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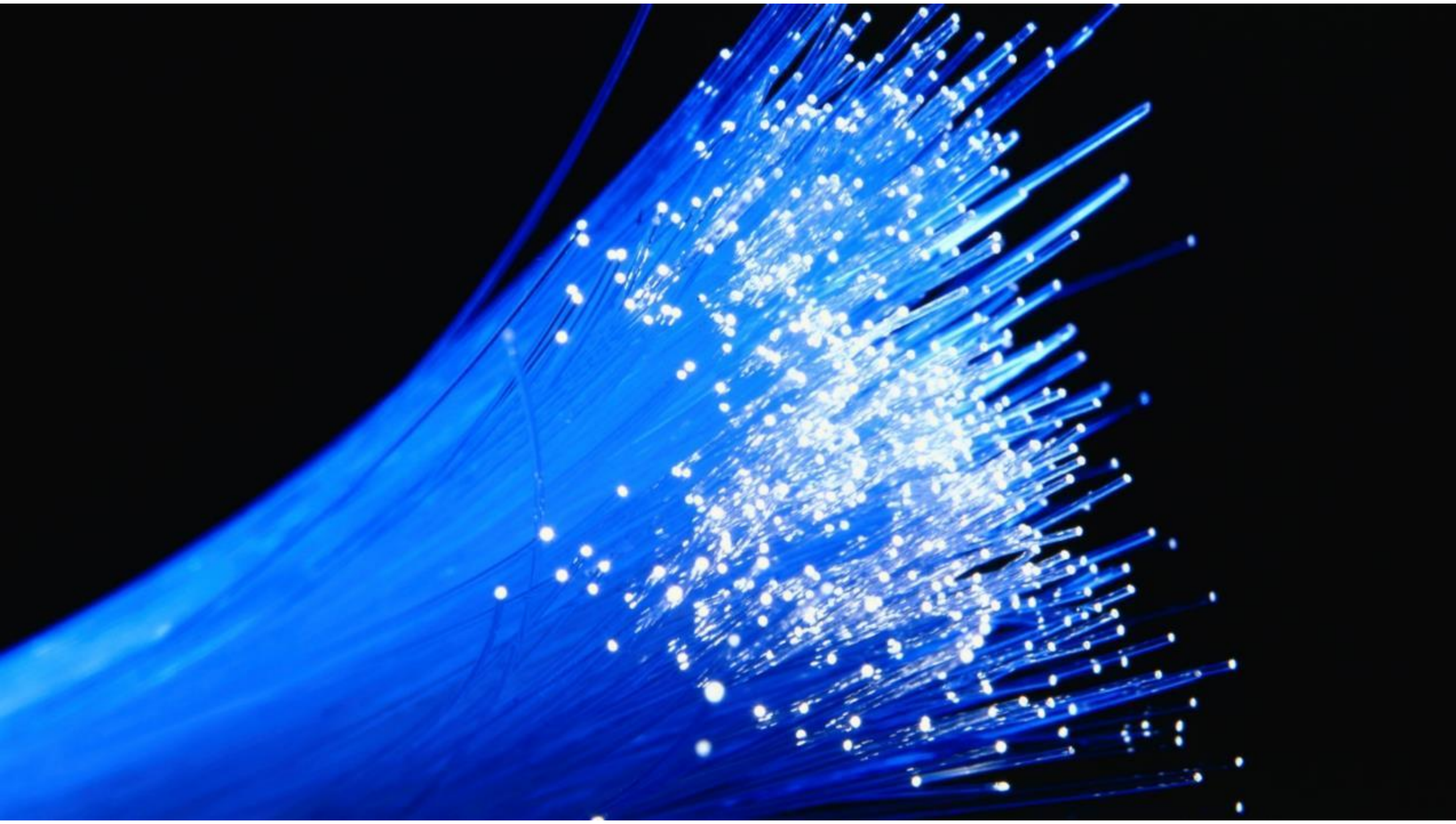

# Broadband Strategic Plan

**Prepared for the State of Delaware**

**May 2021**

**Columbia Telecommunications Corporation**

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# 1 Executive Summary

The Delaware Department of Technology & Information (DTI) hired CTC Technology & Energy (CTC) in fall 2020 to develop a pragmatic, actionable broadband strategic plan for the State. As a framework for this effort, DTI focused on broadband service gaps and "digital equity"—which requires broadband access (meaning high-speed service is available), but also that such access is affordable, that residents own or have access to well-functioning devices, and that they possess the skills needed to effectively use broadband and computers.

## 1.1 Summary of tasks

Over the course of fall and early winter 2020, the CTC project team conducted quantitative and qualitative research to understand Delaware's broadband availability and digital equity gaps and opportunities. Specifically, the project team:

1. **Assessed the current state of residential and commercial broadband infrastructure and services.** We evaluated the current availability of broadband in Delaware through a rigorous desk survey and extensive, targeted field surveys of telecommunications infrastructure.

   Our goal was to develop an understanding of where Delaware is unserved with broadband—at 25 Mbps download/3 Mbps upload (25/3) as defined by the Federal Communications Commission (FCC), but also at the 10/1 Mbps threshold that previously has applied to the U.S. Department of Agriculture's (USDA) ReConnect grant and loan program, as well as other federal funding programs. This effort informed the partnership and grant strategies we developed.

2. **Benchmarked Delaware's broadband availability against other states.** Using the data we developed and other publicly available data, we benchmarked the State's broadband availability relative to other states.

3. **Surveyed Delaware residents and businesses:** We conducted a mail survey of Delaware residents to gather statistically valid data on broadband adoption and use—with a focus on identifying digital equity issues and concerns.

4. **Hosted an online speed test tool.** To complement the service availability data, we hosted an online speed test tool to gather data on residents' actual experience with their broadband services.

5. **Prepared high-level designs and cost estimates for fiber and fixed wireless broadband deployment.** CTC's engineers developed high-level candidate designs and cost estimates for network deployments that would fill the State's broadband service gaps.

6. **Conducted outreach to potential broadband providers, partners, and key stakeholders.** To inform our recommendations about partnerships and grant strategies, we engaged with internet service providers (ISP) and other potential partners to identify their interest in partnering with the State, as well as their issues and concerns. In addition, in developing this report, we engaged a wide range of stakeholders throughout the State and provided them with the opportunity to offer input and feedback on the strategic direction.[1]

7. **Analyzed federal funding opportunities.** With a particular focus on the FCC's just-concluded Rural Digital Opportunity Fund (RDOF) auction, we analyzed federal funding opportunities—and the implications of RDOF awards for the State's short- and long-term planning.

8. **Developed recommendations, including potential partnership approaches.** Drawing on the data and analysis produced throughout the engagement, we developed a series of actionable recommendations for partnership approaches and other steps the State can take to address its digital equity and broadband service gaps.

## 1.2 Summary of findings

The key findings described in this report include the following:

### 1.2.1 Delaware has been a pioneer in broadband deployment for decades

The State of Delaware's innovative efforts to date have positioned Delaware as one of the most connected states in the country and provide valuable best practices to be leveraged in efforts to close the remaining gaps.

The State has been deploying internal telecommunications infrastructure since the 1990s. Because of this pioneering effort, robust communications capacity has been available to key anchor institutions in Delaware ahead of those in many other states. Additionally, the State has made significant inroads in addressing the challenges of unserved residents.

Impactful interagency collaboration among DTI, the Delaware Department of Transportation (DelDOT), and the Delaware Department of Education (DOE) has led to an extensive statewide infrastructure network and meaningful partnerships to serve residents. For example, DTI's partnership with fixed wireless provider Bloosurf has extended service to much of rural Sussex

[1] The stakeholders engaged in the development of this report included: State Senator Brian Pettyjohn; State Representatives Ruth Briggs-King, Krista Griffith, and Jeff Spiegelman; Mark Cabry, University of Delaware; Russ Ehrlich, Delmarva Power; Patches Hill, Delaware Department of Education; Mike Hojnicki, New Castle County; Dwayne Kilgo, Sussex County; Todd Lawson, Sussex County; Sean Looney, Comcast; Kendell Massett, Delaware Charter Schools Network; Bonnie Metz, Verizon; Linda Parkowski, Kent County; John Taylor, Delaware Prosperity Partnership; Richard Wilkins, Delaware Farm Bureau; and Kevin Yingling, Delaware Electric Cooperative.

and Kent counties, while DOE has supported a program to connect eligible low-income students to Bloosurf's network.

This culture of partnership also led DTI and DOE to implement the Connect Delaware program in 2020; the program used federal CARES Act funding for both the extension of broadband infrastructure in the State and the provision of free broadband service for low-income students through the 2021 calendar year.

### 1.2.2 Approximately 11,600 Delaware homes and businesses lack broadband service in contiguous unserved portions of the State

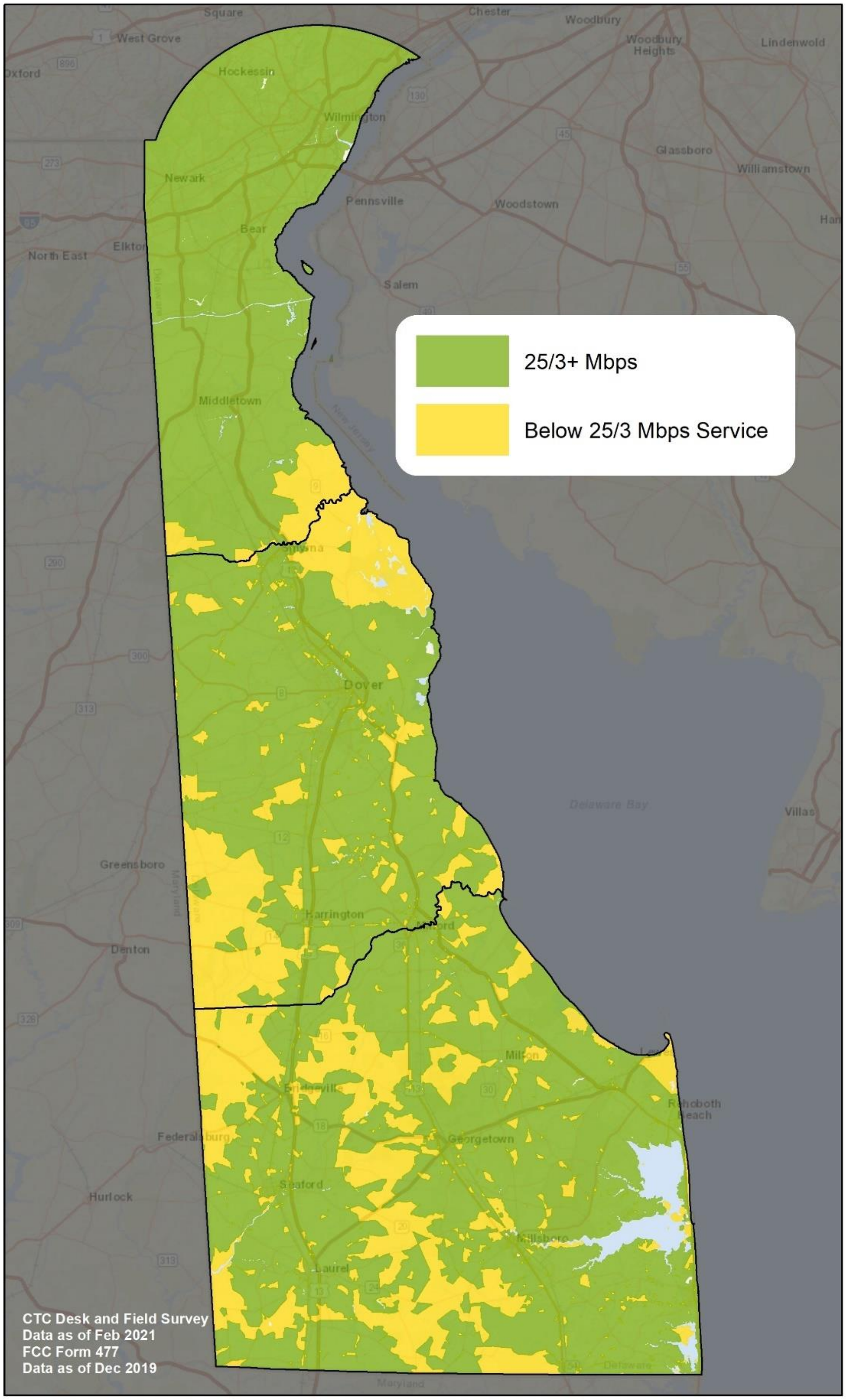
Our extensive desk and field surveys determined that an estimated 11,600 homes and businesses in contiguous parts of the State are unserved with wired broadband, based on the current federal definition of broadband (25/3). Figure 1 illustrates these contiguous areas designated as unserved by FCC Form 477 data[2]—and validated through our extensive desk and field surveys.

