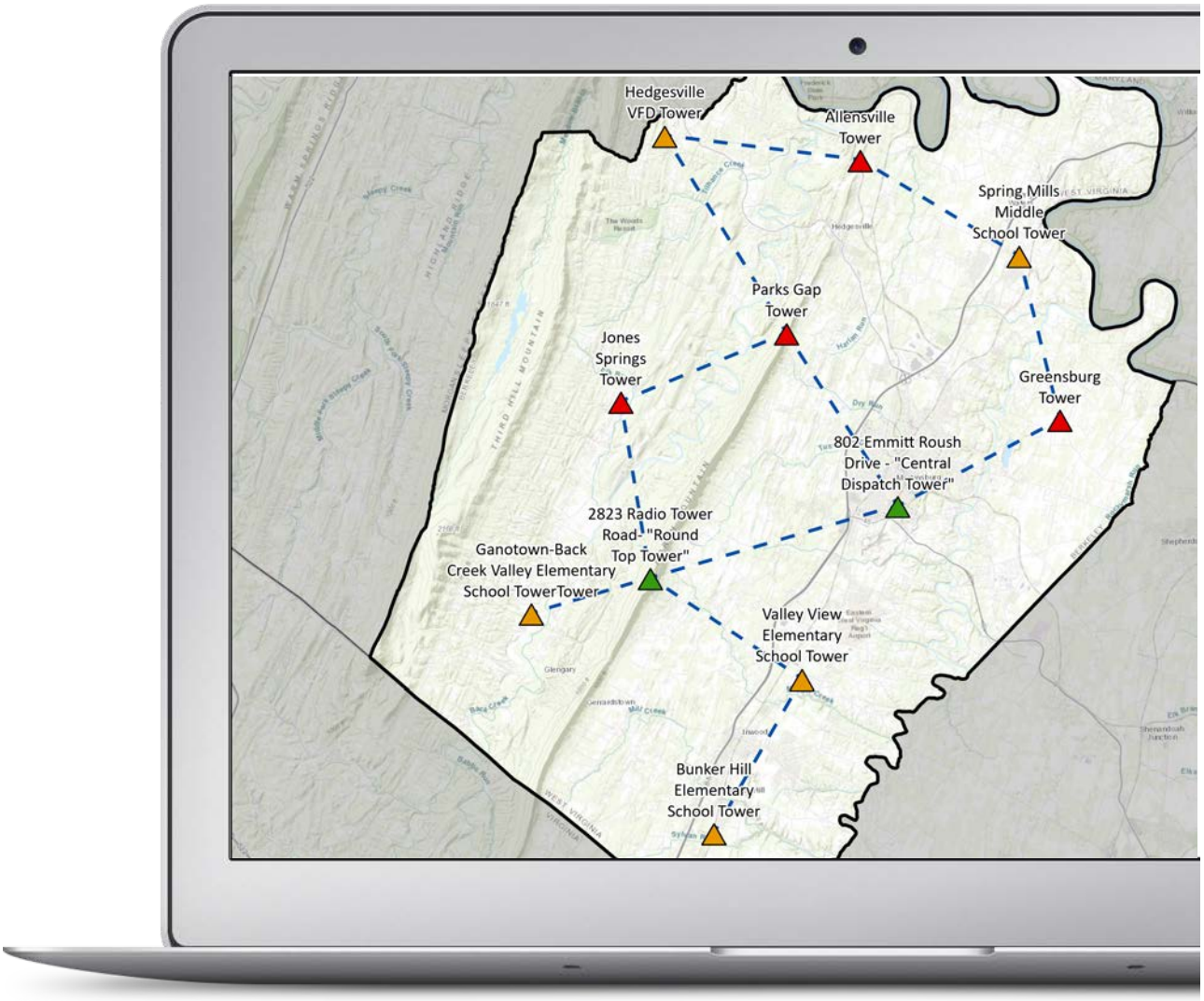
BERKELEY COUNTY BROADBAND FEASIBILITY STUDY



DESIGN NINE
broadband planners

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1 EXECUTIVE SUMMARY

A broadband study of Berkeley County began in summer of 2021 and was completed in the fall of 2021. The report has several key sections:

- **Technical and Asset Analysis** – Demographic data, tower and fiber assets in the county, underserved and unserved areas of the county, and geo-coded survey results.
- **Market, Current Use, and Gap Analysis** – A review of current service provider service offerings, speeds, and prices for those services and what bandwidth is available.
- **Broadband Surveys** – In Berkeley County, both a residential broadband survey and a business broadband survey was distributed. A strong response was received.
- **Connectivity Solutions** – This section provides an overview of various technologies, including both broadband wireless and broadband fiber.
- **Technical Development Plan and Cost Estimates** – Design and estimates of county-wide fixed point wireless network and fiber designs and cost estimates for three fiber projects.
- **Infrastructure Funding and Grant Opportunities** – A discussion of a variety of grant and funding strategies.
- **Network Operations Options** – An overview of the tasks, roles, and responsibilities that may be required if the County makes strategic broadband infrastructure investments.

The survey data collected as part of this study indicates that residents and businesses are anxious for better Internet service. Because a very large number of often passionate comments were received, they have been included in a separate document.

- 84% of respondents are interested in having access to Gigabit fiber Internet.
- 96% believe that local government should help facilitate better Internet access.
- 54% of residents report the quality of Internet service is affecting where they choose to live.
- 100% of businesses indicated that the Internet is important to the success of their business.
- 84% of businesses reported that they need employees able to work from home.

Large portions of the county qualify as "unserved" or "underserved" by the FCC definitions of broadband service. Conversely, there are only a few areas, mostly on the eastern side of the county that meet the FCC standard of 25/3 Megabits as "served."

Residential and business use of Internet bandwidth continues to increase by 30% per year. Rural areas of Berkeley County will fall farther and farther behind other areas of the county and the state without a strategic plan to develop modern broadband infrastructure.

The County should take advantage of all possible grant funding to make investments in basic broadband infrastructure like towers, conduit, and dark fiber, and to develop public/private partnerships with Internet providers, who would offer all retail services to residents and businesses. The goal should be for the County to develop a world class basic broadband infrastructure–digital road systems. Local governments build and maintain roads, but they do not own the businesses that use those roads to deliver goods and services.

1.1 FUTURE-ORIENTED INFRASTRUCTURE

Affordable high speed Internet is essential to the future growth and prosperity of Berkeley County. Over the past twenty years, Internet access has evolved from a luxury to a necessity. School students need Internet access to complete homework and to study. Online shopping can save energy and make it easier for the elderly and homebound to obtain the needs of every day life. Telemedicine and telehealth services and applications is revolutionizing health care, reducing costs, and allowing older citizens to live independently longer.

More and more workers and business people are working from home, either on a part time or a full time basis, and the Covid crisis has highlighted the critical need for reliable high performance Internet service for work, learning, and access to health services. New work from home job opportunities are growing rapidly, but most of those jobs require reliable, symmetric Internet service to qualify.

Many business employees are already trying to work more from home more often (e.g. one or two days per week) to reduce travel costs. Some major businesses in other parts of the U.S. are actively planning to have 20% of their workforce work full time from home to reduce employee travel costs and office energy costs. Corporate employees working from home require high bandwidth services to be connected to the office network and to use corporate videoconferencing systems. These corporate network services often require 10-50 Megabit ***symmetric*** connections.

Broadband has become essential community infrastructure.

Just as communities had to take on the task of building and maintaining roads in the early twentieth century, communities must now provide digital road systems as a matter of community and business survival. These digital road systems must be designed with certain characteristics:

The communities of Berkeley, with the right broadband infrastructure, can be attractive to an emerging new group of businesspeople and entrepreneurs that typically are well-educated, own their own businesses or work for large global corporations, and are making choices about where they lived based on family needs and interests, rather than business interests. This new breed of entrepreneurs and workers place a high value on the kinds of amenities that contribute to a good quality of life–traditional neighborhoods, vibrant downtown areas, a wide range of cultural and recreation opportunities, good schools, and a sense of place. These businesspeople and their families make relocation decisions based on quality of life only where there is abundant and affordable broadband, because broadband is the enabler of this new approach to personal and work life.

Governor Justice and the State Broadband Enhancement Council have set aggressive goals for the state:

- As much as $1 billion in grants, loans, and Federal matching funds are going to be available to West Virginia local governments and to ISP/government public/private partnerships.
- The funds will support both expanded fixed point broadband wireless networks and fiber to the home initiatives.

Berkeley County has a unique opportunity to leverage the new sources of grant funding in 2022 to enhance both the community and economic development climate of the county. If the County

can use State funds, ARPA funds, other grant opportunities, and some local funds to make carefully targeted passive infrastructure investments and to develop constructive public/private partnerships, most homes and businesses in Berkeley County could enjoy dramatic improvements in Internet service in the next two years, with many areas of the county connected to Gigabit fiber Internet service.

1.2 NEXT STEPS

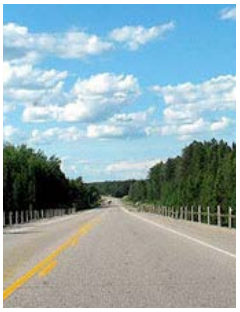
The County must consider several early phase tasks and activities:

- Read and review this report.
- Identify key ideas and concepts that may be important to future community and economic development initiatives.
- Meet with community leaders to discuss these key ideas and concepts in more detail.
- Reach consensus on high priority areas and projects.
- Assemble a "grant development team" that will identify both short term and longer term funding sources and be responsible for developing the grant proposals needed to successfully apply for funding.

The new and expanded sources of funding represent an incredible opportunity for the County to permanently solve broadband shortcomings in the County, but time is of the essence. There are already supply chain issues developing for the materials, equipment, and skilled labor needed to build out new networks. Berkeley County should move ahead with all possible speed to make broadband-related decisions and to get projects underway to avoid what are likely inevitable delays, especially in the second half of 2022.

2 BROADBAND AS ESSENTIAL INFRASTRUCTURE

Governments build and manage roads, but don't own or manage the businesses that use those roads to deliver goods and services. There is true competitive pricing between competing service providers, and little or no government regulation is required.



The tremendous versatility of the Internet and the underlying technology bases now allows services that used to require their own, separate (analog) road system (voice telephony and TV services) to be delivered alongside other services like Internet access on a single, integrated digital road system.

If we managed overnight package delivery the way we manage telecom, UPS and Fedex would only deliver packages to residences and businesses where each delivery firm had built a private road for their exclusive use. We recognize immediately the limitations of such a business model–few of us would have overnight package delivery to our homes because the small number of packages delivered would not justify the expense of building a private paved road.

Before the rise of the automobile, most roads were built largely by the private sector. After cars became important to commerce and economic development, communities began building and maintaining roads because it became an economic development imperative to have a modern transportation system in communities.

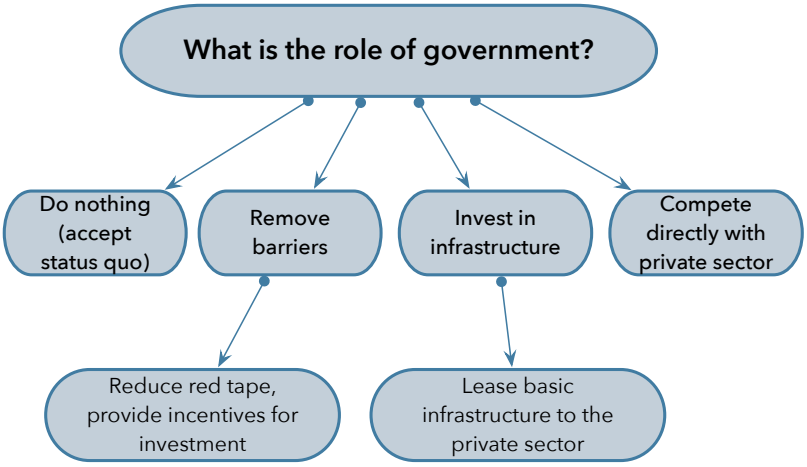
Before the rise of the Internet, digital networks were built largely by the private sector. As broadband has become critical to commerce and economic development, communities with digital roads are more competitive globally.

The time has come to recognize that it is inefficient and wasteful to build full duplicated digital road systems, which only raise the cost of telecom services to all public and private users. Networks that share capacity among a wide variety of public and private users have a lower cost of construction and a lower cost of operation–benefiting all users.

A UTILITY COMPARISON		
SHARED ROADS	SHARED AIRPORTS	SHARED TELECOM
Historically, roads have been built and maintained by the community for the use of all, especially private firms that want to use them to deliver goods and services.	Airports are built and maintained by a community or region as an economic and community development asset. Both public and private users benefit from the shared use of a single, well-designed airport	Duct and fiber may be installed and maintained by the community and/or a neutral owner/operator for the use of all, including private firms that want to use them to deliver goods and services.
Access to the community road system is provided by parking lots and driveways, built by property owners, developers and builders.	Airport assets like departure gates, ticket areas, and runways provide access to the airline services.	In the digital road system, access across private property to the community–wide network in the public right of way is provided by duct and fiber built by property owners and/or developers and builders.
The local government uses roads only to deliver government services. Local government does not offer services like overnight package delivery.	While the local government or a consortium of local governments typically own the airport facility, the local governments do not offer flight services.	Local government uses the digital transport system only to deliver government services. Government does not offer services like Internet access or Voice over IP.
Private sector businesses use roads so that their own cars and trucks can deliver goods and services to customers. Because businesses do not have to build and maintain roads, all businesses benefit directly by being able to reach more customers at less expense.	Private sector airlines are able to offer competitively priced airfares because of the shared cost of the airport terminal facilities. Each airline does not build its own airport (which would sharply increase the cost of airfare).	Private sector businesses use the digital transport system to deliver goods and services to customers. Because businesses do not have to build and maintain a digital road system, all service providers benefit directly by being able to reach more customers at less expense.
There are no road connection fees, and anyone may connect to the road system for free. Governments pay for the cost of maintaining roads largely from those that use the roads . Fees are proportional to use, from taxes on tires and gasoline.	Businesses and citizens do not pay a fee to access the airport facility. The cost of maintaining the airport facility is paid by the airlines, which bundle that cost into the price of airfare. Fees are proportional to actual use by flying customers. Airlines benefit because they do not have to build, own, and operate the airport directly. Those costs are shared across all users.	Any qualified service provider may connect to the digital road system for a nominal fee and begin to offer services, without any significant capital expense. Network capital and operating costs are recovered by charging service providers a small fee that is based on a percentage of their income from services offered over the system.

2.1 WHAT IS GOVERNMENT'S ROLE?

Successful improvements in broadband access, affordability, and reliability for Berkeley County involves several decision points, as outlined in the illustration below. Government has several "first choice" options.



Do nothing is to accept that businesses and residents in the County will have to continue to use whatever is available, despite the cost and bandwidth limitations that limit what many are able to do online.

Government can **remove barriers** to private sector investment. This can be an effective and low cost strategy. Possibilities include reducing permit fees for fiber construction and tower installation, incentives to developers to install conduit and meet-me boxes in new residential and commercial construction, simplified permit requirements for utility pole installation on private property, and identifying areas of residential and business demand and sharing that information with providers.

The County can choose to **make investments in basic infrastructure** (e.g. more wireless broadband towers, conduit, dark fiber) and make that infrastructure available to the private sector via revenue-generating lease agreements.

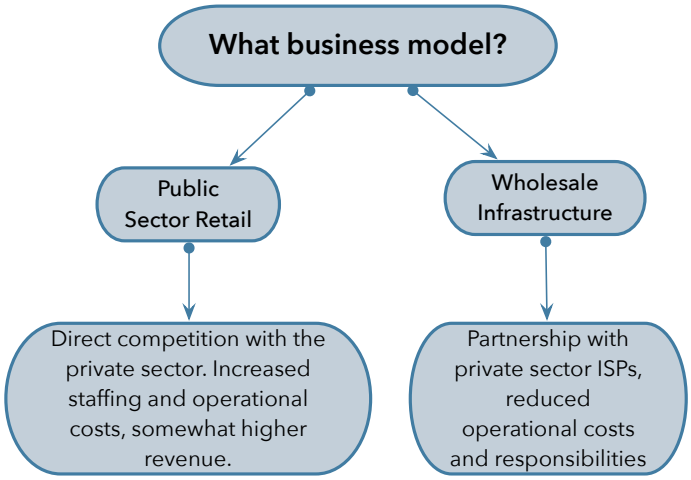
When communities have chosen the option to **compete directly with the private sector** by offering retail Internet, phone, and TV services lawsuits from incumbents often create difficulty moving forward as well as expensive legal fees.

2.2 THE SHARED INFRASTRUCTURE BUSINESS MODEL

Traditionally, the telecom services market has been vertically integrated, with telephone and cable companies owning the cable infrastructure (i.e. twisted pair copper cable for telephone, and coaxial copper cable for TV). These companies bundled analog services with their own infrastructure, which made sense when only one service could be delivered over the cable.

American residents and businesses needed two networks: one for voice telephone service, and one for television. The rise of the Internet and associated changes in technology led to digital services (voice, video, Internet) that could be delivered simultaneously over a single cable or wireless connection.

By the early 2000s, it was becoming apparent that it was inefficient and costly to have two competing "retail" cable systems (e.g. telephone, cable) delivering the same content and services—it was only creating higher costs for residents and businesses.



A new business model became possible: wholesale leasing of the cable/wireless infrastructure to private sector service providers, which unbundles the infrastructure from the services. A side effect of this unbundling is that it becomes much easier to determine what a customer is actually paying for a given service: in the vertically integrated 20th century model, with the cost of infrastructure maintenance bundled together with the services, it is much more difficult to determine what a service actually costs.

While a few communities have pursued the retail business model (typically building fiber to the home and business and selling retail Internet and other services directly to customers), most of these retail efforts have been by local governments that are also providing electric service—owning the utility poles is a significant cost advantage not available in most communities.

Within the wholesale business model, there are several different ways to generate revenue.

Passive Infrastructure Leasing – In this approach, the County makes investments in a few targeted passive infrastructure types, typically broadband towers, and optionally conduit and dark fiber. This kind of basic infrastructure has virtually no day to day maintenance and management responsibilities, and can be leased out to private sector Internet providers so that those companies can expand their service area and service quality more rapidly.

Lit Circuit Wholesale – In this approach, the network provides lit fiber circuits to providers, with one circuit allocated to each customer. Service providers are charged for the cost of each circuit. Service providers are responsible for their own customers and their own customer billing. Revenue is based on the number of customers who actually buy service (the take rate). Revenue is dependent on the marketing success of the service providers.

Utility Fee Wholesale – In this approach, every household and business in the community pays a monthly small utility fee. Service providers pay only a small fee for use of the network that is based on the total number of potential customers. In this model, the effective take rate from a revenue perspective is 100%. With this high take rate, the individual utility fee can be very modest because everyone pays something, rather than just those buying a service.

Features	Municipal Retail	Wholesale Infrastructure
Basic Concept	Generally more difficult to because of possible legal challenges from incumbent providers. Generally not an option in Massachusetts.	One or more private sector ISPs would use the infrastructure to sell their own services directly to residents and businesses. Can be a dark fiber approach, lit fiber approach, and/or wireless towers.
Government Involvement	Local government competes directly with the private sector for Internet service.	County involvement is limited to providing basic infrastructure to ISPs.
Management	Local government is responsible for management and operations. Most functions could be outsourced to a qualified third party entity.	ISPs responsible for virtually all day to day customer services and support. County only responsible for network and tower maintenance and repairs.
Competition	The incumbent telephone and cable providers would compete vigorously against local government service offerings.	Private sector ISPs would provide competition to the telephone and cable companies.
Service Options	Local government would sell only Internet. Businesses and residents could get TV and voice using their Internet connections.	ISPs would focus on high speed Internet, with some other service offerings like voice and business services.
Risks	The primary risk would be lawsuits from incumbent providers.	The lit network approach requires hard-nosed business management experience. It is important to identify prospective service providers early in the process.

In the wholesale infrastructure business model, local government investments are limited to basic transport infrastructure, including conduit, fiber, and network equipment. Services for businesses and residents are offered by private sector providers offering Internet, TV, telephone and other data services.

2.3 SERVICE PROVIDERS AND SHARED INFRASTRUCTURE

The wholesale infrastructure model, where the local government is NOT selling retail telecommunications services, has been resistant to legal challenges, with at least one hundred communities in the U.S. that lease infrastructure to private sector service providers. Communities that have been challenged in court are ones that chose to pursue the retail model, with customers purchasing retail services like Internet, TV, and phone directly from the town or city government. Lafayette, Louisiana is one of the best known examples. The City of Lafayette was sued by the incumbent telephone and cable company and won in court. The project is now more than ten years old, passed a 40% take rate target in 2017, and has begun expanding service outside the City limits. The City had a key advantage when starting the effort, because it is an electric city; owning the pole structure and being able to deploy the less expensive aerial fiber widely gave the project a distinct cost advantage.

The service providers that are usually most eager to become providers on a community-owned network are smaller local and regional providers. WISPs (Wireless Internet Service Providers) are usually quick to see the advantages of being able to deliver a superior Internet service over a modern fiber infrastructure with little or no capital expense on their part.

Once a community-owned network is under construction, it is typical that the incumbents, particularly the cable companies, begin lowering rates and offering special deals to customers to try to lock them in to multi-year contracts. There are two ways to approach this:

- If the announcement of construction of community-owned infrastructure lowers prices and improves service from the incumbents, that is an economic benefit to the citizens and businesses of the county. The new network, bringing new providers and a wider range of packages and pricing to citizens and businesses, creates the needed competition that motivates the incumbents to provide better prices and service.
- If the County does move forward, a modest but well through out information and education campaign about the benefits and advantages will be important to counter mis-leading information from the incumbents. Part of the effort must be to let citizens and businesses know not to sign long term contracts with the incumbents.

3 TECHNICAL AND ASSET ANALYSIS

A wide variety of assets in Berkeley 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 county, some new towers are going to be needed, with very modest lease fees–to attract WISPs onto those towers.

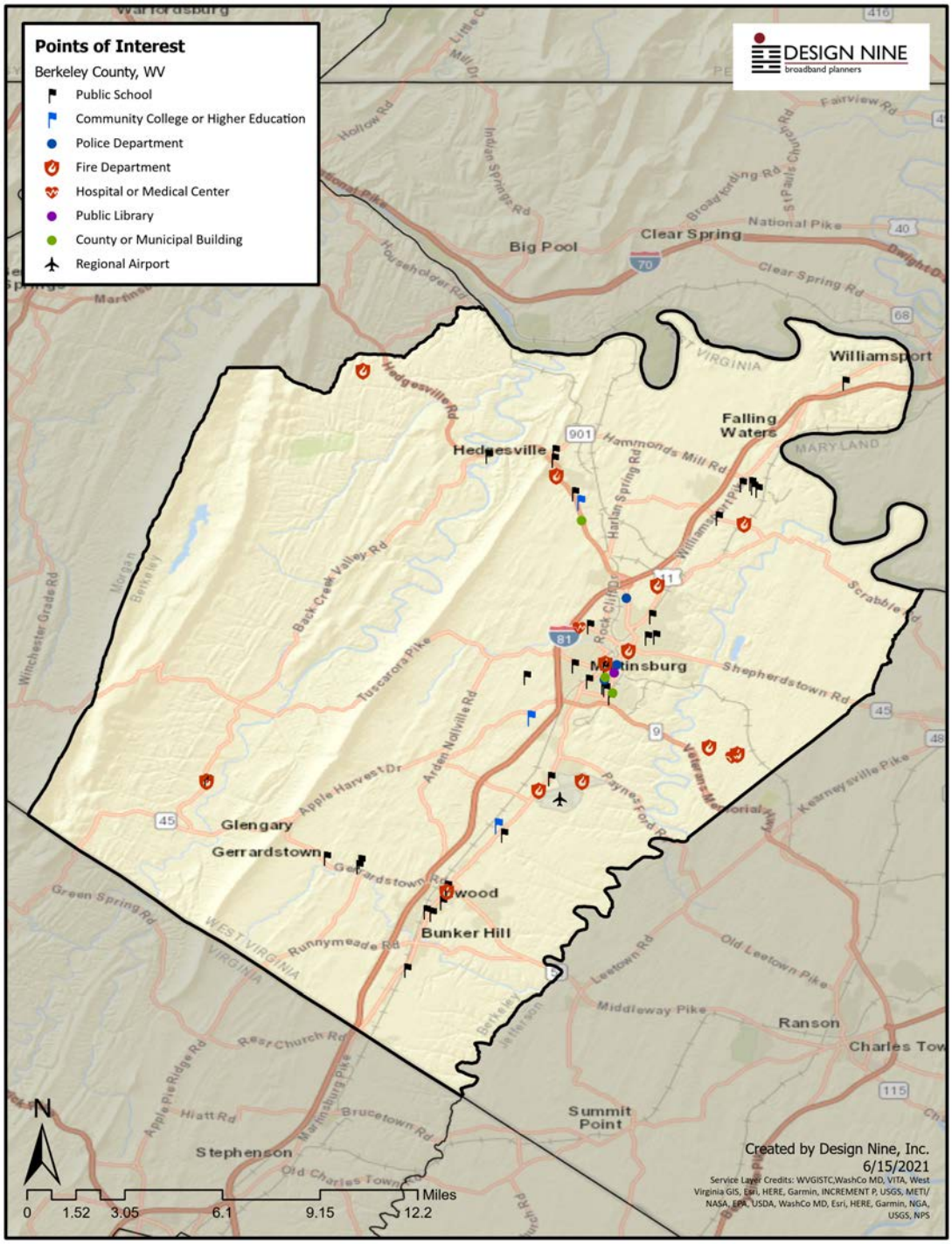
The fixed point wireless network designs make the assumption that as a general rule, access to space on the cellular towers is too expensive, and so some new towers will be needed even where there may be an existing privately owned tower. If funding is developed for one or more of the county-wide wireless 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 the county, 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. Companies like Segra and Level3 have some local fiber available for business and institutional customers.

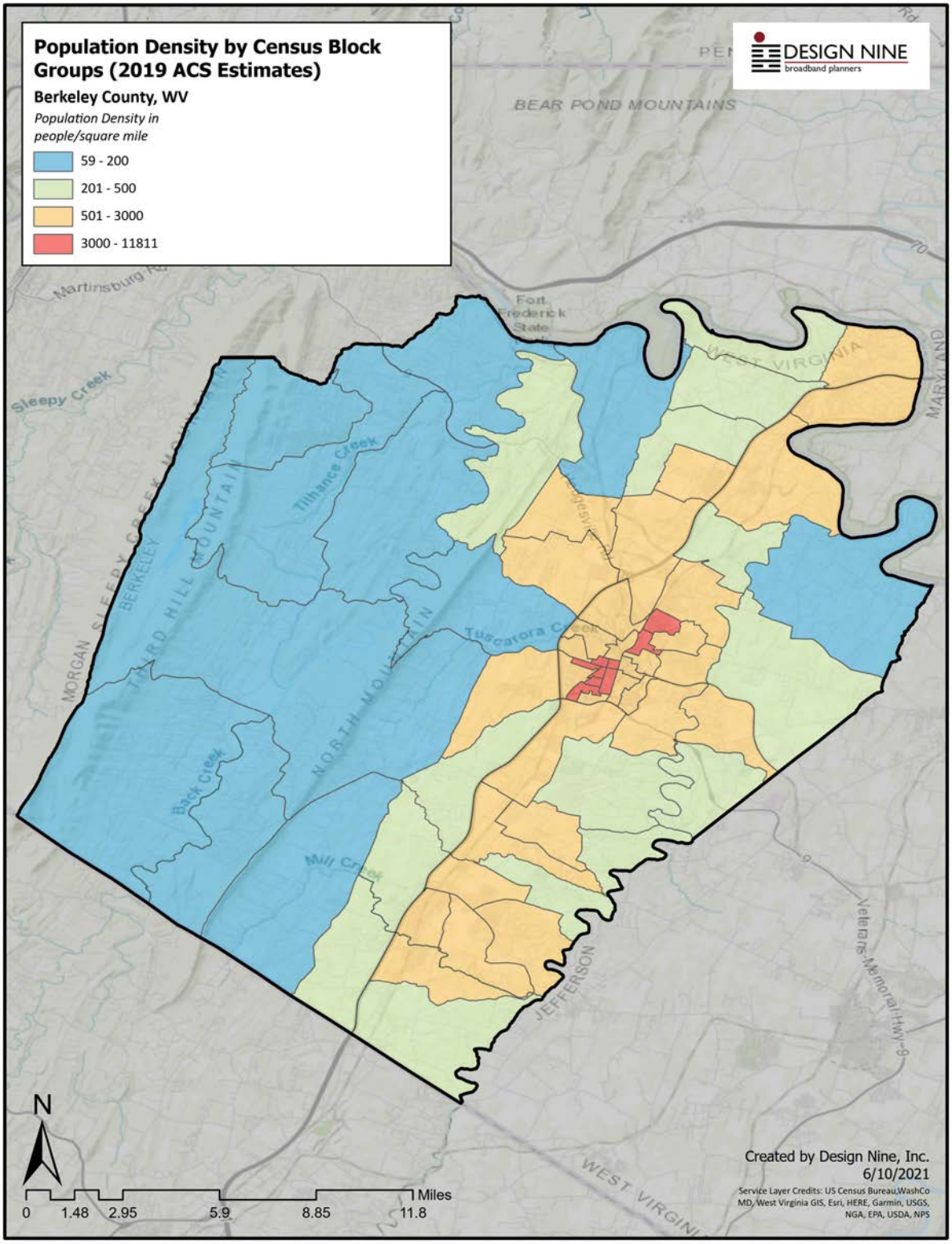
Service Levels – This map illustrates information on served, underserved, and unserved areas in the county obtained from FCC 477 reports. The data is self-reported by the service providers.

3.1 POINTS OF INTEREST

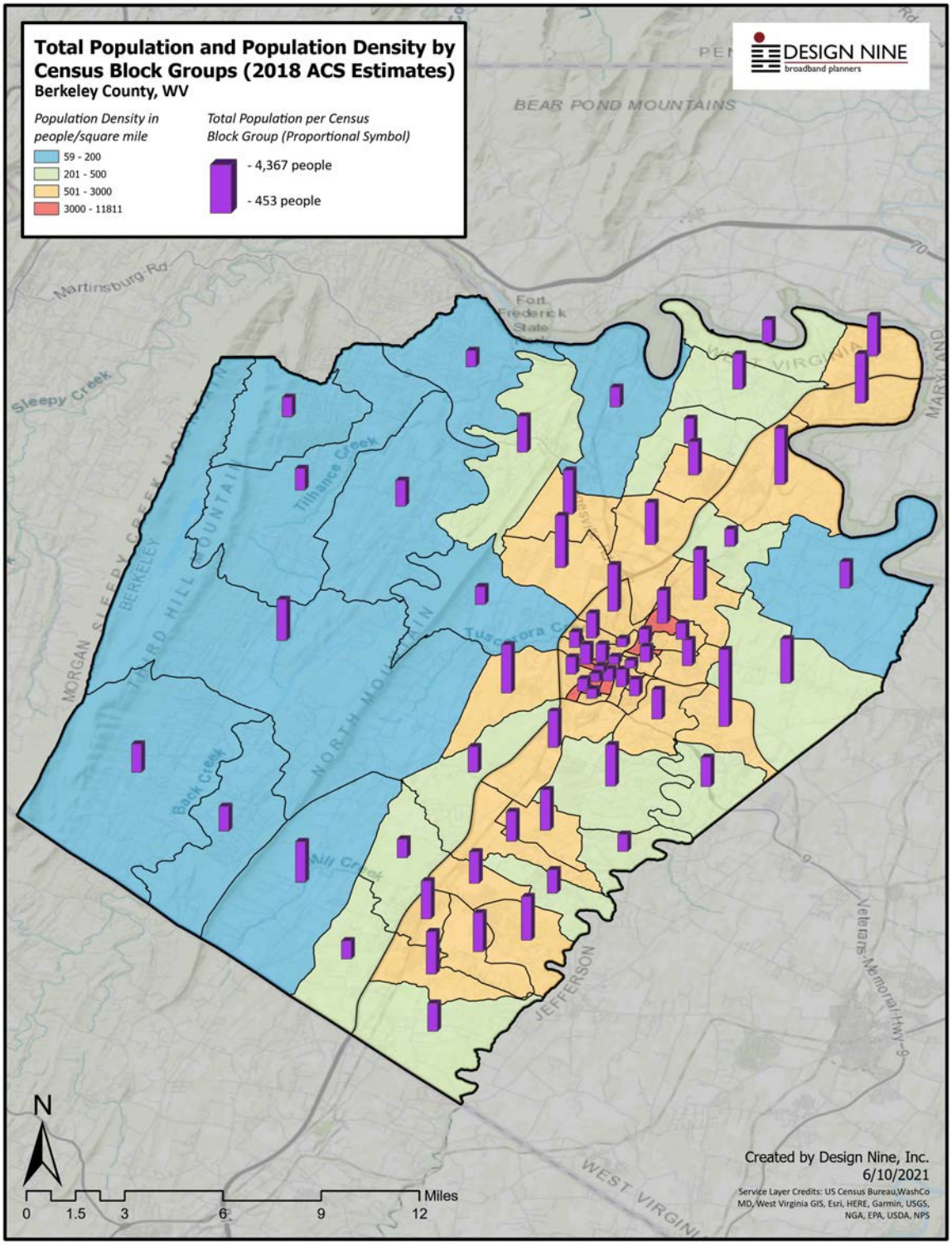
County facilities, municipal facilities, libraries, K12 and higher education facilities, fire and rescue stations, and public safety locations are all candidates to be anchor tenants for fixed point wireless and/or fiber services.



3.2 POPULATION AND DENSITY DISTRIBUTION



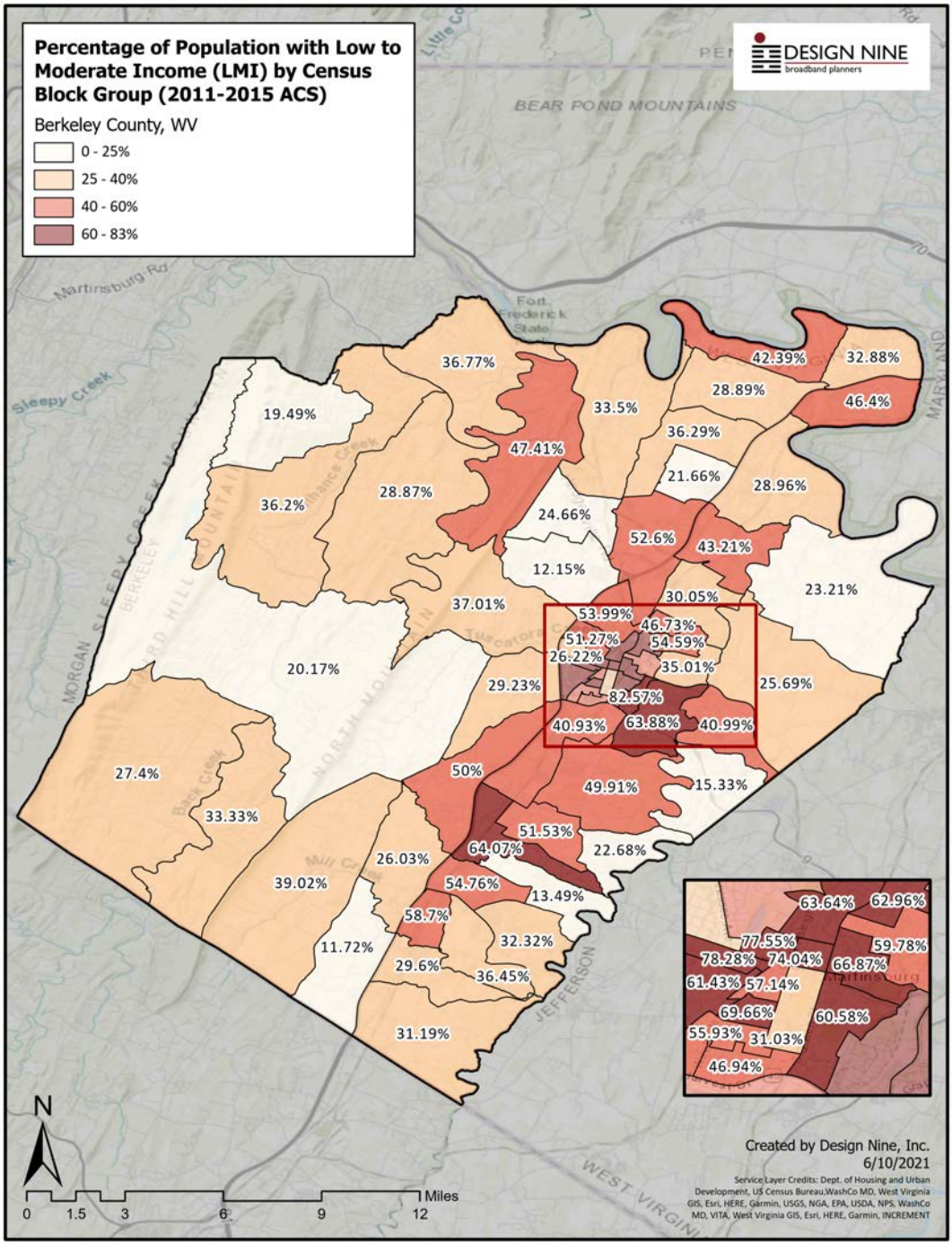
This map shows the population and density distribution in the county, by census block. This information can be helpful when working with service providers and when trying to identify what technologies are most appropriate for various areas of the county.

