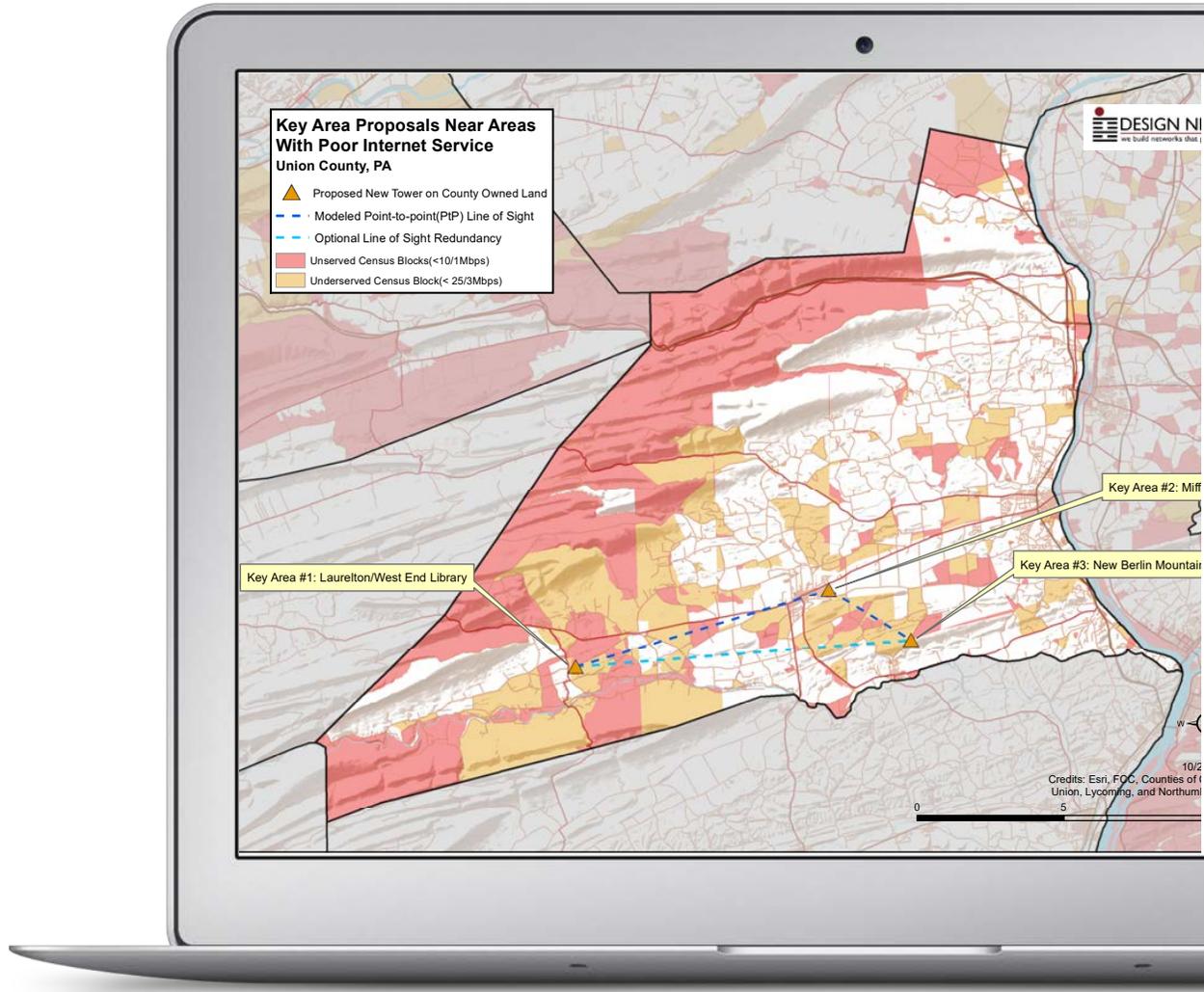


# UNION COUNTY

## Broadband Asset and Service Analysis and Strategies



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### **Disclaimer**

The telecommunications business is continually evolving. We have made our best effort to apply our experience and knowledge to the business and technical information contained herein. We believe the data we have presented at this point in time to be accurate and to be representative of the current state of the telecommunications industry.

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# 1 SUMMARY

A broadband study of Clinton, Lycoming, Northumberland, and Union counties was commissioned by SEDA-COG and completed during the summer and fall of 2019. The study included meetings with stakeholders and interested parties in each county, interviews and meetings with businesses, meetings with county official in each of the four localities, and residential and business broadband surveys.

There are five separate documents that comprise the work:

- **Broadband Assessment and Plan** – This report includes a full summary of the survey results, a discussion of future broadband needs, an analysis of current and future technology systems to deliver broadband and Internet, ownership options for county and/or regional ownership of broadband infrastructure investments, funding and grant options for funding broadband initiatives, and legal and regulatory issues.
- **Clinton County Broadband Asset and Service Analysis and Strategies**
- **Lycoming County Broadband Asset and Service Analysis and Strategies**
- **Northumberland County Broadband Asset and Service Analysis and Strategies**
- **Union County Broadband Asset and Service Analysis and Strategies**

This report on Union County includes:

- **Asset Maps** – Demographic data, tower and fiber assets in the county, underserved and unserved areas of the county, and geo-coded survey results.
- **Service Provider Analysis** – A review of current service provider service offerings, speeds, and prices for those services.
- **Key Area Fixed Point Wireless Projects** – Three underserved areas of the county were identified and a fixed point wireless project for each area is described, including cost estimates and maps.
- **County-wide Fixed Point Wireless Project** – As an appendix, a county-wide fixed point wireless project is described and includes detailed cost estimates and maps. Each of the fiber pilot projects has been located with projected line of sight to a tower in this design.

Union County has a large underserved and underserved area (as designated using Federal Communications Commission) data in the western and southern part of the county. The eastern part of the county is largely served, but has many pockets of underserved and unserved areas. These pockets of underserved and unserved are likely to get improved service over time from the incumbents as they build out incrementally at the edges of their existing network. In the more rural western area of the county, fixed point wireless broadband is going to be an important strategy for improving Internet service for some years.

The County government should not become an Internet provider. Instead, it should focus on developing public/private partnerships by making targeted investments in basic broadband infrastructure like towers and dark fiber. These assets have long life spans of forty years or more and can be leased out to private sector ISPs (Internet Service Providers). While the revenue from the lease agreements will be modest, the funds generated can be used to support maintenance of this infrastructure.

The Federal government has been steadily increasing the amount of grant funding available for broadband infrastructure, with USDA and HUD both having programs that are designed to help underserved and unserved areas construct new broadband infrastructure. As noted above, the Broadband Assessment and Plan document has much more information on these grant programs and other potential sources of funding, including strategies for funding infrastructure with local sources of funds.

## 2 UNION COUNTY ASSETS

A wide variety of assets in Union county are identified in the following pages.

The included maps provide detail on the following:

**Points of Interest** – This information is used to identify key users of Internet services that could benefit from improved broadband infrastructure in the county. K12 schools, public safety facilities, fire and rescue locations, health facilities, and county facilities are included.

**LMI/HUD Areas** – Low and Moderate Income (LMI) and HUD-eligible areas often qualify for certain kinds of grants not available to other areas.

**Towers** – Of particular importance are towers, which can be divided approximately into two categories: publicly owned towers and privately owned towers. As a general rule, WISPs (Wireless Internet Service Providers) have found that the lease fees to obtain space on cellular towers is too high to justify the expected revenue from broadband Internet customers in the area around that tower. To improve broadband Internet coverage in rural areas of the four counties, some new towers are going to be needed, with very modest lease fees—to attract WISPs onto those towers.

The fixed point wireless network designs make the assumption that as a general rule, access to space on the cellular towers is too expensive, and so some new towers will be needed even where there may be an existing privately owned tower. If funding is developed for one or more of the county-wide wireless networks (or a portion of one of the county-wide networks), an early and important step would be to assess space availability on existing towers where the design has specified a tower. If some existing towers can be used rather than building a new tower, there would be significant cost savings.

**Fiber Routes** – In most areas of all four counties included in the study, fiber routes are typically long haul routes passing through the county to other major metro areas and/or connecting only a few institutional and enterprise customers. They are typically not designed to support fiber to the home or business.

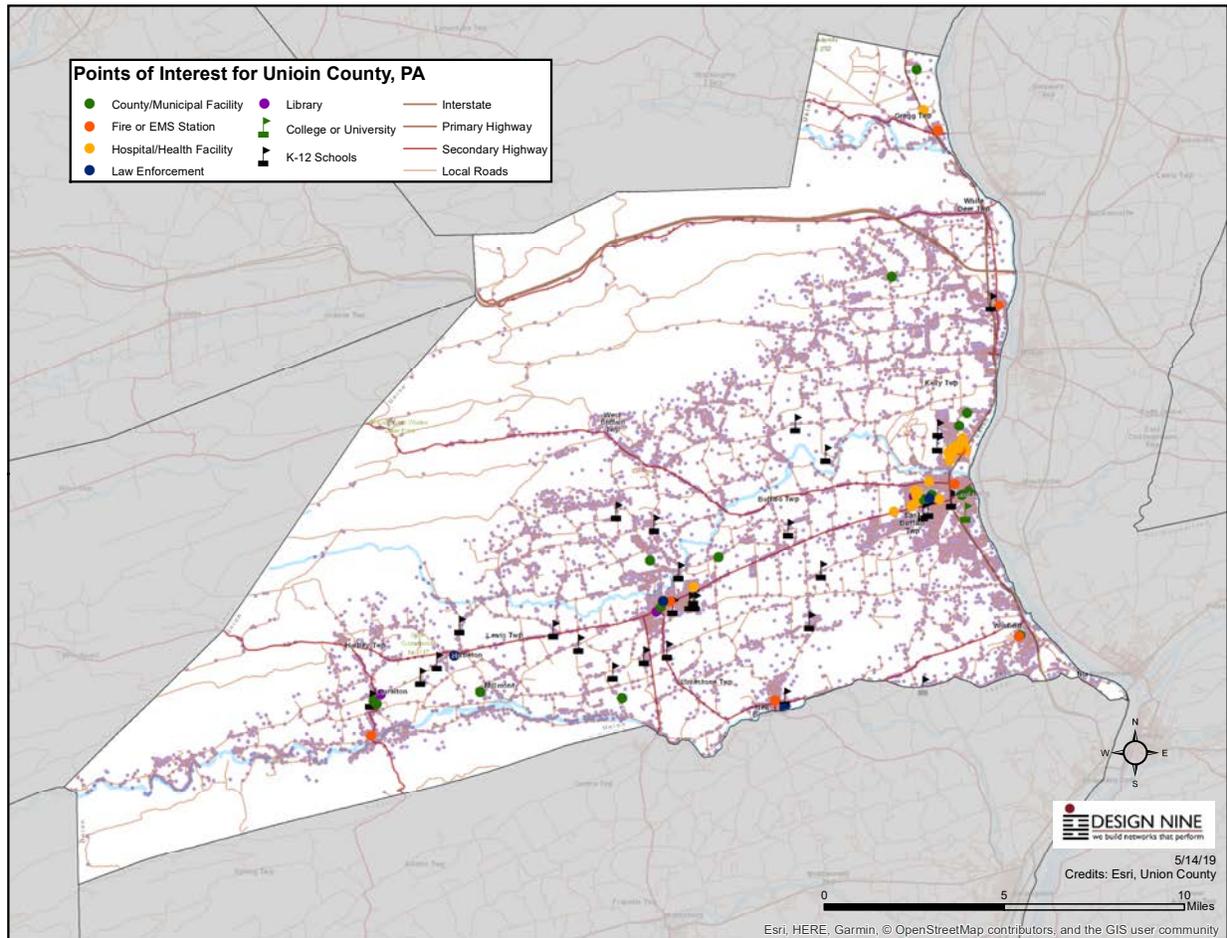
**Service Levels** – This map illustrates information on served, underserved, and unserved areas in the county obtained from FCC 477 reports. The data is self-reported by the service providers.

**Survey Satisfaction and Speed** – These maps show residential and business customer satisfaction and Internet speed data collected from the broadband survey conducted as part of the study. A complete summary of all data collected by the residential and business survey is contained in the separate Broadband Recommendations report.

**Penn State Speed Test Results** – A Penn State research project has collected speed test data submitted by Pennsylvania residents and businesses for several years. The charts in this sub-section show the median upload and download speeds (Megabits/second).