We found approximately 450 homes and businesses are unserved in New Castle County, 3,800 in Kent County, and 7,350 in Sussex County.

In addition to these contiguous unserved areas, we note that within the State's mostly served areas, there exist small clusters of unserved addresses where incumbent ISPs have not extended their infrastructure—primarily because they are not required to do so by franchise requirements, and the potential return on investment is not high enough to merit the cost to pick up those customers. While it is difficult to estimate how many of these isolated unserved premises exist without address-level data or field surveys (and they therefore are not included in our map), they likely number in the low hundreds statewide.

[2] FCC data are presented at the census block level, and the FCC considers a census block served if just one of the premises in the block could be served. The data thus tend to overestimate service availability, particularly for rural areas where one census block can span many square miles. FCC service data are also inconsistent for parks, wildlife reserves, and other non-populated areas. For example, if an ISP has extended service to a single visitors' center or building, FCC data may show a large unserved area around that location as being served. Our desk and field surveys sought to correct for those issues. Unless otherwise noted, the maps presented in this report represent data augmented by our field surveys. We also note that, in future State initiatives to work with ISPs to build out networks, providers will need to demonstrate where they do and do not serve, presenting an opportunity to further augment the FCC data.

**Figure 1: Unserved Areas – 25/3 Mbps (Wired Only)**



### 1.2.3 Delaware's broadband service availability and digital equity metrics are comparable to those of neighboring states

CTC analyzed FCC Form 477 data and the U.S. Census Bureau's American Community Survey data to determine how Delaware compares to four nearby states—Maryland, New Jersey, Connecticut, and Rhode Island—with respect to broadband access and use.

Delaware ranked comparably among the four other states in all aspects of our analysis, including:

- Percent of premises with access to broadband services at various speed tiers
- Percent of premises served by three or more broadband providers
- Percent of premises with access to fixed terrestrial broadband providers at various speed tiers and degrees of competition
- Percent of households with no internet access
- Percent of households with no computer
- Percent of households in which a member is required to telework
- Percent of households with children whose school learning was affected by Covid-19

### 1.2.4 Residential survey results indicate a high level of service availability—but significant barriers to adoption and effective use of broadband and computers

Most respondents to the State's survey reported that having access to high-speed internet was extremely important to them, especially among those who telework, have a home-based business, or who use the internet to pursue educational opportunities. Almost all respondents had some form of home internet access, but 5 percent accessed the internet at home primarily through their mobile/cellular subscriptions.

One in 10 households with children reported that a lack of internet access prevented their children from completing homework assignments.

Only four in 10 respondents felt that the market currently provides high-speed internet at a price their household can afford. Discounted internet services and subsidy programs are available but appear to be significantly underused, with many low-income respondents reporting they were unaware of programs such as Comcast's $10-per-month Internet Essentials service.

Although almost all respondents reported being able to access the internet at home from a desktop, laptop, or tablet, many experience periodic problems with these devices and one-fourth of respondents did not know how to troubleshoot issues with technology. The same fraction of respondents said it would take them one to six months or longer to replace their computer if it broke. This suggests that device problems may eclipse broadband connectivity access as a barrier for a significant portion of the State's population.

When it comes to skills and avoiding harms, the data were mixed. A majority of respondents expressed agreement or strong agreement that they know how to upload content to a website (63 percent), create and manage a social media profile (60 percent), and connect with a doctor online (58 percent). However, those percentages declined for older and lower-income residents.

Additionally, many respondents disagreed or strongly disagreed that their children have the skills to identify false or misleading information (45 percent), avoid online bullying by peers (41 percent), detect and avoid online scams and predators (51 percent), or avoid exposure to graphic violence or pornography online (34 percent).

Clearly, Delawareans face broadband skills gaps—but they are also looking for help. Almost half expressed a desire to become more confident in using computers, smartphones, and the internet.

### 1.2.5 The Covid-19 pandemic affected residents' broadband needs

Survey respondents reported increased use of and demand for broadband services during the Covid-19 pandemic. Almost all (99 percent) respondents access the internet from some location, including a range of locations outside the home. However, use of the internet outside of the home declined significantly during the Covid-19 pandemic.

Notably, use of the internet for a variety of critical activities increased substantially during the pandemic as compared to pre-pandemic: telemedicine or medical appointments (31 percent vs. 75 percent), homework (30 percent vs. 37 percent), attending online classes (22 percent vs. 45 percent), and homeschooling (6 percent vs. 24 percent). Additionally, 45 percent of respondents reported using the internet for teleworking on a daily basis, compared with 16 percent of respondents before the pandemic. These shifts may persist after the pandemic ends.

### 1.2.6 Fiber-to-the-premises or fixed wireless networks could fill the State's broadband gaps

CTC's engineers designed candidate fiber-to-the-premises and fixed wireless networks to illustrate and estimate the costs for potential technical solutions to fill the State's broadband service gaps. Constructing fiber-to-the-premises to connect 11,634 unserved addresses would cost approximately $75 million, inclusive of fiber-to-the-premises infrastructure and electronics, as well as service drops and customer premises equipment at 60 percent of the unserved premises.[3]

On a per-passing[4] basis, the fiber-to-the-premises deployment would cost about $5,550—a number comparable to the cost in other communities that, like Delaware, with a high percentage of aerial infrastructure and relatively low housing density.

While fiber-to-the-premises represents the best-in-class class technical solution to address broadband needs in the long term, there exist a range of lower-cost wireless approaches to meet the most critical broadband needs in the short term. We examined using fixed wireless technologies that can be deployed relatively quickly, are impactful at any funding level, and leverage existing infrastructure to expand reach and reduce deployment timeframes. These are not solutions offering ubiquitous coverage and they are not able to deliver fiber-like capacity—but as a targeted solution, they could provide a broadband lifeline to facilitate distance learning for students, job searches, access to government services, and access to healthcare professionals in the ongoing pandemic crisis.

We found that a fixed wireless network using the Citizens Broadband Radio Service (CBRS) band at 57 existing tower locations could effectively serve 79 percent of the State's premises that currently are unserved by wireline networks—although, as discussed, it would have clear technical limitations relative to a fiber optic network. (We note, too, that 100 percent of unserved premises could be connected using fiber.) Our candidate fixed wireless network would have a capital cost of $10.6 million but high ongoing operating costs.

### 1.2.7 Incumbent ISPs could use an edge-out approach to reach almost 90 percent of unserved residents

As an alternative to constructing a new fiber-to-the-premises or fixed wireless network, we evaluated whether incumbent ISPs could extend their existing network footprints to reach unserved residents. Using the State's GIS database, the State's data about unserved areas, and our field and desk survey results, CTC's engineers estimate that approximately 9,600 unserved homes could be served if existing ISPs would expand their network footprints by one-half mile into unserved areas, for a total of 883 miles of new fiber and/or coaxial cable.

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[3] This model assumes a 60 percent take-rate (i.e., the percentage of residents and businesses that subscribe to the service).

[4] A "passing" is the infrastructure that passes a home or business along the public rights-of-way, but it does not include the "service drop"—the portion of the network that connects from the road to the home or business itself. The availability of a passing to a home or business is the universally understood definition of what is served, both within the industry and among the state and federal government entities that fund broadband expansion and regulate communications services.

This approach is known as a "network edge-out." Because the State's largely suburban character means incumbent networks are relatively close to the unserved areas, it could provide service to 87 percent of the State's unserved homes. Based on our estimated construction cost of $45,000 per mile, a network edge-out would cost approximately $39.8 million. The federal government's recent unprecedented funding of broadband infrastructure projects means that the State could afford to work with incumbent providers to extend the network even beyond the half-mile edge-out, providing service to every unserved home and business in Delaware.

### 1.2.8 The FCC's Rural Digital Opportunity Fund auction awarded funding in the State—but questions remain about execution

While this report was being finalized in December 2020, the FCC released the results of the Rural Digital Opportunity Fund reverse auction. As of this writing, there are still multiple contingencies on the funding awarded for service in Delaware—and the exceptionally low clearing price (i.e., federal subsidy) secured by the winning bidder in the State, which was just 10 percent of the FCC's reserve price, creates some questions about how quickly new services will be deployed. Further, under the RDOF rules, the winning bidder is not obligated to show results for five years. As a result of these uncertainties, we have included in this report our comprehensive analysis of the pre-RDOF status quo, along with our analysis of the RDOF results.

At a high level, the RDOF auction provided a great opportunity with substantial portions of Delaware's unserved areas eligible for federal funding. A total of 7,757 address locations[5] were assigned in the auction at a support of $1.3 million per year over 10 years. All eligible areas in Delaware were won—more than 99 percent of them by Talkie, a small fiber optic provider. Bloosurf picked up that the one remaining census area with just eight address locations.

Unlike almost everywhere else in the country, SpaceX did not pick up any eligible areas in Delaware. While it bid on most, but not all, areas in the State, it stopped bidding after round 14 in Delaware.

We do not know whether Talkie can deliver. Support levels for Talkie for the areas it won in Delaware are higher than the average support levels for fiber optic providers. At 61 percent of reserve prices—the maximum available support assigned by FCC for each census area—it is feasible they could deliver absent any other commitments and absent any additional support. But Talkie has very large commitments in neighboring Maryland—where it bid aggressively, driving support levels into single digits in some areas where it was bidding against other local fiber providers.

[5] The FCC calls these "locations" for short and refers to what it calls "broadband addressable locations." The FCC uses a variety of different databases to estimate numbers and locations of residential and business addresses; it does not currently make these data publicly available.

### 1.2.9 New federal broadband funding presents opportunities

The federal appropriations bill[6] signed into law on December 27, 2020, includes several broadband funding streams. The FCC will administer a subsidy program to offset the cost of monthly internet service for low-income households, while the National Telecommunications and Information Administration (NTIA) will administer three distinct grant programs to build new broadband infrastructure and purchase services.

While the funds for these programs and the initial statutory requirements were included in the legislation, many program details have not yet been determined. The federal agencies that will manage the programs are developing implementation criteria over the first months of 2021.

## 1.3 Summary of recommendations

Based on our data collection and analysis, we recommend the State consider the following strategic and tactical steps toward achieving its broadband goals. From a budgetary standpoint, we recommend the State use 50 percent of the remaining funds appropriated for broadband under the CARES Act to support wired infrastructure expansion, with a particular focus on edge-out of existing cable infrastructure (given the value of that approach on a per-premises basis). We further recommend the State split the remaining funds, devoting 25 percent to support fixed wireless expansion, and the final 25 percent for subsidy programs.

### 1.3.1 Support residents and ISPs to maximize federal Emergency Broadband Benefit subsidies and minimize the burdens of participation

The Connect Delaware program has done an exemplary job of connecting students across the State. The impending launch of the FCC's $3.2 billion Emergency Broadband Benefit Program (described in detail in Section 10.1) presents both an opportunity and a series of potential obstacles to be overcome. The State can play an important role in enabling residents and ISPs to maximize that federal funding for shared benefit.

While the FCC has not yet defined the program's rules, we are concerned there could be a significant burden on families to prove their eligibility and ensure their subsidy is appropriately applied. We encourage the State to build on the success of Connect Delaware and take a series of steps to alleviate potential barriers for Delaware residents:

- Develop a public outreach strategy to maximize the participation of Delaware families in this new subsidy program
- Work with ISPs to streamline the verification of families' eligibility

[6] "Consolidated Appropriations Act, 2021," December 21, 2020, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed December 2020).