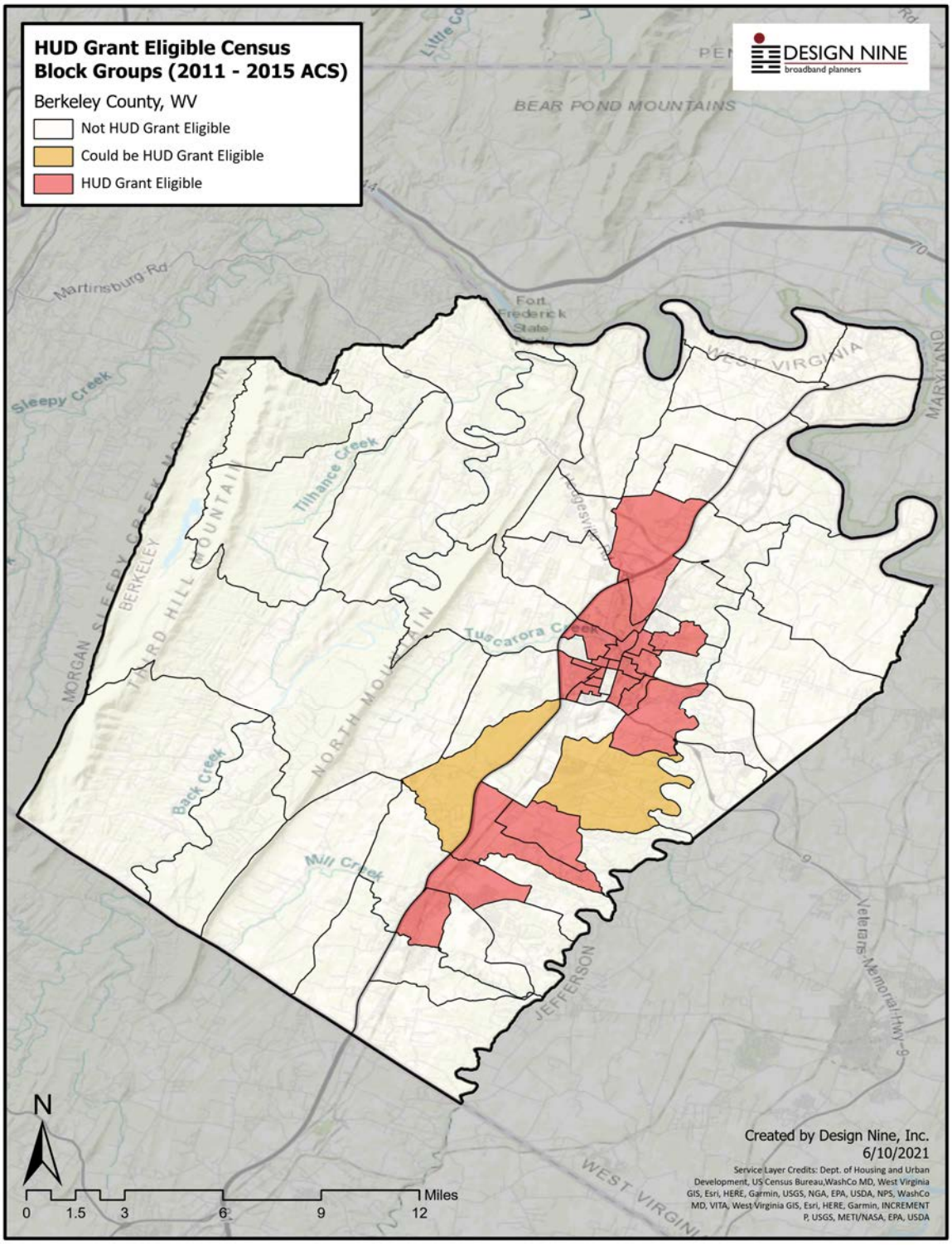


3.3 LMI AND HUD ELIGIBLE AREAS

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.




HUD Grant Eligible Census Block Groups (2011 - 2015 ACS)
Berkeley County, WV
Not HUD Grant Eligible
Could be HUD Grant Eligible
HUD Grant Eligible
DESIGN NINE
broadband planners
BEAR POND MOUNTAINS
Martinsburg Rd
Fort Frederick State
WEST VIRGINIA
Sleepy Creek
Tilhance Creek
Tuscarora Creek
Back Creek
Mill Creek
JEFFERSON
Veterans Memorial Hwy-9
N
0 1.5 3 6 9 12 Miles
Created by Design Nine, Inc.
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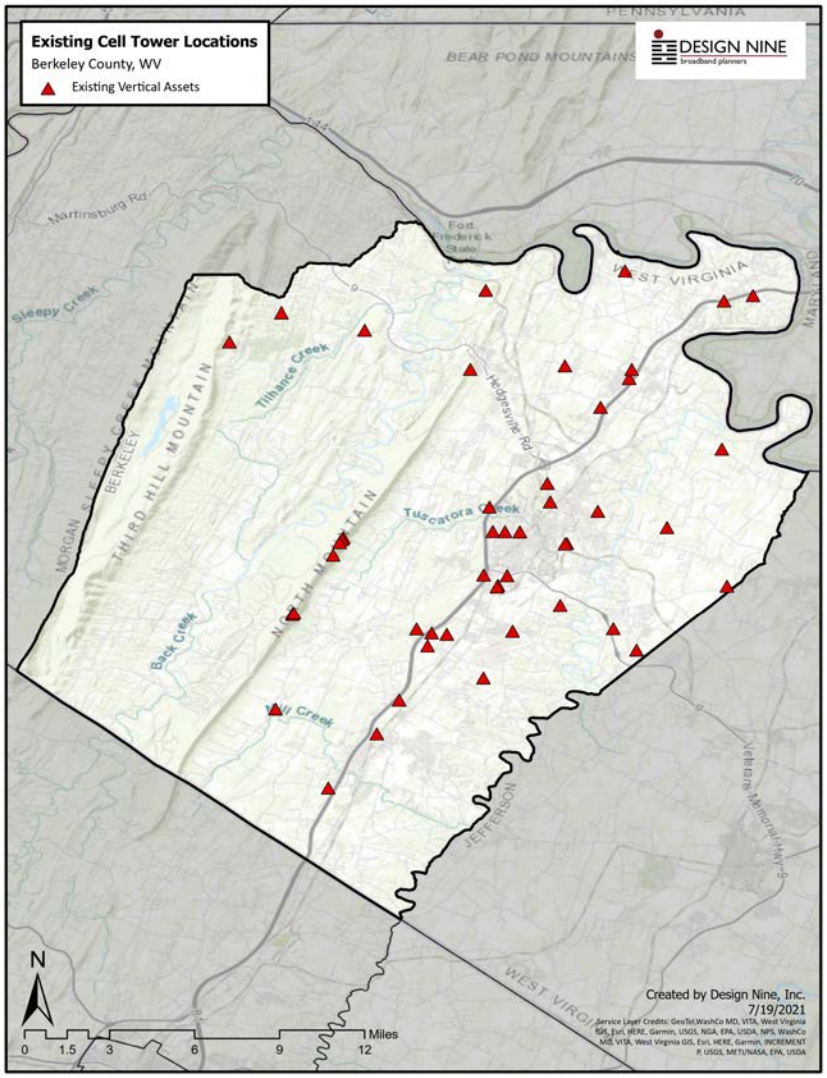
Service Layer Credits: Dept. of Housing and Urban Development, US Census Bureau,WashCo MD, West Virginia GIS, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS, WashCo MD, VITA, West Virginia GIS, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA

3.4 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. Tower ownership data is not always updated in a timely manner in the FCC database.

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.

This table provides additional detail on tower owners and tower locations. Data on tower locations and ownership was collected from County sources, the FCC tower registration database, and commercial data sources.

Tower Entity/Owner	Full Address	Height (ft)	FCC ASR	LATITUDE	LONGITUDE
United States Cellular Corporation	S By Se From Marlowe Marlowe, WV 25419	103.6	1010350	39.5836	-77.8533
Shenandoah Mobile	Rt 2 Box 442-B, Falling Waters, WV 25419	91.7	1033397	39.5808	-77.8681
United States Cellular Corporation	2955 Butts Mill Rd, Hedgeville, WV 25427	91.4	1259859	39.5662	-78.0515
Gs Communications	Mobile Home Community, Harlan Springs, WV 25403	25	1208111	39.548	-77.9493
United States Cellular Corporation	Cannon Hill Rd, Hedgesville, WV 25427	57.9	1207832	39.5462	-77.9976
Shenandoah Mobile	263 Orrick Riner Lane, Martinsburg, WV 25403	77.4	1033398	39.5268	-77.9311
United States Cellular Corporation	3.56 Mi East Of Us Route 11, Martinsburg, WV 25404	57.9	1267494	39.5054	-77.8692
Shenandoah Mobile	Rt 6 Box 497, Martinsburg, WV 25403	76.9	1033236	39.4758	-77.9878
Shenandoah Communications Dba = Wrnr Am	Twr 1 - Eagle School Rd 2.1 Mi Ne, Martinsburg, WV 25404	80	1035569	39.4736	-77.9325
Shenandoah Communications Dba = Wrnr Am	Twr 2 - Eagle School Rd 2.1 Mi Ne, Martinsburg, WV 25404	80	1035570	39.4736	-77.9325
Shenandoah Communications Dba = Wrnr Am	Twr 3 - Eagle School Rd 2.1 Mi Ne, Martinsburg, WV 25404	80	1035571	39.4736	-77.9325
West Virginia Radio Corporation Of The Alleghenies	1606 W King St, Martinsburg, WV 25401	68	1035789	39.4633	-77.9861
State Of West Virginia Dhhr/Bph State Trauma Emergency Care System	4 Mi E Of Martinsburg, Wv, Martinsburg, WV 25403	91.4	1282650	39.4601	-78.0624
West Virginia Radio Corporation Of The Alleghenies	Boyds Gap 5.5 Mi W, Martinsburg, WV 25403	54.9	1035788	39.4592	-78.0631
Spectrasite Communications Through American Towers	Turkeyfoot Rd (310925), Martinsburg, WV 25427	63.7	1062556	39.4577	-78.0643
Dp Media Of Martinsburg	3.9 Km W Of Nollville Wv, Martinsburg, WV 25403	68	1059977	39.4576	-78.0642
United States Cellular Corporation	In The City Of Martinsburg, Martinsburg, WV 25404	61	1023221	39.4572	-77.9483
Typhoon	North Mountain, Nollville, WV 25403	27.4	1208113	39.4512	-78.0676
Sba Towers	1673 Winebrenner Rd (Wv13520-A), Martinsburg, WV 25404	89.9	1229193	39.4353	-77.8666
United States Cellular Corporation	100 Brian Dr, Martinsburg, WV 25405	58.5	1244254	39.4349	-77.984

American Tower	Route 4, Box 577 (375288/Evans Run), Martinsburg, WV 25405	71.6	1236173	39.4255	-77.9517
United States Cellular Corporation	1.25 Mi Nw Of Rt. 45 And Poorhouse Rd, Martinsburg, WV 25403	30.5	1034520	39.4212	-78.0883
Cellco Partnership	2938 Charlestown Rd, Martinsburg, WV 25430	53.6	1283559	39.4134	-77.9246
Sba Towers	Martinsburg Airport, Martinsburg, WV 25405	48.8	1033110	39.4121	-77.976
Cellco Partnership	Tabler Station Business Park, Martinsburg, WV 25405	51.8	1280522	39.4105	-78.0096
Shenandoah Mobile	Rt 2 Box 204, Inwood, WV 25428	64.5	1033237	39.3769	-78.0339
United States Cellular Corporation	Cr26, Box318A, Bunker Hill, WV 25413	54.9	1203193	39.3321	-78.0701
Cig Towers	Near 807 Grade Rd, Falling Waters, WV 25419	59.4	1291400	39.5962	-77.9186
Vertical Bridge Towers	807 Grade Rd (Us-Wv-5011 - River Bend), Falling Waters, WV 25419	59.4	1298578	39.5962	-77.9186
Vertical Bridge Towers	807 Grade Road, Falling Waters, WV 25419	0	NA	39.5962	-77.9186
Vertical Bridge Towers	122 Beards Crossing Road, Hedgewsville, WV 25427	0	NA	39.5863	-77.9897
Adelphia Gs Cable, Debtor-In-Possession	Woods Golf Resort, Hedgesville, WV 25427	31	1208115	39.575	-78.094
Zayo	Mtn Lake Rd, Hedgesville, WV 25427	0	NA	39.5602	-78.1205
Vertical Bridge Towers	882 Tj Jackson Drive, Falling Waters, WV 25419	0	NA	39.5415	-77.9165
Kgi Wireless	664 Greensburg Rd, Martinsville, WV 25404	0	NA	39.4653	-77.8972
American Tower	1791 W Veterans Memorial Hwy, Rosemont, WV 25401	0	NA	39.4632	-77.9799
Vertical Bridge S3 Assets	800 Boston St (Us-Wv-5009 - Boston St Public Works), Martinsburg, WV 25401	43.6	1298281	39.4631	-77.9723
Vertical Bridge Towers	700 West Race Street, Martinsburg, WV 25401	0	NA	39.4631	-77.9723
Graincomm I	267 Golf Course Rd, Martinsburg, WV 25404	59.4	1302081	39.4569	-77.9492
Shenandoah Communications	North Mountian, Norville, WV 25403	27	1275569	39.4512	-78.0676
Vertical Bridge Towers	144-436 Retail Commons Parkway, Martinsburg, WV 25403	0	NA	39.441	-77.9908
Vertical Bridge S# Assets	1625 Winchester Ave (Us-Wv-5016 - Martinburg Quarry), Martinsburg, WV 25405	59.4	NA	39.4358	-77.9835
Vertical Bridge Towers	1623 Winchester Ave., Martinsburg, WV 25405	0	NA	39.4358	-77.9835
Adelphia Gs Cable, Debtor-In-Possession	North Mountain, Arden, WV 25403	37.1	1208114	39.4207	-78.0884
New Cingular Wireless Pcs	354 Clyde Bourm, Inwood, WV 25428	30.5	1238182	39.4133	-78.025
Cellco Partnership	Business Park Dr, Tablers Station, WV 25428	35.9	1297622	39.4112	-78.0173

Cellco Partnership	Off Busoness Park Dr, Tablers Station, WV 25428	38.1	1298118	39.4046	-78.0194
Shenandoah Mobile	South Of Novak Dr, Martinsburg, WV 25405	51.8	1297250	39.3882	-77.9909
American Tower	Sr 51, Gerrardstown, WV 25420	0	NA	39.3724	-78.097
Adelphia Gs Cable, Debtor-In-Possession	Church & Washington Sts, Inwood, WV 25428	25	1208112	39.3597	-78.0453
Crown Castle	1220 T J Jackson Dr, Falling Waters, WV 25419	0	NA	39.54615	-77.91522
Crown Castle	1305 Edwin Miller Blvd, Martinsburg, WV 25401	0	NA	39.4784	-77.95677
Crown Castle	1510 New York Ave, Martinsburg, WV 25401	0	NA	39.44071	-77.9788
Crown Castle	1872 Edwin Miller Boulevard, Martinsburg, WV 25404	0	NA	39.487846	-77.95829
Crown Castle	1937 Short Road, Kearneysville, WV 25430	0	NA	39.402428	-77.91275
Crown Castle	2739 Radio Tower Road, Gerrardstown District, WV 0	0	NA	39.421467	-78.087683
Berkeley County - Round Top Tower	823 Radio Tower Rd, Gerrardstown WV, 25420	120	NA	39.37182	-78.09652
Berkeley County - Central Dispatch Tower	802 Emmett Rousch Drive Martinsburg, WV 25401	140	NA	39.44685	-77.96489
Shenandoah Communications Inc.	Eagle School Rd 2.1 Mi NE Martinsburg, WV 25401	262	1035571	39.4769	-77.9311

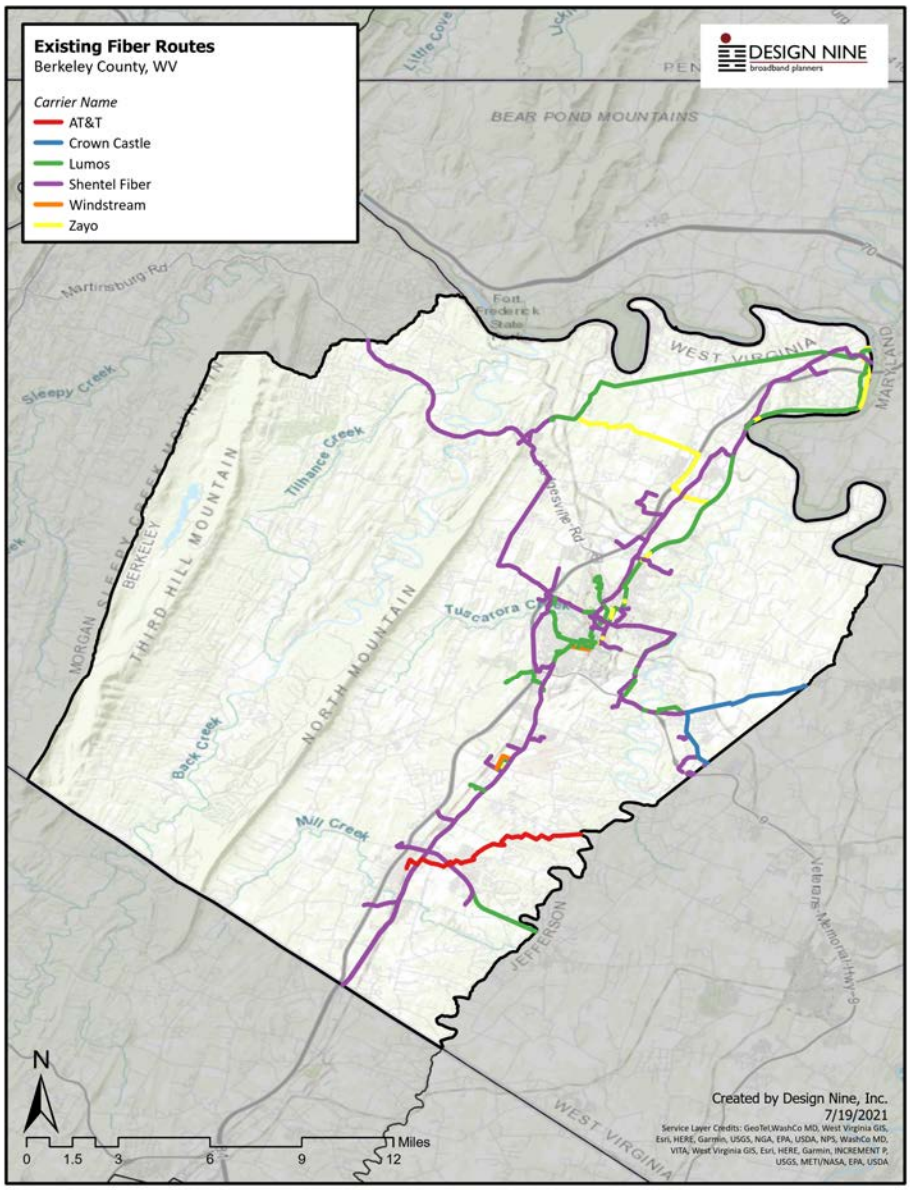
3.5 FIBER ROUTES IN THE COUNTY

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

Most fiber routes in 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.

Berkeley County has mostly north-south long haul fiber routes, with some other shorter routes on the east side of the county. In the Martinsburg area, this is a major competitive advantage, and gives the county an edge in economic development–the eastern part of the county is desirable for data centers and other high volume data businesses.

Large areas of the county have no long haul fiber availability, which creates a challenge for local and regional WISPs (wireless Internet providers) who need affordable transport and Internet backhaul fees.



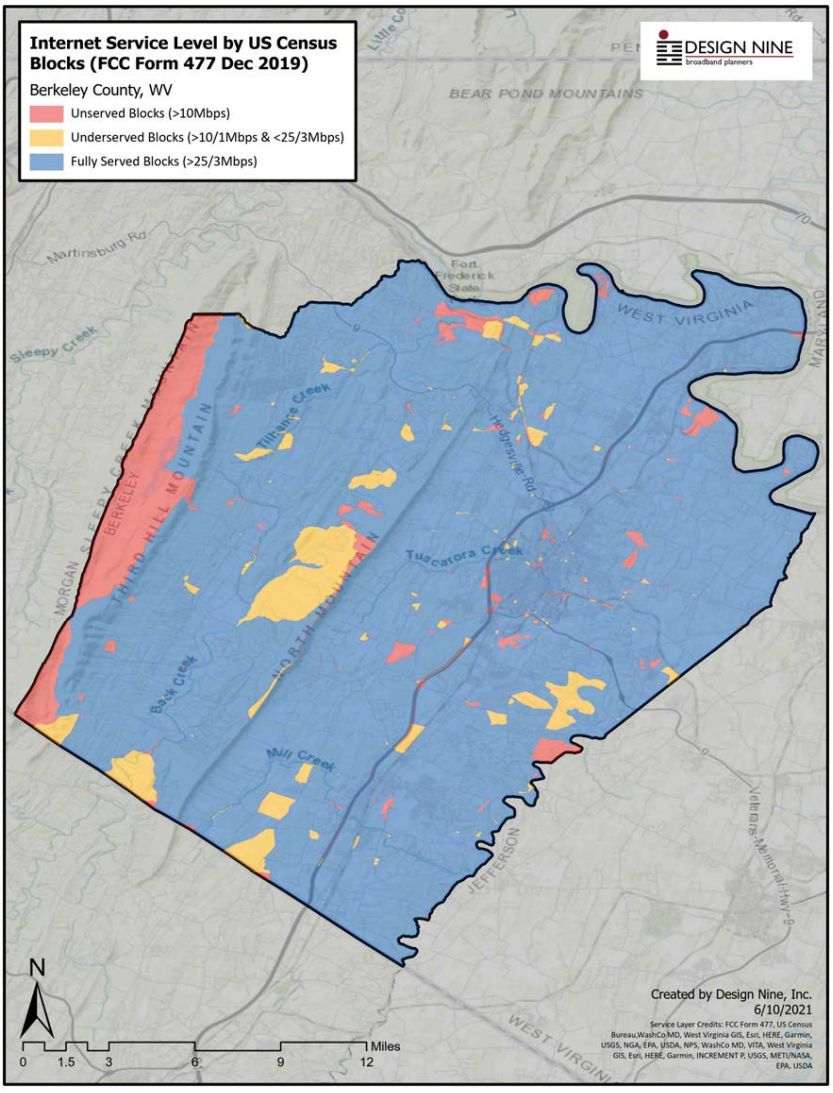
3.6 SERVED, UNDERSERVED, AND UNSERVED AREAS

The areas on the map below have been identified using FCC (Federal Communications Commission) 477 data. The map also shows the three areas (outlined in red) where fiber pilot studies were done as part of this work (see Section 7). 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

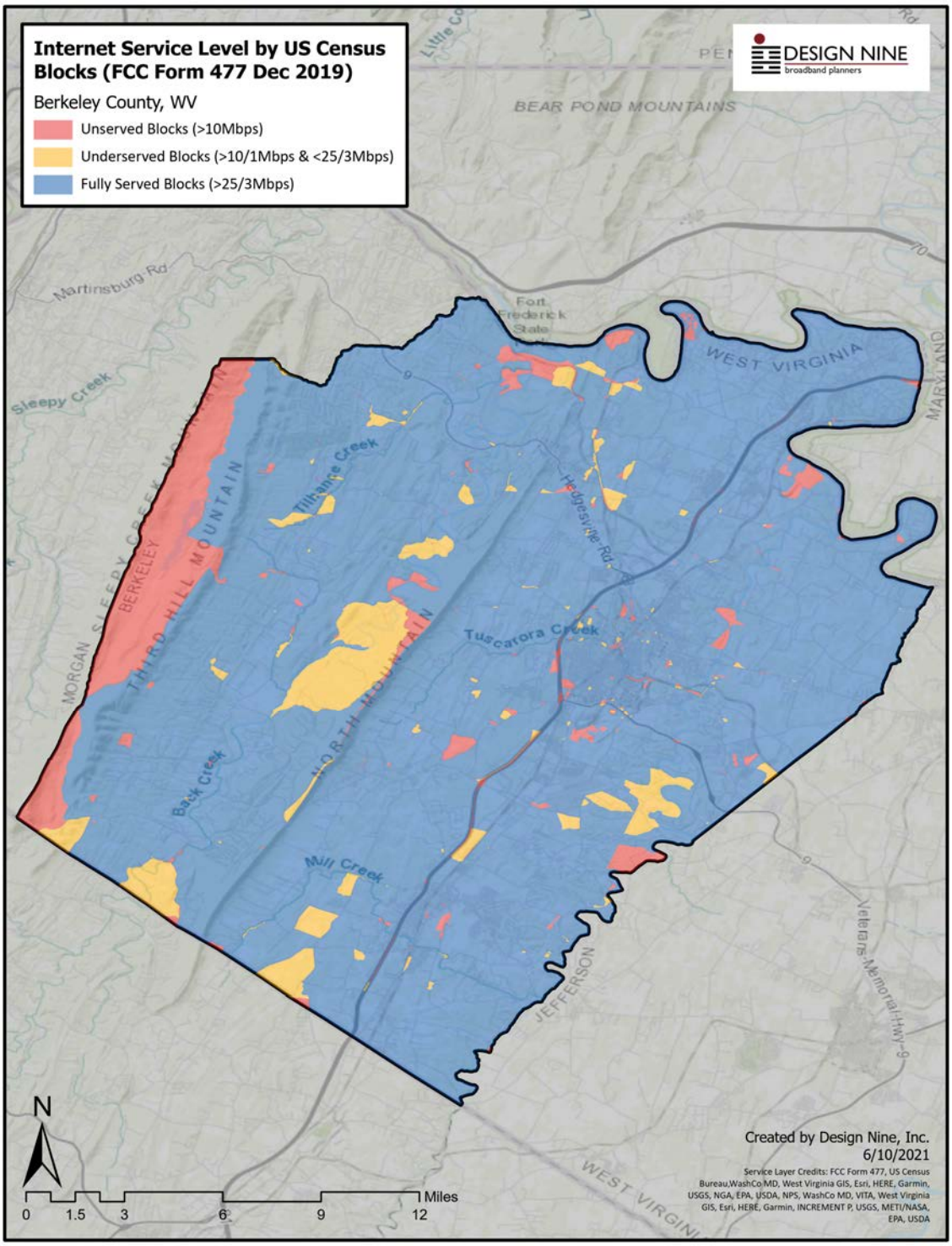
Served – Equal to or better than 25 Megabits down/3 Megabits up



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.

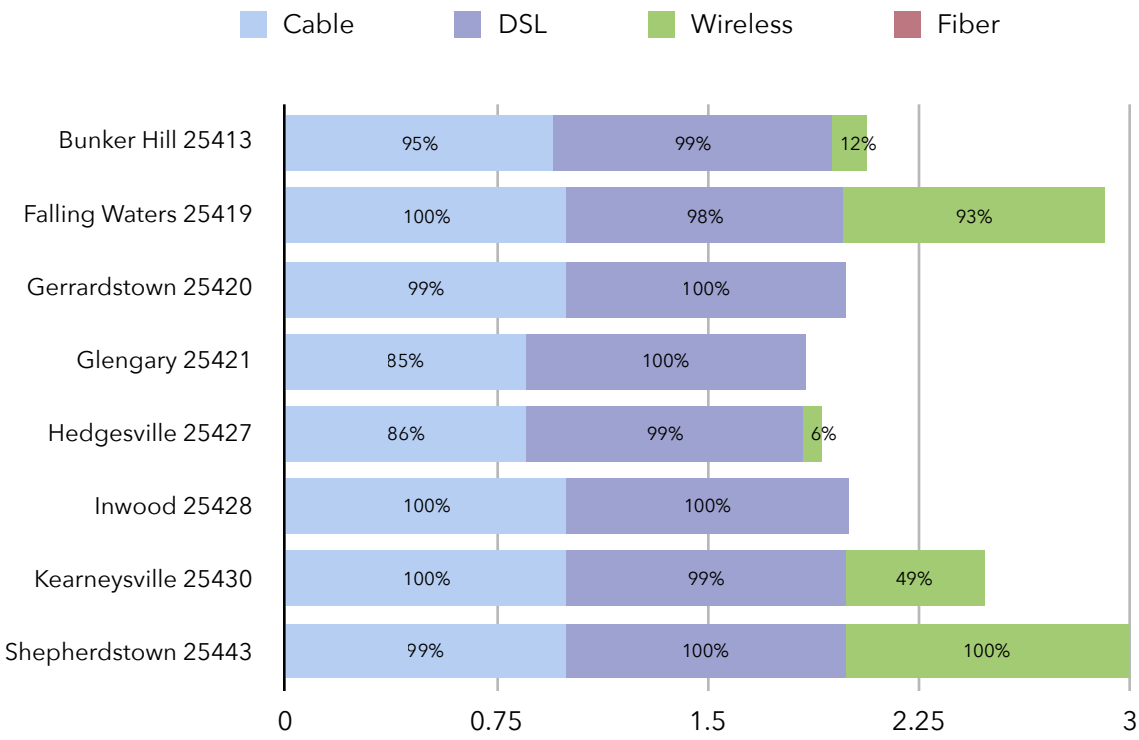
While the FCC data indicates that the entire county is fully served, there is wide variance in the kind and type of service available to households in the county. Fixed point wireless Internet is widely available, and in most areas with wireless service, DSL is also available.



4.1 GAP ANALYSIS

According to a February 2021, Consumer Reports Survey, 75% of Americans say they need uninterrupted access to the Internet seven days a week[1]. How they get their service and the prices they pay for those services are very important. This service provider report provides key insights into the services currently available in Berkeley County. The chart below shows estimates of available broadband technology type in areas of the county by zip code.

This data is assembled from public sources, Decision Data which combines FCC data and data they collect from social media and Broadband Now. Also note that zip code boundaries are not aligned with local government jurisdictions, and some zip code data may include some areas outside the county. In the case of Berkeley County only 9.5% of residents in zip code 25443 live in the county. The information in these charts is current as of May 2021.

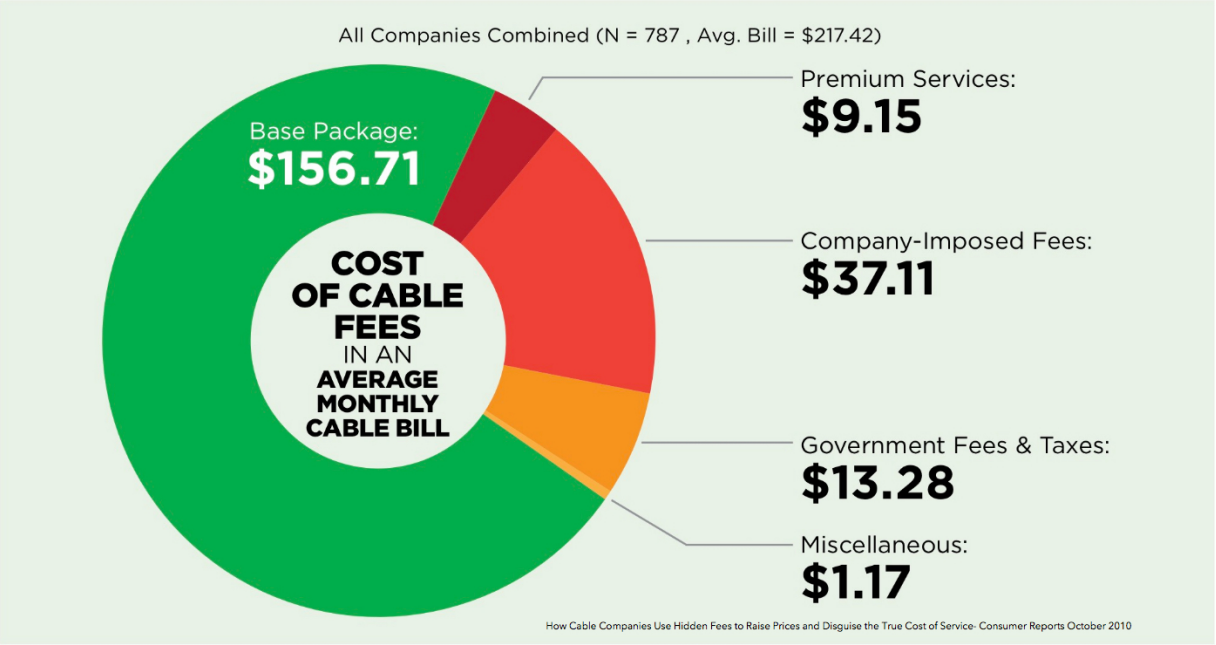


According to a 2019 Consumer Reports study[2], the national average advertised price for standard triple play services of Internet, television, and telephone across the country is $156.17. Because of

[1] Consumer Reports- Research Snapshot February 2012, The Importance of Broadband Internet

[2] Cord Cutting Continues, Fueled By High Cable Pricing, Consumer Reports' Survey Finds 9/17/2019

Figure A: Cost of Cable Fees in an Average Monthly Cable Bill (2018)



fees and taxes, the actual national average bill is $217.42. Nationally, consumers get an average of 24% added to their bill. Data caps which were turned off early in the pandemic are back[3] and will increase prices for heavy users.

It is normal to find a statement such as this in fine print terms and conditions, "Equipment, installation, taxes and fees, including regulatory recovery fees, Broadcast TV Fee (up to $19.45/mo.), Regional Sports Fee (up to $14.45/mo.) and other applicable charges extra, and subject to change during and after the term agreement. ."[4] The Broadcast TV Fee was $14.95 four months ago. The Regional Sports Fee was $8.75 per month at the same time. These two fees have increased a total $10.20 monthly in last quarter in areas we have researched.

Cord-cutting will increase in 2021 with another 27% of consumers dropping their cable service.[5]

According to OpenVault, the average home used 482.6 GB of data a month in the fourth quarter of 2020. That is an increase of 40% over the 2019 number.[6] Year over year increases have become

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[3] Consumer Reports -Get Ready for Cable TV and Internet Price Hikes and Data Caps in the New Year 12/21/20

[4] Xfinity terms and conditions- Beckeley County, WV 05/17/21

[5] Forbes -Cord-Cutting To Accelerate In 2021, With 27% Of Cable Households Disconnecting 1/12/21

[6] Broadband Insights Report (OVBI) 4Q20 page 2

standard but last year's increase is higher than growth seen in recent years. Internet users span all age groups ranging from 100% of 18- to 29-year olds to 73% of 65-year-olds and older.[7]

The table below illustrates the estimated telecom expenditures, public and private, over the next thirty years. Over that time period, **over $3.23 Billion** will be spent on telecom services. This shows that there is money for broadband, but most of it is placed in envelopes every month and most of it leaves both the county and the state. Redirecting as little as 5% of those funds could build fiber to every home and business in Berkeley County.

Telecom Expenditures - Berkeley County, WV

Berkeley County 30 Year Estimated Telecom Expenditures				
Total Households	44,221			
Businesses	1,658			
Estimated Internet Access Type	Households using Cell Phone for Internet	Households with "little" broadband DSL	Households with Cable Modems	Households with no Internet
Household Percentage	9%	42%	32%	17%
Number of households	3,980	18,573	14,151	7,518
Average monthly telecom expenditures	Cell Phone for Voice/Internet $90 Cable/satellite TV: $65 bundle	Cell Phone $70 Phone: $13 Satellite TV: $60 Broadband Internet: $45	Cell Phone $70 Phone $15 TV $43 Broadband Internet $45	Cell Phone, no Internet, $70 Cable/satellite TV: $65
Monthly Cost of Services	$155	$188	$173	$135
Annual household cost	$1,860	$2,256	$2,076	$1,620
Annual cost all households	$7,402,595	$41,900,282	$29,376,895	$12,178,463
30 year expenditure	$222,077,862	$1,257,008,458	$881,306,842	$365,353,902
Total residential expenditures	$2,725,747,063			
Total Estimated Cost of Hidden Fees	$401,831,982			
Total Business Costs	$102,961,800			
Total expenditures	**$3,230,540,845**			

[7] Statista- US Internet usage penetration 2021 by Joseph Johnson, April 14, 2021

4.2 MARKET ANALYSIS

This information provides pricing data and services available from providers in Berkeley County. Prices, availability and promotional offers change frequently and sometimes vary depending on street address. Information was compiled using a variety of public sources and Internet Service Provider (ISP) websites including Decision Data which combines FCC data and data they collect from social media and Broadband Now. Exact availability requires customer names and specific street addresses. Internet Service Providers showing less than 1% coverage in the county are not shown in the following data. All Points Wireless services could be confirmed in the one zip code area, zip code 25413, where our sources showed availability.

Summary of Service Provider Data - Berkeley County, WV

	Least Expensive Internet Only Service	Least Expensive Internet Only Service Meeting 25/3	Least Expensive Triple Pay Package Meeting
Frontier DSL	$44.99	$44.99	N/A
Lumos DSL	Unlisted pricing*	N/A	N/A
Xfinity Cable	$65	$65	$130.99
Telegia - Wireless	$61.25	N/A	N/A
All Points	$79	$299	N/A
HugesNet	$59.99	$59.99	N/A
Viasat	$100	$150	N/A
Starlink	$99	$99	N/A

* Lumos DSL shows as on 3.2% available in one zip code, 25401. Their DSL pricing is unlisted and can only be found by providing an address within the service area.

All the information available at the time of the report is included in this table. If a table cell has no information, that information was not found. However, if there is no information in the "One-time Fees," it does not necessarily mean there are no one-time fees. It just means that information on the one-time fees could not be found on the company's public website.

NOTE: Many ISPs do not provide upload speeds. This table indicates that no upload speed was discoverable by the abbreviation 'NA' (Not Available).