## 2.1 POINTS OF INTEREST

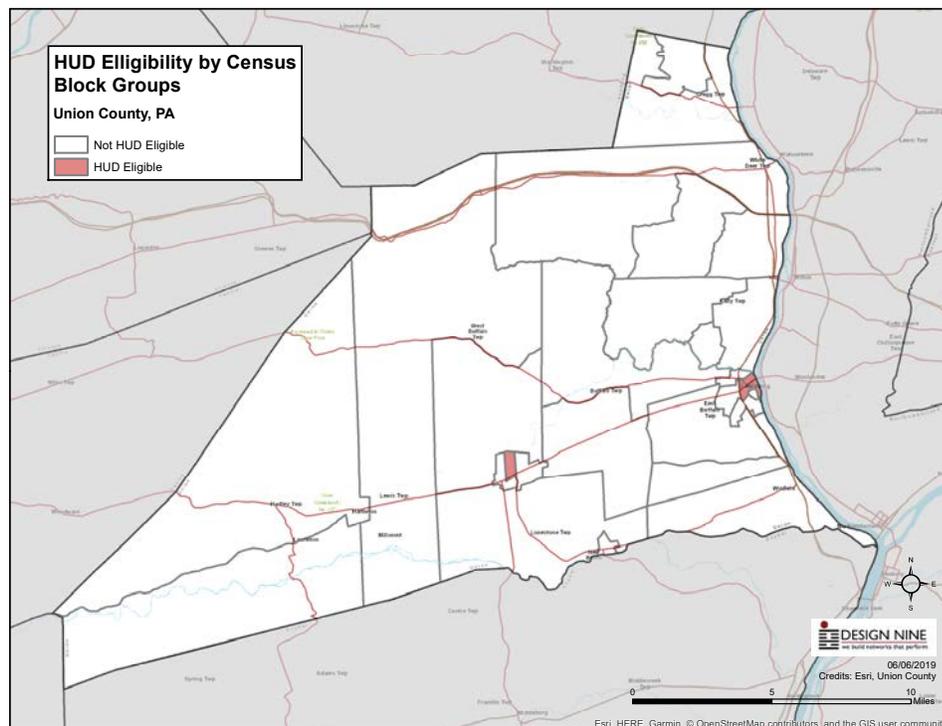
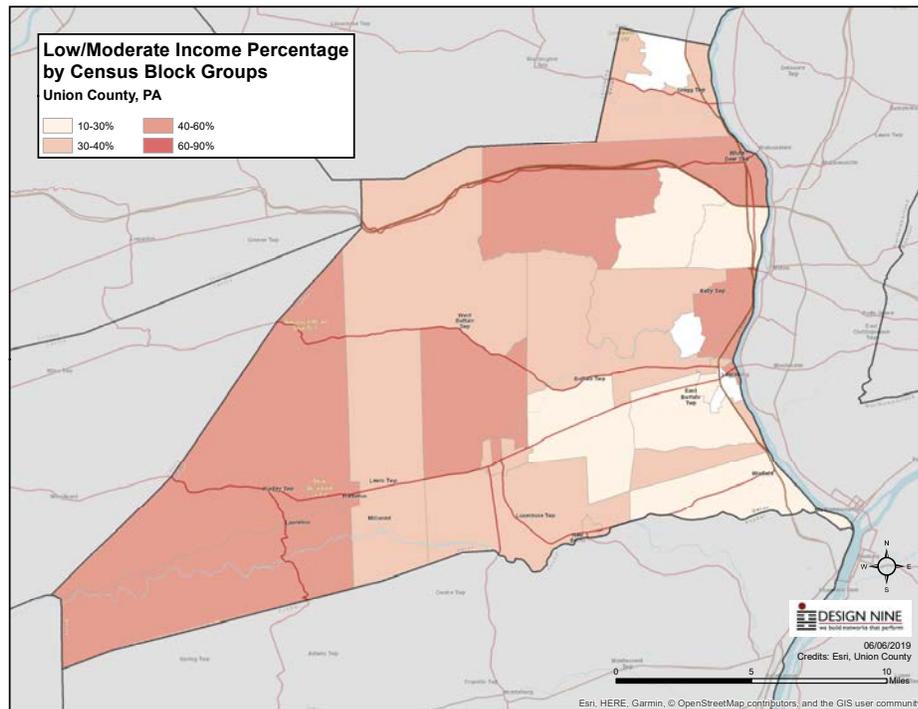
County facilities, municipal facilities, libraries, K12 and higher education facilities, fire and rescue stations, and public safety locations are all candidates to be anchor tenants for fixed point wireless and/or fiber services.



## 2.2 LMI AND HUD ELIGIBLE AREAS

HUD-eligible areas are determined by LMI (Low and Moderate Income) statistics—but can be different from census blocks in the county that meet LMI thresholds.

**HUD-eligible census blocks can qualify for CDBG funding for telecom infrastructure projects.**



## 2.3 TOWERS IN THE COUNTY

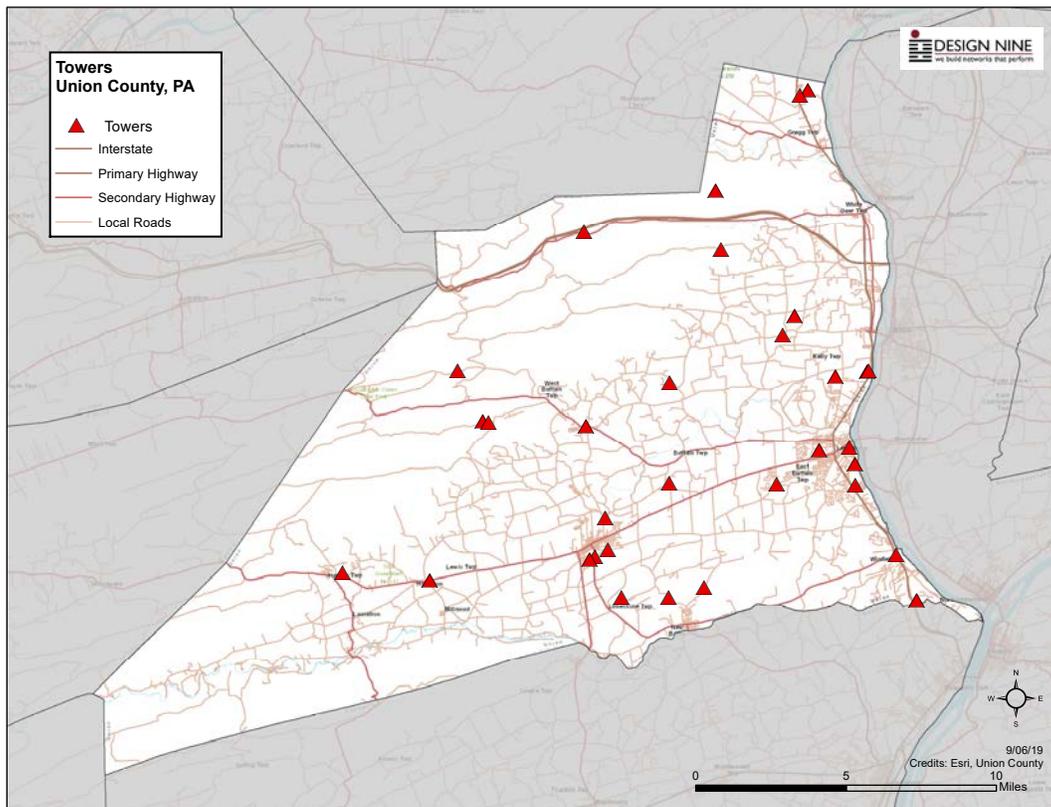
A variety of publicly-owned and privately owned towers are shown here. Tower data is collected from an FCC database, County data, and other publicly available sources. The FCC database usually includes most towers that are in a locality, and generally includes all or nearly all cellular towers.

Towers can be divided approximately into two categories: publicly owned towers and privately owned towers. Publicly owned towers can be owned by local government, by regional authorities, or by the state. In the county, privately owned cellular towers are the most common type of tower, and are generally clustered along major roadways and higher density population areas.

Many commercial towers, especially cellular towers, may have tower lease fees that are too high for a WISP (Wireless Internet Service Provider) to make a business case for putting fixed point broadband equipment on the tower. The cost to a WISP for getting on a privately owned tower often has to be checked on a case by case (tower by tower) basis.

To improve broadband Internet coverage in rural areas of the county, some new towers are going to be needed, with very modest lease fees—to attract WISPs onto those towers.

A second consideration for placing WISP equipment on a cellular tower is where space is available—that is, at what height? Space may be available at an affordable price, but the location on the tower may not be high enough to cover an area large enough for a decent number of customers. In Union County, neither the County nor the FCC database provided any ownership information.

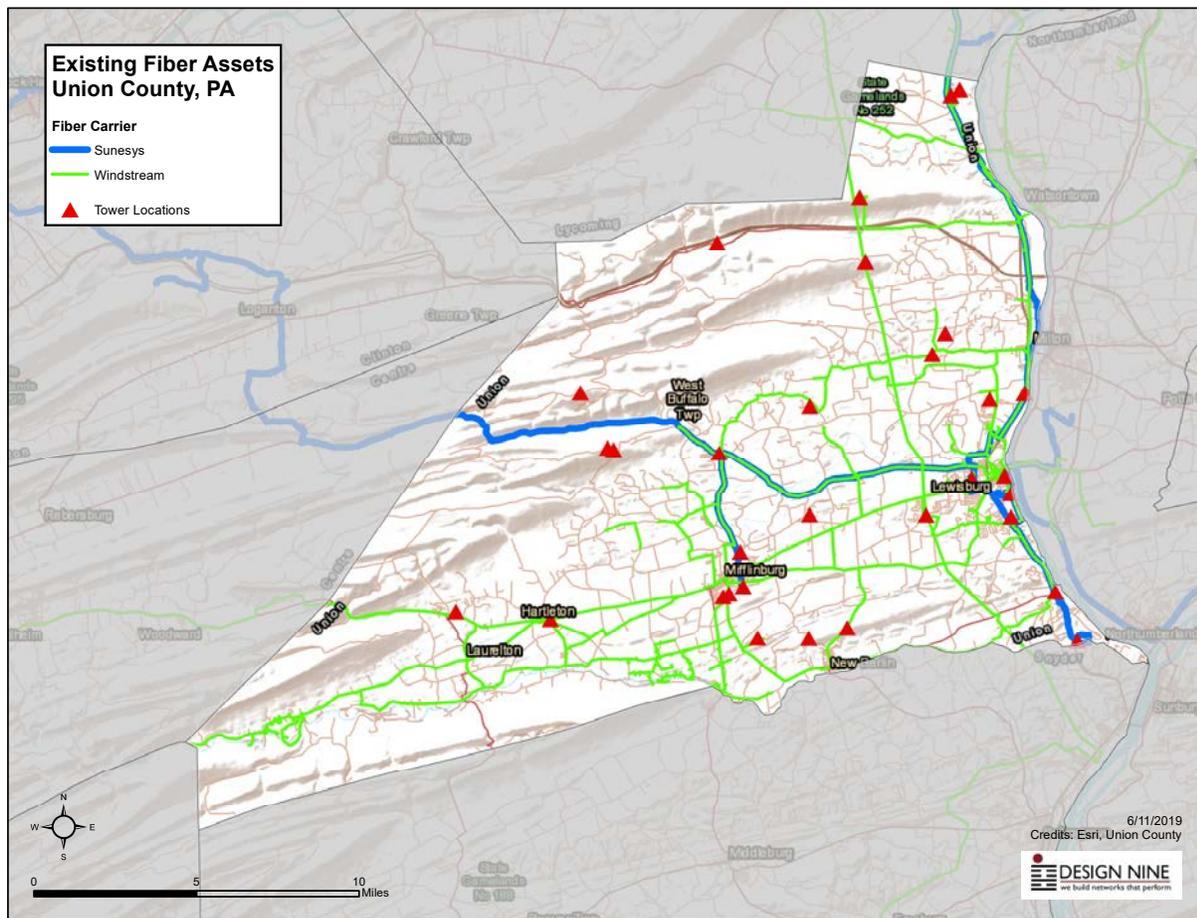


NAME	Ownership	Latitude	Longitude	Height Estimate (meters)
Union County Tower Site	Union County	40.89593755140	-76.97569454250	60
Union County Government Center Tower	Union County	40.96199625980	-76.90158948040	40
Union County Court House Tower	Union County	40.96302273740	-76.88235236250	36
Sand Mountain Tower Site	Private, Not Specified	41.00180499440	-77.13118559530	100
Cellular Tower	Private, Not Specified	40.91149727060	-77.04470924500	35
Nittany Mountain Tower Site	Private, Not Specified	41.05899432260	-76.96295093400	76
Cellular Tower	Private, Not Specified	40.91110506520	-76.85329853030	35
Cellular Tower	Private, Not Specified	40.88911834790	-76.84066773640	56
Cellular Tower	Private, Not Specified	41.13561406390	-76.90659959230	70
Cellular Tower	Private, Not Specified	40.94580890680	-76.92880812860	35
Cellular Tower	Private, Not Specified	40.91026465230	-77.04818951580	46
WVMC Mifflinburg Tower	Private, Not Specified	40.91461350180	-77.03648810630	35
Cellular Tower	Private, Not Specified	40.97439124460	-77.04986979860	55
Cellular Tower	Private, Not Specified	40.99735261530	-76.89074554370	50
Cellular Tower	Private, Not Specified	41.01752025290	-76.92423679810	45
Cellular Tower	Private, Not Specified	40.90072043960	-77.14965973750	40
Cellular Tower	Private, Not Specified	40.99503409530	-76.99634313760	59
Cellular Tower	Private, Not Specified	40.90444874560	-77.20510013840	40
Cellular Tower	Private, Not Specified	40.89175402490	-77.02814784890	91
Cellular Tower	Private, Not Specified	41.08763398840	-76.96613671100	54
Cellular Tower	Private, Not Specified	40.89147114600	-76.99820184340	20
Cellular Tower	Private, Not Specified	40.94636648460	-76.99713182410	50
Cellular Tower	Private, Not Specified	40.97718864470	-77.11546910730	43
Cellular Tower	Private, Not Specified	41.02681355990	-76.91641025580	45
Bucknell Stack	Private, Not Specified	40.95500239590	-76.87881429530	20
Sunbury Broadcasting Corp. North Lewsiburg no.1	Private, Not Specified	40.99966224850	-76.87044296960	62
Sunbury Broadcasting Corp. North Lewsiburg no.2	Private, Not Specified	40.99995553620	-76.86972009270	50
WGRC Tower	Private, Not Specified	40.94461948640	-76.87883486460	127
Not Provided	Private, Not Specified	40.97632647230	-77.11195092030	43
Not Provided	Private, Not Specified	41.06812305110	-77.05002001120	40
Not Provided	Private, Not Specified	40.92997217690	-77.03795506660	40

## 2.4 FIBER ROUTES IN THE COUNTY

Fiber route data is compiled from publicly available sources. Some telecom providers do not share their route data.