- Develop a bridge program for residents and ISPs that can fill the gap during the two months the FCC will need to get the program up and running
- Advocate to the FCC that the State can determine eligibility criteria for families and verify that eligibility itself

Together, these steps could build on the State's success to maximize the impact of federal funding for Delaware residents.

### 1.3.2 Provide technical assistance to position Delaware competitively for federal funding, including from NTIA and USDA

As with the earlier federal ReConnect grant and loan program, we recommend the State collaborate with counties and ISPs to position Delaware competitively to receive federal funds from the latest grant programs. The State could, for example, provide technical assistance and letters of support to applicants.

### 1.3.3 Evaluate the impact of the Connect Delaware subsidy program and consider continuing it if successful

The State should evaluate the Connect Delaware subsidy program's impact in terms of the number of students that used the subsidy to connect to the internet. This evaluation could also be augmented by an analysis of increased participation in distance learning.

If the State determines the Connect Delaware subsidy program was successful, it could consider continuing the program beyond the scope of the CARES Act, as a means for students in need to receive free home broadband service for educational purposes. The State could also consider lessons learned from the initial months of the program to adjust its scope and implementation for future iterations.

### 1.3.4 Add staff resources to manage the implementation of the State's broadband strategy

In CTC's view as an independent consultant, DTI has led broadband initiatives for the State exceptionally well. We recommend that DTI be allocated the resources necessary to support additional staff to manage the implementation of the State's broadband strategy over the next several years. Specifically, we recommend that DTI hire the following:

- A broadband program administrator to oversee and direct broadband strategy
- Two project managers to be responsible for infrastructure and programmatic initiatives
- A staff person to be responsible for managing project budgets and federal grant application processes

This team would ensure that the State's broadband strategy is aligned with its goal of guaranteeing universal broadband access, and would collectively be responsible for grant-related initiatives, coordination among State entities as well as external partners, and data collection and program evaluation.

### 1.3.5 Adopt symmetrical 100 Mbps speeds as a minimum broadband target for the next five years

Most of the State has cable and fiber infrastructure that easily reaches these speeds, and some current fixed wireless technologies are also capable of reaching that benchmark. We believe, however, that the State should prioritize fiber infrastructure where it can, and hybrid fiber-coaxial cable as an alternative.

Additionally, Delaware should adopt symmetrical Gigabit service as its preferred five-year and planned 10-year goal. We recognize there may be situations where a rapid rollout of fast fixed wireless solutions is preferable, but for today's main wireline technologies, there is virtually no difference in infrastructure between a 100 Mbps capability and a 1 Gbps capability: Most of the underlying infrastructure is the same.

For both goals, the symmetric requirement is particularly important. Slower upload speeds (and particularly the low threshold adopted by the FCC) are often woefully inadequate in light of today's two-way applications such as videoconferencing and telemedicine—and there is no reason to believe that this will change in the future.

### 1.3.6 Invest in last-mile infrastructure

To the extent feasible, the State should invest in broadband expansion with long-term benefits. We recommend that the State prioritize encouraging incumbent broadband providers to edge out their networks to provide service to the many residents who live beyond the reach of existing broadband infrastructure. Our analysis indicates that a half-mile extension of existing telecommunications networks could connect 87 percent of unserved homes and businesses, making it an ideal approach for filling most broadband coverage gaps in the State. As noted above, the new federal funding of broadband infrastructure could enable the State to support the build-out of incumbents' networks beyond the half-mile extension, thereby bringing service to every remaining home and business in the State.

Secondarily, we recommend that, where possible, the State provide competitive options for residents by supporting the installation of wireless equipment at homes where the installation cost may be prohibitive to individual homeowners.

### 1.3.7 Expand partnerships with ISPs to maximize RDOF-funded buildout—and protect against the possibility that RDOF obligations may not be met

The RDOF auction had an enormous impact on the State's options for several reasons. First, the RDOF areas constituted a very high share of the State's unserved areas. Talkie picked up most of these areas with a high-speed fiber solution. However, we do not know if Talkie will be able to meet its commitments. If it cannot, the State's options for federal grant funded opportunities may be limited until the areas are released for funding eligibility—something that could take years. A partner and grant strategy will depend on which of these two scenarios will unfold: Talkie delivers or Talkie cannot deliver.

We recommend the State engage with Talkie and seek confirmation that Talkie has the requisite capital and operational scale to meet its RDOF obligations. If the State is satisfied with its engagement with Talkie, it could consider a partnership to encourage Talkie's expansion further into the remaining unserved areas of the State.

However, if the State believes Talkie will not deliver, the State could self-fund new initiatives to encourage providers to build in the RDOF-funded areas. In this case, the State could explore partnerships with a variety of entities, including a consortium bidder that participated in the RDOF auction and the Maryland Broadband Cooperative. Working with Bloosurf or BridgeMaxx may also present a temporary solution.

### 1.3.8 Maximize the benefits of NTIA and ReConnect funding opportunities

We recommend the State develop a request for information (RFI) or directly reach out to potential partners to target the NTIA funding opportunity and the ReConnect program in six parts of the State:

- The area between Federalsburg and Bridgeville, sandwiched between RDOF areas
- South of Georgetown
- The southwestern areas between Laurel and Delmar
- Northeast and west of Smyrna
- Southwest of Smyrna
- North of Frederica and east of Dover

Targeting these areas would leave the door open for Talkie to make good on its RDOF commitment while making a dent in the unserved areas—and enabling partners to expand into the RDOF areas with future grants or the next RDOF auction if Talkie fails to deliver.

### 1.3.9 Partner with ISPs to promote low-cost internet programs to eligible residents

Results of the residential survey indicate that residents may be significantly underutilizing existing broadband subsidy programs. We recommend the State develop an initiative to educate residents about the availability of low-cost programs offered by incumbent ISPs, and to assist residents with enrollment.

Potential initiatives such as a phone hotline, an online information portal, a cross-promotion effort with State stakeholders, and a postcard and social media campaign could increase the impact of already-available low-cost internet options in the State.

# 2 DTI and other departments have actively addressed the State's broadband challenges

The State of Delaware has been proactive in deploying internal telecommunications infrastructure since the 1990s. Because of this effort, robust communications capacity has been available to key anchor institutions in Delaware ahead of those in many other states. Additionally, the State has made significant inroads in addressing the challenges of unserved communities through interagency collaboration, its partnership with fixed wireless provider Bloosurf, and the recent Connect Delaware initiative.

The State's innovative efforts to date have positioned Delaware as one of the most connected states in the country, and provide valuable best practices to be leveraged in developing efforts to close the remaining gap.

## 2.1 DTI, DelDOT, and DOE have had a highly productive, 20-year collaboration

A pioneering collaboration that began in 1997 between DTI, the Delaware Department of Transportation (DelDOT), and the Delaware Department of Education (DOE) set the groundwork for a well-connected state. Through this inter-agency collaboration, DelDOT constructed extensive fiber for transportation purposes, quickly placing Delaware at the cutting edge of intelligent state transportation systems.

This initial public investment in fiber infrastructure has supported a broad array of public institutions. Excess fiber capacity was made available to DTI to support education initiatives and other state agency communications needs.

This impactful collaboration has continued for decades, and the agencies have worked together successfully, avoiding working in silos. Today, the State's fiber backbone extends approximately 700 miles.[7] We know that many states have attempted or are currently attempting to develop collaborative, inter-agency communications infrastructure programs, without success. Delaware's commitment to investment and partnership in the 1990s, when the commercial internet was at its infancy, resulted in both a robust state network and a culture of collaboration that has supported innovative connectivity solutions throughout the years.

## 2.2 DTI has partnered with Bloosurf to expand rural wireless service

In August 2018, DTI issued a Request for Proposals (RFP) seeking to identify qualified partners to build, operate, and maintain a network to provide broadband service to unserved areas of the State. Specifically, target areas of the State were identified that included approximately 127,700

[7] "Delaware Broadband Initiative: Fiber Broadband," State of Delaware Department of Technology and Information, https://broadband.delaware.gov/pages/index.shtml?dc=fiber (accessed December 2020).

homes and businesses in rural areas of Sussex and Kent Counties. As a result of the RFP, DTI engaged in a partnership with wireless provider Bloosurf.

DTI provided Bloosurf approximately $2 million to support network startup costs, including design and construction. Funds were not made available for any ongoing maintenance costs. As a result of this partnership, Bloosurf has deployed its network throughout parts of rural Delaware, providing households with a broadband connection where wired service is unattainable due to cost or geography.

DOE has developed a partnership with Bloosurf to connect low-income students to affordable internet options. Families are eligible for the program if they do not have landline-based internet service options, and are enrolled in any of the following federal assistance programs:

- Free and Reduced Lunch
- Medicaid
- Public Housing Assistance
- Supplemental Nutrition Assistance Program (SNAP)
- Temporary Assistance for Needy Families (TANF)
- Supplemental Security Income (SSI)
- National School Lunch Program (NSLP)/Head Start
- Low Income Home Energy Assistance Program (LIHEAP)
- Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)

Eligible families engage with the program through their school, and receive free installation and three months of free internet service from Bloosurf. After the three-month period, service is $30 per month.[8]

## 2.3 The CARES Act-funded Connect Delaware program aims to expand broadband infrastructure and service

On August 24, 2020, Governor John Carney announced the allocation of $20 million in CARES Act funding to support the buildout of new broadband infrastructure and to acquire broadband equipment and services for low-income students in Delaware.[9] DTI, in partnership with DOE, developed the Connect Delaware program to address these goals. In its execution, Connect Delaware has been a valuable asset to the State's comprehensive work addressing gaps in

[8] "Getting Families, Educators Connected," Delaware Department of Education, https://www.doe.k12.de.us/Page/4273 (accessed December 2020).
[9] "Governor Carney Announces $20 Million for Broadband Infrastructure," State of Delaware, News Release, August 24, 2020, https://news.delaware.gov/2020/08/24/governor-carney-announces-20-million-for-broadband-infrastructure/ (accessed December 2020).

broadband availability and adoption, and its engagement of key stakeholders has helped build an understanding of broadband needs in the State.

Connect Delaware is comprised of two discreet subprograms. Its infrastructure program supports the buildout of new broadband infrastructure by the private sector in Delaware. Its subsidy program provides fixed and hotspot broadband connections to qualifying low-income students in the State. For both programs, all funds were required to be spent, and all services required to be completed, by December 30, 2020 due to the federal requirements of the CARES Act.

### 2.3.1 Infrastructure program

A statement of work was issued to ISPs in Delaware in early October 2020 to outline infrastructure program requirements and solicit proposals for participation. Funding dispersed through the infrastructure program could only be used for capital costs for the ISP to purchase or construct communication facilities, and could not be used for operations or maintenance costs.

Participating providers were required to warrant the following minimum technical performance requirements for the facilities that would be provided using program funds:

- For a wireline service, at least 50 Mbps download throughput and >3 Mbps upload throughput
- For a wireless service, at least 25 Mbps download throughput and >3 Mbps upload throughput
- Latency <50 ms for both wireline and wireless service
- For a wireless service, backhaul capacity per base station of at least 1 Gbps

This process resulted in the State executing contracts with Bloosurf, Comcast Communications, and BridgeMAXX Wireless to build new communication facilities in the State.

Bloosurf added LTE base stations to five existing sites to bolster network capacity for up to 350 customers. Comcast built 1.2 miles of new line extensions to connect 17 premises. BridgeMAXX expanded seven new sites in largely unserved areas to provide service to approximately 500 homes and small businesses, and added additional capacity at six of its existing transmission sites by adding 3.5 GHz equipment to provide a faster option to approximately 9,500 unserved homes.

Despite the challenge of the extremely short timeline dictated by CARES Act requirements, the infrastructure program was successful in spurring the deployment of new broadband infrastructure to serve unconnected premises throughout Delaware.

