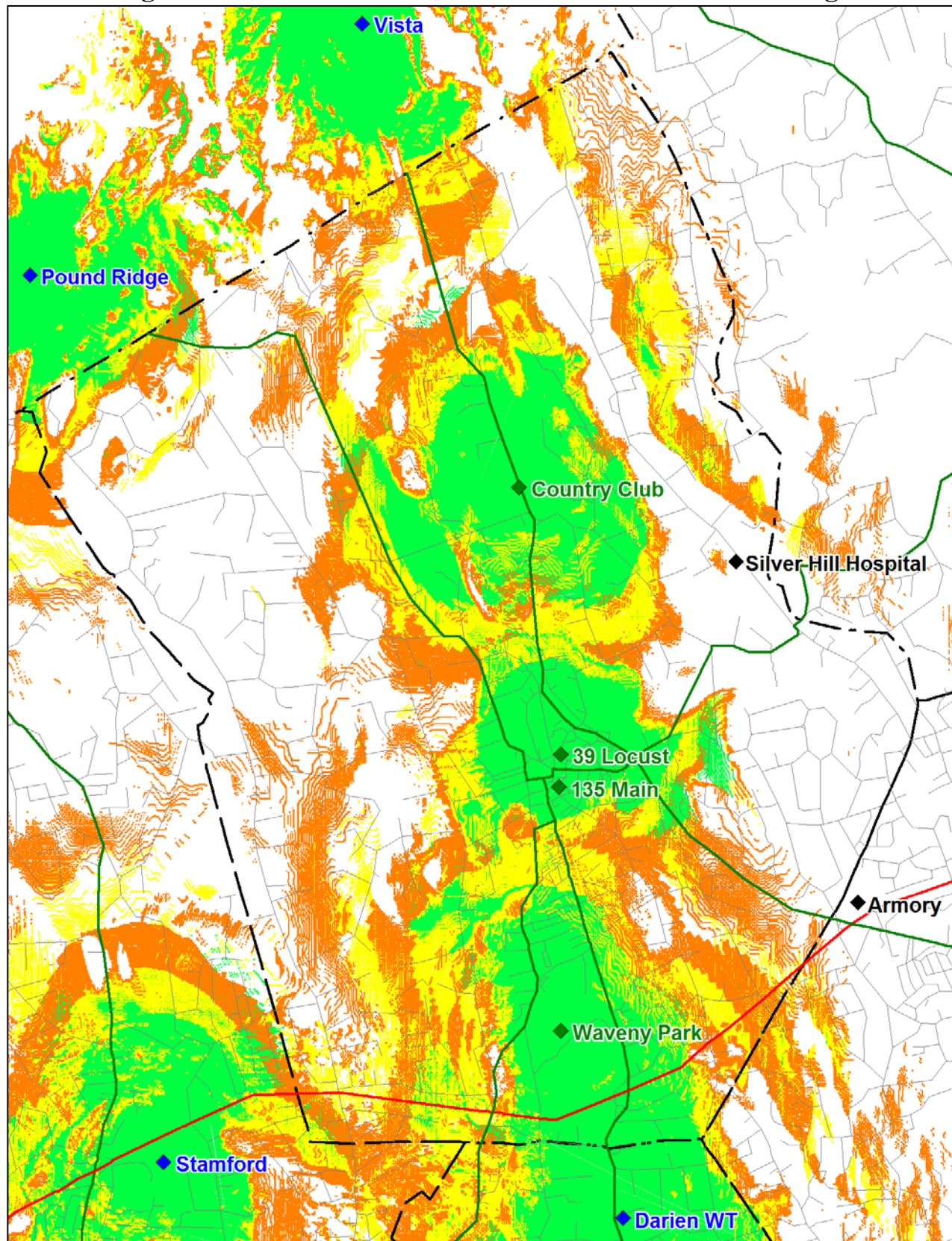




**Figure 8: AT&T Active Sites – 700 MHz Predicted Coverage**



**Figure 9: AT&T Active Sites – 1900 MHz Predicted Coverage**



### AT&T Observations Summary

Predicted coverage from existing sites reaches approximately 3/4 of the Town at 700 MHz, 2/3 of the Town at 850 MHz and only 1/2 of the Town at 1900 MHz. Adding in the Approved sites at Armory and Silver Hill Hospital fills in many of the coverage holes NE and SE of Downtown. The biggest holes are W of route 124 and E of route 123 along Valley Rd. There are also noticeable gaps E of Downtown.

The coverage discrepancies of the Drive Test vs the Predicted maps, especially at 700 MHz, are likely due to two factors. First, Drive Test measurements are more accurate than Predictions; the inherent uncertainty of Predictions (8-10 dB) can make a big difference at any point on the map. Second, looking at the E site of Town, it seems that we missed an external site unaccounted for in our Predictions that is providing coverage in-town at 700 MHz. Centerline can try to identify this site and account for it in another phase of the project, perhaps after the Silver Hill Hospital and Armory sites go live.

The plots give a general pictorial representation of coverage levels and gaps. However, with the inherent variability of the predictions, it's not meaningful to attempt to identify specific neighborhoods that may not be receiving adequate service.

## Verizon Results Overview

Verizon has 2 active sites in town (39 Locust and Waveny Park) and 3 active periphery sites providing coverage inside New Canaan borders (Darien WT, Stamford and Vista).

Verizon provides primary voice service over CDMA technology in the 850 MHz band and primary high-speed data service over LTE technology in the 700 MHz band. The 850 MHz band can provide secondary data service and the 1900 MHz band provides extra capacity for both voice and data users using EVDO technology.

### *Verizon Drive Test Results*

Coverage in the 700 MHz band covers about 2/3 of the Town. Their coverage is significantly less than AT&T's N of Downtown as they do not have an active site at the Country Club. In addition, they have the same holes as AT&T W of route 124, and E of 123 along Valley Rd and SE of Downtown likely due to terrain features.

Coverage in the 850 MHz band is noticeably worse, only covering 1/2 of the Town, as the holes increase in size. This is likely due to the weaker CDMA technology link budget vs LTE as well as the reduced signal propagation of higher frequencies.

According to the Drive Test data, the 1900 MHz band only provides coverage in about 1/4 of the Town. However, the team was not able to identify a common primary reference channel across all sites for the Verizon 1900 MHz band. Without a reference channel, the system couldn't necessarily lock onto the correct signals so the collected drive test data only partially represents their 1900 MHz coverage. It's impossible to know how much data was missed but 50% is a rough estimate.

Other factors impacting 1900 MHz coverage are the dense foliage and higher frequency compared to the lower frequencies. Coverage from 39 Locust is restricted because the antennas are below tree height. A significant coverage hole also develops S of Main St along White Oak Shade Rd, likely due to terrain features.

The Verizon Drive Test data maps are provided on the following pages. The colored dots represent collected signal strength measurements along the drive routes. The legend for each indicates the meaning of each color.



Figure 10: Verizon 850 CDMA Drive Test

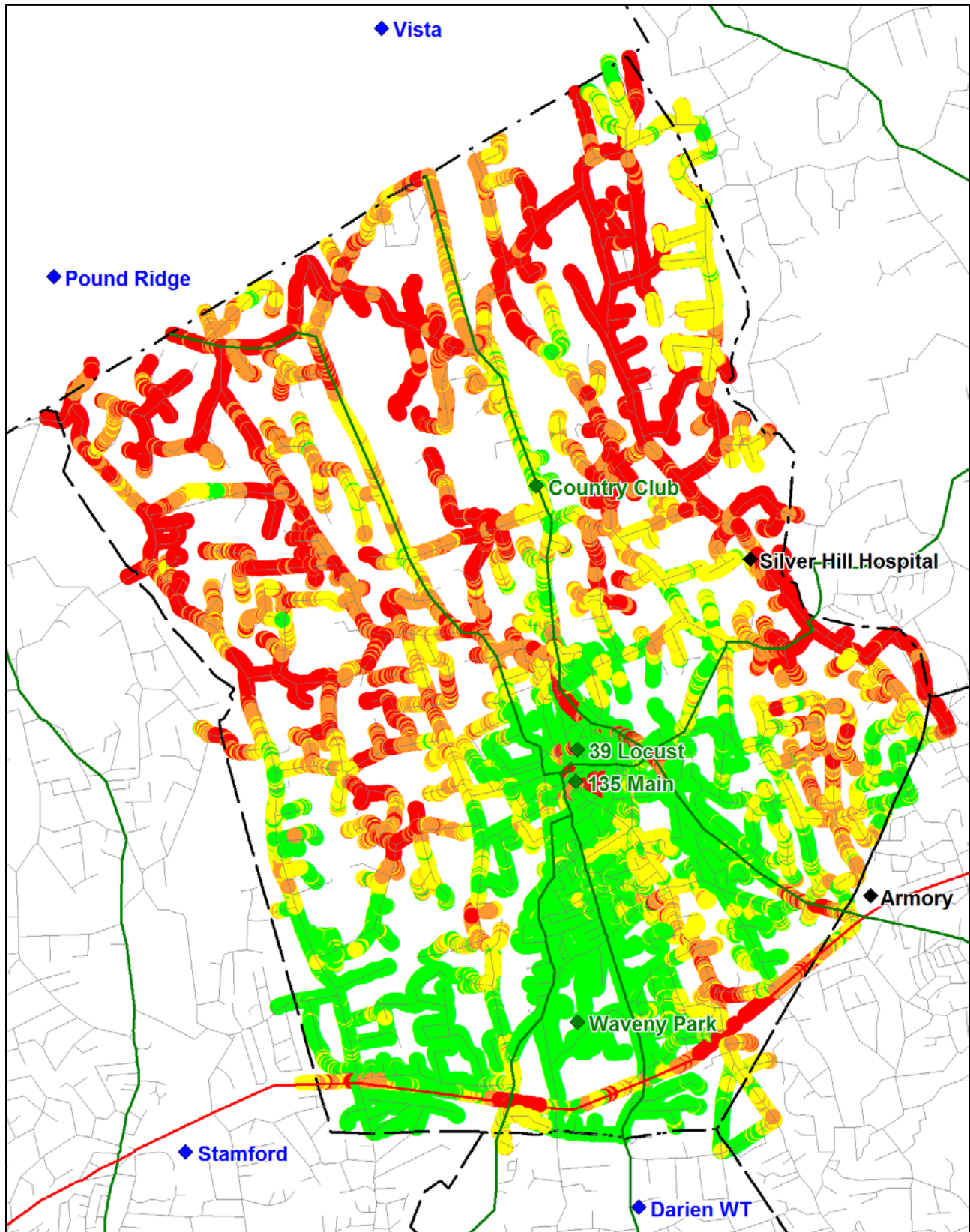


Figure 11: Verizon 700 LTE Drive Test

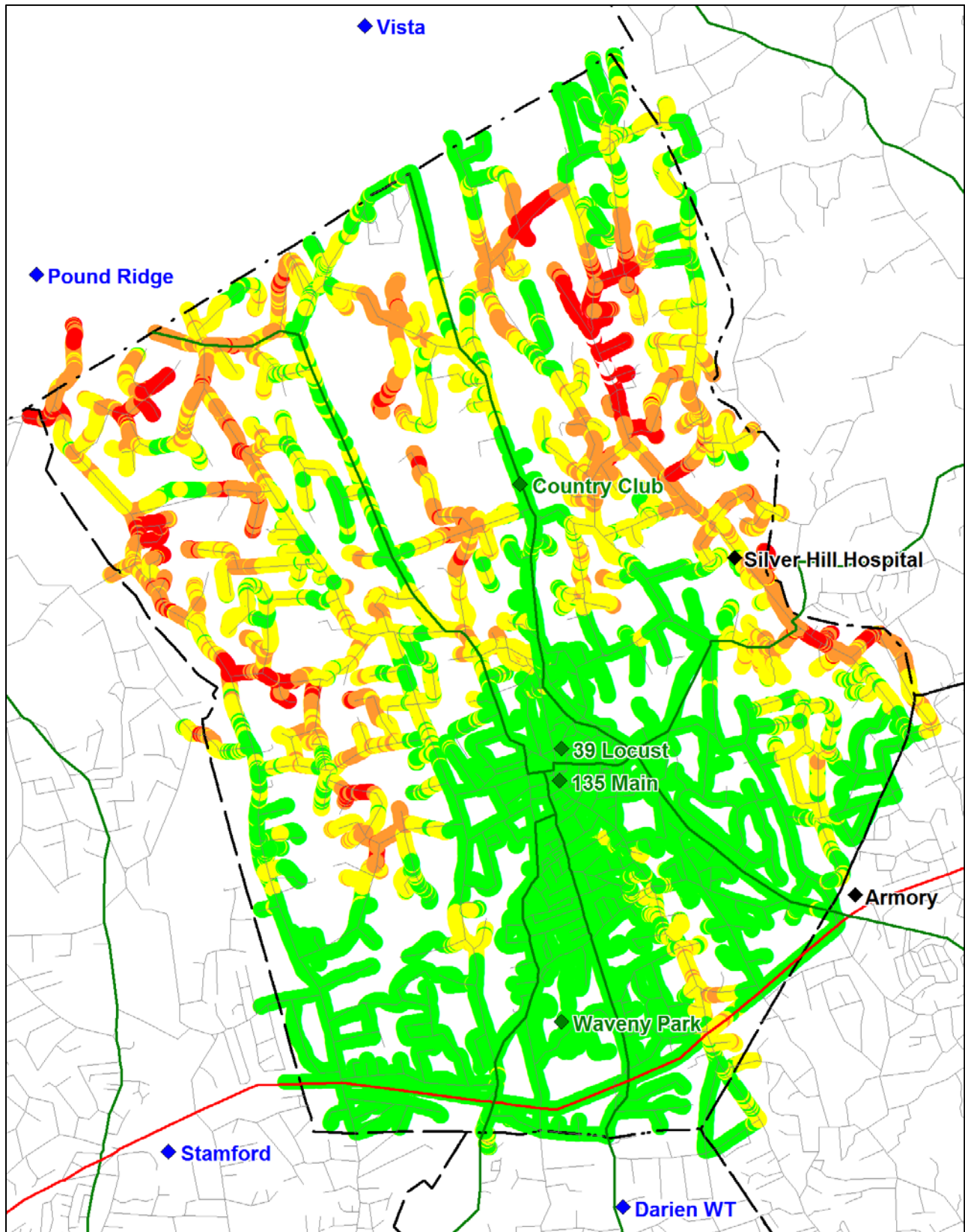
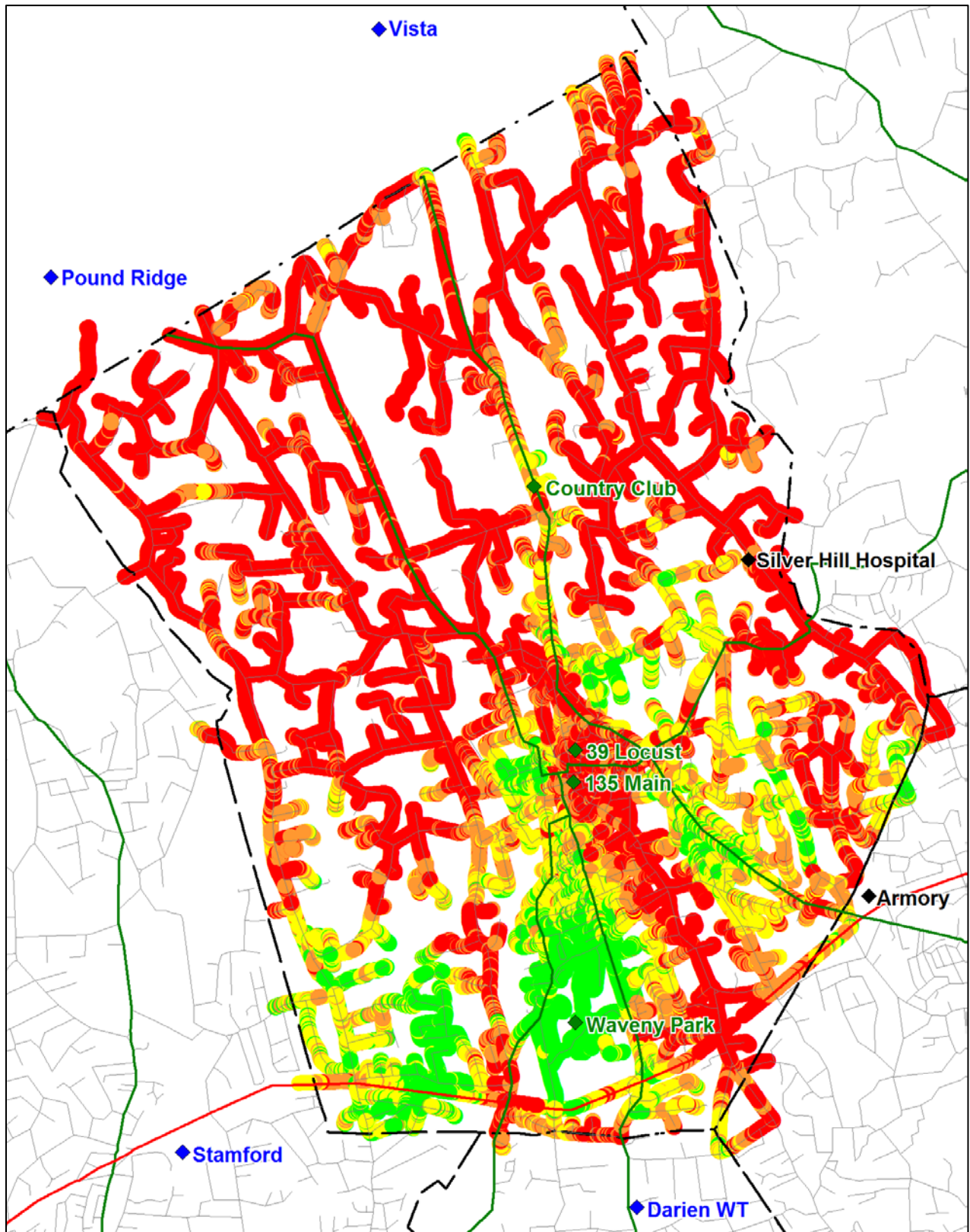




Figure 12: Verizon 1900 EVDO Drive Test





### *Verizon Coverage Prediction Results*

The 700 MHz band covers about 2/3 of the Town with no site N of Downtown. Notable gaps are E, W and N of Downtown.

Coverage at 850 MHz is slightly less than 700 MHz with the same coverage gaps as above but more pronounced. These increased gaps are due to reduced signal propagation at the slightly higher frequency.

The NY site at Vista provides some coverage on the fringes of Town but its position outside the town border in thick forest provides little benefit to the Town itself. By factoring in the "Approved" sites at the Armory and Silver Hill Hospital, many of the coverage holes NE and SE of Downtown are addressed. These sites will not address, however, the gaps NE and E of Downtown along Rtes 123 and 124.

As expected, coverage degrades significantly at 1900 MHz with the higher frequency band and foliage effects. The same gaps as above are expanded. A significant coverage hole also develops S of Main St along White Oak Shade Rd.

The Verizon Predicted Coverage maps are provided on the following pages.