Wireline Internet service provider comparison for Berkeley County, WV

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Frontier DSL	After promo period price might increase	$44.99		25/NA	None	Activation $85	Internet Only
Frontier DSL Voice	No second year pricing	$25			None		Limited digital voice
Lumos DSL	Unlisted Pricing						Internet Only
Xfinity Cable	$80.95	$29.99 1 year, no contract	Modem $14	100/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Includes $10 discount for paperless billing include Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month
Xfinity Cable	$65	No promo, no term agreement	Modem $14	50/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Includes $10 discount for paperless billing include Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Xfinity Cable	$95.95	$44.99 2 years, no contract	Modem $14	200/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Promo rate Includes $10 discount for paperless billing Includes Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month
Xfinity Cable	$100.95	$59.99 1 year	Modem $14	400/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Promo rate Includes $10 discount for paperless billing Includes Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month
Xfinity Cable	$105.95	$69.99 1 year	Modem $14	800/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Promo rate Includes $10 discount for paperless billing Includes Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Xfinity Cable	$106	$79.99 Promo for 2 years $89.99 Prom for year 3	Modem $14	1200/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Promo rate Includes $10 discount for paperless billing Includes Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month
Xfinity Cable	$116	$80 Promo for 2 years	Modem $14	1200/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Promo rate Includes $10 discount for paperless billing Includes Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month
Xfinity Cable	$299.95	No promo rate. Two year agreement	Modem $14	2000/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet only, Includes Peacock Premium & Voice remote at No cost, streaming limited to three devices. Extra devices $5 month

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Xfinity Cable TV, Phone	$130.99	$89.99 two-year promo. Two year aggree-ment	Modem $14	200/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month	Early Terminat ion Fee	Internet, TV and Unlimited Calling nationwide Promo rate Includes $10 discount for paperless billing Includes 130+ channels
Xfinity Cable TV, Phone	$159.99	$99.99 two-year promo. Two year aggree-ment	Modem $14	800/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month	Early Terminat ion Fee	Internet, TV and Unlimited Calling nationwide Promo rate Includes $10 discount for paperless billing Includes 205+ channels 150 hrs DVR service
Xfinity Cable TV, Phone	$189.99	$129.99 two-year promo. Two year aggree-ment		1200/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month	Early Terminat ion Fee	Internet, TV and Unlimited Calling nationwide Promo rate Includes $10 discount for paperless billing Includes 210+ channels 300hrs DVR service

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Xfinity Cable TV, Phone	$199.99	$149.99 two-year promo. Two year aggree-ment		1200/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month	Early Terminat ion Fee	Internet, TV and Unlimited Calling nationwide Promo rate Includes $10 discount for paperless billing Includes 245+ channels 300hrs DVR service
Xfinity Cable Internet, Phone	$109.9	$59.99 one-year promo.		100/NA	1.2 TB Additional blocks of 50GB for $10 each after 1 courtesy month Unlimited Data extra $30 per month		Internet, TV and Unlimited Calling nationwide Promo rate Includes $10 discount for paperless billing
All Xfinity services with Cable TV include this statement in Services and Incentives Column							Equipment, installation, taxes and fees, Broadcast TV Fee (up to $19.45/ mo.), Regional Sports Fee (up to $14.45/mo.) and other applicable charges extra, and subject to change
Xfinity Cable TV	$30	No contract	$7.50 for each TV box				TV only- 10 channels- Service limited to a single outlet
Xfinity Cable TV	$65.27	No contract	$7.50 for each TV box				TV only- 140+ channels- Service limited to a single outlet
Xfinity Cable TV	$85.26	$69.99 No contract	$7.50 for each TV box				Promo rate includes $10 per month discount for paperless & auto billing for 24 months. TV only- 220+ channels- Service limited to a single outlet

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Xfinity Cable TV	$139.21	$89.99 No contract	$7.50 for each TV box				Promo rate includes $10 per month discount for paperless & auto billing for 24 months. TV only- 260+ channels- Service limited to a single outlet

Wireless Internet service provider comparison for Berkeley County, WV

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees	Incentives & Notes
All Points	$79	1 Year		4/1	1	100 GB	$199	Internet only- Telephone available $35 mthly
All Points	$99	1 Year		8/2	2	None	$149	Internet only- Telephone available $35 mthly
All Points	$199	1 Year		15/3	3	None	$99	Internet only- Telephone available $35 mthly
All Points	$299	1 Year		25/3	3	None	$99	Internet only- Telephone available $35 mthly
Morgan County Wireless	$80			25/3			$200 setup	Includes Modem/ Router
Telegia	$61.25			10/3	3		$149 installation	
Telegia	$71.25			15/5	5		$149 installation	
Telegia	$81.25			20/5	5		$149 installation	

Satellite Internet service provider comparison for Berkeley County, WV

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees
HughesNet	$59.99	$49.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	3	After 10 GB (speeds drop to 1-3 Mbps)	Purchase and lease options. Latest pricing is $249.99 to purchase or $99 lease activation
HughesNet	$69.99	$59.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	3	After 20 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation
HughesNet	$99.99	$89.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	3	After 30 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation
HughesNet	$149.99	$139.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	3	After 50 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation
Viasat	$99.99	$69.99 for first three months 24 month contract	$12.99/ month (modem)	12/3	3	40 GB priority data	Equipment purchase instead of lease $299.99- Setup Fee- Unknown
Viasat	$149.99	$99.99 for first three months 24 month contract	$12.99/ month (modem)	25/3	3	60 GB priority data	Equipment purchase instead of lease $299.99- Setup Fee- Unknown

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees
Viasat	$199.99	$149.99 for first three months 24 month contrac	$12.99/ month (modem)	30/3	3	100 GB priority data	Equipment purchase instead of lease $299.99- Setup Fee- Unknown
Starlink	$99	Has moved from public beta*	Unknown	100/40	Up to 40	None	$499 for the Starlink Kit, which includes a mounting tripod, a WiFi router, and a terminal to connect to the

*Starlink is taking orders on a first come, first served basis and according to their website is targeting service availability in Berkeley County in mid to late 2021. There is a $99 reservation deposit, shipping and handling is $50 and they estimate taxes on the $499 equipment for a WV location at $32.94.

5 CURRENT USE ANALYSIS

5.1 HOW MUCH BROADBAND IS ENOUGH?

Bandwidth needs for the past several years have been growing by an estimated 30% per year and show no sign of slowing.

This means residential and business bandwidth needs are doubling every three years.

As computers and associated hardware (e.g. video cameras, audio equipment, and VoIP phones) become more powerful and less expensive, new applications and services are continually emerging that drive demand for more bandwidth.

"Next generation" is the term used to describe future planning for network connectivity and infrastructure. Next-generation broadband reaps substantial benefits. There are several key benefits of Next-generation broadband:

- Dramatically faster file transfer speeds for both uploads and downloads.
- The ability to transmit streaming video, transforming the Internet into a more visual medium.
- The means to engage in true-real time collaboration.
- The ability to use many applications simultaneously.
- The ability to maintain flexible work schedules by being able to work from home on a part-time or full-time basis.
- The ability to obtain health-related services for an occasional illness and/or long term medical services for chronic illnesses.

Clearly, consumers have a strong interest in a visual medium from when and wherever they are. YouTube is the second most popular search engine after Google, which demonstrates the need to support the infrastructure to transmit streaming video. In addition to video streaming, true real-time collaboration also provides an effective way for people to interact from wherever they are. People can engage in a two-way real-time collaboration so that fruitful, visual conversations can be held between friends, family, business associates from the state, country, or internationally.

Because of fiber networks, employees have the capability of working from home. Findings suggest that if all Americans had fiber to the home, this would lead to a 5% reduction in gasoline use, a 4% reduction in carbon dioxide emissions, $5 billion in lower road expenditures, and 1.5 billion commute hours recaptured.

In Berkeley County today, many residents and businesses are still relying on copper-based services. The bandwidth tables on the following pages show what is likely to be needed over the the next several years in terms of bandwidth. The existing copper infrastructure is going to become a limiting factor in economic development.

5.1 JOB AND WORKFORCE CHALLENGES

Most residents and businesses in the county currently have, at best, Internet service that meets the FCC definition of "fully served," which is 25 Megabits down/3 Megabits up bandwidth. However, what has become painfully clear during the Covid pandemic is that this definition of "fully served"

is not adequate to support many kinds of work from home activities. During the Covid lockdown, it was common to have both spouses trying to work from home while K12 and/or college age children were also trying to use video-heavy distance learning resources.

When home-based workers need to connect to a corporate VPN (Virtual Private Network), bandwidth requirements can increase even more. Work from home and business from home activities should have, at a minimum, a symmetric service of at least 10 Megabits download and 10 Megabits upload speeds. Higher speed service could include service levels like 25 Megabits down/10 Megabits up. The critical requirement is an upload speed that supports work from home.

If the goal is to enhance business access to broadband, there can be no upper limit on the definition of broadband. Saying that broadband (as an example) is 5 Megabits/second of bandwidth or 10 Megabits/second is to tell the residents and businesses in the county that there will be limits on their work and job opportunities.

Broadband is a community and economic development issue, not a technology issue. The essential question is not, "What system should we buy?" or "Is 5G wireless better or cheaper than fiber?" Instead, the question is:

"What do businesses of and home-based workers of Berkeley County need to be able to compete globally over the next thirty years?"

In short, the county today has "little broadband" in the form of DSL limited cable modem service, along with a very limited amount of "big broadband" in the form of fiber to some businesses and residents. If the County makes investments in broadband and telecommunications infrastructure, it is absolutely critical that those investments are able to scale gracefully to meet business and economic development needs for decades. To close that gap between the FCC definitions and what the county needs to support future work opportunities and to support K12 and higher education school work, the county needs the following:

Broadband Services, Technologies, and Needs

BROADBAND SERVICE	TARGET DATE	TECHNOLOGY	WHERE NEEDED
25 Mbps download **3 Mbps upload**	2022	Wireless	As much of the county as possible, given funding constraints
25 Mbps download **10 Mbps upload**	2023	Wireless	In many locations in the county
1 Gbps download **1 Gbps upload**	2022	Fiber	In some key business and commercial areas
50 Mbps download **10 Mbps upload**	2024	Wireless & Fiber	In many locations in the county
100 Mbps download **100 Mbps upload**	2025	Fiber	Available to a minimum of 50% of residents and businesses in the county

Two key concepts that should drive county investments in telecom are:

"Broadband" is not the Internet

Bandwidth is not a fixed number

Broadband and "the Internet" are often used interchangeably, but this has led to much confusion. Broadband refers to a delivery system, while "the Internet" is just one of many services that can be carried on a broadband network. The challenge for the County is to ensure that businesses and homes have a broadband network with sufficient bandwidth to deliver all the services that will be needed and expected within the next three to four years, including but not limited to "the Internet."

The economic impact can include the following effects:

- Difficulty retaining some existing businesses - As business bandwidth needs continue to increase over the next several years, some businesses may need to move out of the county to ensure that they have the right bandwidth to support their business operations.
- Difficulty attracting new businesses - New businesses interested in some of the advantages available in the county (e.g. small town quality of life, good recreational opportunities, affordable housing) may be deterred by the cost and limited bandwidth available, and therefore choose other areas to locate.
- Difficulty keeping younger workers and families in the county - Younger workers and families tend to be heavy users of Internet services, and real estate agents are reporting that younger house buyers are reluctant to live in areas with poor Internet service.
- Reductions in real estate value - Homes with poor Internet service are more difficult to sell, leading to reduced prices and then impacting county property taxes negatively.

5.2 BUSINESS BANDWIDTH NEEDS

The table below shows bandwidth consumption for several types of businesses and a projection of the bandwidth needed 5 and 10 years out. The Covid pandemic has had the effect of dramatically increasing the number of home-based works and has also affected business travel decisions. More and more businesses will invest in high definition (HD) quality business videoconference systems to reduce the need for travel and to maintain high quality communications with a dispersed workforce. These HD systems require substantial bandwidth; a two-way HD video conference requires 20-25 Mbps during the conference, and a three-way conference requires 30-35 Mbps during the conference.

Business Bandwidth Needs

	LARGE BUSINESS		**SMALL BUSINESS**		**HOME BASED WORKER**	
DESCRIPTION	A larger business with about 50 workstations.		A small business with 10 to 15 employees, and 7-10 workstations.		One or two people working from home.	
	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps
Telephone	20	5	5	1.5	2	0.5
Credit Card Validation	4	4	1	1		0
Security System	1	5	1	2	2	2
Internet	50	500	7	10.5	2	20
VPN Connection	20	100	5	50	2	5
Data Backup	5	7.5	1	10	2	10
Web Hosting	1	2		0		0
Workforce Training (online classes)	5	20	1	10	2	10
HD Video-conferencing	20	125	2	20	2	10
Totals		**768.5**		**105.0**		**57.5**
5 YEARS FROM NOW	3-10 Gbps		250-500 Mbps		100-200 Mbps	
10 YEARS FROM NOW	10 + Gbps		2-4 Gbps		500-750 Mbps	

As more workers are moved to home-based offices, the business location must provide network access (Virtual Private Network (VPN)) to employees working from home. These home-based workers will make extensive use of videoconferencing to attend routine office meetings remotely and to enhance communications with co-workers, including videoconferences with other home-based workers in the company. A VPN network providing remote access to just two or three home-based employees could require 50 Mbps of bandwidth during normal work hours.

5.3 RESIDENTIAL BANDWIDTH NEEDS

The table below depicts the bandwidth needed for typical residential services which are available now or will be available in the near future. The Covid pandemic has illustrated the shortcomings of cable Internet services, in which the upload and download speeds are highly asymmetric.

For home-based workers, upload speeds need to be equal to or nearly equal to download speeds. Current cable Internet systems are not able to deliver symmetric or near symmetric service. Today's shared networks (cable and wireless in particular) rely on the "bursty" nature of traffic to provide services to end users. If all end users were consuming their advertised maximum bandwidth, today's cable and DSL networks would grind to a halt.

Residential Bandwidth Needs

	RESIDENTIAL DAYTIME		EARLY EVENING		EVENING & LATE NIGHT	
DESCRIPTION	Work from home, K12 distance learning and home schooling, telemedicine, streaming video		Increased Internet use as children arrive home from school and employees from work.		Peak television and Internet use. Multiple TV's are on, phone and computer being used.	
	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps
Telephone	1	0.25	1	0.25	1	0.25
Work From Home	1	10	1	10	1	10
HD TV	1	4	2	8	2	8
Security System	1	2	1	2	1	2
Internet	1	1.5	1	1.5	2	3
Online Gaming	0	0.25	1	5	2	10
VPN Connection	0	0	1	2	1	2
Data Backup		0	1	5	1	5
Telehealth	1	4	1	4	1	4
Distance Learning/ home schooling		0	1	10	1	10
Videoconferencing		0		0		0
Average needed bandwidth		**15-25**		**25-35**		**20-35**
Five years from now	50-75 Mbps		60-90 Mbps		50-100 Mbps	
Ten years from now	150-300 Mbps		200-350 Mbps		175-250 Mbps	

Existing cable modem network users are overwhelming the digital cable networks that were upgraded as little as three or four years ago, and the firms have had to artificially reduce the bandwidth available for certain kinds of high bandwidth services (e.g. peer to peer file sharing). Some cable providers have even run into capacity issues with the TV portion of their networks, and

some consumers have observed that some HD TV channels have been so highly compressed that picture quality has been noticeably degraded.

5.4 CURRENT AND FUTURE USES AND SERVICES

When analyzing future service needs, it is important to take into account ALL services that may be delivered over a broadband connection. Broadband is not a service – it is a delivery medium. Using roads as an analogy, broadband is the road, not the trucks that use the road. Internet access is a service delivered by a broadband "road," and that Internet service is just one of many services that are in demand. Today, congestion on broadband networks is not due just to increased use of email and Web surfing, but many other services.

This means that current DSL, wireless, and cable modem services are completely inadequate for future needs. Current DSL offerings are in the range of one Mbps to three Mbps for most residential users, three Mbps to five Mbps for business DSL users, and there are severe distance limitations on DSL. Higher bandwidth is possible, but as the DSL bandwidth goes up, the distance it can be delivered goes down.

Typical wireless broadband (not cellular data service) offerings are in the range of 5 Mbps to 10 Mbps. Some wireless providers are rolling out 10-20 Mbps services. As bandwidth increases, the cost of the equipment also increases, and even a 20 Mbps service is well short of the FCC definition of broadband: 25 Mbps down and 3 Mbps up.

Across the U.S., current average bandwidth for cable modem services is typically 10 to 25 Mbps, with cable companies promising much more using the phrase "up to..." to obscure actual bandwidth being delivered.

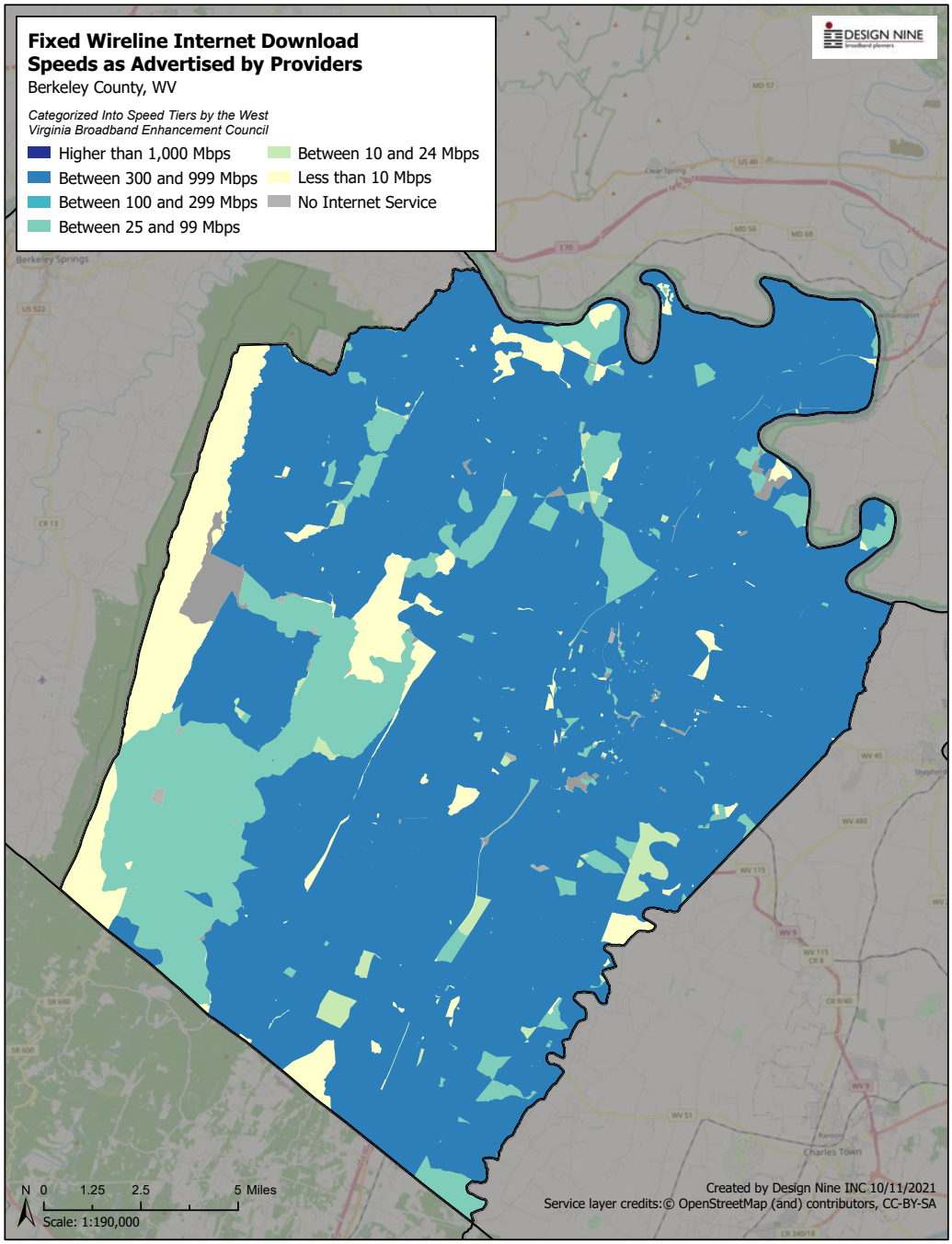
The challenge for the area is to ensure that the businesses, residents, and institutions have a telecommunications infrastructure in place that will meet future needs.

Distance learning, entertainment, and video conferencing are three major applications of internet video. Distance learning from home with live video feeds requires high-performance two to five Mbps connections in the near term, the next two to four years. Over the next four to seven years, there will be many distance-learning courses that will incorporate live HD two-way video feeds, enabling students to participate in classroom discussions at a much higher quality level. Distance learning could be an important home-based application for workforce training and retraining.

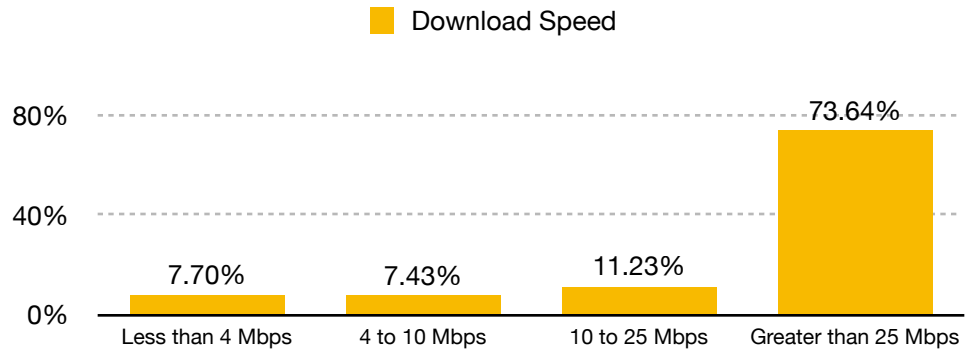
U.S. homes now have more than half a billion devices connected to the Internet, according to a study by the NPD Group. Furthermore, the average number of connected devices per household is 10 and growing rapidly. This is more than three times the average number of people per household.

5.2 WEST VIRGINIA SPEED TEST ANALYSIS

The state of West Virginia has been collecting speed test data provided by residents and businesses. The data on the map below is provided by the state but is based on rates advertised by the providers. At best, it is extremely optimistic, based on the actual survey data collected during this study. Even in the eastern part of the county in the Martinsville metro area, 300+ Megabits/second download speeds seems generous.

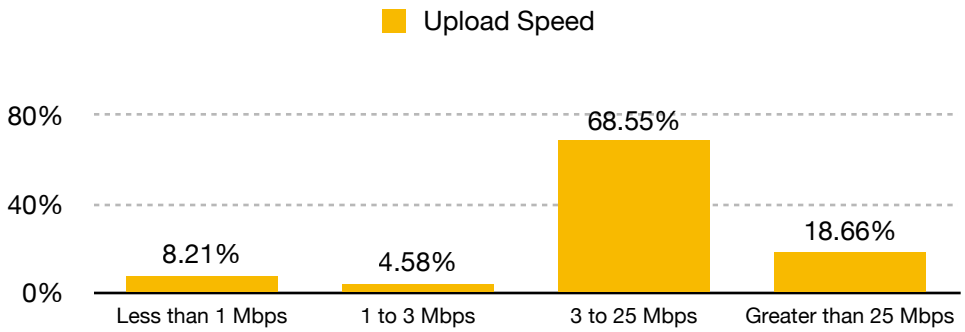


This download data is from the WV Speed Test, and is therefore much more accurate than the "advertised speeds" shown on the map on the previous page.



Download Speed Category	Number of Responses	Percentage
Less than 4 Mbps	964	7.70%
4 to 10 Mbps	931	7.43%
10 to 25 Mbps	1,407	11.23%
Greater than 25 Mbps	9,224	73.64%
Grand Total:	12,526	

This is the upload speed data from the WV Speed Test. The speed test data is not geolocated, so it is likely skewed towards the high end of speeds by those areas in the county with cable Internet service.



Upload Speed Category	Number of Responses	Percentage
Less than 1 Mbps	1,028	8.21%
1 to 3 Mbps	574	4.58%
Greater than 3 Mbps	8,587	68.55%
Greater than 25 Mbps	2,337	18.66%
Grand Total:	12,526	

6 BERKELEY COUNTY RESIDENTIAL SURVEY RESULTS

During the Summer of 2021, a broadband survey was conducted in Berkeley county as part of a county wide study in broadband needs. The online (Web) version of the survey was publicized on social media, the County Web site, and a Postal Service mailing to all households. Residents were encouraged to complete the survey online or fill out and return the paper version by surface mail. Businesses were encouraged to complete a separate business-focused survey, and the results of that are included later in this report.

A total of 2,308 responses were collected in the residential survey—more than 5% of households in Berkeley County responded to the survey. Not all responders answered every question. Note that because of rounding, not all percentages sum exactly to 100%. Many comments were received and are included in the appendices.

Some of the key findings from the results are listed below.

87% of respondents are interested in faster and more reliable Internet service

52% of residents are "dissatisfied" or "very dissatisfied" with current Internet speeds

96% of respondents said that they believe the County government should help facilitate better broadband

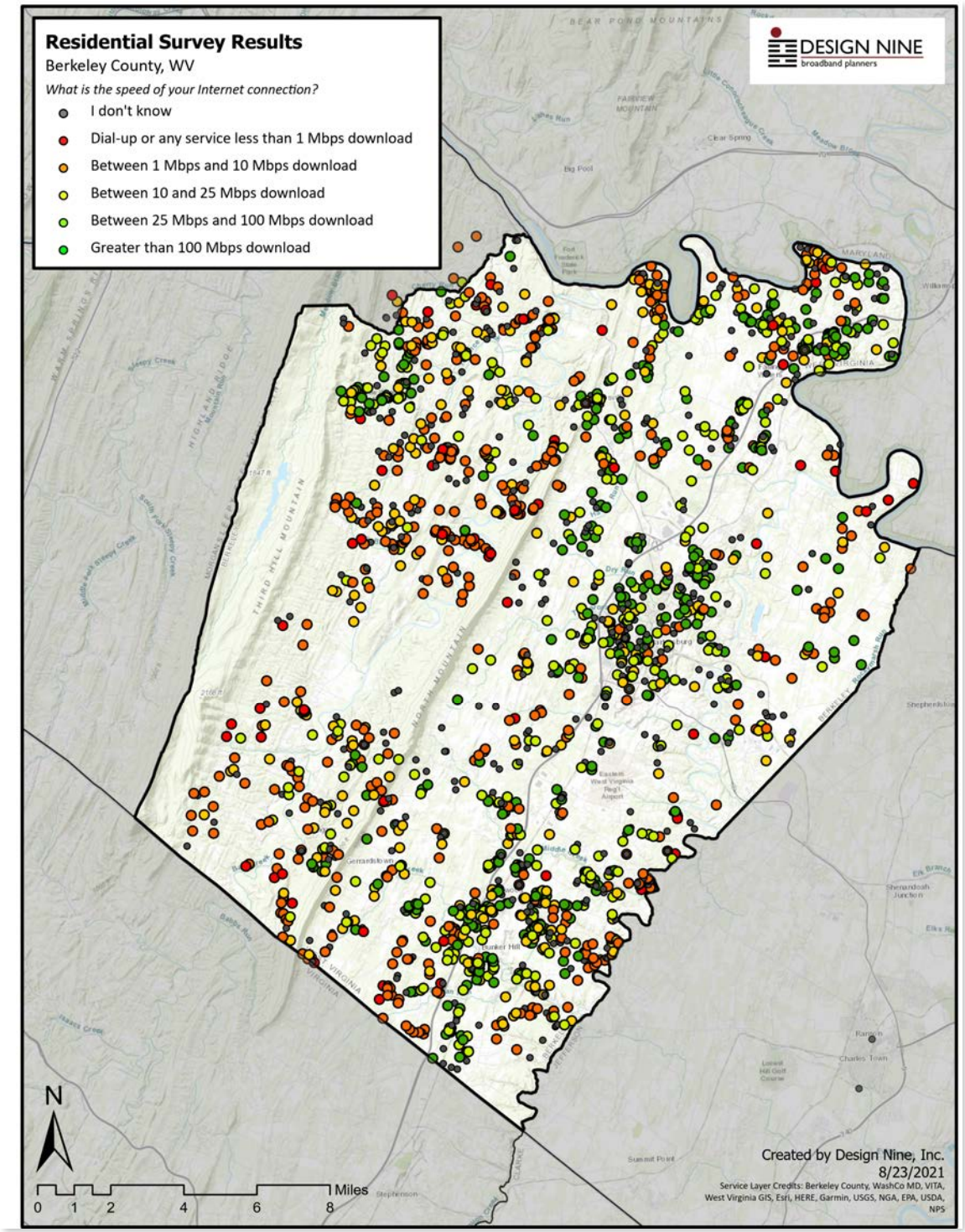
82% of residents have 5 or more Internet-connected devices in their home

67% of respondents report they have trouble using common Internet services

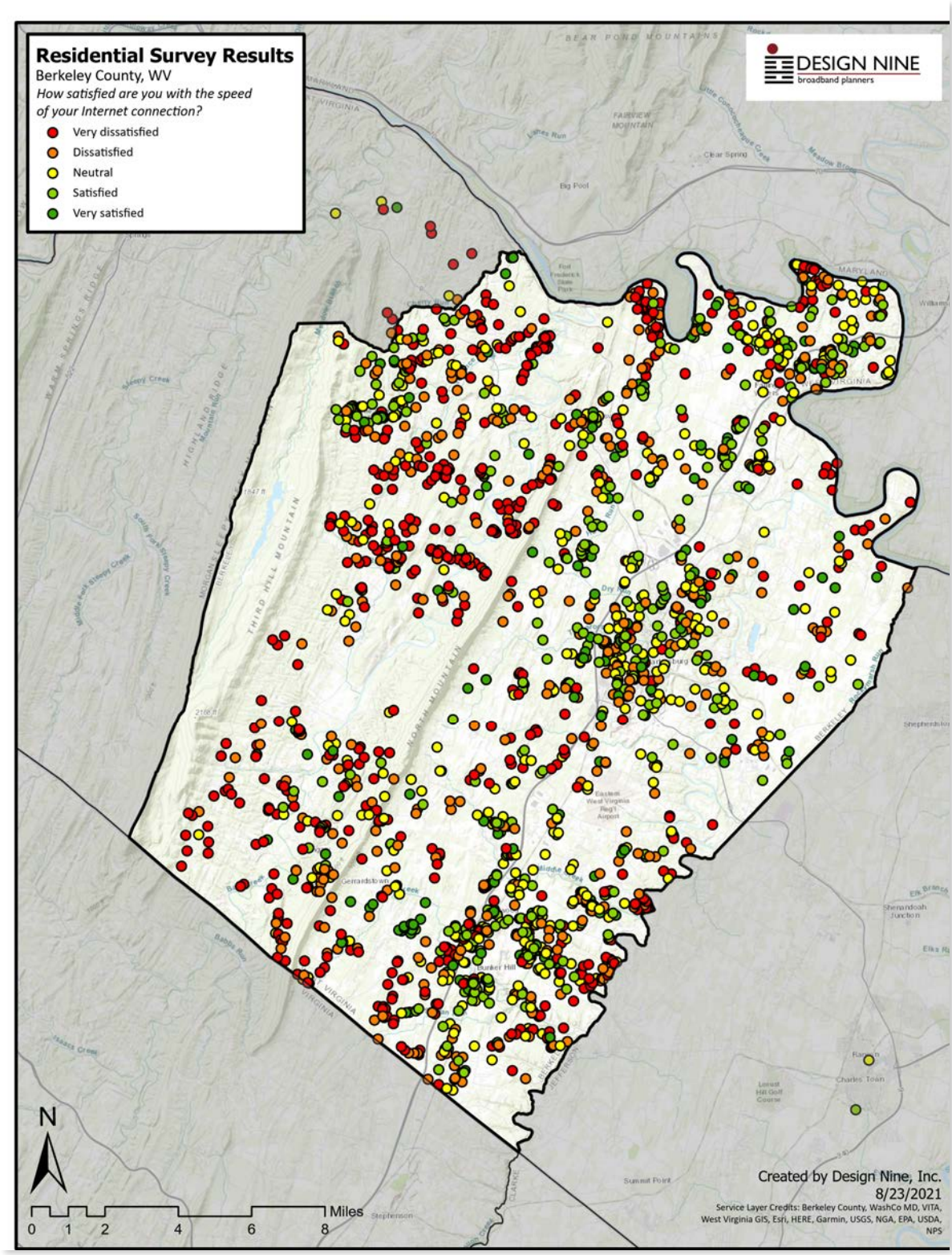
54% indicate that availability of broadband Internet is affecting where they choose to live

6.1 DISTRIBUTION OF RESIDENTIAL SURVEY RESPONSES

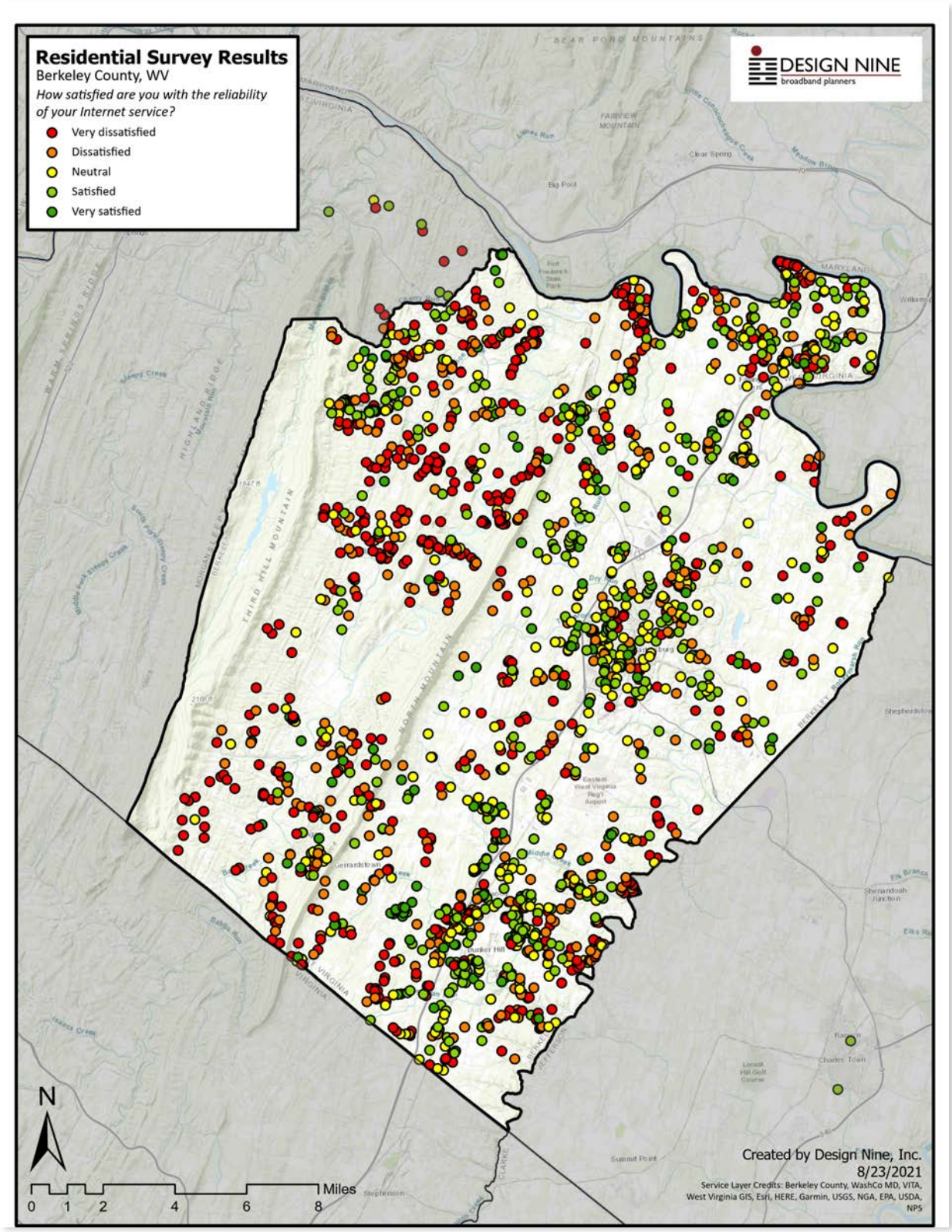
The map below shows the geographic distribution of responses to the residential survey, coded according to the speed of their Internet connection (Question 9).



The map below shows the geographic distribution of responses to the residential survey, coded according to their satisfaction with the speed of their existing Internet service (Question 11).



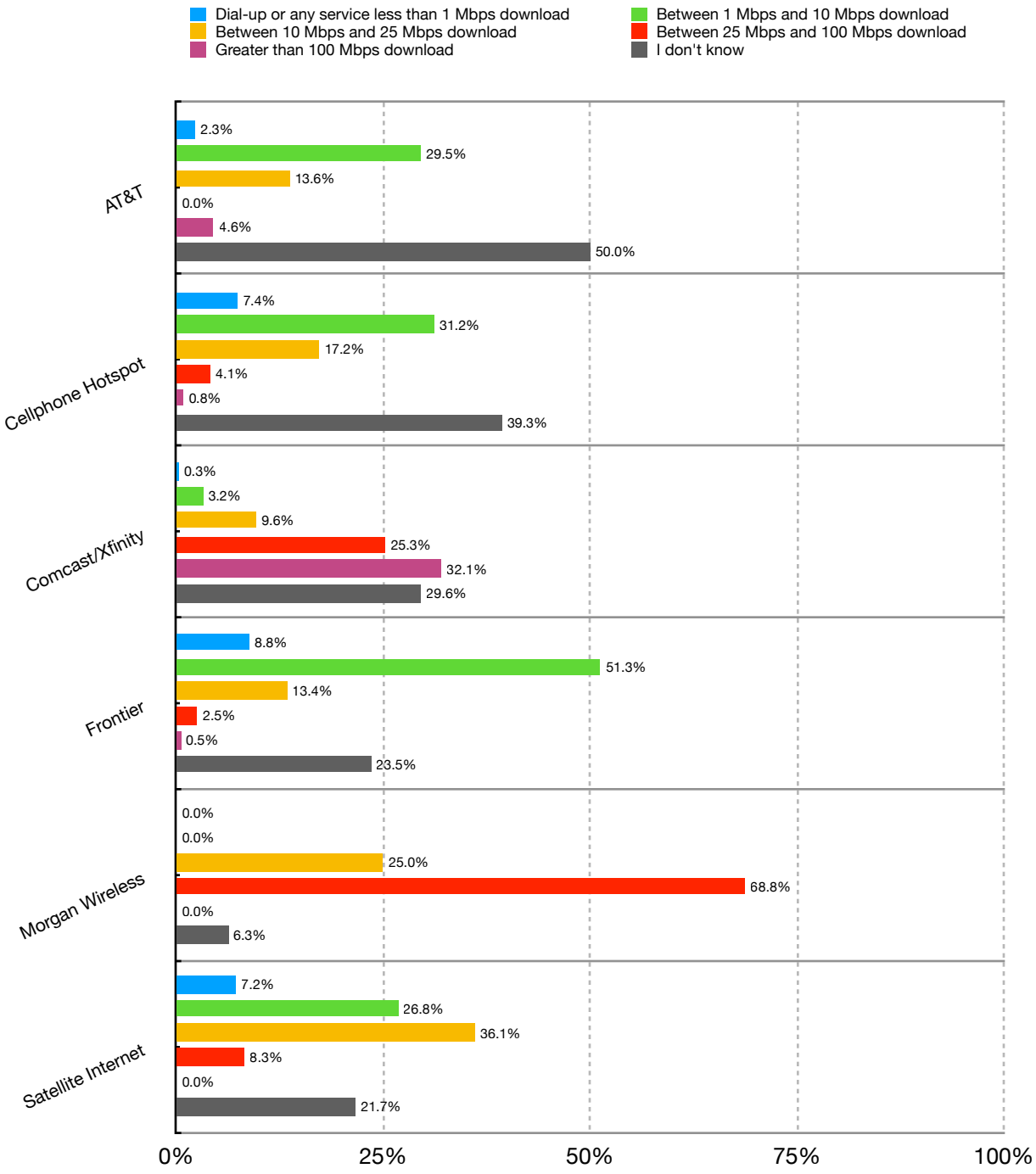
The map below shows the geographic distribution of responses to the residential survey, coded according to their satisfaction with the reliability of their existing Internet service (Question 12).