### *2.3.2* Subsidy program

DTI worked with DOE to develop a subsidy program that would provide broadband services free of charge to low-income students through the 2021 calendar year. DOE and the State's school districts and charter schools were key stakeholders in the implementation of this program. DTI issued a scope of work in early October to solicit proposals from internet service providers to provide broadband service to eligible students through December 31, 2021. Eligible broadband services met the following technical requirements:

- Provide 25/3 Mbps capacity, or a connection capable of operating at least two simultaneous Zoom or Google Classroom sessions
- Provide latency <150 ms
- No data restrictions based on the time of day; unlimited data with at least 25 GB per month at full speed
- Provide a Wi-Fi connection capable of supporting at least five simultaneously connected devices
- Include necessary equipment to enable service, including Wi-Fi distribution throughout the home
- Include all necessary installation at the home, or capability to work out-of-the box with written instructions
- Availability of customer service from 8am to 5pm, seven days a week

AT&T, Comcast, Mediacom, and Verizon executed contracts with the State to provide services through the program. The four providers and their corresponding products were added to a catalog of eligible services, which was distributed to school districts and charter schools. AT&T and Verizon offered hotspots, and Comcast and Mediacom offered fixed home connections.

School districts and charter schools assessed the broadband needs of their eligible students, and selected the products that would best meet student needs. Orders were then submitted by districts and charters to DTI, which placed orders directly with participating service providers. Service providers delivered products directly to school districts and charter schools, which distributed products to families, and invoiced the State directly for the services. Hotspots were shipped directly to school districts and charters, and individual voucher codes that could be redeemed for fixed service were sent electronically.

Student eligibility for the subsidy program was based on enrollment in a variety of federal subsidy programs:

- Medicaid
- Public Housing
- Supplemental Nutrition Assistance (SNAP)
- Temporary Assistance for Needy Families (TANF)
- Supplemental Security Income (SSI)
- National School Lunch Program (NSLP)/Head Start
- Low Income Home Energy Assistance Program (LIHEAP)
- The Women, Infants, and Children program (WIC)

While some free and low-cost internet programs determine eligibility and allocate services on a household basis, Connect Delaware did both at the individual student level. Through the program, households with more than one eligible student were able to receive services for each student. For example, a family with two students could both receive a fixed home broadband connection and a mobile hotspot. This eligibility structure removed the penalty that would have been otherwise faced by multi-student families attempting to engage in simultaneous distance learning with a single connection.

All of the State's 19 school districts and 23 charter schools requested a total of 25,789 products through the program. The distribution of requested products among participating internet service providers is reflected in Table 1.

**Table 1: Products Requested by School Districts and Charter Schools Through the Connect Delaware Subsidy Program**

| Provider | Total Products Requested |
|---|---|
| AT&T | 4,186 |
| Comcast | 2,120 |
| Mediacom | 230 |
| Verizon | 19,253 |
| **Total** | **25,789** |

As of December 2020, school districts and charters were distributing products to eligible students.

### 2.3.3 Partnership structure

The Connect Delaware subsidy program is unique in the manner in which it distributed responsibility across several key players. Responsibility was lifted almost entirely from students and their families, and instead distributed among DOE, DTI, participating service providers, and school districts and charters. This program structure minimized enrollment burdens for families and administrative burdens for school districts and charters, ultimately resulting in high participation and a significant amount of connections for students.

The program also allowed school districts and charters to determine student eligibility based on these criteria, as opposed to requiring a cumbersome proof-of-enrollment process that could serve as a barrier to participation for many families and place additional burden on educators. In total, school districts and charters requested broadband services for 25,789 students.

The role of identifying both student needs and the appropriate broadband service to meet those needs was delegated to school districts and charters. This approach capitalized on educators' firsthand knowledge of students' level of need, both in terms of income and connectivity. Granting educators the ability to determine needs based on their own judgement was critical to ensuring that the program could move forward on a short timeline, and minimized the administrative burden. This process also shifted the burden of enrollment off of families. If it had been the responsibility of families to determine their eligibility and collect and submit the necessary materials to enroll, it is almost certain that families in need would have missed out on the benefit of the program due to the burden of enrollment or lack of awareness. Finally, this structure streamlined the process of disseminating program information, as the majority of information was distributed to school districts and charters, as opposed to individual families.

Additionally, DTI took several actions to streamline how districts and charters were asked to participate, including handling all communications with participating internet service providers. For example, DTI issued the program scope of work and engaged with interested providers to execute contracts with the State, which resulted in the creation of a catalog of eligible broadband services that was provided to school districts and charters. Districts and charters were able to receive bulk quantities of products and services for students without executing contracts themselves.

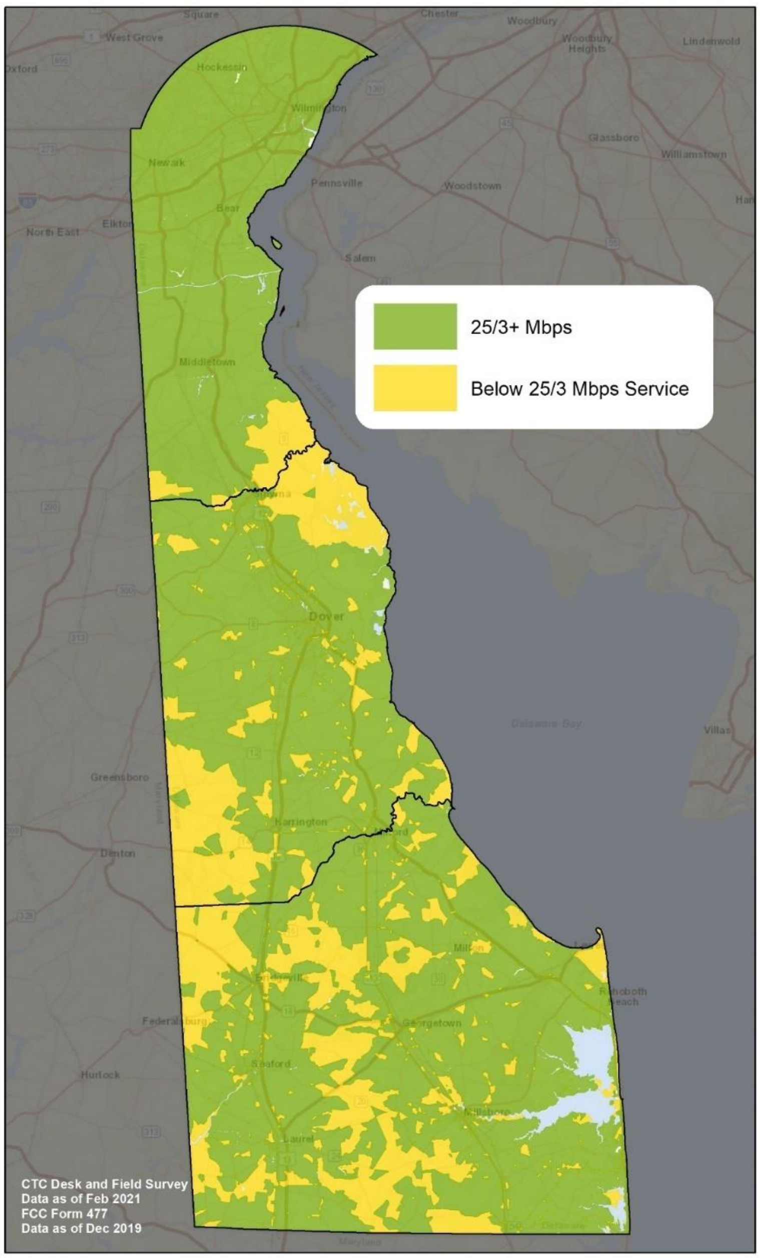
DTI also provided supporting materials and served as a resource to districts and charters throughout the program. For example, DTI provided informational materials to districts and charters, such as answers to frequently asked questions and access to a program-specific email address to direct additional questions, and provided materials for districts and charters to provide to families, including program information sheets in multiple languages and technical support contact information for families having technical difficulties.

DTI's longstanding partnership with DOE was instrumental in the implementation of Connect Delaware and in enabling the program structure. DOE acted as a trusted communication channel and distributed much of the program information to school district and charter school leadership. DOE's relationship with districts and charters made smooth communication with key stakeholders possible.

# 3 Approximately 11,600 Delaware Homes and Businesses in Contiguous Areas Are Unserved by Wired Broadband

Research conducted for this report found an estimated 11,600 homes and businesses in contiguous parts of the State are unserved with wired broadband, based on the current federal definition of broadband (25 Mbps download and 3 Mbps upload). Figure 2 illustrates those unserved areas based on FCC Form 477 data (which we verified and refined through field surveys, as described below). We found approximately 450 homes and businesses are unserved in New Castle County, 3,800 in Kent County, and 7,350 in Sussex County.

**Figure 2: Unserved Areas – 25/3 Mbps (Wired Only)**



## 3.1 Desk surveys and data analysis identified unserved areas

To establish a comprehensive overview of service availability in the State (including for purposes of eligibility for federal funding programs), we performed an assessment of service availability using a wide range of data sources. Among our primary sources were the data self-reported by internet service providers (ISP) on the Federal Communications Commission's Form 477. There is a tendency for ISPs to overstate their service availability on these forms, given that an entire census block is reported as being served if even one location in the block meets the FCC's requirement. In the case of this analysis, that overstatement was to our advantage; if we found census blocks in the State that are shown as being unserved, then we could be relatively certain that the residents there are unserved.[10]

We also evaluated the FCC's Connect America Fund (CAF II) funding documentation to identify areas deemed unserved by that program and to identify areas that would be excluded from eligibility for the federal ReConnect program. Given the six-year buildout window for entities receiving CAF II funding, we note that unserved areas in the State that are subject to an award may still be unserved for years to come.

Next we evaluated the U.S. Department of Agriculture's Rural Utilities Service's (RUS) map of served and unserved areas, which is based on a range of different datasets. In our view the RUS map is under-inclusive of the unserved portions of the country as a whole—but it provides another set of insights to add to our broader analysis.

For purposes of evaluating another potentially relevant federal funding opportunity, we also evaluated the portions of the State deemed eligible for the FCC's Rural Digital Opportunity Fund and added a full analysis of the results of the auction.

Then, using GIS maps, Google Earth imagery, and other relevant sources, we conducted an extensive desk survey to spot check and verify the other datasets in order to develop the most accurate and comprehensive overview of service availability. A CTC outside plant engineer analyzed Google Earth Street View maps where available—searching images of miles of State roadways for the presence of broadband infrastructure such as cable attachments on poles for aerial construction and handholes and pedestals for underground construction—and later performed a field survey to verify results.

[10] This is not always the case. Smaller, local operators sometimes omit submitting Form 477 reports or submissions lag expansions on the ground by years. Larger companies sometimes lag in reporting relatively recent expansions. However, due to the RDOF auction, incumbents had a strong incentive to update their submissions or they could risk having a competitor receiving federal support to overbuild their area by winning it in the auction.

### 3.1.1 Analysis of unserved locations—wired and fixed wireless technologies

Using the FCC's Form 477 data, we identified census blocks in the State where no wired or fixed wireless provider claims to offer 25/3 broadband service (Figure 3). At a high level, the yellow shaded portions of the map represent the State's unserved geography. Conversely, looking at the Form 477 data for areas identified as served, we find that most of the State's served premises have more than one service option (Figure 4).