Figure 13: Verizon Active Sites – 850 MHz Predicted Coverage

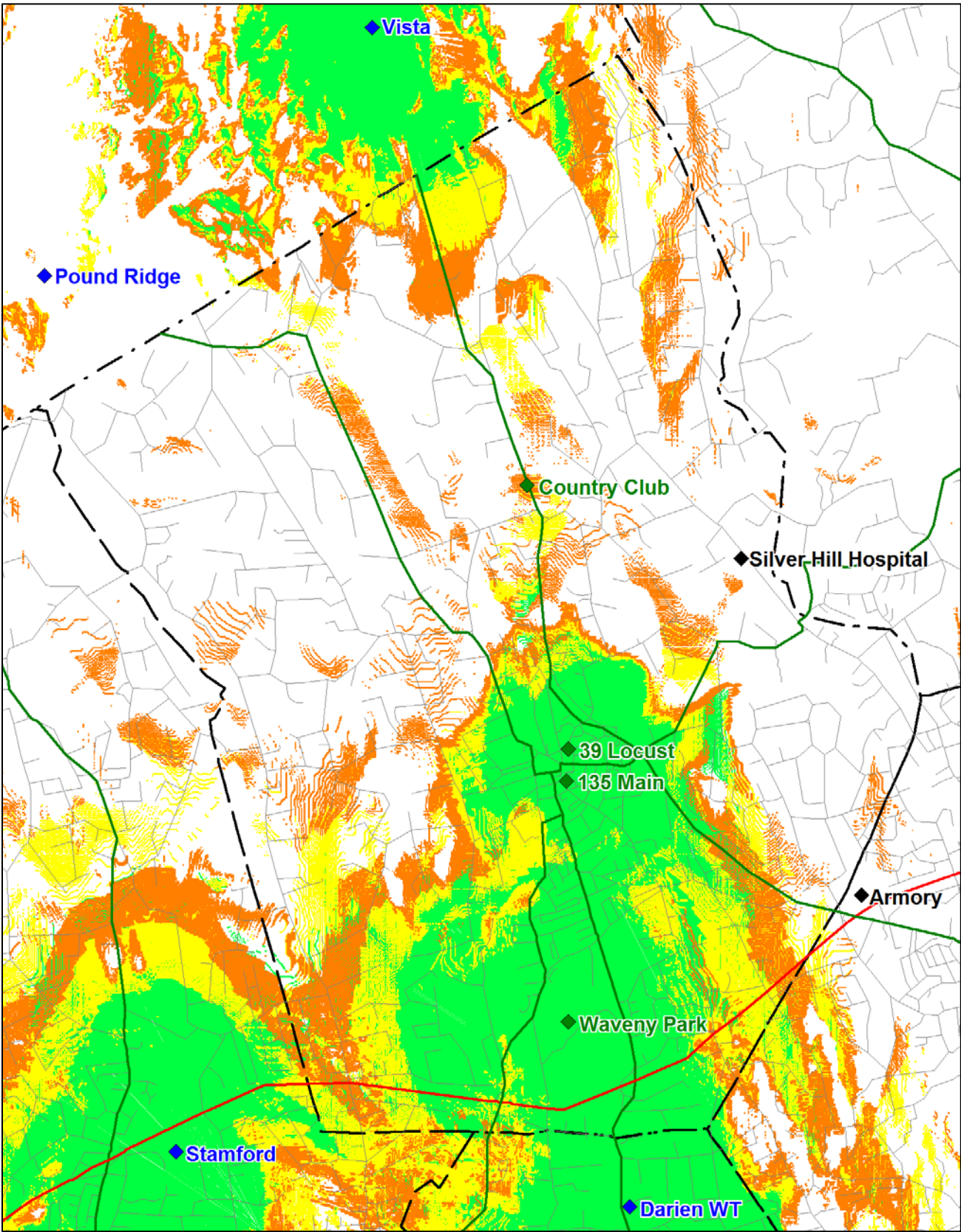
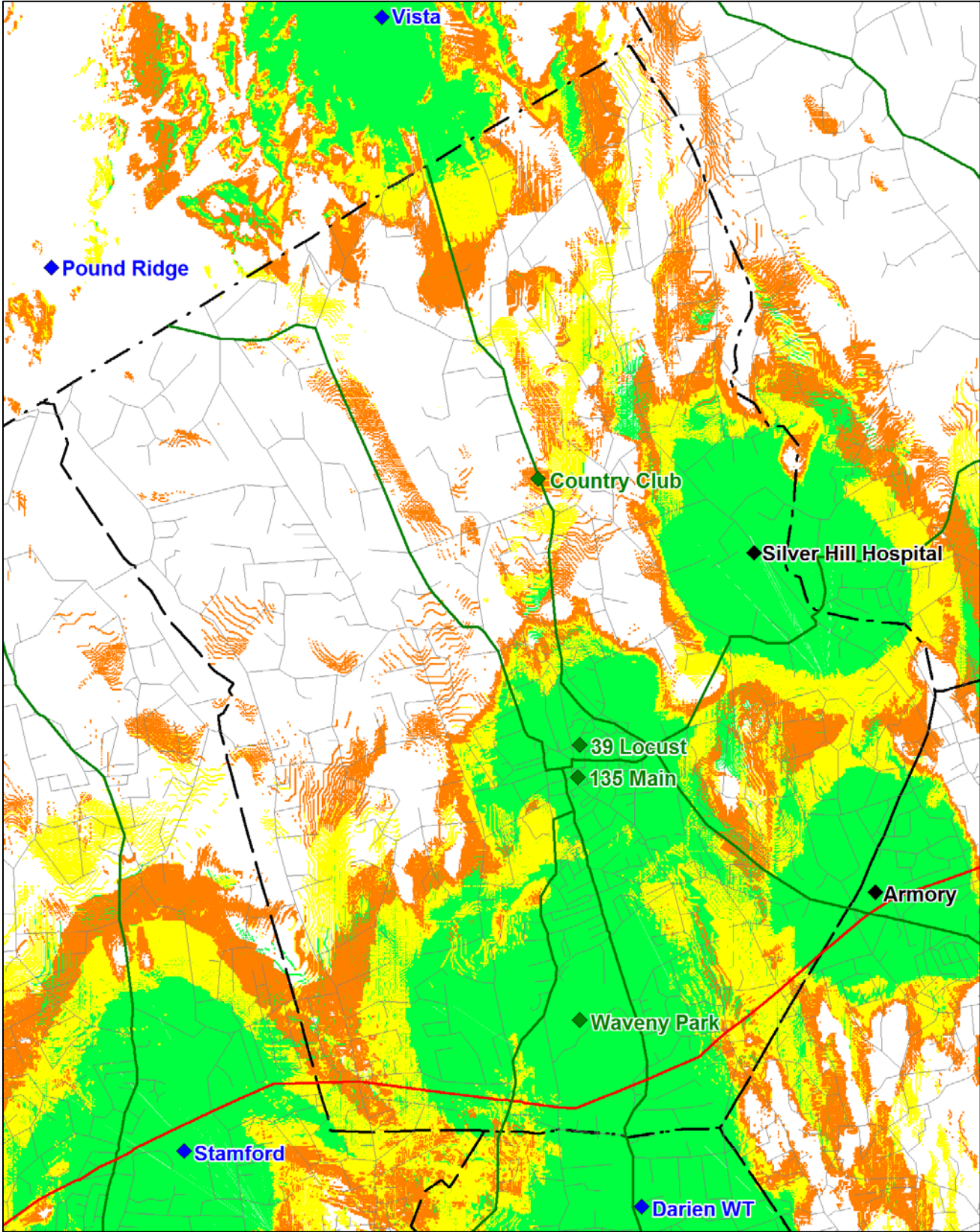
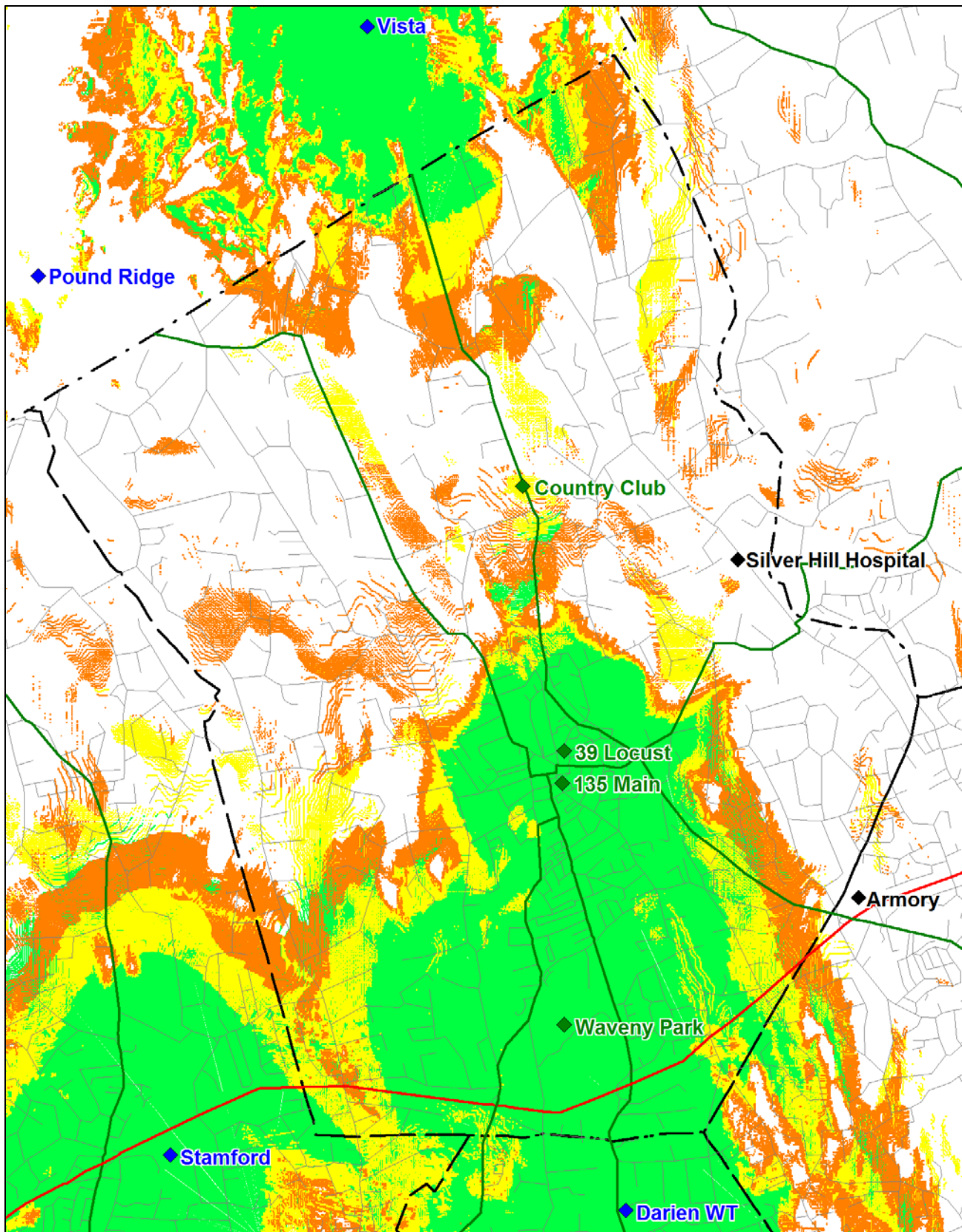


Figure 14: Verizon Active & Approved Sites – 850 MHz Predicted Coverage

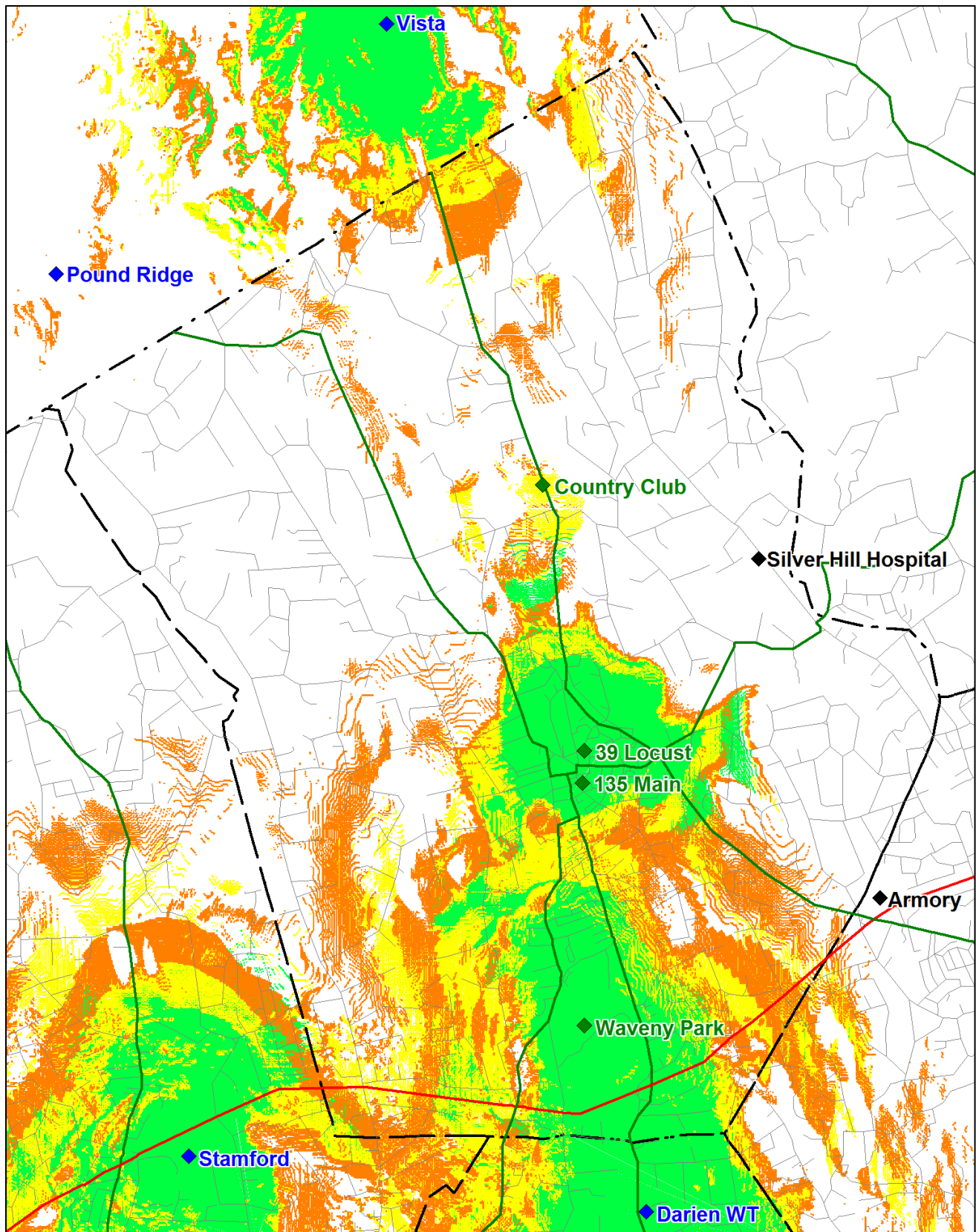




**Figure 15: Verizon Active Sites – 700 MHz Predicted Coverage**



**Figure 16: Verizon Active Sites – 1900 MHz Predicted Coverage**



### Verizon Observations Summary

Coverage from existing sites reaches approximately 2/3 of the Town area at 700 MHz, 1/2 at 850 MHz and only 1/3 of the Town at 1900 MHz. Adding in the Approved sites at Armory and Silver Hill Hospital fills in some of the coverage holes NE and SE of Downtown. The biggest holes are N of Downtown, W of route 124 and E of route 123 along Valley Rd. There are also noticeable gaps E of Downtown.

The plots give a general pictorial representation of coverage levels and gaps. However, with the inherent variability of the predictions, it's not meaningful to attempt to identify specific neighborhoods that may not be receiving adequate service.

## T-Mobile Results Overview

T-Mobile only has 2 active UMTS or LTE sites in town (39 Locust and Waveny Park). The Connecticut site database says both AT&T and T-Mobile are active at Country Club but the Survey indicated that T-Mobile is only operating 1900MHz GSM service here. This 2G technology was not considered within the scope of this study and no Drive Test data was collected for 2G. However, as T-Mobile could potentially upgrade the Country Club site to UMTS technology, we considered this site active for purposes of 1900 MHz coverage predictions and analysis.

There are 3 active periphery sites providing coverage inside New Canaan borders (Darien WT, Stamford and Pound Ridge).

T-Mobile provides primary voice and data service over UMTS technology in the 1900 MHz band. The 2100 MHz provides secondary voice and data service through UMTS technology.

### *T-Mobile Drive Test Results*

The PCS band only provides coverage in about 1/3 of the Town around and between Downtown and Waveny Park. There is minimal coverage N of Downtown as their Country Club site is only transmitting 2G technology and this data was not collected. The dense foliage and reduced signal propagation at higher frequencies decrease coverage compared to the other network operators. Coverage from 39 Locust is restricted because the antennas are below tree height.

As expected, the AWS (2100 MHz) band coverage is noticeably worse than the PCS band, only covering about 1/4 of the Town. This is due to the reduced signal propagation of the slightly higher frequency of the transmissions.

The T-Mobile Drive Test data maps are provided on the following pages. The colored dots represent collected signal strength measurements along the drive routes. The legend for each indicates the meaning of each color.