Most fiber routes, not only in the county but throughout the country have been designed as long haul point to point fiber routes between population centers. This means that even if a fiber cable passes down a rural road or a residential area, it has not been designed for residential or small business fiber to the premises.



## 2.5 SERVED, UNDERSERVED, AND UNSERVED AREAS

The areas on the map below have been identified using FCC (Federal Communications Commission) 477 data. Service providers, including incumbent telephone and cable companies, file a 477 report with the FCC to identify where their service is available and at what speed, using the FCC designations:

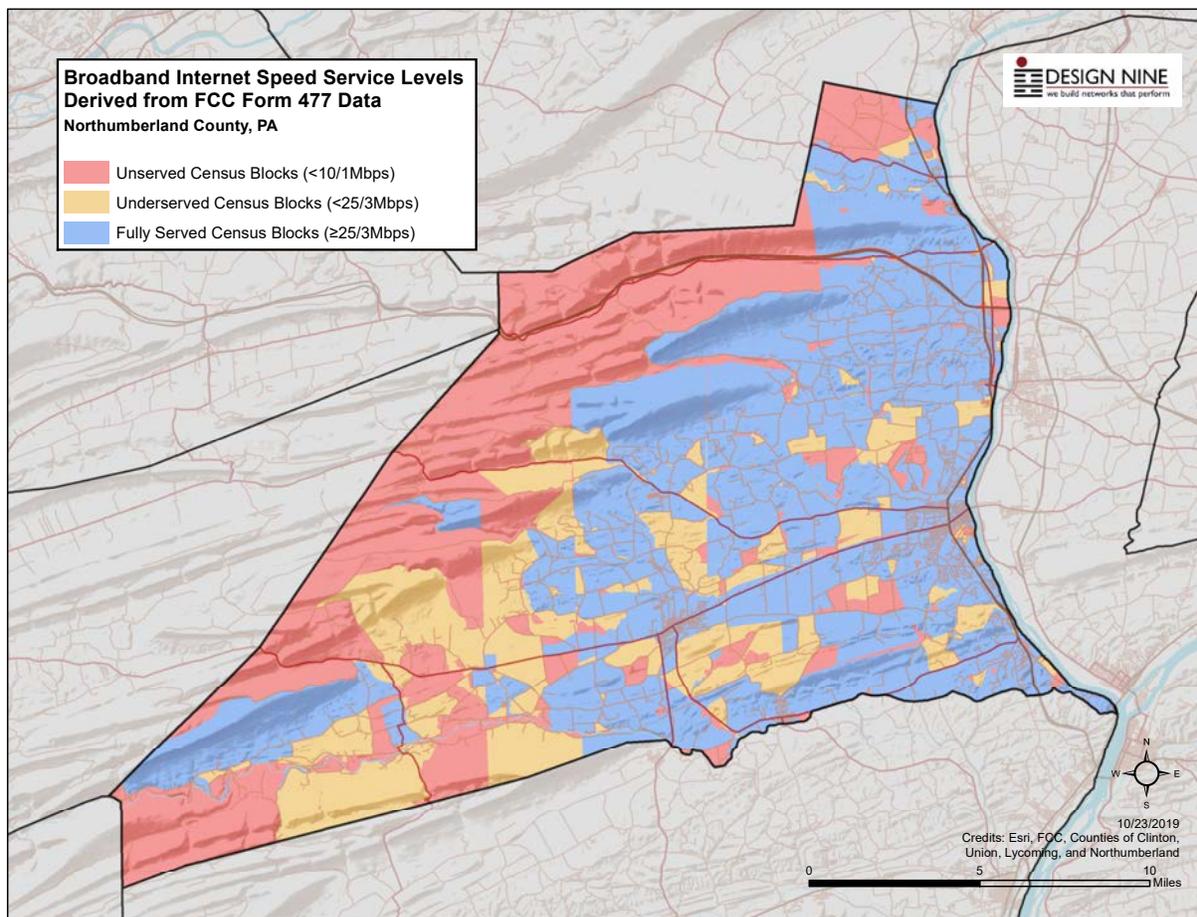
**Unserved** – Less than 10 Megabits down/1 Megabit up

**Underserved** – At least 10 Megabits down/1 Megabit up and less than 25 Megabits down/3 Megabits up

**Served** – Equal to or better than 25 Megabits down/3 Megabits up

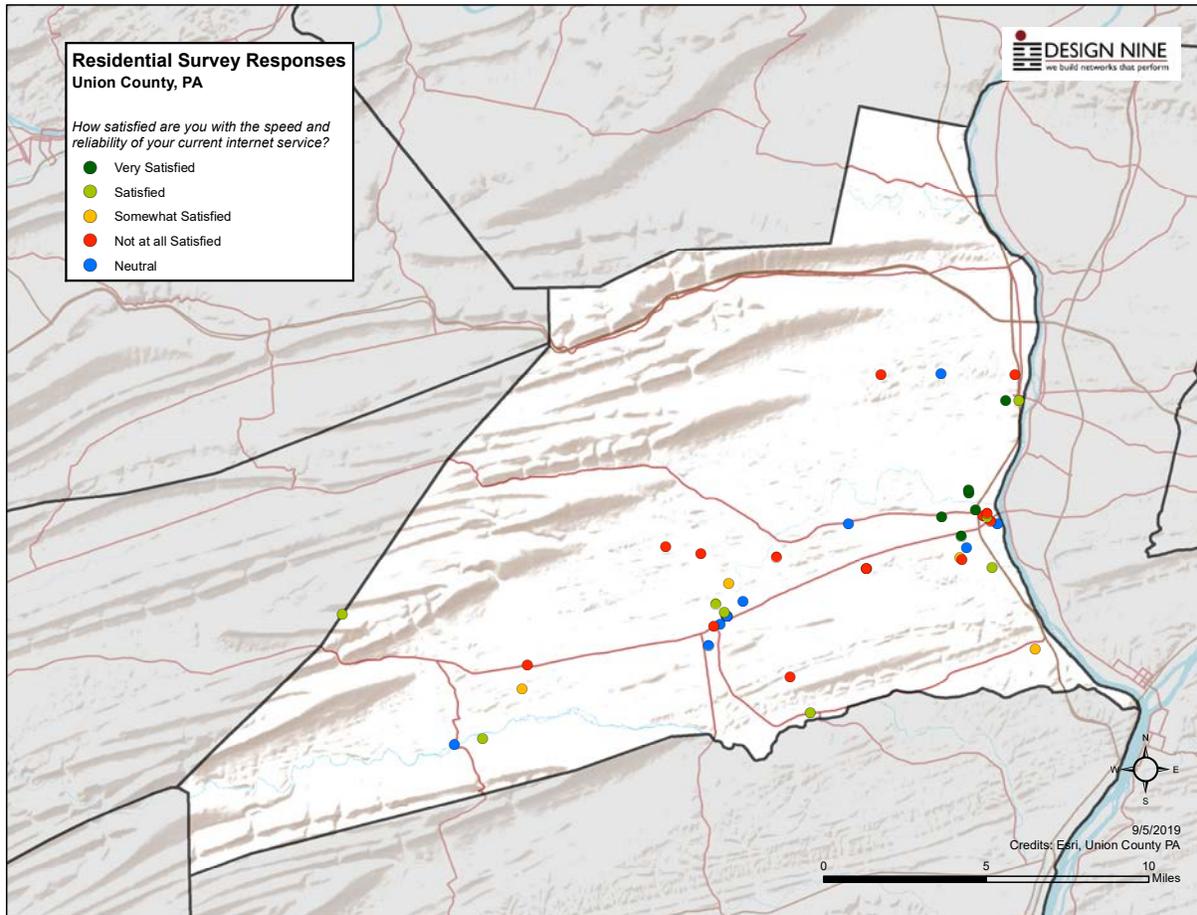
There are two problems with the 477 data:

- The data is self-reported by the providers, who typically report their most optimistic Internet speeds. In practice, customers may not always get the reported speeds.
- A single customer receiving service in a census block means that the provider can indicate that the entire census block is counted. So if one household receives 25/3 service, all households in that census block are counted as receiving that level of service.



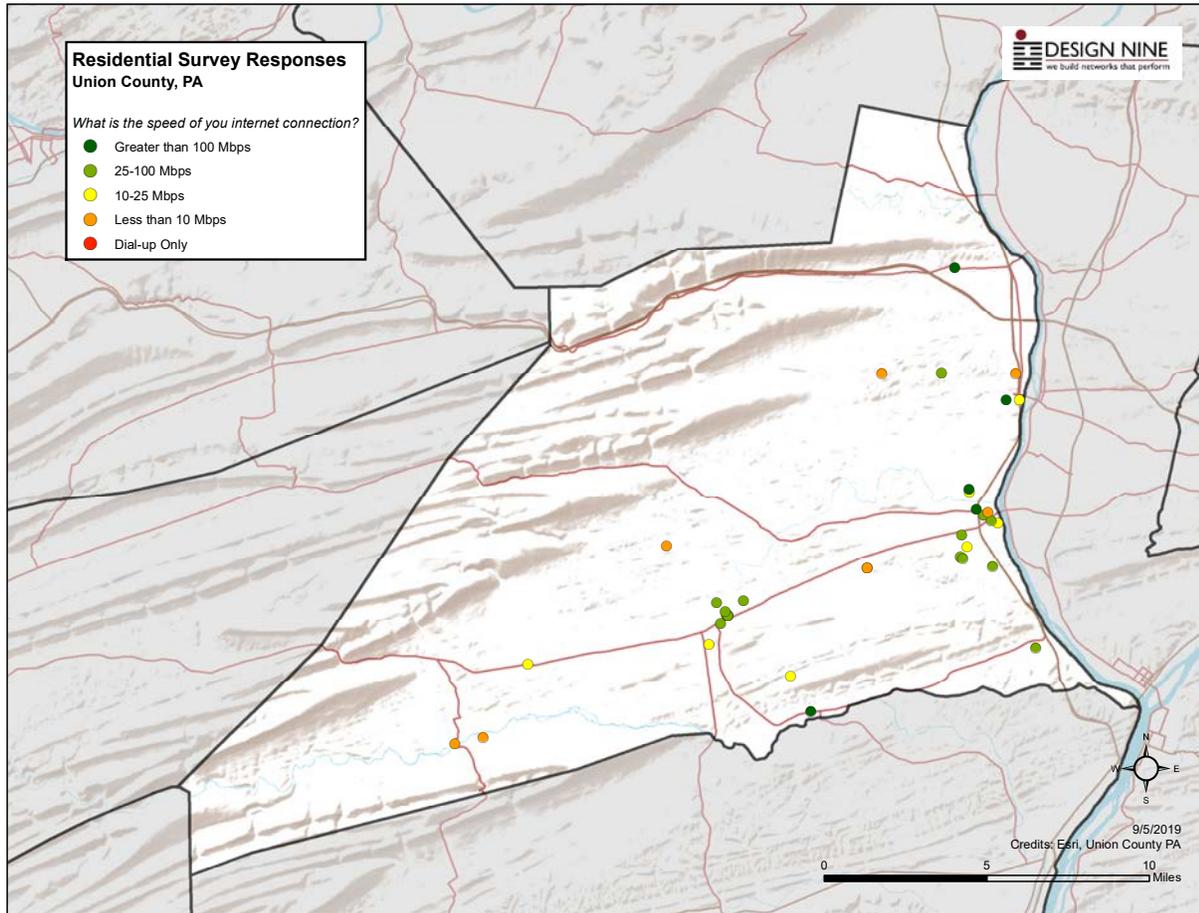
## 2.6 RESIDENTIAL SERVICE SATISFACTION FROM SURVEY DATA

The data plotted on the map below are the residential responses collected from the survey conducted as part of the broadband study. A large percentage of respondents are not at all satisfied with their current Internet service.



