Brooke-Hancock Area

Broadband Development Plan

September 15, 2020

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Brooke-Hancock-Jefferson Metropolitan Planning Commission
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Executive Summary

Magellan Advisors' study of broadband availability and use in Brooke and Hancock Counties found clear gaps but also great potential. Much of the area does not have broadband, including areas with legacy telephone and newer cellular infrastructure. Where broadband is available, costs are high and speeds low relative to many other communities. This puts the region, its businesses, and residents at a competitive disadvantage for accessing services, attracting investment, generating income, and serving customers. The options for internet service providers in the area are limited, as is the area in which they provide service.

In contrast, the Brooke-Hancock area has diverse and reasonably abundant economic assets. Traditional heavy industry has left the area with a range of sites available for business development. There are many options for commercial real estate. Housing costs and cost of living overall are relatively low. Public institutions are lean but fully meet their missions. The Ohio River and the region's location adjacent to a major metropolitan area are major assets, too. The challenge and opportunity for Brooke and Hancock Counties is to capitalize on and develop these assets. It is simply not possible in today's world—especially amid the global COVID-19 pandemic—to accomplish this without abundant, economical, reliable broadband.

A number of practical, technical solutions are available to close Brooke-Hancock area broadband gaps. There are also multiple private companies in the larger three-state region that are interested in entering or expanding the offerings in the area. The critical gap, which creates a barrier to deploying infrastructure and offering services, has two components. The first component is lack of middle-mile network infrastructure and sites needed to deploy network access and distribution infrastructure. Magellan Advisors recommends establishing a public-private partnership to develop a Brooke-Hancock Backbone Network (BHBN) to close this gap. By developing middle-mile infrastructure, the area can better facilitate and benefit from private investment in access infrastructure and services.

The second component of Brooke-Hancock's broadband gap is the organizational capacity to establish and manage this partnership. While the area has some strong leaders and technical talent, there is no organization that is mobilizing everyone to close the area's broadband gaps. This is not surprising because it is a new function for the public sector, necessitated by increasing requirements and lack of private investment. Similarly, while there are network assets in the area and substantial funding opportunities to deploy more, no one is pulling these assets together. With this plan, Brooke Hancock Jefferson Metropolitan Planning Commission (BHJ-MPC) has begun pursuing funding, convening key leaders, and working to capitalize on existing assets. Magellan Advisors recommends designating or establishing an agency to continue this work, to lead the partnership, to attract and direct investment, and ultimately to build, manage, and own the infrastructure on behalf of the public.

This report is a detailed plan for developing network infrastructure to close the area's broadband gaps and drive broader community and economic development. It addresses the organizational and practical, as well as economic and technical, challenges that must be overcome to achieve this goal. Key tactics include local governments adopting

broadband friendly policies, contributing public assets for broadband development wherever possible, establishing broadband development programs, and stepping up as anchor tenants of the BHBN. Households and organizations must demonstrate willingness to pay for services that use the BHBN. Generally, a focused, inclusive, results-oriented process is necessary to accomplish these things. BHJ-MPC has established a Regional Broadband Task Force consisting of local business, civic, and technical leaders to guide this process and provide ongoing governance that will ensure the BHBN is built, managed, and used for maximum public benefit.

To achieve maximum return on investment in the BHBN, Magellan Advisors recommends approaching broadband development as an initiative to digitally transform the regional economy. The Brooke-Hancock area appears to lag behind in technology infusion that has occurred in most industries and is ongoing in public institutions. Lack of broadband infrastructure and services are barriers to technology adoption and use, but closing that gap does not necessarily mean households and organizations will realize the full benefits of internet technology. To address this, business and civic leaders and public officials should actively support the lead agency in tying broadband development directly to upgrading practices, processes, skills, and systems to fully capitalize on the BHBN.

I. Introduction

The BHJ-MPC engaged Magellan Advisors to conduct a feasibility study and produce a Strategic Broadband Development Plan for the area. The study area encompasses Brooke and Hancock Counties in the northern panhandle of West Virginia, between Ohio to the west and Pennsylvania to the east, along the eastern shore of the Ohio River. Magellan Advisors conducted a survey of internet access availability and use across the area, gathered extensive information on relevant assets, and interviewed multiple community stakeholder representatives, including local and regional internet service providers.

From this information we developed an inventory of assets, identified potential network routes and interconnection points, and laid out preliminary locations and routes for network infrastructure. This Plan details the range of broadband connectivity solutions and development tactics and evaluates them in terms of the area's needs and opportunities. The preliminary design includes cost and coverage estimates. We also evaluate the options for operating the infrastructure based on available assets, current and prospective service providers, and technical functionality and limitations of solutions.

This Plan clearly identifies gaps in market demand as well as infrastructure and supply. The community and economic impact of expanding broadband across the area could be huge, depending on how these gaps are addressed. We provide detailed recommendations for closing these gaps, including organizational development, private partners, and public funding to develop a Brooke-Hancock Backbone Network (BHBN). The dual purpose of such a network would be to make it viable for companies to provide broadband to the most remote and rural parts of the area and provide faster, more economical and reliable connections to anchor industry and institution sites.

Generally, we recommend approaching this as an initiative to digitally transform the local economy. This means changing the way organizations and people work. The basic case for this approach is that such transformation is required to achieve reasonable returns on investments in broadband infrastructure and services. This Plan substantiates this approach and provides a detailed, practical plan for linking development of the BHBN to economic transformation. More specifically, we recommend designating a lead agency to develop and lead a public-private partnership with internet service providers and local governments. We recommend developing the BHBN as a provider-neutral infrastructure that is available to all private partners to competitively provide broadband and related services to the community.

A. Demographic and Economic Overview

The population of Brooke and Hancock counties has been generally declining and that trend is expected to continue.[1] Brooke County's population is predicted to decrease 10.21% from 2010 to 2045. Hancock County's decrease will be even steeper at 13% over that time period. The two counties will lose approximately 9,800 residents over 35 years. Male population is forecast to decline more than female. The largest losses (effectively

[1] Information from this section is drawn from BHJ-MPC's *Long-Range Transportation Plan 2045* except where otherwise noted.

9,000 people) will be working age adults, ages 20 to 64. The population of persons under age 20 will drop by nearly 30%. In contrast, the number of older adults will increase. By 2045, persons age 65 and older will make up an estimated 29% of the area's population, up from 19% in 2010.

Table 1. Comparison of Major Local, State, and National Socio-economic Indicators, Percent, 2014-2018[2]

Indicator	Brooke County	Hancock County	West Virginia	United States
Population age 16 years+ in civilian labor force	58.7%	54.9%	53.1%	62.9%
Unemployment rate	3.1%	7.1%	6.7%	5.9%
Persons in poverty, percent	13.2%	13.7%	17.8%	11.8%
Households with a computer	80.7%	83.7%	81.8%	88.8%
Households with a broadband Internet subscription	72.3%	70.6%	72.9%	80.4%
Persons age 25 years+ with high school graduate or higher	89.4%	91.2%	86.5%	87.7%
Persons age 25 years+ with bachelor's degree or higher	18.5%	19.4%	20.3%	31.5%
Persons under age 65 years with a disability	11.3%	11.2%	14.1%	8.6%
Persons under age 65 years without health insurance	7.7%	5.8%	7.9%	10.0%
Owner-occupied housing unit rate	72.0%	74.7%	72.9%	63.8%
Median value of owner-occupied housing units	$92,000	$92,000	$115,000	$204,900
Median selected monthly owner costs with a mortgage	$907	$942	$1,023	$1,558
Median gross rent	$659	$599	$711	$1,023

Socio-economically, Brooke and Hancock Counties fall between the State of West Virginia and the nation as a whole, as shown in Table 1. Brooke County had a higher labor force participation rate than Hancock County from 2014 through 2018, for example, but Hancock County had a higher unemployment rate. Both were better than the state but worse than the United States as a nation. Both counties exceed the country, as well as the state, in the percentage of persons who are high school graduates but are below both the state and nation for persons with a bachelor's degree or higher. West Virginia had relatively fewer people with health insurance than the country overall, and both counties have a smaller percentage of people insured than the state.

[2] Source: https://www.census.gov/quickfacts/fact/table/hancockcountywestvirginia,brookecountywestvirginia,WV,US/INC110218

The one area in which Brooke and Hancock Counties have clear economic advantage over the rest of the country and state is housing. Ownership rates are relatively high while costs are substantially lower. Median rent costs are 12% lower than for West Virginia and 38% lower than the nation. For further, more specific comparison: In nearby Pittsburgh, the homeownership was less than 50%, it cost over $24,000 more—about $240 a month—to buy a home, and monthly rental costs were effectively $300 higher than in the Brooke-Hancock area.

The area is in a similar situation for income. But, as shown in Table 2, Brooke and Hancock Counties are closer to the state than the nation. Broken down to the firm (establishment) and employee level, Brooke County doesn't perform as well as Hancock County, and the state lags behind the nation. Hancock County has larger employers on average than West Virginia, the United States, and Brooke County.

Table 2. Income for 2014-2018 (in 2018 dollars) Compared

Indicator	Brooke County	Hancock County	West Virginia	United States
Median annual household income	$45,580	$49,772	$44,921	$60,293
Per capita annual income	$25,637	$25,537	$25,479	$32,621
Annual payroll per establishment	$560,360	$788,126	$645,057	$896,985
Annual payroll per employee	$36,351	$39,799	$41,831	$54,227
Employees per establishment	15.4	19.8	15.4	16.5

The U.S. Department of Housing and Urban Development (HUD) puts priority on serving Low to Moderate Income (LMI) households whose total annual gross income does not exceed 80% of Area Median Income (AMI), adjusted for family size. For 2020, HUD estimates the AMI for the Weirton-Steubenville, WV-OH MSA, of which Brooke and Hancock counties are parts, at $62,400.[3] HUD's LMI levels are:

- **Extremely low:** 30% of the area median family income, or less than about $18,700 per year for Brooke-Hancock
- **Very Low:** 31% and 50% of the area median family income, between about $14,700 and $31,200 annually in the area
- **Low:** 51% and 80% of the area median family income, between about $31,200 and $49,900 annually based on area AMI

Figure 1 provides some sense of where these households are located. While the area does not appear to have many extremely or very low-income households, low income households appear to be concentrated along the river in Weirton, Wellsburg, and between Chester and New Cumberland.

[3] From https://www.huduser.gov/portal/datasets/il/il2020/2020MedCalc.odn

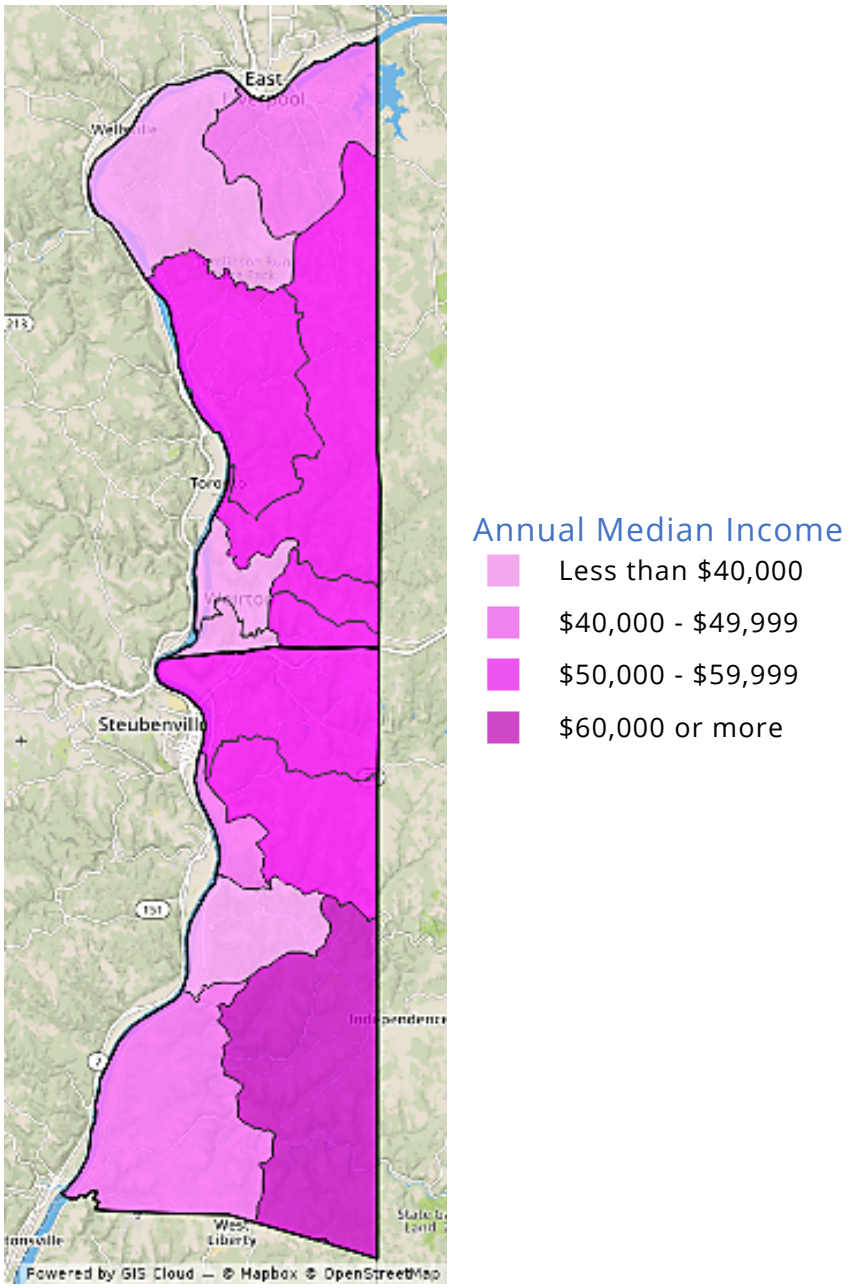
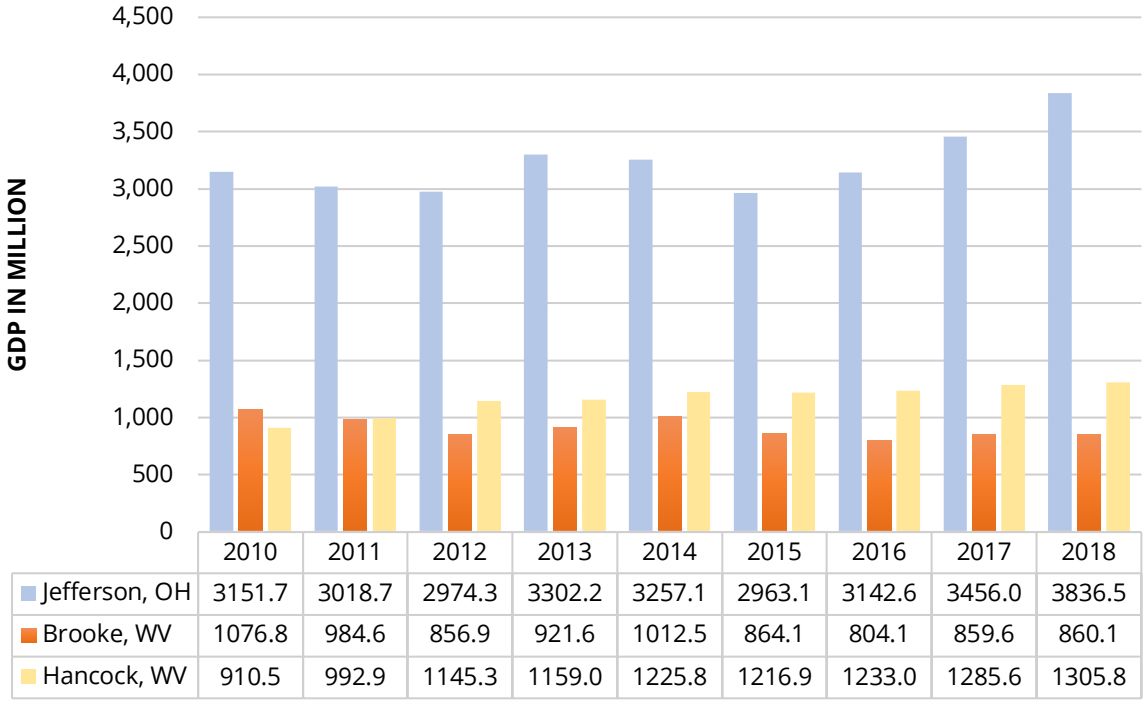


Figure 1. Median Household Incomes for Brooke and Hancock County Census Tracts[4]

The area has generally experienced a gradual decrease in labor force over the last three decades. The region also has a higher unemployment rate than the national average. The shutdown of steel industries played a major role in this increase. Due to different continuous economic revitalization efforts, the unemployment rate fell gradually and is currently at a similar level to that of the 1990's. Prior to the COVID-19 crisis, 3,000 jobs were anticipated to be added in the West Virginia region that contains Brooke and Hancock Counties, primarily service providing jobs, and a decrease of manufacturing jobs

[4] Source: U.S. Census Bureau, *American Community Survey*, 2014-2018 5-year estimates.

in the region was expected. According to this projection, healthcare sector, personal care and service, and legal occupations are expecting to see the most increase in the next 10 years.



	2010	2011	2012	2013	2014	2015	2016	2017	2018
Jefferson, OH	3151.7	3018.7	2974.3	3302.2	3257.1	2963.1	3142.6	3456.0	3836.5
Brooke, WV	1076.8	984.6	856.9	921.6	1012.5	864.1	804.1	859.6	860.1
Hancock, WV	910.5	992.9	1145.3	1159.0	1225.8	1216.9	1233.0	1285.6	1305.8

Figure 2. GDP for Brooke, Hancock, and Jefferson Counties Compared

Brooke County's gross domestic product (GDP)—the aggregate value of all goods and services sold in the area—has generally declined, as shown in Figure 2, over $200M annually between 2010 and 2018. Hancock County's GDP has steadily increased because of manufacturing, real estate and finance, rental and leasing industries. More recently Brooke County saw a 7.3% increase in GDP for the 2017-18 fiscal year, mostly due to manufacturing and mining industries. Hancock County had an increase of 13.6% in 2017-18 fiscal year. Transportation-warehousing and manufacturing industries have generated the biggest GDP increase in 2017-2018 fiscal year for Hancock County.

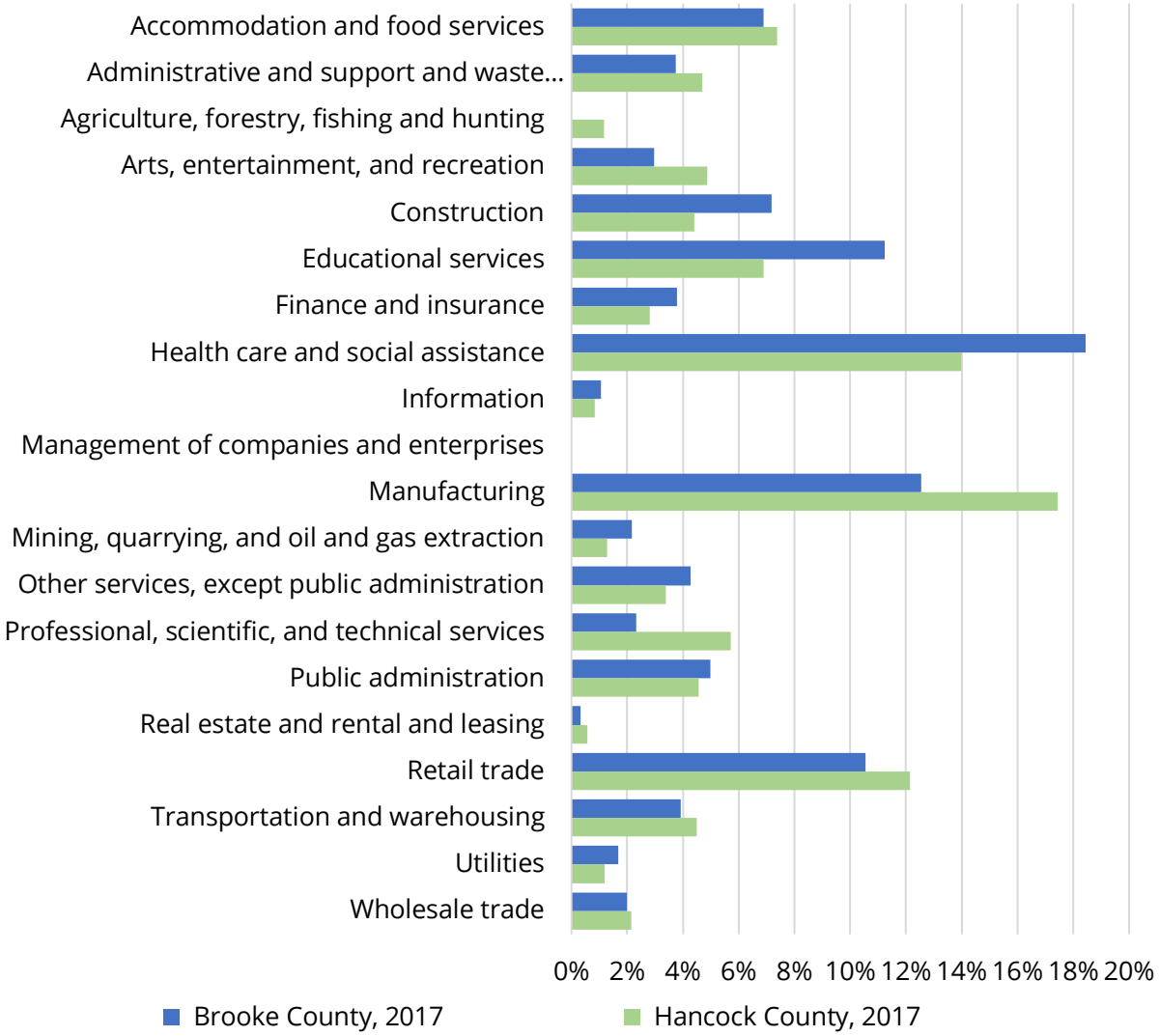


Figure 3. Percentage of Total Employment per Sector Comparing Brooke and Hancock Counties[5]

The area has strong in healthcare and social assistance, manufacturing, and retail trade, according to Census Bureau estimates, as shown in Figure 3. Brooke had relatively more healthcare-related jobs, while Hancock had more manufacturing. Brooke had substantial portions of jobs in education and construction. Hancock was strong in administrative, hospitality, and transportation jobs. While these industries and jobs were most common in the area, except for manufacturing, they were not as prominent as in other places.

[5] Source: U.S. Census Bureau, *American Community Survey*, 2010 and 2017, https://data.census.gov/cedsci/

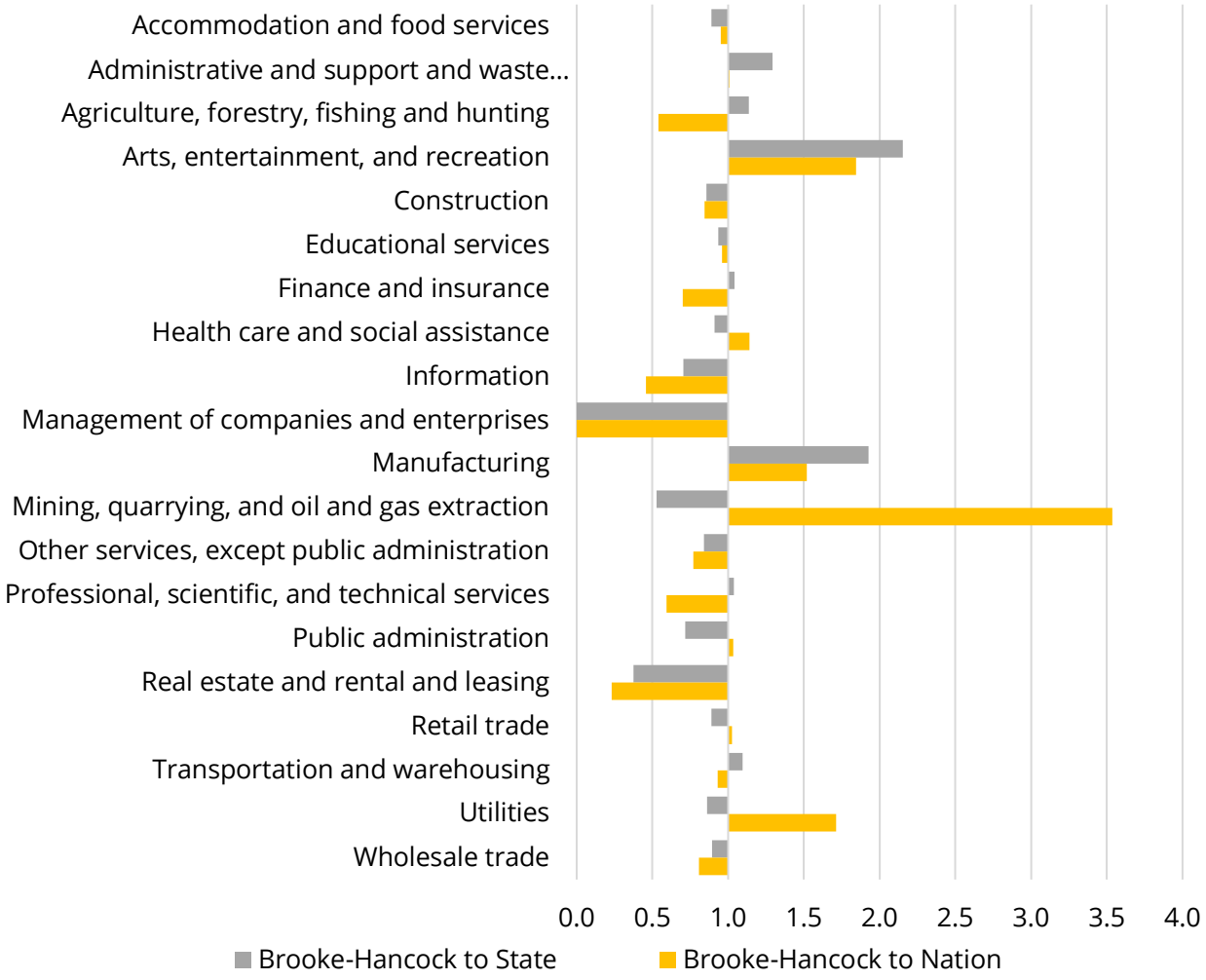


Figure 4. Location Quotients for the Brooke-Hancock Area Relative to the State of West Virginia and the United States[6]

Figure 4 compares the Brooke-Hancock area to the state of West Virginia and the nation as a whole. A location quotient of one means the local area has the same proportion of jobs. Less than one means the area has relatively fewer jobs in and industry, while greater than one means the local economy has more jobs than elsewhere. Gas industries are major employers in the area in comparison to the U.S., but to a lesser extent than other areas of West Virginia. Arts, entertainment and recreation jobs are more prominent in Brooke-Hancock area than elsewhere, as are manufacturing. While less than 5% of local jobs were in arts, entertainment and recreation, the area had an edge relative to the rest of the country and state.

All of the data summarized above were collected before the COVID-19 pandemic. Clearly, the public health crisis has had a huge impact on employment and other economic indicators. While it may not directly impact most demographic trends, it will undoubtedly interact with them. Early evidence is that lower-income persons and those in labor-

[6] Source: U.S. Census Bureau, *American Community Survey*, 2010 and 2017, https://data.census.gov/cedsci/

intensive jobs have been impacted most. The disease itself hits older people harder. Key sectors for Brooke-Hancock such as hospitality and retail have practically stopped. Healthcare has had to shift as an industry to focus on response to COVID-19. More people are working from home. Effectively all students are going to school virtually.

Exactly what the long-term impacts will be—whether things will return to normal soon or whether there are long-term structural changes—is unclear. The crisis has highlighted how important it is to be proactive, plan ahead, and seek foresight. It has also exacerbated deep and persistent socio-economic issues and made them more obvious and problematic. In the same way, the pandemic has driven demand and requirements for broadband to which the market may not be able to respond effectively. The technology is critical for dealing with the current crisis—and crises in general. The question for leaders is what role the public sector should play in deploying solutions to the crisis, for avoiding such situations in the future, and for generally improving civic functions and economic performance.