**Figure 17: T-Mobile 1900 UMTS Drive Test**

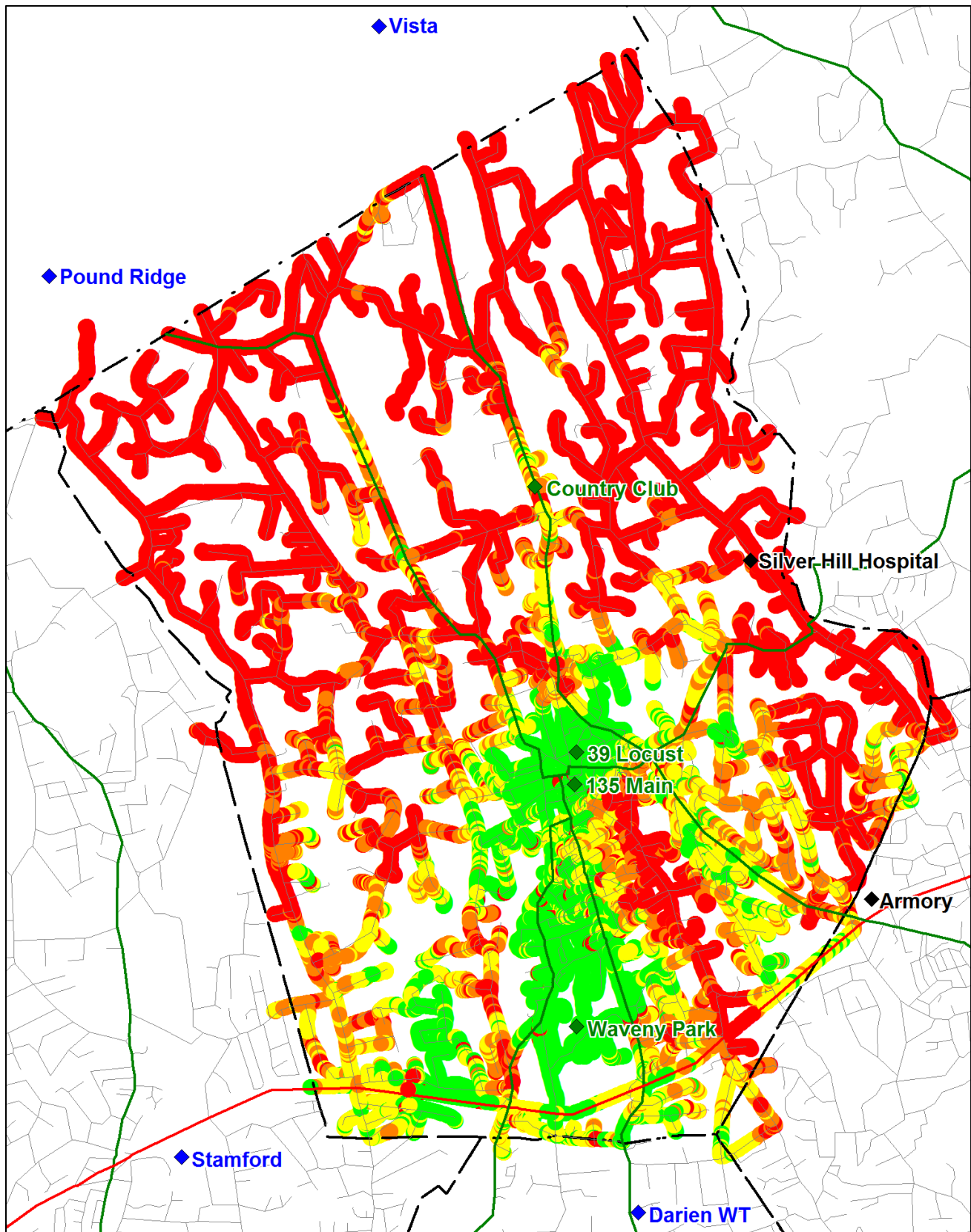
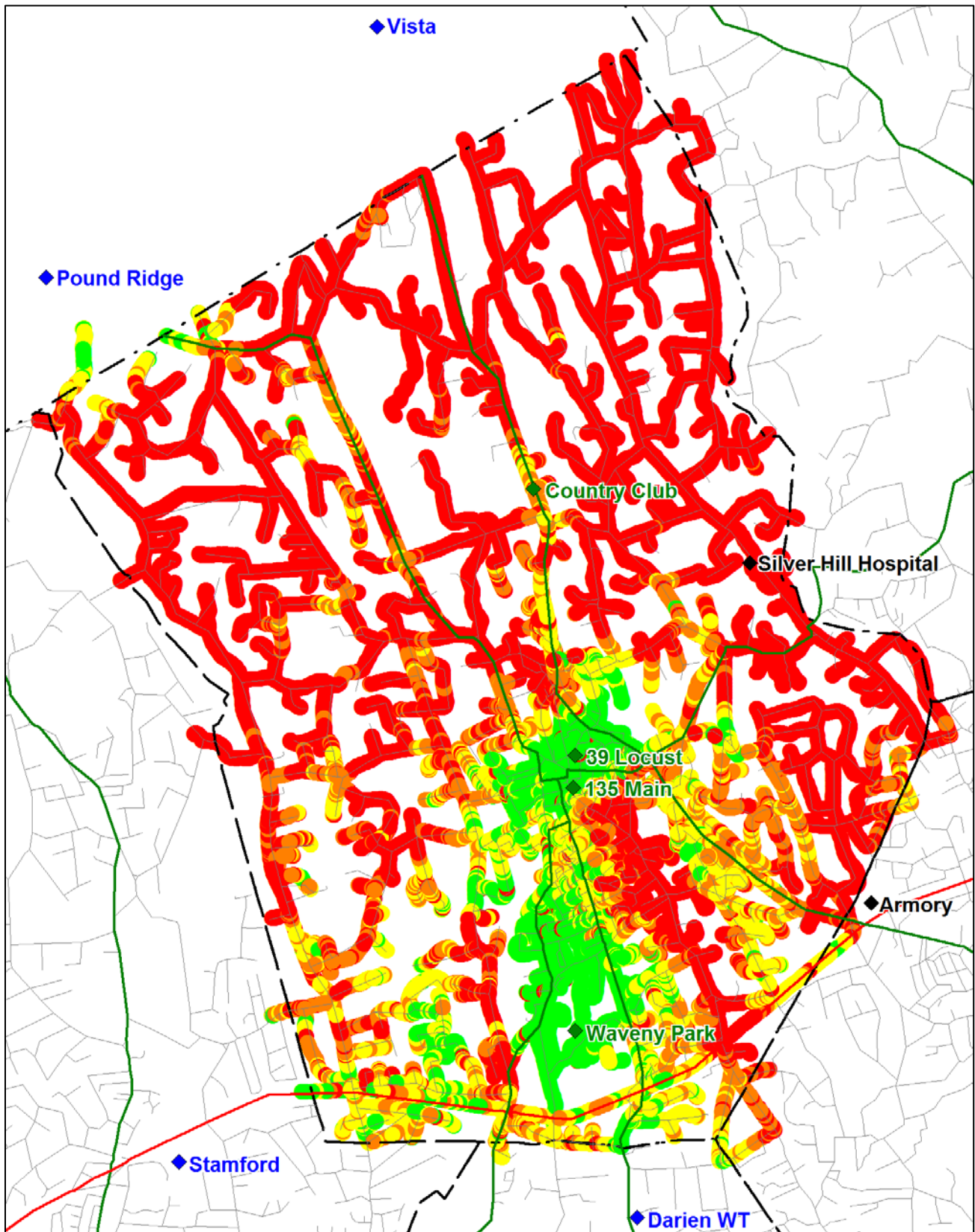


Figure 18: T-Mobile 2100 UMTS Drive Test





### *T-Mobile Coverage Prediction Results*

The PCS band provides coverage in about 1/2 of the Town around and between Downtown and Waveny Park. The dense foliage and reduced signal propagation at higher frequency decrease coverage compared to the lower frequencies of the other network operators. Coverage from 39 Locust is restricted because the antennas are below tree height. Coverage from Country Club was considered as T-Mobile could potentially upgrade their current 1900 MHz GSM service at that site to UMTS.

The NY site at Pound Ridge provides some coverage on the fringes of Town but its position outside the town border in thick forest provides little benefit to the Town itself. By factoring in the "Approved" site at Silver Hill Hospital, an island of coverage is created around the site which has a minimal border with Country Club and a sizable gap with 39 Locust.

As expected, the AWS (2100 MHz) band coverage is significantly worse than the PCS band, only covering about 1/4 of the Town. This is due to the exclusion of the Country Club site and reduced signal propagation at the slightly higher frequency of the transmissions.

The T-Mobile Predicted Coverage maps are provided on the following pages.



Figure 19: T-Mobile Active Sites – 1900 MHz Predicted Coverage

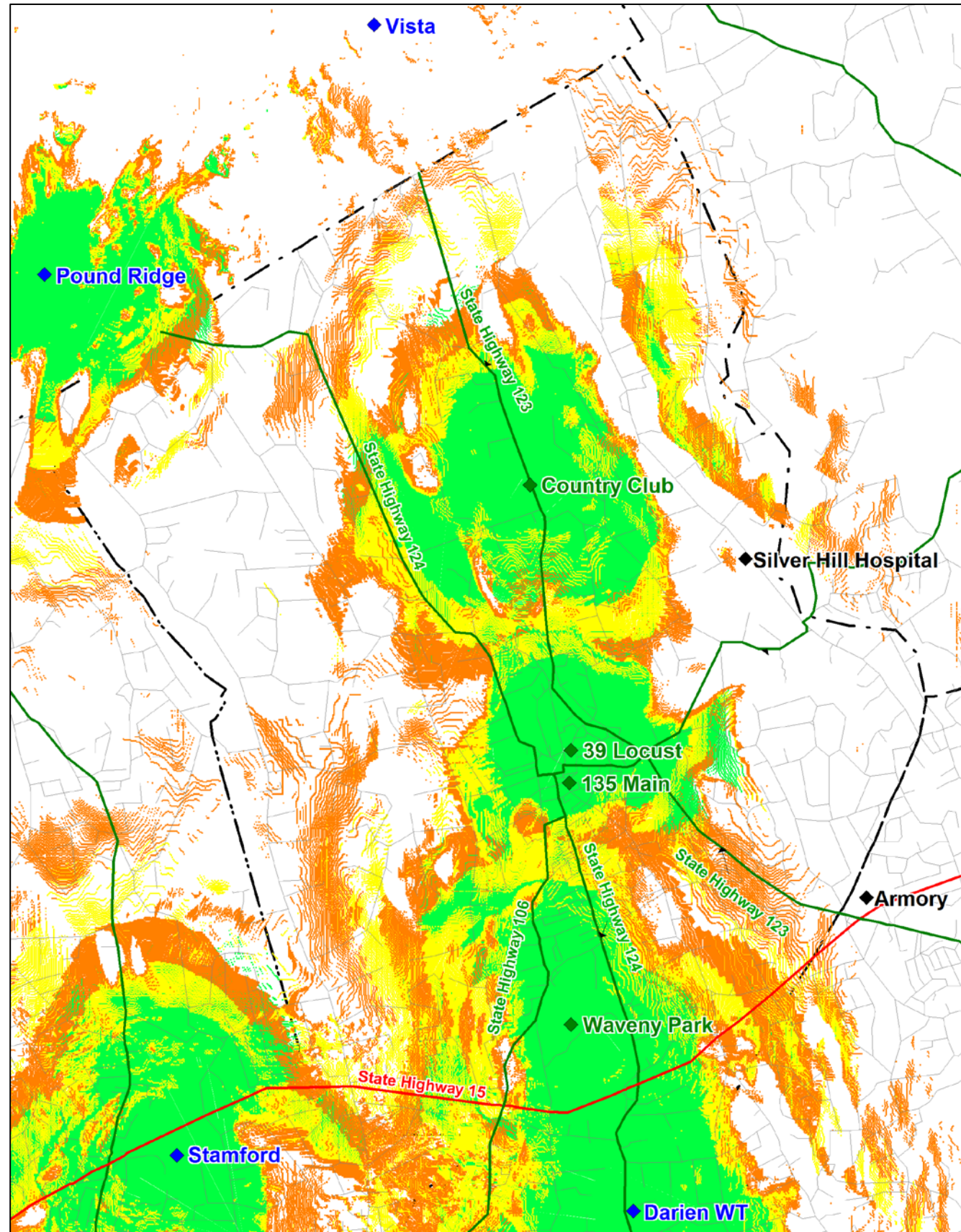
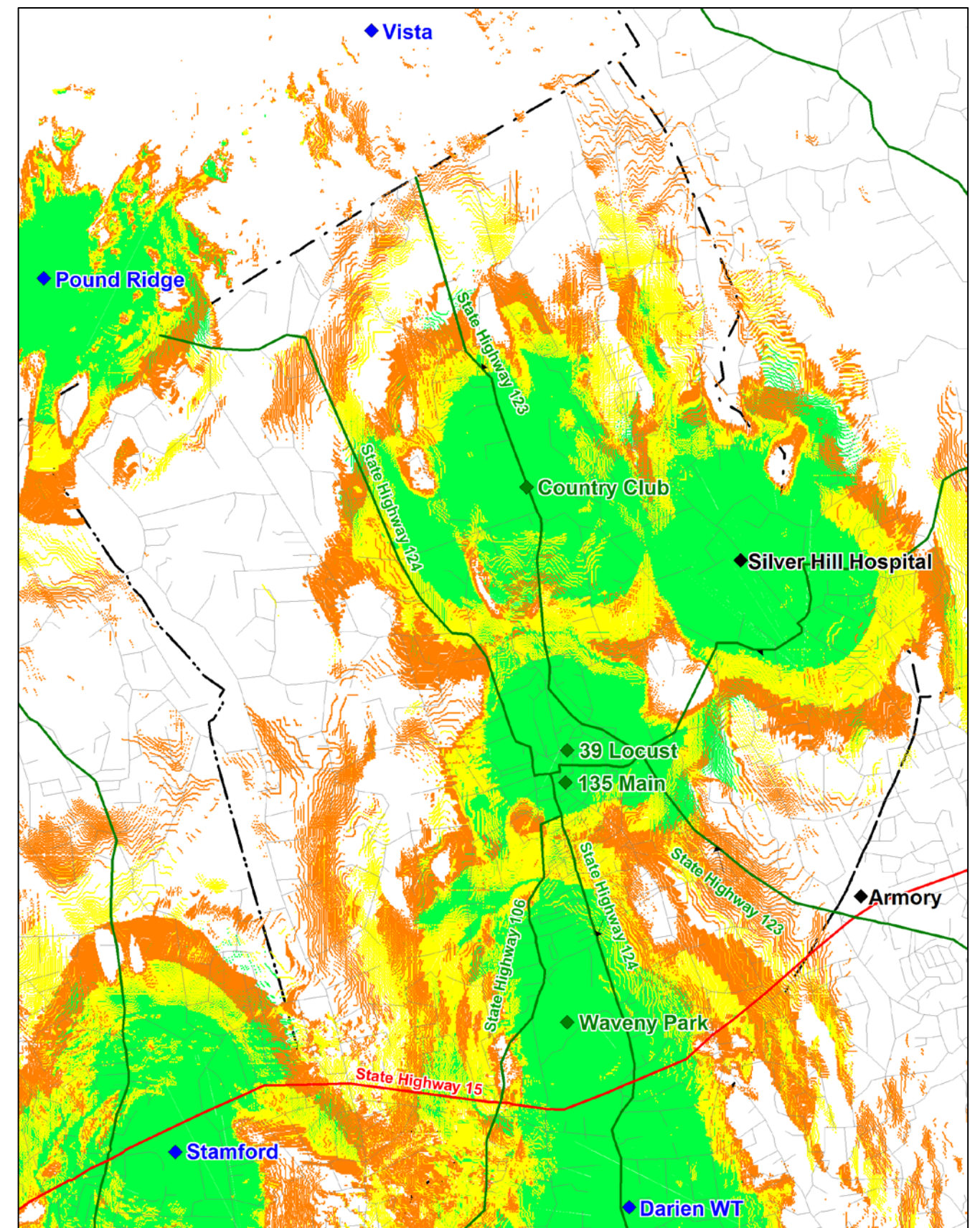
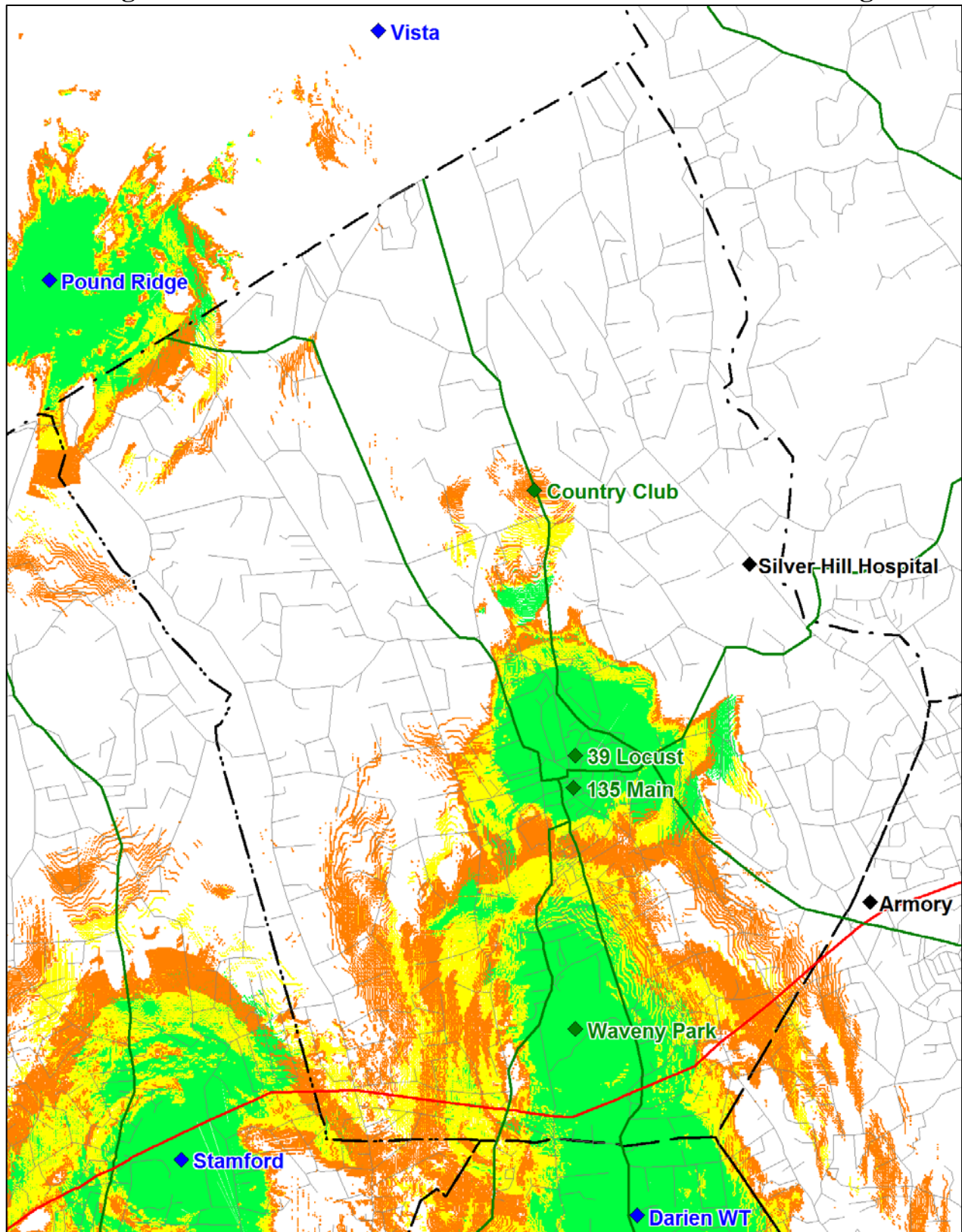


Figure 20: T-Mobile Active & Approved Sites – 1900 MHz Predicted Coverage





**Figure 21: T-Mobile Active Sites – 2100 MHz Predicted Coverage**



### T-Mobile Observations Summary

Coverage from existing sites reaches approximately 1/2 of the Town area at 1900 MHz and only 1/4 of the Town at 2100 MHz. PCS coverage predictions assume that T-Mobile will upgrade their service at Country Club to UMTS. Coverage areas are only around and between Downtown and Waveny Park. Adding in the Approved site at Silver Hill Hospital creates an island of coverage around the site but there is still a sizable gap between sites NE of Downtown, N of Rte 106 and NE of Rte 123.

The plots give a general pictorial representation of coverage levels and gaps. However, with the inherent variability of the predictions, it's not meaningful to attempt to identify specific neighborhoods that may not be receiving adequate service.

## Sprint Results Overview

Sprint only has 2 known active sites in town (39 Locust and Waveny Park). There are 3 active periphery sites providing coverage inside New Canaan borders (Darien WT, Stamford and Vista).

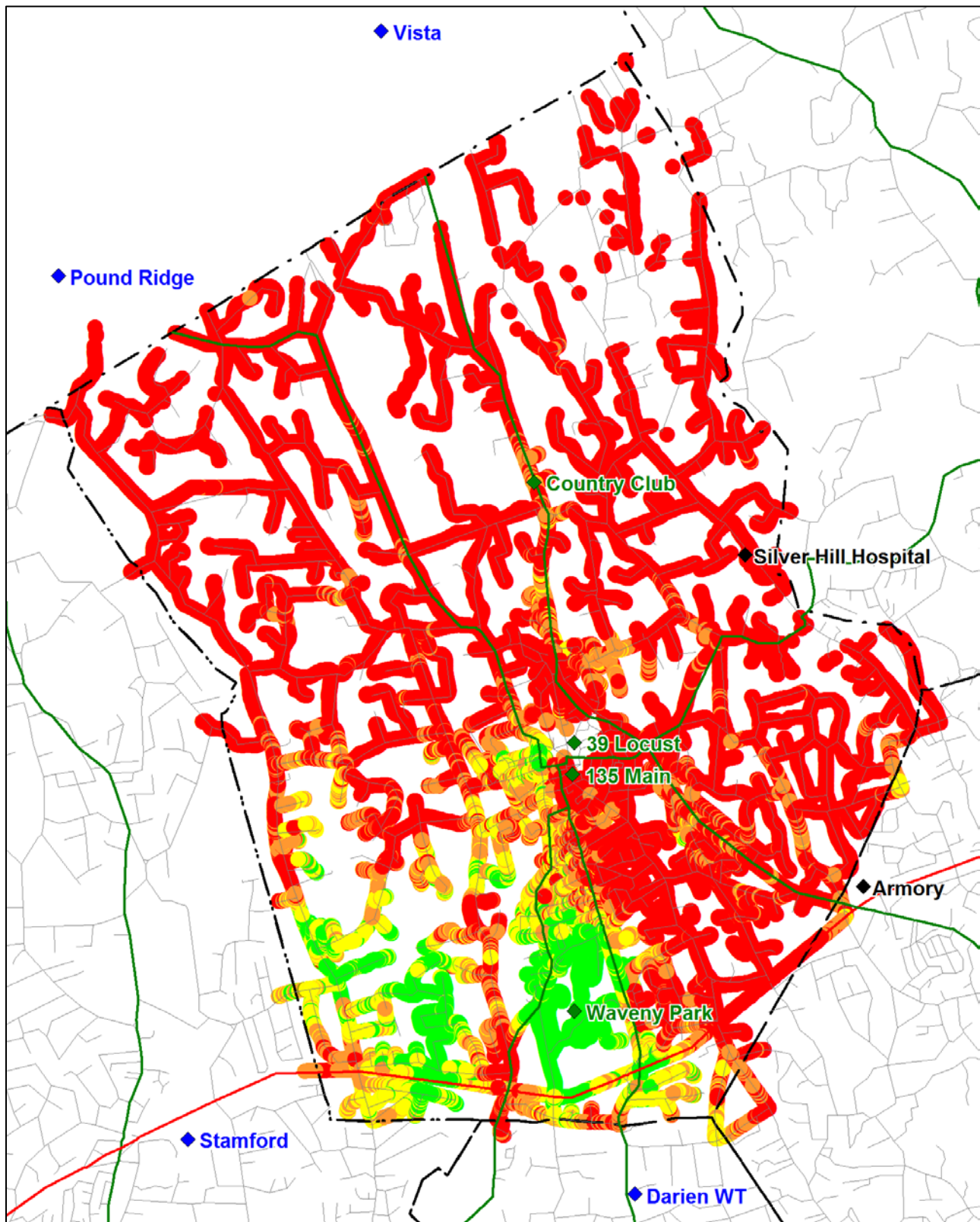
Sprint provides primary voice and data service over CDMA and EVDO technologies in the 1900 MHz band.