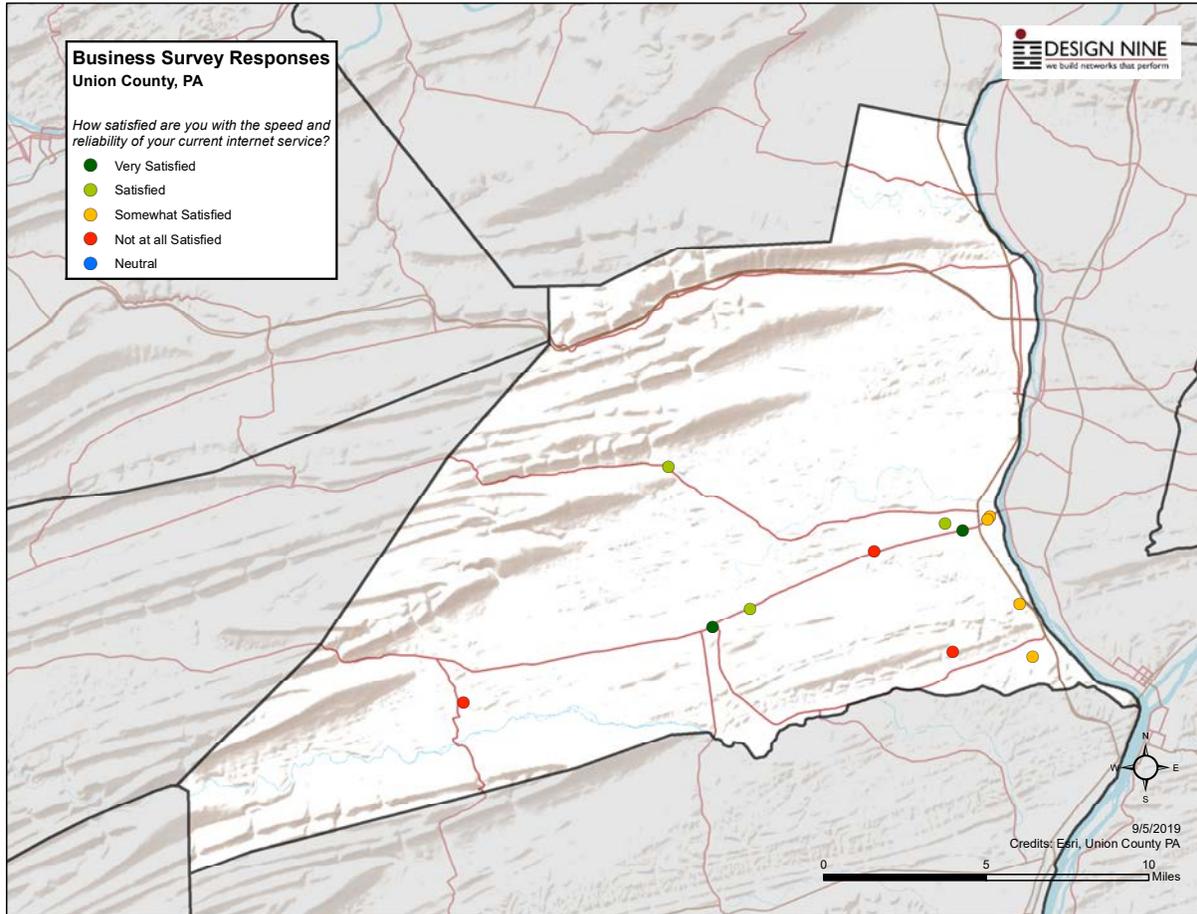
## 2.7 RESIDENTIAL INTERNET SPEED FROM SURVEY DATA

The data plotted on the map below are the residential responses collected from the survey conducted as part of the broadband study. A large percentage of respondents have reported speeds less than 10 Megabits down, or in the FCC classification, "unserved."



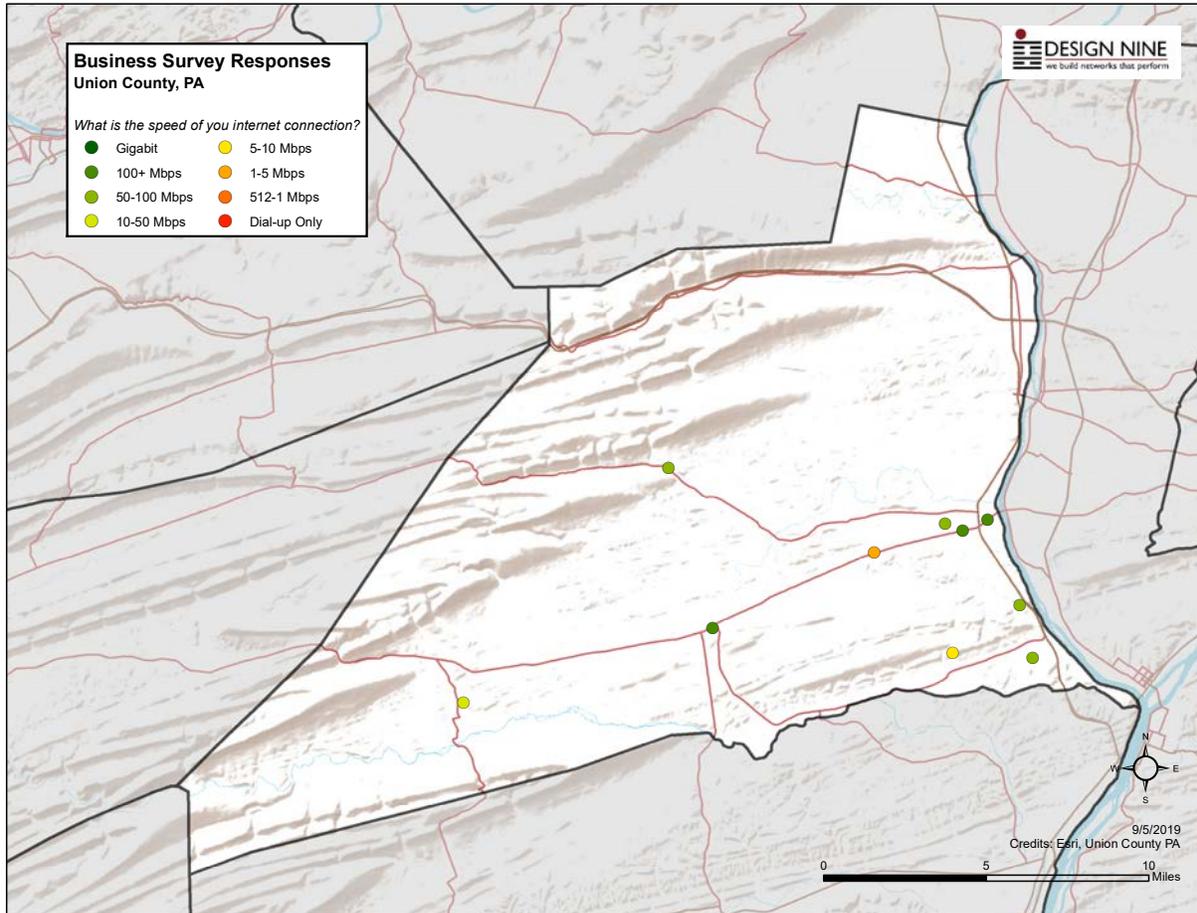
## 2.8 BUSINESS SERVICE SATISFACTION FROM SURVEY DATA

The data plotted on the map below are the business responses collected from the survey conducted as part of the broadband study. A mix of responses were received.



## 2.9 BUSINESS INTERNET SPEED FROM SURVEY DATA

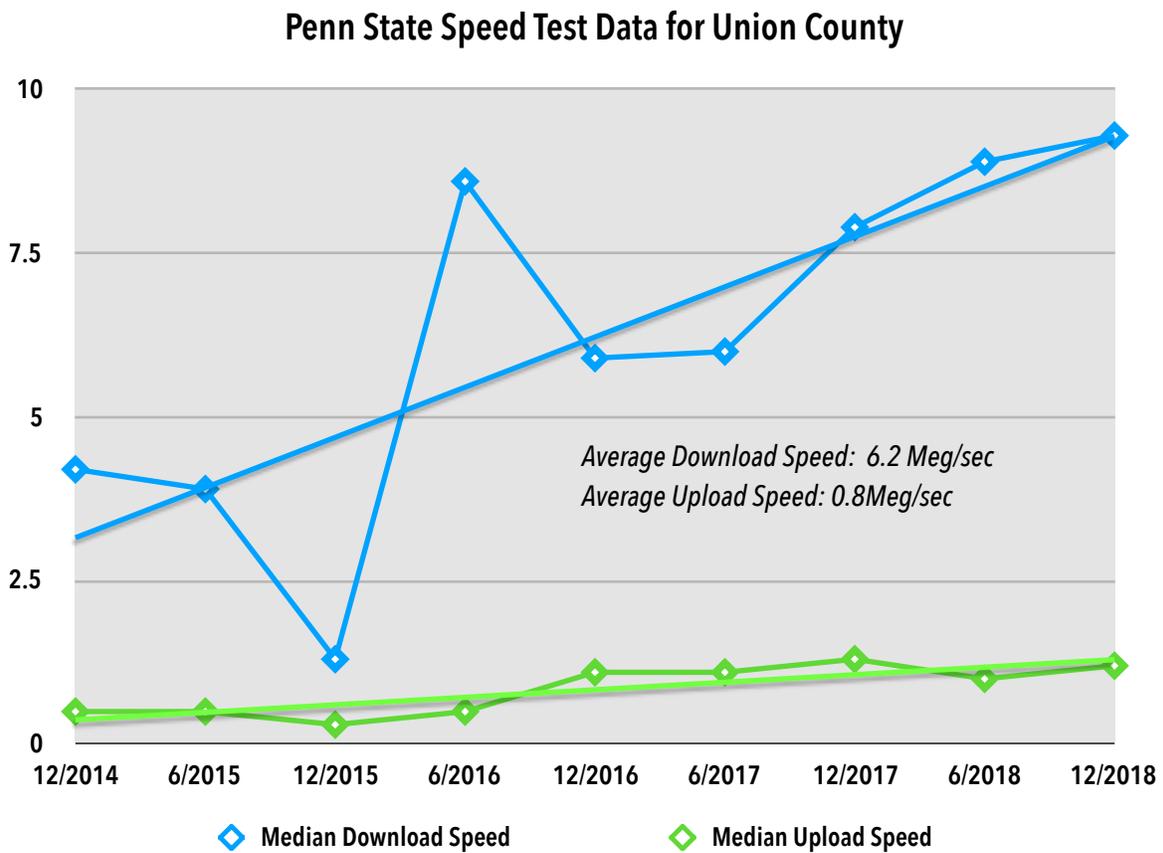
The data plotted on the map below are the business responses collected from the survey conducted as part of the broadband study. Most businesses have speeds of 10 Megabits or better.



## 2.10 PENN STATE SPEED TEST DATA

A Penn State research project has collected speed test data submitted by Pennsylvania residents and businesses for several years. The chart below shows the median upload and download speeds (Megabits/second).

Download speeds have been increasing in the past two years, and upload speeds have been increasing only slightly. The average upload speed of 6.2 Megabits/second does not meet the FCC definition of underserved (minimum 10 Megabits/second). Using this data, the entire county is unserved or underserved. Union County has extremely poor upload speeds.



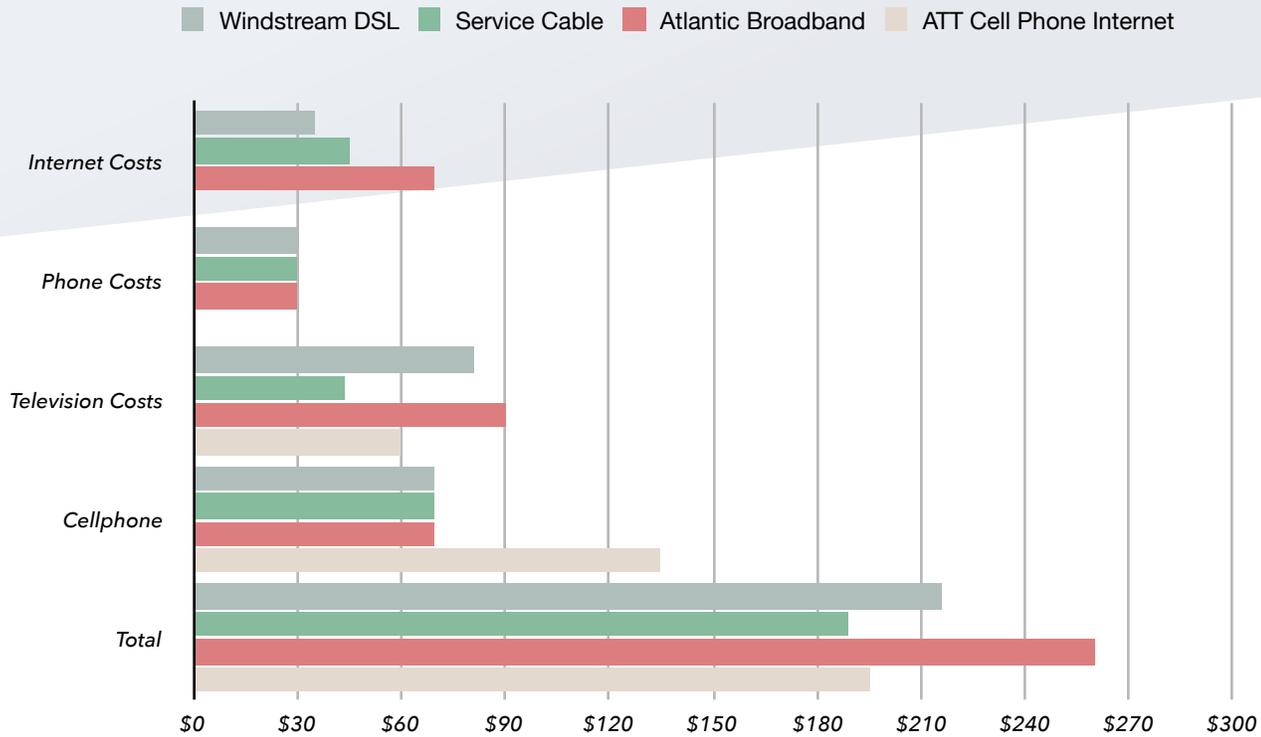
# 3 UNION COUNTY SERVICE PROVIDER ANALYSIS

This section of the report provides key insights into the services currently available in Union county. It also provides data that show which areas by zip code are most impacted by poor Internet service and/or the lack of Internet Service provider options.