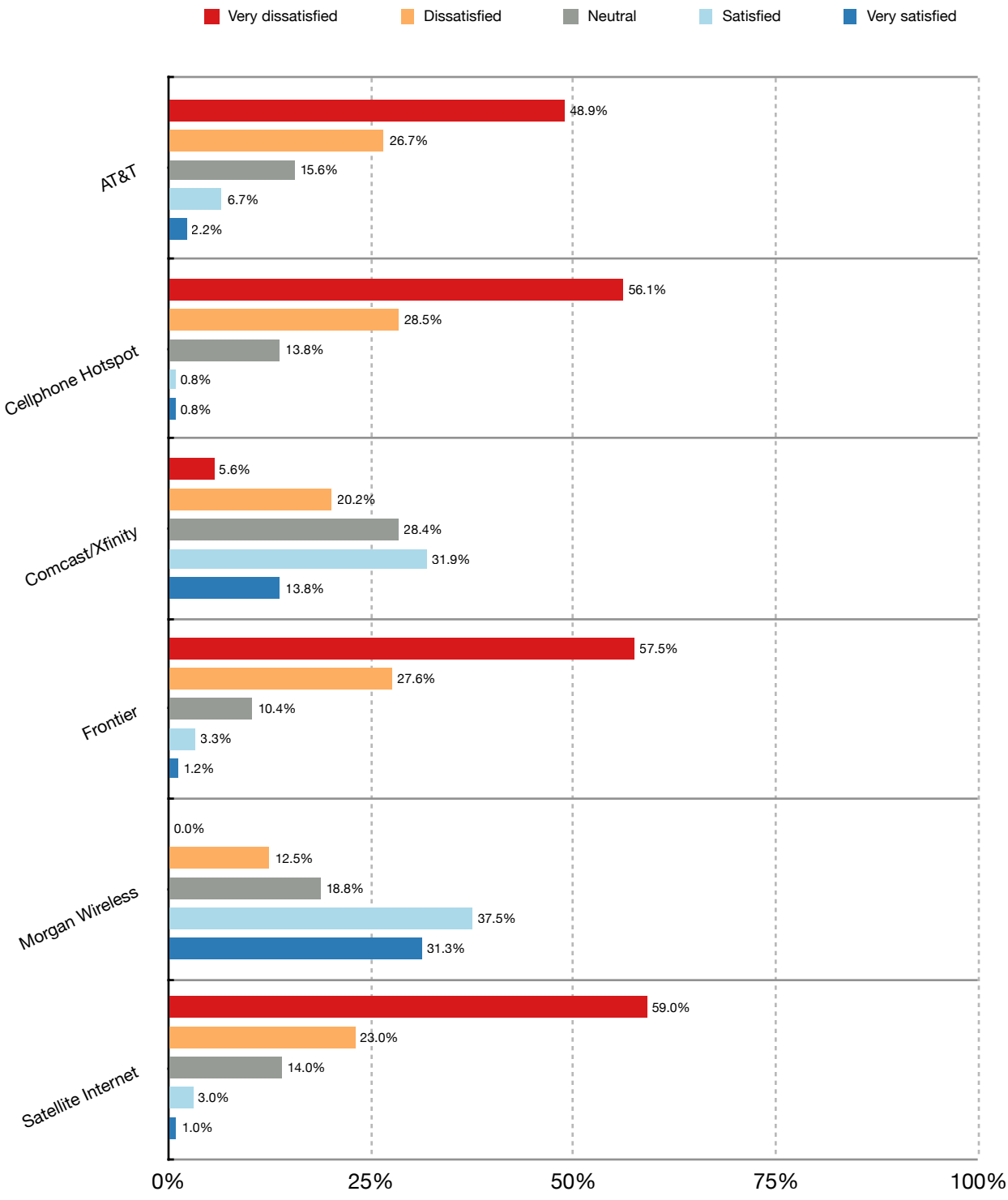
6.2 SERVICE PROVIDER SPEED AND SATISFACTION

The survey respondents provided both speed and satisfaction data, and the charts on the following pages provide insight into the responses, ranked by service provider.

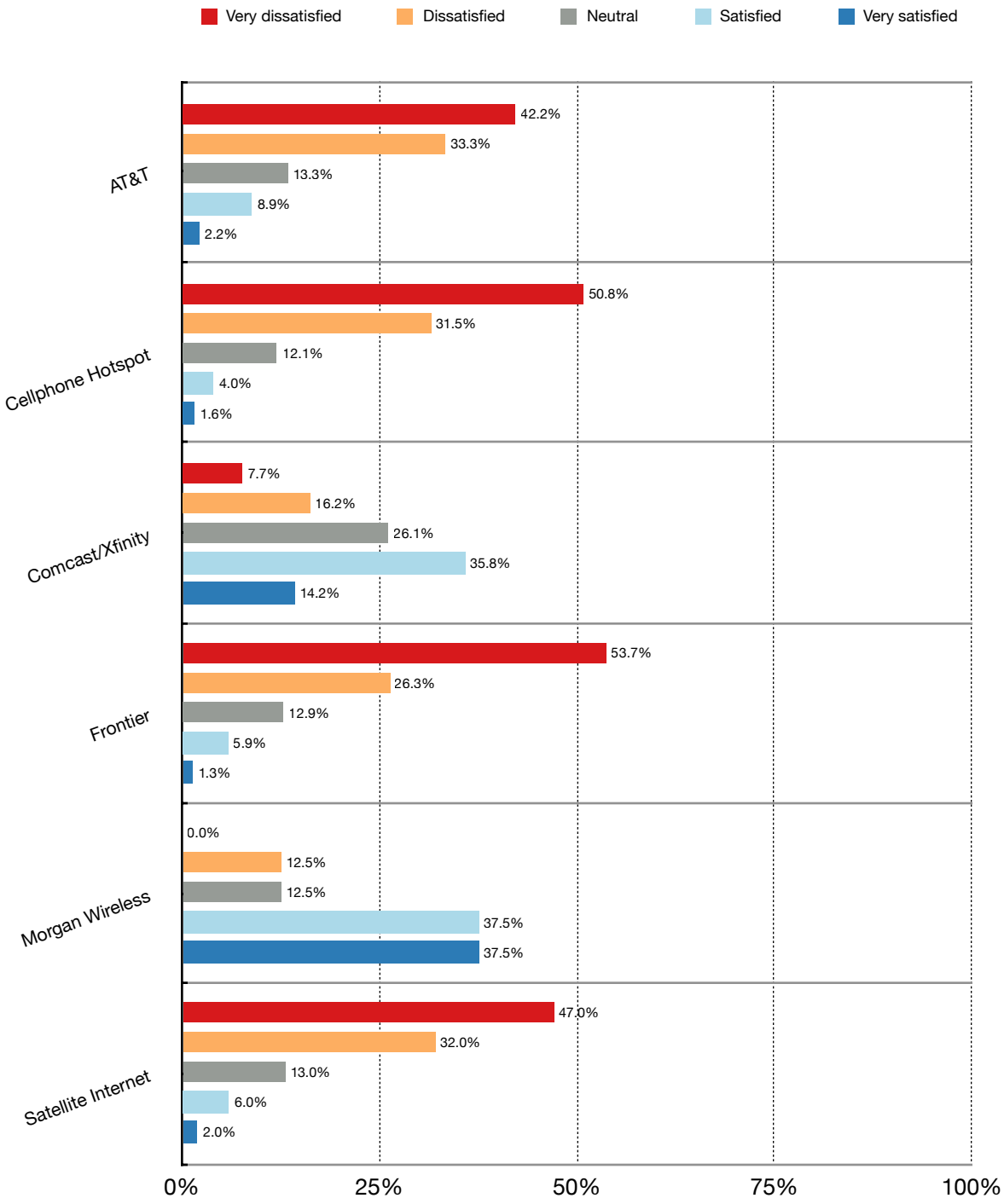
Internet Speed by Reported Internet Service Provider



Satisfaction with Internet Speed by Reported Internet Service Provider

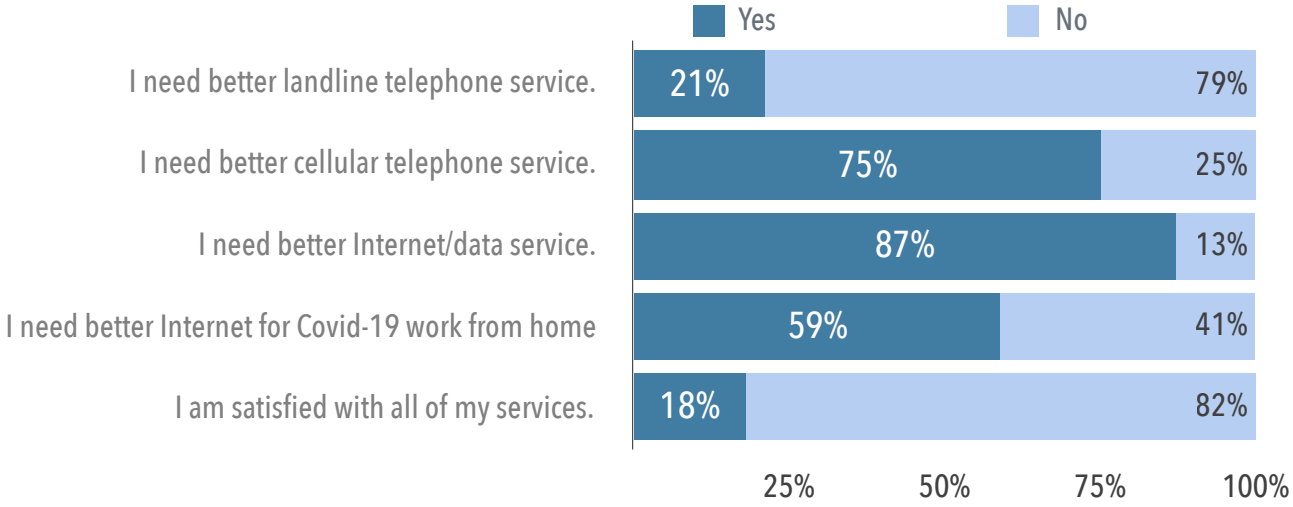


Satisfaction with Internet Reliability by Reported Internet Service Provider



6.3 RESIDENTIAL SURVEY SUMMARY DATA

1. Select the items you agree with below



2a. Total number of adults in household

1	2	3	4	5	6	7+
254	1424	292	129	36	7	3
11%	62%	13%	6%	2%	0%	0%

2b. Total number of K-12 Students in the house hold

1	2	3	4	5	6	7+
373	262	105	28	8	0	1
16%	11%	5%	1%	0%	0%	0%

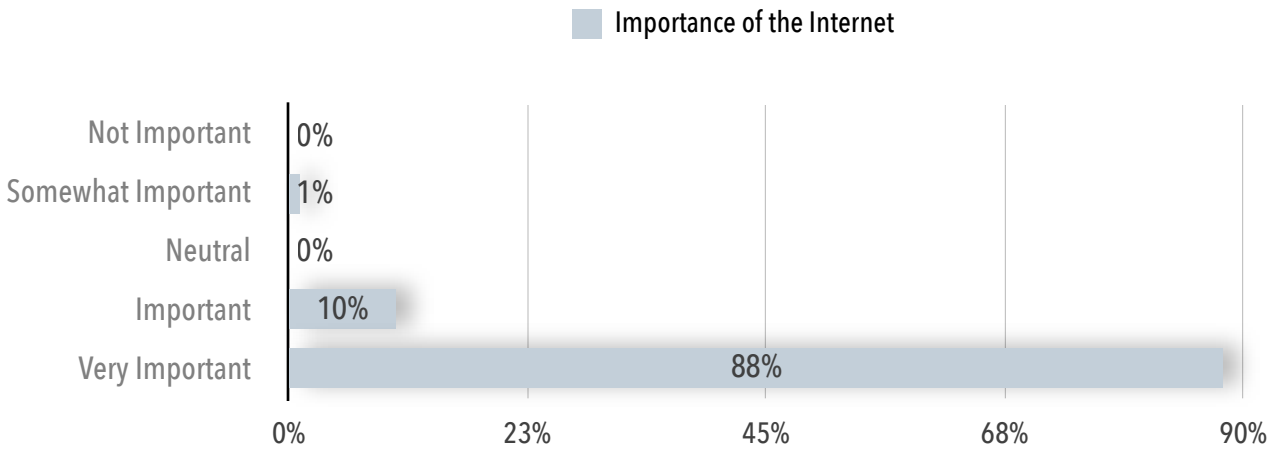
2c. Total number of college students in household

1	2	3	4	5	6	7+
348	74	12	0	0	0	0
15%	3%	1%	0%	0%	0%	0%

2d. How many total Internet users in household

1	2	3	4	5	6	7+
200	834	377	392	161	64	45
9%	36%	16%	17%	7%	3%	2%

3. How important is Internet access to you or your household?



4. How much do you spend each month for ALL telecom services? This would include any fees for services like phone, TV, and Internet. Do not include cellphones.

$50 or less	$50 to $75	$75 to $100	$100 to $150	$150 to $200	More than $200/month
58	126	193	395	490	869
3%	6%	9%	19%	23%	41%

5. How much do you pay just for Internet access each month?

No Internet	I only use free hotspots	$10 to $20	$21 to $40	$41 to $60	$61 to $80	More than $80/ month	I don't know
85	38	24	189	1,153	1,147	2,508	248
2%	1%	0%	4%	21%	21%	47%	5%

6. What type of Internet do you have at home?

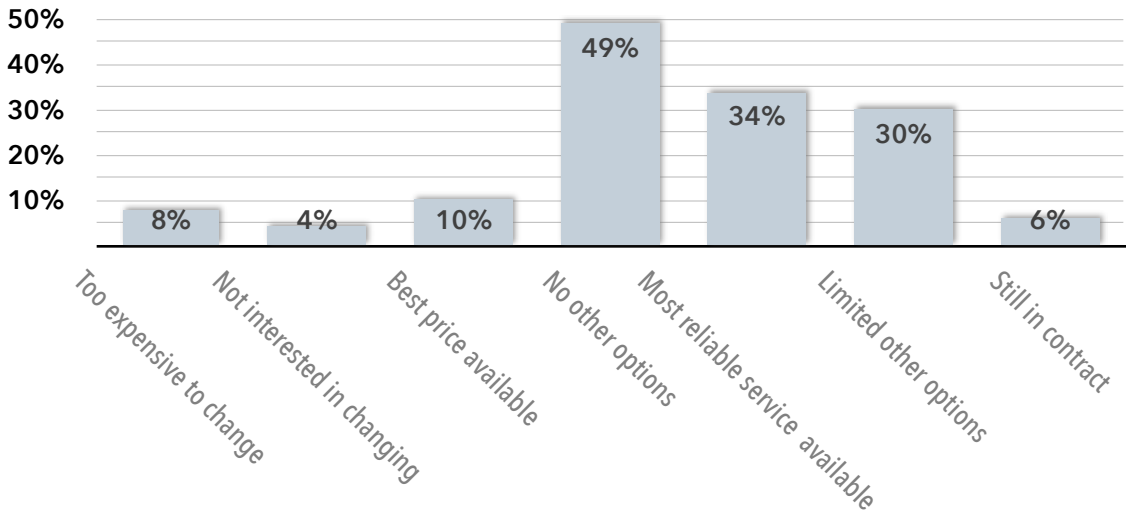
Dial-up	14	1%
Cable modem	970	46%
DSL line	394	19%
Fiber	34	2%
Satellite	144	7%
Cellular wireless	173	8%
Wireless ISP	121	6%
I don't know	135	6%
No Internet	64	3%
Other	76	4%

Other ISP responses:

Many comments were received (more than 55 pages) . Because of the volume of replies, these comments can be found in a separate document.

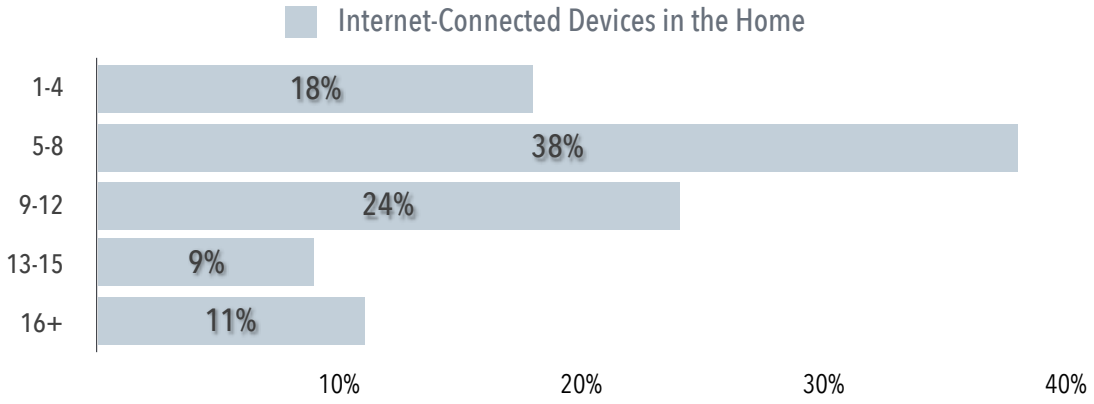
7. Based on the type of Internet connection you selected above, why do you still have it? (select all that apply)

49% of respondents indicated they have no alternative to their current Internet provider



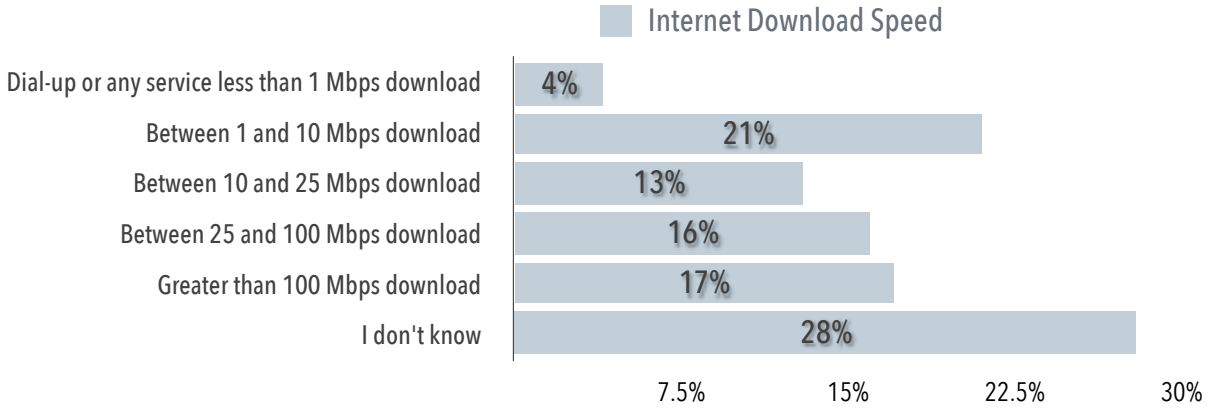
8. How many devices (for example computers, cellphones, smart TVs) connect to the Internet in your household?

44% of residents have 9 or more Internet-connected devices in their home



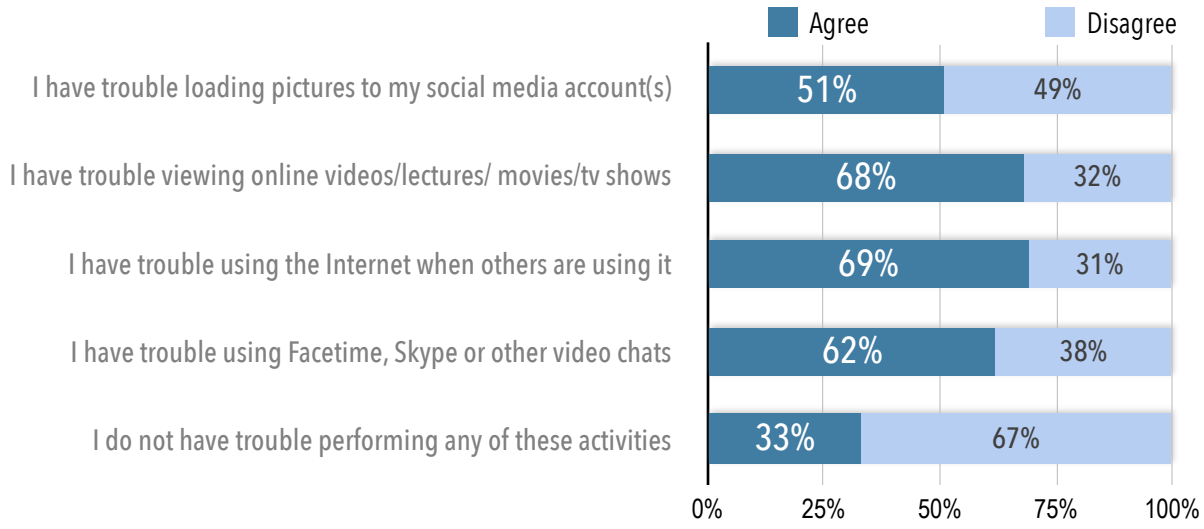
9. What is the speed of your Internet Connection?

As few as 38% of residents have Internet service that meets the FCC definition of adequate broadband service (25 Meg down, 3 Meg up). It is not unusual that many respondents do not know their exact Internet speeds.

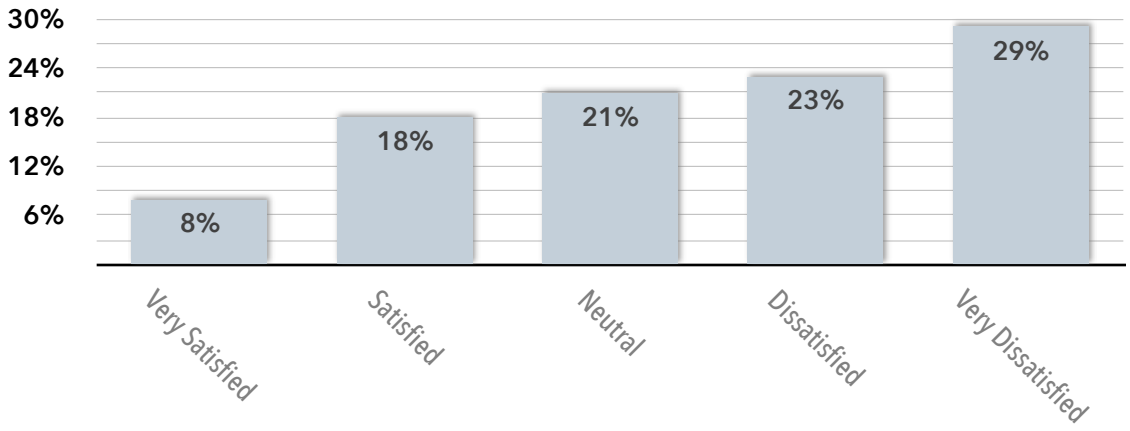


10. Select the items you agree with below

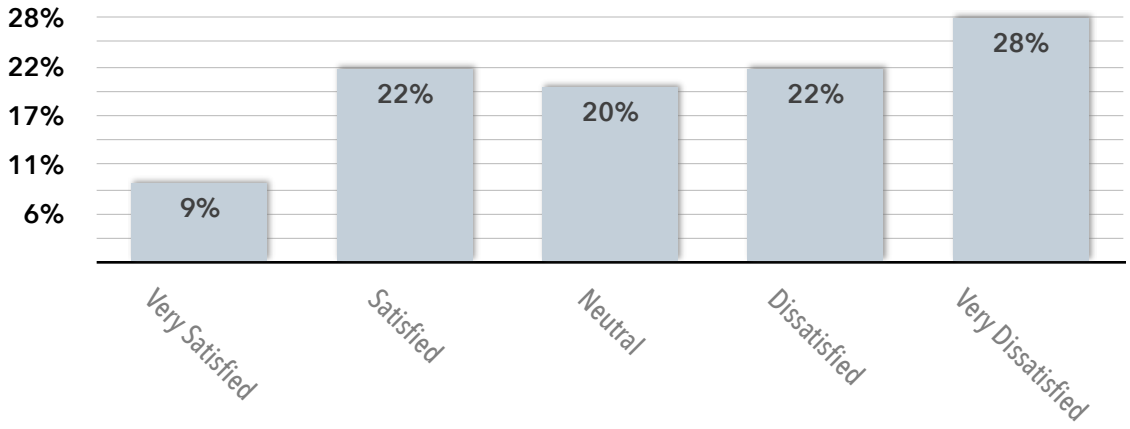
67% of respondents report they have trouble using common Internet services



11. How satisfied are you with the speed of your internet service?



12. How satisfied are you with the reliability of your internet service?



13. Select all items you use the Internet for now

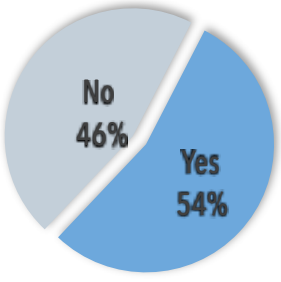
Email	2,099	91%
Access news and current evens	1,870	81%
Learn about Covid-19 pandemic issues and information	1,214	53%
Homework/Schoolwork/Distance learning	1,184	51%
Work from home during Covid-19 pandemic	1,269	55%
Download or listen to music or audio books online	1,527	66%
VoIP Internet phone (Vonage, Skype, FaceTime, etc.)	1,200	52%
Online Backup (files, photos, music)	1,398	61%
Telemedicine or tele-health	1,201	52%
Online gaming	887	38%
Social media and social networking	1,833	79%
Shopping and online banking	2,003	87%
Streaming video and TV services (Netflix, Hulu, Disney, etc.)	1,742	75%
Home security (cameras, video doorbells, etc.)	909	39%
Smart speakers (Alexa, Homepod, Google Assistant, etc.)	982	43%
Other	208	9%

Other uses for the internet:

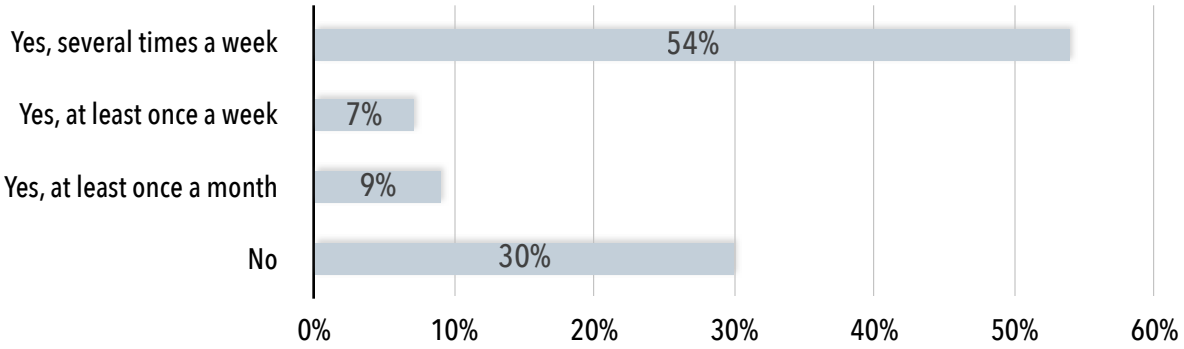
Many comments were received (more than 55 pages). Because of the volume of replies, these comments can be found in a separate document..

14. High speed, affordable Internet influences where I choose to live?

Availability of broadband Internet is affecting where people choose to live. The response of of 40% is typical of many communities. Internet availability can impact home prices and community development.



15. Does anyone in your household use / need the Internet to complete school assignments, participate in distance learning, or receive job training course work?

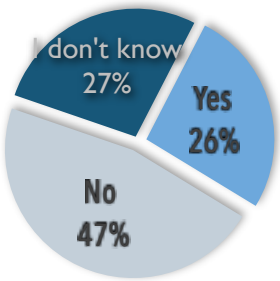


16. Who is your Internet Service provider?

Some responses included more than one provider.

Frontier	597	28%
Shentel	0	0%
AT&T	45	2%
Comcast/Xfinity	1,097	52%
Morgan Wireless	16	1%
Cellphone Hotspot	127	6%
Satellite Internet	98	5%
Other	131	6%

17. Do you have data limits (caps) on your current Internet service?

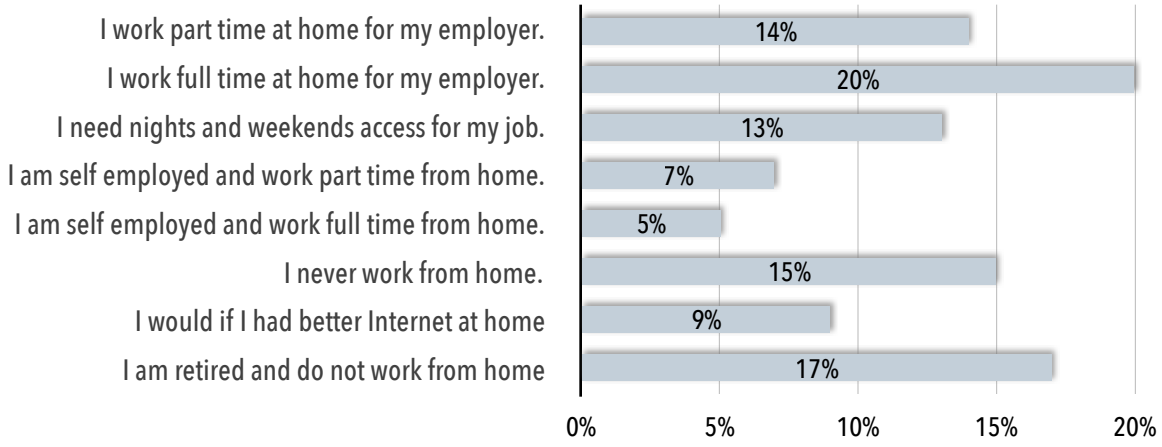


18. If you have data caps, have you exceeded those caps?

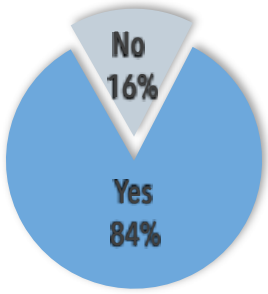
Yes	18%
No	17%
I do not have data caps	37%
I don't know	28%

19. Do you work from home?

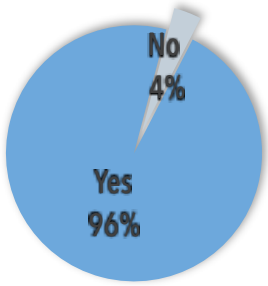
46% report working from home part or full time—the Internet has made residential neighborhoods into business districts. Home-based jobs and businesses reduce traffic congestion and reduce road maintenance. This is also a high number relative to past surveys we have conducted, and undoubtedly the Covid crisis has caused this number to rise.



20. I am interested in high speed fiber cable delivered internet service?



21. Should your county government help facilitate better and more affordable broadband services?



22. Any Other Comments

Many comments were received (more than 55 pages). Because of the volume of replies, these comments can be found in a separate document

7 BERKELEY BUSINESS SURVEY RESULTS

During the Summer of 2021, a broadband business survey was conducted in the county of Berkeley, West Virginia as part of a county wide study in broadband needs. The online (Web) version of the survey was publicized on social media. Businesses were encouraged to complete the survey online or fill out and return the paper version by surface mail. A total of 39 responses were were collected from businesses in the County. Not all responders answered every question. Some key findings from the results are listed below.