### *Sprint Drive Test Results*

Based on the other carriers' results, Sprint was expected to provide coverage in the PCS band for about 1/4 of the Town around and between Downtown and Waveny Park. According to the Drive Test data, there is coverage in only about 1/6 of the Town. However, the team was not able to identify a common primary reference channel across all sites for the Sprint 1900 MHz band. Without a reference channel, the system couldn't necessarily lock onto the correct signals so the collected drive test data only partially represents their 1900 MHz coverage. It's impossible to know how much data was missed but 50% is a rough estimate.

The Sprint Drive Test data map is provided on the following page. The colored dots represent collected signal strength measurements along the drive routes. The legend for each indicates the meaning of each color.

Figure 22: Sprint 1900 UMTS Drive Test



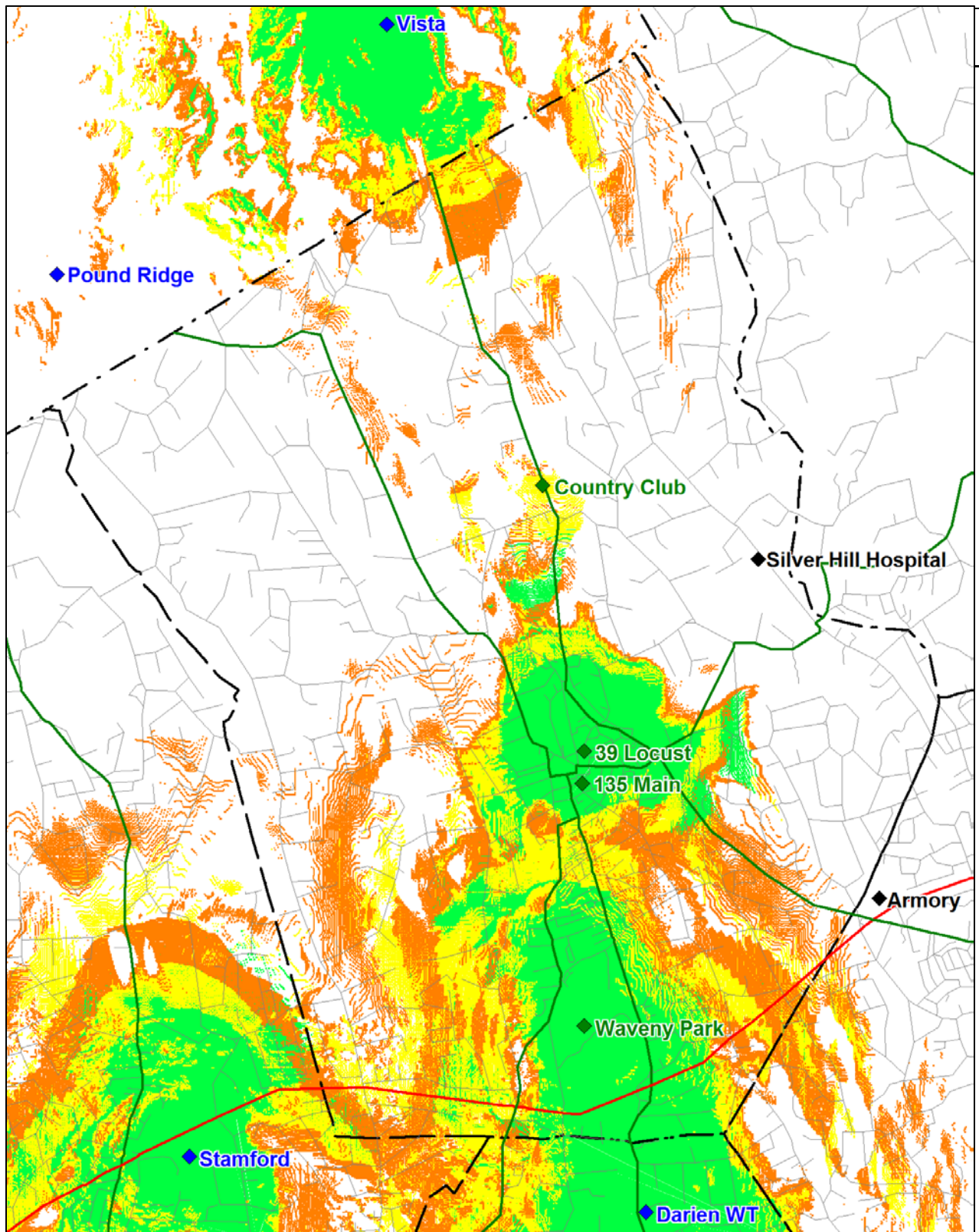
### *Sprint Coverage Prediction Results*

As expected, Sprint's predicted 1900 MHz sites provide coverage for about 1/4 of the Town around and between Downtown and Waveny Park. The NY site at Vista provides some coverage on the fringes of Town but its position outside the town border in thick forest provide little benefit to the Town itself.

The Sprint Predicted Coverage map is provided on the following page.



**Figure 23: Sprint Active Sites – 1900 MHz Predicted Coverage**



### Sprint Observations

Coverage from existing sites reaches only 1/4 of the Town. There are no active Sprint applications for additional sites so the impact of Approved sites was not considered.

## **Wireless Study Conclusions**

### **Summary of Observations**

AT&T has the best coverage footprint in the Town of New Canaan with its primary voice service in the 850 MHz frequency band on three active cell sites within the Town: Country Club, 135 Main and Waveny Park.

AT&T covers about 2/3 of the Town area with its 850 MHz primary voice service and 3/4 of the town with its 700 MHz primary data service. Notable holes are areas W of route 124, E of 123 along Valley Rd, SE of Downtown and N of the Country Club. Coverage from 135 Main is restricted because the antennas are below tree height. The other holes appear to be due to terrain features.

Verizon has the second best footprint, covering about 2/3 of the Town with its 700 MHz primary data service and 1/2 of the Town with 850 MHz primary voice service. This is due to the lack of an active site N of Downtown. They have the same holes as AT&T W of route 124, and E of 123 along Valley Rd and SE of Downtown likely due to terrain features. Coverage from 39 Locust is restricted because the antennas are below tree height.

T-Mobile covers about 1/2 of the Town with its 1900 MHz voice and data services. The dense foliage and higher frequency decrease coverage compared to the lower frequencies of AT&T and Verizon. Coverage from 39 Locust is restricted because the antennas are below tree height.

Sprint with only 2 sites in Town and operations in higher frequency bands, only cover about 1/4 of the Town area. Coverage from 39 Locust is restricted because the antennas are below tree height.

The table below summarizes the approximate coverage footprints in the Town for each carrier.

**Table 4: Coverage Footprints by Carrier**

Carrier	Approximate Footprint (% Area of the Town)	
	Primary Wireless Voice Service	Primary Wireless Data Service
<b>AT&amp;T</b>	67%	75%
<b>Verizon</b>	50%	67%
<b>T-Mobile</b>	50%	50%
<b>Sprint</b>	25%	25%

Adding in the Approved sites at Armory and Silver Hill Hospital fills in many of the coverage holes but AT&T still would have coverage holes E of Downtown, W of route 124 and E of route 123 along Valley Rd.

### Possible Solutions

Existing Outdoor Voice service coverage footprints for the operators range from 1/4 to 2/3 of the Town area. Verizon would need a site N of Downtown equivalent to Country Club if they wanted to match AT&T's footprint. If T-Mobile upgrades their Country Club site to UMTS technology, they would still be at a disadvantage vs AT&T and Verizon because of their higher frequency of operation. Sprint would be in the same boat as T-Mobile if they could find an equivalent site N of Downtown.

Adding in the Approved sites at Armory and Silver Hill Hospital fills in many of the coverage holes NE and SE of Downtown at 850 MHz for AT&T and Verizon but Silver Hill Hospital would be an island of coverage for T-Mobile at 1900 MHz even with an upgrade to UMTS at the Country Club site.

Even with the Country Club site and both Approved sites, AT&T still would have coverage holes E of Downtown, W of route 124 and E of route 123 along Valley Rd as reproduced on the next page. Most of these areas are residential so In-Building voice service would be the likely target for customers.



Figure 24: AT&T Active Sites – 850 MHz Predicted Coverage

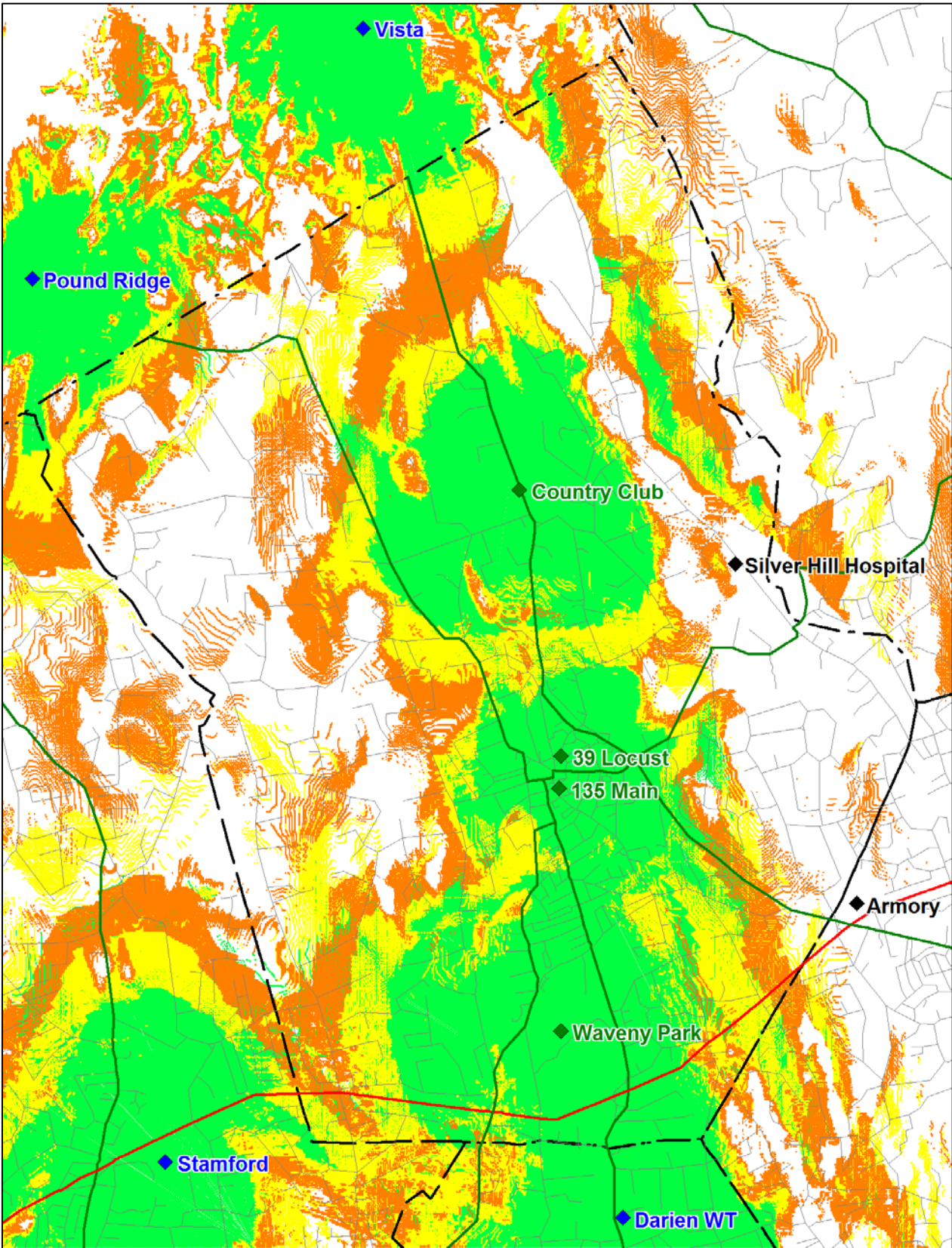
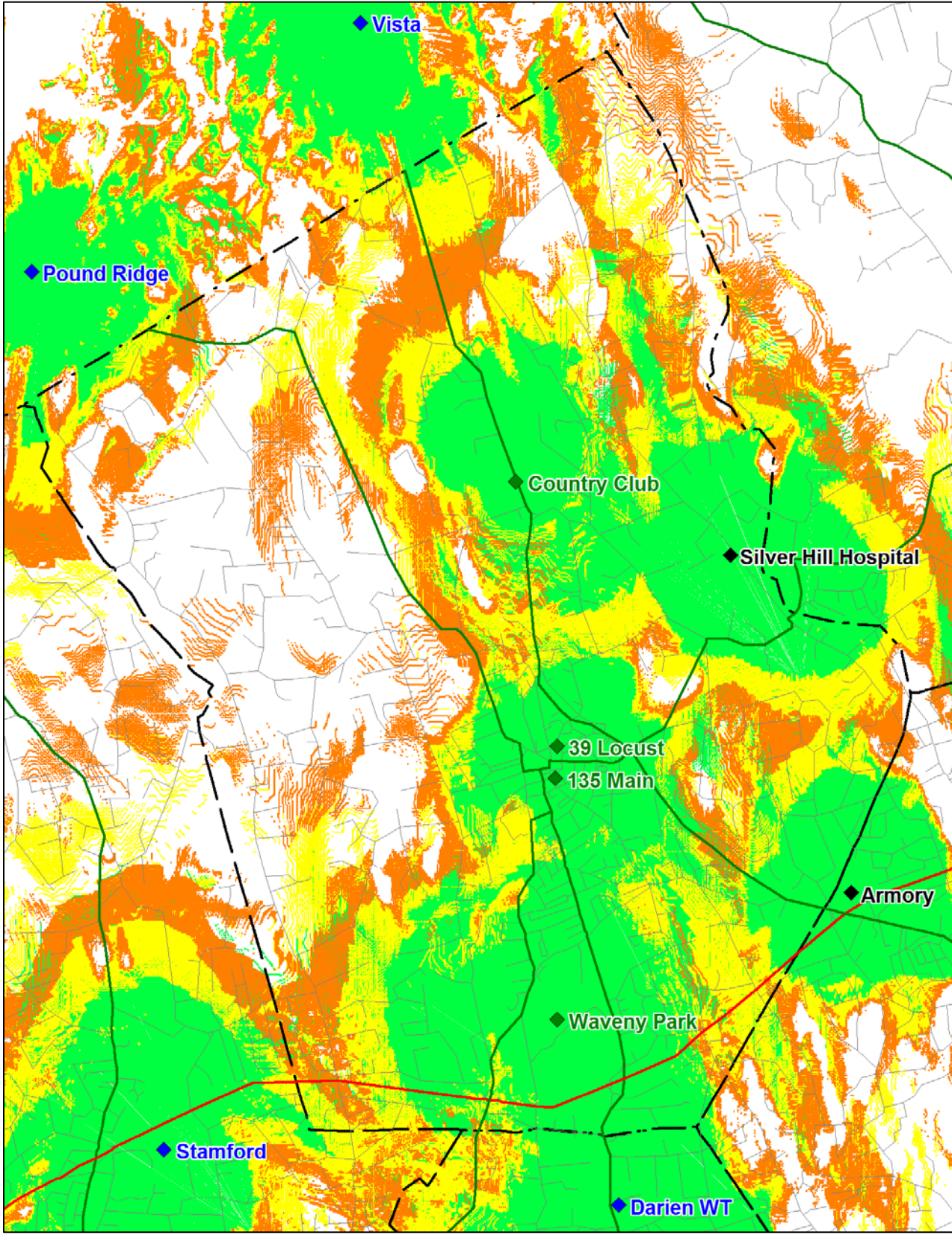


Figure 25: AT&T Active & Approved Sites – 850 MHz Predicted Coverage





Possible solutions to these gaps along with their respective trade-offs are:

1. Traditional Macro sites targeted to fill in the gaps.
  - ✓ On the plus side, these sites are straightforward and would provide predictable coverage improvements based on the models we derived for this study
  - X On the minus side, they can detract from the environment of the communities they aim to serve.
  - X Another minus in the cases of Valley Rd and SE of Downtown where terrain is the main issue, they would have to be located specifically where they could cover down the valleys that are blocking signals
2. Stealth Macro sites targeted to fill in the gaps.
  - ✓ On the plus side, these sites would provide predictable coverage improvements as above and could blend in with the community environment
  - X On the minus side, they have the same issue with specific terrain issues as traditional Macro sites
  - ✓ Some kinds of stealth sites like slim monopoles with internal antennas, can be reasonable to construct if there are suitable sites available for this option
  - X More complex stealth sites like monopines, steeples, cupolas, etc. can be very expensive to construct and only suitable to select locations, if available
3. Distributed Antennas Systems (DAS)
  - ✓ On the plus side, these sites can provide highly targeted coverage to specific problem areas if those areas are accessible where the antennas can be installed
  - ✓ If DAS nodes can be installed in the same right-of-way as a utility lines, requisite fiber and power can be readily available.
  - X On the minus side, DAS nodes typically operate at 5-10% of the power and 25% of the height as an equivalent Macro site. This gives them significantly reduced signal propagation particularly in areas like New Canaan where they would be below the level of the dense, tall trees. Their coverage footprint would be ~5% of the area of an equivalent Macro site.
  - X Unless these antennas can be installed off the roads, they might not provide the in-home coverage desired
4. Small Cells
  - ✓ On the plus side, these can provide targeted coverage similar to DAS above
  - X On the minus side, these have many of the same pitfalls as DAS above with the added need for more individual cells vs distributed antennas

All of the 4 options are potential, viable solutions with their own benefits and tradeoffs. An ultimate solution to address coverage gaps would have to consider many issues such as budgets, zoning issues, construction logistics, community aesthetics and others. Detailed study of each problem area would be required to determine the best solution on a case-by-case basis.

## **Glossary of Terms**

**Advanced Wireless Services (AWS)** – the name commonly given by the wireless industry to the frequency band from 1710 to 1755 MHz for uplink and from 2110 to 2155 MHz for downlink.

**Wireless Carrier** – a wireless service provider (AT&T, et. al.)

**Code division multiple access (CDMA)** – a wireless radio access technology where multiple users share the channel by adding a unique code for each data signal that is being sent to and from each of the radio transceivers.

**Cellular band** – the 850 MHz frequency band, licensed by the original cellular carriers AT&T and Verizon.

**Coverage** – the geographical area over which the signal strength or quality level of a given radio frequency is available for specific defined levels of service.

**Coverage availability** – a statistical representation of the likelihood that a wireless caller is receiving a particular service level.

**Coverage Levels (Indoor, Outdoor, In-Vehicle)** – a signal level that represents service coverage for different user locations

**Distributed antenna system (DAS)** – a network of spatially separated, low-power, small radio nodes connected to a common source via a transport medium that provides wireless service within a geographic area or structure.

**Decibel (dB)** – a measurement that expresses the ratio of two amounts of power by use of a logarithmic formula, " $10 \log (P2/P1)$ " where "log" represents the common or base 10 logarithm.