Five of the zip code areas have minimal or no access to fixed wireless Internet Service Providers. Millmont, zip code 17845, has less than 10% access to cable services. Though Broadband Now shows a tiny amount of fiber, we were unable to verify that. Five of the zip codes have less than 75% of the homes with meeting the 25 Mbps standard. Very few of the residents have real choice in broadband providers.

The average household in the United States pays \$67 per month for Internet in their home. Usually rural area either pay more and/or get a lot less for their money. Smartphones have become what can be an expensive substitute for reasonably priced Internet services. A single smartphone with an unlimited data plan can cost from \$135 per month with significant limitations on speeds after 22 GBs of data. Even "unlimited data" has limitations after a certain amount of data has been used.

Unfortunately averages can be misleading for specific areas. Using the best available data, the graphs below showing communication costs for families receiving the Internet in different ways in Union County. The best DSL with advertised speeds better than 25 Mbps is only available to 3.2% of families in West Milton. Atlantic Broadband in a phone conversation reported spotty cable coverage in most areas. Some areas in Mifflinburg have access to 60 Mbps speeds through Atlantic Broadband but the cost of a TV, Phone, and Internet bundle jumps from \$170 to \$190 per month after the first year. Most cable services go up year after year. Service Cable offers a 40 Mbps package for \$119 per month which includes television and phone services. Though the website does not indicate it, this is likely an introductory rate and would rise substantially in subsequent years. Even assuming they were happy with the speed and choice on the lowest priced services we found, a typical family would spend a minimum \$2, 268 annually for Internet, TV, phone, and cellphone.



**Union County, PA Population 2010 by Zip Code- Population Data from US Census Zip Code**

Zip/ ZCTA	Town	% Household in the County	DSL	Cable	Fixed Wireless	25 Mbps Coverage	2010 Pop.	Land- Sq-Mi	Density Per Sq Mi
17837	Lewisburg	100%	84.9%	70.8%	95.9%	70.8%	19,815	62.31	318.02
17844	Mifflinburg	100%	99.6%	70%	9.9%	70%	10,042	112.07	89.61
17845	Millmont	100%	94.2%	8.6%	0%	8.6%	2,245	65.49	34.28
17855	New Berlin	100%	76.2%	73.6%	6.1%	73.6%	992	1.95	508.20
17856	New Columbia	100%	97.9%	94.4%	76.3%	94.4%	3,365	35.50	94.79
17886	West Milton	100%	81.5%	74.9%	9.2%	74.9%	895	0.97	918.89
17889	Winfield	56.2%	86%	87.4%	10.6%	87.4%	2,735	22.72	120.38

**Internet Service Providers-3**

Zip Code	USPS Town	TDS DSL	Verizon DSL	Windstream DSL	Atlantic Broad- band Cable	Service Electric Cable	Nittany Cable	Nittany Fiber	Evenlink Wireless
17837	Lewisburg			84.9%		70.8%			95.9%

Zip Code	USPS Town	TDS DSL	Verizon DSL	Windstream DSL	Atlantic Broad-band Cable	Service Electric Cable	Nittany Cable	Nittany Fiber	Evenlink Wireless
17844	Mifflinburg			99.6%	55.8%	14.2%			9.9%
17845	Millmont			94.2%	8.6%				
17855	New Berlin		5.8%	70.4%		73.6%			6.1%
17856	New Columbia			97.9%		94.4%			76.3%
17886	West Milton	3.2%	78.3%			74.9%			9.2%
17889	Winfield		62%	62.8%		84.5%	2.9%	2.9%	10.6%

### 3.1 WIRELINE PROVIDERS

This information provides pricing data and services available from providers in Union County.

#### TDS DSL

\$29.95/mo for 6 - 15 Mbps ↓ – max upload of 0.768 Mbps ↑ Turbo Internet. \$100 processing fee applies Processing fee waiver available to qualifying customers. Setup \$14.95. Modem w/WiFi \$8/month.

\$29.95/mo for 18-25 Mbps ↓ – upload speeds of 1.5 to 5 Mbps ↑ Mach Internet. 1 year promo rate. Regular rate id \$65.95. \$100 processing fee applies Processing fee waiver available to qualifying customers. Setup \$14.95. Modem w/WiFi \$8/month.

\$29.95/mo for 36-50 Mbps ↓ – upload speeds of 1.5 to 10 Mbps ↑ Warp Internet. 1 year promo rate. Regular rate id \$65.95. \$100 processing fee applies Processing fee waiver available to qualifying customers. Setup \$14.95. Modem w/WiFi \$8/month.

\$39.95/mo for 75-100 Mbps ↓ – upload speeds of 7 -15 Mbps ↑ WarpX Internet. 1 year promo rate. Regular rate id \$65.95. \$100 processing fee applies Processing fee waiver available to qualifying customers. Setup \$14.95. Modem w/WiFi \$8/month.

\$29.95/mo for 2-5 Mbps ↓ – upload speed of 0.512 Mbps ↑ Express Internet. 1 year promo rate. Regular rate id \$55.95. \$100 processing fee applies Processing fee waiver available to qualifying customers. Setup \$14.95. Modem w/WiFi \$8/month.

#### VERIZON DSL

\$34.99/mo for 0.5 to 15 Mbps ↓ – Mbps ↑ High Speed Internet. Verizon home phone service required. Activation fee waived online. Modem w/WiFi \$29.99 one-time purchase.

\$54.99/mo for 0.5 to 15 Mbps ↓ – Mbps ↑ High Speed Internet Enhanced + Freedom Verizon home phone service required. Activation fee waived online. Modem w/WiFi \$29.99 one-time purchase.

## **WINDSTREAM DSL**

\$36/mo for 21 to 33 Mbps↓ – Mbps ↑ 1 year promo rate. Regular rate is \$45. Setup \$50 (includes activation. Professional installation is free.) Modem with WiFi \$5.99 per month.

## **NITTANY CABLE CABLE & NITTANY FIBER- UNVERIFIED AND NO INFORMATION AVAILABLE ON WEBSITE**

### **SERVICE ELECTRIC CABLE**

\$49.95 mo for 10 Mbps↓ – 1.0 Mbps ↑ with a 200 GB/mo data cap. Setup including installation \$61. Modem: \$4.95 per month or one-time fee of \$99.95.

\$75.95 mo for 40 Mbps↓ – 4.0 Mbps ↑ with a 1000 GB/mo data cap. Setup including installation \$61. Modem: \$4.95 per month or one-time fee of \$99.95.

\$95.95 mo for 200 Mbps↓ – 20.0 Mbps ↑ with a 2500 GB/mo data cap. Setup including installation \$61. Modem: \$4.95 per month or one-time fee of \$99.95.

\$129.95 mo for 500 Mbps↓ – 50.0 Mbps ↑ with a 4000 GB/mo data cap. Setup including installation \$61. Modem: \$4.95 per month or one-time fee of \$99.95.

\$149.95 mo for 1,000 Mbps↓ – 50.0 Mbps ↑ with a 6000 GB/mo data cap. Setup including installation \$61. Modem: \$4.95 per month or one-time fee of \$99.95.

## **3.2 WIRELESS INTERNET SERVICE PROVIDERS (WISPS)**

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### **EvenLink**

\$39.95/mo for 3 Mbps ↓ – Mbps ↑

## **3.3 SATELLITE INTERNET SERVICE PROVIDERS**

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### **HUGHESNET**

\$59.99/mo for 25 Mbps ↓ 3 Mbps ↑ 10 GB/mo data cap. Two year contract with up to \$400 ETF. Two year promo rate. Speeds will be reduced and will typically be in the range of 1 to 3 Mbps once monthly plan data is use. From 2am-8am, customers have access to 50 GB/month of additional plan data. Setup \$99. Modem: \$14.99/mo.

\$69.99/mo for 25 Mbps ↓ 3 Mbps ↑ 20 GB/mo data cap. Two year contract with up to \$400 ETF. Two year promo rate. Speeds will be reduced and will typically be in the range of 1 to 3 Mbps once monthly plan data is use. From 2am-8am, customers have access to 50 GB/month of additional plan data. Setup \$99. Modem: \$14.99/mo.

\$99.99/mo for 25 Mbps ↓ 3 Mbps ↑ 30 GB/mo data cap. Two year contract with up to \$400 ETF. Two year promo rate. Speeds will be reduced and will typically be in the range of 1 to 3 Mbps once monthly plan data is use. From 2am-8am, customers have access to 50 GB/month of additional plan data. Setup \$99. Modem: \$14.99/mo.

\$149.99/mo for 25 Mbps ↓ 3 Mbps ↑ 50 GB/mo data cap. Two year contract with up to \$400 ETF. Two year promo rate. Speeds will be reduced and will typically be in the range of 1 to 3 Mbps once monthly plan data is use. From 2am-8am, customers have access to 50 GB/month of additional plan data. Setup \$99. Modem: \$14.99/mo.

## **VIASAT/EXEDE**

\$50/mo for up to 12 Mbps ↓ with 12 GB data cap. Contract term two years. Once Priority Data is used up, speeds will be reduced to 1 to 5 Mbps during the day and possibly below 1 Mbps after 5 pm. Free zone from 3 am to 6 am daily. Setup with free standard installation \$0. Modem w/WiFi \$10 per month

\$75/mo for 12 Mbps ↓ with 25 GB data cap. Contract term two years. Once Priority Data is used up, speeds will be reduced to 1 to 5 Mbps during the day and possibly below 1 Mbps after 5 pm. Free zone from 3 am to 6 am daily. Setup with free standard installation \$0. Modem w/WiFi \$10 per month

\$100/mo for 12 Mbps ↓ with 50 GB data cap. Contract term two years. Once Priority Data is used up, speeds will be reduced to 1 to 5 Mbps during the day and possibly below 1 Mbps after 5 pm. Free zone from 3 am to 6 am daily. Setup with free standard installation \$0. Modem w/WiFi \$10 per month

\$150/mo for 25 Mbps ↓ with no data cap. Contract term two years. After 100 GB of data usage, your data may be prioritized behind other customers during network congestion. Setup with free standard installation \$0. Modem w/WiFi \$10 per month

# 4 UNION KEY AREA PROJECTS

Three key areas in the county were selected for projects that could potentially be funded from grants and other funding sources. There are two maps on the next two pages showing key details:

**Map one** shows the underserved and unserved areas of the county with the three Key Area projects overlaid. Although the county has very large areas that are completely underserved, the household density is very low. The key areas were selected to focus on underserved areas with higher household density than many of the unserved areas.

**Map two** shows the key area projects with the estimated wireless propagation—that is, the shaded areas indicate where households and businesses are likely to receive service. The propagation analysis software takes into account terrain and tree cover. However, for best service, a clear line of sight between the customer premises and the tower will produce the strongest signal and the highest speed service. The newer LTE radios now being deployed by many service providers will provide some service through light tree cover (near line of sight).

All sites have been analyzed using line of sight software to predict the availability of line of sight between the towers, which would allow the creation of an area-wide network. This will make the three key area projects more attractive to WISPs (Wireless Internet Service Providers), who can offer service via the three towers as a single contiguous network.

The tables in this section describe the cost of constructing or improving towers to expand broadband access in the area. When a tower exists there will still be costs necessary to get it ready for a WISP to use, we typically refer to this as tower “Fit-up”. Where a new tower is required the costs will include the construction of the tower and higher costs for items such as road improvements and power service installation.

There is a contingency in the estimate for each tower, and we have included \$15,000 in each estimate where it is known the tower will be on private property. If the project does require leasing on private property it is often best to get a long term lease with the lease payments made up front. *I.E., \$1,500 per year for 10 years, paid in full up front.*

The table below provides a summary of the three Key Area fixed point wireless projects and a comparison of the cost of placing underground fiber in the same underserved/unserved areas. The

Key Area Sites	Estimated Cost of Fixed Point Wireless	Estimated Route Miles in Unserved/ Underserved Areas for Fiber to the Home	Cost of Fiber to the Home (Low Estimate at \$110,000/mile)	Cost of Fiber to the Home (High Estimate at \$135,000/mile)
Key Area 1 Laurelton/West End Library Site	\$190,168	19.7	\$2,161,500.00	\$2,652,750.00
Key Area 2 - Mifflinburg Area School	\$190,168	25.1	\$2,763,750.00	\$3,391,875.00
Key Area 3 - New Berlin Mountain Road	\$190,168	51.5	\$5,667,750.00	\$6,955,875.00
<b>Grand Total</b>	<b>\$570,503</b>		<b>\$10,593,000</b>	<b>\$13,000,500</b>