86% of business respondents want better Internet access

100% of respondents said that they believe the County government should help facilitate better broadband

100% indicated that the Internet is important to the success of their business over the next five years

Only 31% of businesses are "satisfied" or "very satisfied" with their current Internet service

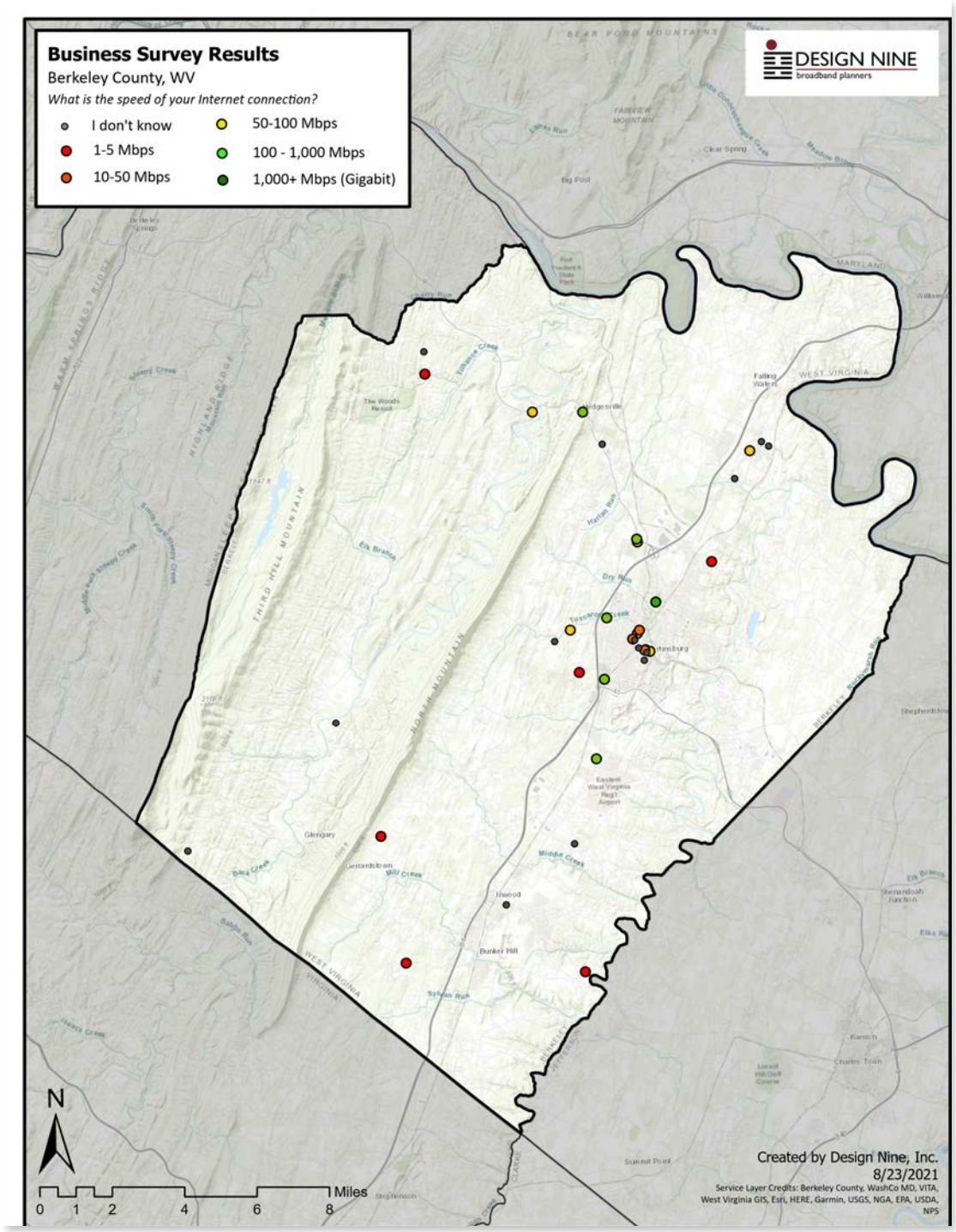
24% of the businesses that responded are home-based

84% of businesses that responded need employees to be able to work from home

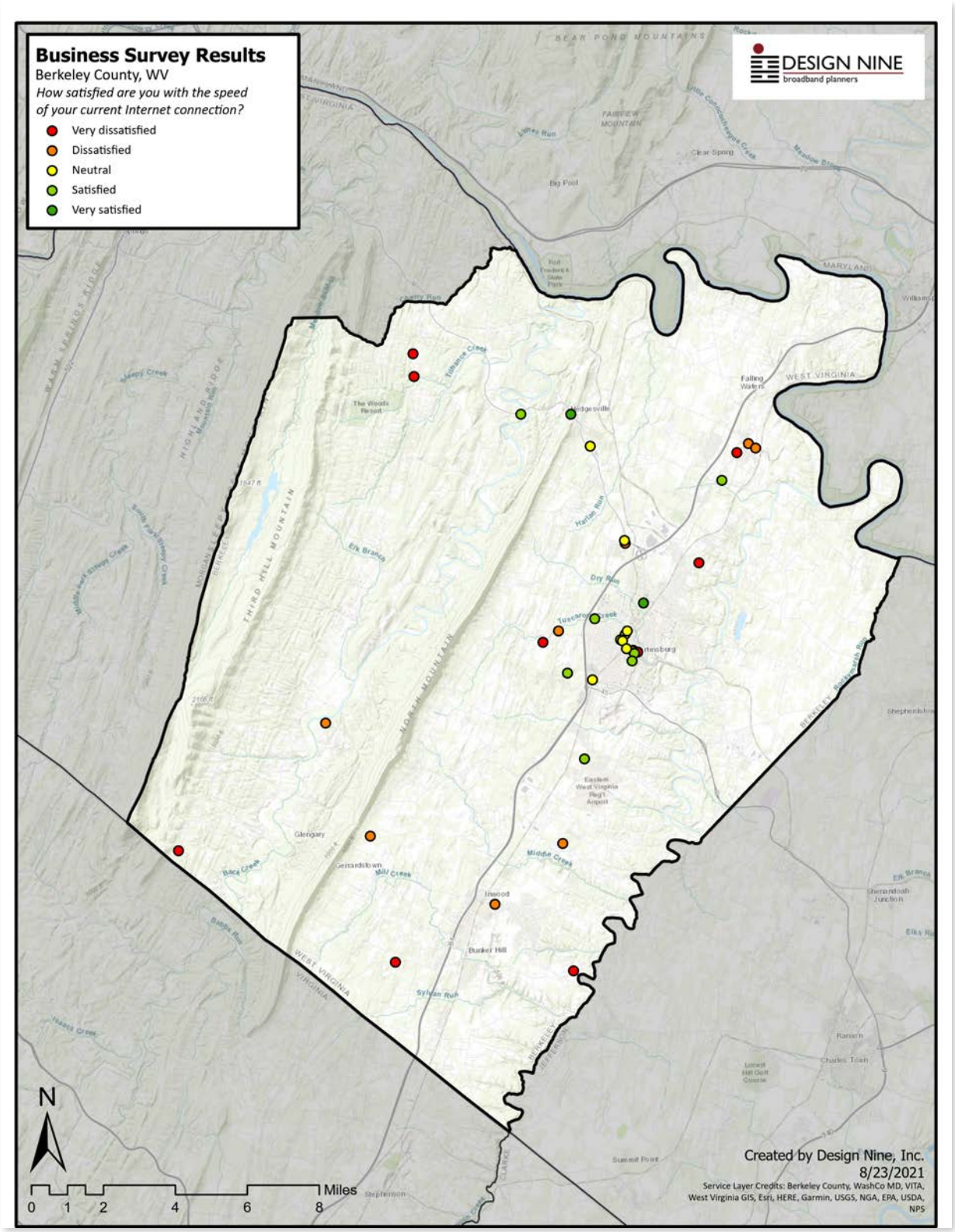
Home-based workers and businesses need affordable Internet access

7.1 DISTRIBUTION OF BUSINESS SURVEY RESPONSES

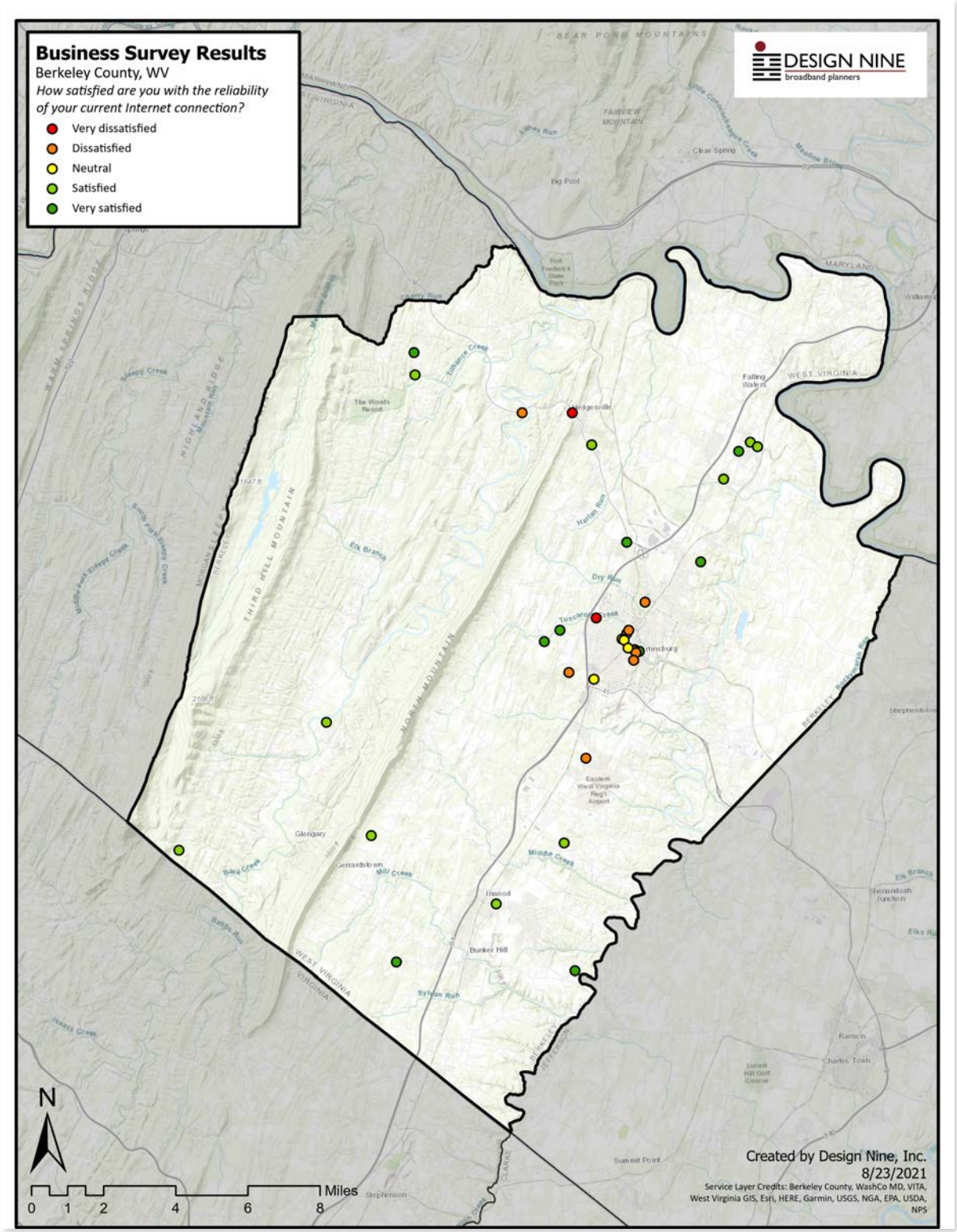
The map below shows the geographic distribution of responses to the business survey, coded according to the speed of their Internet connection (Question 10).



The map below shows the geographic distribution of responses to the Business survey, coded according to their satisfaction with the speed of their existing Internet service (Question 11).

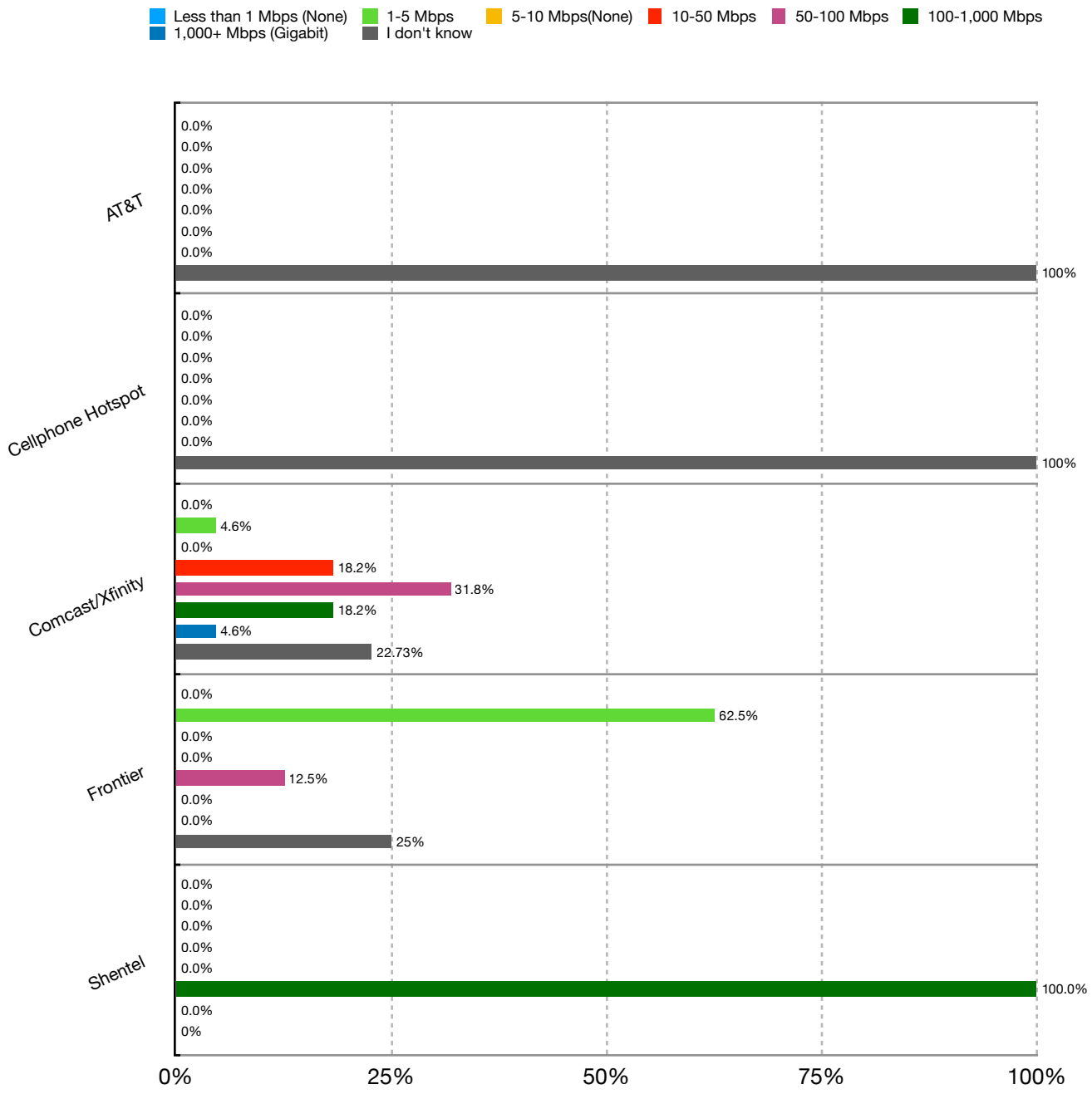


The map below shows the geographic distribution of responses to the Business survey, coded according to their satisfaction with the reliability of their existing Internet service (Question 12).

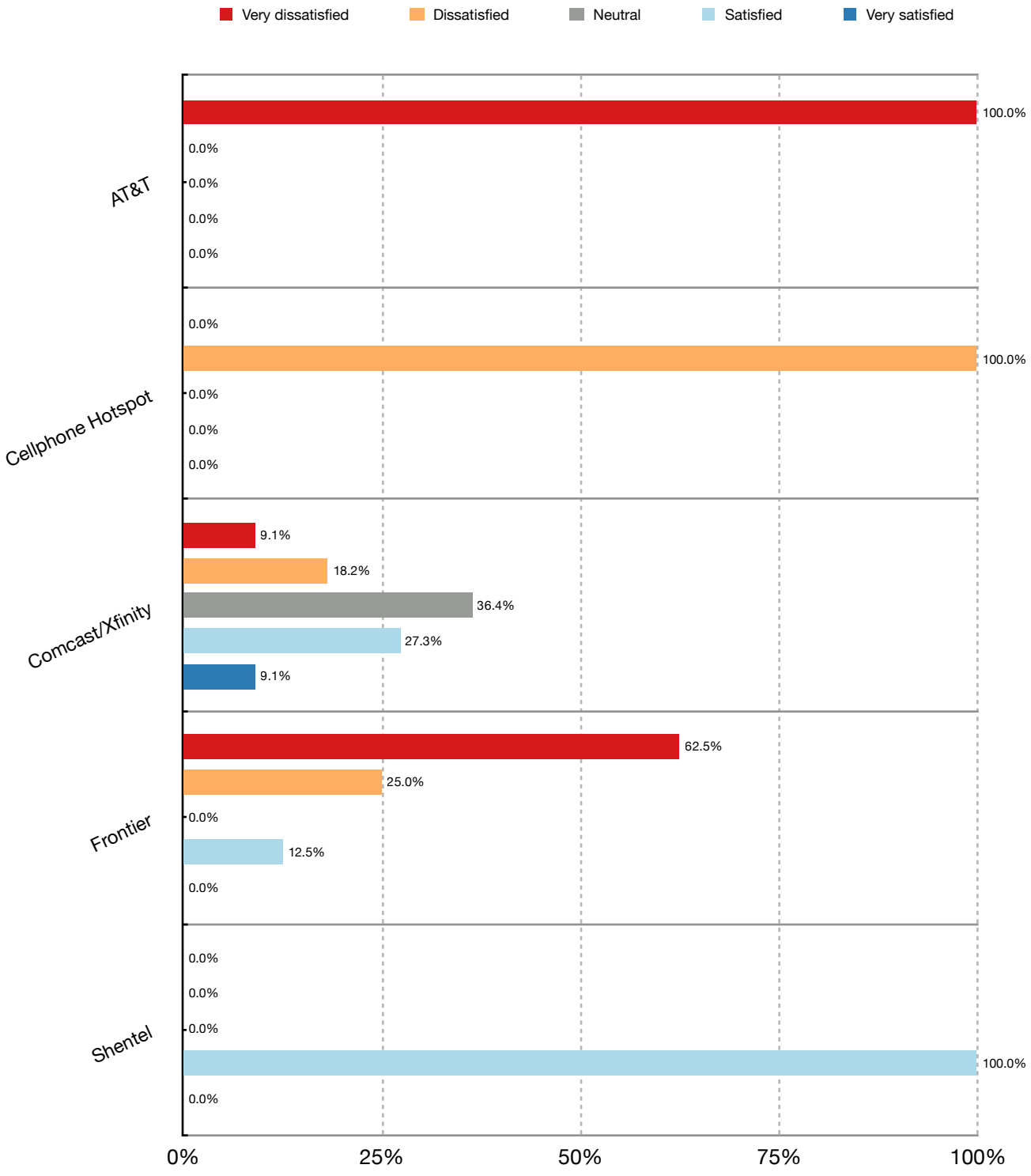


7.2 SERVICE PROVIDER SPEED AND SATISFACTION

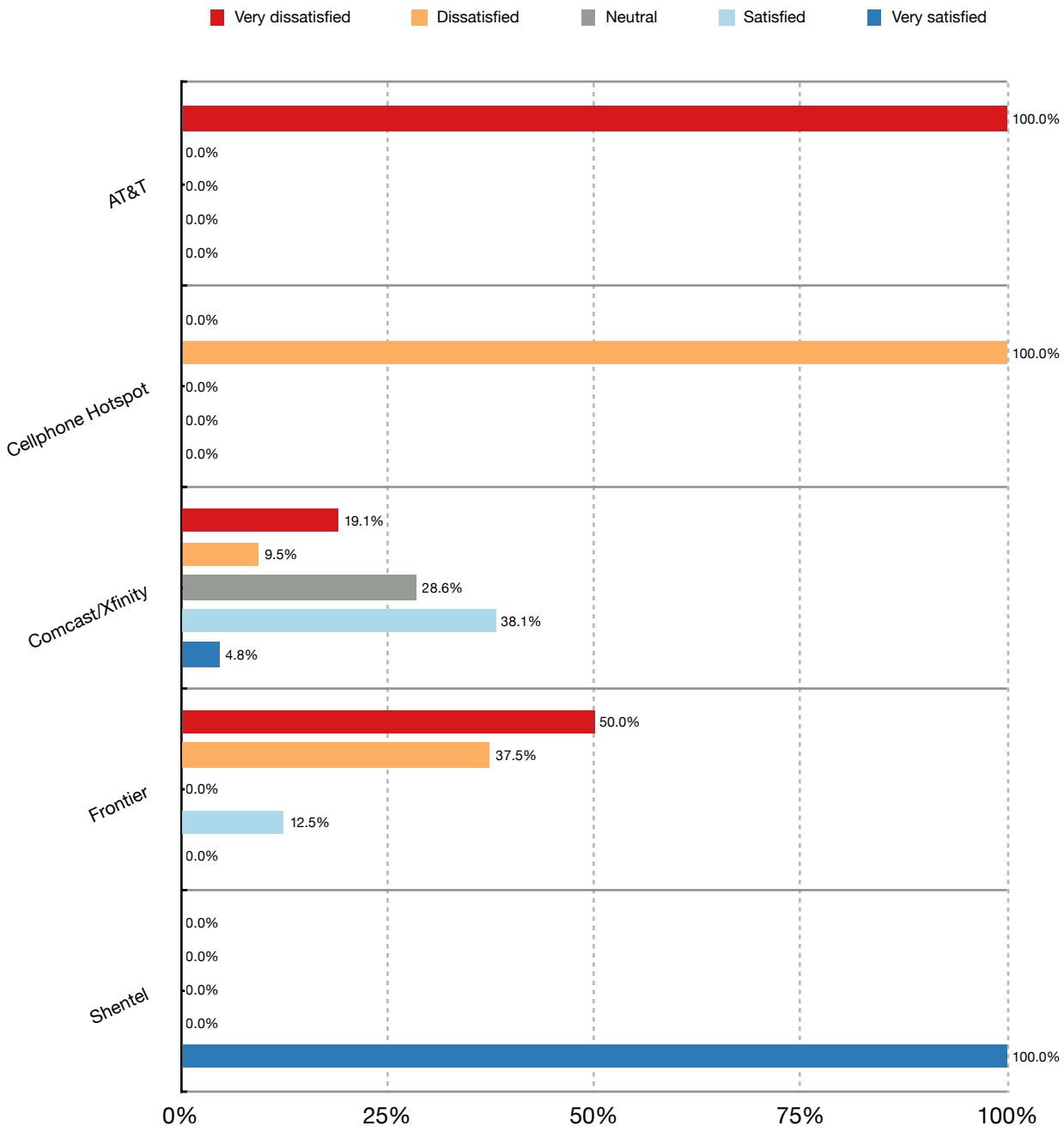
Internet Speed by Reported Internet Service Provider



Satisfaction with Internet Speed by Reported Internet Service Provider



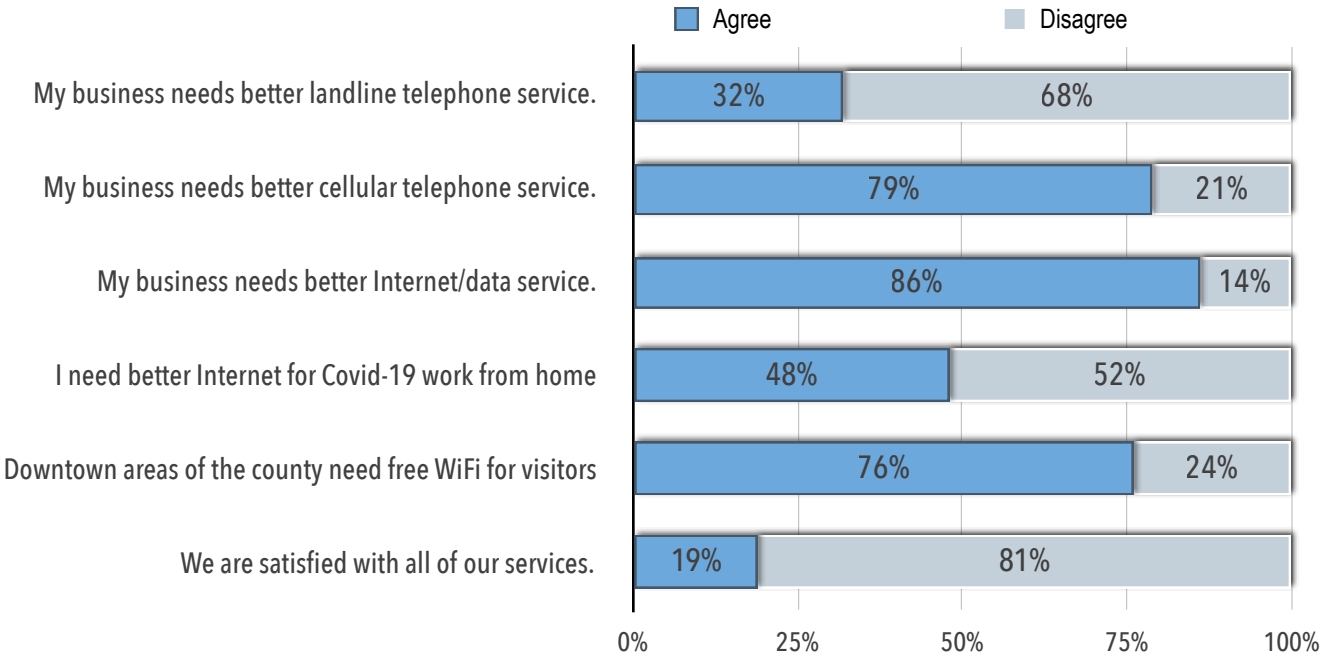
Satisfaction with Internet Reliability by Reported Internet Service Provider



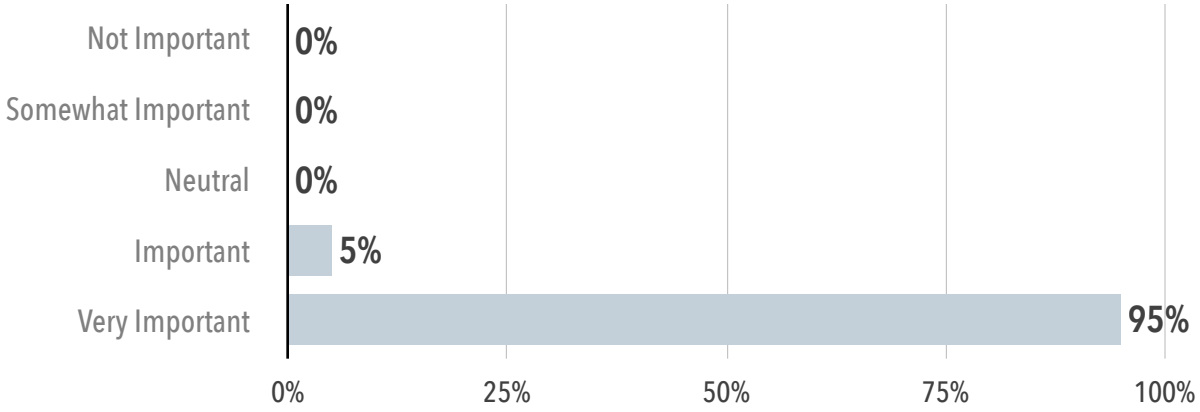
7.3 BUSINESS SURVEY SUMMARY DATA

1. Select the items you agree with below

A large number of businesses indicated that the downtown areas of the county could benefit from free WiFi for visitors and shoppers.



2. How important do you think Internet technology will be for the success of your business over the next five years?



3a. Total number of employees

1 to 10	56%
11 to 40	18%
41 to 80	10%
81 to 150	5%
Over 150	10%

3b. Total number of Internet users

1 to10	56%
11 to 40	18%
41 to 80	5%
81 to 150	3%
Over 150	18%

4. If you are a business, what type? (select all that apply)

Retail / Wholesale	5	13%
Professional / Office	9	23%
Government	1	3%
Educational	7	18%
Medical	5	13%
Non-Profit	4	10%
Restaurant/Food Service	1	3%
Communications/Technology	1	3%
Agriculture/Forestry	3	8%
Manufacturing	1	3%
Construction / Maintenance/ Repair	2	5%
Other	12	31%

Other types of businesses

- Personal service - tattooing
- We buy used furniture, repair and resell it.
- Hospitality
- Financial
- Lodging, Golf, Restaurant, Recreation, Spa, and Real Estate Brokerage
- Financial (Banking)
- Auto and truck repair
- Real Estate Broker-Internet service is now consumer first question
- Gun range and training facility
- Veterinarian
- Pet Boarding and doggie daycare
- Online art tool business
- Teacher at a school

5. Is this a home-based business?

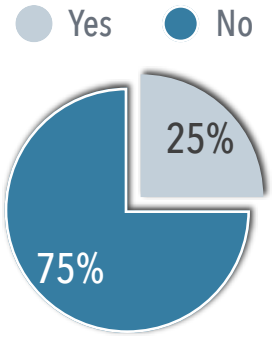
Yes	No
9	29
24%	76%

24% of the county businesses that responded are home-based

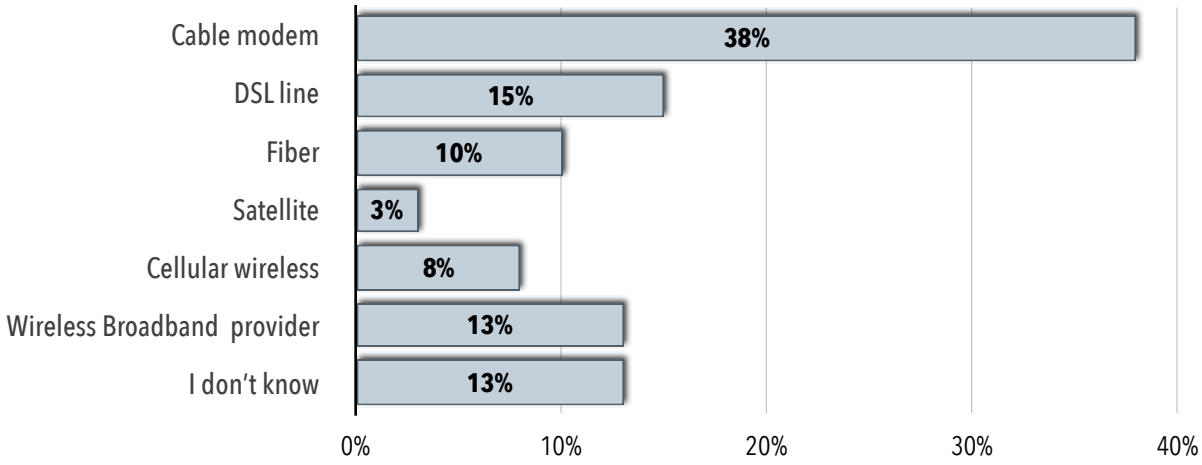
6. How much do you pay now for Internet access each month?

No Internet	$0 to $100	$101 to $150	$151 to $300	$301to $500	$501 to $1,000	$1,001 to $5,000	$5,000 or more	I don't know
1	7	12	5	3	2	0	1	8
3%	18%	31%	13%	8%	5%	0%	3%	21%

7. Are you satisfied with what you pay for Internet service?

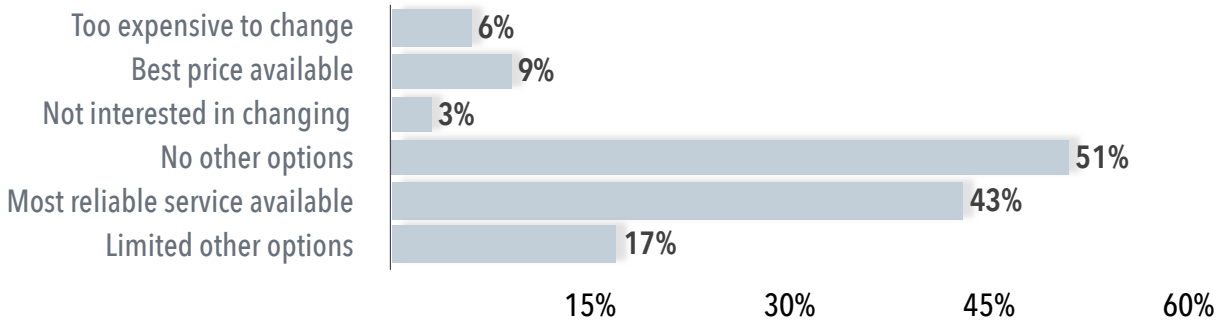


8. What type of Internet do you have?



9. Based on the type of Internet you selected above, why do you still have it?

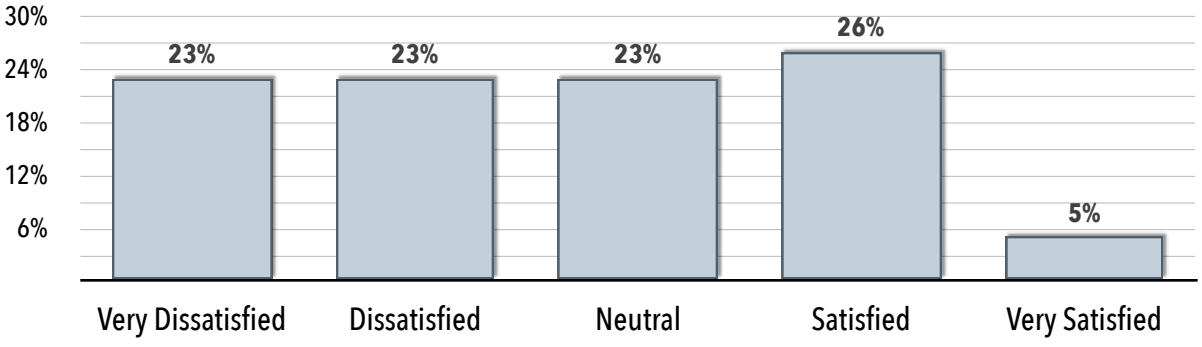
Respondents could choose more than one option.



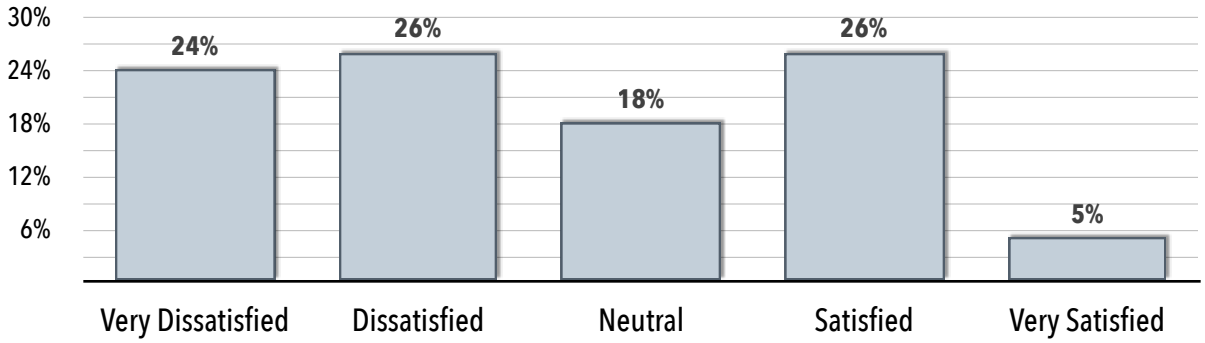
10. What is the speed of your Internet connection? (A Gigabit is 1000 Megabits (Mbps)

Dial-up only	56-512 Kbps	512 Kbps-1 Mbps	1-5 Mbps	5-10 Mbps	10-50 Mbps	50-100 Mbps	100+ Mbps	1,000+ Mbps (Gigabit)	I don't Know
0	0	0	6	0	4	8	0	0	15
0%	0%	0%	18%	0%	12%	24%	0%	0%	45%

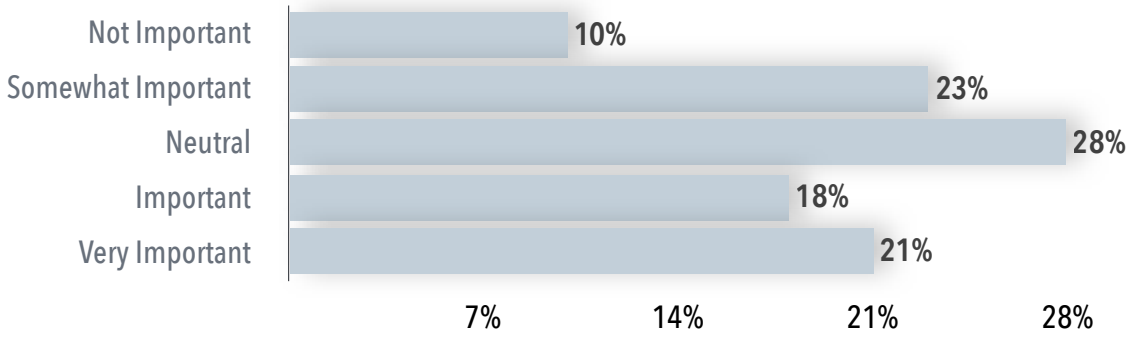
11. How Satisfied are you with the speed of your Internet service?



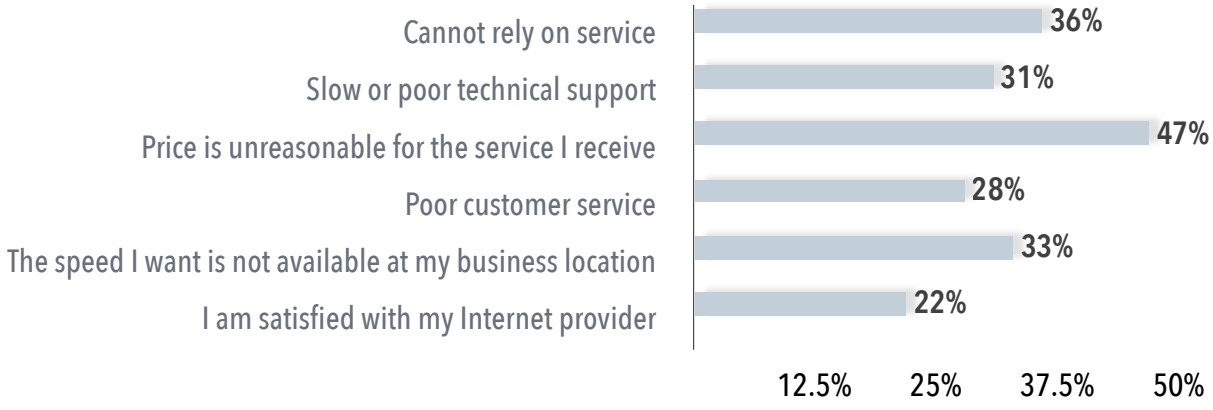
12. How Satisfied are you with the reliability of your Internet service?



13. How important is a redundant or second Internet connection to your business?



14. Please select all that apply to your current Internet provider



15. Select all the items you use the Internet for now(Select all that apply)

Email	38	97%
Communication between headquarters and remote sites	21	54%
VoIP Internet Phone(Vonage, Skype, etc.)	14	36%
Provide free WiFi service to customers	6	15%
Online Backup (files, photos, music)	33	85%
Transfer large files	25	64%
Monitor / control security, alarms, health, processes, etc.	19	49%
Processing credit card / debit card transactions	27	69%
Ordering / managing inventory	25	64%
Maintaining a Web presence, or blog	22	56%
Social media (Facebook, LinkedIn, Twitter, etc.)	30	77%
Receiving and processing online orders	21	54%
Cloud-based business, accounting or other services	20	51%
Other	0	0%

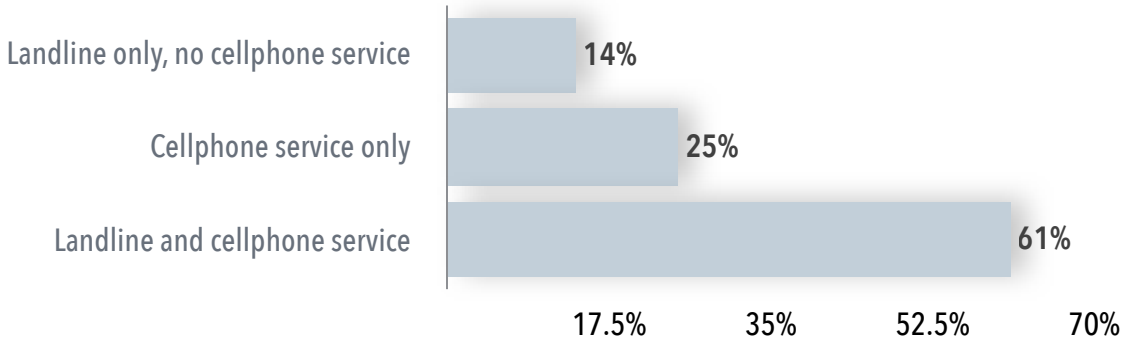
Other uses for the Internet

- We don't offer free WiFi to DOWNTOWN visitors but we do offer it to clients in our Spa, Pro Shop, and Restaurant.
- Our staff work in the field and must use the internet for timekeeping and record keeping.
- Teacher with class of 23 students who use iPads throughout each and every day
- Engineering services
- Educational, Classroom use

16. Who is your Internet Service provider?

Frontier	8	24%
Shentel	0	0%
AT&T	1	3%
Comcast/Xfinity	22	65%
Morgan Wireless	0	0%
Cellphone Hotspot	1	3%
Satellite Internet	0	0%
Other	2	6%

17. What kind of telephone service do you have?

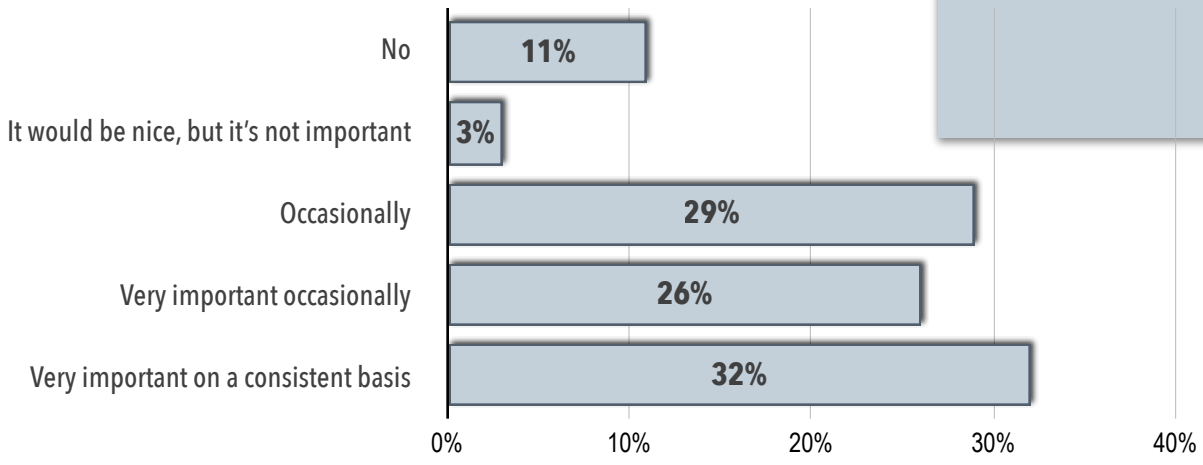


18. Do you or your employees use a VPN (Virtual Private Network) to obtain remote access for your work or to a company network?