**Figure 3: Served Areas (25/3), Including Fixed Wireless**

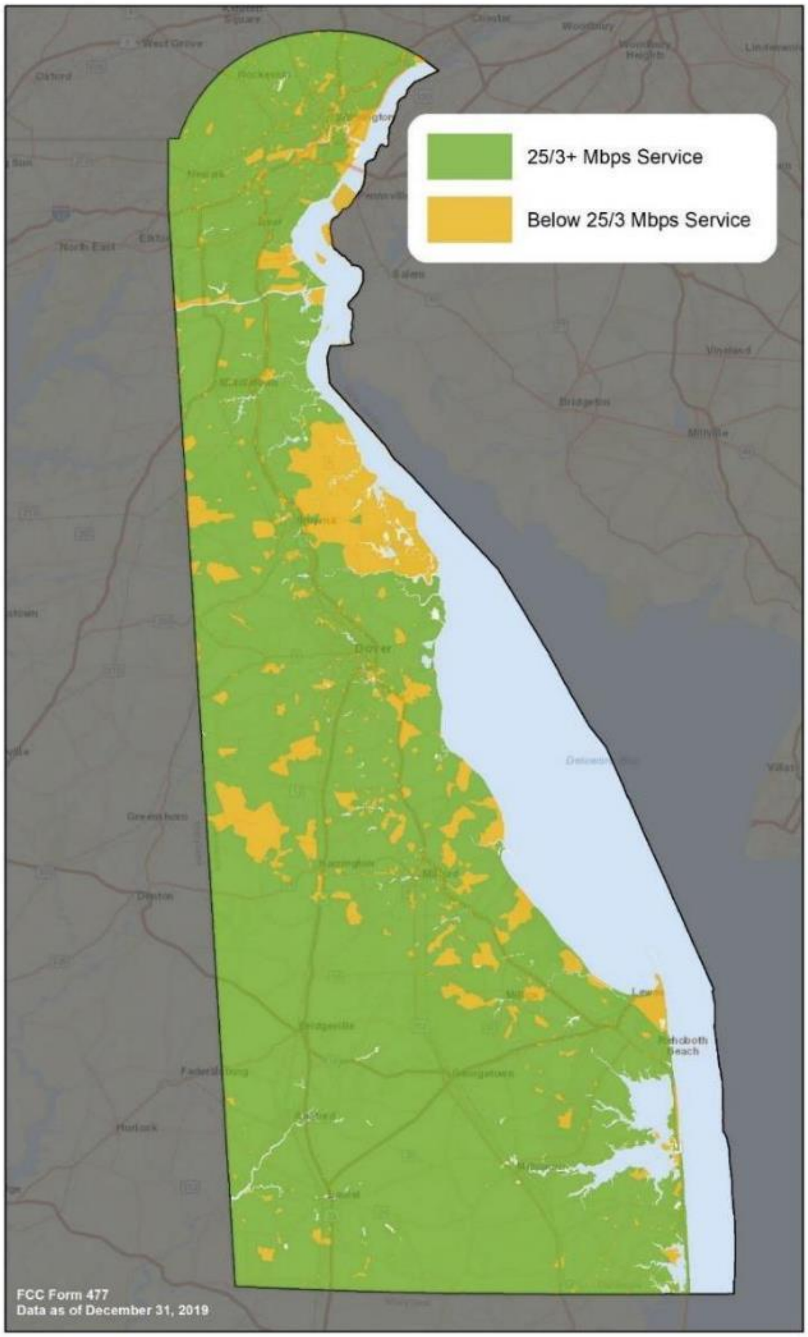
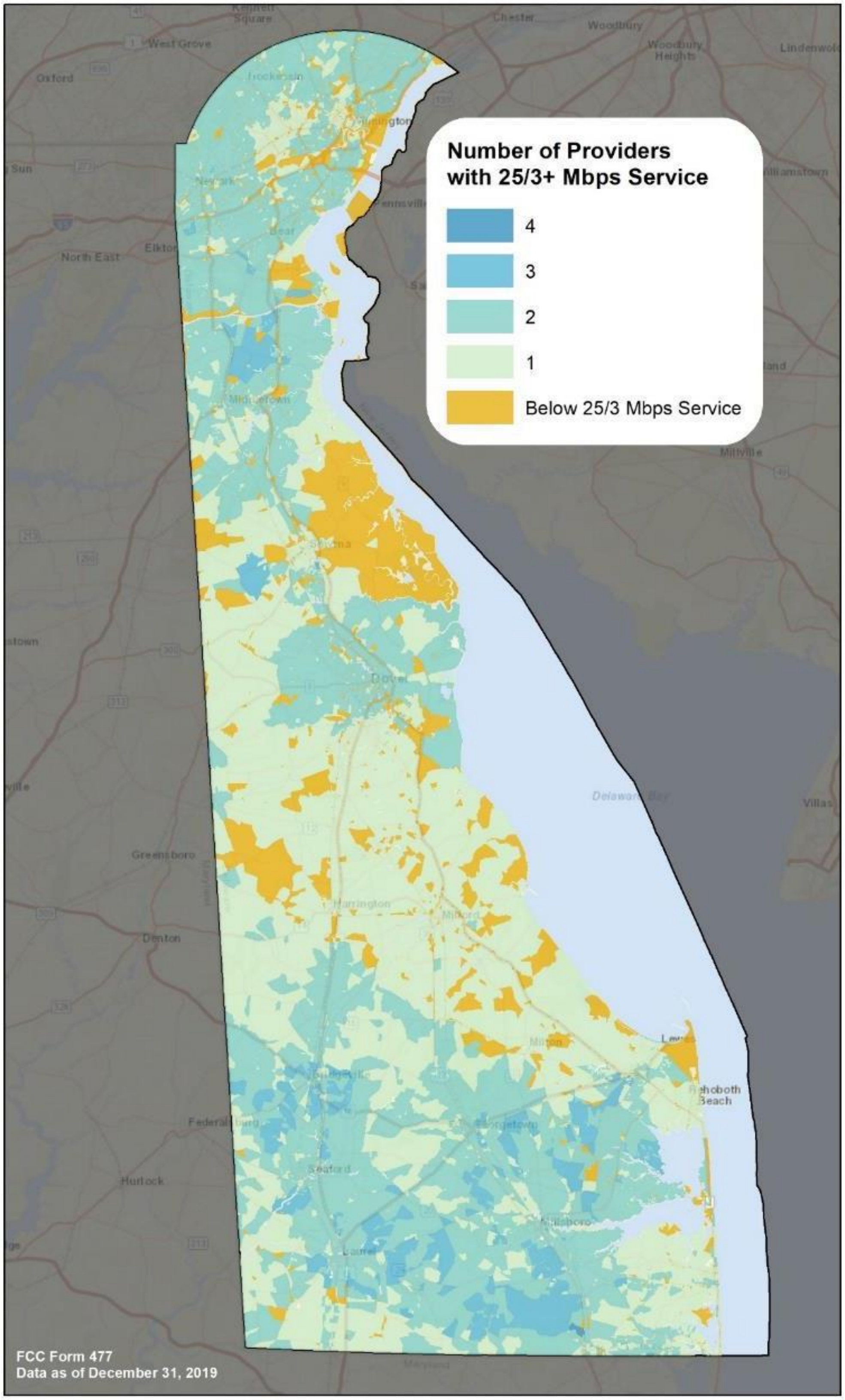


**Figure 4: Number of Providers (25/3), Including Fixed Wireless**



Although broadband is defined as 25/3 for purposes of our broader analysis, we also assessed the availability of 10/1 service, which is relevant for some federal grant and loan programs. Figure 5 illustrates areas unserved with 10/1. Many areas that are served by 10/1 have multiple providers (Figure 6).