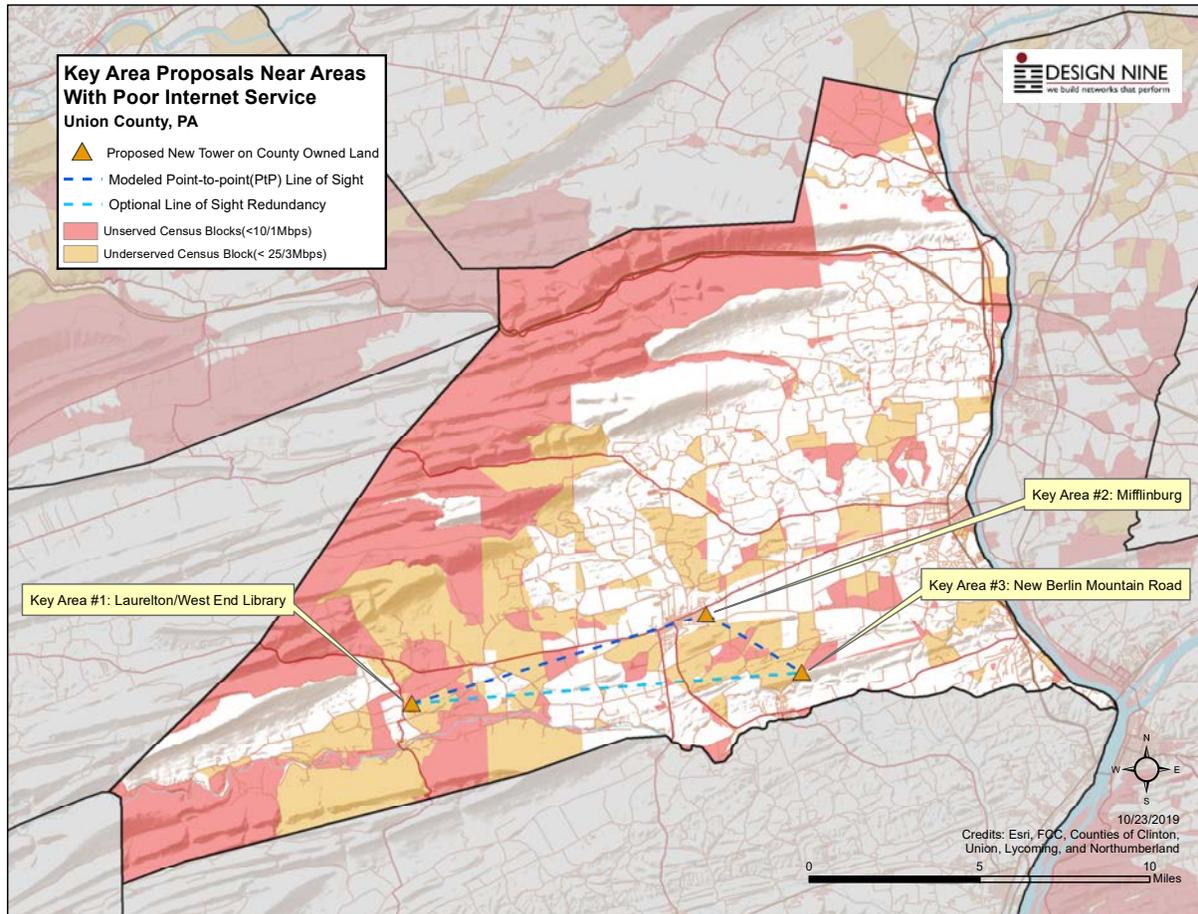
fiber estimate costs include all of the fiber and conduit materials, handholes, and network equipment, including customer premises equipment (CPE). A more detailed analysis of the fiber option is likely to identify some less expensive options, including some areas where less expensive aerial fiber could be

deployed, and some routes where household density is low may remain limited to wireless broadband access.

*It is important to note that any tower improvements or new tower sites should be reviewed with local WISPs before committing funds. If possible, obtain an agreement from a WISP to use the tower to offer services prior to making improvements or constructing a new tower.*

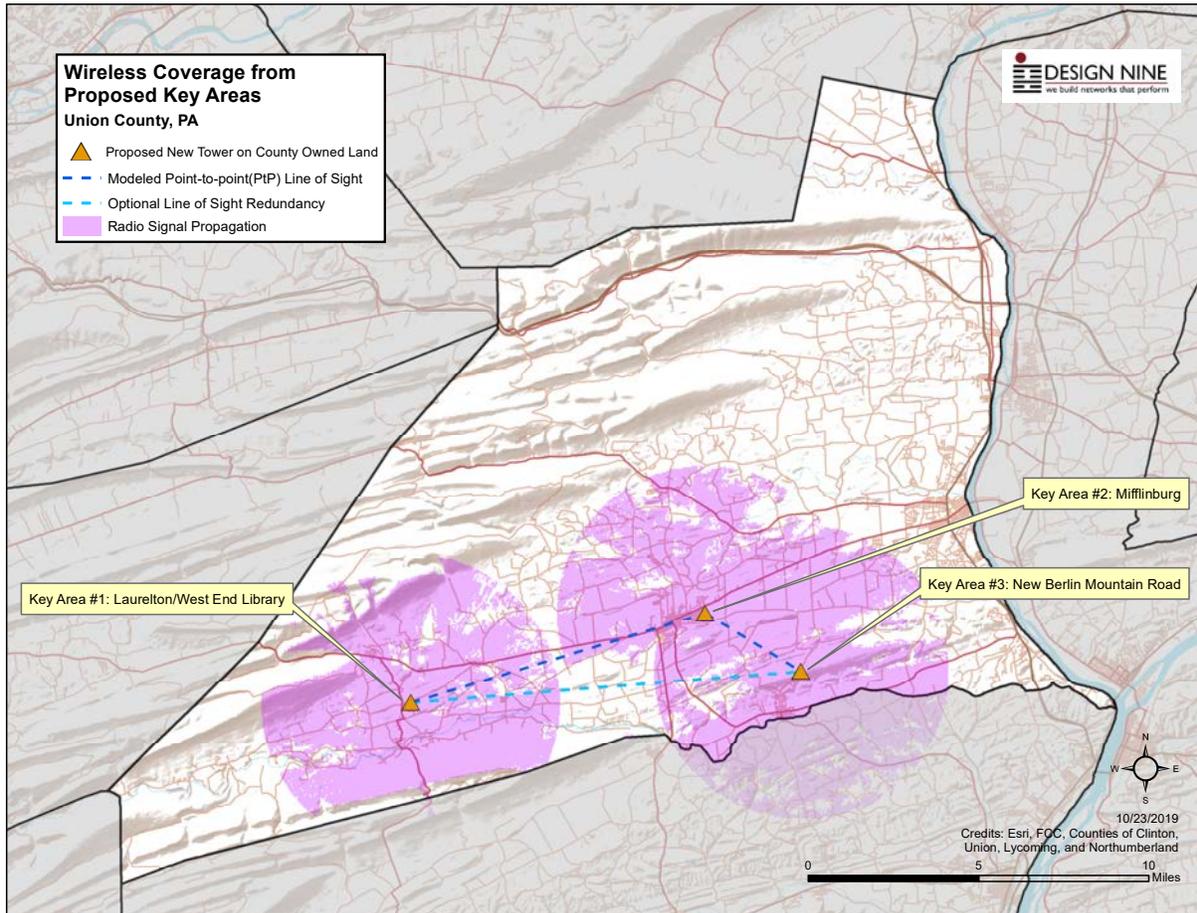
## Map One: Network Design

This map shows the unserved and underserved areas in the county and the location of three towers proposed in three key areas. All three of the towers are new construction, and could be placed on county property. It would be possible to create a ring point to point network between the towers to provide some redundancy in service.



## Map Two: Propagation Analysis

The shaded areas show the likely coverage that will be obtained from the towers. Line of sight or near line of sight between the tower and a wireless customer is required. Heavy tree cover may diminish the signal (less speed) or block the signal entirely.



## 4.1 KEY AREA ONE: LAURELTON

This is a new tower that could be placed on county property.

### Laurelton

ITEM/PROJECT	UNITS	UNIT COST LOW	UNIT COST HIGH	TOTAL (AVG)
Tower Fit-up Activities: \$0				
Tower Study / Mapping / Load Analysis	0	\$4,500	\$7,000	\$0
Site Development (road repairs and general maintenance)	0	\$0	\$1,500	\$0
Fit-up: New Power Service / Installation Assumes power available on site, new meter placement required to support WISP equipment	0	\$1,250	\$2,500	\$0
Labor and Contracting: \$82,640				
New: Site Development (Clearing, Road Improvements, etc.)	1	\$10,000	\$20,000	\$15,000
New Site: New Power Service / Installation	1	\$1,250	\$3,450	\$2,350
180' Guyed Tower Construction Labor & Contracting	1	\$50,000	\$74,750	\$62,375
Cabinet Installation Labor	1	\$600	\$1,150	\$875
Power System Installation Labor	1	\$300	\$575	\$438
Generator Installation Labor	1	\$1,250	\$1,955	\$1,603
Propane Service Installation Tank furnished and installed by local gas provider	1	\$750	\$1,250	\$1,000
Materials: \$36,585				
180' Guyed Tower Construction Materials	1	\$17,500	\$27,500	\$22,500
Small Telecom Cabinet AMPROD AM47P-2636-24RU OR EQUIVALENT, ALUMINUM CABINET - FRONT AND REAR DOORS- HVAC/HEAT - ADJUSTABLE RACK RAILS 19"	1	\$6,000	\$7,500	\$6,750
Cabinet Foundation and Installation Materials	1	\$1,000	\$1,500	\$1,250
10kW Liquid Propane Generator	1	\$4,000	\$6,000	\$5,000
Battery backup system	1	\$905	\$1,265	\$1,085
Total:				\$120,225
Project Management, Network Engineering, Testing				\$38,420
Site Engineering, Surveying, Viewshed Analysis, Etc.				\$9,500
Misc Fees, Technical Services				\$7,500
Site Acquisition, Land Lease				\$2,500
Contingency				\$12,023
<b>TOTAL:</b>				<b>\$190,168</b>

## 4.2 KEY AREA TWO: MIFFLINBURG

This is a new tower that could be placed on county property.

### Mifflinburg

ITEM/PROJECT	UNITS	UNIT COST LOW	UNIT COST HIGH	TOTAL (AVG)
Tower Fit-up Activities: \$0				
Tower Study / Mapping / Load Analysis	0	\$4,500	\$7,000	\$0
Site Development (road repairs and general maintenance)	0	\$0	\$1,500	\$0
Fit-up: New Power Service / Installation Assumes power available on site, new meter placement required to support WISP equipment	0	\$1,250	\$2,500	\$0
Labor and Contracting: \$82,640				
New: Site Development (Clearing, Road Improvements, etc.)	1	\$10,000	\$20,000	\$15,000
New Site: New Power Service / Installation	1	\$1,250	\$3,450	\$2,350
180' Guyed Tower Construction Labor & Contracting	1	\$50,000	\$74,750	\$62,375
Cabinet Installation Labor	1	\$600	\$1,150	\$875
Power System Installation Labor	1	\$300	\$575	\$438
Generator Installation Labor	1	\$1,250	\$1,955	\$1,603
Propane Service Installation Tank furnished and installed by local gas provider	1	\$750	\$1,250	\$1,000
Materials: \$36,585				
180' Guyed Tower Construction Materials	1	\$17,500	\$27,500	\$22,500
Small Telecom Cabinet AMPROD AM47P-2636-24RU OR EQUIVALENT, ALUMINUM CABINET - FRONT AND REAR DOORS- HVAC/HEAT - ADJUSTABLE RACK RAILS 19"	1	\$6,000	\$7,500	\$6,750
Cabinet Foundation and Installation Materials	1	\$1,000	\$1,500	\$1,250
10kW Liquid Propane Generator	1	\$4,000	\$6,000	\$5,000
Battery backup system	1	\$905	\$1,265	\$1,085
Total:				\$120,225
Project Management, Network Engineering, Testing				\$38,420
Site Engineering, Surveying, Viewshed Analysis, Etc.				\$9,500
Misc Fees, Technical Services				\$7,500
Site Acquisition, Land Lease				\$2,500
Contingency				\$12,023
<b>TOTAL:</b>				<b>\$190,168</b>

## 4.3 KEY AREA THREE: NEW BERLIN

This is a new tower that could be placed on county property.

### New Berlin Mountain Road

ITEM/PROJECT	UNITS	UNIT COST LOW	UNIT COST HIGH	TOTAL (AVG)
Tower Fit-up Activities: \$0				
Tower Study / Mapping / Load Analysis	0	\$4,500	\$7,000	\$0
Site Development (road repairs and general maintenance)	0	\$0	\$1,500	\$0
Fit-up: New Power Service / Installation Assumes power available on site, new meter placement required to support WISP equipment	0	\$1,250	\$2,500	\$0
Labor and Contracting: \$82,640				
New: Site Development (Clearing, Road Improvements, etc.)	1	\$10,000	\$20,000	\$15,000
New Site: New Power Service / Installation	1	\$1,250	\$3,450	\$2,350
180' Guyed Tower Construction Labor & Contracting	1	\$50,000	\$74,750	\$62,375
Cabinet Installation Labor	1	\$600	\$1,150	\$875
Power System Installation Labor	1	\$300	\$575	\$438
Generator Installation Labor	1	\$1,250	\$1,955	\$1,603
Propane Service Installation Tank furnished and installed by local gas provider	1	\$750	\$1,250	\$1,000
Materials: \$36,585				
180' Guyed Tower Construction Materials	1	\$17,500	\$27,500	\$22,500
Small Telecom Cabinet AMPROD AM47P-2636-24RU OR EQUIVALENT, ALUMINUM CABINET - FRONT AND REAR DOORS- HVAC/HEAT - ADJUSTABLE RACK RAILS 19"	1	\$6,000	\$7,500	\$6,750
Cabinet Foundation and Installation Materials	1	\$1,000	\$1,500	\$1,250
10kW Liquid Propane Generator	1	\$4,000	\$6,000	\$5,000
Battery backup system	1	\$905	\$1,265	\$1,085
<b>Total:</b>				<b>\$120,225</b>
Project Management, Network Engineering, Testing				\$38,420
Site Engineering, Surveying, Viewshed Analysis, Etc.				\$9,500
Misc Fees, Technical Services				\$7,500
Site Acquisition, Land Lease				\$2,500
Contingency				\$12,023
<b>TOTAL:</b>				<b>\$190,168</b>

## 4.4 SMALL CELL BROADBAND UTILITY POLE ACCESS COSTS

A single wooden utility pole with a wireless connection to a 180' tower and local access radios could provide access to any residence with line of sight within a half mile or more. This would spread the cost of pole construction and equipment costs across several households or businesses. There are many areas in the region where there is a cluster of homes along a relatively short stretch of road. All of those homes could share the use of a single local utility pole access site.