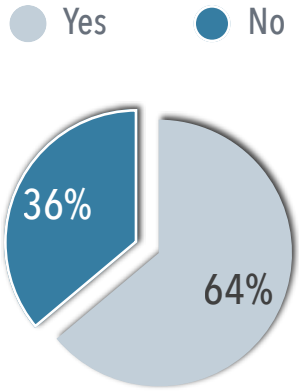
Yes	No	I Don't Know
12	15	10
32%	41%	27%

19. Do you or your employees need or want to work from home?

84% of businesses that responded need

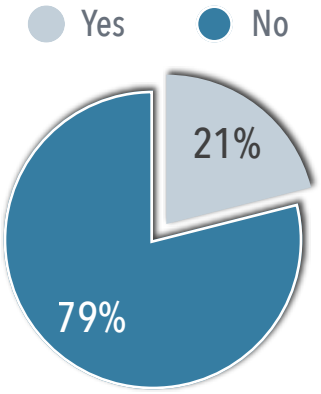


20. Does limited Internet access at employees' residences impact your business?



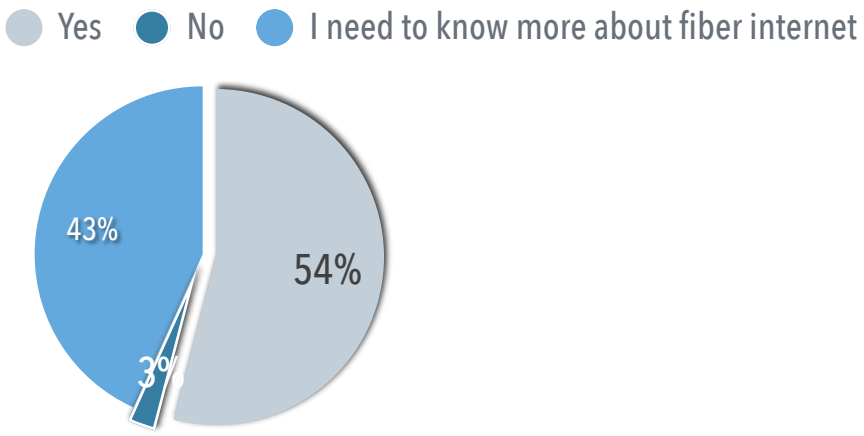
21. Do the existing internet service options impact your business's decision to relocate or stay in the County?

If yes, briefly state why:



- Our business currently experiences multiple internet outages every month lasting several minutes to more than a day. The most recent outage in June lasted almost the entire day. Our employees are unable to work without internet service as all our data is cloud based. Outages mean we are unable to work.
- Comcast/Xfinity is the most reliable internet service around. Cost is high for a small non-profit.
- If we could afford to move to different a location with better internet access we would once our children are out of school
- Moving is a huge process, and don't know what other location to chose at this time.

22. Are you interested in fiber delivered Internet Service?



23. Should the County government facilitate better and more affordable broadband services?

Yes	No
37	0
100%	0%

24. Any other comments?

- Comcast is the worst internet service provider ever per every survey conducted on providers. They repeatedly get the lowest ratings in every category. Why are they allowed to continue to be the only provider and charge rates 2x-4x higher here in Martinsburg than most metro areas in the entire country? And the price just went even higher now that they were allowed to implement unrealistic data caps (which are causing issues with employees working from home) and price gouge even more.
- Several members of my staff had poor internet service at home which affected us during COVID. Now that they are not working remotely it does not affect the business but, clearly, it affects them personally. Usually, their service provider was Frontier.

- I need internet services in order to further build my business. There are many scheduling programs that could make my business run smoother, save time and become paperless . But without internet I am in the dark ages.
- It's a real shame that we only have 1 option for internet at this address. And it isn't a very good one. I left my previous position because of our lack of access to fast internet. I wasn't able to connect to and run the programs necessary to carry out basic functions. I currently try to run my home based business with our Frontier home internet connection but have to rely more on my cellphone service plan through AT&T. Hot spots etc did not work here so I use my phone itself for everyday processing of orders, shipping labels, updating my shop etc. Our current internet is difficult for the kids to use for virtual school etc especially if several people try to access internet at the same time. Very frustrating and expensive to use out cell phones.
- We really need more options for high speed internet, particularly in parts of the county. For instance, my daughter is building a house in Hedgesville and they cannot get cable to her house. I have a neighbor in our development who put in the service request for a brand new home 3 miles from town and still in July has no service. How can kids learn at home, people attend college at home and employees work from home? Let's get with it!
- Cell phone/email reception is spotty and too intermittent, and unreliable, all around Berkeley and Jefferson counties.
- Interested in better speed 1-3 mbps is what I get
- Add a tower in Sleepy Creek like the one in Roundtop to service the West facing properties in Back Creek Valley

8 TECHNOLOGY ASSESSMENT

8.1 OVERVIEW OF THE TECHNOLOGY

In large portions of Berkeley County, broadband wireless will be an important strategy for improved Internet access for businesses and residents. But both fiber and wireless technologies and systems are going to be important to meet the goal of improving access to broadband. The rest of this section provides more detail and some specific build out strategies.

Businesses and residents may obtain Internet service:

- With a small radio directly attached to their home or business that receives a signal directly from a towers owned by a private provider, from a County-owned tower (e.g. shared with public safety use), or from a community-owned tower (e.g. a coop).
- With a small radio attached to a utility pole (60 or 70') to improve line of sight to a tower.
- With a small radio directly attached to their home or business that receives a signal from a "community" utility pole. The "community" pole will receive a signal from a distant tower and redistribute it locally to a cluster of customers (typically within a half mile).
- With a fiber connection to the fiber installed in areas where economic development is important, and in other areas as additional fiber network segments are added.

The table below summarizes how fiber and wireless can work together in a variety of ways.

Distribution Type	Access Type	Capacity
Wireless	Wireless	Typical customer connection starting at 5 to 10 Megabits, can be higher, with 50 Meg connections common. More dependent on the capacity of the wireless Distribution link.
Wireless	Fiber	Users can have fiber Gigabit connections locally, but total throughput dependent upon the capacity of the wireless link, which can be up to a Gigabit, depending on distance and budget.
Fiber	Fiber	Any amount of bandwidth needed, with standard connection typically a Gigabit (1,000 Megabits).
Fiber	Wireless	Typical customer connection starting at 5 to 10 Megabits, can be higher, with 50 Meg connections common.

8.2 WIRELESS TECHNOLOGIES

WISPs (Wireless Internet Service Providers) use a wide variety of radio frequencies to deliver fixed point wireless broadband. By "fixed point," this means that these systems are not designed to support roaming in the way that cellular voice/data radios are (that is, mobile phone and data services).

Fixed point broadband is broadcast from a tower to individual homes and businesses (fixed points). Most of the frequencies used require clear line of sight between the tower and the location where service is desired.

Hilly topography can work for or against good wireless broadband service. Towers located on the tops of hills and mountains can provide service over a larger area than a tower in relatively flat terrain, but hills also block the signal. A residence can be a short distance from a large tower, but heavy tree cover or an intervening hill will block service. The solution to this can be addressed in several ways:

More larger towers of 180′ to 300′

The taller the tower, the wider the coverage, but as tower height increases, the cost of the tower also increases. Towers taller than 199′ require a light at the top to make them visible to low-flying aircraft, and lighted towers are more expensive to erect, and the bulbs have to be changed periodically at significant expense. Many broadband towers are 180′ to avoid the additional cost of lighting.

Small cell broadband utility poles

Small cell broadband utility poles, often called community poles, are shorter towers or utility poles of typically 60′ to 80′, located in or very near a cluster of homes. The towers can be wooden utility poles or relatively low cost steel monopoles or steel lattice towers. These towers are located to get above local tree cover so that clear line of sight to a distant taller tower is available. Local access point radios provide service to homes and businesses with line of sight to the pole. In many parts of the county, these are going to be an important part of a strategy to get better broadband to rural residents and businesses.

Variety of radio frequencies

WISPs are beginning to deploy a wider range of licensed and unlicensed radio frequencies to overcome distance, bandwidth, and line of sight issues. Traditional 2.4 Ghz and 5.7 Ghz WiFi and WiMax frequencies are being supplemented or replaced with LTE and CBRS licensed broadband frequencies that provide better bandwidth and will tolerate light tree cover better (2.5 Ghz, 3.5-3.7 Ghz). Some WISPs are also using lower frequencies (e.g. 900 Mhz) that will travel farther and will also provide better penetration in light tree cover.

8.3 EMERGING WIRELESS TECHNOLOGIES

MIMO Wireless

MIMO (Multiple Input, Multiple Output) describes a variety of technologies that can be summarized as using more than one receive and transmit antenna for wireless data applications. Wireless protocols that are using the MIMO concept include IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), 4G, LTE (Long Term Evolution), and WiMAX. Each of these protocols use the MIMO technology to increase the amount of available bandwidth in a given section of radio frequency spectrum.

New hardware is required to make effective use of MIMO. While the technology increases wireless bandwidth, the typical amount of bandwidth being used by wireless devices is also increasing rapidly. Some applications where MIMO is likely to provide noticeable improvements are in home

wireless routers, where the effective throughput will be able to better handle the demanding bandwidth requirements of HD and 4K video streams. MIMO is slowly being developed for use with cellular smartphones, but both the phones and the cell tower radios have to be upgraded to support MIMO.

LTE/4G/5G

LTE (Long Term Evolution) is a set of protocols and technologies designed to improve the performance of voice/data smartphones. Like MIMO, both the user phone and the cell tower radios have to be upgraded to support LTE improvements. In 2013, only 19% of U.S. smartphone users were able to take advantage of LTE speeds, although that percentage has been increasing rapidly since then, and more than 85% of the U.S. cellular towers have been upgraded to LTE. As noted previously, the actual bandwidth available to a smartphone user is highly variable and depends on distance from the cell tower, the number of smartphones accessing the same tower simultaneously, and the kinds of services and content being accessed by those users.

The primary purpose of cellular bandwidth caps is to keep cellular users from using too much bandwidth and degrading the overall service. While LTE and MIMO improvements will improve overall cellular service, these technologies are not going to replace fiber to the home and fiber to the business.

In 2017, new fixed broadband wireless systems entered the marketplace using LTE frequencies, and many WISPs have begun to replace existing wireless radio systems with LTE equipment. These LTE systems do not provide any cellular voice services; they are designed specifically to support only broadband/Internet service.

In our conversations with both vendors of these systems and WISPs that have begun using LTE systems them, we get two very different stories. The vendors have been conservative in discussing the improvements, while some WISPs have been taking single user test results and suggesting that they will be able to deliver higher speeds at greater distances to all users.

To achieve the full benefit of 5G technology, more fiber is needed.

There is little debate that the LTE equipment offers higher bandwidth, at somewhat greater distances, and with somewhat better penetration of light foliage and tree cover. Over the next two to four years, most WISPs will change out most of their existing radio systems for the improved LTE radios. Perhaps the most significant advantage of LTE fixed point broadband is its ability to provide better performance when clear line of sight between the customer and a tower is not available. LTE provides better penetration of light to moderate tree cover and other line of sight obstacles.

The official standard for 5G radio technologies was release in 2019, and many metro areas of the country now have 5G radio systems. It is worth noting that many smartphones, even some late model smartphones, do not have 5G support built in.

5G does bring much higher speeds to wireless broadband (e.g. it might be able to deliver 30 to 50 Meg of bandwidth consistently). But 5G has significant limitations that do not make it a good solution in rural areas of the U.S.

The fact that 5G can deliver much higher bandwidth means that 5G cell sites will require fiber connections. This is going to effectively limit 5G deployments to denser urban environments where both customers and fiber are plentiful.

There is no free lunch in the physics of radio frequencies. The higher bandwidth of 5G means that cell sites need to be closer together because the 5G frequencies do not travel as far as existing 4G/LTE frequencies currently being used by the cellular industry. Most users will have to be within 500 to 1,000 feet to receive 5G service.

Some experts estimate that more than a million miles of new fiber will have to be deployed just to support the 25 largest metro areas in the U.S. 5G will not appear overnight.

As many as 60 cell sites per square mile may be needed to make 5G widely available in a given area. If, as an example, about 25%, or 80 square miles of Berkeley County is underserved, very conservatively, 270 or more cell sites would be needed to provide good coverage (as many as nine or ten cell sites per square mile).

For rural areas, the cost of 5G service may be one of the most significant obstacles. The cellular carriers see the increased customer bandwidth use possible on 5G networks as a major revenue opportunity. While they will increase the "standard" bandwidth package for monthly service, bandwidth caps and rate limiting is likely to keep 5G cellular customers bills high.

Many rural areas of Berkeley county has poor or no cellular voice/data service, and somewhat counter-intuitively, more fiber can solve that problem. Cell towers need fiber backhaul connections to provide the best cellular data performance, and so rural fiber will also help address the issue of poor cellular service.

White Space Broadband

White space broadband uses some of the frequencies that were formerly used by analog TV channels. These lower frequencies travel farther and provide better penetration of light foliage. Microsoft has been supporting a number of community white space experiments, and has promised much wider support for this technology, but there are few other users, equipment is still relatively expensive, and few WISPs have ventured into this still largely experimental technology. A Microsoft white space project in southern Virginia, although still underway, serves less than three hundred households and is still regarded as experimental. Other white space pilot projects have reported good results. One ISP experimenting with the technology has indicated that their trials with white space equipment has been able to deliver 50 Meg/50 Meg service.

Low Earth Orbit (LEO) Satellite Internet

The Elon Musk-funded Starlink effort began offering "beta test" service in late 2020. There is a one time equipment and installation fee of $499, and a monthly fee of $99. The company is promising download speeds of between 50 Meg/sec and 100 Meg/sec and upload speeds of up to 20 Meg/sec. Latency is lower than traditional satellite Internet services. If the prices remain reasonable, this is likely to become a much better alternative to the older satellite Internet services.

In early fall of 2021, Starlink announced that the company would be moving the service out of beta, which would make the service more available to more users. The service has received generally favorable reviews from beta users in terms of speed and reliability. It will be important mostly for rural users who have line of sight problems for terrestrial fixed point wireless and for households and businesses that are completely outside the coverage area for fixed point wireless.

Service reports emerging in late 2021 indicated that Starlink was able to provide download speeds reliably at 50 Mbps to 75 Mbps, with a latency of 45 to 60 milliseconds. Low latency is critically important for good quality two way voice and video conversations.

By comparison, geosynchronous satellite service may have latency of ten to twenty times higher than Starlink. At the end of 2021, speed test results from the Ookla speed test service suggested that as Starlink is adding more customers, the average speed is flattening out, and Ookla's third quarter 2021 data was showing Starlink with average 87 Mbps download and 14 Mbps upload speeds, and average latency of 44 milliseconds.

Millimeter Wave Service

Millimeter wave services use a variety of very high frequency wavelengths in range of 30 Ghz to 300 Ghz. An emerging wireless broadband service that uses the term "millimeter wave" covers very short wavelengths in the 71-76 GHz, 81-86 GHz, and 92-95 GHz (70/80/90 GHz) bands. These shorter wavelengths permit the use of very small antennas while still being able to provide high directivity and high gain. A primary advantage of the smaller antennas is the ability to use more of them and to make each individual antenna highly directional. The higher frequencies also permit transmission of much higher bandwidth. However, the higher bandwidth rates are distance limited.

In early testing in 2020, U.S. Cellular was able to demonstrate speeds of 100 Mbps at distances of three miles using 5G radio equipment (5G equipment is also close to the millimeter wave spectrum using lower frequencies of 24 Ghz, 28 Ghz, and 39 Ghz for some equipment). Radio equipment tests are often conducted in optimum conditions, and in real world conditions, the practical distance may be lower and the bandwidth may be lower, where buildings and trees can degrade or block the radio signals.

8.4 DARK FIBER AND LIT FIBER

About Dark Fiber

Dark fiber is installed in conduit underground and/or hung on utility poles. It is called "dark" because no network electronics are installed to "light" the fiber (using small lasers in a fiber switch). For small municipal/local government fiber installations, dark fiber has a significant advantage in terms of management—very little ongoing operational responsibility is required.

Dark fiber is leased out to service providers, who install their own network electronics in cabinets or shelters attached to the fiber cables. The providers typically lease fiber pairs between the cabinet and their customers, and are responsible for all equipment-related management and maintenance. Dark fiber networks can be used by service providers to provision either Active Ethernet or GPON services to their customers.

Dark fiber networks do not generate large amounts of revenue, but this is offset by very low maintenance costs—primarily an emergency break-fix arrangement with a local or regional firm qualified to splice fiber. Emergency break-fix contracts are usually based on a time and materials basis, so there is little or no expense if there are no fiber breaks.

Other costs include "locates," which are called in to Wisconsin 811 (Diggers Hotline) and are performed by either the local Public Works department or a private sector contractor. For small fiber networks, locate costs are generally modest.

About Lit Fiber

A "lit" fiber network includes the network electronics needed to transmit data over the fiber (using the small lasers in a fiber switch, hence there is light traveling over the fiber cable). In a lit network, "lit circuits" are leased out to service providers rather than fiber pairs. The muni/local government/ community network provides the network electronics, which reduces costs for the service provider —meaning they are able to pay higher lease fees for the circuits they use to deliver services (like Internet) to their customers. Lit networks generate more revenue, but also have higher expenses because the network electronics have to be monitored and managed on a 24/7/365 basis (this task can usually be outsourced at reasonable cost). However, very small fiber deployments often do not pass enough homes or businesses to generate sufficient revenue to cover the higher costs.

Like dark fiber, a lit network incurs break-fix and locate costs as well.

8.5 THE MEET-ME BOX CONCEPT

In some of the larger towns, some smaller communities, rural neighborhoods, and subdivisions, "meet me" boxes could be installed. A meet me box is a telecom cabinet with fiber cables installed between the cabinet and nearby homes and/or buildings. Providers only have to reach the meet-me box, lowering their costs. Both wireline and wireless providers can use this infrastructure. This approach can also be used to provide fiber services in business and industrial parks. A small Virginia county installed five miles of fiber in their business park and was able to attract a Tier One provider to provide service to an existing business (a manufacturing plant that was going to leave if the county did not help them get better Internet service).

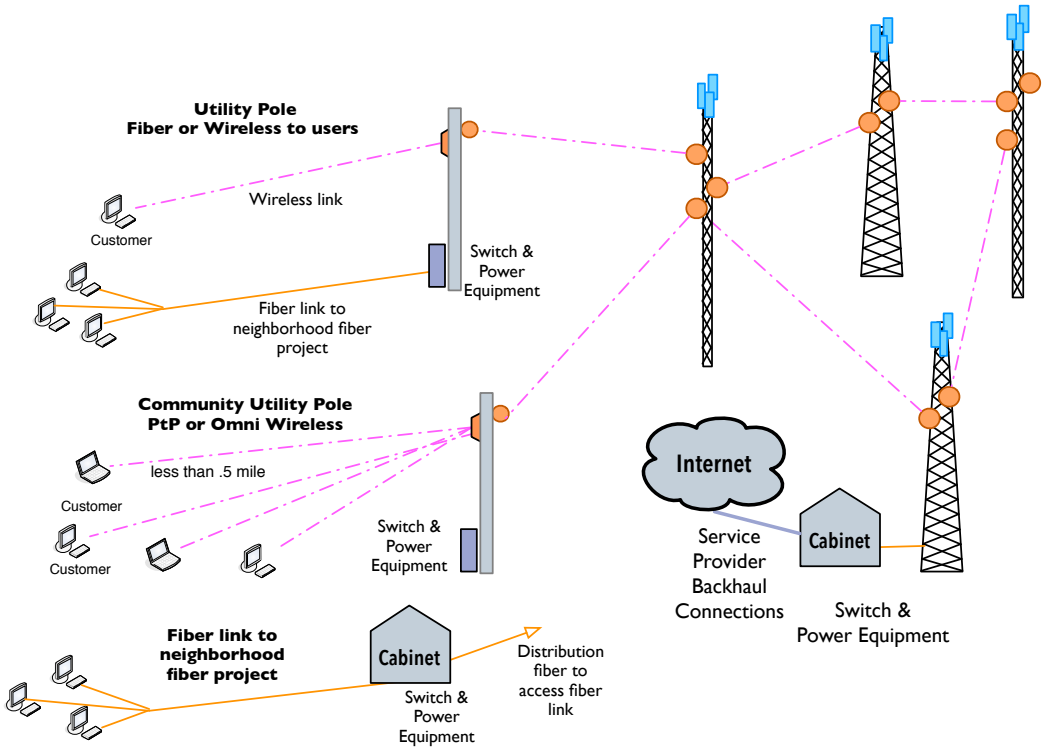
The dark fiber approach minimizes operational costs. Service providers would install their own equipment in the cabinet and would pay a small monthly lease fee for the fiber strands they use to connect customers to their services.

For a meet-me box installed in a "main street" area (e.g in an alley behind commercial/retail buildings) with relatively inexpensive and short fiber drop cables into nearby buildings, the lower end of an installation might start at $35,000. For a box installed in a rural sub-division that requires distribution conduit/fiber and drop cables, the cost to connect 25 homes might start at $175,000 on the low end and increase as the number of homes connected increases. Larger numbers of homes or businesses will each add to the cost, but adding more connected premises also increases the value of the infrastructure and increases the revenue potential.

8.6 TERRAIN CHALLENGES

The propagation study map studies that are included later in this report illustrate the challenge of providing adequate fixed point wireless Internet service in the county. The mountainous terrain throughout the county shows that many towers and community poles will be needed to near an adequate solution using fixed point broadband wireless. In some areas, the difficulty of obtaining line of sight for a radio link between two locations may dictate using fiber in place of wireless.

As an example, in Richwood, West Virginia, a group of about seventy-five homes along two and a half miles of road led to a fiber to the home solution that was less expensive than broadband



wireless, primarily due to the cost of bringing electric service to many community poles. A combination of taller towers and shorter community poles may be needed to provide good service to most areas of Berkeley County.

8.7 CONNECTIVITY SOLUTIONS

Both wireless and fiber networks, as well as legacy copper-based networks, all share three primary components. How these are designed and deployed can vary greatly, but all networks have these three parts in some form.

- The **Core Network** provides access to the Internet, a place for service providers (ISPs) to distribute their services locally on the network, and for larger institutional and business customers to meet service providers. Berkeley County has both landline and wireless service providers, but there are still areas that are underserved. Each of these providers has their own Core Network, but wireless broadband could be more widely available if additional county-owned towers were available to the private sector providers.
- The **Distribution** portion of the network connects the Core Network with collections of users. A Distribution network can include both fiber and wireless portions of a network.
- The **Access or Last Mile** portion of the network connects residential users and businesses to the network, and like the Distribution network, that connection will be by fiber or by a wireless link.

The illustration below shows the full range of technology options (fiber and wireless) and how they can be connected together in various ways to meet the diverse needs of the county. More detail is provided on the following pages.

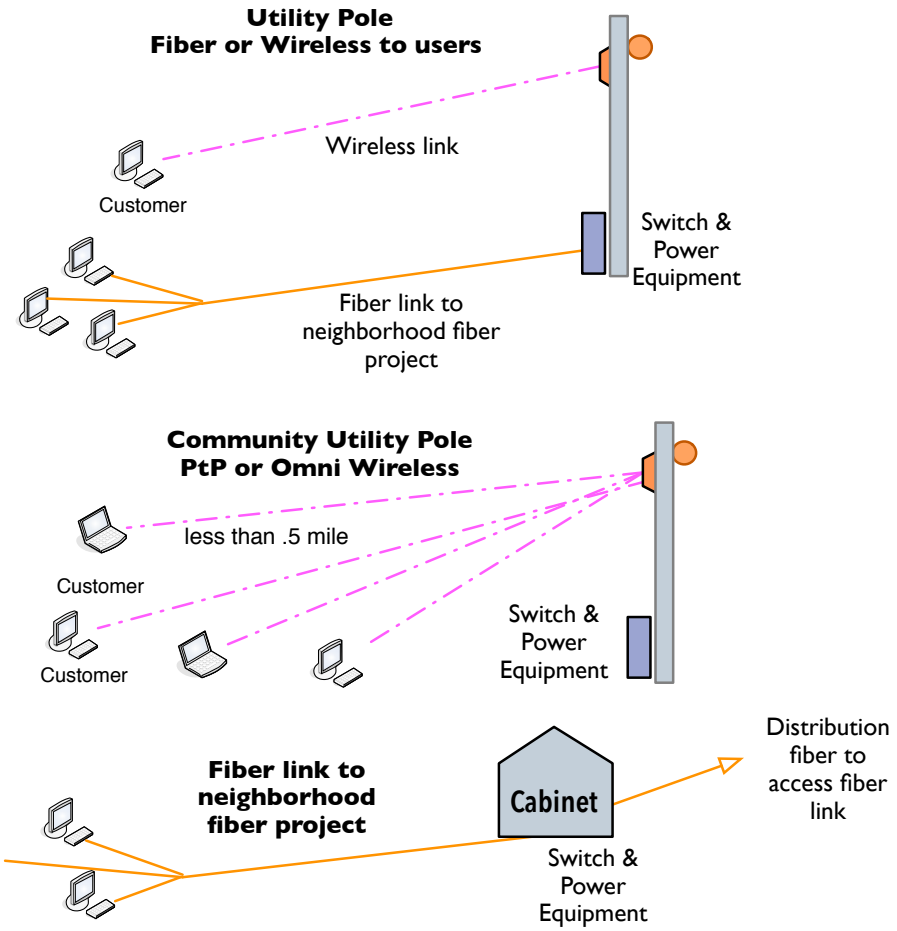
Last Mile Access

The Last Mile Access is the portion of the network that connects customers to their service provider and the Internet. Both broadband wireless and fiber links can be utilized to provide service. There are several ways that customers can receive service:

- Service providers can install their own local access radios on the Distribution towers, using both point to multi-point and point-to-point radios to deliver service to their customers.
- A single user utility pole (or inexpensive steel lattice tower) can be installed on the property of a single resident or business. A radio at the top of the pole receives service from another tower site (typically one of the Distribution towers).
- A utility pole (or inexpensive steel lattice tower) can be installed near a cluster of homes (e.g. a rural residential sub-division, several homes in close proximity on a rural road). Service providers can install their point to multi-point radios on this pole and provide economical service to several customers from a single pole.
- A utility pole (or inexpensive steel lattice tower) can be installed in a rural subdivision. A service provider installs a point to point radio on the pole, and fiber cable can be run from the pole past several homes to offer fiber service with wireless backhaul.
- Customers near existing fiber can have a fiber drop installed directly to their home or business.

Distribution Network

Distribution is the portion of the network between the Distribution sites to the Last Mile Access portion of the network. It is desirable for each distribution site to have a connection back to more than one Distribution site (tower) on a redundant ring. This ring topology protects against hardware failure at the port level and does provide some protection if one of the tower to tower wireless links is disabled by an equipment failure.

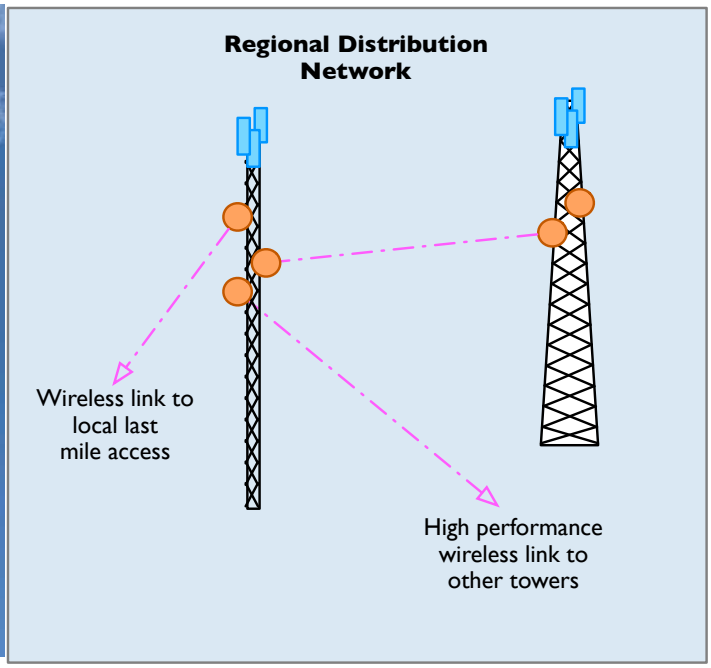


These tower sites are typically 120' to 180' tall to provide the height needed to enable Line Of Sight (LOS) between towers, and for local access, to enable service providers to mount point to multi-point radios on the towers.

Towers taller than 199' become subject to FAA regulations because the height can be a potential hazard to airplanes. Towers that exceed 199' usually have to be painted (alternating red/white) and have a blinking light at the top. These requirements increase the long term maintenance costs, but the taller towers can improve line of sight to other towers.

The towers can provide two functions:

- Space for backhaul connections to other towers in the county.
- Space for local access radios to provide Internet access within 2-3 miles of the tower (or farther with good Line Of Sight).



Core Network and Service Providers

In the past, the telephone company switch office (Central Office, or CO) has provided that function. Today, many communities have either a community-owned data center or a privately owned data center that offers an affordable range of options for customers of broadband services.

The Co-Location facility provides a meet point for various public and private fiber cables and networks to inter-connect. A local facility with space available for both public and private uses could help attract additional private sector investments (e.g. a long haul fiber provider wants connect to this facility because of increased access to customers).

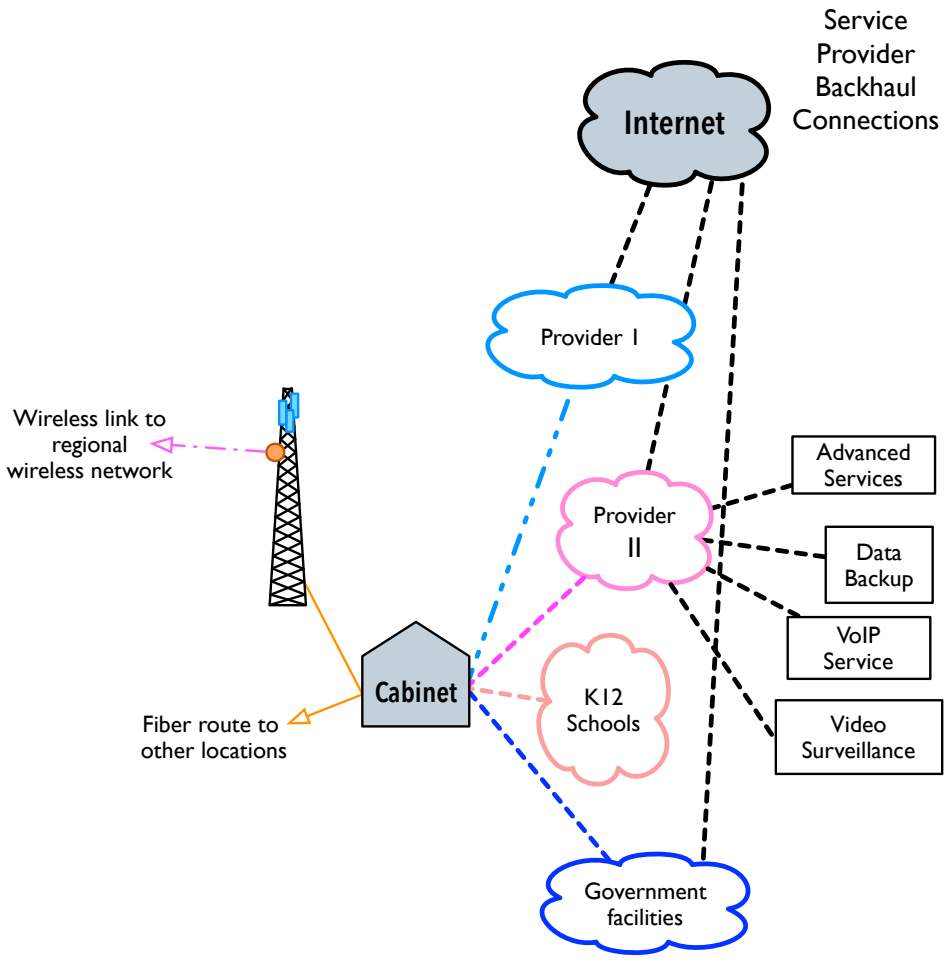
A colocation facility is a controlled environment (i.e. secure, heated, and air-conditioned) room with Internet access through wired and/or wireless systems. The colocation facility is a place where fiber, wireless, and copper-based network facilities meet. It is equipped to house high-end network equipment, servers, and other electronic gear.

A variety of middle layer network components and services can be located within the co-lo including, for example, directory services, replicated content servers, routing services, and other elements needed to deliver new multimedia services to the home and small office from multiple, competing providers.

Characteristics of the colocation facility are:

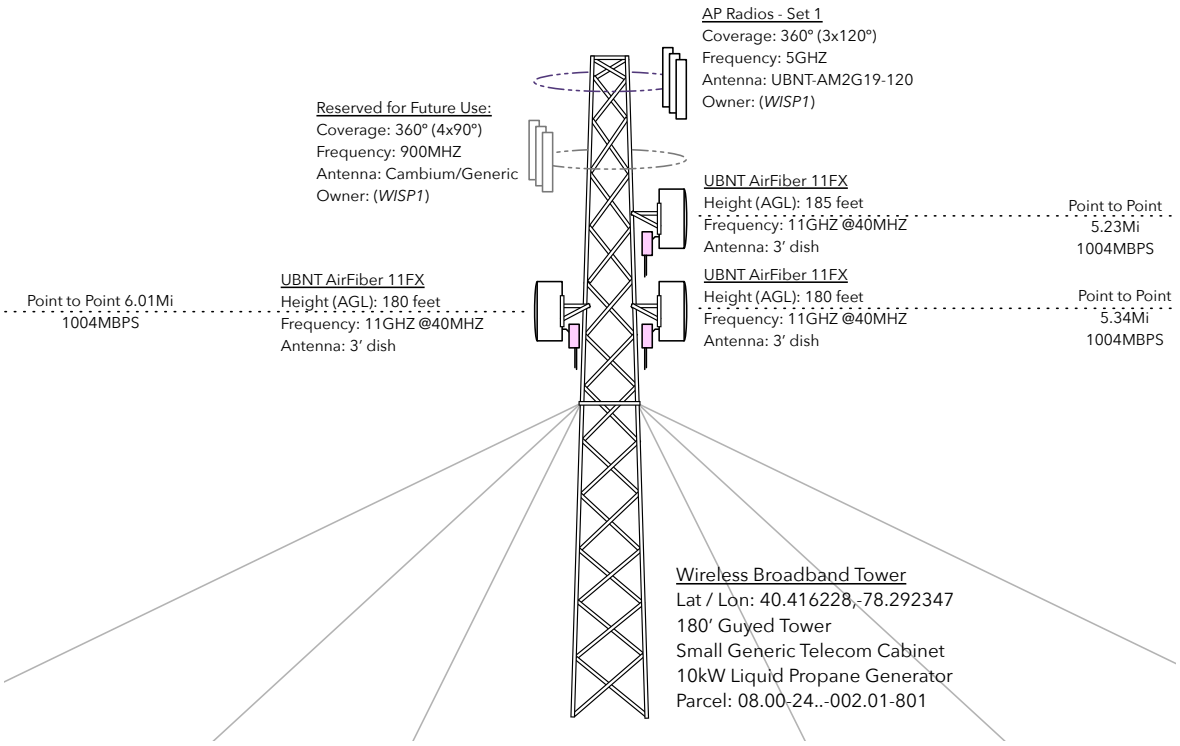
- A reliable source of AC electric power is required, with backup UPS (Uninterruptible Power Supply) service, and additional power backup available by an onsite generator is desirable.
- Controlled access to the facility (e.g. by electronic keycard) 24 hours/day, seven days a week. Service providers need to be able to gain access to the equipment room as needed, and work activities performed at night or on weekends is common.

- Racks for locating network equipment and servers, and optionally locked cages for equipment racks.
- Sufficient cooling capacity for the network's current and long-term needs. Equipment rooms require both a cool air input vent and an air return vent.



8.8 WIRELESS NETWORK ARCHITECTURE

The diagram below shows an example of the equipment typically placed on a tower, and details about the equipment that is planned. Several sets of Access Point radios can be placed on a tower operating in different frequencies, and can be owned/operated by multiple WISPs. Point to point radios link this tower to several other sites.



When developing wireless networks there are several categories of costs at each site. Construction of the network will incur site related costs at each tower site including:

- Site development - clearing the site of trees and vegetation, construction of a tower road for access to the site, and strict adherence to all erosion and sediment control measures required by the Owner.
- Passive site equipment - In most cases, a network cabinet will be installed and a new power service will need to be run to it. At each site there will be a generator and most likely a propane tank also installed. Reliable power systems will be installed inside the cabinets, and other equipment management solutions will be installed in the cabinet for network equipment.
- The tower itself - new towers in this estimate are designed as 180' guyed towers. A guyed tower is usually a small profile lattice type tower that is supported by guy wires at several points on the tower. Guyed towers usually have a smaller visual profile than self supporting towers because they are narrow from the top all the way to the base. Self supporting towers will have the same lattice type structure but the tower widens as you get closer to the base. If the tower base is obscured by trees all around, a self supporting tower may be preferred.

Some sites may require design changes based on site conditions. Other types of towers such as monopoles could be considered for this project, especially if the owner is working with cellular providers on developing a site.

- Network equipment such as Point to Point radios, routers, switches, and access point equipment will be installed during the construction of this network. Since the network has built in redundancy the configuration will need to support automatic failover and other high-level network functions. In addition to the networking expertise needed to configure large networks such as this the contractor(s) configuring the network will need to understand spectrum management, wireless signal propagation, and other physical aspects specific to wireless networks.
- Permitting - depending on the locality developing a wireless site usually requires extensive permitting processes that require a relatively long timeline and professional services.

8.9 SMALL CELL BROADBAND POLES

Line of sight issues are a constant problem for rural residents and businesses, as clear line of sight (or near line of sight) is required for fixed wireless Internet services. Even newer technologies like white space and LTE systems work better with clear line of sight to distant towers.