**Figure 5: Served Areas (10/1), Including Fixed Wireless**

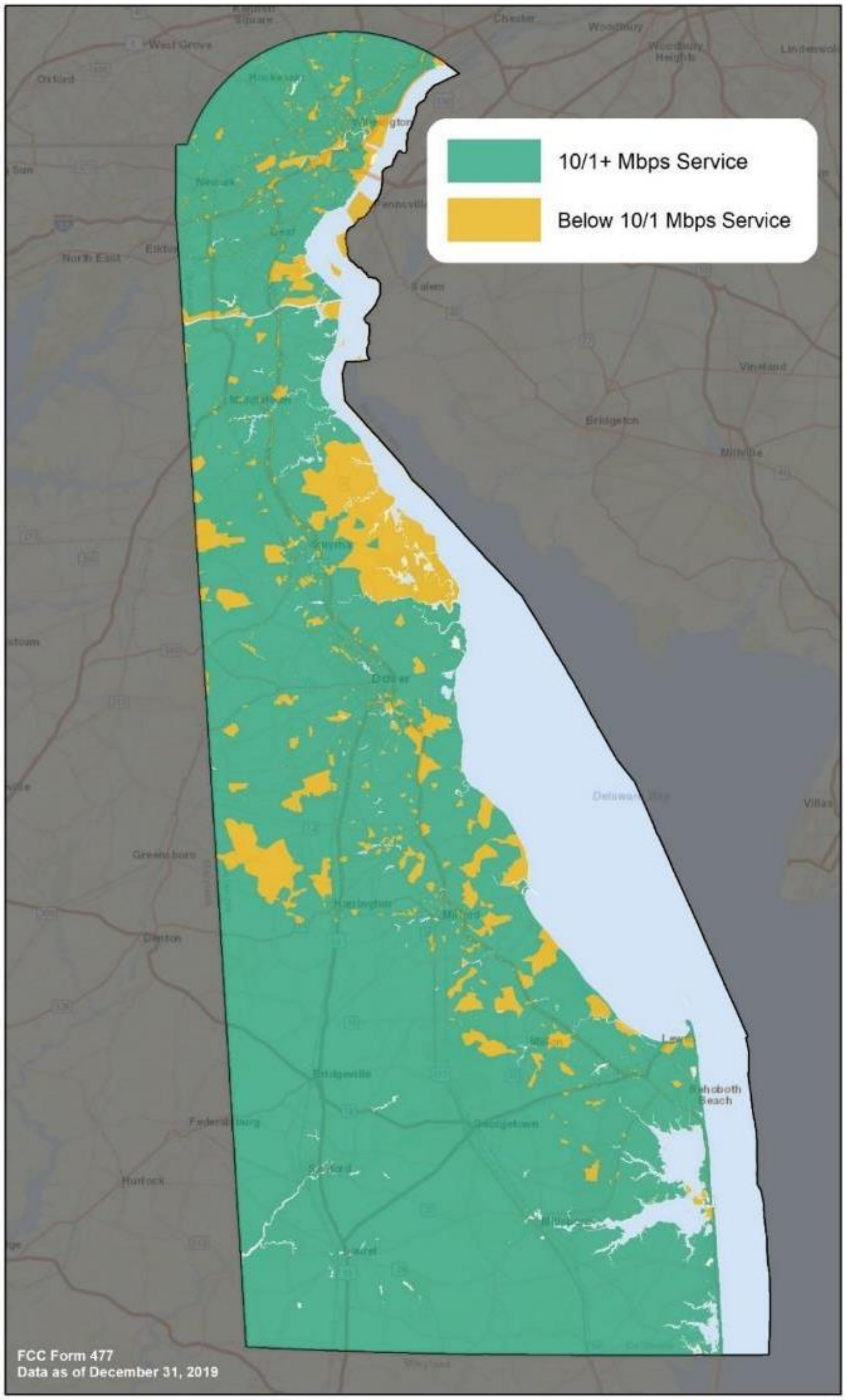
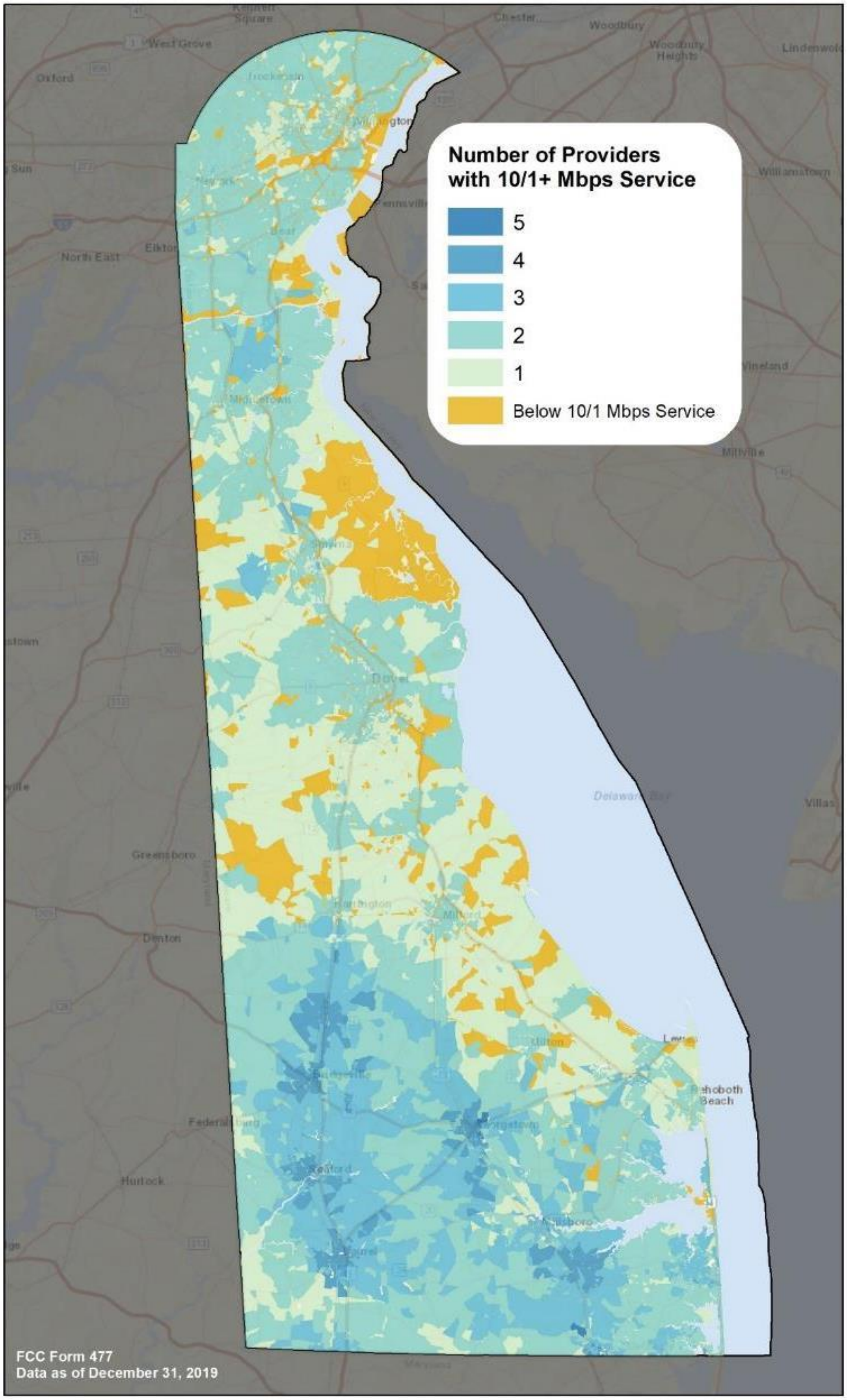
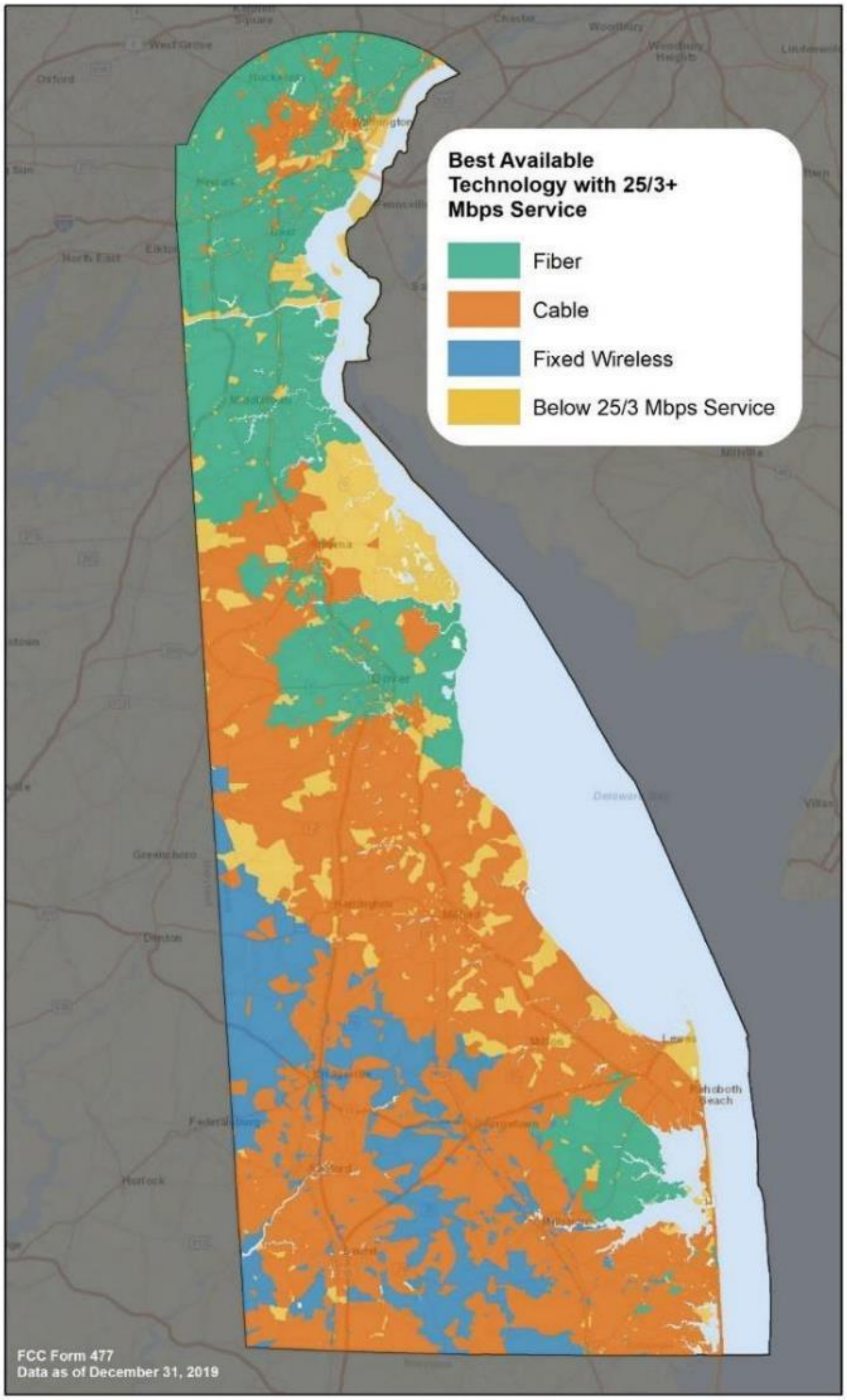


**Figure 6: Number of Providers (10/1), Including Fixed Wireless**



Drawing on the full range of data we analyzed, we next identified the best available technology for delivering 25/3 services across the State—in other words, of the technologies that are claimed in Form 477 to be providing service in a given census block, which is the best technical option (Figure 7).

**Figure 7: Best Available Technology for 25/3 Service, Including Fixed Wireless**



### 3.1.2 Analysis of unserved locations—wired technologies only

We repeated our analysis with the FCC's Form 477 data, this time identifying census blocks in the State where no wired provider claims to offer 25/3 broadband service (Figure 8). At a high level, the yellow shaded portions of the map represent the State's unserved geography. Conversely, looking at the Form 477 data for claimed service, we find that most of the State's served premises have more than one option (Figure 9).

**Figure 8: Served Areas (25/3), Wired Only**

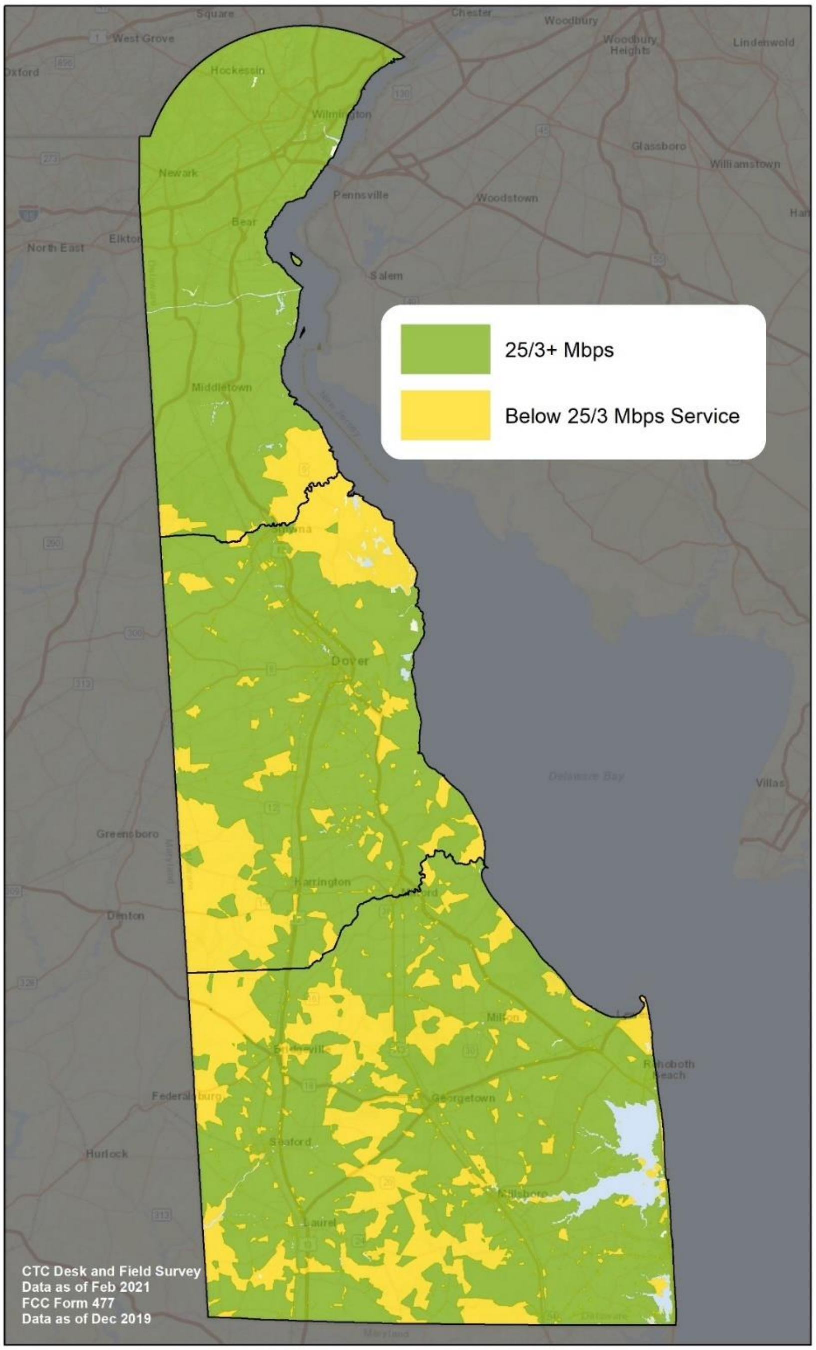
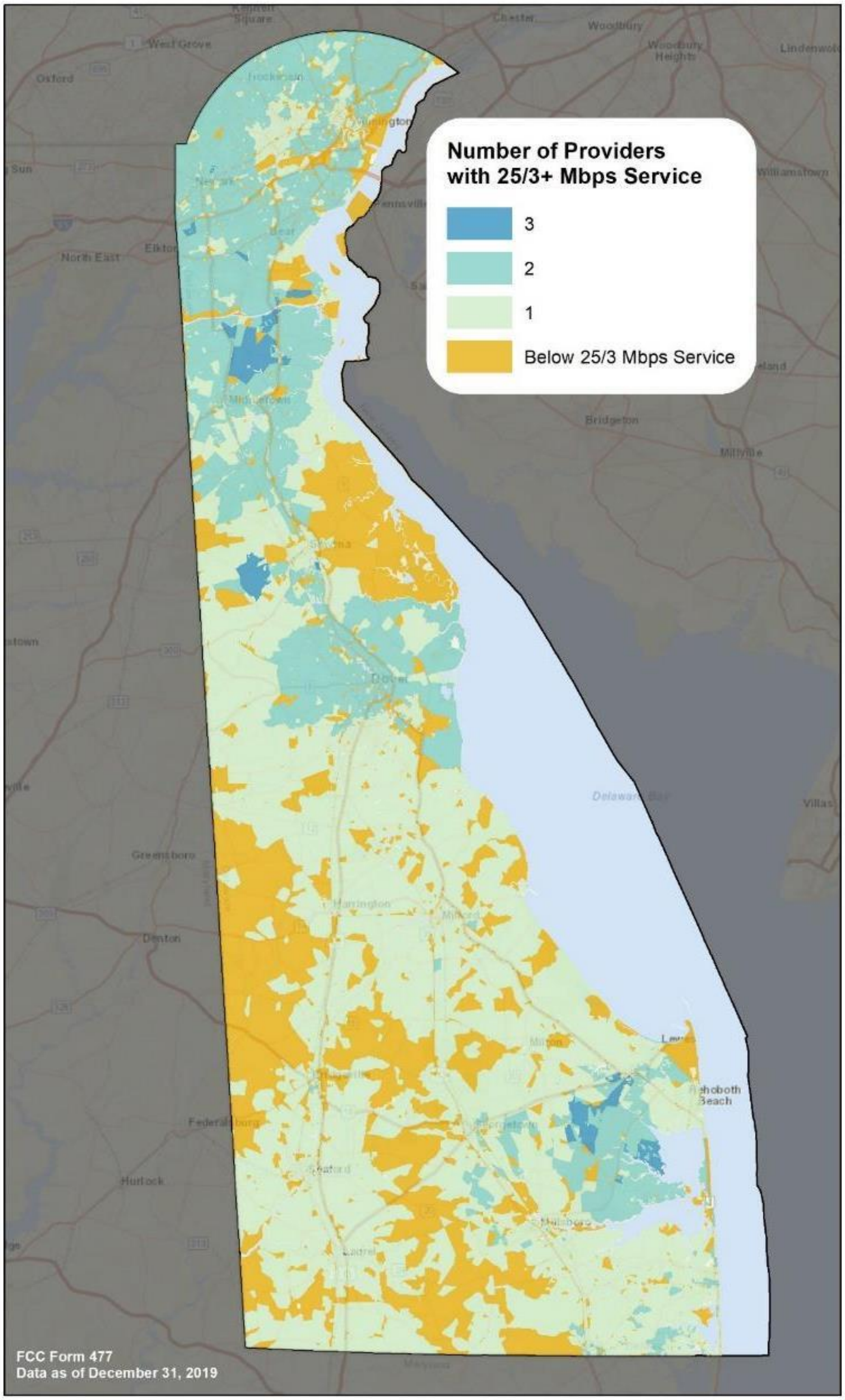