B. Where to Focus Broadband Development

Broadband is valuable because it enables individuals and organizations to communicate and get information necessary to be successful, make a living, and operate effectively. The demographic and economic characteristics of the area provide a starting point. Brooke and Hancock Counties are geographically a bridge between the eastern and mid-western states, sandwiched between Ohio and Pennsylvania, along the Ohio River, remote from the rest of West Virginia. The area's demographic and economic dynamics are profoundly impacted by this location.

The challenge and opportunity for Brooke and Hancock Counties is to deploy infrastructure and establish partnerships that capitalizes on local assets and location. Increasingly, this means having a talent pool that can use the technology as well as install, maintain, and operate it. Many other places have similar challenges and opportunities. To reverse the demographic trends, particularly to attract more working age adults, the region can highlight its low housing costs. This only makes sense if it is supported by major investments in broadband and related technologies. If local employers don't make such investments, the area won't have the jobs people need, regardless of housing costs. It's impractical for businesses to invest in technology if they don't have good connectivity. If broadband services are not available, people won't be able to work from home, learn online, get telehealth services, or stay connected with family and friends outside the area.

Therefore, the initial conclusions are that Brooke and Hancock Counties face a fundamental challenge to transform the local economy. This transformation likely involves attracting young families from Pittsburgh and other metro areas. More fundamentally, the transformation cannot occur without digitalization of economic and civic activities. Local governments can target technology-intensive industries, presuming the area develops its broadband infrastructure and services, and encourage existing industry to use technology more.

To more directly transform the local economy, local governments can put more functions and services online. This enables them to deal with the pandemic more effectively but also generally improves services and increases access. By the same token, the public sector can

invest in network infrastructure for economic transformation, much in the same way it invested in roads, schools, sewer, and water. The next section presents the results of Magellan's research into exactly where network infrastructure and services are needed. Following sections of the document address options for closing gaps and supporting regional economic transformation before laying out a plan for Brooke and Hancock Counties to develop the broadband assets and attract investment to provide better, cheaper, faster internet access for the area.

II. Broadband Market Analysis

Broadband needs are what is required to meet economic and home broadband demand, minus what is available. They are defined by the gap between the demand side of the local broadband market—what consumers do with broadband and are willing to pay for broadband—and the supply side—what is provided. While any estimation of needs should be future-focused, plans are based on the current state.

To understand the broadband market in Brooke and Hancock Counties, Magellan Advisors surveyed households and organizations about their broadband services and related issues. We also spoke with key stakeholders in the area, including provider representatives, to understand their interests and needs related to broadband.

A. Broadband Demand

COMMUNITY STAKEHOLDER INPUT

Magellan coordinated with BHJ-MPC to arrange face-to-face outreach meetings with regional leaders and representatives of education, large and small businesses, area utilities and municipalities, internet service providers (ISPs), public safety agencies and other key community stakeholders. Representatives were engaged in an open discussion about how they use technology, their broadband services, and what better broadband might mean to them. Altogether, Magellan Advisors talked the representatives of approximately 23 organizations.

Stakeholders from industry, healthcare, and government told us they have either traditional dedicated lines or mass market broadband. Small businesses and residents have broadband in population centers but otherwise rely on cellular, which has coverage gaps. The options are very limited, and costs are high, we were told.

Much of Brooke County has been left to rely on Frontier Communications, which provides DSL services at speeds that mostly fall under the Federal Communication Commission's (FCC) definition of broadband (25 Mbps/3 Mbps). Frontier's abysmal reliability and customer service was a common theme throughout meetings. Many businesses, institutions, and residents had given up hope of improved services from the provider.

Hancock County stakeholders felt better served by Comcast, but many complained of the high costs of the bills due to lack of competition. Comcast bills were regularly reported at $300 a month or higher, which stakeholders saw as an economic barrier to many small businesses and residents. The larger entities that could afford the services were minimally satisfied but desired better, faster, more reliable and affordable service.

There are several small internet service providers using wireless technology for broadband. They are challenged by terrain and the availability of backhaul from their central antenna to the internet.

Business, Industry, and Economic Development

Brooke and Hancock Counties' economies are historically based on large industry, including steel, coal and power. The local economy and community have been impacted by the decline in coal and steel industry. A community representative noted that when he

began working here, there were around 12,000 steel workers, and now that number is less than 3,000. Several past steel sites have been designated by the Environmental Protection Agency (EPA) as brownfield cleanup sites. Several of these sites, including Frontier Crossing, are now under redevelopment and are key assets for the Business Development Corporation (BDC) of the Northern Panhandle as it attracts new industries to replace steel and coal. The BDC understands that to attract businesses, particularly large industries that rely on the supply chain, the region must have robust, reliable connectivity.

The BDC understands there are issues with the internet service on properties with potential for development in Brooke and Hancock Counties. Companies now operate in real time and are looking for redundancy and reliability. The BDC noted that site selectors are now looking for access to fiber infrastructure as part of their selection.

The local Chamber of Commerce maintains some tech-based small businesses including Mobile 360, which provides IT services to businesses as well as a few mom-and-pop computer stores in Weirton. The Chamber believes there are big economic development opportunities and a large focus is the drive to bring back manufacturing to the region, which is tied to accepting and transitioning to tech.

Small businesses in Brooke and Hancock Counties discussed the challenges they face when engaging with customers and keeping businesses competitive with a lack of access to reliable, affordable high-speed broadband. Representatives from WesBanco, a regional bank with remote branches, discussed the difficulty of transacting business due to antiquated infrastructure. He noted that bringing quality broadband to the region is important for businesses, consumers and children. Local churches and the distribution company SAL Chemical noted the need for connectivity to keep their businesses and community successful. Both pointed out the necessity of home access for employees, highlighting that the need for fiber spans all aspects of the Brooke-Hancock economy.

Local Government

Brooke and Hancock County Commissions discussed needing connectivity to provide quality of life for citizens. They often hear from community members, for example, a single mom who has to drive her kids to get connectivity because of no home connection, and parents who are trying to homeschool four children and cannot do so adequately because of poor service from Frontier DSL. After an initial review, local officials believe that approximately 3500 residents in Hancock County could use better service than they have access to now, and even more in Brooke County.

Magellan had interviews with representatives from cities and towns across both counties including the Town of Beech Bottom, and the Cities of Wellsburg and Weirton. Each community faces challenges with connectivity and there is a strong belief that residents and businesses across the valley are suffering due to outdated infrastructure. The communities have access to some infrastructure and plans for a few capital projects and regional development are opportunities to leverage assets or ground opening to place conduit or fiber infrastructure. These include a new bridge, water line projects, a Federal Emergency Management Agency (FEMA) project in Wellsburg to place a 48” pipe, the extension of the Rails to Trails program, city rights-of-way assets, and redevelopment zones including Frontier Crossings. These opportunities could be utilized along with public policies to increase access to broadband infrastructure across the region and lower the cost to entry for providers.

Public Safety

Public safety representatives echoed the lack of connectivity along with geographic challenges of maintaining and updating infrastructure for first responders including police, sheriffs and local 911 centers. Brooke County has significant challenges with its public safety connectivity. The County has dead spots including one on US Highway 22. Hancock County has some connectivity issues for public safety and could use increased connectivity from a fiber network, but overall fares much better than Brooke County.

Public safety has issues with phone connectivity as well, and when Brooke County 911 phone lines go down, they switch calls going to Hancock and vice versa. For a while, the disconnect happened every day. Hancock County 911 was out for three days at Thanksgiving.

Brooke County does own some tower infrastructure but has no GIS mapping of these assets. The County is working on propagation analysis for additional towers, and has no microwave backhaul on the existing radio network. Brooke County hopes to have cell tower companies invest in new sites on County-owned property to increase connectivity. The County discussed radio congestion issues due to users from other states on some frequencies.

Hancock County Emergency Communications radio network relies on copper lines and one microwave network with ten or eleven radio towers, including some County-owned water towers and some that are privately owned. No towers are fiber connected. One County tower is a cell site that is collocated. The County has its own infrastructure including water towers that cover the whole County from Chester to Weirton. Hancock County maintains cellular and radio for a balanced backup because there are areas where one works and the other doesn't; there are a few areas where neither works, or is spotty at best.

Education & Healthcare

Representatives from Weirton Medical Center engaged in conversations that highlighted the need for connectivity within the region to support emergency and non-emergency medicine as well as increased access to telemedicine services to increase the general health and wellbeing of the region's citizens. Weirton Medical Center has a main campus in Weirton, WV and 50 ancillary physician offices across three states from diagnostic lab centers to a hospital. Weirton is underserved by connectivity and represents the need for fiber in the region to support critical community anchors. Its main hospital gets connectivity from Frontier and Comcast, and all physician offices are on Comcast. The main campus has 200 Mbps symmetrical service from Frontier and the services range at offices, with only 50 Mbps at radiology offices. They have Metro-E where possible, but not at every practice and many simply have business class service.

In 2014, the hospital put $500,0000 into a brand-new wireless network that Frontier managed for them. The network was a hotel grade infrastructure not meant for hospital use and they never anticipated the number of connected devices. Hospital representatives report that it constantly went out.

The phone lines are connected by Frontier and the connection is worse than the network lines. When staff sends faxes to a long-distance number there are major outages and people can't call the help desk. This happens almost monthly, and the internet outages are

quarterly. Staff cannot call out on long distance even though the hospital spends over $5k a month for the phone bill, and the phone systems are only five years old.

The hospital currently does some telehealth and its home healthcare line does a lot of telehealth cardiology monitoring for patients with congestive heart failure within the hospital's West Virginia scope of product. The goal is to expand more telemedicine access, particularly to infectious disease and neurology, which the hospital could offer as long as it has a reliable network and patients have good connectivity at home. The hospital and region also have limited access to behavioral health centers and one just closed. The closest treatment center is now three hours away. Telehealth addiction and behavioral access would be greatly beneficial for the region.

Weirton Medical representatives noted it would be wonderful to have a reliable symmetrical 1Gbps connection for the price they are paying. They are interested in a new network, if it was truly regional, and in lit services. They pointed out that having a reliable ISP coming in would be sufficient. They feel they have spent hard dollars to build things around the limitations of infrastructure and are forced to create their own internal redundancy.

SURVEY RESULTS

After removing duplicate and unusable responses, there were a total of 541 responses to the broadband survey. The Magellan Advisors broadband survey focuses on locations. Of these responses, 498 were from households and 43 were from organizations. Not all respondents answer all questions, so each item on the survey was analyzed separately.

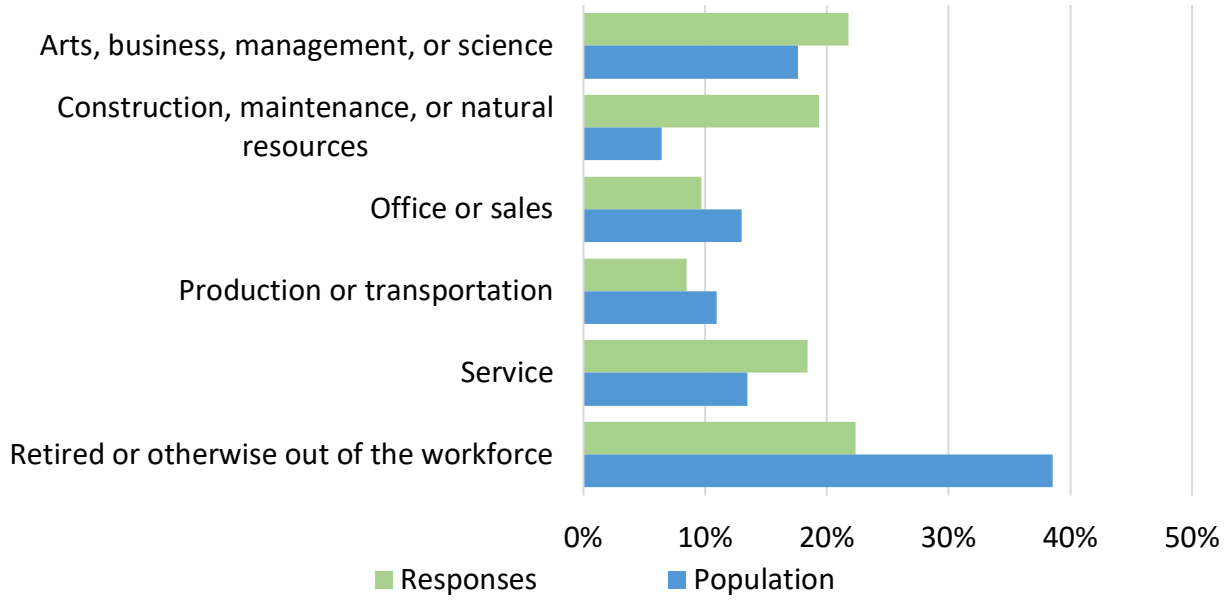


Figure 5. Percentage of Occupations for 331 Household Responses Compared to the Population

Figure 5 and Figure 6 show how responding households compare to the population[7] in terms of education and occupation. Figure 7 compares organization responses by industry to the population. Respondents tended to be employed, particularly in service and trade occupations, at a higher rate than the population. The population seems to have a larger percentage of retired persons than the survey responses. Respondents' educational levels were generally higher than for the population.

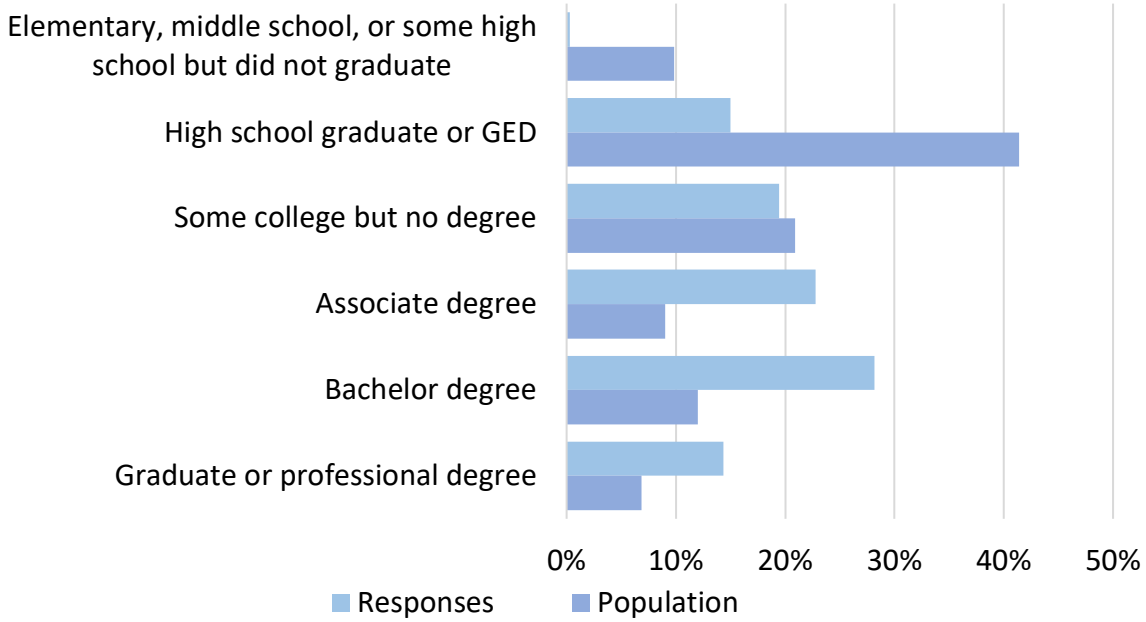


Figure 6. Education Level by Percentage of 334 Household Responses Compared to Area Population.

Organizational responses generally matched the population, although the population data did not include Public Administration. See Figure 7 for a comparison of organizational responses by sector to the local economy. Education, Finance, Manufacturing, and Real Estate sectors may be over-represented in the results, while Hospitality and Food Services, Healthcare, and Retail may be underrepresented.

[7] Estimates of population characteristics are from the U.S. Census Bureau. Estimates for individuals are for 2017, from the American Community Service. The survey response is for the primary breadwinner in the household, so expected to generally higher than the population. Organization estimates are from the 2018 County Business Patterns. See http://data.census.gov for this data.

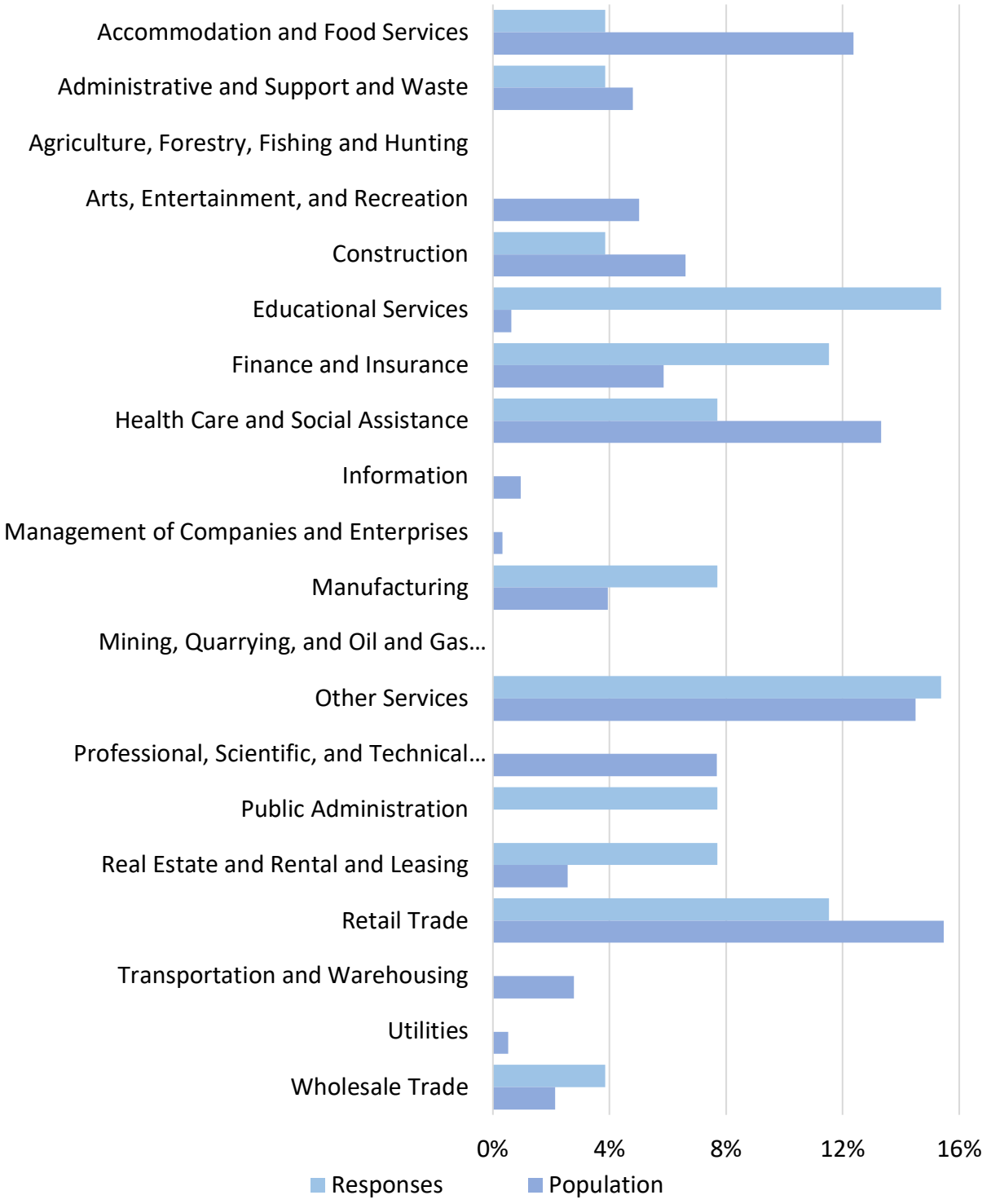


Figure 7. Percentage of 26 Organization Responses by Industry Compared to percentage of total enterprises in the Area.

We had no responses from Agriculture, Arts, Mining, Professional Services, Transportation, or Utilities. Although there are clearly Agriculture and Mining (including oil and gas)

enterprises in Brooke and Hancock Counties, Census Bureau data does not indicate that any such companies have locations in the area.

Responses and Connectivity by Community

One of the first questions was about the address and the type of internet service at the location. Figure 8 provides a summary of the number of responses indicating whether locations had broadband, low-speed internet connection only (which includes cell phone, dial-up, and satellite), or no internet service.

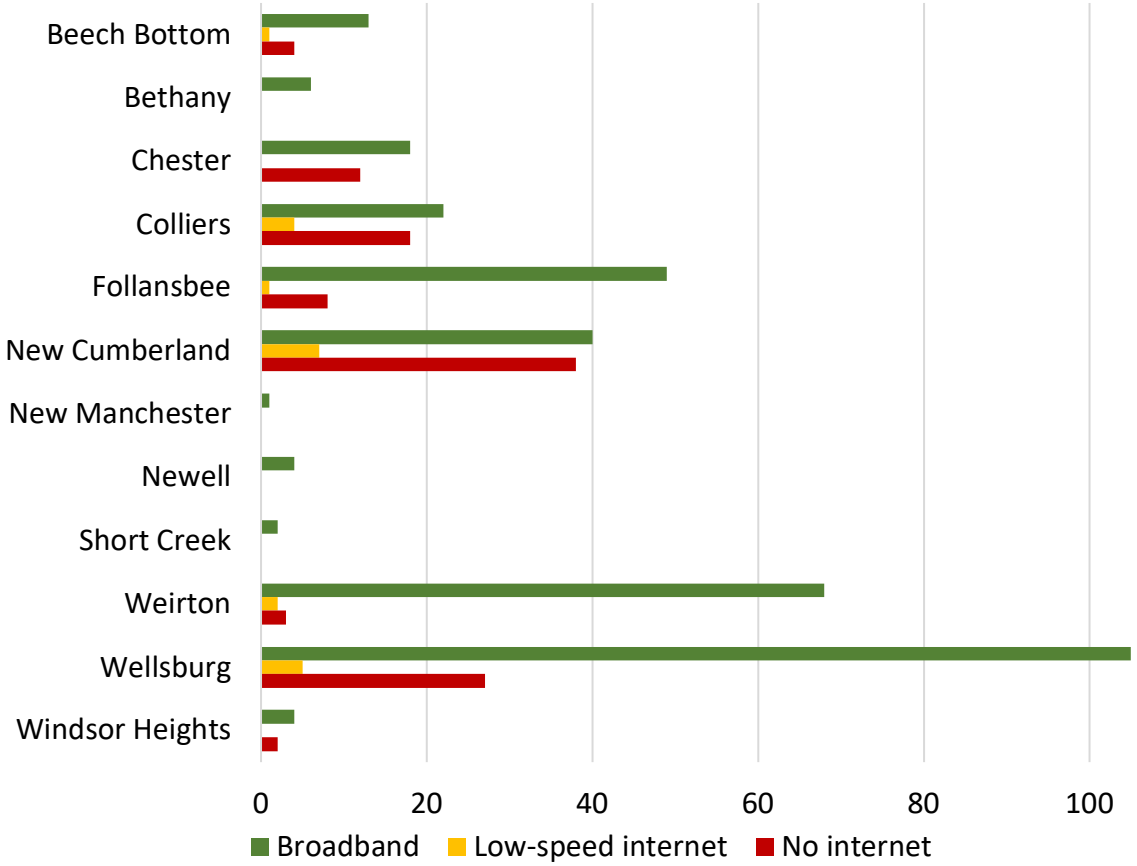


Figure 8. Survey Responses (541) by Community and Type of Internet Service

Importance of Internet Access and Willingness to Pay

While many locations had broadband service, particularly in the larger cities, a substantial number, particularly in the smaller towns, did not. It is also notable that Wellsburg had the most responses, followed by New Cumberland, then Weirton, then Follansbee, which is some indicator of the importance of this issue. We also asked if respondents consider internet access an essential service like power or water. Figure 9 shows that the overwhelming response is "yes," particularly among those without broadband.

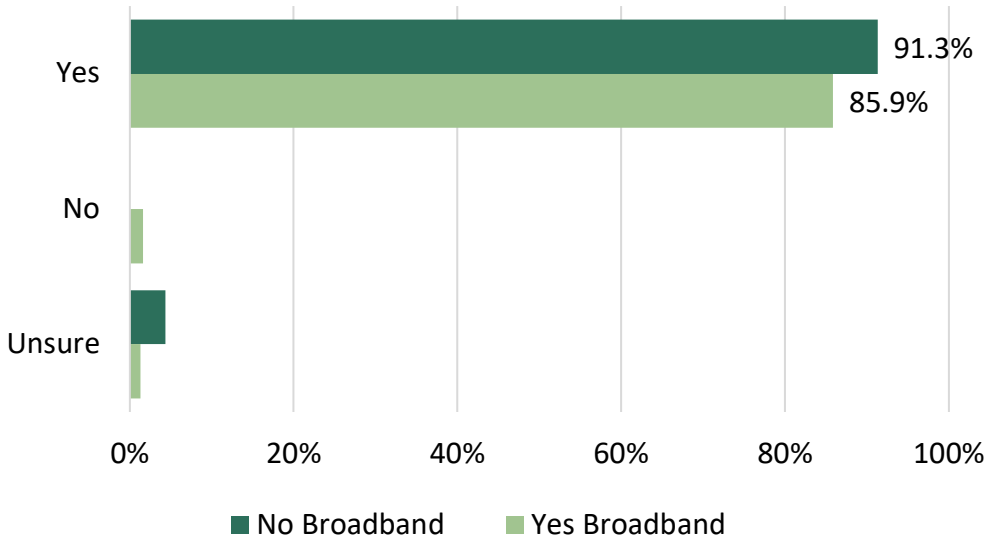


Figure 9. Is Internet Access an Essential Service? Percentage of 405 Responses

Reliability was generally the most important attribute of internet service for respondents, as shown in Figure 10. The highest percentage of respondents also identified reliability as critical.

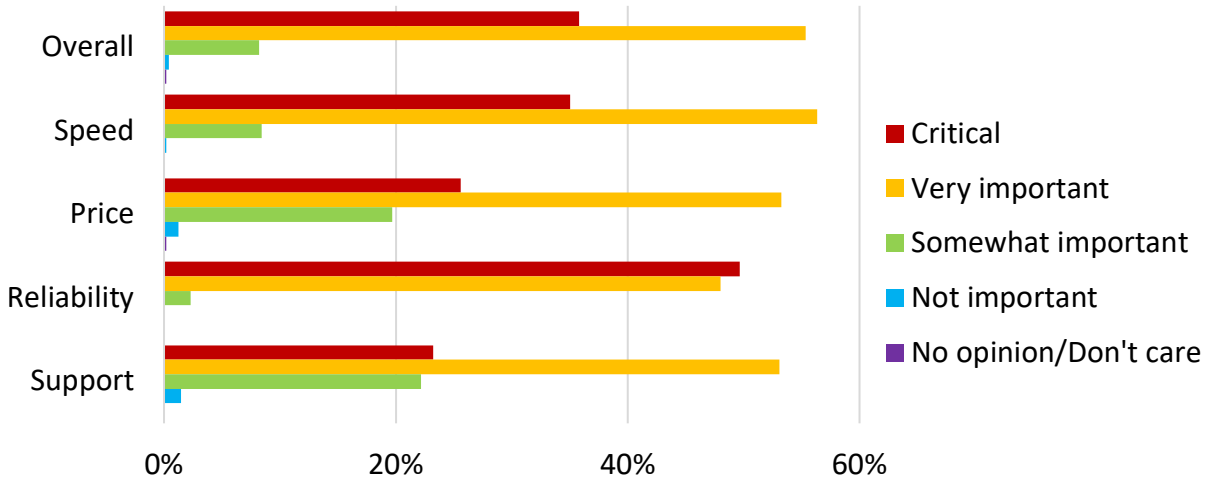


Figure 10. Importance of Various Aspects of Internet Services by Percentage of 488 Responses

Willingness to pay is a fundamental measure of demand or economic importance. As illustrated in Figure 11, respondents were generally willing to pay $25 per month for minimal broadband. There was stronger willingness to pay for faster speeds with the most willingness to pay between $25 and $50 per month for 120 Mbps of total bandwidth, followed by $100 or more for gigabit speeds.