The increased use of wooden utility poles is already common in some other areas of the country, and increased use of this technique to get the customer CPE radio/antenna above tree cover is a relatively simple solution.

The utility poles would normally be placed on private property, subject to existing or updated ordinances governing the placement of wooden utility poles. The local government would have no responsibility for maintenance and repairs.

The cost of placing an eighty foot pole can range from a low of about $2,000 to $7,000 or more, depending on permitting, engineering requirements, and the location of the pole. Some municipalities provide "by right" permitting of these poles if they are placed on private property, which can reduce the cost of installing them.

Because these are placed on private land, local government would not have to provide any direct funding. However, the localities could encourage wider use of this option with a public awareness campaign developed in partnership with wireless providers. Local banks could be encouraged to provide low cost financing of the poles so that property owners could make a small interest and principal payment monthly over several years to reduce the financial impact.

This strategy requires minimal financial support from the County and that it has the potential of improving broadband access in rural areas of Berkeley County quickly. The County should work with WISP partners to promote this option to improve access to new and existing wireless broadband towers.

8.10 NANO-CELL AND WIFI CALLING SERVICE

A common complaint in Berkeley County is the poor cell service in many areas. In some parts of the county, there may be adequate broadband service via DSL or fixed point wireless Internet, but poor cellular phone/data service. There are now two solutions to improving rural cellular service that do not involve the expense or difficulty of attracting and/or building more cellular towers.

WiFi Calling – This approach takes advantage of the WiFi Calling feature that is now common in many late model cellphones. Once the phone is connected to a WiFi network (e.g. in the home using the home's broadband Internet service), the phone will automatically route the call over the WiFi network–phone calls and text work normally, as if the phone is connected to a cellular tower.

Nano-cell Calling – Poor or no cellular service in rural areas can be addressed by promoting the wider use of "nano-cell" devices. These small pieces of equipment are connected to the DSL or wireless broadband connection and provide improved cell service in the home or business. The working distance of these devices is limited, and service generally drops off once you leave the house itself (it may work for some short distance in the yard). These devices work very well and do not require an upgrade to a newer phone.

The cellular providers do not always promote the use of these devices, so many cellular users who would benefit from their use are not aware that this option is available. The device averages around $200 retail, but the cellular providers often provide substantial rebates (50% discount or more) and in some cases may provide them at no charge.

The improved wireless broadband service will also support use of WiFi calling and/or nano-cell devices.

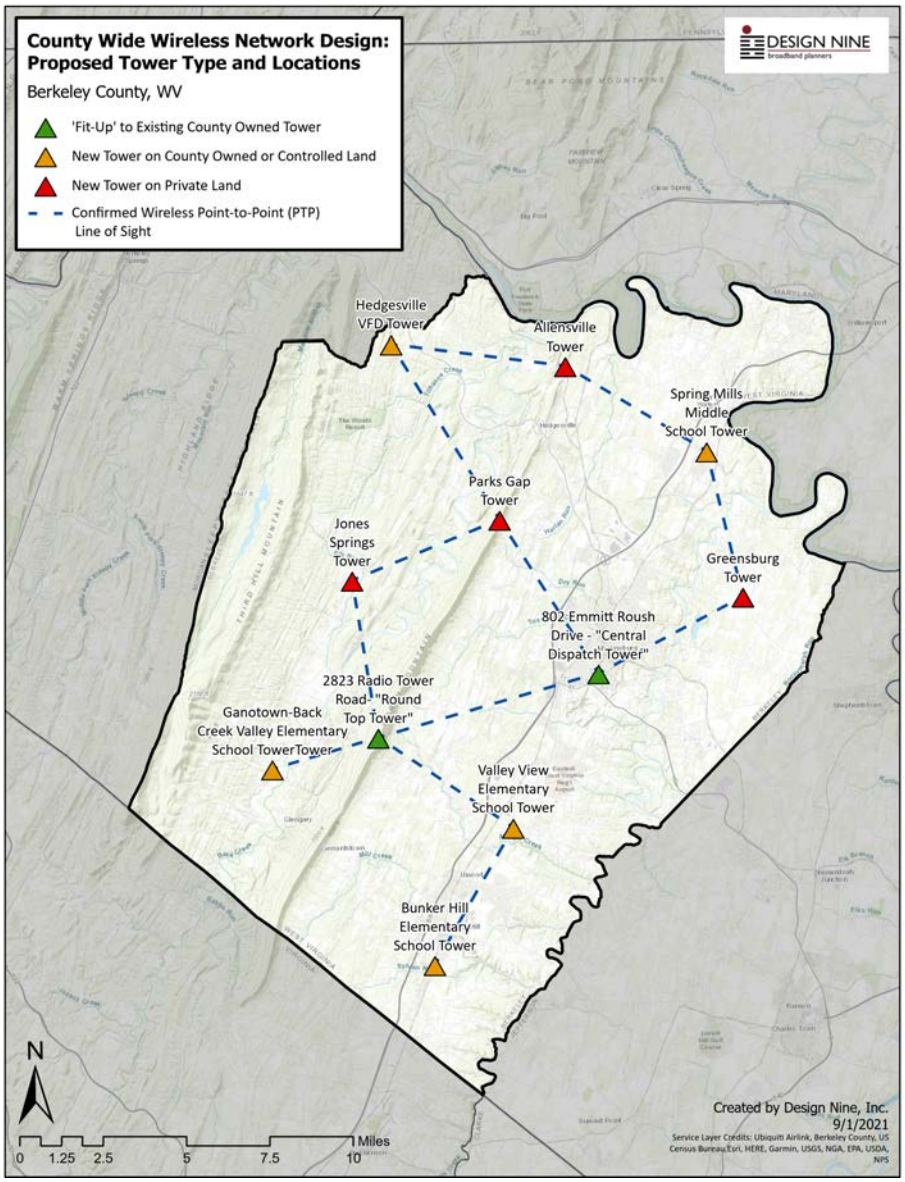
This strategy is important because improved broadband service can also improve cellular service without the need for more cellular towers, especially in parts of the county where cellular providers have not been able to make the business case for more towers.

9 BROADBAND CONNECTIVITY PROJECTS

This section describes a county-wide fixed point wireless solution for Berkeley County. Broadband speed and availability is generally considered adequate in the Martinsburg area, but the west of the Martinsburg metro area is widely underserved or unserved. A more robust fixed point wireless tower network, made available to service providers at modest cost, could bring much improved Internet access to those areas of the county.

9.1 WIRELESS NETWORK TOWER DESIGN

The network design provides an affordable county-wide network that could serve a significant portion of the county and eventually be expanded provide improved broadband coverage to most homes and businesses in the county. Wireless propagation studies were used to calculate coverage areas, and those studies included calculations that evaluated terrain and foliage coverage in the county. This solution could provide improved service to nearly 90% of households in the county. Where line of site to the proposed towers is poor, additional households and some small unserved pockets could be added by placing inexpensive utility poles.



This design assumes Wireless Internet Service Providers will lease space on these towers and supply their own access radios. Connectivity between towers could be provided by high performance microwave links and would enable providers to use those links to create a single county-wide broadband wireless network that would provide wireless customers with 25 Meg down and 3 Meg up meeting the FCC "fully served" definition.

Consultation with interested service providers is essential and their input should be solicited and evaluated to determine where they can connect to one or more planned towers as the build out proceeds.

This design is intended to show what is required to maximize Internet coverage to most county residents and businesses. The County government may not need to build and/or own all of the towers. WISPs that receive state and/or Federal funding may choose to build their own towers, and the County may only need to place a few towers in locations where household density is very low and private sector WISPs cannot make a business case for constructing their own tower.

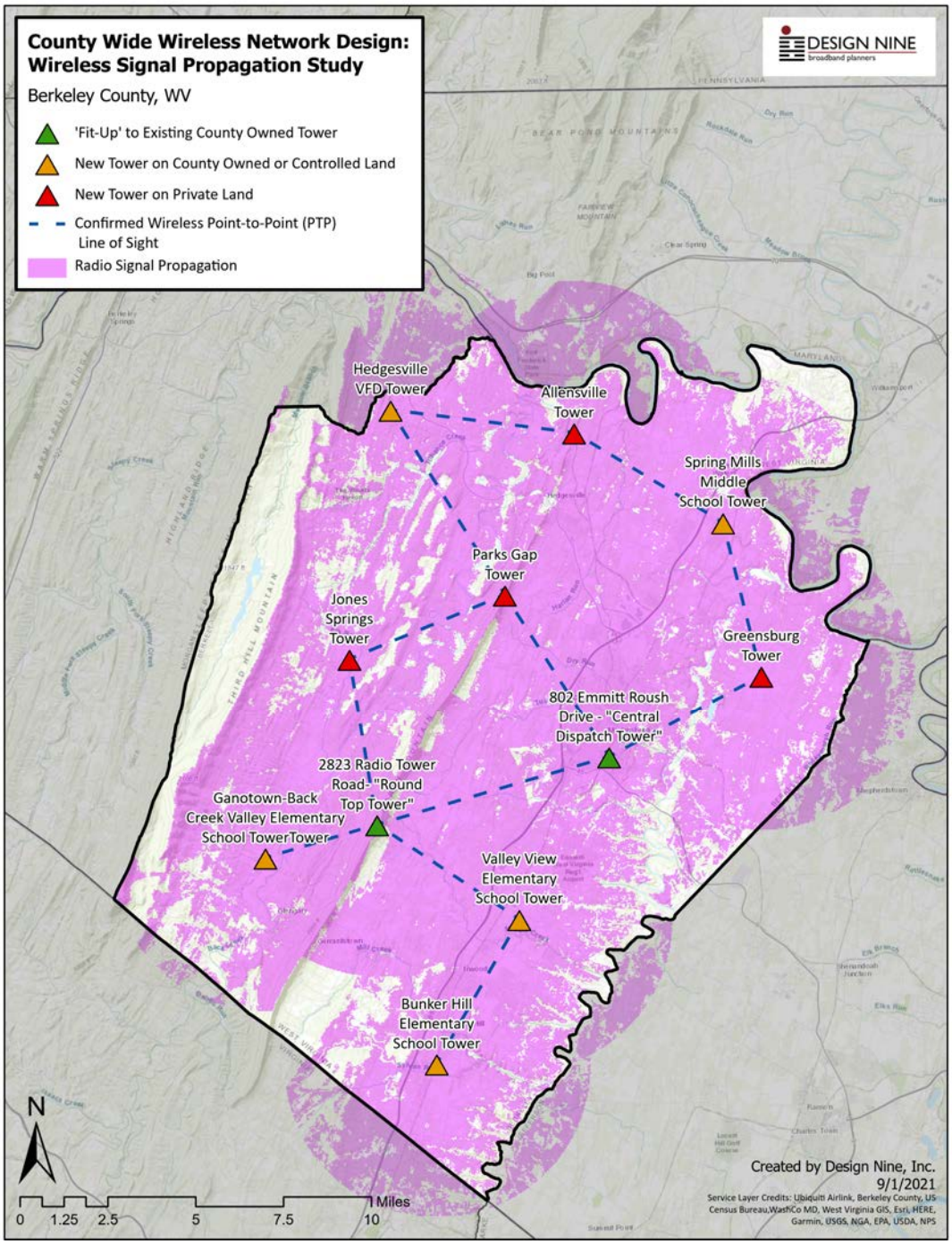
The wireless network design consists of fourteen new towers and uses four existing county-owned towers/elevated water tanks. The dotted lines indicate point to point connections between each tower, which creates a single county-wide broadband network. The point to point connections (the dotted lines) have all been calculated to have adequate line of sight between towers and poles. A WISP could connect to the county-wide network at any one of the towers.

The County government would not be offering Internet services from any County-owned towers. Instead, space on the towers would be leased at affordable rates to private sector WISPs who want to expand their market area.

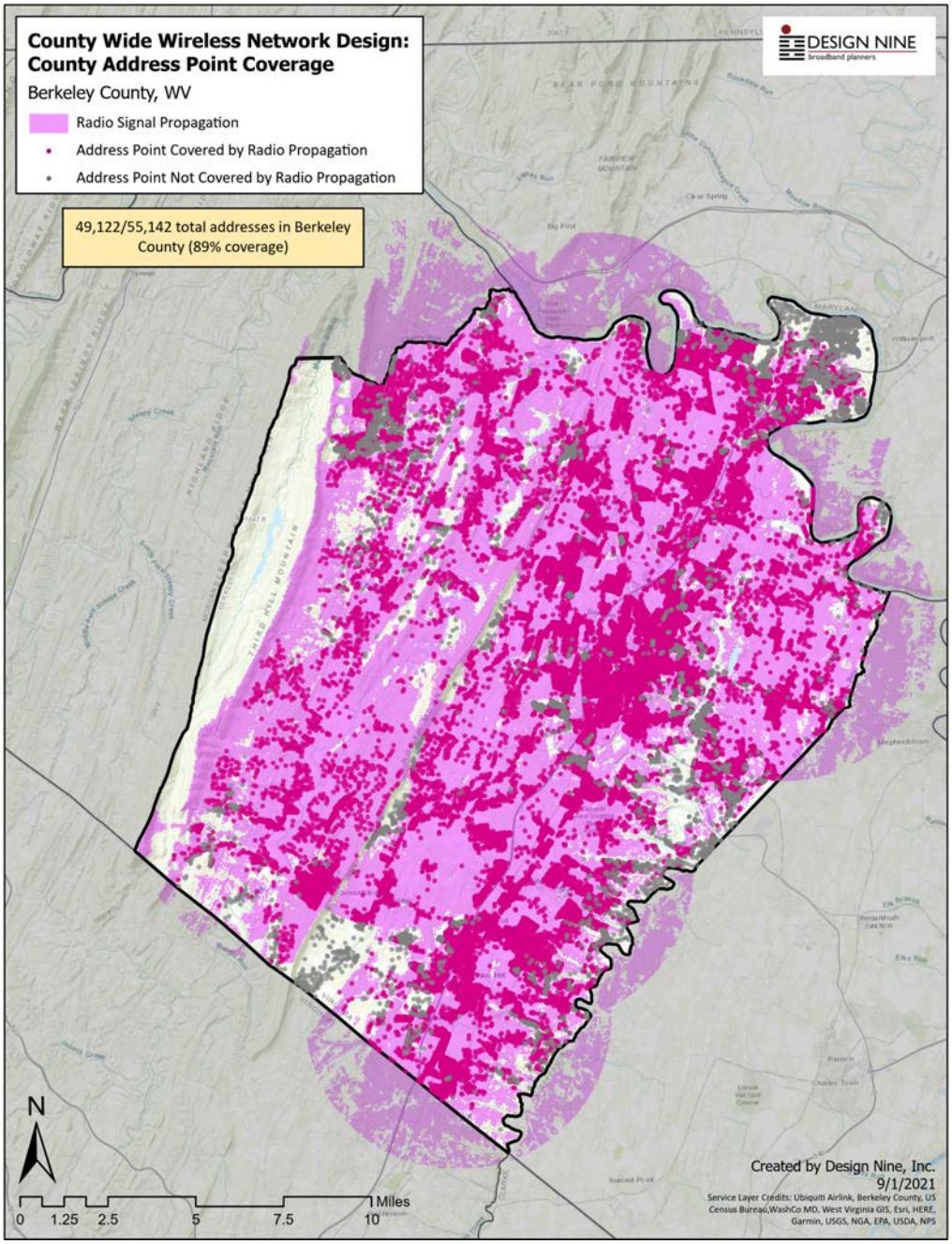
Leasing tower space is not a telecommunications service, and the County would not be selling Internet service to county residents and businesses.

The map below shows the estimated radio signal propagation for the wireless project. Colored triangles indicate the type of tower site being developed.

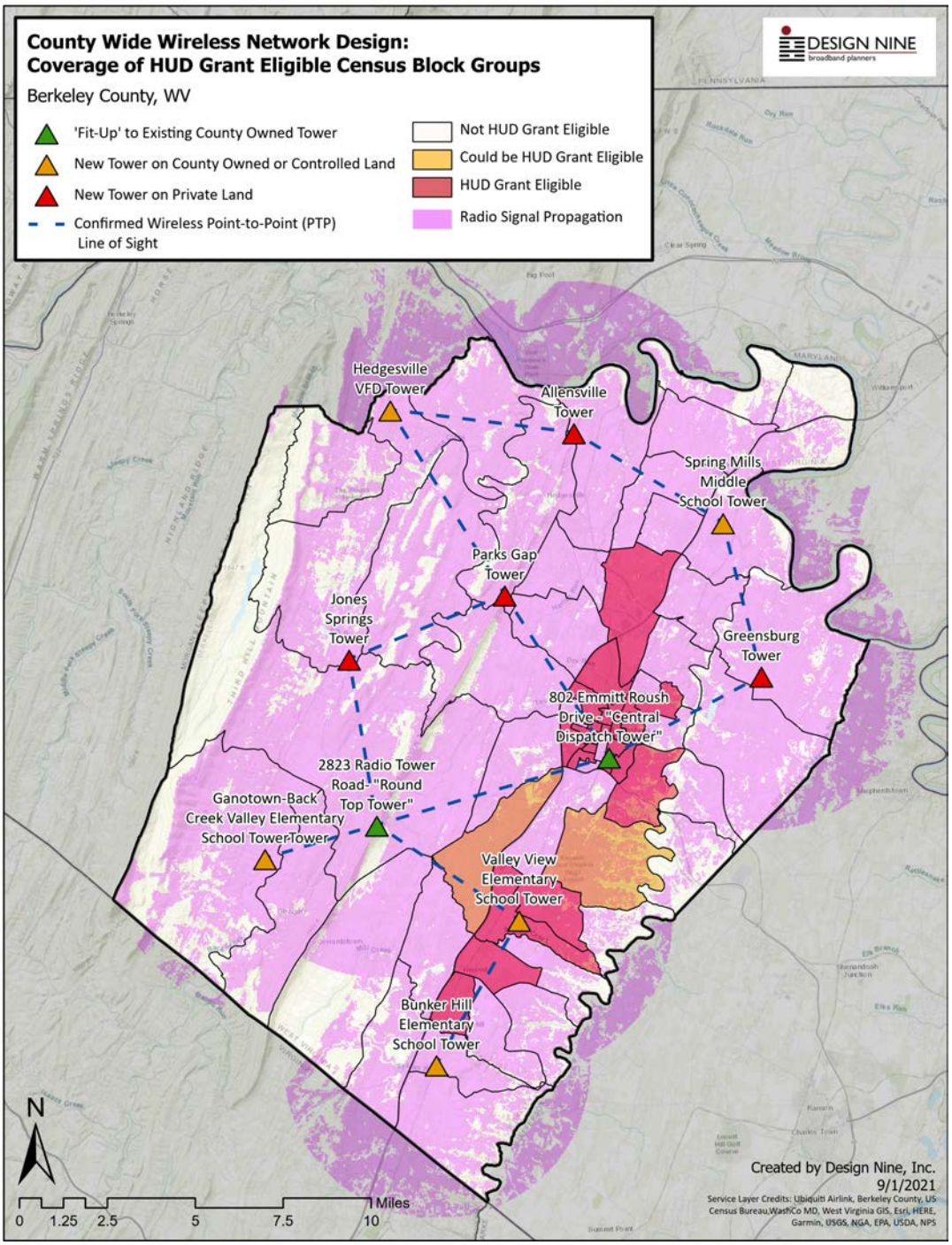
This design is intended to optimize coverage to as much as 90% of the county. The western portion of the county, which enjoys adequate cable Internet service for most households, has not been included. WISPs offering service in the county may have useful insight into areas that could benefit most from additional towers.



This map shows the estimated signal coverage (approximately 89%) and includes the address points (households) that can potentially receive service within those shaded propagation areas. It is important to note that the propagation software does make an estimate of foliage and terrain when calculating signal propagation, trees, buildings, and other obstacles near a residence or business could degrade or limit coverage. In many cases, a wooden utility pole placed near the premises (or an existing grain elevator) may improve line of sight to a tower and enable improved service.



This map shows the estimated propagation of the county-wide wireless network, overlaid on areas of the county that are eligible for HUD grants. None of the recommended tower locations are in HUD-eligible areas, but the Bunker Hill tower could be moved to the north and into a grant eligible area without affecting coverage significantly if another suitable tower location can be identified. The tower locations can often be moved slightly without affecting the overall radio signal propagation.



9.2 COUNTY-WIDE WIRELESS COST ESTIMATE

In this design, there are eleven tower locations that may require placement on private land. In most cases, the proposed tower locations can often be shifted from one parcel to another without affecting line of sight to other towers, but once an exact parcel has been identified, it will be important to validate that the proposed line of sight to other towers has not been affected. It is also possible that negotiating a site lease agreement with a land owner could take longer than the 3-5 months needed to prepare the site and erect the tower.

SITE	DESCRIPTION	TOTAL COST
Allensville Tower	A new tower constructed on private land that is bought or leased to serve rural areas between around Allensville, Johnstown and surroundings. Service Provider to Install wireless equipment. Point to point links to two other towers.	$221,425
Bunker Hill Elementary School Tower	A new tower constructed on the site of Bunker Hill Elementary School to serve Inwood, Bunker Hill and surrounding areas. Service Provider to Install wireless equipment. Point to point links to one other tower	$194,069
Ganotown-Back Creek Valley Elem. School Tower	A new tower constructed on the site of Back Creek Valley Elementary School to serve Ganotown, Glengary and surrounding areas. Service Provider to Install wireless equipment. Point to point links to two other towers.	$194,069
Greensburg Tower	New tower on private land (bought or leased) to serve rural areas northeast of Martinsburg. ISP to Install wireless equipment. Point to point links to two other towers.	$221,425
Hedgesville VFD Tower	A new tower constructed on the site of the Hedgesville Volunteer Fire Department to serve rural areas in the northwest of the county. Service Provider to Install wireless equipment. Point to point links to two other towers.	$203,425
Jones Springs Tower	New tower on private land (bought or leased) to serve rural areas in the west of the county. ISP to install wireless equipment. Point to point links to two other towers.	$221,425
Parks Gap Tower	A new tower constructed on private land by Dry Run Rd. that is bought or leased to serve as a signal relay point to other towers on the western side of the county. ISP to installl wireless equipment. Point to point links to three other towers.	$230,781
Spring Mills Middle School Tower	A new tower constructed on the site of Spring Mills Middle School to Gainesville and surrounding areas. ISP to install equipment. Point to point links to two other towers.	$203,425
Valley View Elem. School Tower	A new tower constructed on the site of Valley View Elementary School to serve Inwood and Pikeside and surrounding areas. Service Provider to Install wireless equipment. Point to point links to two other towers.	$203,425
802 Emmitt Roush Drive - "Central Dispatch Tower"	Fit-up to an existing county-owned tower located in Martinsburg. To serve the Service Provider to Install wireless equipment. Point to point links to three other towers.	$64,444
2823 Radio Tower Road-"Round Top Tower"	Fit-up to an existing county-owned tower located on the ridge line along Radio Tower Rd. To serve as a signal relay point to other towers on the western side of the county. ISP to Install wireless equipment. Point to point links to four other towers.	$73,800

$2,031,713

9.3 TOWER AND WIRELESS NETWORK DEVELOPMENT ACTIVITIES

This section identifies the key tasks and timelines associated with identifying ISP partner(s) and tower sites.

Tower Site and Tower Development Process

ACTIVITY	DESCRIPTION	DISCUSSION	TASKS
Issue Berkeley County partnership RFP	For many of the grant opportunities, a private sector ISP will be needed.	The RFP should be short and should not require large amounts of work from respondents. For best response, allow at least 45-60 days for ISPs to submit a response.	• Start RFP development by obtaining sample RFPs from other localities. • Develop draft RFP and have it reviewed. • Issue RFP. • Review responses and conduct interviews as needed. • Select best candidate.
Assess and inventory prospective tower sites in the county	Grant applications for wireless towers require specific locations for towers.	Use report data to identify where towers are needed.	• Appoint someone to lead tower site effort. • Assemble a list of locations from report data. • Begin meeting with property owners to determine willingness to provide space for tower and availability of road access and electric service. • Collect site agreements.

Tower Site and Tower Activities

TASKS	MONTHS											
	1	2	3	4	5	6	7	8	9	10	11	12
Obtain sample ISP partner RFPs												
ISP RFP development and review												
Issue RFP for ISP partner(s)												
Review responses and conduct interviews												
Select ISP partner(s)												
Appoint site identification team												
Collect prospective sites												
Meet with property owners												
Collect site agreements												

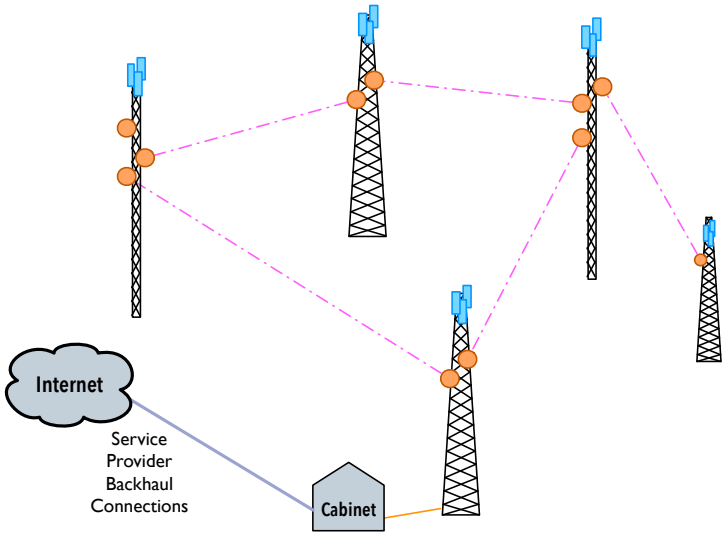
9.4 TOWER COST DETAIL

About Wireless Tower Cost Estimates

The line items for each named tower include the cost of the tower, site preparation, estimated cost of electric service, generator cost and placement, cost of the tower, and labor to assemble and erect the tower, and backbone equipment.

This section of the report provides an estimate of the cost of using existing towers to provide improved Internet access. The diagram below shows the logical design of a five-tower network. Four of the five towers have adequate line of sight between the towers to build a fully redundant ring between the towers, which will provide much more reliable service, because a single tower or equipment failure will not affect service.

Any placement of new towers should be preceded by a careful viewshed analysis of how much area/users are likely to be able to receive service. Site acquisition and site preparation costs can affect the overall cost of such a project. Existing county properties (e.g. fire/rescue stations, county parks, dump transfer sites, etc.) may be candidates for towers. Note that existing towers may require an engineering study to confirm that additional antennas can be added without exceeding the tower load limits.



Existing Tower Improvements

For existing towers owned by the state, the county, or other stakeholders that might be candidates for project use, modest upgrades to equipment at the base of the tower would be needed to make them broadband-ready.

Upgrades to existing towers typically may include adding or upgrading generators, additional cabinet or shelter space for service provider equipment, and sometime fencing and physical access changes.

Note that this estimate represents a worst-case scenario. If the site already has a generator that can be used by a new WISP co-locating on the tower, that could reduce the cost by as much as $7,500. If no road improvements are needed and existing electric service does not require a new H-frame and meter, another savings of up to about $3,000 is possible. If the tower has a current certification (i.e. had a formal engineering inspection), additional savings are possible, bringing the best-case cost to about $11,000 to $12,000.

Existing Tower Development and Improvements (Fit-up)

ITEM/PROJECT	UNITS	UNIT COST (LOW)	UNIT COST (HIGH)	COST (AVG)
Tower Study / Survey	1	$4,500	$7,000	$5,750
Site Development (Clearing, Road Improvements, etc.)	1	$0	$1,500	$750
Small Telecom Cabinet AmProd AM47P-2636-24RU or Equivalent	1	$6,000	$7,500	$6,750
10kW Liquid Propane Generator	1	$4,000	$6,000	$5,000
Cabinet Foundation and Installation	1	$2,500	$4,000	$3,250
New Power Service / Installation (assumes power available on-site)	1	$1,500	$2,500	$2,000
Power System Installation Labor	1	$300	$500	$400
Generator Installation Labor	1	$1,250	$1,700	$1,475
Propane Service Installation - tank and install by local gas company	1	$750	$1,250	$1,000
Poject management				$10,000
Total:				$36,375

New Tower

New towers have a range of configurations and cost options. This estimate is for a new 180 ft bare tower with no radio equipment. If located on existing county properties, the time needed to plan for construction can be shortened. If site acquisition or a site lease of private property is required, purchase or lease negotiations can add several months to the process. Note that a full permitting process may be required even if a new tower is placed on existing county-owned property. The permit process can add 60 to 120 days to the time needed to put a new tower in service.

New Tower Costs (180' Guyed)

ITEM/PROJECT	UNITS	UNIT COST (LOW)	UNIT COST (HIGH)	COST (AVG)
Labor and Contracting: $82,640				
Site Development (Clearing, Road Improvements, etc.)	1	$15,000	$15,000	$15,000
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
Materials: $35,735				
180' Guyed Tower Construction Materials	1	$17,500	$27,500	$22,500
Small Telecom Cabinet	1	$4,000	$6,000	$5,000
Cabinet Foundation and Installation Materials	1	$1,000	$1,500	$1,250
10kW Liquid Propane Generator	1	$4,000	$6,000	$5,000
Spare Fuses	1	$10	$20	$15
Power System Installation Materials	1	$20	$40	$30
Samlex 1000W Inverter	1	$350	$450	$400
Samlex SEC1230-UL Battery Charger	1	$200	$300	$250
100ah 12v Non Spillable Backup Battery	4	$250	$350	$1,200
DC Voltage Monitoring Device	1	$40	$60	$50
Unmanaged Rack Mount PDU (6O)	1	$35	$45	$40
Total:				$118,375
Project Management, Network Design				$37,500
Site Engineering, Surveying, Viewshed Analysis, Etc.				$9,500
Misc Fees, Technical Services				$7,500
Contingency				$11,838
TOTAL:				$184,713

New Community Pole

A single wooden utility pole or inexpensive steel lattice tower with a line-of-site wireless connection to a 180 ft 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 county 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.

If there were twenty homes that could receive service and the cost of the pole and equipment was $12,000, each household connected would have a one-time cost of $600. There could be a matching grant program where each county could provide 50% of the cost of putting the pole and equipment in place, and the balance would have to be developed from other sources. Some localities are using this concept to offer WISPs exclusive access to the pole in return for a portion of the construction costs.

Pole costs vary depending upon what equipment is installed. Point-to-point link radio costs vary with distance from a nearby tower. More information is contained in Chapter Six - Small Cell Broadband Poles.

Neighborhood Pole Costs

ITEM/PROJECT	UNITS	COST (LOW)	COST (HIGH)	COST (AVG)
Site Development (Clearing, Road Improvements, etc.)	1	$0	$2,000	$1,000
3x3 NEMA Box	1	$300	$600	$450
New Power Service / Installation	1	$500	$1,250	$875
60' Wooden Utility Pole Construction Materials	1	$2,500	$3,500	$3,000
Unmanaged Rack Mount PDU (6O)	1	$35	$45	$40
60' Wooden Utility Pole Construction Labor & Contracting	1	$2,000	$3,000	$2,500
Neighborhood Pole Coordination and Project Management				$5,000
Total:				$12,865

Point-to-Point Links

The table below show the cost of a backhaul radio installation, with one licensed radio set (AirFiber 11FX). The licensed radios are less susceptible to interference and have higher bandwidth. A regional 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.

A tower in a larger network may have one, two, or several backhaul radios included, and number of radios depends on the tower's location in the network and how many other towers it is connected to using point to point link pairs.

Licensed PTP Radio - Single Side - AirFiber 11FX

ITEM/PROJECT	UNITS	UNIT COST	COST
AF11X Radio	1	$799	$799
AF11-CA Adapter Kit	1	$49	$49
AF11FX Duplexer	2	$199	$398
AF11 X Antenna 11GHz, 35dBi	1	$379	$379
FCC Licensing	0.5	$2,000	$1,000
Shipping @ 5%	1		$131
Point to Point Link Assembly, Installation, Alignment, and Testing	1	$3,600	$3,600
Project Management, NIIT	0.5		$3,000
TOTAL			$9,356

9.5 ESTIMATED TIMELINES FOR COMPLETION

Each kind of project will have its own timeline, and will vary widely depending on the type of funding. Grant-funded projects may need six months to one year to plan and apply for funding, depending on where in the grant cycle the network owner commits to applying for a grant and the length of time that the grant agency takes to review and approve grants.

Tower improvements and construction times can be dependent on weather (more weather related delays are likely in late fall through early spring) and on procurement. Most grant-funded projects require careful attention to a public procurement process, which can add 90 to 180 days to the timeline.

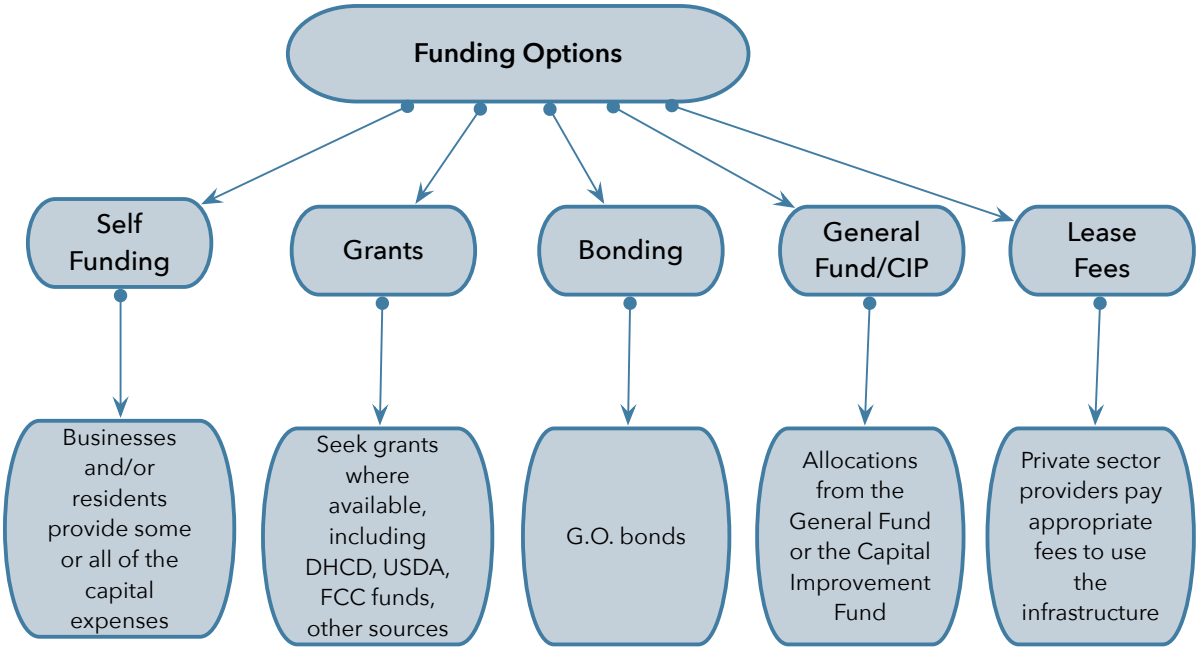
Broadband Construction Timetable

Project Type	Project Execution Planning	Project Procurement	Project Engineering and Construction	Total Estimated Timeline
Improvements to existing towers	2-3 months	3-4 months	2 months	7-9 months
New towers of 180 ft	4-6 months	4-5 months	4-8 months	12-19 months
Small cell community broadband poles	3 months	2 months	2 months	7 months
Public WiFi Hotspot	3 months	1 month	1 month	5 months
Point to point tower backhaul links	2-3 months	3-5 months	1-2 months	6-10 months
Fiber to the home/ business projects	4-6 months	4-6 months	6-12 months	14-24 months

10 INFRASTRUCTURE FUNDING AND GRANT OPPORTUNITIES

It is important to note that any investment by county government in broadband infrastructure should be focused on passive infrastructure. Passive infrastructure can be leased to private sector service providers, generating long term revenue for maintenance and expansion. Leasing passive infrastructure like towers and dark fiber is not a "telecommunications service" (Wisconsin counties are forbidden by state statute from offering telecommunications services).

These assets will have a conservative life span of thirty years or more (e.g. wireless towers, conduit, fiber cable). These types of infrastructure investments create hard assets that have tangible value and can then be leveraged for additional borrowing. The demand for services and the associated fees paid for those services will provide the revenue that will pay back loans over time. There is ample time to recoup not only the initial capital investment, but also to receive regular income from the infrastructure.



The financing of local government and/or community-owned telecommunications infrastructure faces several challenges with respect to funding.

- Not all local governments are willing to commit to making loan guarantees from other funding sources like property taxes, because the idea of community-owned telecom infrastructure has a limited track record and therefore a higher perceived risk.
- Similarly, citizens are not always willing to commit to the possibility of broadband fees or higher taxes that may be needed to support a telecom infrastructure initiative, for many of

the same reasons that local governments are still reluctant to make such commitments: perceived risk and a lack of history for such projects.

- Finally, banks and investors are also more skeptical of community telecom projects because of the relative newness of the phenomenon. By comparison, there are decades of data on the financial performance of water and sewer systems, so the perceived risk is lower.

Somewhat paradoxically, the cost of such a community digital road system is lower when there is a day one commitment to build to any residence or business that requests service. This maximizes the potential marketplace of buyers and attracts more sellers to offer services because of the larger potential market. This is so because:

- Service providers are reluctant to make a commitment to offer services on a network without knowing the total size of the market. A larger market, even if it takes several years to develop, is more attractive.
- Funding agencies and investors that may provide loans and grants to a community network project want to know how the funds will be repaid and/or that grants will contribute to a financially sustainable project. Knowing that the size of the customer base is the maximum possible for a service area helps reduce the perceived risk for providing loans and grants.

10.1 WEST VIRGINIA FUNDING OPPORTUNITIES

The West Virginia legislature has been evaluating legislation to improve broadband access in the state. The Governor and the legislature seem firmly committed to make it easier and less expensive to build broadband infrastructure in underserved parts of the state.