**Figure 9: Number of Providers (25/3), Wired Only**



Although broadband is defined as 25/3 for purposes of our broader analysis, we also assessed the availability of 10/1 service, which is relevant for some federal grant and loan programs. Figure 10 illustrates areas unserved with 10/1. Many areas that are served by 10/1 have multiple providers (Figure 11).

**Figure 10: Served Areas (10/1), Wired Only**

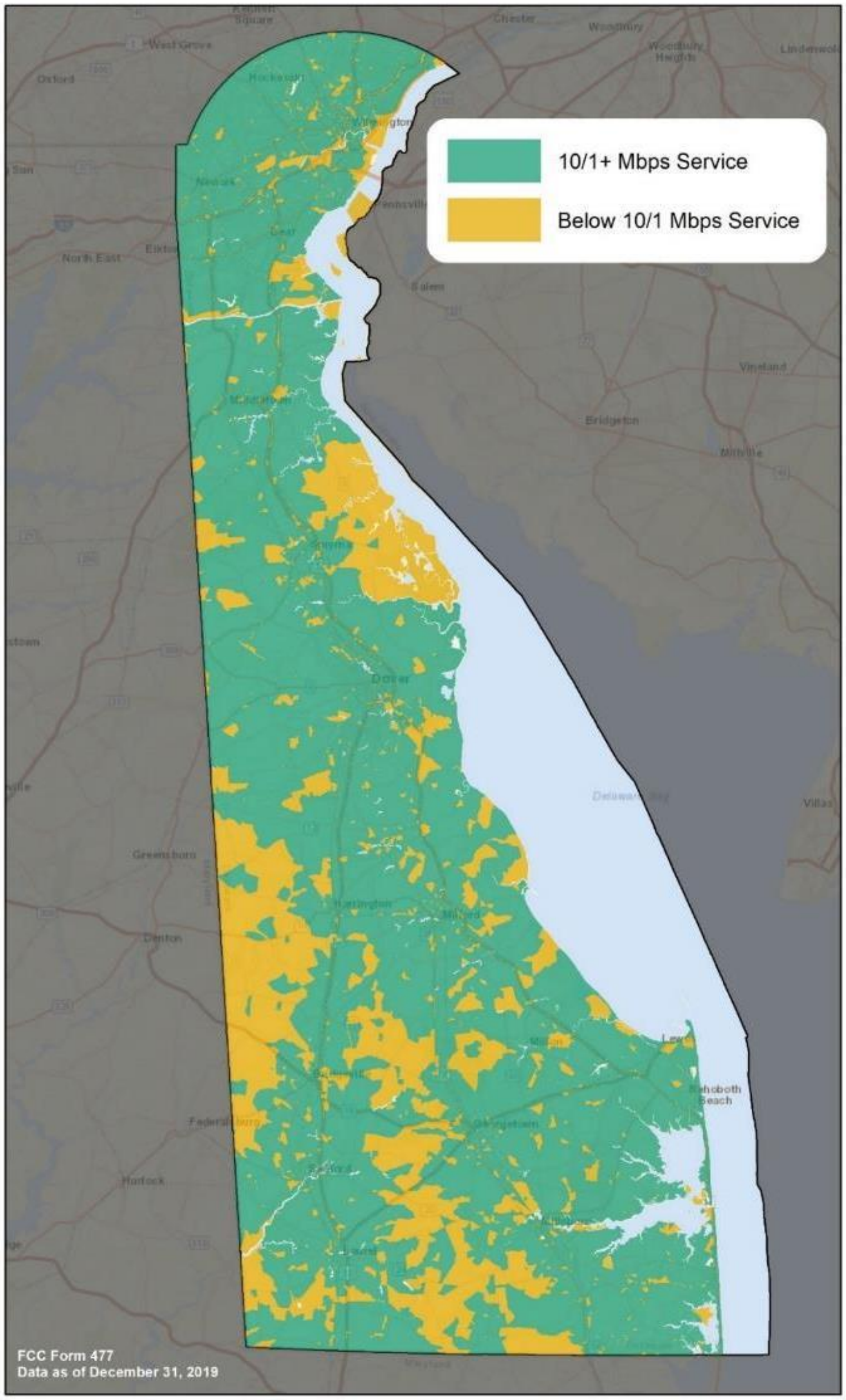
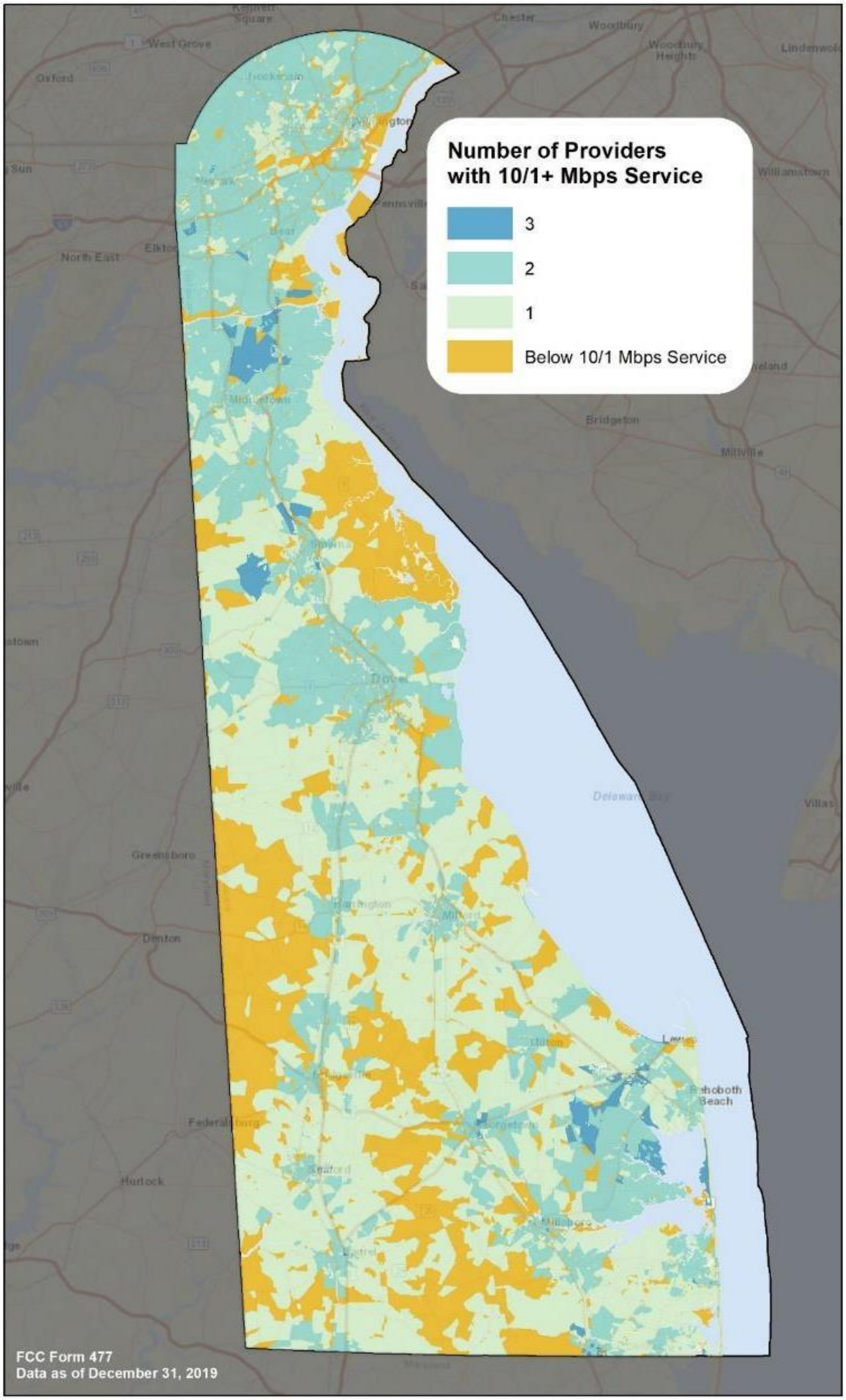


**Figure 11: Number of Providers (10/1), Wired Only**



### 3.1.3 Analysis of unserved locations—fixed wireless technologies only

Fixed wireless technology represents a significant challenge to identifying coverage areas as it is impossible to validate visually and requires detailed technical disclosures by providers, which they will typically not release, or extensive testing in actual residences. In addition, submissions to the FCC by fixed wireless providers are not verified and typically is based on propagation models that may deliver certain speeds in general to a particular area, but in practice is vulnerable to physical obstructions and signal interference. Yet these claims can doom a federal grant application. We therefore conducted our analysis of fixed wireless coverage claims separately from the wired analysis.

We repeated our analysis with the FCC's Form 477 data, this time identifying census blocks in the State where no fixed wireless provider claims to offer 25/3 broadband service (Figure 12). At a high level, the green shaded portions of the map represent the State's provider-claimed served geography in regard to fixed wireless.

Conversely, looking at the Form 477 data for claimed service, we find that most of the State's served premises have more than one fixed wireless option (Figure 13). Note that because current Form 477 data are reported only through December 31, 2019, the data do not reflect recent projects that providers initiated in partnership with the State to expand service.

Additionally, we do not include cellular services in this analysis. While we note that mobile internet is a last resort for some households that do not have access to fixed broadband, it is not a sustainable solution for the State's broadband needs. Mobile solutions rely on the availability of nearby fiber backhaul and towers—and are constrained by shared capacity, which results in unreliable and sub-broadband-speed performance. They are also typically vulnerable to line-of-sight obstacles, and the very same rural areas that lack fixed broadband options experience similar challenges with mobile broadband in terms of high infrastructure costs per address location.