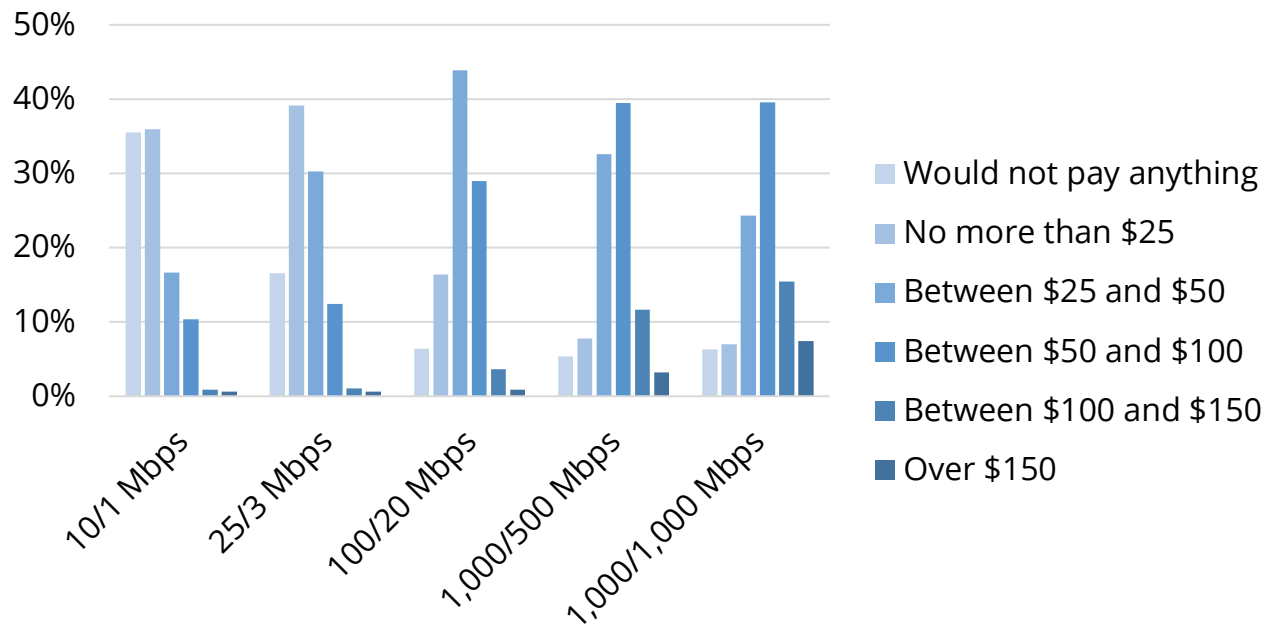


Figure 11. Willingness to Pay for Various Broadband Speeds by Percentage of 470 Responses

Willingness to pay is clearly impacted by expectations about the quality of service. We asked about how much people would pay for excellent service versus terrible service. Low service expectations greatly decreased people's willingness to pay for internet access, particularly at lower speeds. Expectation of excellent service increased willingness to pay 7.5% across all levels of internet access.

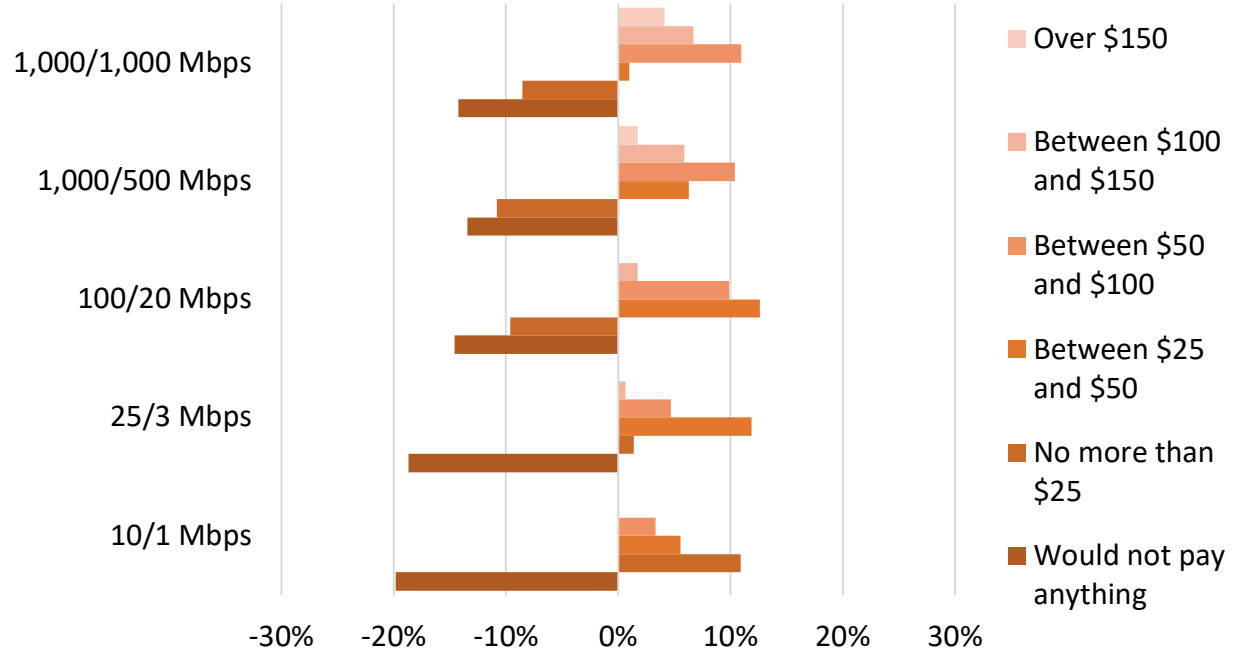


Figure 12. Difference in Willingness to Pay for Excellent and Terrible Service by Percentage of 470 Responses

Internet Use by Households

The most common uses of the internet among household respondents, as shown in Figure 13, were communication, general interest, and entertainment. Well over 50% of respondents do these activities online every day. Three quarters of respondents used the internet regularly for special interests. Seventy percent of respondents said they buy online at least once a week. Gaming and learning were similarly frequent uses of the internet, with just over half of households doing these things at least once a week. Selling online was relatively uncommon. The majority of responding households never used the internet for home business and remote work.

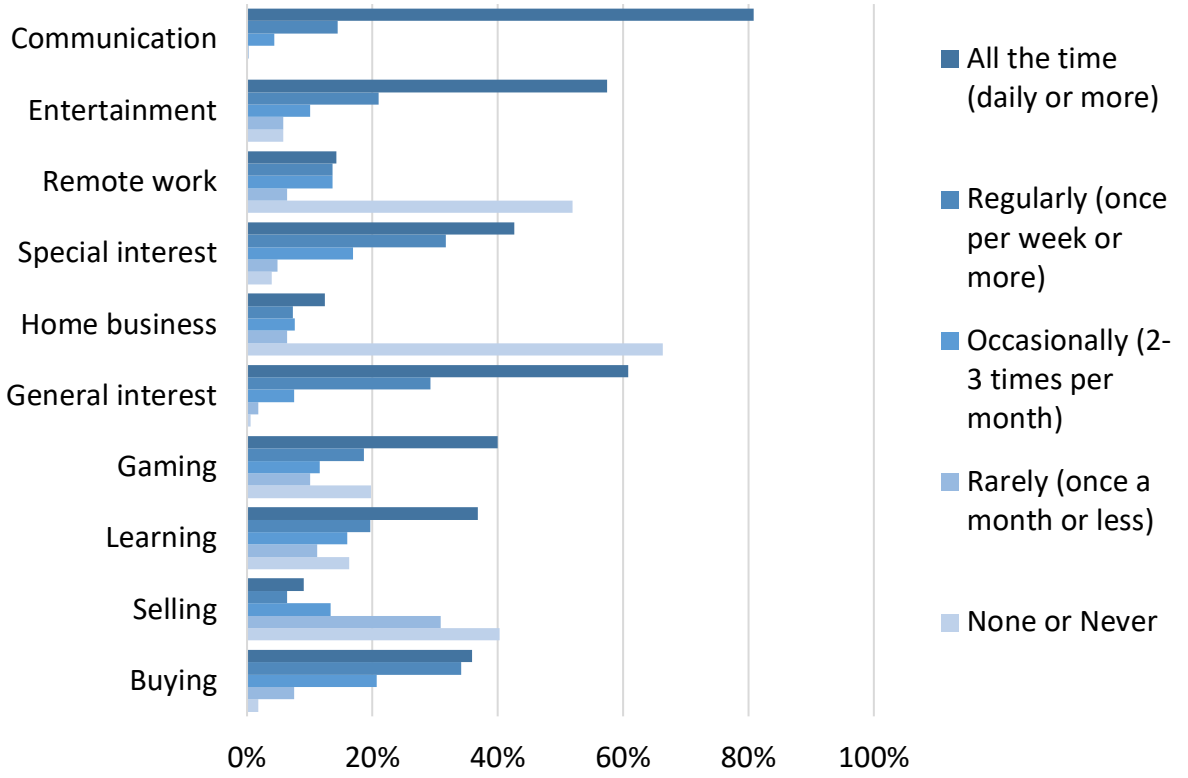


Figure 13. Frequency of Uses for the Internet by Percentage of 334 Responses

Somewhat ironically, households without broadband more regularly engaged in activities that would benefit from broadband than those with high-speed internet access. As illustrated in Figure 14, nearly half of households without broadband had members who regularly did schoolwork or training at home. Over 39% required regular health monitoring and 13% had home-based businesses. Not surprisingly, more respondents with broadband telecommuted—22.4% versus 17.4%—than did those households without broadband.

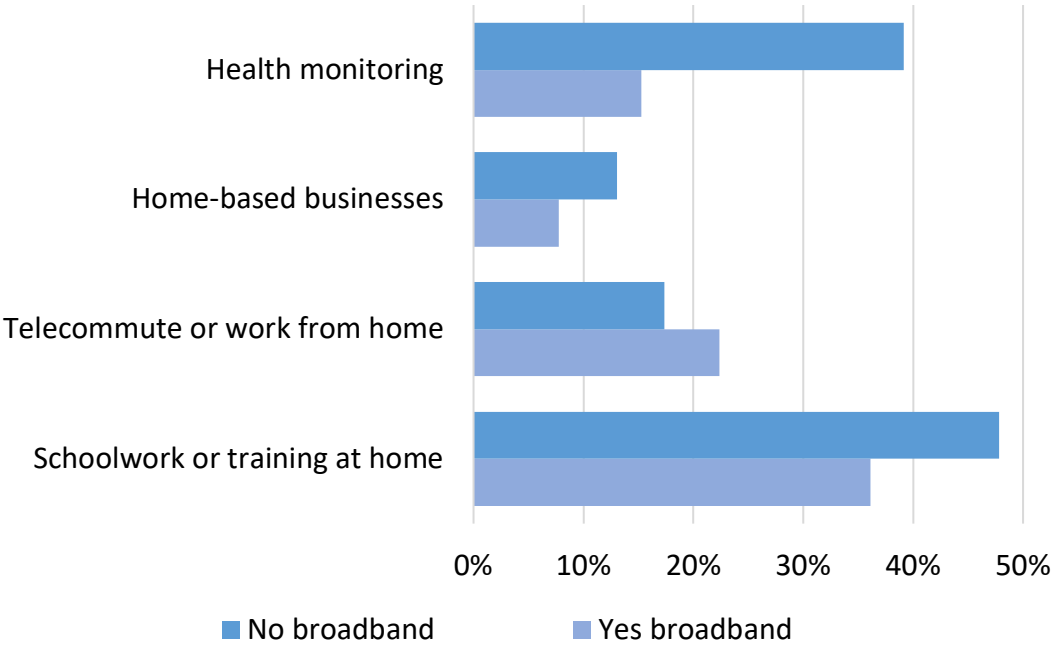


Figure 14. General Activities by Percentage of 336 Broken Down by Households with and without Broadband

Most respondents still use traditional broadcast television for video entertainment, as shown in Figure 15. Forty five percent of responding households watch the majority of videos online via streaming services.

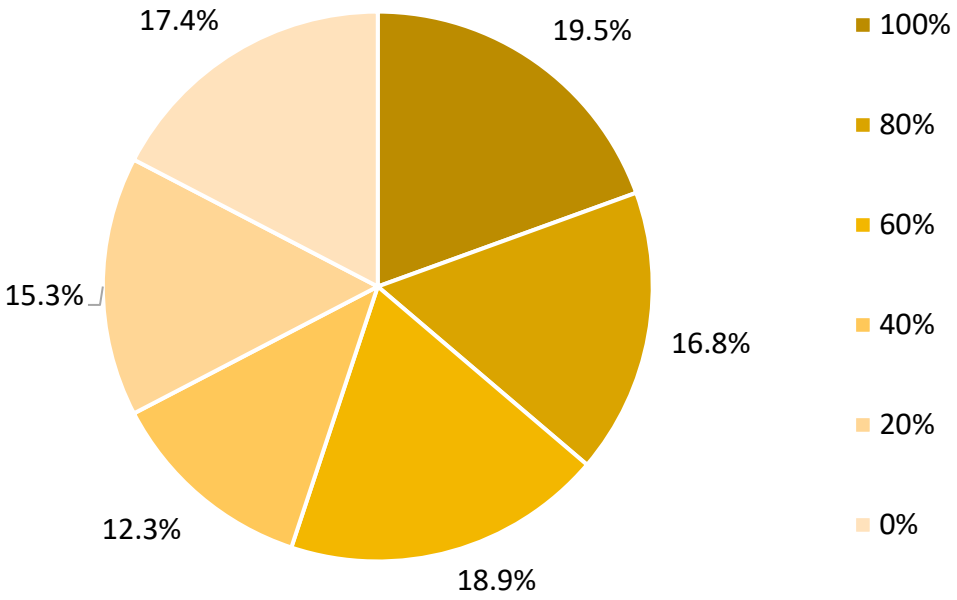


Figure 15. Percentage of Video Entertainment via Broadcast Television by Percentage of 334 Responses

Over two thirds (67%) of survey respondents indicated having telephone service from their internet service provider. Just over 40% subscribed to television services. Well over half (55%) got only internet service.

Reasons for Not Having Broadband

Those respondents who indicated they did not have broadband, including those with slow or no internet connections, at their location were asked why. The top reason by far, as shown in Figure 16, was that it was not available. Slow speeds was a distant second, followed by costs. Lack of need for internet was clearly not a reason for most respondents.

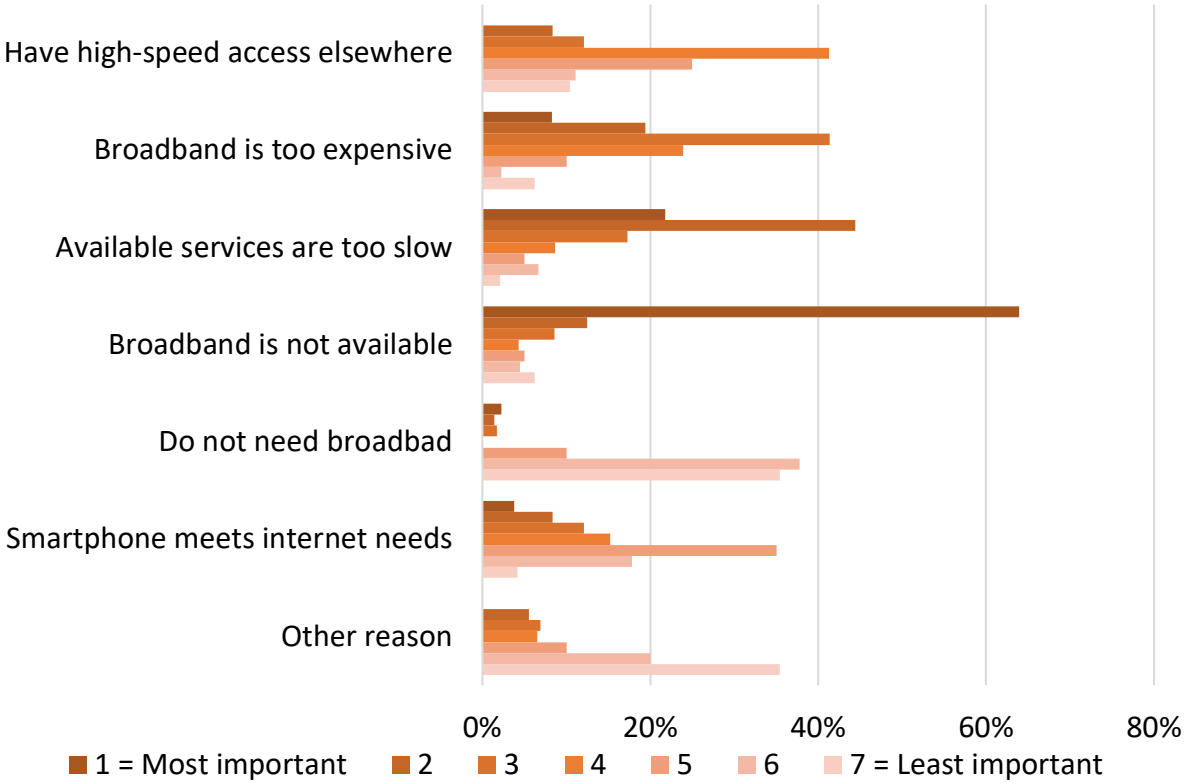


Figure 16. Ratings of Reasons for Not Having Broadband by Percentage of 133 Respondents

Organization Broadband and Technology Issues

It is important to understand how organizations use broadband and related technology because this ripples throughout the economy. Employees at companies that make extensive use of technology, for example, tend to earn more than their peers and are more likely to use technology at home. Organizations also tend to pay more for connectivity and spend more on technology than households, thereby anchoring the local technology market.

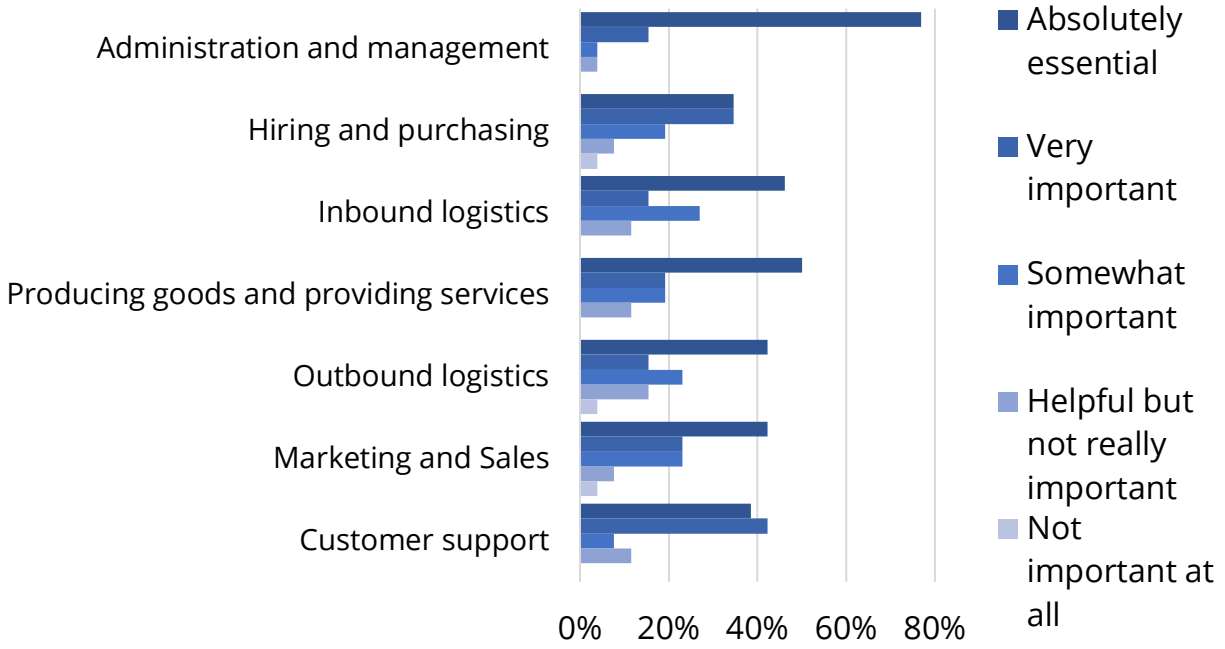


Figure 17. Importance of Technology for General Business Functions Among 26 Respondents

Organizations responding to our survey indicated that technology was most important for administration and management (see Figure 17). For survey respondents, technology was least important for getting products and services to customers. It was relatively unimportant for hiring and purchasing, customer support, and marketing and sales.

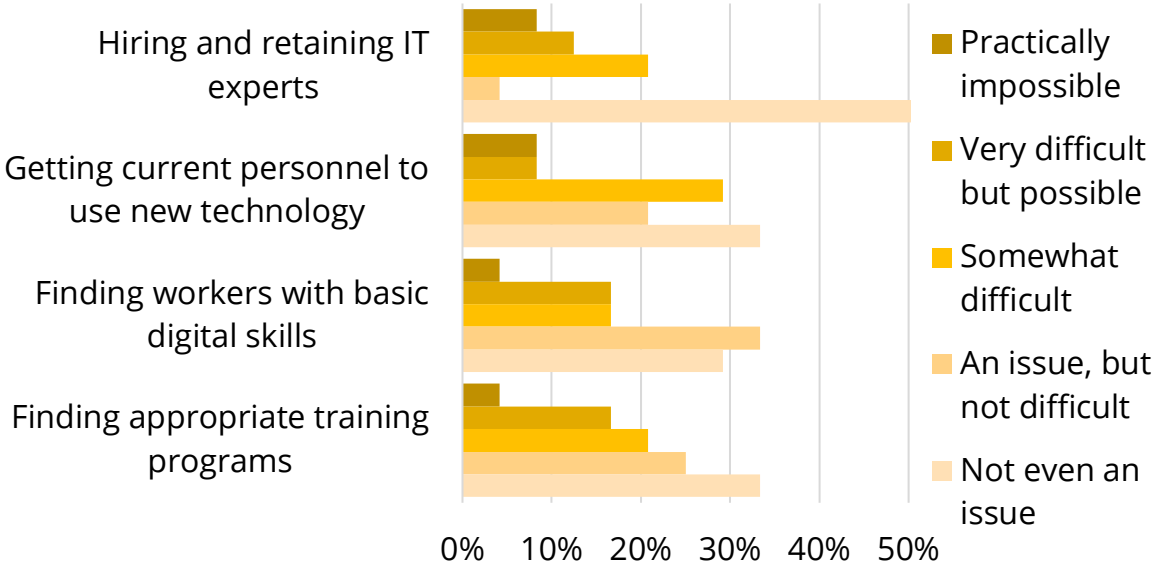


Figure 18. Difficulty Level of Acquiring Technology Capabilities by Percentage of 24 Responses

Participating organizations did not seem to have problems finding or supporting technology, as indicated by Figure 18. That said, about 40% of respondents indicated that, across the board, it was difficult to find technology talent and get employees up to speed with technology.

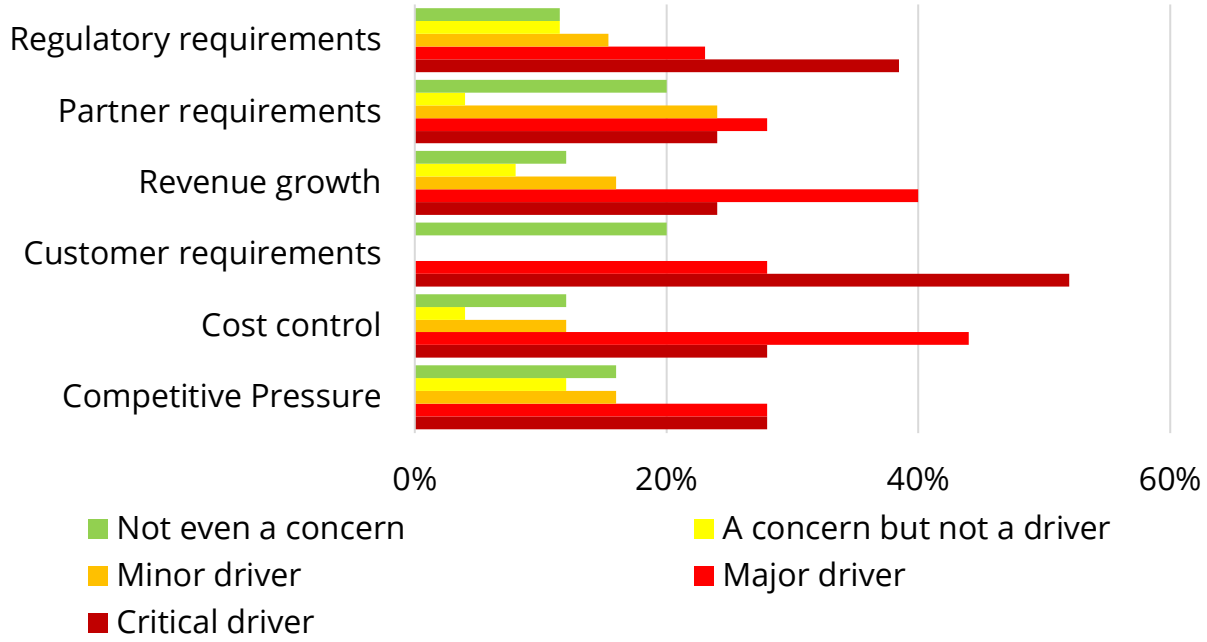


Figure 19. Importance of Technology Investment Drivers by Percentage of 25 Responses

The strongest driver of technology investments for organizations that participated in the survey was customer requirements, followed by regulatory requirements. See Figure 19. Revenue growth and partner requirements were relatively less important. Note that all these factors were considered critical or major drivers by the majority of respondents.