Community poles should only be located where a WISP and/or the community has made a minimum customer subscription commitment for the improved broadband service.

V1	VARIABLE	VALUE	NOTES
V2	Weight Variable	5	0-10 scale used in Best Estimate column (10 is best)
V3	Towers	1	Number of Towers
V4	Height	60	Tower Height
V5	Type	Wooden Utility Pole	Tower Type
V7	Backbone Radio System Licensed / Un-licensed	Un-licensed	WISP is responsible for radios and network equipment
V8	Backbone Links	1	Typically a link to a taller tower
	Site Development (Average)	\$1,000.00	Poles need to be placed in locations with good line of sight to other poles or towers and where electric service and road access require minimal new construction

1	ITEM/PROJECT	UNITS	BEST ESTIMATE
2	Site Development (Clearing, Road Improvements, etc.)	1	\$1,000
3	3x3 NEMA Box	1	\$450
4	New Power Service / Installation	1	\$875
5	60' Wooden Utility Pole Construction Materials	1	\$3,000
6	Miscellaneous parts and materials	1	\$175
7	Power System Installation Materials	1	\$30
8	DC Voltage Monitoring Device	1	\$50
9	Unmanaged Rack Mount PDU (60)	1	\$40
10	60' Wooden Utility Pole Construction Labor & Contracting	1	\$2,500
11	Power System Installation Labor	1	\$400
12	Project coordination and management	1	\$7,500
13	Contingency (10% of costs)	1	\$1,602
14	Total:		\$16,020.00

## 4.5 POINT TO POINT COST ESTIMATE

The three key areas could be linked using high bandwidth point to point microwave radio links. This creates a single contiguous network. WISPs are often interested in having the point to point radio links included as part of their tower lease payments because it lowers their capital costs to provide service on more than one tower. Many counties also use the point to point tower network to carry K12 school traffic (a redundant network link), public safety data traffic, and to provide connectivity between county facilities (additional radio equipment may be needed).

A county-wide backhaul network between towers has several desirable characteristics:

- It reduces the cost to providers of being able to affordably offer service on all the towers.
- It increases the reliability and robustness of the WISP services because of the ring design (on at least four of the towers).
- County government data and/or public safety services could also be carried on the backhaul network to provide improved access to some remote facilities.
- K12 schools may be interested in having a redundant network to improve reliability of their existing fiber connections. This can be especially important during periods when online standardized testing is taking place.

To connect all four towers in the three key areas, three point to point radio links would be required. The table below provides cost estimates for a single point to point link.

The point to point system described in the table is the Ubiquiti AirFiber 11x Radio System. The radios operate on licensed frequencies. In ideal conditions, this system has a maximum throughput of 1.2Gbps and is capable of very long range links. Costs for licensing the link and costs for installation of the link are included.

**AirFiber 11FX Pair Including Licensing**

Item	Units	Unit Cost	Total
AF11X Radio	2	\$799	\$1,598
AF11-CA Adapter Kit	2	\$49	\$98
AF11FX Duplexer	4	\$199	\$796
AF11 X Antenna 11GHz, 35dBi	2	\$379	\$758
FCC Licensing	1	\$2,000	\$2,000
Shipping @ 5%	1		\$263
Install, Configure and Align	1	\$9,500	\$9,500
<b>TOTAL</b>			<b>\$15,013</b>

## 4.6 ACCESS RADIO EQUIPMENT COST ESTIMATE

If a tower is leased out to a service provider, most WISPs prefer to install their own access radios on the tower. The access radios propagate the Internet data signal to customers with line of sight to the tower. This generally a better way for the county or tower owner to manage access, as the WISP is responsible for all of the tower radios and customer premises equipment (CPE) radios.

In some cases, there may be a reason for the county or the tower owner to own and manage the access radios. For example, service is badly needed in the area around the tower but a WISP does not feel they can gain enough customers to justify the cost. In this case, the tower owner (e.g. the county) may choose to put radios and offer Internet service to meet local business and resident needs. The cost of providing radios to thirty customers has been included in this estimate.

The estimate table below shows the costs for 2 sets of access points, one licensed, and one unlicensed. It is common for a WISP to install multiple sets of access points on a tower and choose the best frequency based on performance when at the customer premise. The licensed equipment costs shown below are based on the Cambium PMP450 platform in 3.65GHz frequencies, the same frequency as LTE. The unlicensed equipment costs shown below are based on the costs for Ubiquiti 5GHz access points. In completely clear line of sight conditions the WISP is likely to utilize the Ubiquiti radios, when line of sight is partially blocked the LTE frequencies will likely perform better. Both technologies can deliver broadband speeds exceeding 25/3Mbps and the maximum capacity that a customer can receive will vary based on their wireless connection and the other customers on the access point.

Costs are included in the estimate for the installation of the access points.

<b>Access Equipment Costs: \$29,389</b>				
ITEM	UNITS	LOW	HIGH	AVERAGE
Licensed Access Equipment (3x120° Sectors)	1	\$9,925	\$12,925	\$11,425
Licensed CPE Radios and Mounts	30	\$288	\$338	\$9,390
Unlicensed Access Equipment (3x120° Sectors)	1	\$394	\$444	\$419
Unlicensed CPE Radios and Mounts	30	\$104	\$154	\$3,870
Site Switching	1	\$164	\$214	\$189
Cabling	1	\$110	\$160	\$135
Equipment Shipping	1	\$1,099	\$1,424	\$1,261
Access Point Installation	1	\$1,800	\$3,600	\$2,700
<b>TOTAL</b>				<b>\$29,389</b>

## 4.7 LEASING TOWER SPACE

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Once existing and/or new towers have space available to lease to WISPs, there are policy and contract decisions that must be evaluated.

- There should be a single public fee schedule for all providers.
- There should be a single tower space agreement that is used for all providers.
- Tower access should be made available in ten foot vertical segments, as high as possible on the tower without interfering with other uses (e.g. public safety antennas). Note that it is unlikely that any tower will have more than two providers on it.
- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- It may be more effective to have a single lease agreement with access to all towers, and the contract should require the ISP to put equipment on all towers within a certain period of time (e.g. nine to twelve months). This limits ISPs from “cherry picking” towers with more potential customers and ignoring towers in parts of the county with lower population density.
- Monthly tower lease fees should be on the order of \$200 to \$250 per tower. Higher fees make it difficult for providers to make a business case for the cost of equipment and the extensive marketing required to develop a customer base around a tower.
- If there are two vertical spaces available for lease, the lower segment could be made more attractive to a WISP by offering a reduced lease fee.
- An initial grace period of three to six month should be offered on fees, and/or offer a one year sliding scale of fees (e.g. first three months, fee waived; months four to six, 25% of normal fee; months seven to nine, 50% of normal fee; months ten to twelve, 75% of normal fee). There are many ways to structure the initial fee period, but it is important to recognize that the WISPs incur substantial early costs to develop revenue and customers for a new tower.
- All tower leases should expire on the same date even if started at different times. This allows the regional enterprise to potentially make a smoother transition to a new provider if there are performance issues, and will give the regional entity more leverage and control over the WISPs.
- In contracts, fee reductions should be worded as discounts that can be revoked if performance requirements are not adequately being met.
- There are considerations for ground-space (e.g. WISP cabinets, shelters, H-frames for electric service) that will have to be evaluated at each tower site. If new shelters will be allowed, the regional entity should set minimum standards for new shelters.

### Tower Space Revenue Estimate

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Tower revenue opportunities are limited. It takes WISPs many months to acquire enough customers on a new tower to break even, and even longer to begin to show a profit. Fees for tower space need to be modest to attract one or two providers, and it is good practice to offer several months of free service while the WISP markets in the new service area and tries to sign up customers.

Because of interference problems, two providers are the most that are desirable on a tower, and offering towers on an exclusive basis (e.g. an open auction for tower space) could bring in more revenue from a single provider.

### Sample Tower Leasing Revenue Projection

Service Item	Description	Monthly Fee	Max Number of WISPs per Tower	Projected Annual Revenue
Tower Space on One Tower	10 feet of vertical space leased to one ISP	\$200	1	<b>\$2,400</b>
Tower Space on Three Towers	10 feet of vertical space leased to one ISP	\$200	1	<b>\$7,200</b>
Tower Space for Six Towers	10 feet of vertical space leased to one ISP	\$200	1	<b>\$14,400</b>

### Tower Space Operational Expenses

Assumptions include:

- Each provider on a tower will install their own electric service (meter) and pay their own utility costs.
- Site leases on private land can be negotiated for \$1000/year with a single up-front payment of \$10,000 (for ten years).

If several towers are available (e.g. three, four), there will be some efficiencies gained in costs so that revenue would likely exceed expenses—costs like legal services and insurance will not increase proportionally with more than one tower.

### Tower Lease Annual Expense Projections

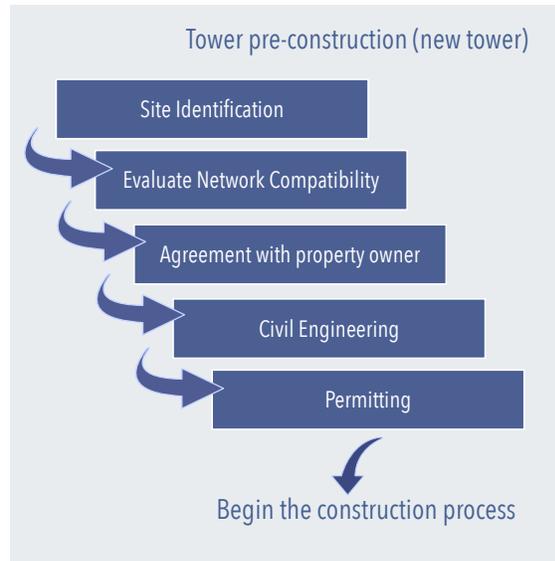
Budget Item	Description	Annual
Legal Services	Legal counsel on an as-needed basis for review of construction and service contracts, IRU agreements, and other business documents.	<b>\$1,500</b>
Accounting	Part time accounting and bookkeeping services will be required	<b>\$2,400</b>
Generator Maintenance/ Fuel	Generators require periodic maintenance and occasional fuel (propane) tank refills.	<b>\$950</b>
Site Maintenance	Routine tasks like trimming weeds and grass around the tower.	<b>\$600</b>
Site Leases	Some towers may be placed on private property which would require annual site leases. This will vary depending on the availability of local government properties that may be available for tower placement.	<b>\$1,000</b>
Insurance	Some insurance is likely to be needed (general liability, unemployment, asset insurance, umbrella policy).	<b>\$2,500</b>
Total Costs	<b>Projected annual expenses</b>	<b>\$8,950</b>

## 4.8 TOWER SITE AND TOWER MANAGEMENT

### Tower Site Identification

When a site for a new tower is being considered for use, the diagram below illustrates the steps that need to be followed. For example, if an existing public safety tower or an existing cellular provider tower may have space for fixed point wireless broadband equipment (i.e. co-location).

- Site identification – Identify areas of poor service and look for existing towers.
- Network Compatibility – Line of sight to other towers and to key service locations and customers needs to be evaluated. A wireless propagation study and line of sight study will provide the data needed to make this determination.
- Property owner negotiation – A lease has to be negotiated with the property owner. Local government sites (e.g. K12 schools, parks, recreation areas, fire/rescue stations) are candidates for towers because of reduced or no lease fees.
- Engineering – An engineered site plan will be required to as part of the permitting process.
- Leases and permits – A permit to place the tower is required in most localities, and there may be a multi-stage permitting process that can take several months.



### Tower Construction

Once the engineering work is completed and a construction permit has been issued, tower construction can proceed. For a typical fixed point wireless tower of 199' feet or less, construction usually takes less than a month, but weather and soil conditions can create delays.

- Bidding and contracting – Bid documents and construction specifications have to be prepared and sent



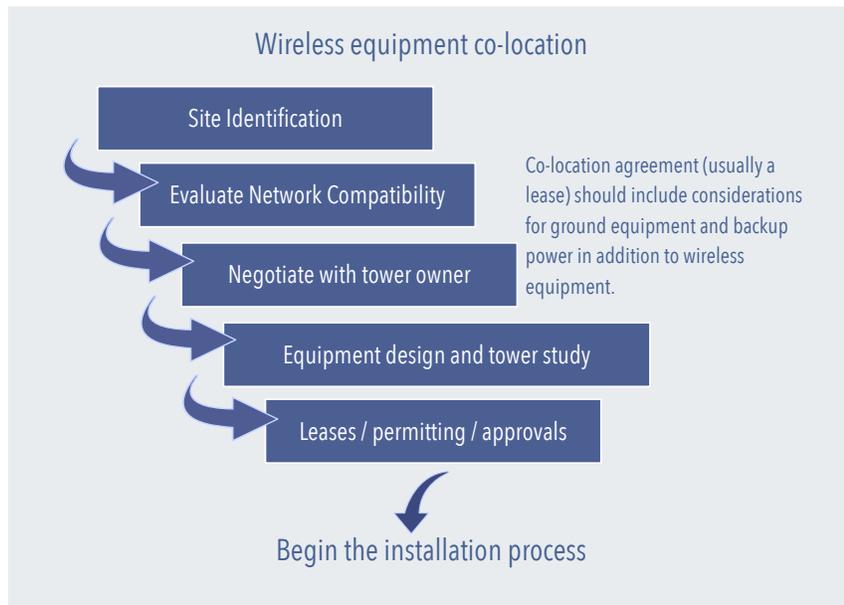
to candidate contractors. Once bids are received, proposals have to be reviewed, and depending upon funding sources, may require review by local government and/or a funding agency prior to awarding a contract.