- In October, 2021, the West Virginia Broadband Council and the Governor (Jim Justice) announced an aggressive strategy for bringing broadband to more West Virginia households and businesses. The program will use $236 million in state broadband funds and add it to $362 million in Federal Communications Commission funding and $120 million from other state and federal sources, for a total of $718 million in government funding expected to be allocated by fall 2022. The funds will be allocated through competitive programs that draw matching funds from private-sector and local government partners, generating more than $1 billion in total broadband investment.
- The West Virginia "GigReady" program provides an opportunity for local governments and organizations to dedicate funds available through the American Rescue Plan Act (ARPA), or other local funding. The GigReady program will assist participants in two distinct phases. In phase one, the program will provide technical assistance to help communities scope projects, select private partners and vendors, and complete other necessary steps in the broadband development process. In phase two, upon completion of the technical assistance phase, participants may then be eligible for implementation funding through the GigReady program or other funding sources. Participants who have qualifying, shovel ready projects that do not need technical assistance can apply to proceed directly to phase two by submitting a complete application, including all information listed as "optional" in the application.
- The LEAD program (Line Extension Advancement and Development) will fund extensions of existing last-mile cable modem and fiber-to-the-premise broadband networks that can be

constructed quickly. Approximately $25 million is targeted for this funding opportunity. Actual funds awarded may be more or less depending on the volume of applications received, the need of proposed projects for grant support, and the requirements of the U.S. Treasury.

- Published in 2020, the West Virginia Broadband Plan provides a broad overview of broadband activities in the state. The report provides detail on current broadband speed availability across the state, Federal grant opportunities, long term goals of the West Virginia Broadband Enhancement Council, and county level results of the WV Speed Test site.
- Passed in 2019, Senate Bill 3 creates the "Wireless Technology Business Property Valuation Act," which would make it less expensive for telecommunications and broadband internet companies to build more towers, particularly in rural parts of the state. The tax treatment of the towers would be changed to reduce property taxes on the towers, making it less expensive to build and maintain those towers.
- Senate Bill 800 is a "Make-Ready Pole Access" provision. This portion of the law would require electric utilities companies to evaluate using their utility poles to expand broadband access.
- Passed in 2019, Senate Bill 3 also creates the "West Virginia Small Wireless Facilities Deployment Act," which would make it easier for ISPs and cellular providers to use the state's existing rights of way and utility poles to place the next generation of wireless and broadband technologies. 5G services could be deployed more quickly in West Virginia if this is included in the final bill.

Berkeley County should maintain regular communications with the West Virginia Broadband Enhancement Council (broadband.wv.gov) to pursue every possible funding opportunity.

10.2 ARPA (AMERICAN RESCUE PLAN ACT) FUNDING

The American Rescue Plan Act of 2021, is the biggest federal funding program for broadband projects. ARPA has $350 billion in funding. Each state receives an ARPA fund allocation, and how much is targeted toward broadband initiatives will be decided by a state legislative committee and/or the governor of the state.

The 2020 CARES (Coronavirus Aid, Relief, and Economic Security Act) funding was typically distributed by state governments to localities (e.g. counties, towns, cities), which were then able to make decisions on how to spend the money within both the state and Federal guidelines attached to the funds.

ARPA funding has fewer requirements and "strings" attached than many other Federal broadband grant programs, and Berkeley County should make obtaining ARPA funds for county broadband projects a priority in late 2021 and early 2022.

The West Virginia Department of Economic Development intends to support this Program using funds allocated to the State of West Virginia through the Capital Projects Fund (CPF) of the American Rescue Plan Act (ARPA). According to guidance published by the U.S. Treasury, states will be required to provide a plan describing how they intend to use allocated funds under the Capital Projects Fund consistent with the American Rescue Plan and guidance issued by Treasury.

The Department intends to include this Program in its application for funding that Congress has allocated to West Virginia through the Capital Projects Fund. While the Department expects that projects conforming to the requirements of this Program will be eligible for funding under the Capital Projects Fund, U.S. Treasury must approve use of Capital Projects Fund allocated funding for this Program.

Approximately $45 million is targeted for this funding opportunity. Actual funds awarded may be more or less depending on the volume of applications received, the need of proposed projects for grant support, and the requirements of the U.S. Treasury.

Support from local communities and partnerships between private and public entities are strongly encouraged. Applicants that are not local governments must at a minimum include with their applications letters of support from the municipal or county legislative body or bodies in the Eligible Areas for which they are submitting applications. Local governments may also provide greater support for private applicants, such as capital funding, agreements to purchase service, or access to public land or facilities that could be used to deploy broadband infrastructure or services. Applicants which are local governments or affiliated organizations must identify in their applications partners which are private for-profit or non-profit companies with experience in the development and operation of broadband networks and services. If awarded, such partners shall be considered sub-recipients of grant funds.

10.3 HUD COMMUNITY DEVELOPMENT BLOCK GRANTS

The U.S. Housing and Urban Development CDBG State Program allows the Wisconsin state government to award grants to smaller units of general local government (e.g. counties, towns) that develop and preserve decent affordable housing, to provide services to the most vulnerable in our communities, and to create and retain jobs. In recent years, CDBG funds have been successfully used for broadband infrastructure development where the local government applicant can show the improvements meet the general guidelines of the program—so grant funds have to spent in low and moderate income areas.

Over a 1, 2, or 3-year period, as selected by the grantee, not less than 70 percent of CDBG funds must be used for activities that benefit low- and moderate-income persons. In addition, each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available. More information is available here (https://www.hud.gov/program_offices/comm_planning/communitydevelopment/programs).

10.4 USDA RECONNECT PROGRAM

The ReConnect program is a new funding program managed by the USDA Rural Development Office. This program is sometimes called the USDA e-Connectivity pilot program. Grant applications can be a combination of 100% grant, 50% grant/50% loan, or 100% loan. $1.1 billion has been allocated to the program for 2022, and a wide variety of entities can apply, including non-profits, coops, and state and local governments.

As much as $200 million will be available for loans, with another $250 million allocated for loan/grant combinations. A $350 million fund will be distributed with a 25% matching requirement and another $350 million in grants with without a match, for projects in tribal and socially vulnerable communities. Applications are due in the spring of 2021, and USDA will begin accepting applications in late 2021. More information is available here: (reconnect.usda.gov). A mapping tool is available on the Web site to show areas that are eligible. To qualify as an eligible area, households must have less than a minimum of 10 Megabit down/1 Megabit up broadband service.

10.5 911 FEES

Improved broadband access in the county can improve household access to 911 services by using broadband Internet to carry 911 voice calls, using one or more strategies to include:

WiFi calling – now a commonly available feature on new cell phones. WiFi calling switches voice telephone call from the cellular network to a nearby WiFi Internet network seamlessly. The reduces the need for additional large cell towers in low density areas of the county.

Nano-cell Devices – Nano-cells are a small box attached to a home wireless router. The nano-cell, which is typically obtained from the cellular provider, enables a cellphone to operate inside the home or business even if there is no cell tower near by.

A modest increase in the 911 fee to improve 911 access in rural areas of the county could generate funds to support additional broadband towers and community poles, but this approach would require legislative changes at the state level–which has been a topic of discussion in Charleston. See the tables above in the Special Assessment section of this chapter.

10.6 OPPORTUNITY ZONES

An Opportunity Zone is an economically-distressed community where new investments, under certain conditions, may be eligible for preferential tax treatment. Localities qualify as Opportunity Zones if they have been nominated for that designation by the state and that has been approved by the Internal Revenue Service. Opportunity Zones are designed to create tax incentives for private investors to make investments that can encourage economic development and job creation in distressed communities. Opportunity Zones would be of most use for Internet Service Providers who could use the tax benefits to make a business case to improve Internet access in a qualifying area (zone).

Opportunity Zones are defined by census tract, and the Census Bureau's Geocoder online tool can provide census tract ID numbers. A link to the list of currently qualified census tracts can be found on this page (https://www.cdfifund.gov/opportunity-zones). Berkeley County does not appear to have any designated Opportunity Zones.

10.7 BONDING

Revenue bonds are repaid based on the expectation of receiving revenue from the network, and do not obligate the local government or taxpayers if financial targets are not met. In that respect, they are different from general obligation bonds. Many kinds of regional projects (water, sewer, solid waste, etc.) are routinely financed with revenue bonds. We believe many community projects

will eventually finance a significant portion of the effort with revenue bonds, but at the present time, the limited financing history of most community-owned broadband networks has limited using revenue bonds.

Selling revenue bonds for a start up municipal network can be more challenging because there is no financial or management history for the venture. Bond investors typically prefer to see two or three years of revenue and expenses and a track record of management success. It would be advisable for the county to have an early conversation with qualified municipal bond counsel to assess the viability of this approach. ***However, the Covid crisis and the subsequent increase in demand for better broadband seems to encouraged the bond market to regard muni broadband financing as less risky than in past years.***

Obtaining funding using revenue bonds requires an excellent municipal credit rating and an investment quality financial plan for the operation and management of the network. Revenue bonds must be used carefully, and a well-designed financial model is required to show investors that sufficient cash flow exists to pay back the loans.

General obligation bonds are routinely used by local governments to finance municipal projects of all kinds. G.O. bonds are guaranteed by the good faith and credit of the local government, and are not tied to revenue generated by the project being funded (i.e. revenue bonds). G.O. bonds obligate the issuing government and the taxpayers directly, and in some cases could lead to increased local taxes to cover the interest and principal payments. Some bond underwriters have indicated a willingness to include telecom funds as part of a larger bond initiative for other kinds of government infrastructure (e.g. adding $1 million in telecom funds to a $10 million bond initiative for other improvements).

In discussions with bond underwriters, it has been suggested that it would be easier to obtain bond funds for telecom if the telecom bonding amount was rolled into a larger water or sewer bond, or some other type of bond request that are more familiar to the bond market.

10.8 RDOF/CAF2 FUNDING

The second round of the FCC Connect America Fund (CAF2) (Rural Digital Opportunity Fund) continues to provide funds to incumbent and competitive service providers. The funds must be used in unserved or underserved areas as defined by Federal census blocks. To be eligible, a census block could not have been served with voice and broadband of at least 10/1 Mbps (based on Form 477 data) by an unsubsidized competitor or price cap carrier.

The FCC published the final eligible census blocks for the auction on February 6, 2018. The final areas were based on FCC Form 477 data as of December 31, 2016 (the most recent publicly available FCC Form 477 data at the time). So there is a time lag between the determination of a qualifying census block or blocks and the schedule for submitting a bid to serve those areas. The first round of funding was announced in early 2021, and was immediately met with widespread criticism. SpaceX (Starlink) was awarded almost $900 million, and it may have to return some of those funds because the company appears to have included some ineligible census blocks. Many large incumbents also received substantial awards when some smaller ISPs that might have offered competition to the incumbents received much less or no funds.

Because many CAF2 qualifying areas are only served by low performance DSL (e.g. less than 10/1 Mbps service), incumbent carriers use the awards to upgrade DSL switches, which is not a long

term solution. More recently, competitive carriers are applying for CAF2 funds to provide higher performance broadband wireless and in some cases fiber to the home. Because the use of CAF2 funds are so restricted, it has not had as much impact as many hoped. The FCC, as of fall 2021, has not announced the rules for the second round of funding.

10.9 LEASE FEES

Initiatives like tower access and access to local government-owned conduit and fiber can create long term revenue streams from lease fees paid by service providers using that infrastructure. The City of Danville, Virginia has recovered their entire initial capital investment from lease fees paid by providers on the nDanville fiber network.

10.10 COMMUNITY REINVESTMENT ACT

The Community Reinvestment Act (CRA) was developed forty years ago to encourage banks and savings institutions to help meet the credit needs of their local communities, with a focus on low and moderate income areas of those communities. The Federal agencies that oversee private banks assign a CRA rating to each institution. Banks are often looking for well-planned community efforts that need loans. Such loans can improve a bank's CRA rating.

The CRA was revised in 2016 to encourage banks to support community broadband efforts. A community broadband project may be able to get some loan financing from a local bank that wants to get credit for their CRA work.

10.11 COOP MEMBERSHIP FEES

Coop members pay a one time membership fee to join the coop. For fiber and wireless improvements, this fee could be set at a level that pays for part or all of the cost of building the fiber to the business or residential premises and/or placing the towers and equipment to deliver wireless service. It may also be possible to work with local banks to provide a financing option (e.g. the membership fee could be paid monthly over a period of several years to reduce the financial burden on a household or business).

The coop membership fee offers the area a way to self-finance a substantial portion of the initial network, as well as providing a long term framework for expansion.

10.12 CONNECTION FEES

Tap fees, pass by fees, and connection fees are already commonly used by local governments for utilities like water and sewer. The revenue share model can be strengthened from additional sources of revenue, including one time pass by fees, connection fees and sweat equity contributions. It is important to note that the Coop Membership Fee can be treated as a connection fee in whole or in part.

Pass By Fees – Pass by fees could be assessed once the fiber passes by the property, just as some communities assess a pass by fee when municipal water or sewer is placed in the road or street– and the fee is assessed whether or not the premise is connected, on the basis that the value of the property has been increased when municipal water or sewer service passes by. At least one study

has indicated that properties with fiber connections have a higher value by $5,000 to $7,000 that similar properties without fiber access.

One Time Connection Fees – A one time connection fee can be assessed to property owners (e.g. residents and businesses) when the fiber drop from the street to the premise is installed. This is similar to the kinds of connection fees that are typically charged when a property is connected to a municipal water or sewer system. The fee is used to offset the cost of the fiber drop and the Customer Premise Equipment (CPE) needed to provide the operational access to the network. The connection fee can be modest (e.g. $100) or it can be a larger percentage of the actual cost of the connection. Fiber CPE may range from $250 to $350 and a fiber drop may cost from $200 for a premise very close to the distribution fiber passing along the property to $1,000 or more if the premise is hundreds of feet from the road. One variant would be to charge a minimum connection fee for up to some distance from the road (e.g. $100 for up to 75' and $2 for each additional foot).

There is already some data that indicates that residential property values increase by as much as $5,000 to $7,000 if fiber broadband services are available, so pass by fees can be justified on the basis of increased property values accruing to the property owner. Given the novelty of this approach, pass by fees may need more time to become an accepted finance approach, but tap fees (for installing the fiber cable from the street or pedestal to the side of the home or business) may be easier to use, especially for businesses that may need improved broadband access. Tap fees have the potential of reducing the take rate in the early phases of deployment, but as the value of the network becomes established, it is likely that there will be much less resistance to paying a connection fee.

10.13 NEW MARKETS TAX CREDIT

New markets tax credits are a form of private sector financing supported by tax credits supplied by the Federal government. The New Markets Tax Credit (NMTC) Program permits taxpayers to receive a credit against Federal income taxes for making qualified equity investments in designated Community Development Entities (CDEs). The CDEs apply to the Federal government for an allotment of tax credits, which can then be used by private investors who supply funds for qualifying community projects. Substantially all of the qualified equity investment must in turn be used by the CDE to provide investments in low-income communities.

The credit provided to the investor totals 39 percent of the cost of the investment and is claimed over a seven-year credit allowance period. In each of the first three years, the investor receives a credit equal to five percent of the total amount paid for the stock or capital interest at the time of purchase. For the final four years, the value of the credit is six percent annually. Investors may not redeem their investments in CDEs prior to the conclusion of the seven-year period.

Throughout the life of the NMTC Program, the Fund is authorized to allocate to CDEs the authority to issue to their investors up to the aggregate amount of $19.5 billion in equity as to which NMTCs can be claimed.

These tax credits can be quite useful, and there may be some areas that qualify. However, it can take up to a year or more to apply and then finally receive NMTC-related cash. This can be a useful long term source of funds.

10.14 SPECIAL ASSESSMENT/SERVICE DISTRICT

Communities like Bozeman, Montana and Leverett, Massachusetts have been funding broadband infrastructure improvements with special assessments (in Leverett, $600/year for five years), and in Bozeman, TIF (Tax Increment Funding) is being used in some areas to add telecom conduit, handholes, and dark fiber. In some localities, it is possible to levy a special assessment in a service district designated for a particular utility (like broadband) or other kind of public service.

Charlemont, Massachusetts intends to add an $11/month assessment to every household to build a town-owned Gigabit fiber network that will pass every household in the community. A town-wide vote supported this funding approach. Put in perspective, the average cost of a large, single topping pizza in the U.S. is currently $9 to $12.

Two small cities in Utah are currently evaluating the potential of a $10-12 utility tax levied on every household and business to finance a full fiber to the premises build out, including a modest "free" Internet service that would be adequate for email and light Web use. Most households will probably choose to select a higher performance Internet package from a private provider on the network. A $5/month special assessment (the cost of one large pizza) on every household in Berkeley County could raise as much as $79 Million for broadband over twenty years—enough to take Gigabit fiber to nearly every home and business.

The tables below shows the kind of funds that could be generated over several time periods. If ten dollars per month were collected from each household for thirty years, it would easily finance the immediate build out of Gigabit fiber that would pass nearly all homes and businesses in each county.

Individual Service District Examples				
Monthly Assessment Amount	Fifty Homes Five Year Assessment	Fifty Homes Ten Year Assessment	100 Homes Five Year Assessment	100 Homes Ten Year Assessment
$5	$15,000	$30,000	$30,000	$60,000
$10	$30,000	$60,000	$60,000	$120,000
$25	$75,000	$150,000	$150,000	$300,000
$50	$150,000	$300,000	$300,000	$600,000

A lesser amount (e.g. $2/month over twenty years) would easily finance the immediate build out of a comprehensive wide area wireless tower network in each, as well as some fiber infrastructure.

Berkeley County Special Assessment Examples		
Monthly Assessment Amount	Twenty Year Assessment	Thirty Year Assessment
Number of Households	44,221	
$2	$21,226,080	$31,839,120
$5	$53,065,200	$79,597,800
$10	$106,130,400	$159,195,600

10.15 PROPERTY TAX INCREASE

While raising taxes can be politically very difficult, a very small incremental increase in property taxes, with the increase clearly earmarked specifically designated for broadband development (.e.g. one-quarter cent) might be possible to sell to citizens and businesses.

The table below illustrates a hypothetical example of what funds might be raised for broadband improvements with a sample county-wide assessed property value.

	Sample Assessed property value	Broadband increment	Annual Broadband Fund	Ten Year Aggregate	Twenty Year Aggregate	Thirty Year Aggregate
1/4 of one cent	$7,000,000,000	$0.0025	$157,500	$1,575,000	$3,150,000	$4,725,000
1/2 of one cent	$7,000,000,000	$0.0050	$315,000	$3,150,000	$6,300,000	$9,450,000
1 cent	$7,000,000,000	$0.0100	$630,000	$6,300,000	$12,600,000	$18,900,000

10.16 GRANT APPLICATION ACTIVITIES

Activity	Description	Discussion	Tasks
Develop a grant application	The grant application process, from start to award announcement, can be nine to twelve months.	Broadband grant application requirements have become more stringent over time, with more grant agency oversight and review. Careful planning is essential to develop a successful application.	• Once a grant opportunity has been identified, review grant requirements to determine if the project can qualify. For example, some grants require two years of financial history. • Identify regional agency that will assist • Begin contacting potential ISP partners. • If the project qualifies, identify at least two people to take the lead to prepare application. • Prepare a task list of all grant materials requirements and identify data needed. • Develop a timeline for developing sections of the grant. • Identify requirements for letters of support and matching funds and develop timeline to solicit and collect commitments. • Complete all sections of grant application with assistance from public and private partners. • Submit grant application.

Typical Timeline	Months											
Tasks	1	2	3	4	5	6	7	8	9	10	11	12
Determine grant qualifications												
Identify regional council partner												
Identify ISP or WISP partner if needed												
Appoint grant team												
Create grant task list												
Prepare timeline and assign tasks to partners												
Identify matching fund requirements and letters of support to solicit and collect as needed												
Complete all sections of the grant application												
Submit grant												
Grant agency review												
Awards announcement												

11 PARTNERSHIP OPPORTUNITIES

Because nearly all telecom infrastructure includes some use of public right of way, public/private partnerships are always a requirement for broadband infrastructure. Among Berkeley County and private entities like ISPs and WISPs, the more common synergies are:

- The need for more bandwidth,
- The need for more affordable bandwidth, and
- The need for more affordable bandwidth to be more widely available.

Potential project partners include:

ISPs and WISPs

Internet Service Providers (ISPs) and Wireless Internet Service Providers (WISPs) are important partners, as they will be the companies leasing tower space and/or conduit/fiber infrastructure.

County passive infrastructure investments will be a public/private enterprise, and service providers are the primary customers of the infrastructure. Service providers cannot be taken for granted. Instead, a fair fee structure, high quality infrastructure, excellent maintenance and operations (where needed), and flexibility on business agreements and pricing will be required to recruit and retain service providers.

See the chapter later in this report (***Network Operations Options***) for more information on how to work with providers. For providers that express interest in using county-owned infrastructure like towers and dark fiber, it will be important to meet with them on a regular basis. These companies may also be partners on grant applications, where it may be required to show that the infrastructure being constructed has a service provider already committed to using it.

Public Safety

The Sheriffs department, fire, and rescue departments all need better access to broadband and improved wireless voice/data communications. Throughout the United States, public safety voice and data communications systems are being upgraded, often at staggering cost. Many of the upgrades include new towers to eliminate "holes" in the served area where first responder, fire, and rescue radios do not work. Combining public safety needs with community broadband needs can bring new sources of funding and cut costs, sometimes dramatically. Elected officials may need to take the lead in this area to ensure that public safety officials work collaboratively with the broadband efforts.

The availability of public-safety towers and/or new towers can enable new services and applications for police, fire, and rescue in Berkeley County. Secure WiFi hotspots can be set up around and near the towers, so that reports can be filed from the field using the WiFi Internet connection. Other communities that have done this have found that it saves time and keeps patrol cars out in the field longer.

There are often grants available for public-safety voice and data communications improvements, like new towers and upgrades to existing tower facilities, that could also support the broadband initiative. Any public-safety tower or communications expenditure should be analyzed to determine if the expenditure can also support expanded broadband access in the county.

K12 Schools

Berkeley County schools have adequate broadband service at existing school locations. But K12 students often lack adequate Internet service at home, and some schools are careful not to assign homework that requires Internet access. Parents consistently report on the burden of having to drive children to a public library or some other WiFi hotspot to get Internet access for school work. The County should work with the schools to apply for education grant funds to achieve this goal, and to keep K12 parents informed about broadband activities.

County Businesses

Businesses in the county and the local Chamber of Commerce chapters have an important role to play as advocates for the broadband work of the County. At both the county and state level, businesses that need more affordable and better broadband should ensure that elected officials understand the urgency. The County, as part of its broadband awareness efforts, should ensure that local businesses are kept up to date with work activities, grants, and other efforts (e.g. attend CoC meetings at least quarterly to report on the work of the County).

Electric Utilities

Electric utilities are natural partners in any county broadband venture. Electric utilities own utility poles, bucket trucks, and the equipment needed to install aerial fiber. Chattanooga's fiber to the premises (FTTx) initiative has enabled millions in savings for the city-owned electric service. When power outages occurs from events like ice storms or tree damage, the utility is able to use the fiber network to very accurately pinpoint where the outage occurs, enabling a more rapid repair of the electric network at less cost.

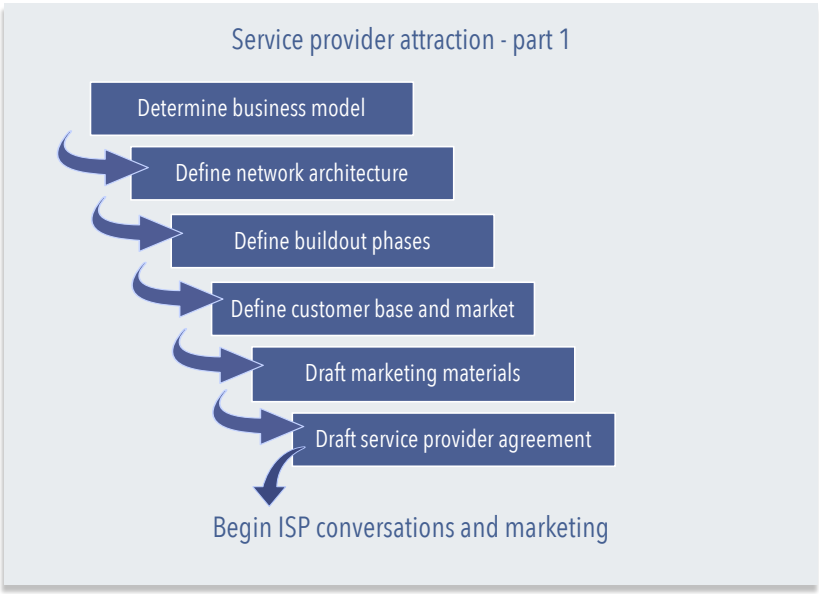
The County should meet from time to time with the local electric utilities to assess their interest in broadband projects, especially if the County and the electric utility could collaborate on fiber to electric service substations.

12 NETWORK OPERATIONS OPTIONS

Throughout the U.S., many WISPs are aggressively pursuing public-private partnerships (PPPs) with county governments. These partnerships may include a variety of strategies: collaboration on a grant opportunity, shared costs of developing a new tower site, revenue sharing, fee waivers, and other sorts of cost and revenue sharing. The advantage of this kind of PPP is that the WISP typically is responsible for most of the day-to-day management of the network assets. County and local government investments are typically limited to passive assets like towers and site maintenance that requires no day to day responsibility and only occasional site and tower maintenance.

12.1 ATTRACTING PROVIDERS TO THE NETWORK

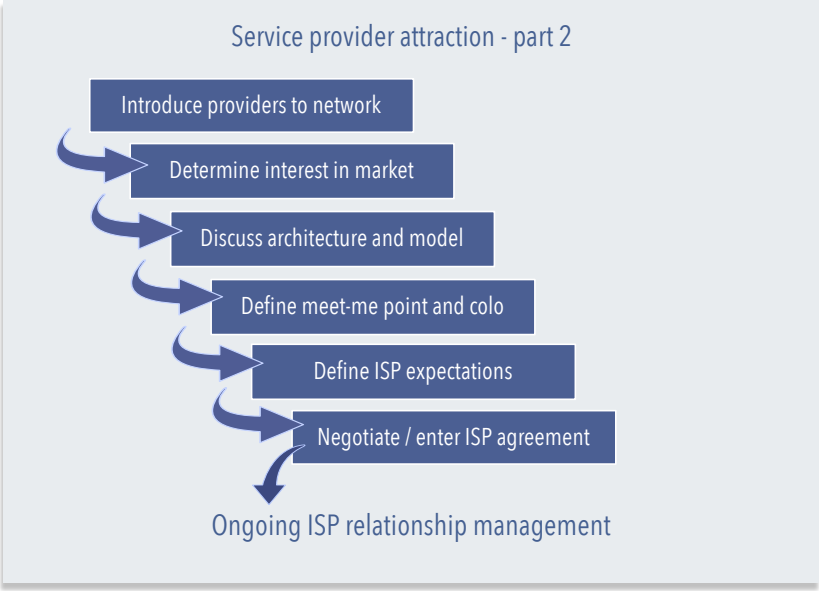
The WISP business is challenging. Setting the high cost of towers aside, a WISP placing equipment on a newly available tower must engage in a significant marketing and sales effort to identify customers who want service. Because most broadband wireless frequencies, including the new LTE frequencies, require or work best with line of sight between the customer and the tower, the WISP, even after identifying a potential customer, must often send a technician to the prospective customer location to determine if line of sight or near line of sight is available. It is common that a low hill, a building, trees, or other vegetation will degrade or block the signal.



If line of sight or near line of sight is available at the customer location, a second visit to install the customer antenna may be required before the customer can receive service. At this point, the WISP may have spent several hundred dollars on the acquisition of a single customer, and it can take many months of service before the WISP will even break even.

The cost of tower access be one of the most expensive parts of offering wireless Internet service. If a WISP has capital funds, it must choose where to place towers and smaller poles very carefully, and few WISPs have the capital to build enough towers to cover an entire county.

Just as government builds roads to enable commerce and services offered by the private sector, local government can also build towers to enable Internet services. Space on those towers is offered to WISPs for modest fees with the goal of expanding and improving Internet access.



Historically, tower space lease fees have been high, because early lessees were cellular companies offering high-margin cellphone and data services. Vertical space on a county-owned tower or water tank often range between $1200 and $2500 per month. But the business margins on fixed point wireless Internet are much lower, and tower lease fees should be set at levels that allow WISPs to make a business case to spend the additional capital for radios and related equipment on a new tower.

Activity	Description	Tasks
Attract Internet Service Providers (ISPs, WISPs)	One or more service providers will be needed to lease poles, and/or manage the network, and to partner for grant funds.	• Once owners/stakeholders have approved the plan, contact local and regional ISPs to assess partnership interest. • Schedule individual meetings with the ISPs to present project goals and objectives. • Assess interest of the companies in public-private partnership. • If interest is positive, reach agreement on which grant opportunities to pursue jointly and in what area. • Develop an MOU (Memo of Understanding) that identifies what tasks the WISP will perform for grant application and what project will perform.

Typical Timeline	Months											
Tasks	Mon 1	Mon 2	Mon 3	Mon 4	Mon 5	Mon 6	Mon 7	Mon 8	Mon 9	Mon 10	Mon 11	Mon 12
Contact ISPs and WISPs												
Schedule individual meetings												
Assess interest in partnerships												
Schedule meetings to discuss grant opportunities												
Develop MOUs as needed for grants that will be pursued jointly												

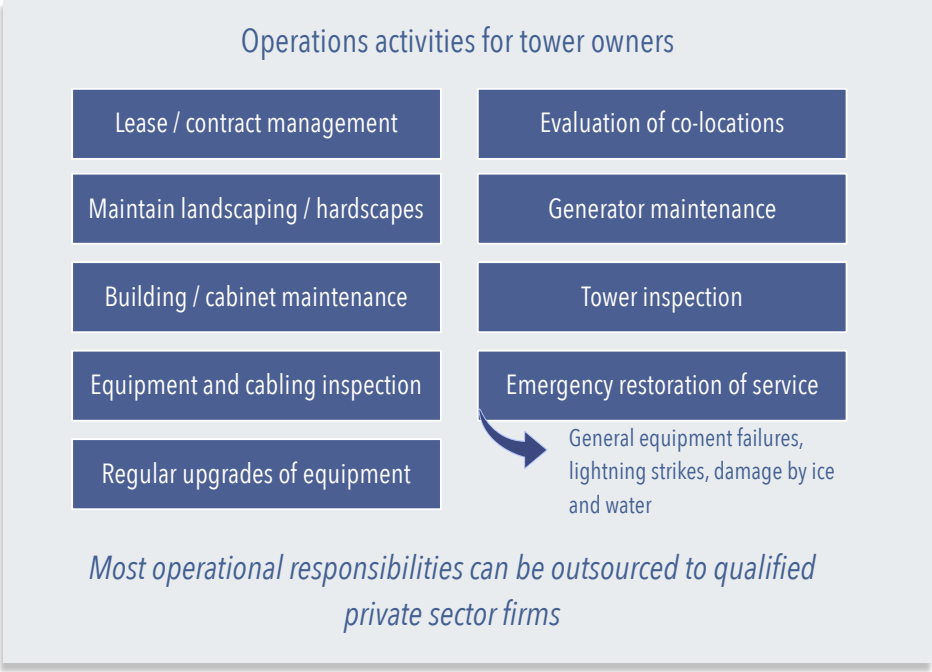
12.2 TOWER MANAGEMENT

A modest application fee, for example $200, for tower access should be nominal for WISPs; high application fees discourage WISPs from evaluating new tower opportunities.

Revenue sharing arrangements, where WISPs pay as they acquire customers, instead of a fixed lease fee are more difficult to manage. While the argument for revenue sharing seems to make sense, in practice, it requires the tower owner to have access to the accounting and financial records of the business, which can be challenging to enforce. It is also a financial disincentive for the WISP, as the fees that they have to pay for tower access continue to increase without end. The following is suggested:

- Use a single public fee schedule for all providers.
- Use a single tower space agreement for all providers.
- Tower access should be made available in ten foot vertical segments or on a per attachment basis, as high as possible on the tower without interfering with other uses, such as public safety antennas. Note that it is unlikely that any tower will have more than two providers on it.
- If a WISP is applying for space on an existing tower, no certified engineering plans should be required, but if a structural analysis is needed to determine wind and tower loading will not exceed tower specifications, the tower owner may have the WISP bear some or all of the cost of that study. Note that there appears to be high variability in the cost of these studies, and the tower owner should be careful to keep the structural analysis costs as low as possible.
- For a typical tower, identify two 10 ft spaces (where space is available) on existing towers and designate/reserve those for WISP use. The spaces should be as high as possible on each tower without interfering with other local government and public safety use. The lease cost of the lower space should be at least 20% less than the higher space. Tell WISPs exactly what space is available at each tower and at what heights; this makes it easier for WISPs to evaluate the potential market that could be served from each tower.

- If an existing shelter is available at the base of a tower and rack space for WISP equipment is available within that shelter, electric power should simply be provided as part of a very modest lease fee for rack space. If there is no space available in the shelter (e.g. lack of space or dedicated for public safety use), then the WISP should install an H-frame and have their own electric meter installed in an area designated at the base of the tower.



- 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 service area with lower population density.
- Monthly tower lease fees should be on the order of $200 to $250 per tower or an equivalent per-attachment fee (e.g. $50-$75 per attachment). 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.
- Consider offering an initial grace period on fees of three to six months, and/or offer a one-year sliding scale of fees. An example sliding scale would waive the fee for the first 3 months, charge 25% of the fee for the next 3 months, up until 12 have passed and the full fee is assessed. 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 tower owner to potentially make a smoother transition to a new provider if there are issues, and will give them more leverage and control over the service.
- In contracts, fee reductions should be worded as discounts that can be revoked if performance requirements are not adequately being met.
- Describe what is available for ground space, such as space for WISP cabinets, shelters, and H-frames for electric service, shared generators that may be provided. Also indicate what the WISP has to provide at the base of the tower. If new shelters will be allowed, set minimum standards for new shelters.

12.3 WORKING WITH INFRASTRUCTURE LEASES

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

Tower Lease Considerations

- There should be a single public fee schedule for all providers that want to lease space on the tower.
- 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.
- For a typical tower, identify two (2) ten foot spaces (where space is available) on existing towers and designate/reserve those for WISP use. The spaces should be as high as possible on each tower without interfering with other local government and public safety use. The lease cost of the lower space should be at least 20% less than the higher space. Tell WISPs exactly what space is available at each tower and at what heights; this makes it easier for WISPs to evaluate the potential market that could be served from each tower.
- 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 enterprise to potentially make a smoother transition to a new provider if there are performance issues, and will give the project entity (e.g. County government) more leverage and control over the WISPs.
- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- 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 ownership entity should set minimum standards for new shelters.

Dark Fiber Lease Considerations

Passive fiber infrastructure (i.e. no electronics) can include conduit, fiber cable, splice closures, and cabinets. Because all powered network equipment would be provided by the lessee (i.e. the ISP), there is no day to day management responsibilities and only occasional routine maintenance. Emergency break-fix for situations like a cable broken by a construction firm working in the right of way can be outsourced to a qualified private sector provider. Local governments routinely manage much more complex water and sewer systems. Some guidelines for leasing dark fiber include:

- There should be a single public price list for the cost of leasing fiber strands.
- A standard master agreement should be used for leases. This agreement will typically require an SLA (Service Level Agreement) that specifies repair times for emergency break-fix (i.e. the fiber cable has been damaged and a qualified break-fix repair firm must be on call to make repairs).
- It will also be important to have IRU pricing (Indefeasible Right of Use). Fiber strand leases are typically for periods of ten years or less. IRUs are long term leases and are typically twenty to thirty years in length. IRU fees have two parts: a single upfront payment that usually reflects some portion of the construction cost for the fiber route. As an example, if a lease will include twelve strands of fiber on a ten mile route of 144 strand fiber that cost $100,000 to construct, the one time fee might be 12/144 * $100,000 = $8,333. Most IRUs also have a modest annual maintenance fee that reflects the cost of maintenance and repairs; this would also be pro-rated to reflect the number of fibers assigned to the IRU agreement.
- Splice points and who is allowed to open handholes to perform splicing must be identified in the master agreement.

12.4 PREPARING FOR TOWER EXPANSION

Activities Preparing for Tower Expansion

ACTIVITY	DESCRIPTION	DISCUSSION	TASKS
Draft tower site lease agreement	Tower site lease agreements between the property owner and the broadband entity will be needed.	The county attorney may be able to provide most or all of the legal agreements needed.	• **Establish a basic tower lease agreement that will be used with all providers.** • **Identify legal counsel who will provide a draft agreement.** • **Circulate draft agreement for comments.** • **Approve lease agreement for use.**
Identify prospective tower sites	New towers will be needed in the county. The broadband plan identifies the general area where towers will be needed and most effective, but specific tower locations will have to be identified with the assistance of residents in the area and property owners. This will be an ongoing activity for at least the first year.	Height above the surrounding terrain, proximity to roads, and proximity to electric service are factors that have to be evaluated.	• **Review broadband plan and prepare a list of sites to survey.** • **Determine road access and electric service. Closer is better.** • **Meet with property owner to discuss a potential lease.** • **If site owner is agreeable, add site to list of grant-ready tower sites.**
Identify prospective community pole sites	Many community poles will be needed to provide the maximum amount of wireless broadband availability.	Community poles should only be placed where there is a cluster of nearby residents who are prepared to purchase Internet service from the provider on the pole.	• **For each area in a build out phase, identify clusters of typically 12-25 homes.** • **Identify a local champion willing to talk to neighbors and assess demand.** • **If demand meets target, add to list for next grant application with community poles.**

Timeline Preparing for Tower Expansion

TASKS	Mon 1	Mon 2	Mon 3	Mon 4	Mon 5	Mon 6	Mon 7	Mon 8	Mon 9	Mon 10	Mon 11	Mon 12
Obtain agreement on using a standard lease for all towers												
Identify legal counsel to draft agreement												
Circulate draft agreement for comment												
Obtain approval for site lease agreement												
Develop list of potential tower sites												
Assess road, electric service access												
Meet with property owners												
Add agreeable owners to prospective tower list												
Identify clusters of residents for community poles												
Identify a local champion to assess demand												
Add clusters that meet demand to prospect list for community poles												

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: Multiport 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 **FOSC**s.

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.