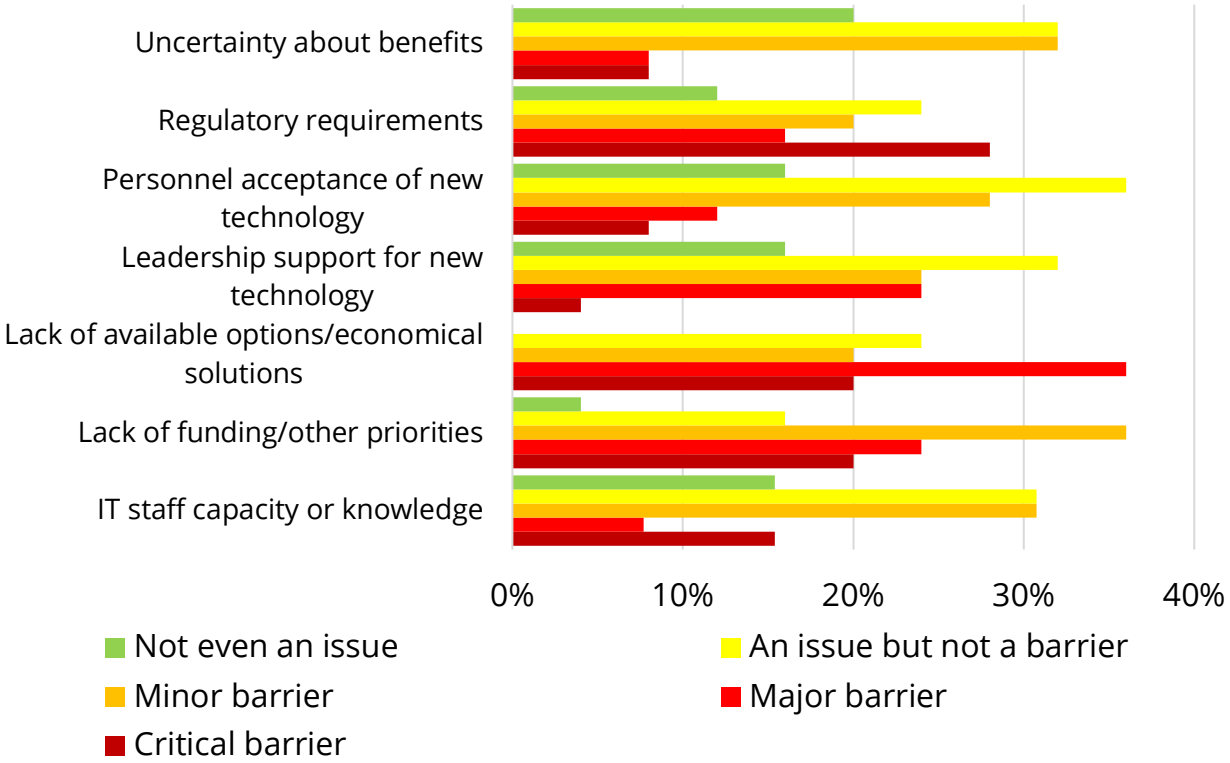


Figure 20. Importance of Technology Investment Barriers by Percentage of 25 Responses

The largest barriers to respondents' technology investments, as shown in Figure 20, were lack of available solutions and regulatory requirements, followed by lack of funding. Employees' ability to use, interest in, and support for technology were considerations but do not appear to be real barriers. Survey respondents seemed generally aware and certain of the benefits of technology.

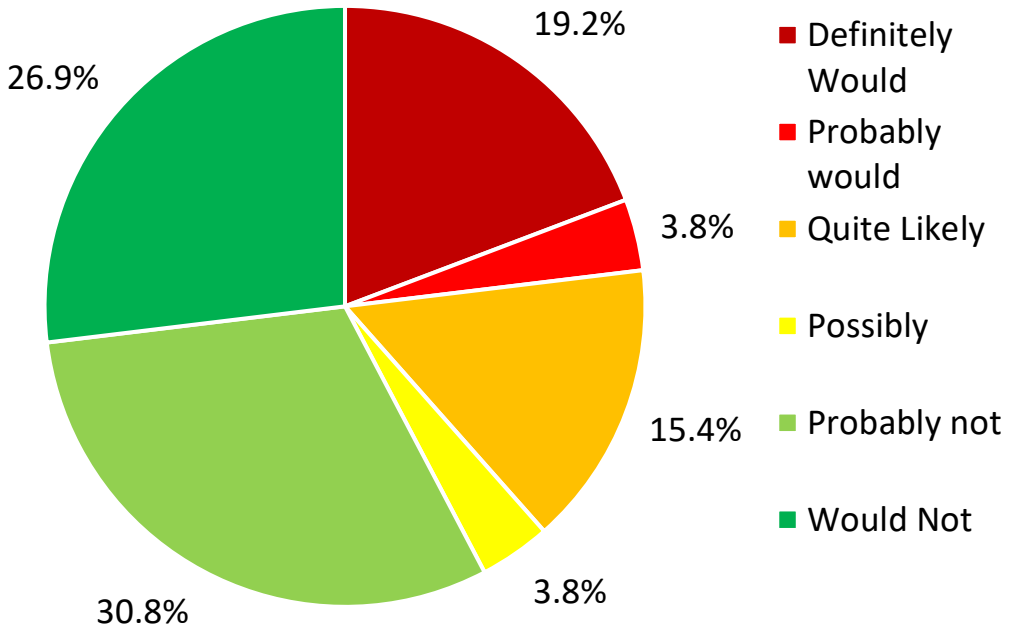


Figure 21. Likelihood of Moving for Better Broadband by Percentage of 26 Responses

Survey respondents also seem well-anchored in the area. As shown in Figure 21, well over half would not move for better broadband. That said, over 40% would at least consider it and nearly a fifth of the respondents would definitely move for better broadband.

B. Broadband Supply

Magellan Advisors identified seven companies that actively provide internet services to some portion of Brooke and Hancock Counties. A fifth company, Centre TV Cable, based in Wheeling, WV, was recently acquired by MCTV, a cable television multi-system operator headquartered in Massillon, OH. This section provides summary information about the ISPs in the local market and details what they provide based on survey results.

SURVEY RESULTS

The three major internet service providers in Brooke and Hancock Counties are Blue Devil Cable, Comcast, and Frontier. As shown in Figure 22, Comcast has the largest market share, followed closely by Frontier. Blue Devil, which is based in Toronto, OH, but provides service in Wellsburg and Beech Bottom, has less than 10% of the total market, based on our survey. CityNet was mentioned in survey responses, as was Centre TV. Access Ohio Valley and Agile Networks also provide services in the area but were not mentioned by survey respondents.

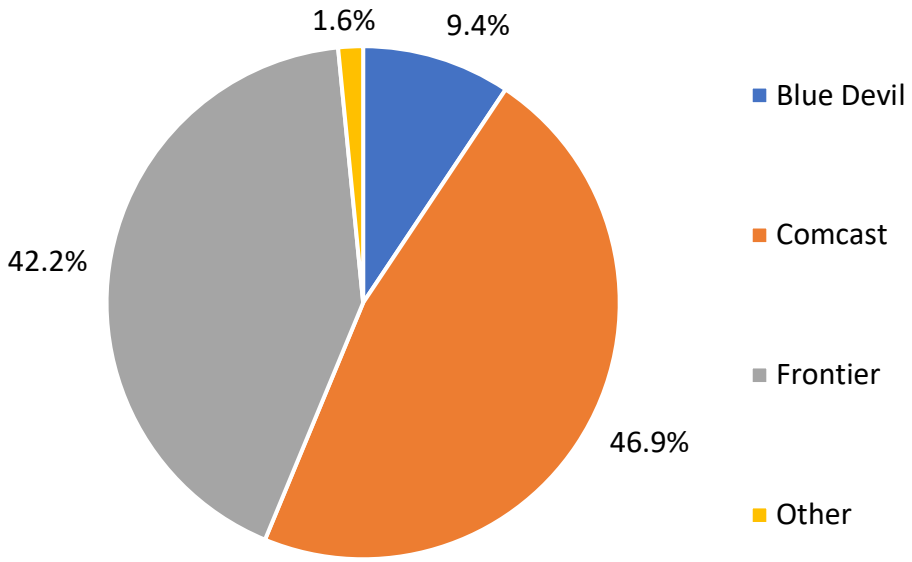


Figure 22. Internet Service Providers by Percentage of 256 Responses

The geographic distribution of survey responses regarding broadband service providers and actual speeds are illustrated in Figure 23. It is apparent from the data that Comcast's services are clustered in the cities, especially Follansbee, Weirton, and Wellsburg. Note how locations with Frontier and no broadband available are clustered together outside the area's population centers. The Frontier locations consistently reported sub-broadband speeds. Blue Devil appears to have a substantial presence in Brooke County, particularly east of Wellsburg and Follansbee. This is unexpected as Blue Devil does not indicate that it offers services in these areas. We can surmise that Blue Devil has infrastructure along Cross Creek Road, Eldersville Road, Washington Pike, and areas between.

The largest gaps in availability appear to be in southern Brooke County and northern Hancock County. In Brooke County, the areas between Beech Bottom and Bethany and to the north of Bethany, as well as the Collier area, seem to have the largest issues. Northview/Rabbit Hill Road and Washington Pike had numerous responses with sub-broadband speeds. Portions of northern Hancock County, particularly areas east of New Manchester and north of Fairhaven, as well as areas around Wylie Ridge, Tope, Ross, and Cameron roads also had sub-broadband speeds. Congo Arroyo also had several responses indicating no broadband available. Areas east of New Cumberland, particularly along Bell Hill and Hardin Run, had numerous responses with sub-broadband speeds.

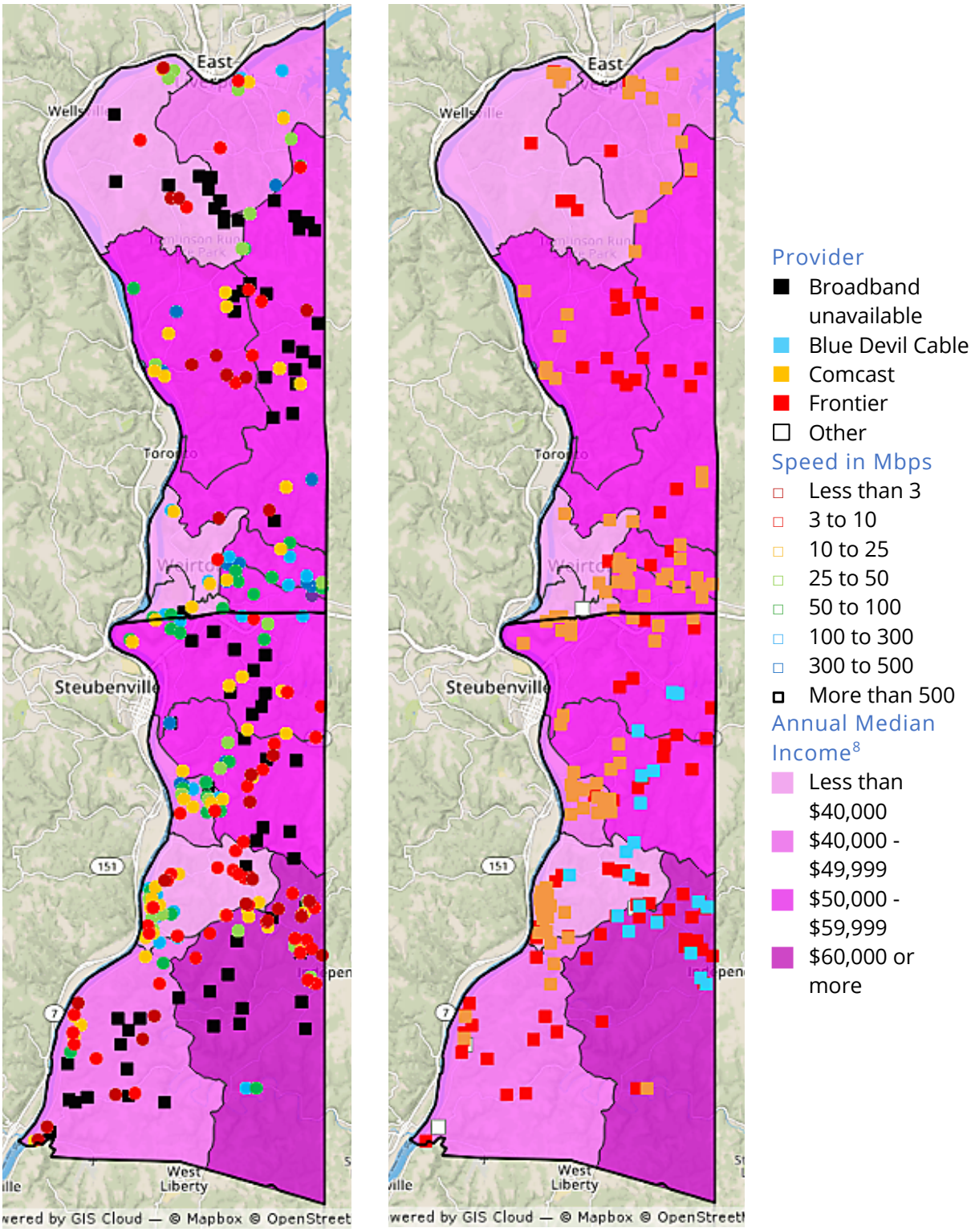


Figure 23. Broadband Providers (356 responses) and Speeds (234 responses) over Annual Median Income.

Table 3 summarizes key performance characteristics for these providers based on survey results. Cost figures were provided by respondents. The other metrics were generated by a diagnostic tool embedded in the survey.[9]

Table 3. Performance Characteristics of Broadband Connections by Provider

Provider	Responses	Average MRC[10]	Average Bandwidth[11]	MRC/Mbps	Latency (milliseconds)
Blue Devil	24	$73.58	12.60 Mbps	$11.93	108.91 ms
Comcast	120	$99.24	113.96 Mbps	$2.72	86.97 ms
Frontier	108	$96.59	12.00 Mbps	$14.17	233.14 ms
Other	4	$58.50	7.38 Mbps	$13.13	225.50 ms

Comcast performed best overall, with the most bandwidth and lowest latency[12]. It had the highest average monthly recurring cost but, due to its relatively high throughput, was still the most economic. The monthly cost per Mbps of bandwidth from Comcast was a fifth of other providers. Frontier had the worst performance overall and the highest cost per Mbps of bandwidth. Generally, all of the costs for bandwidth were substantially higher than the sub-$1/Mbps that is common for fiber-based broadband.

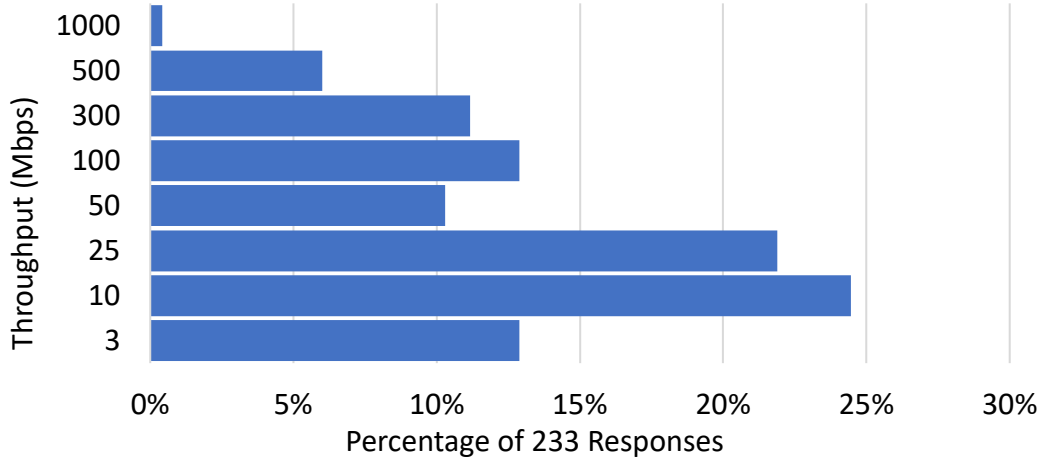


Figure 24. Distribution of Survey Responses by Internet Connection Bandwidth

The benchmark for broadband defined by the Federal Communications Commission is 25 Mbps downstream and 3 Mbps upstream, or total bandwidth of 28 Mbps. Practically 60%

[8] Source: U.S. Census Bureau, *American Community Survey*, 2014-2018 5-year estimates.

[9] The survey uses Measurement Lab's Network Diagnostic Tool to gather data on connections. For details about this speed test, visit https://www.measurementlab.net/tests/ndt/

[10] MRC is monthly recurring costs, or the average amount that a respondent pays per month for internet services.

[11] Bandwidth is the total average capacity of a service or connections, including both downstream and upstream.

[12] Latency is the time it takes for data to traverse the network, or delay.

of the connections tested via this survey, as shown in Figure 24, failed to meet that standard. At the same time, about 80% of respondents were paying more than a dollar per month for a Mbps of bandwidth. Over a fifth of respondents paid more than $10/month per Mbps. See Figure 25.

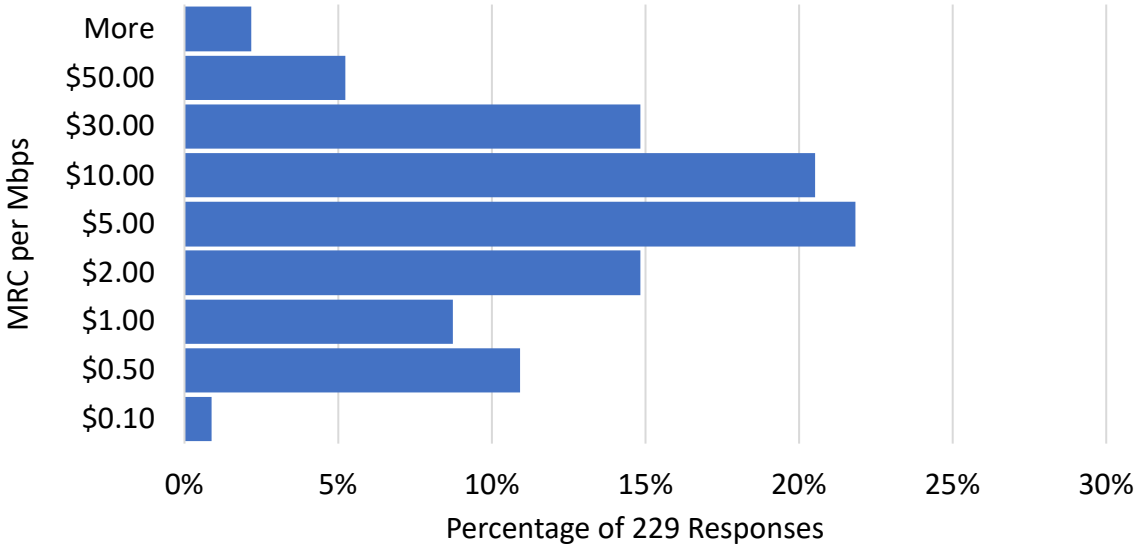


Figure 25. Distribution of Responses by Monthly Recurring Cost per Mbps of Bandwidth

The highest monthly costs paid for internet were from an organization with multiple providers. Out of 253 responses, as shown in Table 4, the average (mean) monthly costs were over $95. This amount may be skewed some by a few costly services, as the difference between the median and mean indicate that most respondents paid substantially less that average. The most common monthly cost for internet was $50, and the least was less than $10/month.

Table 4. Basic Statistics for Internet Service Costs in the Brooke-Hancock Area

	MRC	*MRC/Mbps*
Responses	253	229
Maximum	$3,200.00	$81.67
Average	$95.07	$8.35
Median	$69.00	$3.32
Mode	$50.00	N/A
Minimum	$9.95	$0.06

INTERNET SERVICE PROVIDERS

There are multiple ISPs that provide broadband services—not including cellular and satellite services—in Brooke and Hancock Counties. Through surveys and market analysis it appears that five companies serve the majority of residents and businesses in the region. These five companies have a total of 14 service offerings for residents and an additional seven offerings specifically for small and medium businesses, as listed in the tables below. The average monthly cost for residential offerings was $41.35 and the

median was $49. That said, the average monthly cost per Mbps per month for residents was $3.34, which is a good bit higher than reasonable costs of $1.50 to $2.00. High-speed, fiber-based broadband commonly provides 1 Mbps for less than $0.30 per month.

Small businesses in the region had 7 additional offerings which come with a higher level of service and, traditionally, a higher price. The average monthly cost for businesses was $132.28 and the median was $119. The average cost per Mbps per month for small businesses was $1.61, which is within the range considered reasonable. Most of this can be explained by the reasonable pricing and higher speeds provided by Comcast small business offerings including their gigabit service offering that costs just .20 per Mbps. Comcast is available only in Hancock County and does not cover all areas of the county.

No service providers serve residents or small business with fiber services in either Brooke or Hancock Counties. Comcast had the most offerings, including a gigabit speed over cable. Comcast serves the Hancock County communities of Weirton, Newell, New Manchester, and New Cumberland. They have limited services in Brooke County. Frontier covers most addresses in Brooke and Hancock Counties but their services are over DSL, are more expensive and do not deliver the 25Mbps/3Mbps speeds that are considered broadband by the FCC. Additionally, Blue Devil Cable is available in the Wellsburg area with cable services that are by far the most expensive per Mbps per month, with their lowest speed package costing $11 per Mbps per month.

Wireless service providers are providing internet access to harder to reach areas of the region. Access Ohio Valley and CityNet both provide wireless services to residents in the region. Access Ohio Valley delivers higher speeds than CityNet advertises, and their Mbps per month is close to the regional average of just over $3 per Mbps per month.

Access Ohio Valley (https://www.accessohiovalley.net/) is a wireless internet service provider based in Wintersville, OH. Their service area is primarily Jefferson and Harris Counties in Ohio, but they reach into Brooke County as well as Carroll County, OH. Access Ohio Valley targets their services towards rural customers who cannot receive service from traditional telcos or cable providers. Access Ohio Valley's offerings, summarized in Table 5, technically pertain to the Brooke-Hancock area, although most locations are not served by the company. They own seven towers heading down towards the river and valley and have a tower placed high in WV. The primary focus of those towers is to serve areas along the river and in the nearby hills. Access Ohio operates with line-of-site and the towers are placed to meet those needs.

Table 5. Access Ohio Valley Internet's Internet Service Offerings

Package	*Speed*	*MRC*	*MRC per Mbps*
Wireless 10	10/1	$45.00	$4.09
Wireless 15	15/2	$65.00	$3.82
Wireless 25	25/3	$85.00	$3.04

Blue Devil Cable (https://www.bluedevilcabletv.com/) is an independent cable television operator based in Toronto, OH. In recent years they have expanded into broadband services for Beech Bottom and Wellsburg, as well as Burgettstown, PA.

Table 6. Blue Devil's Published Service Offerings

Package	Speed	MRC	MRC per Mbps	Notes
Wellsburg Internet 3	3/1	$44.05	$11	$35 Installation / data caps*[13]
Wellsburg Internet 5	5/1	$49.05	$8.20	$35 Installation / data caps
Wellsburg Internet 8	8/1	$59.05	$6.50	$35 Installation / data caps
Wellsburg Internet 25	25/5	$76.95	$2.56	$35 Installation data caps

Agile Networks (http://agilenetworks.com/company/), based in Canton, OH, operates a hybrid fiber-wireless network across much of eastern Ohio and into Pennsylvania and West Virginia. They focus primarily on enterprises but also provide residential broadband. They have deployed next generation wireless in Canton's Innovation District and are partnering with the Pennsylvania Department of General Services to use publicly-owned assets for broadband across the Commonwealth.

CityNet (https://www.citynet.net/), based in Bridgeport, WV, has a fiber network that spans eastern Ohio and southwestern Pennsylvania as well as most of West Virginia. They provide a full range of enterprise-focused data, voice, and technology services, including high-performance network connections, as well as retail, fiber-based broadband in Bridgeport. They have a point-of-presence in Wheeling. Current network maps can be accessed at on CityNet's webpage[14]. CityNet provides some wireless-based internet access service in the Brooke-Hancock area. Due to the lack of middle mile infrastructure they have not been able to develop a fiber-optic based service for end users in the region.

Table 7. CityNet's Internet Service Offerings (prices not published)

Package	Speed
Wireless 10	384 Kbps
Wireless 15	512 Kbps
Wireless 25	1.54 Mbps

Comcast (https://corporate.comcast.com/) is part of a communications conglomerate that includes NBC and Universal Pictures. Originally a cable television system operator, it grew through acquisitions including Time Warner Cable in 2014. It is headquartered in Philadelphia, PA, and now provides a full

[13] 1000 GB per month. Additional GBs $.20 per GB.
[14] https://www.citynet.net/page.cfm?mypage=SearchableFiberMap

range of telecommunications offerings, including enterprise network services and voice services. Comcast indicated that anywhere they provide services, they can deliver 1Gbps broadband. Their services, summarized in Table 8, are mostly available in the more densely populated areas with limited or no availability in rural areas.

Table 8. Comcast's Published Internet Service Offerings in Brooke and Hancock County

Package	Speed	MRC	MRC per Mbps	Notes
Performance Pro	200/5	$39.99	$0.20	1-year promo rate
Blast! Internet	300/10	$59.99	$0.19	2-year promo rate
Extreme Pro	600/15	$69.99	$0.11	2-year promo rate
Gigabit	1000/35	$79.99	$.07	3-year promo rate
Business Starter	35/5	$88.95	$2.23	2-year promo rate
Business Advanced 200	200/20	$118.95	$0.54	2-year promo rate
Business Advanced 300	300/30	$168.95	$0.51	2-year promo rate
Business Advanced 600	600/35	$218.95	$0.34	2-year promo rate
Business Advanced 1000	1000/35	$228.95	$0.22	3-year promo rate

Frontier Communications (https://frontier.com/) was originally founded as Citizens Utility Company in 1935 and began major expansion by acquiring GTE access lines in 1993. Other major acquisitions were much of former "Baby Bell" Verizon's landline infrastructure (2010 and 2016) and Global Crossing (2001). It provides a full range of telecommunications services across New England, the Midwest, Southwest, and Western states. Frontier, like CenturyLink, offers a mixed bag of services. They do provide fiber-based broadband in some areas.

Table 9. Frontier's Published Internet Service Offerings in Brooke and Hancock Counties

Package	Speed[15]	MRC[16]	MRC per Mbps[17]	Notes
Frontier Internet	6/1	$27.99	$4	2-year promo rate
Frontier Internet	18/2	$34.99	$1.7	2-year promo rate
Frontier Preferred Internet	24/3	$34.99	$1.25	2-year promo rate
Business Internet 12	12/1	$59.99	$4.61	1-year promo rate
Business Internet 18	18/2	$64.98	$3.25	1-year promo rate
Business Internet 25	25/3	$64.98	$2.32	1-year promo rate

[15] Speeds are in megabits per second (Mbps) download over megabits per second upload. cited in this section are those advertised by providers and should be considered maximum possible speeds. Actual speeds are likely to be lower.
[16] MRC is "monthly recurring cost."
[17] This metric is the MRC divided by the total aggregate throughput, downstream plus upstream.

Fiber Optic Infrastructure

Network service providers have fiber-based networks across the country. The infrastructure is designed for various purposes. The local service providers, described above, use fiber along with other technologies for access to and distribution of their services. There are also long-haul networks that interconnect major corporate and data centers. Access to this infrastructure is very limited, but it can be an asset for backhaul to internet exchange points. Middle-mile or "metro" network infrastructure provides connections to and between enterprises and institutions. Middle-mile is often used to connect multiple sites for an organization or by wireless companies for backhaul and distribution.