- Site development – The tower site has to be cleared of trees, brush, and any other obstructions. The area directly around the tower has to be leveled, and electric service (underground or aerial) has to be brought to the site. Depending upon the location a road (usually gravel) may have to be placed.
- Foundation construction – Once site clearing and any road work is completed, the foundation for the tower is installed. If it is a guyed tower, guy wire anchors have to be installed.
- Tower construction – Once the foundation is in place, the tower is erected. For towers of 199' or less, this is usually only two days.
- Final work details – Once the tower is in place, final work items are completed, including fencing, generators, fuel tanks, landscaping, and any site restoration work.

## Wireless Equipment Co-Location

When an existing tower is being considered for use, the diagram below illustrates the steps that need to be followed. For example, if an existing public safety tower or an existing cellular provider tower may have space for fixed point wireless broadband equipment (i.e. co-location).

- Site identification – Identify areas of poor service and look for existing towers.
- Network Compatibility – If there are towers in the service area, the first step is to determine if a minimum of ten vertical feet of space is available at an appropriate height for broadband wireless equipment. A wireless propagation study will provide the data needed to make this determination.



- Tower owner negotiation – If the tower is in a suitable location and if space is available at an appropriate height, a lease has to be negotiated with the tower owner.
- Tower study – An engineering study may be required to determine if the tower is able to support the additional weight and wind load of the equipment. Additional electric service and a cabinet for network electronics may also be needed.

- Leases and permits – If new electric service and/or a cabinet or shelter has to be installed at the sight, local government permits and/or construction approvals may be required.

## Wireless Equipment Installation

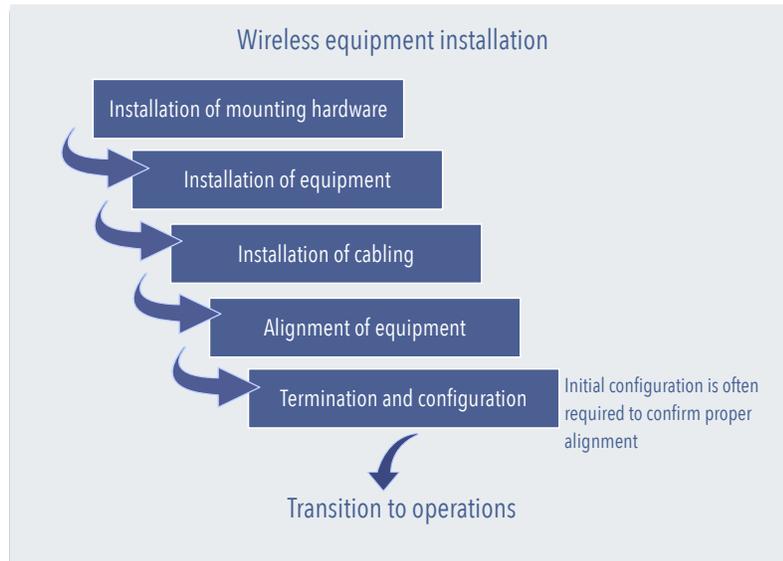
Wireless equipment installation follows the completion of construction on a new tower or the acquisition of space on an existing tower. Electric power is already in place.

- Mounting hardware – Brackets and other mounting hardware have to be attached to the tower at the designated height. This requires a tower climb conducted by a firm with trained tower climbers.

- Equipment installation – Once the mounting hardware is in place, radios are attached to the tower. On the ground, network equipment including switches, powers

supplies, battery backup, and other equipment is installed. A backup generator and fuel tank may also be installed and wired into the equipment cabinet or shelter.

- Cabling installation – Cables are connected between the equipment in the cabinet on the ground to the radios on the tower.
- Alignment of radios – Radios on the tower have to be adjusted. Local access radios that provide service to local customers with line of sight to the tower have to be aligned for optimum coverage. If there are also point to point radios on the tower for connections to other towers or locations, these also have to be aligned. Tower climbers are needed to perform these steps.
- Configuration and testing – Once the physical alignment of the radios is complete and all cabling is connected, the new network equipment is integrated into the rest of the network.



# APPENDIX A: GLOSSARY

**Active network:** Typically a fiber network that has electronics (fiber switches and CPE) installed at each end of a fiber cable to provide “lit” service to a customer.

**Asymmetric connection:** The upload and download bandwidth (speed) are not equal. Cable Internet and satellite Internet services are highly asymmetric, with upload speeds typically 1/10 of download speeds. Asymmetric services are problematic for home-based businesses and workers, as it is very difficult to use common business services like two way videoconferencing or to transfer large files to other locations.

**Backhaul:** Typically refers to a high capacity Internet path out of a service area or locality that provides connectivity to the worldwide Internet.

**Colo facility:** Colo is short for Colocation. Usually refers to a prefab concrete shelter or data center where network infrastructure converges. A colo or data center can also refer to a location where several service provider networks meet to exchange data and Internet traffic.

**CPE:** Customer Premises Equipment, or the box usually found in a home or business that provides the Internet connection. DSL modems and cable modems are examples of CPE, and in a fiber network, there is a similarly-sized fiber modem device.

**Dark fiber:** Dark fiber is fiber cable that does not have any electronics at the ends of the fiber cable, so no laser light is being transmitted down the cable.

**Fiber switch:** Network electronic equipment usually found in a cabinet or shelter

**Fiber Optic Splice Closure:** See **FOSC**.

**FOSC:** Fiber Optic Splice Closure. Typically a water and air tight cylindrical container where fiber cable is split open to allow splicing (connecting together) of fiber strands for a drop to a premises.

**FTTH/FTTP/FTTx:** Fiber to the Home (FTTH), Fiber to the Premises (FTTP), and Fiber to the X (FTTx) all refer to Internet and other broadband services delivered over fiber cable to the home or business rather than the copper cables traditionally used by the telephone and cable companies.

**Handhole:** Handholes are open bottom boxes with removable lids that are installed in the ground with the lids at ground level. The handholes provide access to fiber cable and splice closures that are placed in the handhole. Handholes are also called **pull boxes**.

**IP video:** Video in various forms, including traditional packages of TV programming, delivered over the Internet rather than by cable TV or satellite systems.

**Latency:** The time required for information to travel across the network from one point to another. Satellite Internet suffers from very high latency because the signals must travel a round trip to the satellite in stationary orbit (22,500 miles each way). High latency makes it very difficult to use services like videoconferencing.

**Lit network:** A “lit” network (or lit fiber) is the same as an active network. “Lit” refers to the fact that the fiber equipment at each end use small lasers transmitting very high frequency light to send the two way data traffic over the fiber.

**MST:** Multipoint Service Terminals are widely used in fiber to the home deployments to connect individual home drop cables to larger distribution cables on poles or in handholes. Pre-connectorized drop cables snap into the MST ports and do not require any splicing.

**Passive network:** Refers to infrastructure that does not have any powered equipment associated with it. Examples include wireless towers, conduit (plastic duct), handholes, and dark fiber.

**Pull boxes:** Pull boxes (also called handholes) are used to provide access to fiber cable and splice closures. They are called pull boxes because they are also used during the fiber cable construction process to pull the fiber cable through conduit between two pull boxes.

**Splice closures:** Splice closures come in a variety of sizes and shapes and are used to provide access to fiber cable that has been cut open to give installers access to individual fiber strands. Splice closures are designed to be waterproof (to keep moisture out of the fiber cable) and can be mounted on aerial fiber cable or placed underground in handholes. Also called **FOSCs**.

**Splicing:** The process of providing a transparent joint (connection) between two individual fiber strands so that laser light passes through. A common use of splicing is to connect a small “drop” cable of one or two fiber strands to a much larger (e.g. 144 fiber strand) cable to provide fiber services to a single home or business.

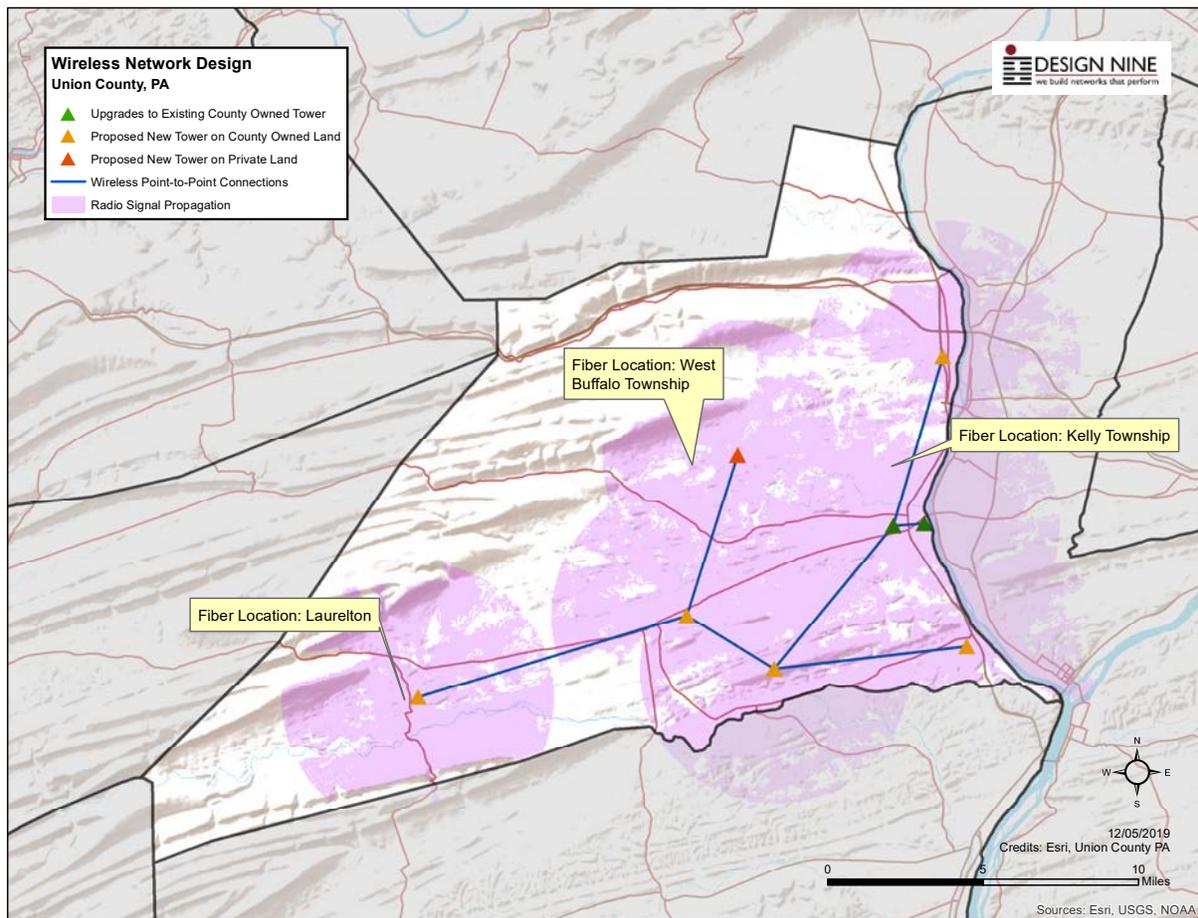
**SCADA:** Supervisory Control and Data Acquisition. Used by the electric utility industry and some other utilities (e.g. water/sewer) to manage their systems.

**Symmetric connection:** The upload and download bandwidth (speed) is equal. This is important for businesses and for work from home/job from home opportunities.

**Virtual Private Network:** A VPN creates a private, controlled access link between a user’s computer and a corporate or education network in a different location. VPNs are often encrypted to protect company and personal data. VPNs usually require a symmetric connection (equal upload and download speeds) to work properly.

# APPENDIX B: COUNTY-WIDE WIRELESS COST ESTIMATE

Approximately 77% to 82% of Union County addresses are covered by this network design. The eastern part of the county is relatively flatter than some of the other counties and a smaller number of towers are needed to achieve good coverage. Six new towers and two existing towers form the network, with one redundant ring in the eastern portion of the county.



### Union County-wide Fixed Wireless Estimate

SITE	DESCRIPTION	TOTAL COST
Union County Government Center	Tower Fit-up, Wide Area Coverage	\$69,948
Union County Courthouse	Tower Fit-up, Wide Area Coverage	\$64,435
New Berlin Mountain Road	New Tower Required, Wide Area Coverage	\$223,835
White Dear Elementary School	New Tower Required, Wide Area Coverage	\$218,323
Winfield-Union Township FD	New Tower Required, Wide Area Coverage	\$218,323
Mifflinburg Area School	New Tower Required, Wide Area Coverage	\$223,835
Mazeppa	New Tower Required, Wide Area Coverage	\$218,323
Laurelton West End Library	New Tower Required, Wide Area Coverage	\$218,323

**\$1,455,343**