**Downlink (DL)** – in mobile wireless networks, the transmission path from the base station (cell site) to a mobile station (cell phone).

**dBm** – a measurement that expresses the ratio of two amounts of power by use of the logarithm relative to 1 milliwatt (0.001 Watts).

**Effective Radiated Power (ERP)** – a standardized theoretical measurement of transmitted radio frequency (RF) energy at the output of an antenna.

**Enhanced 911 (E911)** – a US emergency telephone calling system that provides an emergency dispatcher with the physical address or other geographic reference information and number of the telephone when a user initiates a call for help.

**Evolution-Data Optimized (EVDO)** – a wireless transmission standard, typically for broadband Internet access.

**Fade margin** – the amount of signal loss, expressed in decibels, that a radio signal in a communication path is expected to change due to transmission impairments.

**Global System for Mobile Communication (GSM)** – a second-generation (2G) digital mobile phone technology.

**Frequency band** – the range of frequencies defined for a specific type of radio service. Frequency bands for the major wireless operators are defined by the Federal Communications Commission (FCC).



**Link budget** – a mathematical accounting of all of the gains and losses in a telecommunications channel from the transmitter, through the medium (free space, cable, waveguide, fiber, etc.) to the receiver.

**Long term evolution (LTE)** – commonly referred to as a 4<sup>th</sup> generation technology (4G LTE), LTE is an evolution set of projected improvements to the 3rd generation wireless systems and). These improvements include 100 Mbps+ data transmission rates, increased system capacity and shorter transmission latency times.

**Maximum Path Loss** – the maximum signal attenuation a radio signal can tolerate before it is no longer able to deliver the lowest level of designed service.

**Morphology** – the classification of the character of foliage, buildings and other obstacles in a particular area, generally assigned labels like Dense Urban, Urban, Suburban and Rural.

**Path Loss** – the reduction in power density (attenuation) of an electromagnetic signal as it propagates through space.

**Personal Communications Service (PCS)** – the name given by the wireless industry to the frequency band from 1850-1990 MHz.

**Radio propagation model** – an empirical mathematical formulation for the characterization of radio wave propagation as a function of frequency, distance and other conditions.

**Small Cell** – low-powered radio access nodes that have a range of a fraction of a traditional Macro cell.

**Signal Strength** – the magnitude of the electric field at a reference point at a distance from the transmitting antenna.

**Uplink (UL)** – in mobile wireless networks, the transmission path from the mobile station (cell phone) to a base station (cell site).

**Universal Mobile Telecommunications System (UMTS)** – a wireless telecommunications standard developed and maintained by the International Telecommunication Union (ITU). Its air interface is called Wideband CDMA (WCDMA), a variant of CDMA technology for simultaneous voice and high-speed data service. UMTS is generally considered part of the 3<sup>rd</sup> generation of mobile wireless technologies (3G).

## **Appendix A: Assumptions Made**

1. Antenna azimuths were identified where possible, else standard configurations of 0/120/240 degrees were assumed.
2. Specific antenna types were not identified, a typical antenna was chosen for the coverage predictions: the Commscope SBNHH-1D65C for 700/850/1900/2100 MHz with 65° horizontal beamwidth.
3. Non-terrain obstructions were not considered

## **Appendix B: Link Budgets Used**

The target service levels assumed above for each technology must be translated into equivalent target Downlink received signal levels at the user's mobile station (cell phone). The technology-specific Link Budgets in the table below determine the maximum amount of signal losses that may occur between the cell site transmitters and mobile station receivers to achieve a sufficient target signal quality level.

**Table 5: Link Budgets Used by Technology**

TECHNOLOGY	ERP (dBm)	ERP (W)	Max Path Loss (dB)	Outdoor (50 kbps DL, 90%)	In-Vehicle (512kbps DL, 90%)	Residential (1Mbps DL, 90%)
LTE	34.0	2.5	150	-116 dBm	-110 dBm	-102 dBm
CDMA/EVDO	51.0	125.9	148	-97 dBm	-91 dBm	-83 dBm
UMTS/HSPA	51.0	125.9	148	-97 dBm	-91 dBm	-83 dBm

## **Appendix C: Evaluation of Possible Sites**

### **Coverage Baselines**

#### *AT&T Coverage Baseline*

AT&T has 3 active sites in New Canaan (Country Club, 135 Main and Waveny Park), two Approved sites (Armory and Silver Hill Hospital) as well as 4 active periphery sites that provide coverage inside New Canaan's borders (Darien WT, Stamford, Pound Ridge and Vista). The baseline coverage for AT&T is their primary voice layer at 850 MHz.

#### *Verizon Coverage Baseline*

Verizon has 2 active sites in New Canaan (39 Locust and Waveny Park), two Approved sites (Armory and Silver Hill Hospital) and 3 active periphery sites providing coverage inside New Canaan (Darien WT, Stamford and Vista). The baseline coverage for Verizon is their primary voice layer at 850 MHz.

#### *T-Mobile Coverage Baseline*

T-Mobile has 3 active sites in town (Country Club, 39 Locust and Waveny Park), one Approved site at Silver Hill Hospital and 3 active periphery sites that can provide coverage inside New Canaan (Darien WT, Stamford and Pound Ridge). The baseline coverage for T-Mobile is their primary voice and data service in the 1900 MHz band.

#### *Sprint Coverage Baseline*

Sprint has 2 known active sites in town (39 Locust and Waveny Park), no Approved sites and 3 active periphery sites providing coverage inside New Canaan (Darien WT, Stamford and Vista). The baseline coverage for Sprint is their primary voice and data service in the 1900 MHz band.

### **Coverage Maps**

The graphics on the following pages will show:

- 1) The baseline coverage for each carrier.
- 2) Baseline coverage for each carrier with Major Gaps within the Town borders identified in **red**