Long-haul Networks

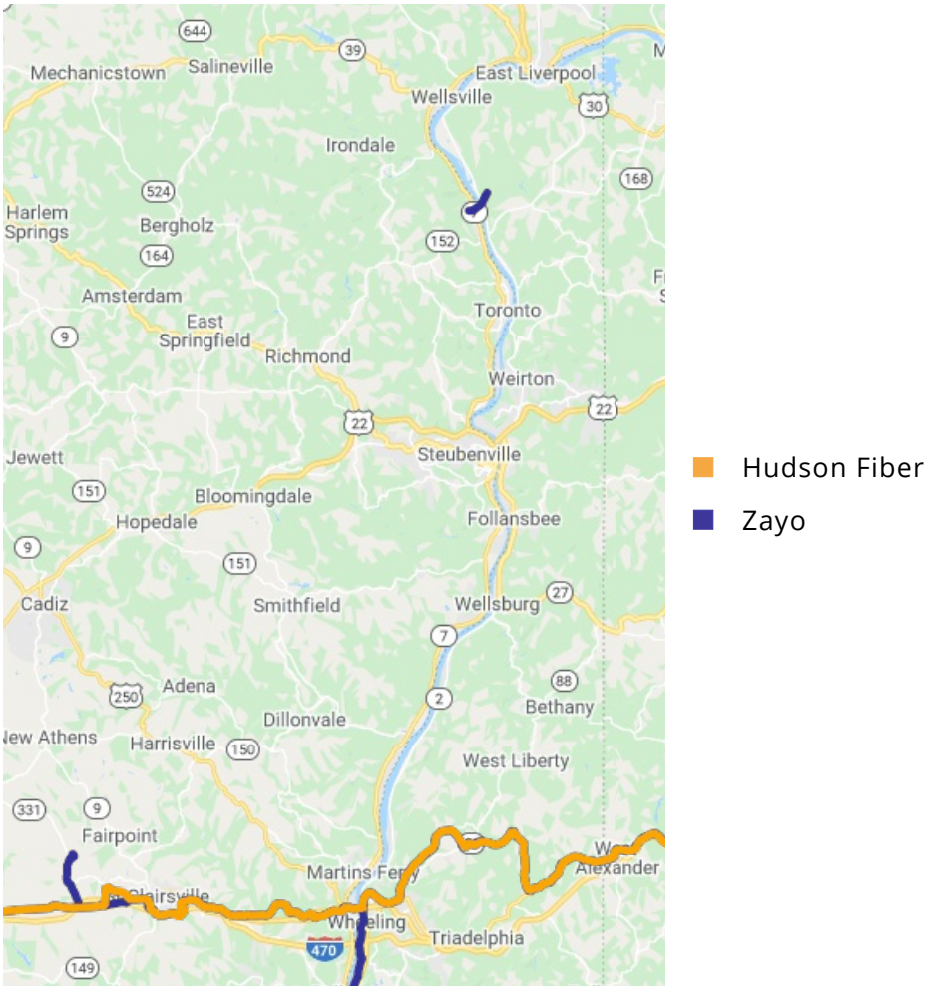


Figure 26. Long-haul Fiber in the Brooke-Hancock Area[18]

There are two long-haul network operators in the Brooke-Hancock area, as shown in Figure 26, but none appear to have infrastructure in the Counties. *Zayo* owns fiber that connects the east and west sides of the Ohio River at New Cumberland Dam and has a

[18] Source: https://www.fiberlocator.com/. This information does not include some routes included in Zayo's network map, nor does it include Crown Castle's local fiber assets.

fiber route from there through New Manchester, into Pennsylvania. Zayo also has network east and south of Wheeling. ***Hudson Fiber Network*** is a data transport company subsidiary of ExteNet. It has long-haul infrastructure running east-west through Wheeling.

Middle-mile Networks

There is some middle-mile fiber network infrastructure in the Brooke-Hancock area, as illustrated in Figure 27. It is either in use and/or not where needed for broadband. ***Crown Castle*** owns and operates a unique network of assets nationwide including 40,000 cell towers, approximately 65,000 miles of fiber, 25,000 On-Net buildings, and 900 data centers. In its southern region alone (which includes the Brooke-Hancock area), Crown Castle operates 24,000 route miles, connects 4,200 On-Net buildings, and has 250 connected data centers. Specifically, Crown Castle has a short section of fiber in East Liverpool, as well as routes in western Pennsylvania, and through Wheeling.

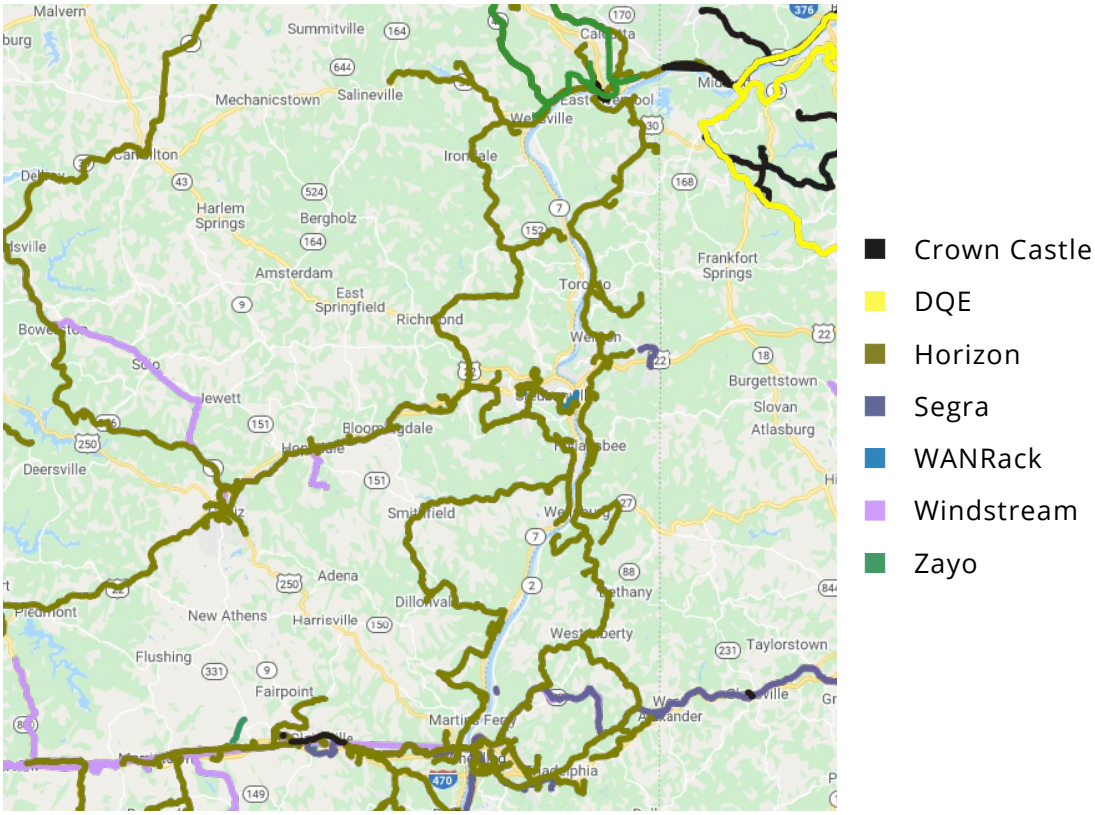


Figure 27. Middle-mile Network Infrastructure in the Brooke-Hancock Area

A subsidiary of Pittsburgh-based Duquesne Light Holdings, ***DQE*** (https://www.dqecom.com/network-map/), has 3,736 miles of middle-mile infrastructure between Morgantown, WV, and Youngstown, OH, and across the state of Pennsylvania, to Harrisburg, with most of the infrastructure in central Pennsylvania. DQE has 15 data centers and multiple hub sites (points-of-presence or "POPs"), is in 118 business parks, and has over 2,000 buildings on-net. It does not have any infrastructure in Brooke or Hancock County, or southeastern Ohio.

Horizon (https://www.horizonconnects.com/) is a diversified telecommunications company headquartered in Columbus, OH. It has a 4,500-mile fiber network across southeastern

Ohio, Pennsylvania, and West Virginia. Horizon Telecom originated in Chillicothe Ohio as a telephone operator in the late 1800's. Horizon now operates as an internet and managed services provider with large fiber assets throughout Ohio and West Virginia. They offer residential broadband in their core markets around Chillicothe, Ohio, and a range of enterprise services throughout their service area. Much of the business is providing backhaul for cellular services.

Horizon has a significant dark fiber network that connects from Wheeling through Brooke and Hancock Counties. The network was built on Broadband Technology Opportunities Program (BTOP) stimulus funds to connect cell towers for a partner in the region. The fiber in the Brooke-Hancock region is serviced off of a ring that connected to two internet POPs, one in Wheeling and one in Steubenville. Horizon's network maps are located online at: https://www.horizonconnects.com/network-map/.

Horizon engaged in conversations with the Magellan team about their current activity, partners and customers in the region, and the lack of middle- and last-mile fiber to support the connectivity needs of the region. Horizon is a backhaul provider for a few smaller ISPs and wireless internet service providers (WISP)s in the region. They do not currently serve any enterprise clients in Brooke and Hancock and are only serving residential broadband in the Chillicothe market. Horizon is currently looking to serve larger accounts including local governments, education, healthcare, large businesses and other providers – accounts that hit the $500 a month or more mark. They felt that they had not seen a huge demand in the region but did believe there may be connections to Wheeling Hospital and a bank in Wellsburg, so a few customers are aware of their service offerings.

Segra is one of the largest independent fiber network companies in the Eastern US, with network infrastructure across the Mid-Atlantic and Southeast. They offer business voice and data solutions as well as wholesale transport services for telecom carriers. The network incorporates SONET, IP, Ethernet, and Dark Fiber architectures, and connects via company-owned data centers throughout the region. Segra's network (see https://www.segra.com/network/) runs through Wheeling and has a small fiber route in Weirton.

WANRack (https://www.wanrack.com/) specializes in building private fiber Wide Area Networks (WANs) for K-12 schools across the nation. The company's experience includes fiber-optic construction projects for school districts, wireless carriers and private enterprises. Headquartered in the Kansas City area, WANRack is privately owned and backed by Grain Management and a network of individual investors. The company has network infrastructure in Steubenville, likely for the local public schools.

Windstream offers fiber transport, fiber, and fixed wireless internet along with networking solutions, unified communications, cloud services, security services, and professional services and solutions to residential, business, and enterprise customers in 48 states across the US. Windstream has network infrastructure in eastern Ohio and in the Wheeling area, but not in Brooke or Hancock counties. A map is provided at https://www.windstreamenterprise.com/wholesale/interactive-map/.

Zayo (https://www.zayo.com/) provides a wide range of enterprise network services directly and via subsidiaries. It is an independent, private company that has grown by

building its infrastructure and acquiring regional networks. The company has an extensive global fiber network, including routes through Wheeling.

C. Broadband Requirements and Uses in the Brooke-Hancock Market

Stakeholder conversations revealed a lack of fiber-optic infrastructure to support basic public safety, healthcare and economic initiatives in the region. Companies and agencies that want fiber infrastructure face exorbitant prices or providers who simply cannot provide the services due to a regional lack of connectivity. This gap also constrains providers' ability to reach farther into the community, especially in more remote, rural locations.

Reliability was the most important factor for survey respondents. About a third of respondents indicated that internet access was critical for their household or organization, and effectively all respondents said it was at least somewhat important. That said, there was clear resistance to paying for broadband, with three-quarters unwilling to pay more than $100 for a gigabit speed connection. Poor customer and technical support seemed to be primarily an issue for lower-speed services, although willingness-to-pay for faster services increased substantially with the quality support.

Weak willingness to pay may be related to the fact that most uses were general purpose and not related to work, learning, or health. Communication, entertainment, and general interest use far outstripped other uses. Even so, respondents generally got entertainment content via traditional means more often than via the net. Relatively few households use the internet for business, selling, or work. Just over a third use it for education. Households without broadband were more likely to do schoolwork or training at home, have a home-based business, or regularly see a healthcare provider.

Organizations in Brooke and Hancock Counties seem to be relatively light users, with less than three-quarters indicating the internet was at least very important for every general business function except administration and management. Businesses do not seem to face substantial issues implementing technology. Customer requirements were the strongest driver, although all customer requirements asked about were no more than minor drivers for a substantial portion (about half) of respondents. The major barriers were regulatory requirements followed by lack of economic options and lack of funding. All of this is based on a rather small number (25) of respondents, but from sectors one would expect to be relatively technology-intensive.

Brooke and Hancock Counties appear to face a "chicken or egg" conundrum regarding broadband: There is not enough market to drive investment but investment is needed for the market to grow. The sparse populations in southern Brooke County and northern Hancock County effectively undermine the business case for broadband development in those areas. Limited availability, poor performance, and relatively high costs, particularly for bandwidth, seem to be barriers to higher value use and higher willingness-to-pay, which further undermines the business case. The primary barriers to the business case seem to be the lack of market along with high cost of reaching remote areas.

Provider representatives who participated in the meetings were open to partnership to create the infrastructure that would allow them to serve the needs of the region. Economic

development and brownfield redevelopment across the region, particularly Frontier Crossing in Weirton, will require fiber infrastructure. Key traditional industries, including agriculture and energy, need connectivity literally out in the fields. Transportation projects such as the new bridge and the rail trail could be ideal opportunities to deploy fiber.

NETWORK REQUIREMENTS

There are two general network requirements for the Brooke-Hancock area. The first is to provide connectivity to major business and institution sites. Most of these are along the Ohio River and in population centers. The other requirement is to reach remote, rural areas, particularly for farms, small businesses, and residential users. Unfortunately, these requirements don't necessarily complement or support each other. Generally, the rural areas are not between the clusters of major sites so there is no business rationale to run infrastructure through them. The situation is exacerbated by the fact that the area is suspended between two neighboring states, with only a single nearby metropolitan area.

We did not see evidence of practices and uses that would drive requirements among major users. Local governments and industries seem to be lagging users of technology, in spite of being relatively well-served, judging simply from the level of engagement and the limited amount of data acquired. Locations in remote areas, in contrast, appear hungry for connectivity for business, education, and quality of life reasons. Their requirements are modest but will undoubtedly grow with better connectivity, as more access generally leads directly to more demanding, higher-value uses.

REGIONAL CONNECTIVITY REQUIREMENTS

Magellan Advisors engaged the Belomar Regional Council's (BRC) broadband consultant(s), Finley Engineering supported by Communications Consulting Group (CCG). That project was well behind our planning process with Brooke-Hancock. Even so, they indicated that the region faced major feasibility issues simply due to its geographic characteristics. Beyond Wheeling, the area is quite rural, the population is light, and the terrain is hilly and rocky. The region's economic assets are concentrated in Wheeling, Moundsville, and the area between the two cities. The region's population is similarly distributed.

The consultants' preliminary assessment was that it would be difficult to make a case for broadband development beyond the population centers of the region. They also did not see value in broader regional connectivity. Regardless, BRC's consultants indicated that they would recommend a backbone network for the region, developed in partnership with private providers.

We were able to identify two regional requirements for Brooke-Hancock. The first is simply to provide backhaul by extending network infrastructure into Wheeling. As discussed elsewhere in this plan, there are at least three independent network service providers—CityNet, Horizon, and Zayo—with infrastructure in Wheeling. A partnership with BRC and its local governments could reduce the capital required to interconnect a backbone network in Brooke and Hancock Counties and increase its value.

There may also be an opportunity to interconnect the Frontier Group's properties in Weirton with the Moundsville Industrial Park, which it also owns. While both sites would benefit from high-capacity/high-reliability network infrastructure, it is not clear how

interconnecting the two might have enough value to drive private investment. Both could be anchor sites on a larger regional network, which could then be used to incent investment. In this scenario, network infrastructure in the BHJ-MPC region would need to interconnect with similar infrastructure in the Belomar region.

To achieve the greatest value, particularly in terms of reliability, the infrastructure would also have to interconnect on the west side of the river. This would create a highly resilient network ring around the valley and connect many more sites. There has been some discussion about expanding this plan to include Jefferson County and possibly even involve the Ohio Mid-Eastern Governments Association (OMEGA). Such an expansion could complement infrastructure into Wheeling but would also reduce the criticality of that connection.

III. Broadband Connectivity Solutions

Broadband connections are composed of numerous components that can be combined in many ways. Industry standards help ensure broadband systems can be deployed and managed effectively. These standards have generally evolved from closed, proprietary standards—defined and owned by a single company, which would license and charge for their use—to open standards that are collaboratively defined, free to use, and owned by everyone. These standards essentially define the options for providing broadband.

This section reviews the range of options, including outdated "legacy" standards that are still commonly used, and provides a general technical approach for building out broadband infrastructure for Brooke and Hancock Counties. It is important to understand that the technical approach is related to, but independent of and separate from, the organizational approach. The area is experiencing a market failure to deliver what has become an essential service. While the technical approach can improve the economics of broadband, they don't determine market viability.

Broadband standards enable the practical intermingling of private and public assets, allowing them to be combined into a functional system. This does represent an expansion of government assets and operations as telecom has traditionally been almost exclusively private sector, albeit with heavy public regulation. Unfortunately, private enterprise has not and is highly unlikely to provide broadband throughout many rural areas, including Brooke and Hancock Counties. There simply are not any means to do this economically. The general connectivity solution is for local governments to directly invest in and own some network assets, while establishing partnerships with private companies to handle other portions of the broadband system.

This section describes a general approach for this that does not involve government subsidizing private industry or picking winners and losers. Under this public backbone model, local governments provide a neutral platform for any private company to economically serve businesses, institutions, and residents. We provide a preliminary network design to educate citizens and leaders about the costs and trade-offs involved in deploying a public backbone network.

A. Network Infrastructure Options

Broadband services are deployed throughout communities as wires that carry digital signals to and from homes and businesses. The content comes into the local community from around the world via national and regional networks. The local infrastructure is built, connected, and operated by internet and telecommunications companies that own the physical connection to each customer. Multiple network systems or standards connect devices to the internet, several of which can provide broadband.

Internet access was originally via dial-up over twisted-pair copper telephone lines. The second wire came later from television companies in the form of coaxial cable. Later satellite and wireless phone companies provided video and voice services, with flexibility to mobile and remote devices using radio waves. Beginning in the mid-1990s, these companies repurposed their infrastructures to connect to the internet and carry data and digital content.

ACCESS AND DISTRIBUTION NETWORK TECHNOLOGIES

Legacy, Copper-based Broadband

Traditional cable television and telephone companies have a huge amount of legacy infrastructure composed of copper wires. In response to growing consumer demand for bandwidth, these companies have upgraded outdated or underperforming equipment in attempts to make the infrastructure faster and more reliable. However, several fundamental issues exist that pose long-term challenges to meeting the growing bandwidth demand through copper infrastructure:

- Broadband signals degrade significantly over copper as distances increase.
- Broadband signals over copper are susceptible to electrical interference and signal degradation, particularly as they age.
- The amount of bandwidth available on portions of broadband networks is often shared among multiple users, which can result in an uneven distribution of speed to users, and slower speeds to all as facilities become congested.
- The copper infrastructure is part of the companies' access networks, which limits the capacity of the "last mile." Even though their backbone and core network infrastructure may have lots of capacity, lines to individual customers can be roadblocks to better performance.
- The upgrades are subject to the companies' revenue models and capital budget limitations, so they do not generally replace the actual cables, particularly in lower income and more rural areas. If they did so, they would have to substantial increase recurring costs to subscribers.

Cable Modem

Cable operators provide broadband to subscribers using the same coaxial cable that has historically delivered content to televisions through a cable modem across the same "tree and branch" network used to distribute channelized broadcast television. Technically termed Data Over Cable Service Interface Specification (DOCSIS), cable broadband literally allocates channels for carrying data to and from customers instead television. Most cable modems are external devices that have two connections: one to the cable wall outlet via coaxial cable that goes out to the internet, the other to a computer or router via Ethernet cable.

On the cable network, where the coaxial physically ends, a DOCSIS interface strips out the data and routes them all to their destinations via fiber optic cable. DOCSIS uses a "multiple access" approach to networking, in which every user's data is intermingled with others on the wire from the house to the router. Transmission speeds vary depending on the type of cable modem, cable network, or number of users sharing the bandwidth throughout the community creating network congestion.

Dial-Up Access

Though not defined as a broadband technology due to speed and bandwidth limitations, dial-up access still exists. Dial-up internet access uses the public switched telephone network (PSTN) to establish an analog connection from a computer to an ISP. Computers connect via a modem by dialing a telephone number on a conventional telephone line and translating digital data into an analog signal.

Digital Carrier Systems

Most commonly known as T-1s, this is the digital telephone standard in the US and has been the mainstay of corporate telecom for years. This service uses a four-wire interface to deliver 1.5 Mbps, which can be subdivided into 24 channels when bonded together. While not falling within today's federal definition of broadband, this is the way many small businesses get internet access and connect their various facilities. T-1s are universally available from local service providers, although they may charge for mileage and other unique situations that make the service more expensive than competing local options such as cable or DSL. Today, many digital carrier services are delivered via fiber.

Digital Subscriber Line (DSL)

DSL is a wireline technology uses high frequencies, which are not used by analog voice calls, to transmit digital data over traditional copper telephone lines faster than modems. DSL-based broadband provides transmission speeds ranging from several thousand bits per second (Kbps) to millions of bits per second (Mbps), generally ranging from 1.5 Kbps to 10 Mbps. DSL operates over the phone line—in parallel with voice traffic so calls are not affected—which plugs directly into a computer or router at the customer's site. The other end of the phone line connects to a DSL line card in the telephone company's central office or remote cabinet. Each user's data is multiplexed with their neighbors' over high-capacity fiber, transported to internet interconnection points, then routed over internet backbones to their online destinations.

The availability and speed of DSL service depends on the distance from the customer to the closest telephone facility known as a central office. Telephone lines were optimized for voice communications and conditioned to eliminate high frequency noise. Consequently, some telephone lines cannot handle DSL, and others must be modified to support the service. Multiple DSL lines can be bonded to provide higher speeds, but the cost also multiplies.

Fiber-Optics

Infrastructure that is built on the aging phone and cable technologies described above result in slower and less reliable access. Due to capacity limits of this infrastructure, companies cannot reliably provide high speeds, and often limit the amount of data consumers can use. Fiber provides robust infrastructure that connects telephone and cable infrastructure between communities and around the world. It was originally used by telecommunications providers for their core infrastructure, to connect major switching centers, and was only available to their biggest corporate and institutional customers. Today, however, fiber is in homes and businesses throughout the world, as illustrated in Figure 28, providing telephone and television as well as internet access services.

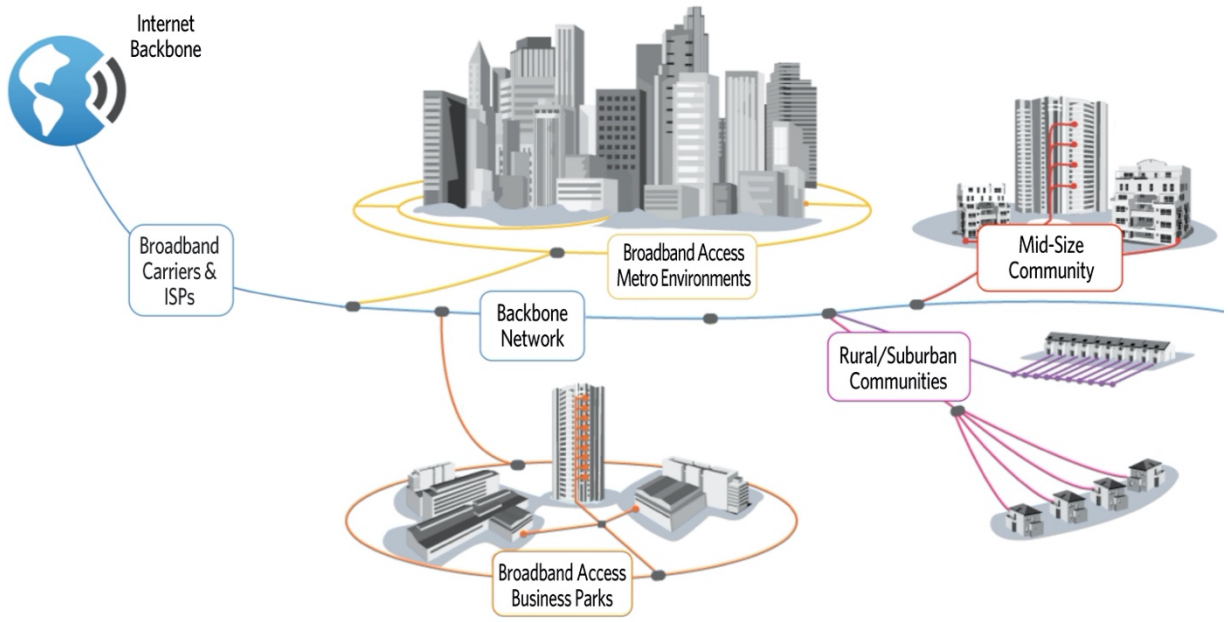


Figure 28. How Fiber-optic Networks Connect Communities

Fiber-optic network technology converts electrical signals carrying data into light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding copper, typically by hundreds of megabits per second. With fiber-optic broadband networks, speeds in the billions of bits per second range are possible. The fiber-optic network today operates at nearly 300 Terabits per second, which is so fast that a single fiber could carry all of the traffic on the internet.

More commonly, fiber-optic networks provide between 100 Mbps and 10 Gbps to users. Fiber-optic networks can be designed to be exceptionally reliable as well as really fast. Fiber is used extensively by major corporations and institutions and are at the core of every telecom company's network. There are numerous standards for fiber-optic networks. The two most common are Active Ethernet (AE) and Gigabit Passive Optical Network (GPON).

The actual speed the customer experiences will vary depending on a variety of factors, such as how the network is structured, the types of hardware attached to the fiber, and how the service provider configures the service. The same fiber that provides broadband internet can also simultaneously deliver other voice and video services. This means that fiber operates synchronously, meaning the service is just as fast to download as to upload.

Dark fiber is a fiber-optic strand with no hardware attached to generate laser light signals across the fibers. From the business perspective, dark fibers are facilities—real estate—that are leased to customers. As with any real estate, the value of dark fiber depends on location, location, location: its end points and route. Dark fiber customers are large enterprises, including internet service providers, that need to interconnect local area networks or "last mile" access network infrastructure.

The dark fiber must be "lit" to carry data across the fiber to provide bandwidth, connectivity, and other network services. Equipment must be placed on each end of the fiber, the equipment must be powered and connected to other network infrastructure, and

it must be securely housed in a building or field cabinet. And, of course, all this infrastructure must be secured and maintained.

Fiber to the Node (FTTN) brings high-capacity fiber-optic cables to communities and then connects to existing DSL and coaxial equipment. This is not an "all fiber" approach. Rather than bringing fiber-optic cables to every home or business, the fiber is connected to the existing copper network to increase its capacity. The copper-based "last mile" network that connects homes and businesses to the local nodes is still a bottleneck and results in subscribers not accessing the true speeds of fiber-optic connections.

Fiber to the Premise (FTTP) provides internet access by running fiber-optic cable directly from an ISP to a customer's home or business. This approach is "all fiber" all the way to the customer. Fiber facilitates much faster speeds than copper wire, generally needs to be serviced less, and is "future proof" because technology can increase the bandwidth of fiber-optic cables. Both AE and GPON are considered FTTP technologies.

Figure 29 illustrates the relative difference between common internet connection methods, comparing access technologies from basic dial-up service through DSL, cable, and fiber. Whereas traditional broadband technologies have an upper limit of 300 Mbps, next-generation broadband that utilizes fiber-optic connections surpasses these limitations and can provide data throughputs of 1 Gbps and greater.

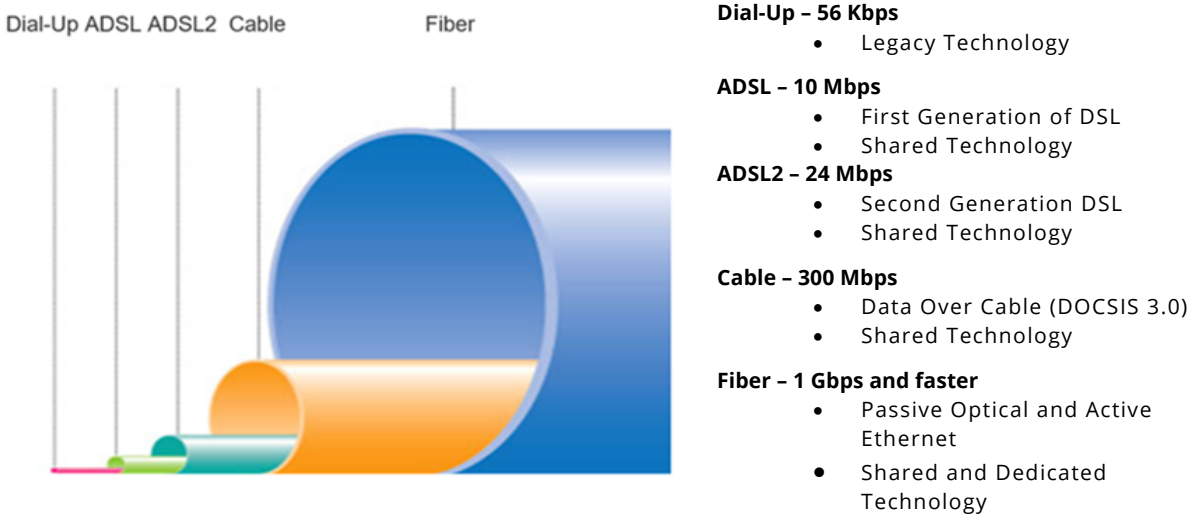


Figure 29. Bandwidth of Various Wired Broadband Media Compared

Access, Distribution, and Interconnection Infrastructure

There are two common means of "lighting" a network: Active Ethernet (AE) and Gigabit Passive Optical Network (GPON). Network users must have the proper equipment connecting their premises over a fiber distribution system to their service provider's equipment located in a local POP or a larger multi-provider exchange. These locations may be small huts or datacenters, but must be secure and have battery backup power. High capacity and high reliability sites will have multiple fiber entrances.