Figure 26: AT&T Baseline Coverage – Active & Approved Sites @ 850 MHz

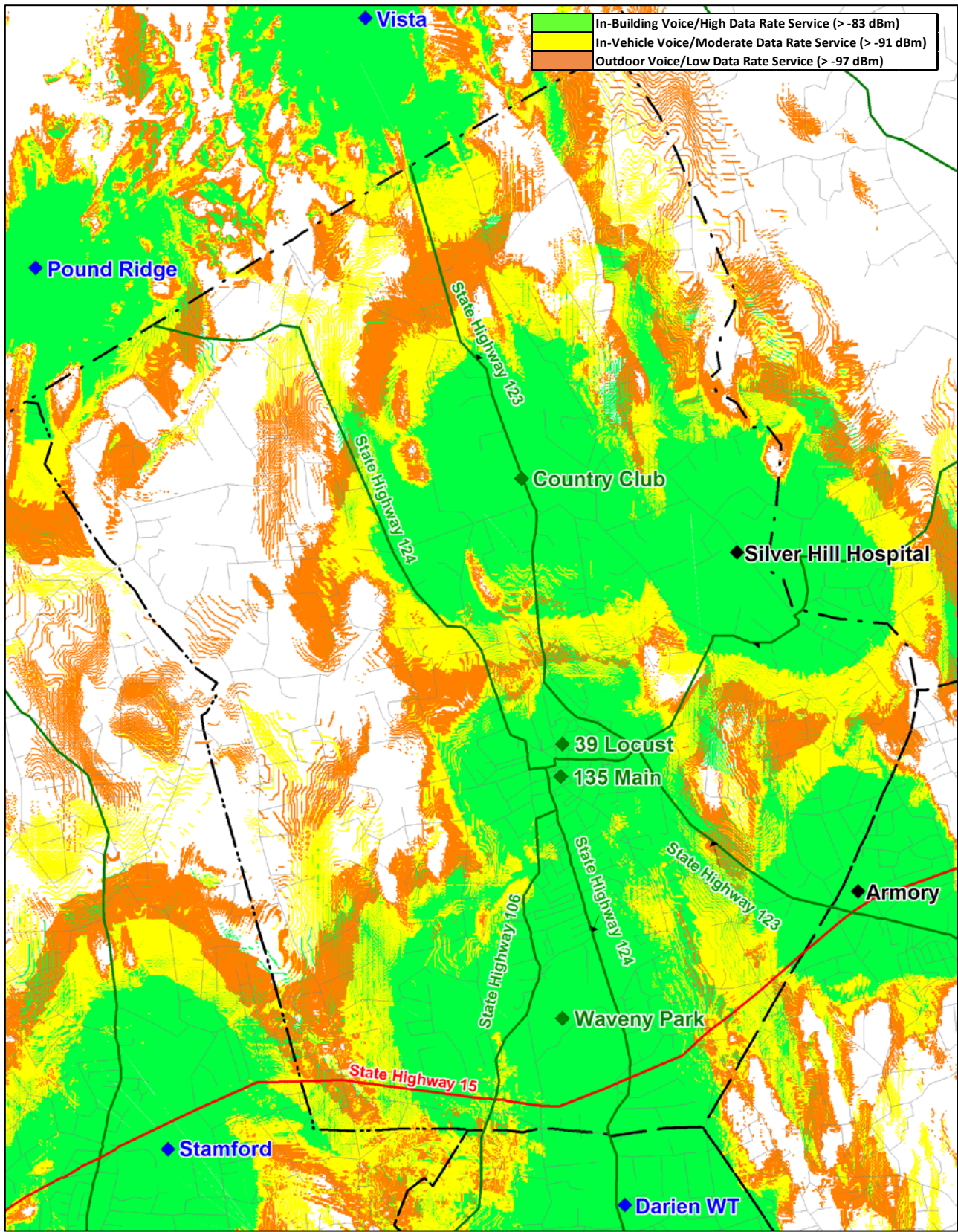


Figure 27: AT&T Baseline Coverage with Major In-Town Gaps

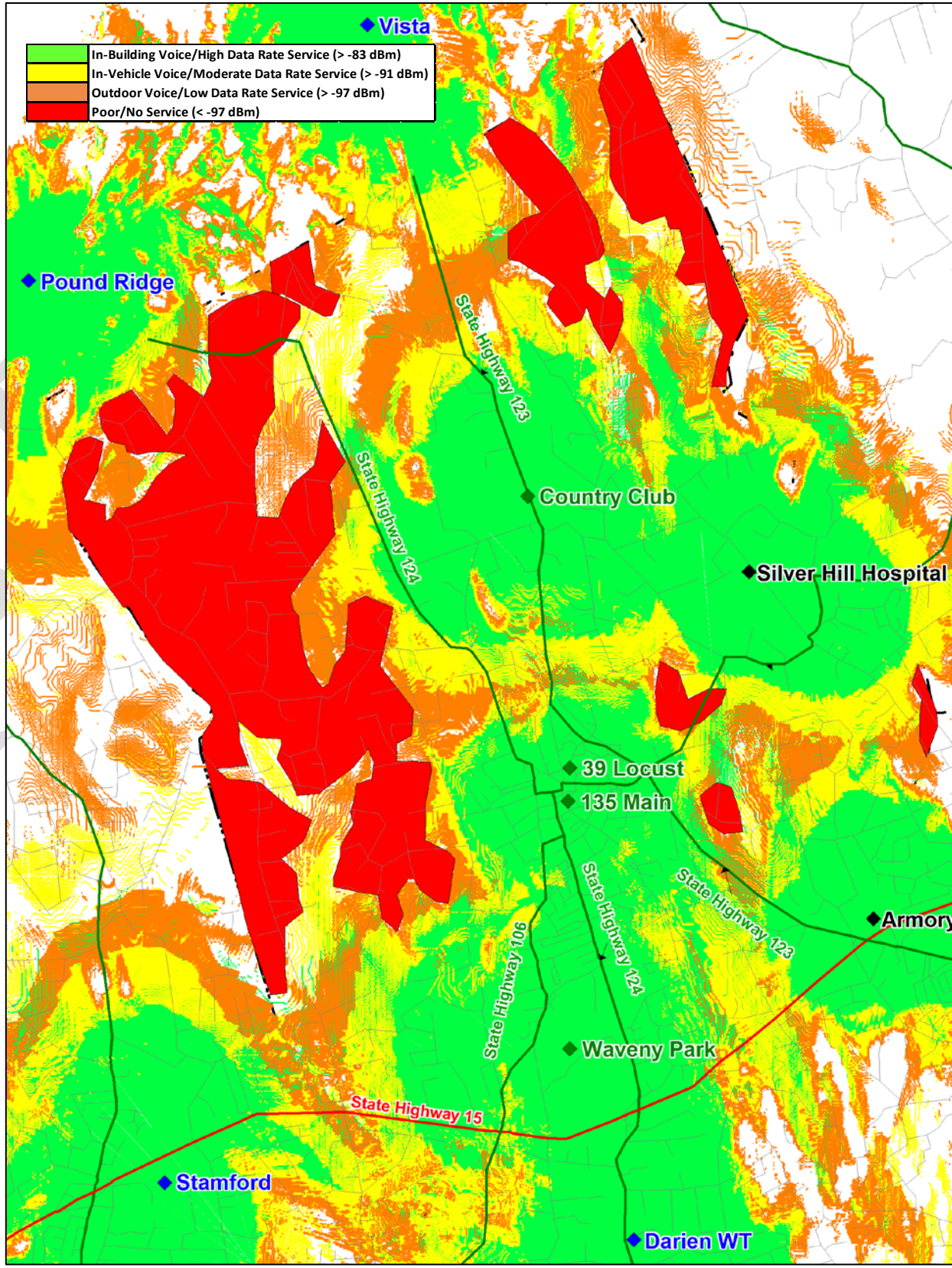




Figure 28: Verizon Baseline Coverage – Active & Approved Sites @ 850 MHz

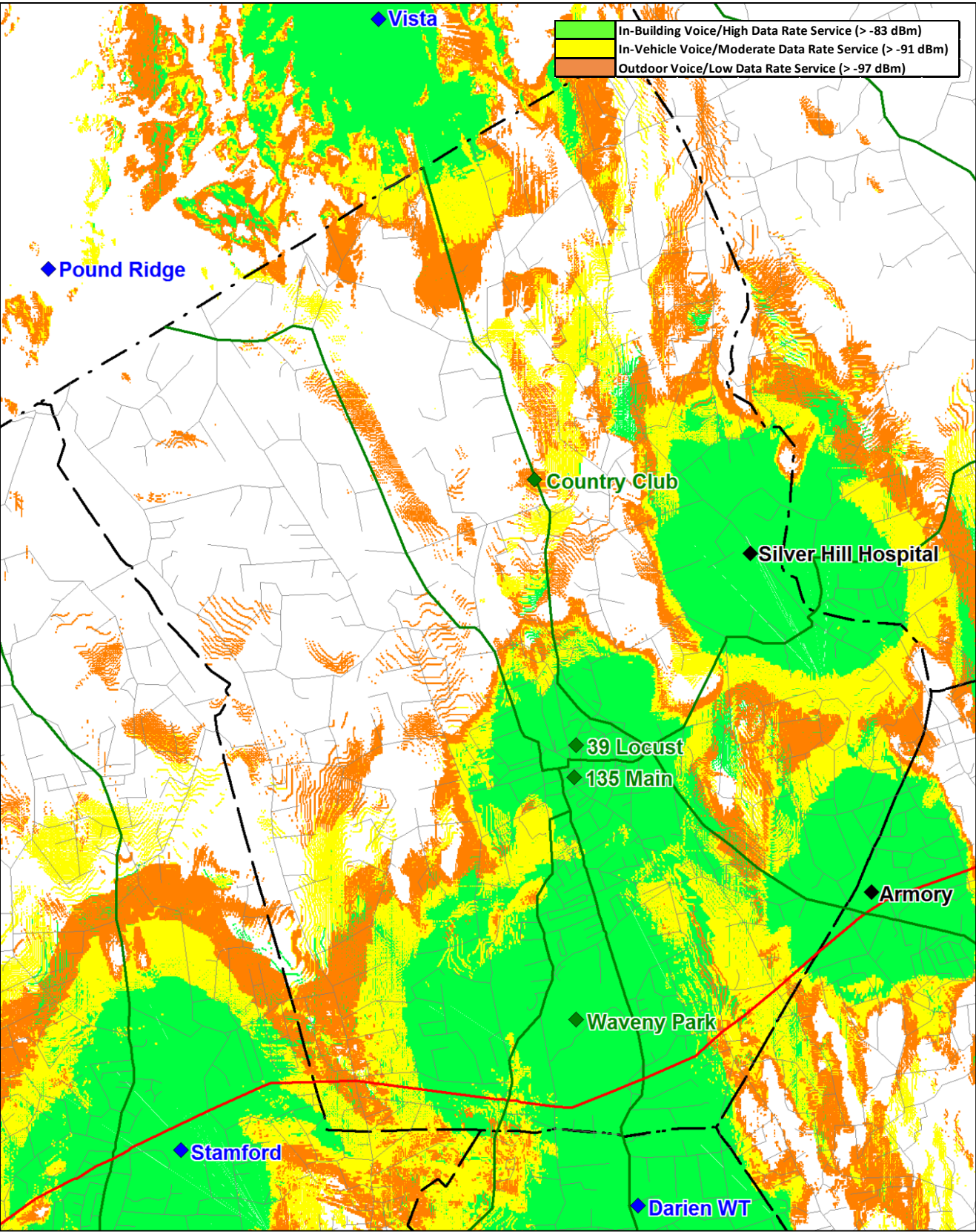


Figure 29: Verizon Baseline Coverage with Major In-Town Gaps

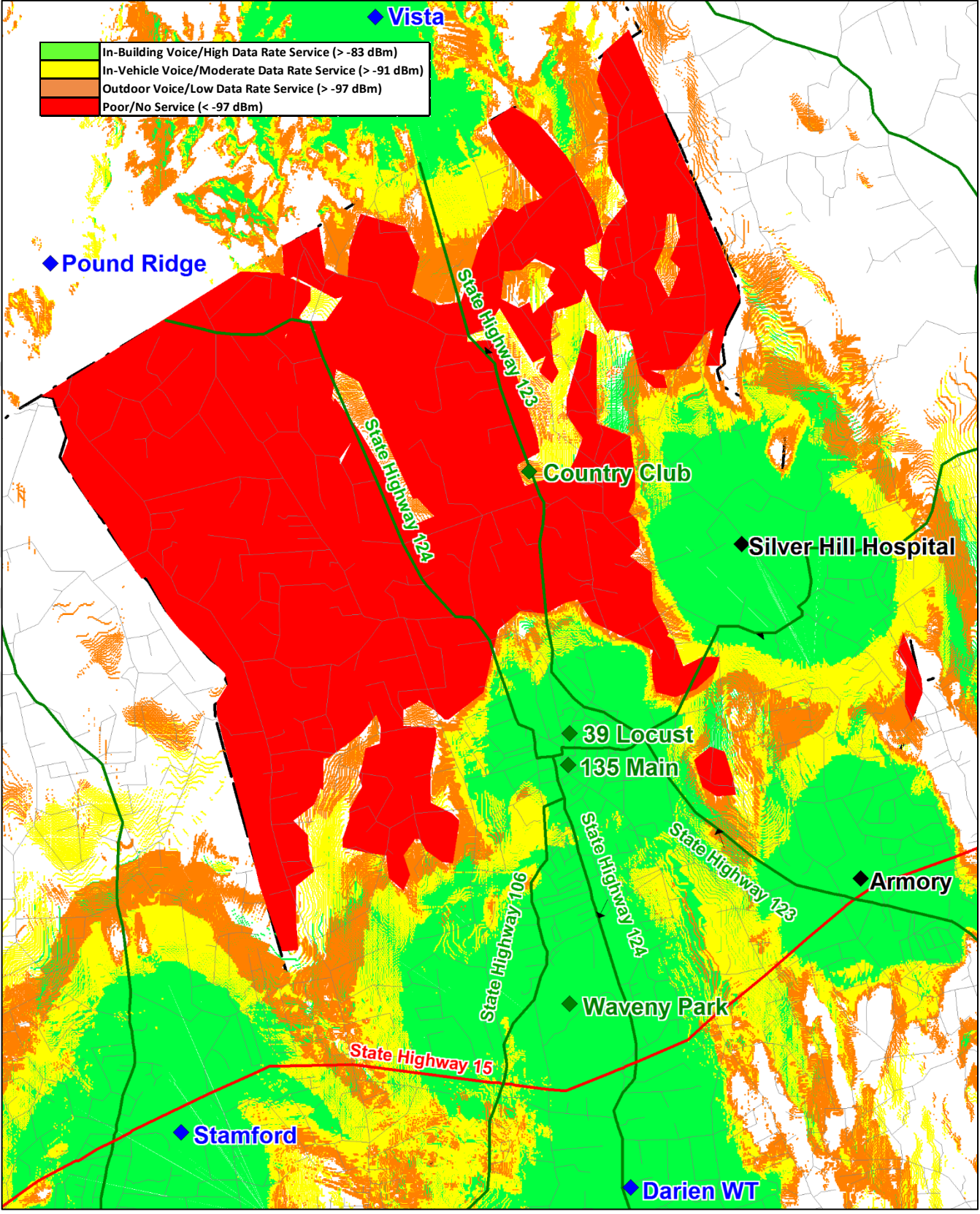




Figure 30: T-Mobile Baseline Coverage – Active & Approved Sites @ 1900 MHz

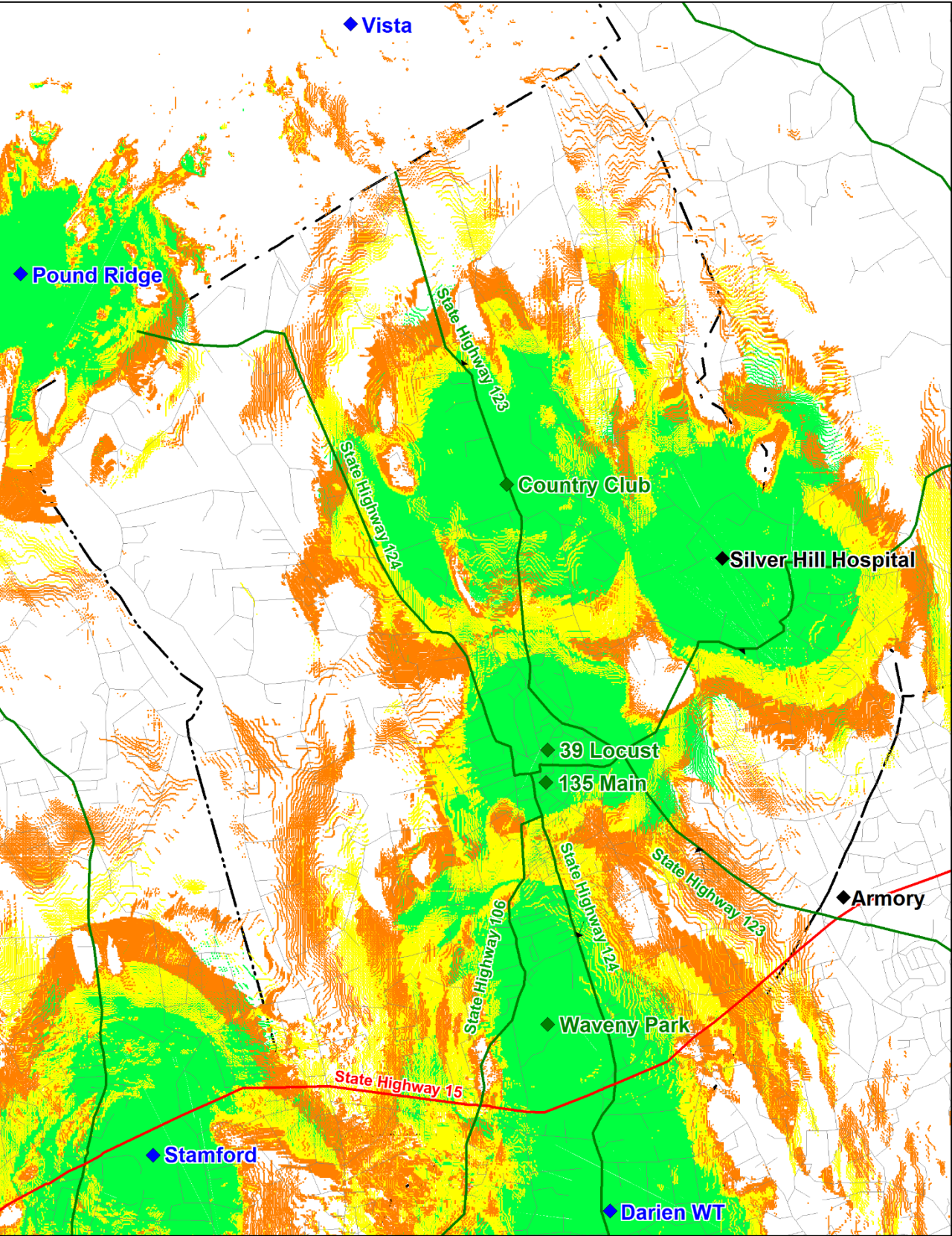


Figure 31: T-Mobile Baseline Coverage with Major In-Town Gaps

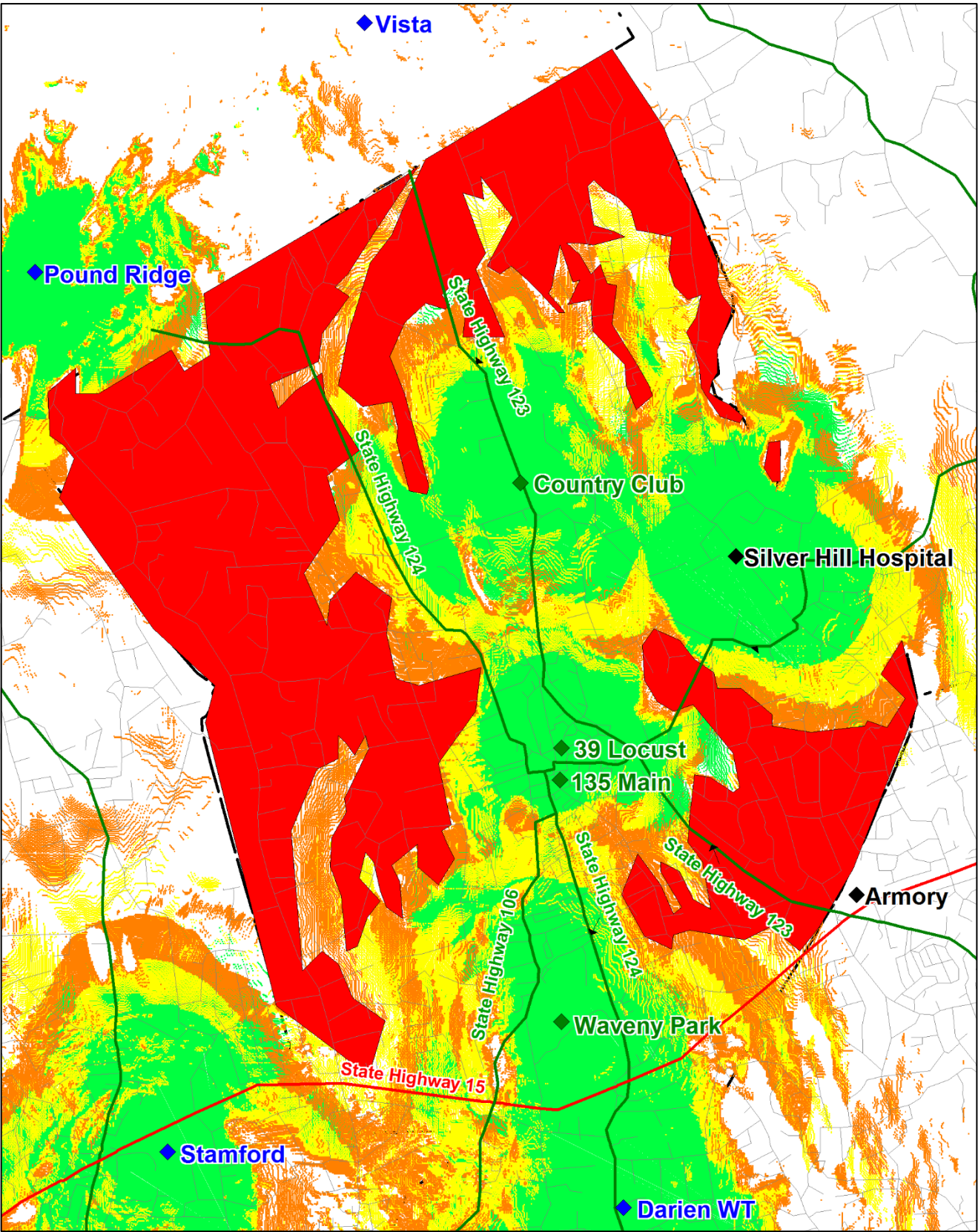




Figure 32: Sprint Baseline Coverage – Active Sites @ 1900 MHz

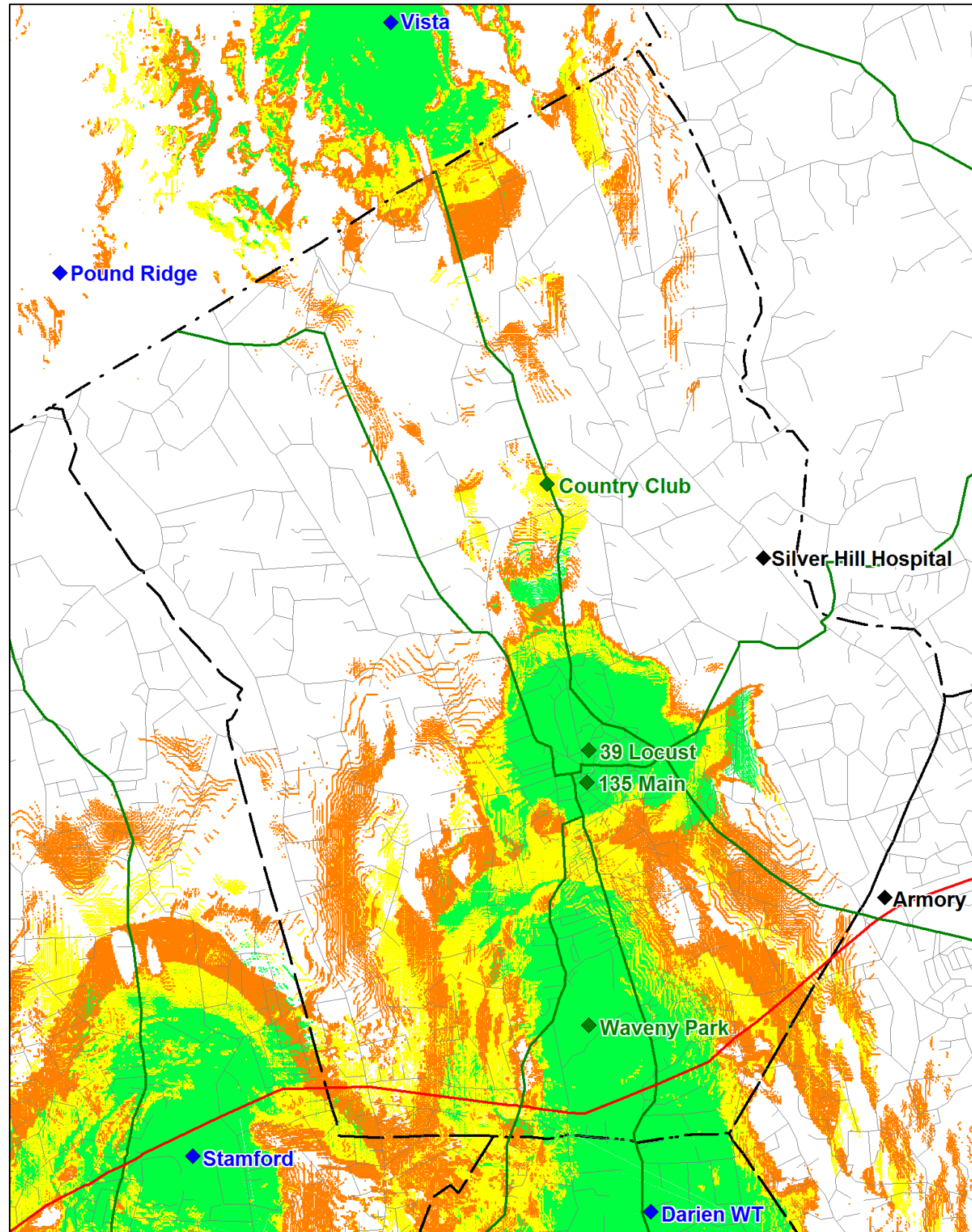
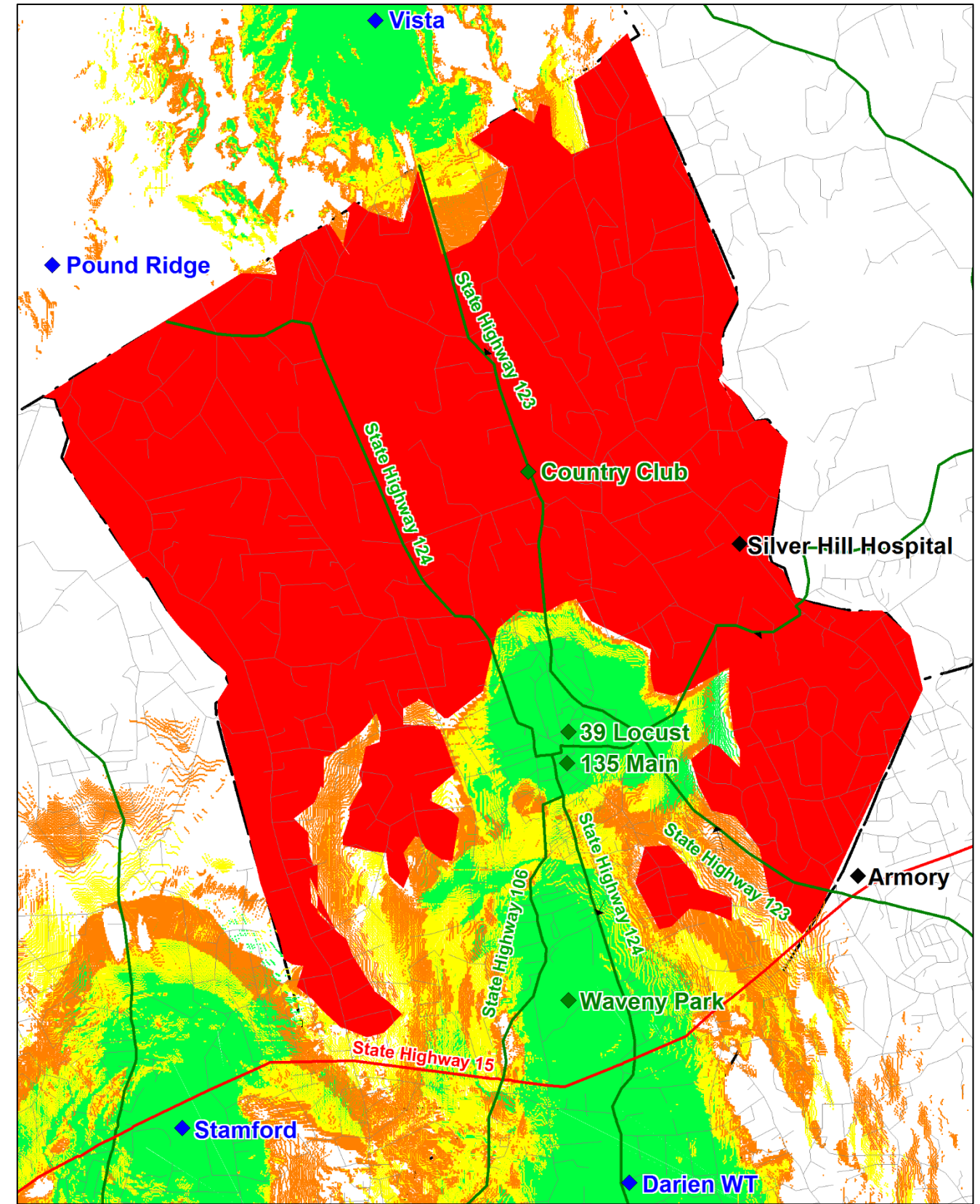


Figure 33: Sprint Baseline Coverage with Major In-Town Gaps





## Possible Candidate Sites

### *Identified Possible Site Locations*

Centerline was presented with 3 Private Property locations and 57 Municipal Property locations to evaluate as potential sites for addressing the identified coverage gaps. The graphics on the following pages overlay the site locations with the different carriers' Coverage Gaps.

Figure 34: AT&T Coverage Gaps Overlaid with Possible Site Locations

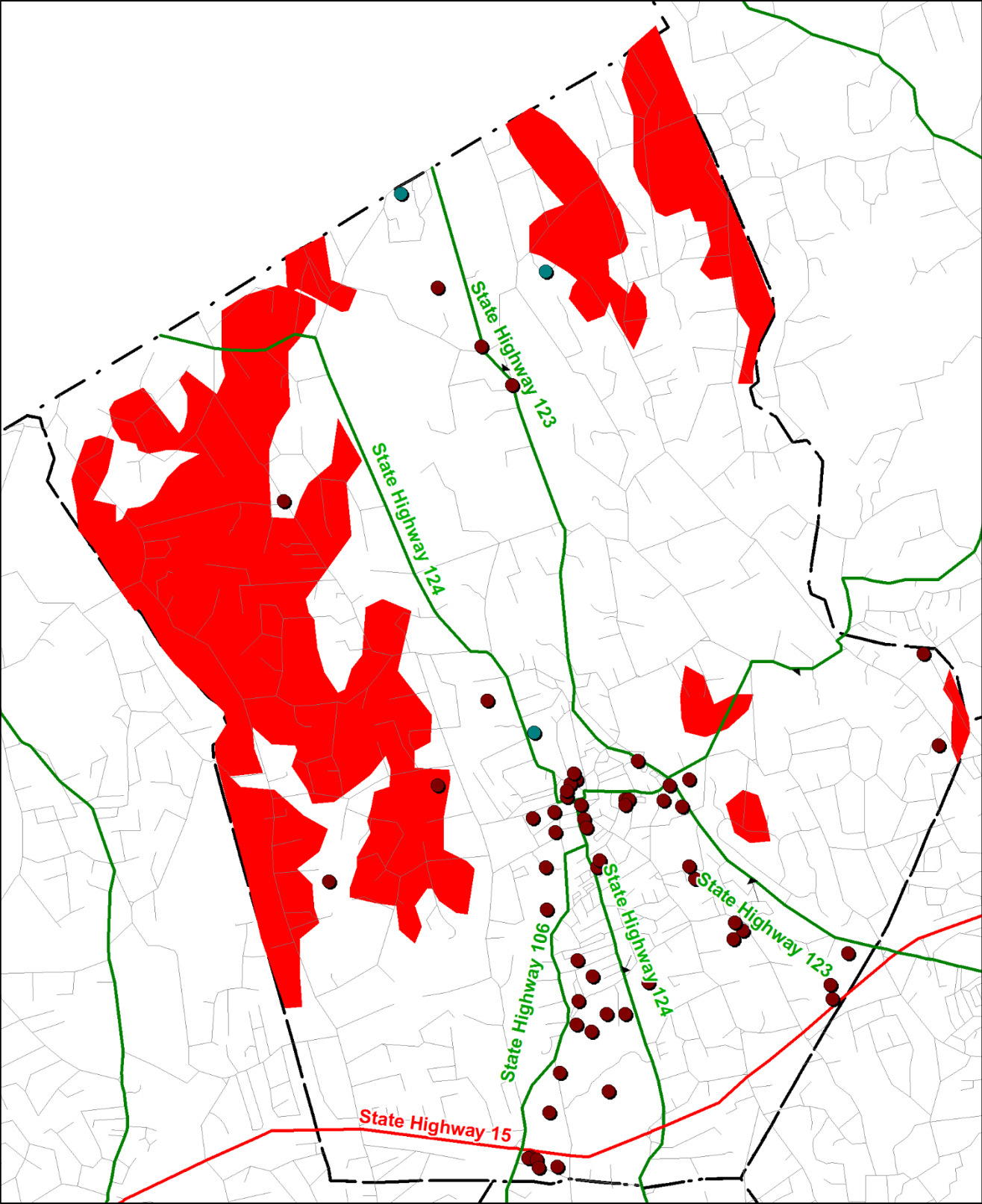
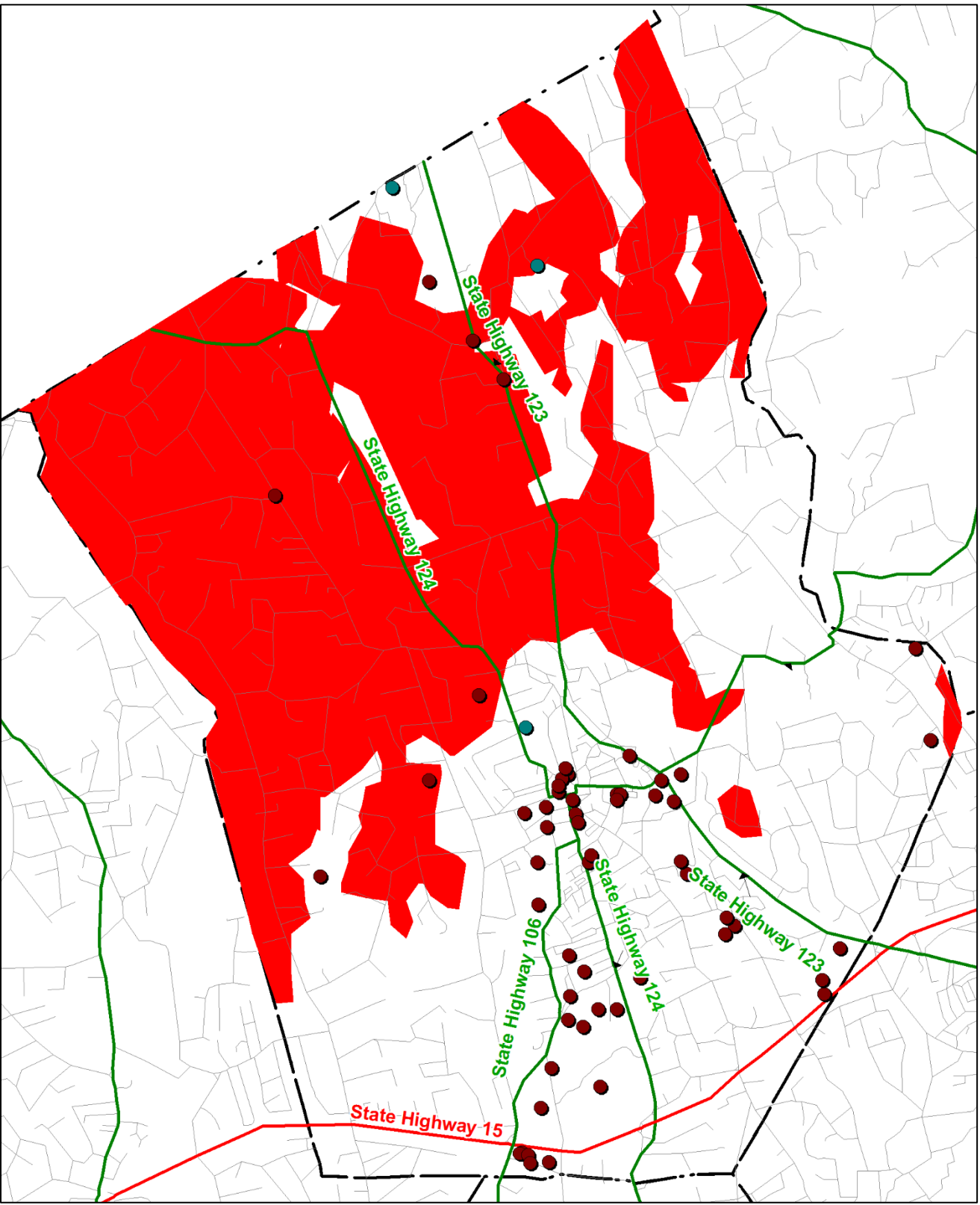
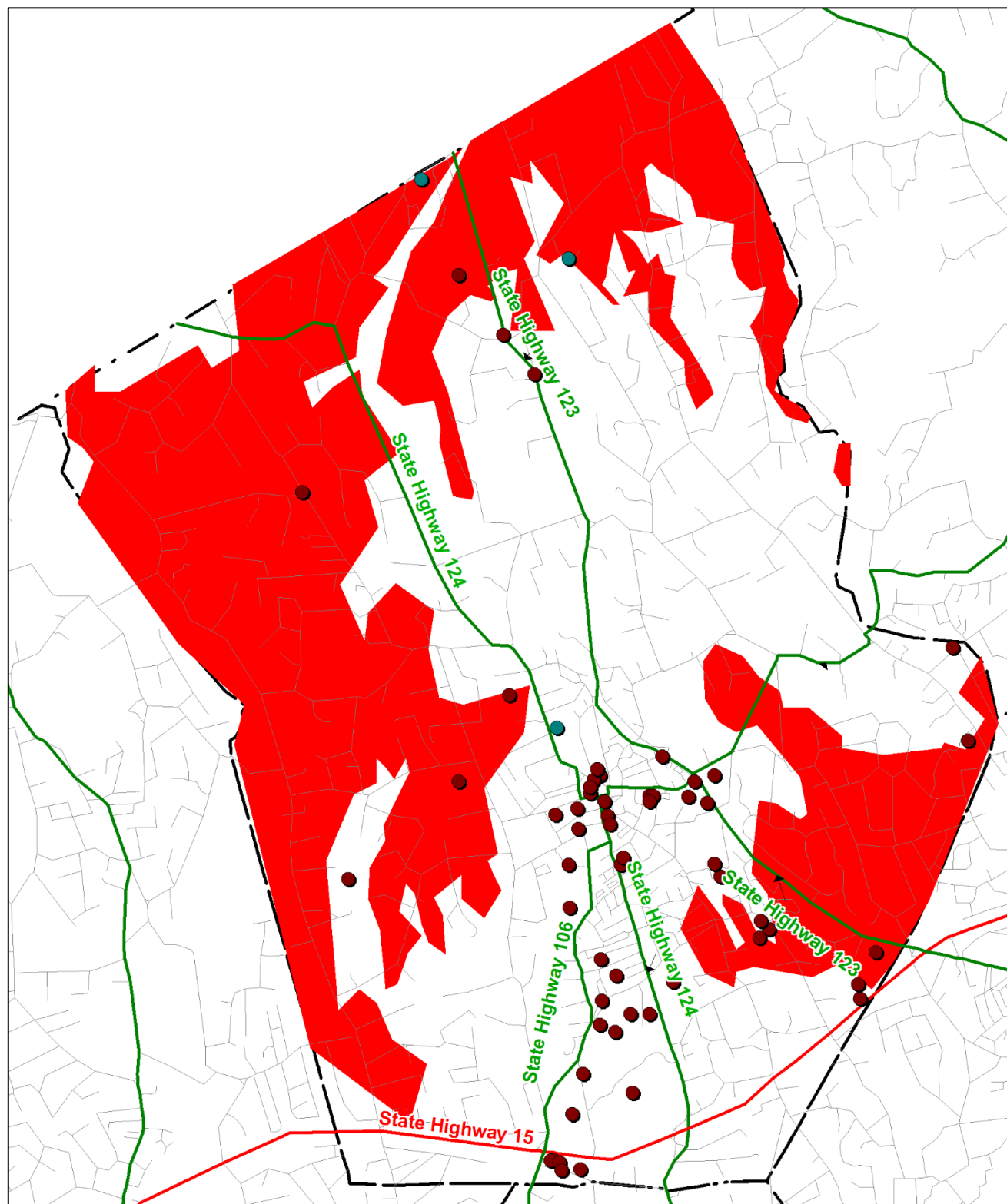


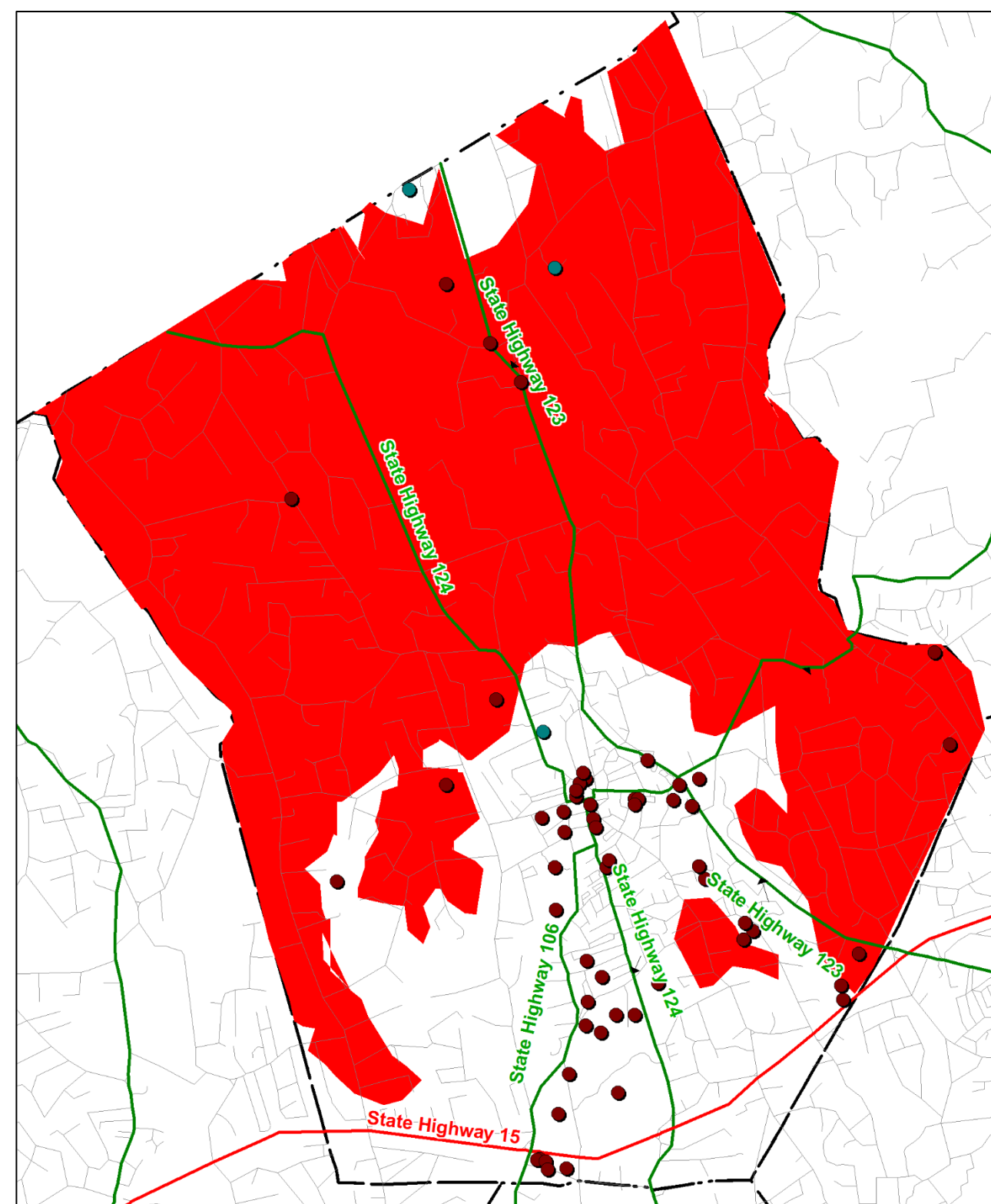
Figure 35: Verizon Coverage Gaps Overlaid with Possible Site Locations



**Figure 36: T-Mobile Coverage Gaps Overlaid with Possible Site Locations**



**Figure 37: Sprint Coverage Gaps Overlaid with Possible Site Locations**



### Identified Likely Site Locations

The sites that are located within the boundaries of the Coverage Gaps are the most likely to be viable cell site locations. Those that are on the perimeter of the Gaps are the next most likely. The sites that fall well outside the Gaps were excluded as candidates. The tables below show each site and its classification. The graphics on the following page show the Most Likely, Next Most Likely and Excluded sites for each carrier labeled on the maps.

Appendix D includes a detailed reference Map and Table of Municipal Properties.

**Table 6: Private Properties Evaluations**

Location Name	Site Classification			
	AT&T	Verizon	T-Mobile	Sprint
St Mark's Bell Tower	Excluded	Next Likely	Next Likely	Next Likely
Grace Church	Excluded	Next Likely	Most Likely	Next Likely
St. Luke's School	Next Likely	Most Likely	Most Likely	Most Likely

**Table 7: Municipal Properties Evaluations**

Site Name	Number	Site Classification			
		AT&T	Verizon	T-Mobile	Sprint
49/114/5 - MILL RD	1	Next Likely	Next Likely	Next Likely	Most Likely
48/116/176 - SILVERMINE RD	2	Next Likely	Next Likely	Most Likely	Most Likely
T/67/723 - 60 MAIN ST	3	Excluded	Excluded	Excluded	Excluded
T/43/823 - 61 MAIN ST	4	Excluded	Excluded	Excluded	Excluded
S/213/M48 - EAST AVE	5	Excluded	Excluded	Excluded	Excluded
T/43/811 - 93 ELM ST	6	Excluded	Excluded	Excluded	Excluded
T/78/613 - HOYT ST	7	Excluded	Excluded	Excluded	Excluded
T/78/619 - SUMMER ST	8	Excluded	Excluded	Excluded	Excluded
T/66/915 - SOUTH AVE	9	Excluded	Excluded	Excluded	Excluded
N/78/643 - HOYT ST	10	Excluded	Excluded	Excluded	Excluded
N/65/97A - 64 MAPLE ST	11	Excluded	Excluded	Excluded	Excluded
37/88/53 - 21 MARVIN RIDGE RD	12	Excluded	Excluded	Next Likely	Next Likely
J/235/H41C - DOUGLAS RD	13	Excluded	Excluded	Excluded	Excluded
42/90/47 - MARVIN RIDGE RD	14	Excluded	Excluded	Next Likely	Next Likely
30/8/4 - TALMADGE HILL RD	15	Excluded	Excluded	Excluded	Excluded
30/8/3 - TALMADGE HILL RD	16	Excluded	Excluded	Excluded	Excluded
34/38/14 - SMITH RIDGE RD	17	Excluded	Excluded	Excluded	Excluded
NC Nature Center	18	Next Likely	Most Likely	Most Likely	Most Likely
S/6/72 - LEDGE AVE	19	Excluded	Excluded	Excluded	Excluded
37/214/3 - 54 LITTLE BROOK RD	20	Next Likely	Next Likely	Next Likely	Next Likely
T/211/876 - 16 LOCUST AVE	21	Excluded	Excluded	Excluded	Excluded
T/43/839 - 77 MAIN ST	22	Excluded	Excluded	Excluded	Excluded
R/213/616 - EAST AVE	23	Excluded	Excluded	Excluded	Excluded
R/213/613 - 186 LAKEVIEW AVE	24	Excluded	Excluded	Excluded	Next Likely
L/17/91 - 198 ELM ST	25	Excluded	Excluded	Excluded	Excluded
L/17/939 - PARK ST	26	Excluded	Excluded	Excluded	Excluded
N/64/929 - 76 SOUTH AVE	27	Excluded	Excluded	Excluded	Excluded



K/139/930 - PARK ST	28	Excluded	Excluded	Excluded	Excluded
K/10/911 - 64 RICHMOND HILL RD	29	Excluded	Excluded	Excluded	Excluded
26/12/167 - WEST SCHOOL	30	Next Likely	Next Likely	Next Likely	Next Likely
N/62/928 - 174 SOUTH AVE	31	Excluded	Excluded	Excluded	Excluded
K/10/H5 - 47 OLD STAMFORD RD	32	Excluded	Excluded	Excluded	Excluded
37/88/12 - 73 OLD NORWALK RD	33	Excluded	Excluded	Most Likely	Most Likely
37/88/58 - 135 OLD NORWALK RD	34	Excluded	Excluded	Next Likely	Next Likely
42/90/66 - NEW NORWALK RD	35	Excluded	Excluded	Most Likely	Most Likely
37/232/13 - 468 SOUTH AVE	36	Excluded	Excluded	Next Likely	Next Likely
J/51/H44A - 68 GOWER RD	37	Excluded	Excluded	Excluded	Excluded
42/90/8 - MARVIN RIDGE RD	38	Excluded	Excluded	Next Likely	Next Likely
31/51/110 - FARM RD	39	Excluded	Excluded	Excluded	Excluded
31/51/114 - FARM RD	40	Excluded	Excluded	Excluded	Excluded
31/51/113 - 11 FARM RD	41	Excluded	Excluded	Excluded	Excluded
1/51/112 - FARM RD	42	Excluded	Excluded	Excluded	Excluded
31/51/111 - 3 FARM RD	43	Excluded	Excluded	Excluded	Excluded
30/51/121 - 677 SOUTH AVE	44	Excluded	Excluded	Excluded	Excluded
30/9/H1 - LAPHAM RD	45	Excluded	Excluded	Excluded	Excluded
30/51/119 - 38 LAPHAM RD	46	Excluded	Excluded	Excluded	Excluded
30/8/2 - TALMADGE HILL RD	47	Excluded	Excluded	Excluded	Excluded
30/8/1 - TALMADGE HILL RD	48	Excluded	Excluded	Excluded	Excluded
30/7/A5 - 272 TALMADGE HILL RD	49	Excluded	Excluded	Excluded	Excluded
Irwin Park	50	Most Likely	Most Likely	Most Likely	Most Likely
L/17/934 - 244 ELM ST	51	Excluded	Excluded	Excluded	Excluded
N/62/927 - 156 SOUTH AVE	52	Excluded	Excluded	Excluded	Excluded
R/82/639 - 394 MAIN ST	53	Excluded	Excluded	Next Likely	Next Likely
Incinerator	54	Excluded	Excluded	Next Likely	Next Likely
W. Road & Dan's Hwy	55	Next Likely	Most Likely	Most Likely	Most Likely
Michigan Rd and Rt 123	56	Excluded	Most Likely	Next Likely	Most Likely
Wydendown Rd and Rt 123	57	Excluded	Most Likely	Next Likely	Most Likely