Basic broadband customer locations on a GPON optical distribution network (ODN) must be equipped with an optical network terminal (ONT). ONTs connect to a centralized optical line terminal (OLT) that can support many ONTs, both of which require power. In between,

there are passive optical splitters that distribute signals from each OLT port to as many as 64 ONT's for delivery of data, video, and voice services. Splitters need to be secure and protected from the elements, but they do not require power.

An active Ethernet system also connects customer premise equipment (CPE) to a centralized OLT acting as an Ethernet switch but does not use splitters. Instead, each customer uses a dedicated fiber pair (or single strand) to connect their CPE to the OLT. This can be moderated by deploying intermediate Ethernet hubs or switches that connect multiple CPE into a single OLT switch port. Many traditional telecoms use this approach with copper (either coaxial or twisted pair) cable from the switch in a cabinet or pedestal to the customer premises.

Providers' distribution networks interconnect to their core networks at their central offices, head-ends, or similar locations using protected links or rings. These core facilities may also serve as co-location sites for third party network access. These sites sit at the intersection of multiple network routes and must be physically secured and provide access to clean, highly reliable power. To the extent that multiple providers or even customers have equipment in these locations, there needs to be either separate entrances or monitored access to shared facilities with secure cabinets or cages for each user.

Aerial and Underground Infrastructure

Fiber and other wired network assets are deployed as aerial infrastructure or underground. Aerial is less expensive to deploy and easier to access but is also more exposed to damage from accidents and the elements. Generally, connections into customer premises, known as "drops," are aerial even if most of the wired infrastructure is buried. Sites that need additional levels of reliability may have buried connections—or even multiple buried connections into different parts of the building—to reduce risk.

Aerial fiber-optic cable is generally attached to utility poles in the communication space, below the power space (at the top of the poles). Aerial fiber cable must be more resilient than buried cable to withstand exposure to the elements, and it must be lashed to a messenger wire. In some cases, it can be over-lashed to existing cable and special (All-Dielectric Self-Supporting, or ADSS) fiber cables can be installed in the power space. Poles require "make ready," which may involve anything from simply checking the poles to moving other cables to installing new poles and/or replacing old ones. Aerial cable should include slack loops equal to 5% of the cable's total length.

Sections of the backbone fiber cable must be spliced together. Connections to customer premises or network sites also typically require fiber cables for those locations to be spliced into the backbone. Splices can be in cases attached to the aerial cable, in equipment huts or pedestals, or in buried vaults. There must be additional cable near splice points, as well as physical space for a splicing trailer. Outside plant splice cases have closures that are 30" long and are capable of housing up to 576 single fusion splices. Splice cases are loaded with splice trays capable of holding 24 single fusion fiber splices with protective sleeves.

All underground cables are installed in conduit at a minimum depth of 24 inches. Typically, at least two conduits are buried, one for current fiber and one for future use. Handholes should be at intervals of no more than 800' apart, depending on network routing. Two different sized handholes are typical: One as fiber-optic pull assist points where no cable

splicing is anticipated, and another larger sized handhole planned in all other areas. All should be able to house 50’ of fiber-optic cable slack. An insulated tracer wire is pulled inside the conduit for underground utility locating purposes.

Wireless Technologies

Wireless broadband can operate as mobile or fixed service. Although cellular connections can approach broadband speeds, mobile wireless broadband is still in its infancy, as discussed below. Fixed wireless can be used to connect remote locations or sparsely populated areas, where DSL or cable service would not be economically feasible, via long-range directional microwave antenna. As discussed below, most of these connections are built on proprietary technologies, although they generally extend Wi-Fi and similar standards.

Wireless (and cellular) signals travel through the air via microwave wireless spectrum. This spectrum is not an infinite resource; there is only so much available. While technology continues to improve the amount of bandwidth that can be delivered over a set amount of spectrum, spectrum is still limited. Spectrum in the US in managed by the FCC, which establishes rules for how spectrum is to be used and who has the rights to use it and governs the use of that spectrum.

The FCC licenses spectrum is for broadcast radio (FM/AM) and TV, military communications, airlines, satellites, emergency use, ship-to-shore communications, cellular communications, and many other uses. License holders have exclusive use of that spectrum within a geographic area or closed user group. Unlicensed spectrum can be used by anyone. Devices that used unlicensed spectrum must comply to operational specifications set by the FCC and other federal agencies. Wi-Fi is probably the most prominent technology that uses unlicensed spectrum. Carriers generally do not deploy services in unlicensed spectrum because they cannot control its use and guarantee quality of service to their customers.

Coverage and speed are an intrinsic trade-off for wireless technologies. The farther a signal travels, the less information it can carry. High frequency signals, which have inherently high capacity, travel shorter distances than lower frequency signals (at the same power level). Lower frequency signals cover terrain and penetrate physical objects more effectively than high frequency signals. Spectrum in the lower spectrum ranges offer better non-line-of-sight solutions, whereas the higher spectrum ranges need a more line-of-sight solution. Line-of-sight requires the transmitting antenna to be able to “see” the receiving antenna with limited trees and buildings in the way to be effective.

Terrain, then, plays an important role in the network design. Radio signals do not get over mountains or hills very well, nor does certain spectrum do very well in penetrating through buildings, foliage, or water, including rain and snow. The farther away the transmitter and the receiver are from each other, the less bandwidth is available. Transmitter sites need a means of connecting to the network, whether via fiber or microwave, to another site where it then transitions to a wireline fiber network. Fiber can be costly to install in remote locations. Electrical power, security and access are also considerations when locating appropriate tower sites.

Cellular Mobile Wireless

Mobile wireless cellular services are widely available from mobile phone companies, typically for use with smartphones and mobile computers. The specific networking technology is referred to by generation of mobile wireless as either 3G, 4G, or the coming 5G which will surpass the federal definition of broadband. Mobile wireless connections operate from antennas on towers that create wireless cells across a geographic area. Connectivity is maintained as devices move from wireless cell to wireless cell. The base of each tower site is connected to other tower sites and the internet, optimally via fiber optic cables. Today, 4G transmits data at around 12/5 Mbps. With each new generation, more wireless applications become possible as more data can be carried across the airwaves.

The fifth generation of mobile wireless networks, known as 5G, is being designed and developed, with forecasted commercial availability in 2020 and an increased maturity of the network in subsequent years. 5G networks operate multiple frequencies using millimeter wavelengths to offer anticipated download/upload speeds of 1 Gbps. The networks are designed to provide increased efficiencies while decreasing latency and to improve the performance of connected devices that define the Internet of Things (IoT), including autonomous vehicles, healthcare monitoring technologies, ultra-high-definition video, virtual reality, and many more applications ripe for development.

As the carriers begin to deploy 5G it has become increasingly obvious that 5G will not be the end all solution for gigabit home and business broadband throughout the US. One widely accepted issue is that 5G will not be a solution for rural homes and businesses. The CEO of T-Mobile was open with this reality when he recently stated that millimeter-wave spectrum used for 5G "will never materially scale beyond small pockets of 5G hotspots in dense urban environments."[19] The claim is based on the reality that 5G's high frequency spectrum does not carry far, needing large investments in small cells, and is easily blocked by walls and other obstacles.

With limits in ROI and physics, the reality of 5G as the all-encompassing gigabit solution is beginning to fade. A mature 5G network will take time and continued investment by carriers. The information is speculative on when larger, national cities will begin to see 5G deployments, but if the investments in current infrastructure are any indicator areas like Brooke and Hancock counties should expect a long wait.

Short of waiting, it is important for local leaders to understand their role in supporting 5G. Local governments could either help carriers support 5G services locally, or depending how 5G network equipment is made available to smaller service providers, they could become a provider of 5G services. The 5G market is simply too nascent and ever-changing to know confidently the direction 5G network equipment will be sold and the availability of local spectrum to support 5G.

What is surely known about 5G is the amount of bandwidth that is needed to support more small cell millimeter wave antennas. Instead of one tall cell tower that can cover a 10-mile radius, 5G requires more antennas closer to where users are located. Some

[19] https://arstechnica.com/information-technology/2019/04/millimeter-wave-5g-will-never-scale-beyond-dense-urban-areas

equipment vendors say a downtown urbanized environment would require antennas to be deployed on every third utility pole. Every 5G antenna would require a fiber connection.

Fixed Wireless

Fixed wireless services allow consumers to access the internet from a fixed point while stationary, and typically requires an external antenna with direct line-of-sight between the distant wireless transmitter and the customer building-mounted receiver. Speeds are generally comparable to DSL and cable modem. These services have been offered using both licensed spectrum and unlicensed devices. To deliver a fixed wireless solution, providers need to consider:

- Available and appropriate spectrum – not all spectrum is created equal
- Tower locations and siting
- Terrain and other sources of interference
- Backhaul options
- Bandwidth requirements

Fixed wireless can be deployed as point-to-point (PtP) or point-to-multipoint (PtMP). PtP involves a one-to-one relationship between antennas at different locations. It is typically used for interconnecting sites, such as a headquarters or main buildings, to a remote facility. Internet service providers typically use this approach for connecting to customer locations where they do not have wired infrastructure. End-users typically use it as a backup or secondary connection or for non-critical sites because the connections have less capacity than fiber and are susceptible to environmental degradation from foliage, weather, and other factors. PtMP involves multiple—even hundreds of—users' antennas connecting to a single, central base station. This model and infrastructure is very similar to cellular but with much more bandwidth and without the mobility.

As illustrated in Figure 30, PtP and PtMP are complementary technologies. PtP can be used to interconnect PtMP base stations as well as for remote sites (although fiber is preferable due to its capacity and reliability). The networks require Line of Sight (LOS) or near Line of Sight (nLOS) to operate. The systems utilize proprietary protocols and specialized devices to achieve the long ranges and high throughputs. Different vendors' products may not interoperate with each other.

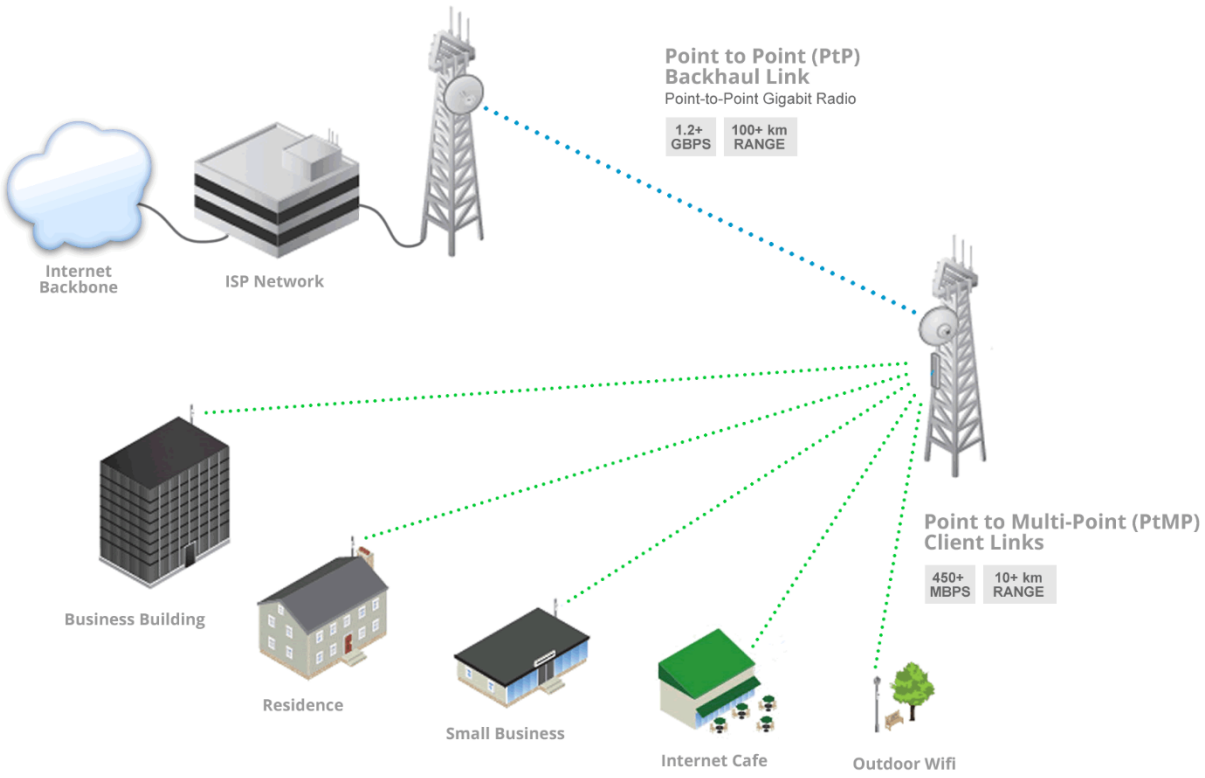


Figure 30. How PtMP and PtP Wireless Connect Communities

Citizens' Broadband Radio Service (CBRS)

The FCC set aside the 3550-3700 MHz (3.5 GHz) spectrum in 2015 under a new, shared spectrum approach. There are three tiers of CBRS users, diagrammed in Figure 31. Current, incumbent, tier 1 spectrum users, which include US military, fixed satellite stations, and, for a limited time, wireless internet services providers (WISPs) are protected from interference by other users. Ten Priority Access Licenses (PAL) for 10 MHz channels between 3550 and 3650 MHz in a specific county will be auctioned off by the FCC in July 2020. These licensees are protected from interference by other users but may not interfere with incumbent users. A licensee may aggregate up to 4 PALs. Any portion of the spectrum may be used without a license for General Authorized Access (GAA), but this may not interfere with incumbent or PAL users.

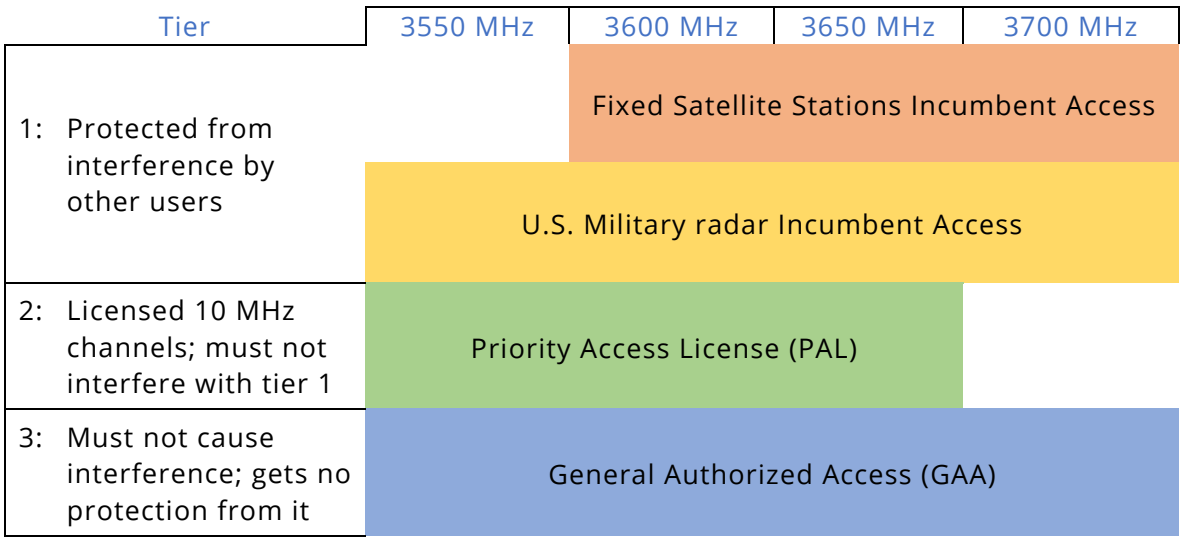


Figure 31. CBRS User Tiers

CBRS uses will be managed by a Spectrum Access System (SAS) with which all Citizen Broadband Service Device (CBSD) base stations must be registered. There are two classes of CBSD. Class A base stations, which can transmit at 1 watt of power, are meant for smaller-scale indoor, enterprise, or campus use. Class B base stations can transmit at 50 watts, giving them much greater range. Strategically placed radio signal sensors will ensure that uses do not interfere with each other, particularly military radar.

Another important characteristic of CBRS is the LTE ("Long -Term Evolution (LTE)") protocol is commonly used with the spectrum. LTE is also used for 4G cellular data service, so it is widely implemented in user equipment. CBRS involves different spectrum but some smartphones have antenna that operate in the CBRS bands. It is reasonably easy and economical to add CBRS/LTE to devices without changing their operating characteristics or systems. Therefore, there are few barriers to end user adoption.

The combination of CBRS/LTE in base stations and user equipment is a radio access network (RAN). A RAN has a network core that authenticates and authorizes user equipment and manages connections to multiple base stations. This allows for mobile roaming from base station to base station without loss of connectivity and makes RANs very secure. The downside of a CBRS/LTE RAN is that some entity must operate to network core and the SAS. These are relatively inexpensive services that can be purchased from vendors or run on private servers.

Low-Power Wide Area Networks (LPWAN)

Although not broadband, LPWAN technology should be considered in any network infrastructure plans. It is generally used to connect many small devices over a large geographic area. Water meter reading is a prime example of a LPWAN application. These are message-based networks, meaning end devices send small packets of information to an LPWAN gateway that then sends the data via a wired network to monitoring or tracking software. Real-time control of the devices is very limited but other, similar technologies exist that allow for remote control.

There are numerous standards for LPWAN with varying degrees of openness and propriety. The proprietary technologies were first to develop and currently have the

largest installed bases. The open standards for LPWAN are still evolving. The major open standards are extensions of other standards, specifically 5G and Wi-Fi. The costs and flexibility of open standard based systems tend to be much better than proprietary technologies, although proprietary technologies may perform better in the short-term.

Wi-Fi

Wi-Fi, which was originally termed "Wireless Fidelity," is an open standard that was developed to connect computers to a local area network (LAN) via unlicensed radio spectrum (the same frequencies used for cordless phones, garage door openers, and other non-network wireless devices). Generally, Wi-Fi is a PtMP technology: Wi-Fi access points connect multiple devices within limited range, typically no more than 150 feet indoors and up to 1,500 feet outdoors. There are multiple standards or versions of Wi-Fi. Some can provide up to 1 Gbps of throughput while others can cover large areas with minimal power requirements.

Wi-Fi coverage and speed depends on multiple factors such as buildings, foliage, and other physical barriers, interference from other spectrum users, radio spectrum used, transmission power, type of antenna(s), and weather. New versions of the Wi-Fi protocol operate at greater distances and/or speeds. It can be deployed PtP to interconnect sites and is being adapted for LPWAN applications.

Wi-Fi access points are often integrated into routers that interconnect the Wi-Fi network (also called a service set identifier or "SSID") to other networks, including a broadband connection to the internet. This is typically referred to as a "hotspot" or Wi-Fi zone. Multiple access points can be interconnected to each other as well as a router to cover a larger area. A Wi-Fi network can even be extended over multiple otherwise independent routers via a centralized server to create "community" Wi-Fi. The latest version, Wi-Fi 6, improves these functions as well as expands the spectrum and increases speeds for Wi-Fi connections.

Today, many organizations use Wi-Fi to provide wireless connectivity throughout a building or campus. Many cities and counties have deployed public Wi-Fi in zones that extend into parks, other public spaces, and even throughout the community. Wi-Fi hotspots are common at hotels, restaurants, and public buildings for public access, and is widely used in homes and businesses for private access.

Satellite

Satellite internet uses licensed spectrum to send data from and to anywhere on earth. The signals go on a 46,000-mile roundtrip from earth-bound devices through the atmosphere to the satellite and back to earth to another computing device. These radio signals have limited capacity and thus the connections are slow. Because of the distance the signal must travel, satellite transmissions are susceptible to weather. Even in the best of circumstances, satellite connections have very high latency. The need to buffer data to address speed issues can increase the delay.

Satellite should be considered a last resort for all but the most rural and remote areas. Areas with a high adoption of satellite generally indicate a need for better wired infrastructure service. Today, the federal government finds no satellite broadband service meets the 25/3 Mbps threshold of broadband.

A STRATEGIC APPROACH TO BROADBAND TECHNOLOGY

Broadband services and technology are changing. Local governments need networks for their constituents and other stakeholders as well as internal operations. They also need to facilitate investment and limit public risk. Therefore, a general strategic approach is to avoid legacy systems that have limited capacity and reach and are expensive to build and find private partners to invest in critical components that are subject to rapid evolution. This means focusing on physical assets and facilities rather than network equipment, especially at the edges of the network. It means finding partners to provide access.

B. Broadband Development Approaches and Options for Local Governments

There are a number of options for broadband development for local governments, ranging from simply implementing broadband-friendly policies to providing public assets for private providers to directly providing services to businesses and/or residents. Each of these approaches comes with a different set of requirements. Selecting the right broadband approach for local government depends on multiple factors, each of which depends the others. These requirements and factors are illustrated in Figure 32.

Figure 32. Inputs to Selecting the Right Broadband Approach

The commonly pursued approaches fall on a continuum from low risk, low control to full control with substantial risk. Figure 33 illustrates this continuum. Moving along the continuum of approach options involves increasing degrees of risk and reward: risks in terms of financial, operational, and regulatory risk; rewards in terms of community benefits, revenue generation, and over potential for profit.

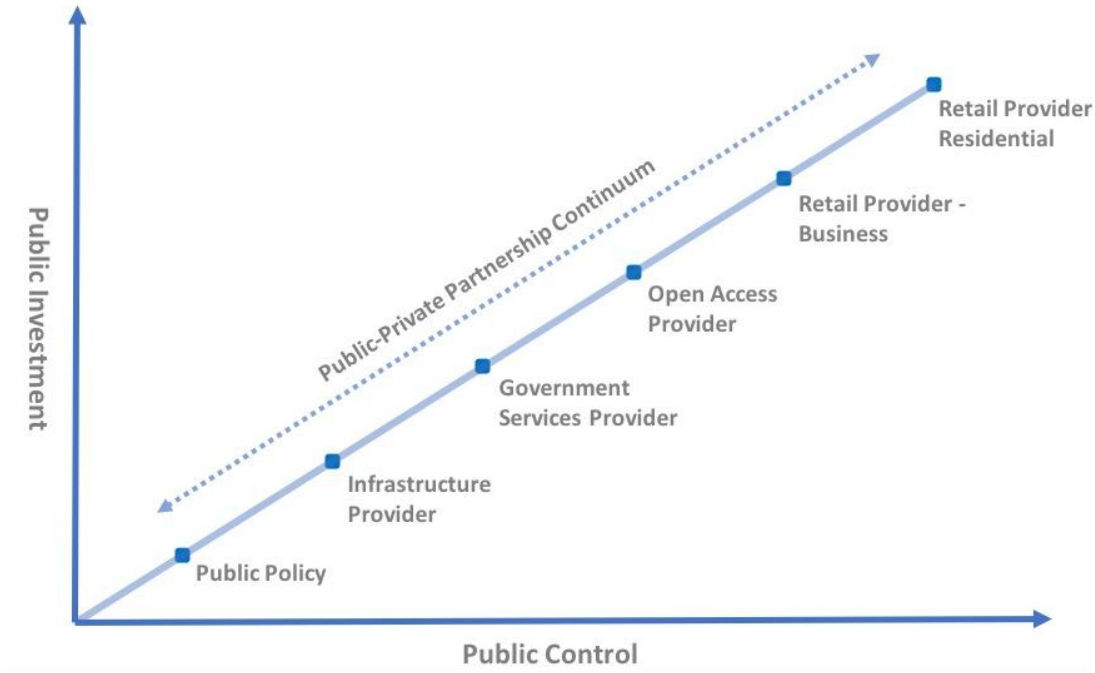


Figure 33. Continuum of Public Broadband Approaches

Moving "up" the continuum generally requires increasing levels of investment and implies greater local government participation in the delivery of broadband services. Understanding the community's needs, knowing the competitive market factors, and determining organizational capabilities of the local government all play into the selection process. Clear understanding of the operational requirements, financial commitments, and risk participating organizations are willing to take to fund and sustain a successful broadband initiative is also important.

Public policy and infrastructure-only options are considered "passive government" business models. In these approaches the public sector does not operate a broadband network as compared to "active" models such as Government Services Providers, Open Access Providers, and Retail Provider Options, where the government operates a broadband network. Public-private partnerships are not classified as a specific business model but instead fall along the continuum because these partnerships take many forms. Local governments must determine which business models meet their organization's risk/reward tolerance to achieve the community's broadband goals.

Figure 33 illustrates the differences among the commonly used approaches that could be enacted by Brooke-Hancock to address the issues indicated in this Plan. While there are variations of each model, they generally fall into the categories described. Based on the lack of middle mile backbone throughout the Brooke-Hancock region, and the providers inability to gain access to middle mile fiber, Brooke and Hancock Counties should take a combination approach. The model would be a combination of infrastructure-only and public-private partnership. This will require moderate investment by the region, but fiber leased to a single or multiple providers will deliver a return.

In many cases, multiple options may be selected by an organization; however, in some cases, a local government will not utilize multiple models, as they may conflict with one

another. For example, local governments generally implement broadband-friendly public policy with any of the business models, as these policies will complement all other business model options. Conversely, a local government would not likely implement a retail model and public-private partnerships together, as these would lead to competition between the local government and one or more private partners.

Table 10. Comparison of Public Broadband Options

	Government Passive Models			Government Active Models			
Considerations	*Public Policy Only*	*Infrastructure Only*	*Partnerships (P3)*	*Public Services Provider*	*Open Access*	*Business-Only*	*Full Retail*
Services	None	Dark Fiber Only	None	All/Any	Transport	All/Any	All/Any
Customers	None	Broadband Providers	None	Public Agencies	Broadband Providers	Businesses	Businesses & Residents
Funding	Low	Moderate	Low to High	Moderate	Moderate	High	High
Compete with Providers	No	No	No	No	No	Yes	Yes
Operational Requirements	Low	Low	Low	Low	Moderate	High	Very High
Regulatory Requirements	Low	Low	Low	Low	Moderate	High	Very High
Revenue Generation	Low	Low	Low to High	Low	Moderate	High	Very High
Operational Costs	Low	Low	Low	Low	Moderate	High	Very High
Financial Risk	Low	Low	Low	Low	Moderate	High	Very High
Execution Risk	Low	Low	Moderate	Low	Moderate	High	Very High

DESCRIPTIONS AND EXAMPLES OF APPROACHES TO PUBLIC BROADBAND DEVELOPMENT

Policy Participation Only

Public policy tools influence how broadband services are likely to develop in the community. This includes permitting, right-of-way access, construction, fees, and franchises that regulate the cost of constructing and maintaining broadband infrastructure within a jurisdiction. This option is not considered a true business model, but does significantly affect the local broadband environment and is therefore included as one option. Municipalities that do not wish to take a more active role in broadband development often utilize policy participation to positively impact the local broadband environment.

Example: Santa Cruz County, CA

The Santa Cruz County board of supervisors in November 2013 approved an eight-month timeline to overhaul its broadband infrastructure plans and regulations. Specific areas of focus include permitting fee reductions and a proposed “dig once” ordinance that would make it easier to install new fiber-optic cables during other work on area roads or utilities lanes.

Infrastructure Provider

Local governments can lease and/or sell physical infrastructure, such as conduit, dark fiber, poles, tower space, and property to broadband service providers that need access within the community. These providers are often challenged with the capital costs required to construct this infrastructure, particularly in high cost urbanized environments. The utility infrastructure provides a cost-effective alternative to providers constructing the infrastructure themselves. In these cases, municipalities generally use a utility model or enterprise fund model to develop programs to manage these infrastructure systems and offer them to broadband service providers using standardized rate structures.

Example: City of Palo Alto, CA

In 1996, Palo Alto built a 33-mile optical fiber ring routed within the city to enable better internet connections. Licensing fiber to businesses generated substantial positive cash flow, in excess of $2 million a year for the city. The City earmarked those funds for more fiber investments.

The Public Backbone Network Model

All of the technologies discussed above are for end-user access, for the “last mile”—and the last 100 feet—of a connection. Internet service providers use distribution networks, which customers do not directly access, to interconnect all of their access infrastructure. Cell sites, for example, almost all depend on fiber connections that transport traffic from cellular radio base stations to the internet and the public telephone network. Distribution networks, in turn, are connected via “backhaul” to exchange and interconnection sites between networks and providers.

Local and regional “backbone” networks comprise a critical part of the hierarchy of networks. Backbone networks interconnect sites. These sites can be end-user sites, such as bank branches, provider assets like access points, or industrial parks and institutional

campuses. Entire buildings can be "lit up" by connecting them to a backbone. Wi-Fi hotspots can be interconnected by a backbone network to provide access at public areas such as conference centers, parks, and entire commercial areas. Network service providers' POPs, provider-neutral exchanges, and meet points are necessarily connected to backbone networks. Anyone on such a backbone can cost-effectively acquire services from any provider in those sites. A backbone network can also function as a distribution network for service providers.

Backbones were originally closed, privately owned networks. Over the last few decades public entities—particularly cities and counties—have deployed provider-neutral backbone networks. These have evolved from single use institutional networks to shared use. In the recent past, healthcare providers, police departments, schools, and traffic departments, as examples, each built their own backbones. Now, communities are converging these networks and opening them up for private uses to drive business investment and economic development.

A public backbone can be a platform for private network service providers to extend and improve their service offerings. In the same way, it can deliver much higher speeds and more reliable services to anchor industries and institutions. These can either generate revenue for local governments that own the network or be provided as an incentive for business expansion/relocation and means to economically bring broadband to under- and un-served areas.

Government Services Provider

A government service provider uses its fiber-optic network to interconnect multiple public organizations with fiber-optic or wireless connectivity. These organizations are generally limited to the community anchors that fall within their jurisdiction, including local governments, school districts, higher educational organizations, public safety organizations, utilities, and occasionally healthcare providers. The majority of these anchors require connectivity and often, the municipal network provides higher capacity at lower costs than these organizations are able to obtain commercially. Municipal and utility networks across the country have been built to interconnect cities, counties, school districts, and utilities to one another at lower costs and with long-term growth capabilities that support these organizations' future needs and protect them from rising costs. In these cases, government service providers may be cities, counties, or consortia that build and maintain the network. The providers utilize inter-local agreements between public agencies to establish connectivity, rates, and the terms and conditions of service.

Example: Seminole County, FL

Seminole County owns and operates a 450-mile fiber-optic network that was installed over the past 20 years by the County's Public Works department primarily to serve the needs of transportation. Since that time, the network has grown to connect the majority of the county's facilities, five cities within Seminole County, Seminole Community College, Seminole County Schools, and other public network to a common fiber-optic backbone. The network has saved millions of dollars in taxpayer dollars across the county and has become a long-term asset that enables the county and the other connected organizations to meet their growing connectivity needs.

Open-access Provider

Local governments that adopt open-access generally own a substantial fiber-optic network in their communities. Open-access allows these municipalities to "light" the fiber and equip the network with the electronics necessary to establish a "transport service" or "circuit" to service providers interconnecting with the local network. Service providers are connected from a common interconnection point with the open-access network and have access to all customers connected to that network. Open-access refers to a network that is available for any qualified service providers to utilize in order to connect their customers. It allows municipalities to provide an aggregation of local customers on a single network that they are able to compete for and provide services. The concept of open-access is designed to enable competition among service providers across an open network that is owned by the municipality. The municipality retains neutrality and non-discriminatory practices with the providers who operate on the network. The municipality establishes a standard rate structure and terms of service for use by all participating service providers.

Example: City of Palm Coast, FL

In 2006, the Palm Coast City Council approved a 5-Year fiber-optic deployment project funded at $500,000 annually for a total investment of $2.5 million. The network was developed to support growing municipal technology needs across all public organizations in the area, including city, county, public safety, and education. It was also planned to support key initiatives such as emergency operations, traffic signalization, collaboration, and video monitoring. The city utilized a phased approach to build its network using cost-reducing opportunities to invest in new fiber-optic infrastructure. As each phase was constructed, the city connected its own facilities and coordinated with other public organizations to connect them; incrementally reducing costs for all organizations connected to the broadband network. Showing a reasonable payback from each stage of investment allowed the city to continue to fund future expansion of the network. Through deployment of this network, the city has realized a savings of nearly $2 million since 2007 and projects further annual operating savings of $350,000 annually. In addition to these savings, the city's network provides valuable new capabilities that enhance its mission of serving the residents and businesses of the community, while generating over $500,000 annually in new outside revenue generated from use of the network.

Retail Service Provider – Business Only

Municipalities that provide end users services to business customers are considered retail service providers. Most commonly, municipalities provide voice and internet services to local businesses. In many cases, a municipality may have built a fiber network for the purposes of connecting the city's primary sites that has been expanded to connect local businesses, in effort to support local economic development needs for recruitment and retention of businesses in the city. Municipalities that provide these services are responsible for managing customers at a retail level. They manage all operational functions necessary to connect customers to the network and providing internet and voice services. Municipalities compete directly with service providers in the local business market, which requires the municipality to manage an effective sales and marketing function in order to gain sufficient market share to operate at a break-even or better.

Example: Fort Pierce Utilities Authority

Primary FPUAnet services are Dedicated Internet Access, Fiber Bandwidth Connections, E-Rate IP Links, and Dark Fiber Links. FPUAnet services also include Wireless Broadband Internet and Wireless Bandwidth Connections, which extend FPUA's fiber through wireless communications. The FPUAnet Communications mission statement is "To help promote economic development and meet the needs of our community with enhanced, reasonably priced communications alternatives." It all began around 1994, when FPUA began to build a fiber-optic network to replace leased data links between its buildings in Fort Pierce. The new optical fiber system proved more reliable and cost effective, and was built with sufficient capacity for external customers. In 2000, FPUA allocated separate fibers through which it began to offer Dark Fiber Links to other institutions. This soon expanded to include businesses and more service types.

Full Retail Service Provider – Business & Residential

Local governments that provide end user services to businesses and residential customers are considered retail service providers. Most commonly, municipalities provide voice, television, and Internet services to their businesses and residents through a municipally owned public utility or enterprise fund of the city. As a retail service provider that serves businesses and residents, the municipality is responsible for a significant number of operational functions, including management of its retail voice, television and internet offerings, network operations, billing, provisioning, network construction, installation, general operations, and maintenance. The municipality competes with service providers in the business and residential markets and must be effective in its sales and marketing program to gain sufficient market share to support the operation. Many municipalities that have implemented these services are electric utilities that serve small to midsize markets. Many of these markets are rural or underserved in areas that have not received significant investments by broadband service providers. Retail service providers must comply with state and federal statutes for any regulated telecommunications services. These organizations must also comply with state statutes concerning municipal and public utility broadband providers; a set of rules has been developed in most states that govern the financing, provision, and deployment of these enterprises.

Example: Bristol Virginia Utilities (BVU OptiNet)

BVU OptiNet is a nonprofit division of BVU, launched in 2001, that provides telecommunication services to approximately 11,500 customers in areas around Southwest Virginia. OptiNet is known for its pioneering work in the area of municipal broadband throughout the area. BVU is acknowledged as the first municipal utility in the United States to deploy an all-fiber network offering the triple play of video, voice, and data services. Offering digital cable, telephone service, and high-speed internet from a remote-area utility provider makes BVU exceptional, even on a global level.

Public-private Partnership (P3)

A broadband public-private partnership is a negotiated contract between a public and private entity to fulfill certain obligations to expand broadband services in a given area. In recent years, P3s have been increasingly implemented as more municipalities employ public broadband and utility infrastructure in conjunction with private broadband providers. P3s leverage public broadband assets, such as fiber, conduit, poles, facilities with private broadband provider assets, and expertise to increase the availability and

access to broadband services. Municipalities forgo the "getting into the business" of providing retail services and instead, make targeted investments in their broadband infrastructure, and make it available to private broadband providers with the goal of enhancing their communities. In this type of model, the local government would be considered an Infrastructure Provider who maintains permanent ownership interest in the broadband infrastructure (e.g., conduit and perhaps dark fiber) that is funded by the local government for a "piece of the action", generally a negotiated revenue share paid by the provider.

Example: The Town of Jupiter, FL

In 2013, the Town of Jupiter completed construction of its initial fiber ring, which was planned to interconnect city facilities at 1 Gbps and 10 Gbps speeds. Previous to this, AT&T provided 50 Mbps connections between the town's facilities at $75 thousand annually. The town constructed its ring for $400 thousand and expects a nearly 5-year payback on this investment. Since completion of the town's ring, the town has been working with a national service provider to form a Public Private Partnership to deploy fiber to the business and fiber to the home services throughout the Jupiter town limits. Fiber end user services are currently unavailable in Jupiter; this agreement would introduce them for the first time.

Under the initial agreement, the local government would build out the broadband infrastructure and would connect the commercial and residential structures to the network at its cost. The network would remain under ownership of the local government, and the partner provider would use the network to deliver fiber-based telecommunications services to the town's constituents. For its investment, the local government would receive a revenue share of gross profits generated off the network. Under this agreement, the local government would receive a revenue stream from its investment and would bring a faster, competitively priced service to its constituents.

BROADBAND DEVELOPMENT BEST PRACTICES

There are several tactics local government can use to promote broadband development. Some of these options are "low-hanging fruit" that capitalize on existing assets and relationships and do not necessitate large investments of public funds. They include developing a Broadband Task Force and implementing broadband-friendly policies. entering public-private partnerships and leveraging regional partnerships to reach shared goals. Other tactics involve direct investment via local public funding, grants, and/or private financing.

Regional Broadband Task Force

With Magellan Advisors' support the BHJ-MPC initially convened a Regional Broadband Task Force (RBTF). Despite the first meetings timing clashing with the initial onset of the COVID-19 pandemic in early March 2020, the BHJ-MPC team was able to bring together a few key members of the community including BHJ-MPC team members, a Hancock County representative, a representative from Bethany College, and a local business leader. The meeting served as an introduction to the Broadband Task Force, why it is necessary, a review of the work completed to date on broadband planning and an opportunity to share in understandings of the broadband needs and challenges that the communities face.

The leaders seem to understand the *why* for better broadband including telemedicine and economic development. Education leadership noted that since the pandemic all students and faculty had moved online. Hancock County leadership has taken on the idea that broadband is infrastructure that is just as important as water, sewer and electric and it is becoming a bigger commitment to the community

The goals of the task force stated at the end of the discussion were to work together to move the project forward to implementation, to convene leadership in both Brooke and Hancock to both facilitate and engage all other businesses and community leaders and to bring about the momentum necessary to get fiber to businesses and broadband to the communities that will allow them to be economically successful.

This diverse group of representatives from a variety of stakeholders, agencies, and local businesses is intended to guide and support broadband development for the area. The RBTF is needed to promote the network, first to local stakeholders, then to potential investors and partners. The Broadband Task Force should meet regularly to review broadband initiatives, as well as gather input from the community about their current and changing needs.

The RBTF should drive and lead deployment of broadband infrastructure and services across the region. The activities and tasks for this purpose include:

1. Establish a vision for broadband in the region.
2. Garner support of local business leaders, elected officials, and other key stakeholders.
3. Determine priorities for broadband development and review construction phasing.
4. Identify funding sources, including private investors and public financing, and coordination between the entities.
5. Provide oversight for broadband development and infrastructure construction.
6. Establish a means for on-going governance of any public broadband.

More specifically, the Task Force's purpose is to facilitate development of a public-private "metropolitan" or middle-mile fiber optic network in the region, as described in this plan (*Recommended Approach*: The Brooke-Hancock Backbone Network (BHBN) Partnership in section VI). The Task Force will ensure the network connects all government and institutional sites, passes through business and industry areas, and provides a distribution infrastructure for services to residential, rural, and suburban areas.

The network will need to connect beyond the region if it is to generate real return. Therefore, the RBTF must include outreach to its peers in adjacent areas and with regional network service providers. In addition, the RBTF should ensure the network can be used by multiple providers on an equal basis and work to maximize financial returns to all investors, particularly taxpayers.

Why a Broadband Task Force is Necessary

Broadband and related technologies are essential in today's economy. Basically, the amount of bandwidth available determines how competitive and productive the region can be. Regions without abundant broadband cannot effectively attract businesses and residents, develop their workforces, or support technology-intensive organizations. Better broadband means higher incomes and more investment.

Broadband is not regulated like traditional telecommunications to ensure everyone has access and costs are low. Decisions about broadband are made by distant executives based solely on profits. They invest where they can pull the most money out of local economies and into corporate coffers, which means only affluent, densely populated areas will get great broadband at a reasonable price. This is not how it has to be: businesses, cities, counties, etc., can invest in broadband directly.

Every state has used task forces to address their broadband issues. Numerous cities, counties, and regions have used broadband task forces to drive development. Cambridge (MA), Davis (CA), and Spring Hill (KS) are examples of the diverse cites that have used broadband task forces. Charles County (MD), La Porte County (IN), and Rowan County (NC) are examples of urban-rural counties like Brooke-Hancock that have used this tactic. The Southern Alleghenies Planning and Development Commission is a nearby example of a regional broadband task force.

In most cases, these task forces focused on planning. We recommend a Broadband Task Force for Brooke and Hancock Counties to lead implementation. By taking the broadband initiative and investing in themselves, the Counties can technologically leapfrog other areas while creating a space for technically inclined individuals. This approach is important to keep returns on broadband investment local and generate economic multiplier effects in the form of business growth, higher wages, more startups, and stronger small businesses.

Taskforce Function and Structure

The RBTF should function informally via its members' political and social capital, legitimized by the Planning Commission and Regional Council. Practically, this means the Commission and Council should be on the Task Force but do not need to formally constitute it.

The Task Force should be co-chaired by two executive-level individuals, one from Brooke County and the other from Hancock County. These individuals could come from local private enterprises, governments, or non-profits, but should have different backgrounds—for example, a business executive and an elected official.

We recommend the RBTF adopt the list of activities and tasks above as a work plan. Kick off the Task Force with a visioning session that directly builds support for the initiative. Meet on a regular basis—ideally, monthly—to coordinate and track the work. If other local and regional leaders buy into and support the RBTF's purpose and program, individual members should not have to put more than a few hours per month into the effort.

Set specific objectives and tasks for each part of the work plan. For example, getting letters of intent from local businesses and government agencies might be an objective under task 2. Members of the Task Force should expect to take on specific tasks, which will be tracked by the co-chairs. While it is reasonable for members to delegate their tasks—one reason to have executive-level members is to tap their organizational capabilities—it is also important for them to take personal responsibility for key results.

Expanding the RBTF as appropriate and practical to accelerate the process and get better funding (task 4) is a critical aspect of this project. It is highly likely that at least some portion of the funding will have to come from local public investment. Private investment will definitely be required. It is not adequate to simply identify funding sources. Funds

must be applied for or requested, a case will need to be made for the investment, and the various funds will need to be coordinated.

Anyone with the pull necessary to achieve results—and who shares the vision and is willing to do the work—should be recruited to the Task Force. It may even make sense to have Task Force members from Beaver County, PA, Jefferson County, OH, Ohio County, WV, and Washington County, PA, to better achieve the RBTF's purpose.

Consultants' Roles

Magellan Advisors and other consultants can create plans, gather data, and provide direction. We can even organize and manage implementation. But because we do not live in the communities or have relationships local, regional, and state leaders, consultants cannot own and lead the process. If the region is going to attract and capitalize on broadband investment, there will need to be sustained local leadership attention on the issue. The RBTF's role is to build and channel such leadership to support broadband development, and then coordinate and oversee broadband providers and independent consultants to do actual work. The RBTF won't start and run itself so direct support is essential. The BHJ-MPC will need to take on this role or establish a lead agency to do so.

Implementing Broadband Friendly Policies

Dig Once

Broadband friendly policies can be defined as policies and/or practices that foster cooperation among entities (especially utilities) that occupy public rights-of-way, to minimize the number and scale of excavations when installing infrastructure (especially telecommunications[20]) in public rights-of-way. Dig Once has numerous substantial benefits, including promoting and supporting the placement of broadband infrastructure (e.g., fiber-optic cable and conduit), reducing the consequences and disruptions of repeated excavations (traffic disruption, road deterioration, service outages, and wasted resources), and enhancing service reliability and aesthetics.

Dig Once accomplishes the goal of minimizing costs of constructing separate trenches and facilities – via shared costs of construction. The cost savings are significant. The Federal Highway Administration estimates it is ten times more expensive to dig up and then repair an existing road to lay fiber than to dig support structure for fiber (e.g., conduit) when the road is being fixed or built. According to a study by the Government Accountability Office, Dig Once policies can save from 25-33% in construction costs in urban areas and approximately 16% in rural areas.[21] In addition, development of Dig Once standards and guidelines for deployment of conduit and fiber will facilitate economic development and growth, as it enables cost-effective staged or gradual deployment of broadband infrastructure by local authorities.

Brooke and Hancock Counties should adopt a Dig Once ordinance to install new fiber and/or conduit in the rights-of-way at reduced costs via coordination of work with private

[20] Many utilities are "monopolistic" providers (such as gas, water/sewer and electric) but there are a number of telecommunications providers that seek permission to encroach on public rights-of-way, including cable TV companies, competitive telecommunications companies, and wireless communications companies.
[21] https://eshoo.house.gov/issues/economy/eshoo-walden-introduce-dig-once-broadband-deployment-bill

providers and utilities. This will enable both the Counties and private organizations to expand their ownership of fiber anytime subsurface utility work occurs, at preferential costs to new construction, leading to expanded broadband access for internal local government needs as well as in the community.

Broadband Infrastructure Program

The Counties should begin to formalize a Broadband Infrastructure Program (BIP), focused on the broadband issues identified in this Plan and solutions such as monetizing any assets that are available. Local governments across the United States are developing these types of infrastructure programs to drive new revenues and to support broadband investment within their communities. These revenues may be generated from leasing vertical assets such as rooftops, streetlights, and towers.

To formalize this program, the Counties should take the following steps:

- Document and maintain an inventory of available assets
- Develop and standardize agreements for vertical asset leasing
- Develop pricing policies for vertical asset leasing
- Publish rates and terms
- Create an enterprise fund to maintain proper budgets, cost accounting, and to track revenues of the program

These actions will indicate that the region is committed to improving connectivity for its internal needs as well as enhancing broadband for its residents, businesses, and economic development, and will allow the region to take measured steps to address the issues and by reducing the need to make additional investments.

In the future the BIP may be used to explore and implement more active approaches to resolving broadband issues in the region. For instance, the BIP could consider reinvesting funds received for the use of County assets into building out additional County-owned conduit or fiber, particularly when joint build opportunities exist that will significantly reduce the cost of construction.

Use of Local Government Assets

Brooke and Hancock Counties, along with the cities and towns, can use their current assets including any above-ground assets such as rooftops and vertical assets. Use of local government assets is one tool to encourage investment by private providers. Public-private partnership arrangements for the use of such assets as well as potential in-kind negotiations for lowered permitting fees and joint build opportunities could significantly lower the cost of entry for new broadband providers in the region. By simply leveraging existing assets the region could stimulate investment that directly benefits the Counties' and cities' internal connectivity needs and concurrently creates a more competitive broadband environment, to the benefit of both businesses and residents of the Brooke-Hancock region.

GOVERNANCE OF PUBLIC BROADBAND INVESTMENT

Governance ensures that maximum public benefit is realized from any public investment in network infrastructure, whether by fostering competition, meeting public sector requirements, or minimizing negative impacts of development. Governance aligns

investment with public goals and priorities. Policy guides development, laying out what can be built and how. Political will is the starting point for the governance and policies simply because without it there is nothing to govern and no possibility for policy. Brooke and Hancock Counties have demonstrated strong political will already by undertaking this planning effort.

Political Will

Political will can be defined as determination to build support for and achieve an outcome via one's personal influence. Most public sector undertakings require some political will, and new undertakings can be especially demanding. Generally, public innovations require more support and stronger rationales to succeed politically than common practices, programs, projects, or procedures. As described elsewhere in this Plan, broadband infrastructure is becoming more important for local economies and municipal operations. It is still relatively unusual as a local government undertaking.

Therefore, it is important for the Counties to assess and build political will, which means providing a strong rationale for this Plan to influential people, including appointed and elected officials, executives with major employers and prospective investors, and those citizens who are well-connected to others. Rationale for broadband can be based on risk of loss—such as poor economic competitiveness—but the strongest rationale is built on this Plan. Broadband can be used to improve operations, increase impacts, reduce costs, and transform economies.

The process of building political will is as important as the individuals involved and the rationale for action. Indeed, all three work together: the process must be tailored to the individuals and rationale. For broadband, the rationale revolves around uses and impacts as well as availability, costs, and performance. Support from business executives and technologists reinforces this rationale. These stakeholders are most likely to respond to peers, particularly personal outreach from top public officials. Generally, the process involves:

1. Clearly articulate project goals and objectives in public documents
2. Identify, educate, and mobilize internal champions to garner support from stakeholders
3. Reach out to and inform councils, commissions, and community stakeholders
4. Organize a task force of diverse advocates

Governance and Ownership

Owners incur the cost of building or buying, maintaining, and operating an asset. They also control how it is used and—depending on business arrangements and economic circumstances—get the bulk of benefits or profits from those uses. These truisms apply to fiber-optic cables in much the same way as to real estate. An optical fiber is simply a real asset that can be used for moving information between two or more locations. To date, most fiber network assets have been privately owned for private interests.

If Brooke-Hancock is to use publicly-owned network assets, built with tax-payer funds, governance must ensure the network meets the interests of its owners—the public. The only way to accomplish this is by directly involving members of the public. We recommend beginning early by creating the RBTF to provide input to this Plan and to engage and

inform other members of the public. As the network is deployed, the RBTF should be transformed into a governance board.

Internal and External Policy Development

Appoint a range of local leaders, reflecting the community's diversity, to the RBTF. Ensure that task force meets regularly. The RBTF should establish policies and procedures for the governance board, including for situations in which those policies and procedures are not followed. This Plan identifies a variety of internal and external policies, including a Dig Once. The RBTF should have a role in reviewing these policies, and the governance board should ensure the policies are consistently applied.

Internal Cooperation, Communication, and Alignment

A key function of governance is to reduce internal "silos." Currently, the Counties operate separately. Their IT departments and functions do not interoperate with each other and do not appear to facilitate collaboration among other local government agencies. Consequently, there is no comprehensive, consistent effort to align technology spending and use with public interests.

By including top level representatives from all departments along with community representatives, a governance board breaks down silos and ensures that every dollar spent on technology benefits as many municipal functions as possible. Indeed, we recommend the governance board establish partnerships between departments to achieve particular goals.

The Counties likely already have capital project and development/permit review processes that involve all relevant departments. We recommend that such collaboration be extended to IT infrastructure projects. Network infrastructure should also be integrated into approval practices for right-of-way projects—public and private—and development agreements. The governance board provides a formal mechanism for such alignment. Internal best practices and workflow for these purposes include:

- Document and share information about municipal, utility, and private sector assets.
- Invite private sector participation in Public Works projects.
- Trade and lease public and private assets for network expansion.
- Utilize GIS asset tracking for management and expansion.
- Streamline excavation and pole permitting processes.
- Streamline wireless permitting processes.
- Combine Public Works schedules for lowering construction costs.
- Build on demand and for savings.
- Bid multi-year infrastructure design and construction contracts.

Internal Budget Considerations

There are several budgetary implications of good governance. The first is combining telecommunications budgets for efficiencies. Rather than putting telecom spending in separate departmental budgets, have a single budget for all departments, including the Libraries and Schools, as practical. This basically gives taxpayers more "bang for their bucks." We recommend cities and counties create master funds for telecom and reinvest savings to enhance and expand the network. It is also important to budget resources and materials for Dig Once and joint trench opportunities.

Ownership and Public Private Partnerships

The master fund and network assets can be used as incentives for private sector participation. Specifically, the Counties can drive private investment to provide competitive access by leveraging its network assets or covering a portion of development cost with the master fund in return for additional assets. These, along with governance measures described above, are strategies to maintain public control over network futures. It is important to understand legal barriers to public ownership and public-private partnerships, including federal, state and local legislation.

C. Gap Analysis

In formulating and recommending a broadband development strategy, it is important to be clear about challenges and goals. Brooke and Hancock Counties comprise a relatively small market with no clear institutional broadband champion. The local economy has transitioned away from traditional, heavy, resource-based manufacturing. It has not developed a strong base of technology-oriented companies. Local governments and other institutions seem to lag behind industry in technology use and most have scant resources for adopting new technology. There is clear unmet demand for broadband among consumers, driven by general interest more than productive uses such as education, healthcare, and work. While there are multiple internet service providers around the region, much of Brooke and Hancock Counties does not have broadband available. Where it is available, the service is relatively costly and slow.

Brooke and Hancock counties are experiencing the “chicken or egg” challenge of broadband: Without strong demand, providers will not make the investment necessary to provide broadband services. But, without economical, fast broadband, the community cannot develop a deep market for it or fully realize the benefits internet technology. This unfortunate circumstance becomes a tragedy when people cannot make a living, go to school, or get healthcare because they don’t have access. To make matters worse, lack of broadband puts local industry, professionals, and the region as a whole at a competitive disadvantage relative to those places with abundant broadband. Without great broadband it will be very difficult for the region to attract technology-intensive industries, develop technically skilled workers, and support highly productive technology use by local businesses and consumers.

The Brooke-Hancock region is lacking middle mile infrastructure in key areas. In other areas, there are substantial middle mile assets that are under-utilized, connecting a few cell sites and major organizations. Comcast has extensive infrastructure in the population centers. Some areas within cities, as well as rural areas, have minimal (Frontier twisted pair) infrastructure and services, with little or no capacity for additional subscribers. There is some WISP infrastructure, and more can be deployed cheaply and quickly, but it cannot provide the performance and reliability of true broadband. Wireless connectivity can be fast and robust with more antenna and backhaul infrastructure, if it is carefully positioned for access and distribution purposes—close to the backbone and close to the customer.

Along with these market and infrastructure issues, there seems to be a gap in technology leadership. This goes back to the challenge of attracting or growing tech companies without tech infrastructure. There are clearly capable technologists in the area and strong leaders. Collaboration and cross-training between these two groups are the critical

catalyst for broadband investment. By activating a small team of technologists and local leaders, the Counties can practically find the partners and resources needed to address gaps in supply, demand, and use.

Which points to a last gap: What organization (or organizations) will convene this group, facilitate the process, take the investment, and own the resulting infrastructure? Will it be a single private company? It may not be viable to create a monopoly with public funds. A duopoly isn't much better. To address the various gaps Brooke and Hancock Counties need to level the playing field and lower barriers to entry so multiple providers—especially locally-based companies—can economically serve the region. This will require some public investment, which must be made in the public's interest with clear accountability and oversight. In other words, a public agency or authority of some type must lead and own the broadband development process.

IV. A Broadband Development Plan for Brooke and Hancock Counties

The goal of the Brooke-Hancock Broadband Plan can't just be better, cheaper, faster broadband. If everyone in the area just sits on the couch and spending money and time staring at a screen, can that be considered a good outcome? Would giving away valuable infrastructure to a distant a corporation that siphons money out of the local economy be a good thing? To get the maximum return on any public investment in broadband, it has to be used to be healthy, more productive, smarter, and wealthier, by as many people as possible.