Figure 38: AT&T Coverage Gaps Overlaid with Likely Site Locations

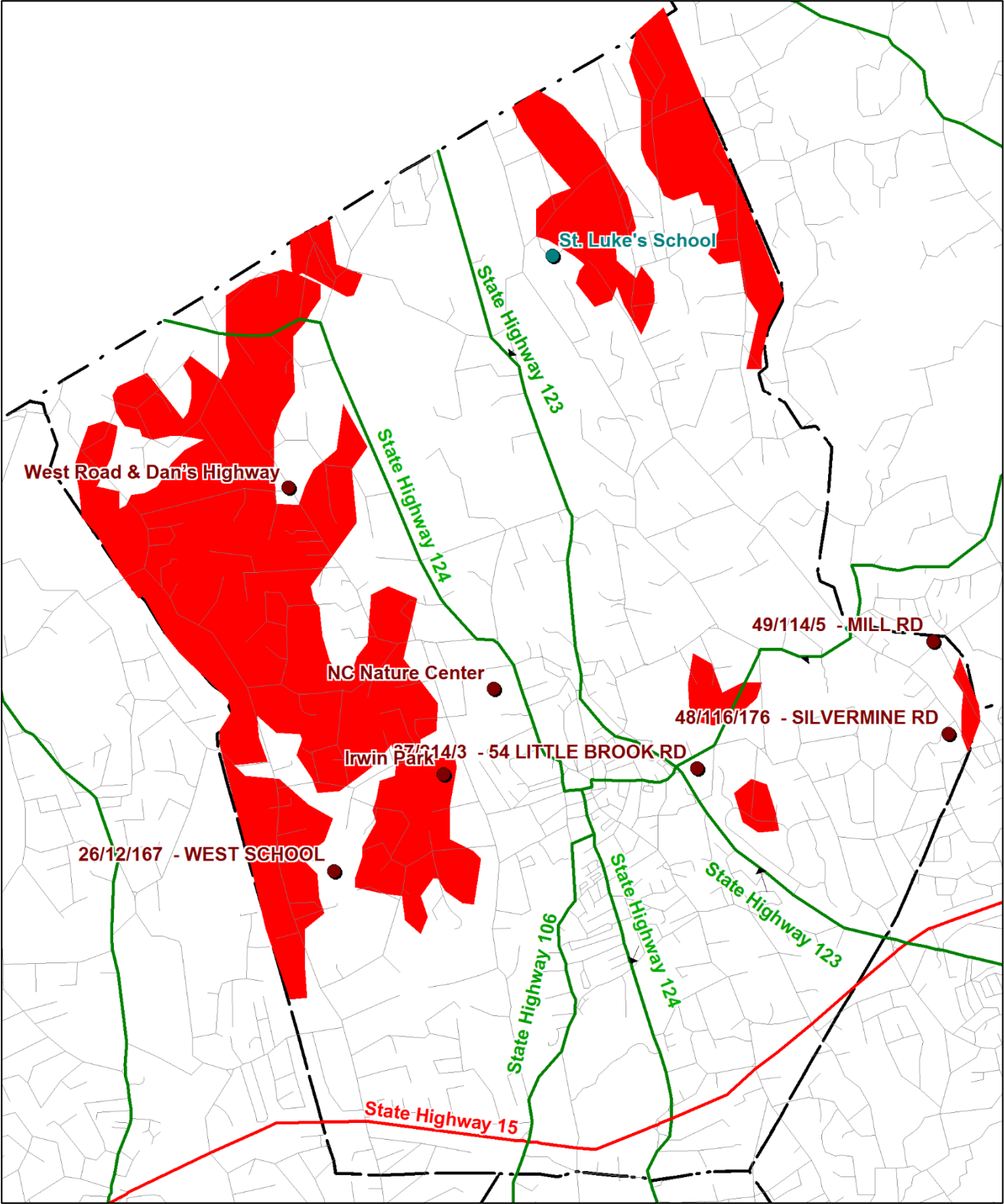


Figure 39: Verizon Coverage Gaps Overlaid with Likely Site Locations

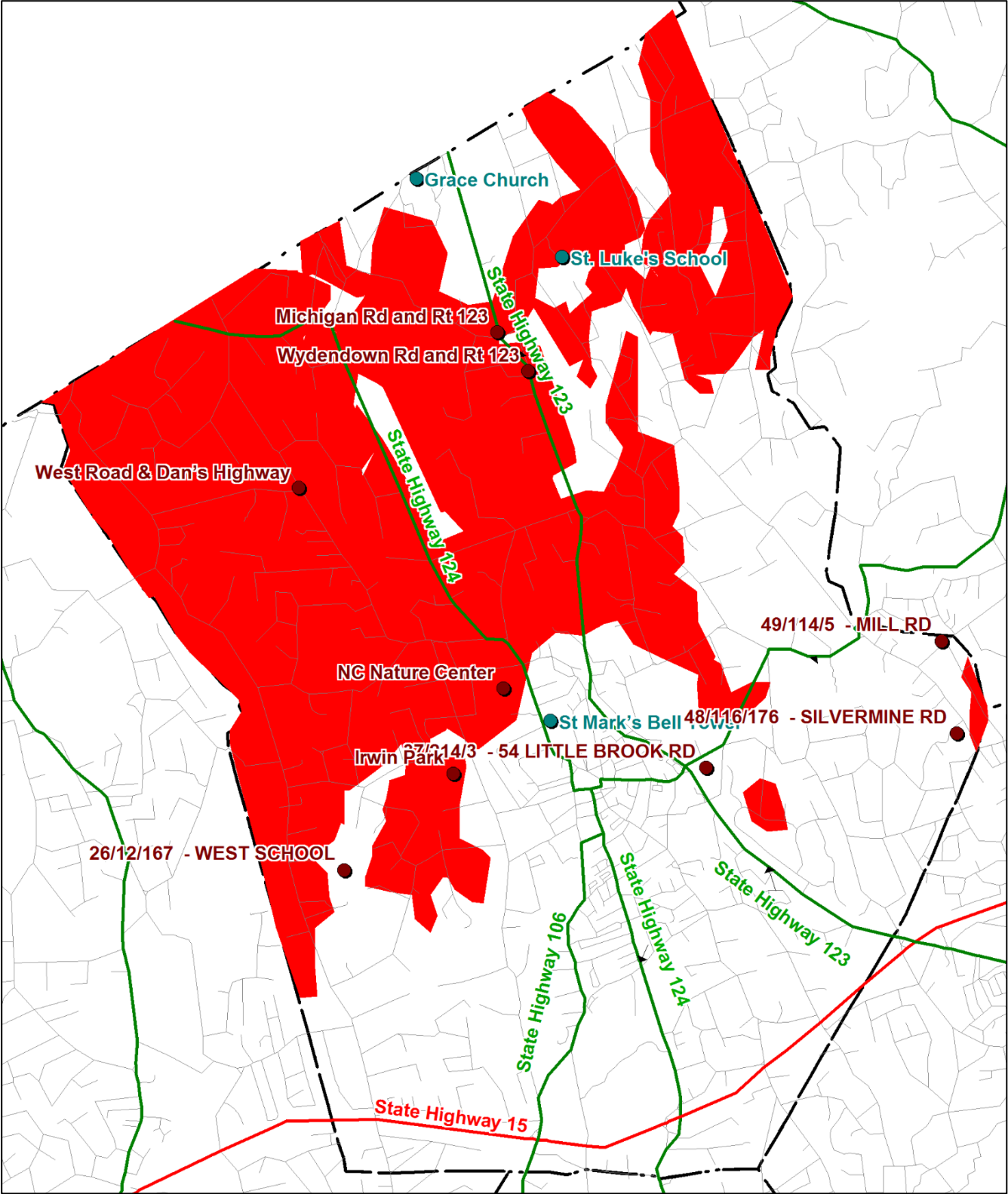


Figure 40: T-Mobile Coverage Gaps Overlaid with Likely Site Locations

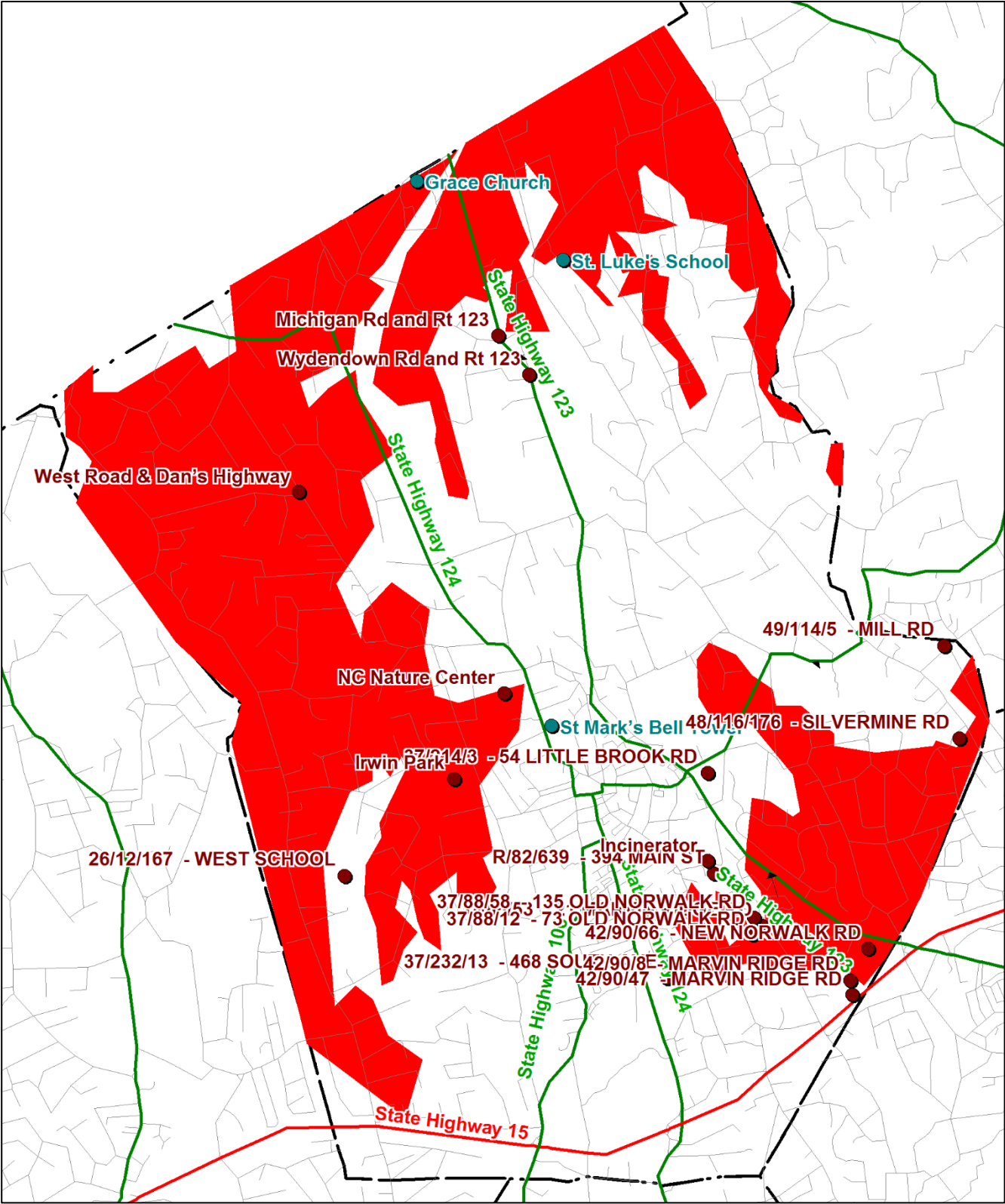
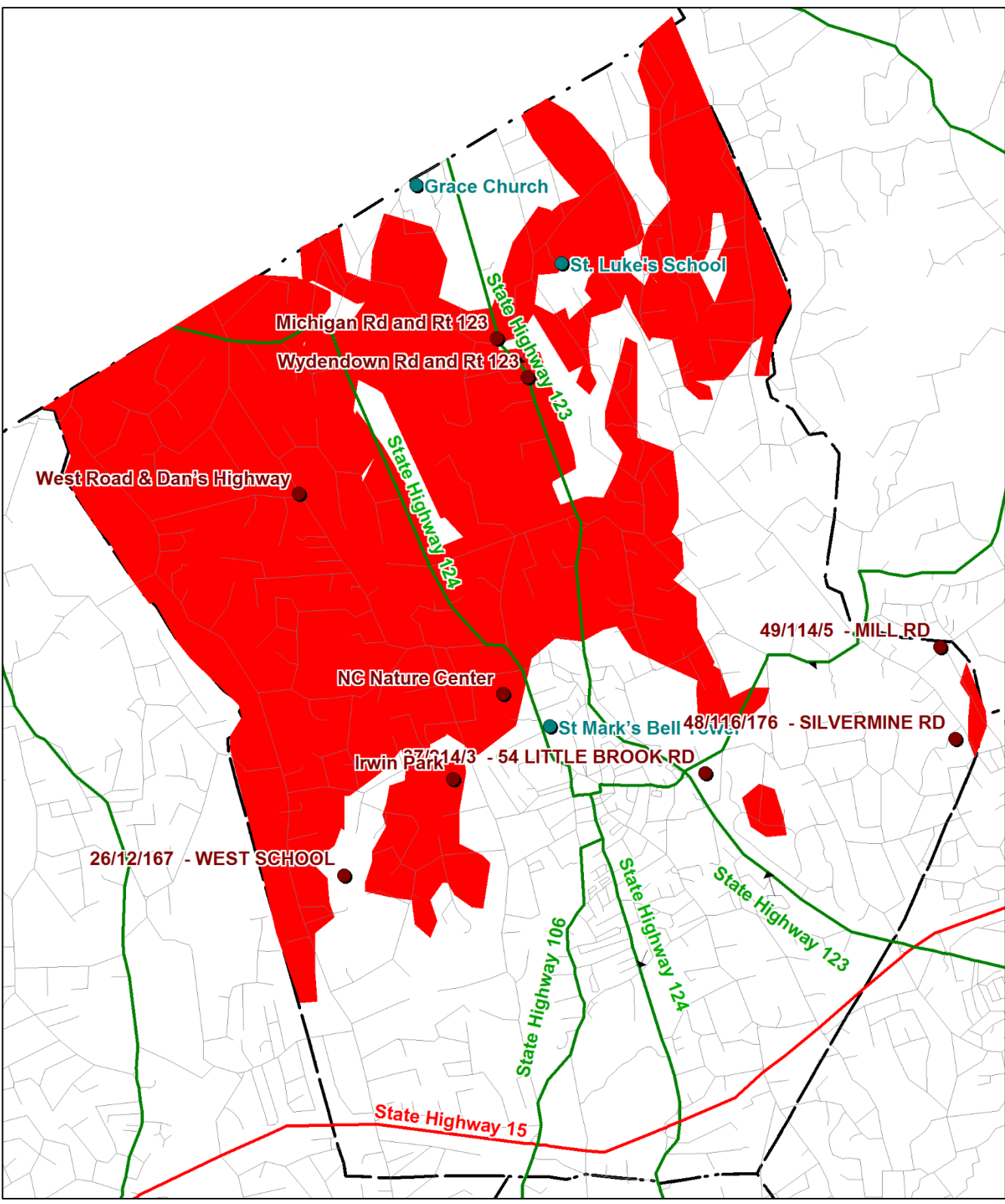


Figure 41: Sprint Coverage Gaps Overlaid with Likely Site Locations



## Site Evaluation Conclusions

Of the 3 Private Property locations provided, all are Most Likely or Next Likely candidates for at least 3 of the carriers. **St. Luke's School** is overall the best Private candidate, being Most Likely or Next Likely for all 4 carriers.

Analysis of the 57 Municipal Property locations provided is summarized as follows:

- 19 are Most Likely or Next Likely candidates for at least 1 carrier
- 18 are Most Likely or Next Likely candidates for at least 2 carriers
- 9 are Most Likely or Next Likely candidates for at least 3 carriers
- 7 are Most Likely or Next Likely candidates for all 4 carriers
- 3 are Most Likely for at least 3 carriers:
  - **NC Nature Center**
  - **Irwin Park**
  - **W. Road & Dan's Hwy**
- Property **Irwin Park** is the overall best Municipal candidate, being Most Likely for all 4 carriers.
- Property **34/38/14 - SMITH RIDGE RD**, could be a Most Likely or Next Likely candidate for all carriers based on its location, but it was previously determined by Verizon to be mostly wetlands.

Detailed analysis using signal propagation predictions will be needed to further qualify each site as a cell site candidate for each carrier.

### *AT&T Conclusions*

For AT&T, one (1) Municipal Property can be considered a Most Likely candidate for a cell site and six (6) as Next Likely candidates.

One (1) Private Property can be considered a Next Likely candidate.

### *Verizon Conclusions*

For Verizon, five (5) Municipal properties are Most Likely candidates and four (4) are Next Likely candidates.

One (1) Private Property can be considered a Most Likely candidate and two (2) as Next Likely candidates.



### *T-Mobile Conclusions*

For T-Mobile, six (6) Municipal properties are Most Likely candidates and twelve (12) are Next Likely candidates.

Two (2) Private Properties can be considered Most Likely candidates and one (1) as Next Likely.

In addition, the Approved site at Armory would be a Most Likely candidate for T-Mobile.

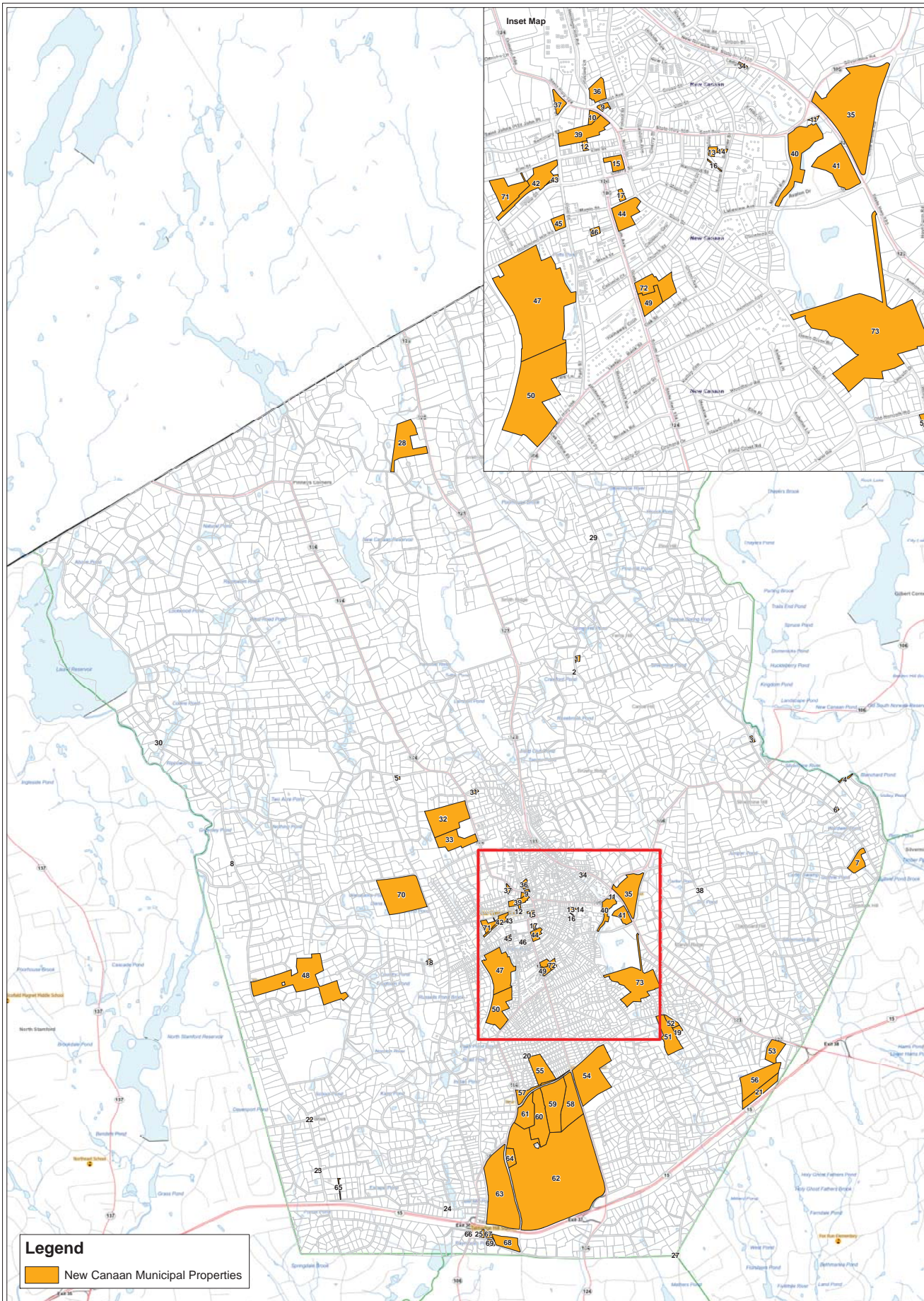
### *Sprint Conclusions*

For Sprint, nine (9) Municipal properties are Most Likely candidates and ten (10) are Next Likely candidates.

One (1) Private Property can be considered a Most Likely candidate and two (2) as Next Likely candidates.

In addition, both Approved sites at Silver Hill Hospital and Armory would be Most Likely candidates Sprint.

## **Appendix D: New Canaan Municipal Property Map**



0 1,500 3,000 4,500  
Feet  
1 in = 1,500 feet  
1:1200



## DRAFT MUNICIPAL PROPERTY MAP

Town of New Canaan  
New Canaan, Connecticut

**Tighe & Bond**  
October 2014