The goal of broadband development must be to enable economic transformation. Success of broadband development must be measured in terms of revenue generated by local businesses, productivity and profitability, individuals' abilities, household income, and expansion of the tax base. Intermediate output metrics should be investment by partners, particularly providers, and infrastructure and service metrics such as route miles, base stations, connection speeds, broadband costs, etc. It is also important to define and track inputs: leaders engaged, pre-subscription letters of commitment, professional service hours—volunteers as well as paid staff and consultant—and, of course, public investment. All of these inputs must go directly as possible into broadband development, which should be focused on economic, practical, and social outcomes.

These general principles make sense. They also make a great foundation for broadband development. The general challenge is to translate them into practical action, which is, of course, the hallmark of a good plan.

A. Recommended Approach: The Brooke-Hancock Backbone Network (BHBN) Partnership

Magellan Advisors recommends Brooke and Hancock Counties develop a regional public backbone network in partnership with private network service providers. The dual objectives of this Brooke-Hancock Backbone Network (BHBN) are to deploy broadband to all areas of Brooke and Hancock Counties and to provide high-capacity, high-reliability connections to key economic and institutional sites. The goals are to do this economically and enable economic transformation.

Business has aggressively digitalized over the last two decades. Education and healthcare have followed suit, and local governments are beginning to do the same. All of this has been accelerated by the COVID-19 crisis. The fundamental reality is that our economy has been transformed by digital technology and the internet. To develop sustainably and prosper over the long-term, Brooke and Hancock counties must leap forward economically.

From accommodating remote "teleworkers" to developing the next generation workforce to growing highly productive, profitable, innovative companies, the region's future depends on better, cheaper, faster connectivity. The network described below should be seen as critical infrastructure for these economic imperatives. The added benefit is the

network enabling more effective, efficient, and flexible public sector functions, including planning, public safety, transportation, and utilities.

The COVID-19 pandemic has accelerated the long-term trend of digitalization of business processes, the economy overall, and everyday life. Broadband is essential for work, healthcare, education, and almost every activity outside the home. The BHBN is essential for internet service providers to economically reach remote, rural locations and provide broadband services for small businesses to thrive. Therefore, the overall purpose or intended outcome of the BHBN partnership should be technology-enabled transformation of the regional economy.

What we propose here is a preliminary design. As such, it should be expected to change substantially before anything is built. The needs and interests of consumers, providers, and a range of major network users will need to be considered in the design process. The design will need to be adapted to available infrastructure and evolving barriers to deployment. Fundamental but as yet unresolved issues regarding ownership of assets and network operations will impact the design. Therefore, this design should be seen as a baseline starting point. A key implication of this is that some entity must own and run the planning process as well as then BHBN itself.

FACILITIES AND ROUTES

The recommended plan is to develop a Brooke-Hancock Backbone Network that would consist of four routes, each representing a phase of development. The proposed network will run along the eastern shore of the Ohio River from Wheeling through Weirton to Chester and will extend eastward reach Bethany, New Manchester, and other rural communities. Initially, the BHBN will help locally-focused ISPs serve rural small business throughout Brooke and Hancock Counties and create high-skill, high-wage jobs. Local government agencies, health and social service providers, schools, and other institutions will help drive the business case for providers to invest by anchoring the network.

The long-term vision is to create a fiber ring with routes along the western shore of the Ohio River from East Liverpool (OH), through Steubenville (OH), back to Wheeling and/or through western Washington County (PA). The general approach is to start with investments in rural areas, connect to and/or establish remote radio tower sites for wireless internet access, and then leverage this infrastructure to attract private investment in adjacent, less rural areas.

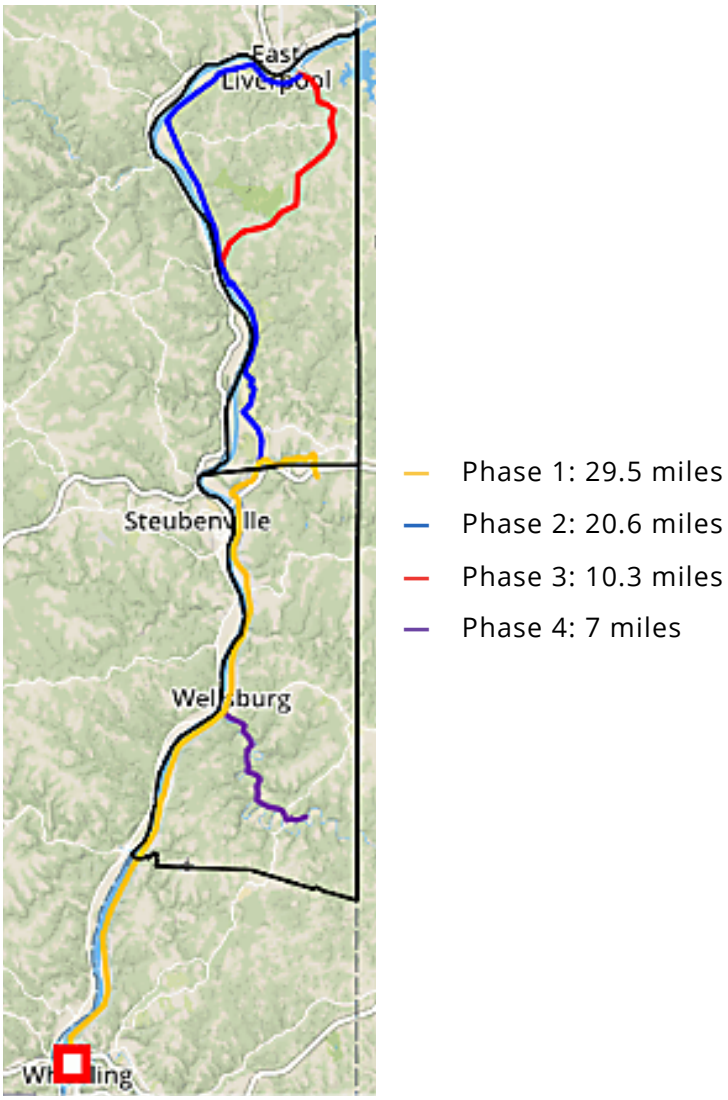


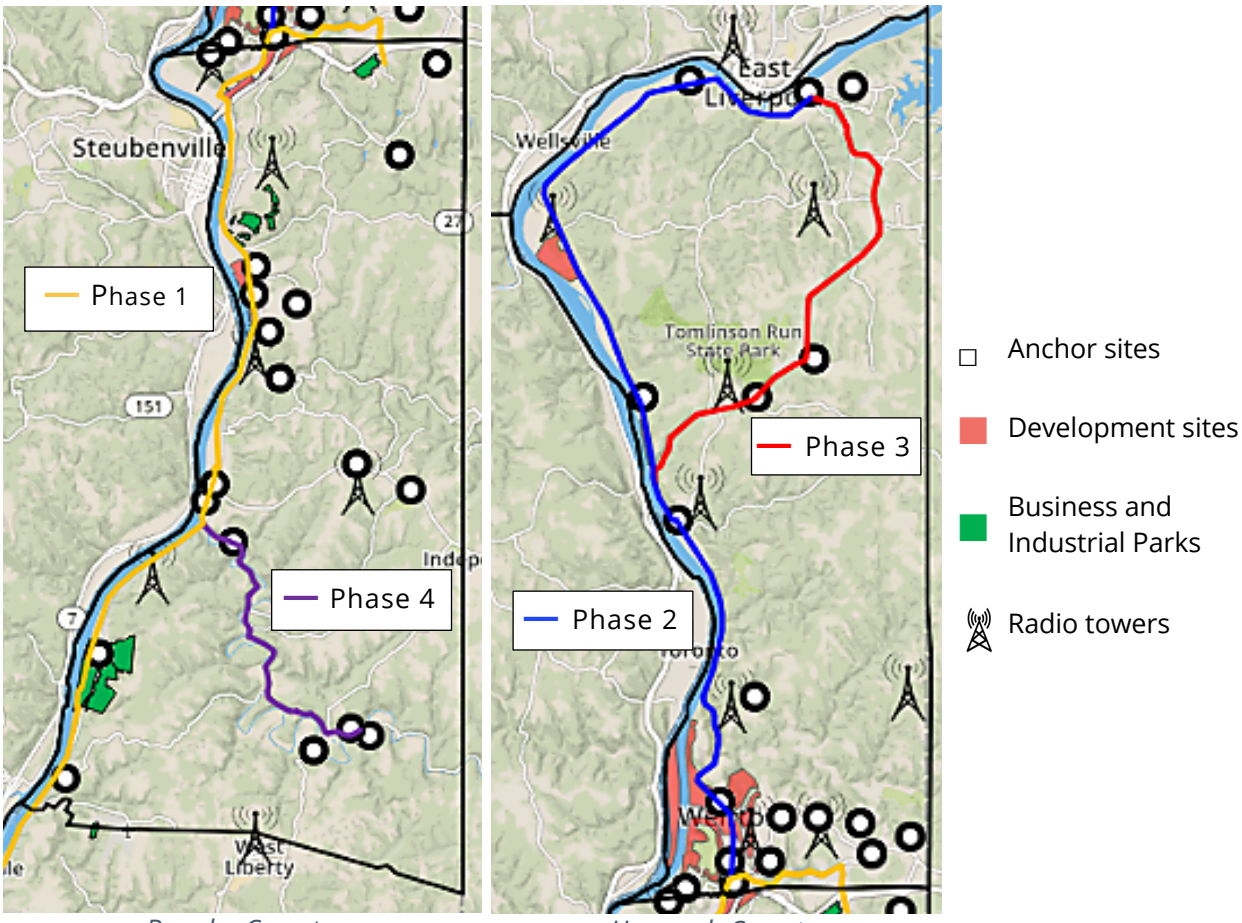
Figure 34. Overview of the Proposed Brooke-Hancock Backbone Network

An overview of the entire proposed backbone network is shown in Figure 34, and overviews for both counties showing key assets is displayed in Figure 35. There are several important caveats about this route the implications of which are that the network design will likely change radically in the next phase of planning:

1. ***The route is designed to provide connectivity to key sites***, including anchor industry and institutions' locations, areas targeted for economic development, and cities.
2. ***The route is NOT optimized for distribution network purposes.*** This will need to be done in partnership with private providers, ideally with additional outreach to end users/prospective subscribers. Also, a fully optimized design would consist of multiple rings for maximum reach and greater reliability. The preliminary design includes a single ring in northern Hancock County, comprised of phases 2 and 3. We recommend considering an expanded design that would include multiple rings—

specifically, with another route through Brooke County and a route along the west side of the river through Jefferson County.

3. ***The design assumes no partner participation.*** While private partners are critical and there are multiple prospective partners, as discussed below, it would be premature to incorporate their assets into the backbone. It should be possible to develop different routes and swap assets with private companies with assets along these routes. The network connects to CityNet's POP in Wheeling to ensure competitive backhaul to the internet is available via the backbone. This will not be necessary if providers connect to the backbone in Brooke or Hancock Counties by establishing local POPs.
4. ***Multiple other sites may need to be connected for community and economic development purposes.*** Weirton Medical Center, industrial sites in the area of Freedom Way, and some major locations should probably be on the backbone, depending on stakeholders' ability and willingness to share in the costs. Private provider partners will have additional locations for the network, depending on the areas they want to serve and types of services they will provide. These partners may operate diverse types of access networks and will need appropriate interconnection points for that infrastructure as well as their core networks. Phase 4 to Bethany College provides some sense of the costs involved in such extensions.
5. ***Assumptions about network deployment may not hold.*** We have assumed that phase 1, for example will be 80% underground in the rail-trail easement and other phases will be 100% aerial, attached to utility poles. This provides some sense of the relative costs of these two approaches. It may not be practical to deploy the network as assumed if these assets aren't available.



Brooke County *Hancock County*

Figure 35. Brooke (left) and Hancock (right) County Portions of the Backbone Networks

The proposed Brooke-Hancock Backbone Network (BHBN) will directly benefit companies that want to provide or expand internet services in the area, enabling them to create jobs and provide access for rural businesses and communities. The BHBN is needed to meet the region's basic internet access requirements. The network will enable ultra-fast, reliable, and economical connections to key business and economic development sites, local government, schools, and other local anchor institutions.

In the process, the BHBN will provide rural businesses with access markets and resources as well as the internet. Private partners, including small, local ISPs, are ready to use BHBN to provide faster, flexible internet access across the region. Magellan Advisors considered the needs and opportunities identified by key stakeholders through the planning process in the BHBN vision.

COVERAGE AND COST ESTIMATES

The BHBN would pass through every city in Brooke and Hancock Counties, and links the region from north to south. The preliminary design brings the BHBN within 500 feet of 36 local government, first responder, and education sites, as shown in Table 11, and nearly 6,500 structures, including all economic development sites:

Phase 1
- Brooke Glass
- Eastridge Commerce Park
- Follansbee Main St.
- Follansbee Middle School
- Freedom Way
- Frontier Crossing (Former ArcelorMittal Weirton Site)
- Three Springs Business Park
- Trimodal Terminal Site

Phase 2
- Frontier Crossing
- Mountaineer Site
- TS&T Pottery Site

Phase 3
- Tomlinson Run State Park

Phase 4
- Bethany College

Table 11. Nominal Coverage of the BHBN

	Phase			
Type	*1*	*2*	*3*	*4*
Distance in miles	29.51	20.58	10.27	7.04
Brooke County institutional sites	12	-	-	2
Hancock County institutional sites	2	17	3	-
Brooke Structures	2,166	-	-	469
Hancock Structures	425	2,500	768	-
Existing tower sites	3	4	2	-

We estimate that the BHBN will cost a total of approximately $5.8M to build, including design, labor, and materials, as detailed in Table 12. We assume the backbone will consist of a 144-strand cable. Phase 1 will be and 20% aerial and 80% underground, with two 2" conduit, 24-inch minimum depth, hand holes every 600 feet, and straight splices every 5,000 feet. The other phases will be 100% aerial. We assume that 10% will cover any contingencies.

Table 12. Estimated Costs to Build the BHBN

Phase	*Design*	*Labor*	*Material*	*Contingency*	*Total*
1	$194,793	$2,078,102	$834,438	$310,733	*$3,107,333*
2	$162,965	$699,587	$325,088	$118,764	*$1,187,640*
3	$55,755	$240,994	$111,222	$40,797	*$407,972*
4	$81,341	$350,437	$162,261	$59,404	*$594,039*
All	**$494,853**	**$3,369,121**	**$1,433,009**	**$529,698**	***$5,826,681***

Further, we presume there will be multiple towers connected to the backbone but have limited information about where and how far away from the backbone they will be located. Therefore, we provide a rough cost estimate to connect towers for planning purposes. We assume the laterals will an average of 500-feet long, all underground with 96-strand cables

in one 2" conduit, 24-inch minimum depth, and hand holes every 250 feet. Without considering engineering design costs, each such lateral would cost approximately $23K, as broken out in Table 13.

Table 13. Estimate for 500-foot Lateral to Tower Site

Labor	$6,939
Material	$14,158
Contingency	$2,110
Total	**$23,206**

INTERCONNECTION POINTS

The preliminary design includes a single interconnection point at CityNet in Wheeling, which presumes that CityNet will be a partner. This was done primarily for costing purposes and to emphasize the need for an interconnection point. A better result would be multiple provider-neutral meet points, at which the BHBN interconnects with multiple providers. These could be Comcast or Frontier facilities, particularly if BHBN partners purchase dedicated internet access from either of these companies for resale to subscribers. It would be preferable for partners to establish points-of-presence in the area. This would anchor their investment and eliminate the need for backhaul to Wheeling, which would substantially reduce build costs.

The logical location for a meet point would be at Frontier Crossing, where phase 1 and phase 2 routes intersect. It would also make sense to have interconnection points in Wellsburg and Chester, at the very least. As noted above, we recommend expanding the network—depending on customer demand and partner interests—to create multiple rings around the area. These rings can be created by simply splicing cables together, but it would be preferable to have more substantial facilities, again, depending on stakeholders' requirements. These facilities could be public buildings but private facilities are preferable to avoid conflicts or appearance of misappropriation of public assets.

Brooke and Hancock Counties should consider developing a datacenter to function as a meet point. Alternately, the Counties could develop and position multiple locations as "fiber-fed" facilities with access to multiple providers via the BHBN.

PARTNERSHIPS

Magellan Advisors recommends Brooke-Hancock develop a public-private partnership in which the public sector owns the backbone network and private companies use it to provide broadband services. The public sector will lease physical assets to private partners, including interconnection facilities and tower sites as well as fiber strands. Public entities will not operate the network, nor will they need to provide network equipment. Generally, it is desirable to have as many private partners—more investment by more companies—but it could be a single partner that manages the network on behalf of the public owner(s), uses it to provide services, and pays a franchise fee, lease, or share of revenue.

In the course of conducting this study Magellan engaged with a variety of service providers, several of whom showed interest in partnering with or providing services in the communities of Brooke and Hancock Counties. The opportunities for Brooke-Hancock, analyzed in Table 14, range from interest in developing wireless, connecting local government buildings and regional stakeholders, to connecting public safety. Interest and opportunities are detailed in the below chart and subsequent paragraphs.

Table 14. Prospective Partners for Broadband Development in the Brooke-Hancock Area

Provider	Services	Interest	Opportunities	Next Steps
Access Ohio Valley	Wireless ISP	Medium	Develop lease agreements with local governments for tower assets that would connect end users to wireless ISP services.	Identify areas and specific sites of interest
Agile Networks	Fiber & Wireless	High	Develop partnership to connect Public Safety, enterprise businesses and possibly residents to fiber and wireless ISP services.	Establish contacts with company executives
Blue Devil Cable	Cable	Low	To be determined	Establish contacts with company executives
CityNet	Fiber and Wireless ISP	High	Develop Partnership to deliver fiber and wireless services to residents and businesses in Brook Hancock	Identify areas and specific sites of interest
Comcast	Cable	Low	To be determined	Reach out to regional managers
Frontier	DSL	Low	To be determined	Reach out to regional managers
Horizon Telecom	Fiber	Medium	Develop partnership to connect local government and stakeholder's to current Horizon fiber, establish a local POP, leverage Horizon fiber to develop regional backbone.	Determine interest in asset swaps and/or co-investments; Identify areas and specific sites of interest

Access Ohio Valley is interested in developing partnerships with local governments in Brooke and Hancock County to expand its services. They are interested in continuing conversations about leasing strategic vertical assets such as water towers that could help them serve both Counties. With the right access to assets Access Ohio could serve an entire county within 60 days, provide service to unserved residents, and provide revenue to local governments. This public-private partnership opportunity should be further vetted and explored by the Brooke-Hancock team.

Access Ohio Valley has seen an increase in customers due to the oil and gas boom because they are able to provide connections quickly and flexibly and also because they are able to get networks up and running quickly. Access Ohio feels that the challenge they have in expanding is that partners have not always fully understood the value it can bring to the table. The company is experienced in building towers and is able to get networks up and running specifically in areas where a local government is “friendly” and is willing to provide or lease access to vertical assets.

A representative of Agile Networks expressed strong interest in partnering with the Counties. That person has since left the company. We were unable to engage Agile’s corporate leaders to assess their interest.

Representatives from Blue Devil Cable were contacted to engage in conversations with Brooke-Hancock and Magellan Advisors about regional opportunities to expand and enhance broadband services. Magellan Advisors made multiple attempts to reach the company but was unable to engage representatives.

CityNet was actively engaged in the Brooke-Hancock stakeholder meetings and expressed a high level of interest in developing a partnership with the counties and stakeholders to expand fiber-optic broadband in the region and enhance their capabilities to serve end users with quality fiber broadband. CityNet has a history of developing public-private partnerships with local governments. Its most recent P3s are currently under development in both Tyler and Wetzel Counties in West Virginia. CityNet worked with the counties to receive grant funding from the USDA RUS ReConnect grant to serve end users with Fiber-to-the-Home services in underserved areas of the counties.

CityNet indicated they are continuing to grow their businesses and they have a high level of interest in expanding into Brooke and Hancock Counties. They continue to monitor all federal and state opportunities for grants and broadband expansion. Brooke and Hancock Counties should continue to engage CityNet in further conversations and work to develop a partnership that brings fiber-optic broadband to the Counties.

Horizon insinuated that they are interested in an opportunity to partner and expand services if the business case fits. They noted that they would be interested in creating opportunities to serve local governments and connect buildings, public safety, and community anchors, and are interested in having conversations to identify these opportunities.

Horizon’s network has significant fiber strand count in the region that could support a portion of the proposed regional network including some 48-strand and a 144-strand backbone going up the river. Brooke Hancock and the Broadband Task Force should continue to engage with Horizon to consider opportunities to develop a partnership that

leverages their significant assets in the region and makes financial sense for both the Counties and Horizon.

Several enterprise and long-haul fiber network owners/operators, including Crown Castle, DQE, Segra, and Zayo, have assets just outside the Brooke-Hancock area. All of these companies have substantial capital assets and fiscal capacity to invest where it makes business sense. Interconnecting these assets, particularly if it enables the companies to reach more customers or increase their route diversity, could be very valuable.

B. Funding Options

Brooke and Hancock Counties are poised for a variety of funding opportunities through state and federal agencies and have been actively pursuing grant programs. Appendix A to this report is a detailed analysis of funding opportunities including high-level tasking for funding opportunities that are available through 2020. Funding opportunities can be updated at any point and the County should continue to monitor the state and federal opportunities and adjust their strategy accordingly. Currently large funding opportunities are budgeted that focus on funding un and underserved communities from both the Rural Utilities Service (RUS - USDA) as well as the FCC. The RUS ReConnect Grant has appropriated $500M for the next round of funding in late 2020, and the FCC Rural Digital Opportunity Fund has appropriated $20.4B in subsidies over 10 years for providers that deliver service to identified census blocks. With the onset of COVID-19 and the rapid increase in digital workforce, healthcare and education, Congress released appropriations for CARES funding that includes funding for broadband including $1.5B through the Economic Development Association (EDA). Although additional appropriations were made, not all funding rules have been written. It is important for Brooke and Hancock Counties to work on strategic business plans that will allow the Counties to be poised and ready for new opportunities that align with regional goals.

In addition to state and federal grant and loan funding, local governments and their development authorities issue general obligation bonds and revenue bonds to finance infrastructure. Several communities across the country have used this option to finance broadband. There have been federal efforts (led by Senator Capito) to explicitly allow private activity bonds to be used for qualified broadband projects and to provide for tax credit payments to issuers of tax-exempt bonds used to finance broadband infrastructure projects. While networks do not qualify as exempt facilities under the U.S. tax code, related infrastructure such as water and sewer do. Bond issuances are very labor-intensive and require detailed plans as well as support of public officials. While they may be legally and politically difficult, bonds can be an effective means of drawing in outside investment.

Lastly, private equity and public market financing has been used to build many networks. Fiber is a valuable real asset, particularly when it interconnects metro areas, provides route diversity, or enables providers to reach under-served markets. Internet service providers are conduits for this investment, but investors may be interested in owning fiber infrastructure. Opportunity Zones, real estate investment trusts, and similar investment mechanisms can also be conduits for private investment in local broadband infrastructure. Grant funds and local public investment can and should be used as catalysts for private investment.

C. Brooke-Hancock Broadband Development Recommendations and Next Steps

The key factors in the feasibility and ultimate success of the BHBN are organizational capacity to develop it, documented demand with commitment to buy subscribe to and use the network, and funding and/or partners to build and operate the network. Recommended next steps for Brooke and Hancock Counties include:

1. Determine what agency will be the regional broadband development leader.

The lead agency will be responsible for coordinating policies among local governments, facilitating investment by providers, and raising funds. Presuming public funds are invested in network infrastructure, this agency will receive those funds, disburse them, and manage the spending. The lead agency will own and manage the BHBN on behalf of the local governments and taxpayers. It may be necessary to create a public authority to fill these roles.

2. Create a diverse Regional Broadband Task Force to guide broadband development efforts.

Initially, the RBTF's role will be to build literal buy-in and support for the BHBN. Therefore, members should be selected based on their interpersonal social networks and standing in the community. They should be able to personally and professionally commit to subscribing to services delivered over the network. Ideally, RBTF members will be able to communicate the imperative to digitally transform the regional economy, and demonstrate what that means in their own businesses.

The RBTF should be the foundation for governance to ensure public funds invested in broadband are used to achieve public goals and further public interests. Formalize the roles, selection process, and terms of members as/when the task force evolves into governance board.

3. Conduct grassroots and top-down outreach to pre-subscribe broadband customers.

Response to the survey was reasonably strong but additional buy-in by community members may be necessary to drive investment. It will also be helpful for business and civic leaders to actively promote BHBN and its partners to their associates and constituents. It is particularly important for major employers, including public institutions, to anchor the network. They will be the base of a business case for private partners to co-invest in the network as means to generate recurring revenue. Build on the survey results and stakeholder engagement done for this project to get pre-subscription commitments. Use this information to phase network deployment and target investment. Do this in conjunction with the high-level design and network design buildout.

4. Seek out funding to build and maintain the BHBN.

Apply for federal and state grants and loans and look for private equity investments. Consider bond financing for broadband. Investors are more likely to invest in communities

that invest in themselves. It is essential to have a single entity to do this as a neutral public enterprise with active support by the full range of local private and public stakeholders.

5. Implement broadband-friendly policies and establish Broadband Infrastructure Programs.

All local jurisdictions should adopt consistent policies such as Dig Once to coordinate infrastructure development and economically build public network infrastructure. Inventory and track assets throughout the area that might be connected via or used for deploying the BHBN.

6. Develop a rate structure for the use of public assets.

Assets such as hilltops, rooftops, towers, and other vertical structures can be useful for deploying broadband and related technologies (e.g., cellular). Publicly-owned fiber should have set lease rates and terms. The lead local broadband agency should have full power to negotiate with providers, based on the predetermined rate structure. Consider asset swap and in-kind opportunities.

7. Engage prospective partners in discussions about their capacity, goals, and interests

Continue discussions with Access Ohio Valley, CityNet, and Horizon to explore public-private partnership opportunities. Identify appropriate contacts with Agile Networks, Crown Castle, DQE, Zayo, and other providers in the larger three-state area and engage them in similar discussions. Determine ways to leverage current regional infrastructure to develop a robust broadband backbone and last mile network in Brooke and Hancock Counties. Specifically, negotiate co-builds and fiber swaps to complement rather than overbuild partners' existing infrastructure.

8. Evaluate assets—easements, public rights of way, towers, utility pole, etc.—backbone deployment and identify sites for access, distribution, and interconnection assets.

There are a wide range of public and quasi-private assets that can facilitate and reduce the costs of deploying BHBN. Under the recommended approach, private partners will deploy their assets adjacent to the BHBN. Sites for these assets will need to be carefully selected based on access, cost, and, most importantly, proximity to pre-subscribed and prospective customers.

9. Design and build provider-neutral interconnection facilities, middle mile backbone network, and tower sites with active involvement of private partners.

We recommend incorporating and interconnecting existing fiber and wireless infrastructure into the BHBN wherever possible. This will boost the potential benefits and revenue from the network while minimizing costs. Be sure to include this activity and all other aspects of high-level and low-level design into the BHBN capital budget.

10. Oversee private partners' deployment of access and distribution infrastructure and their interconnection with BHBN.

It will be critical for the lead agency to maintain a provider-neutral process to create a hybrid fiber-wireless infrastructure on top of the backbone and provide fiber and wireless broadband services to the area. Provider partners will likely be head-to-head competitors. They will also compete head-to-head with incumbent providers that are unlikely to become BHBN partners, and who will undoubtedly seek competitive insights via public records requests and other tactics. The lead agency must make sure partners meet their commitments to deploy infrastructure and provide services. It must also ensure that BHBN assets are available and secure for partners' use. And, it will need to keep the RBTF fully informed of issues and progress. Throughout all of this, the lead agency will need to carefully manage confidential and proprietary information to maintain partner relationships while protecting public interests.