Mobile service plans also typically have data caps that severely limit their usefulness for today's applications, let alone tomorrow's. While 5G has been touted by the wireless industry as a solution to rural broadband, deploying 5G requires enormous investments in closely spaced "small cell" antennas fed with power and fiber; rural areas are unlikely to see such heavy investments to serve a sparsely populated customer base.

**Figure 12: Served Areas – 25/3 Mbps (Fixed Wireless Only, FCC Form 477 Data)**

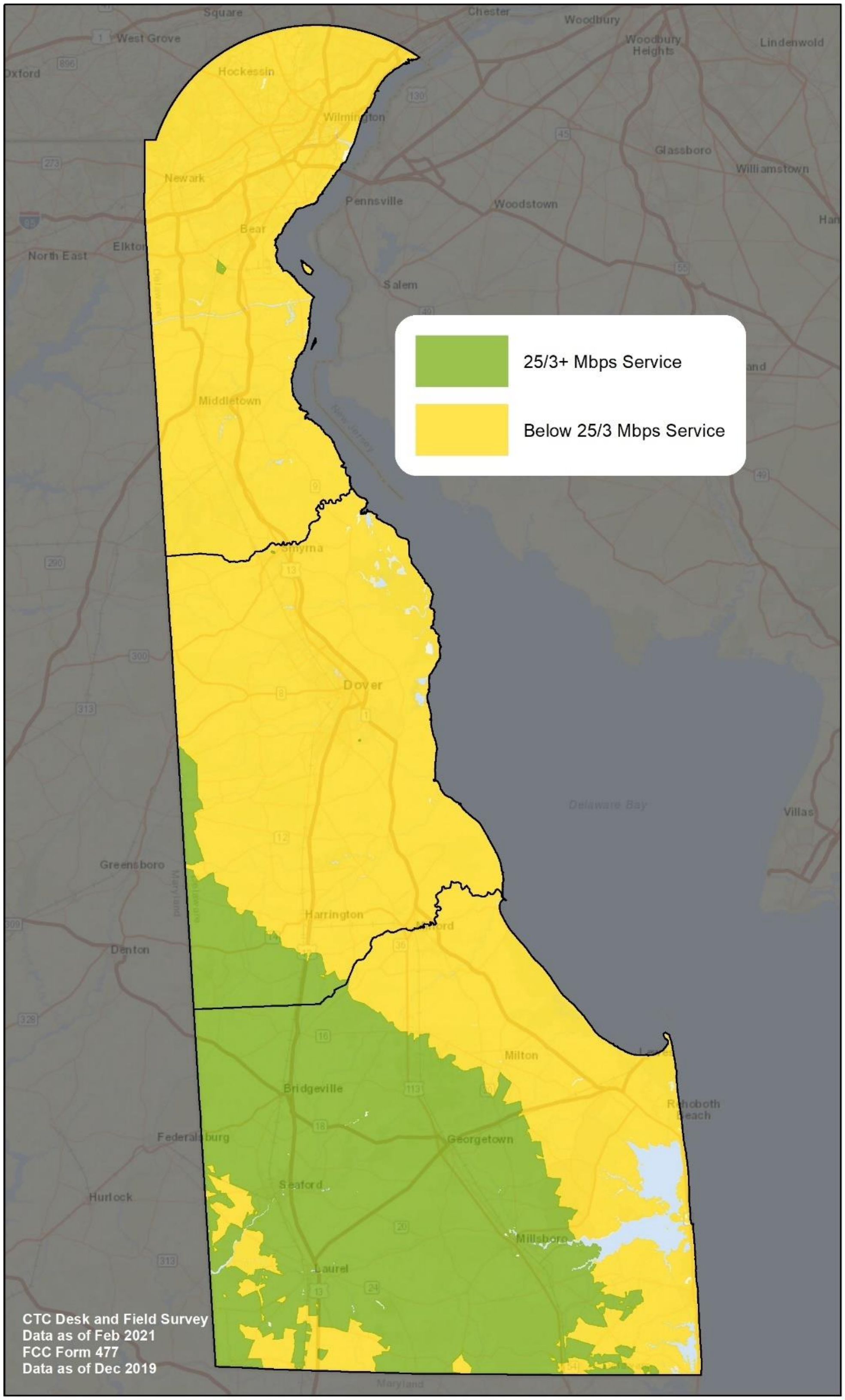
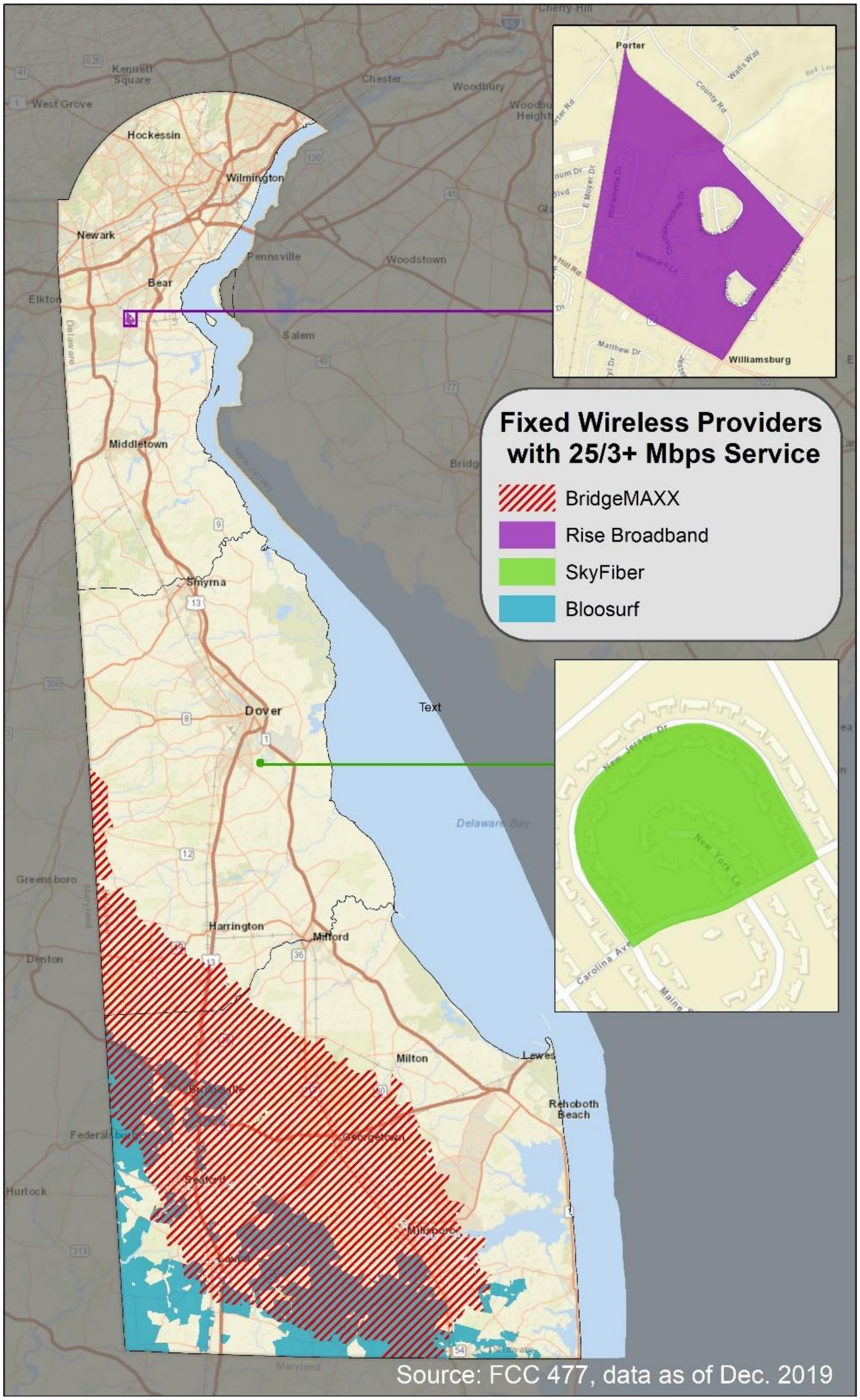


**Figure 13: Number of Providers (25/3), Fixed Wireless Only**



As with the wireline maps, although broadband is defined as 25/3 for purposes of our broader analysis, we also assessed the availability of 10/1 fixed wireless service, which is relevant for some federal grant and loan programs, especially many USDA programs. Figure 14 illustrates areas unserved with 10/1. While the geography covered by 10/1 service is similar to that covered by 25/3 service, Figure 14 shows that the southern coastal region and the southwest corner of the State have 10/1 coverage in some areas that are unserved by 25/3. In addition, many areas that are served by 10/1 have multiple providers (Figure 15).

**Figure 14: Served Areas – 10/1 (Fixed Wireless Only, FCC Form 477 Data)**

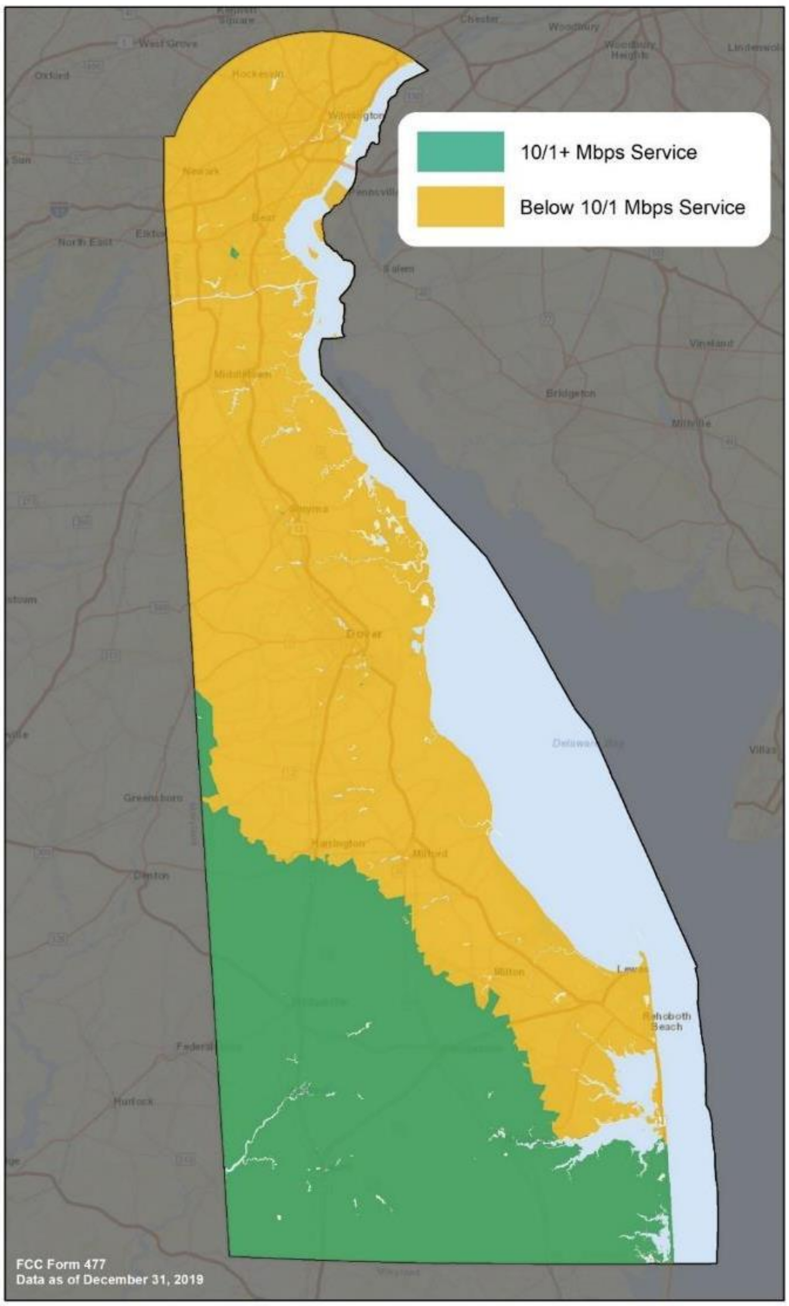
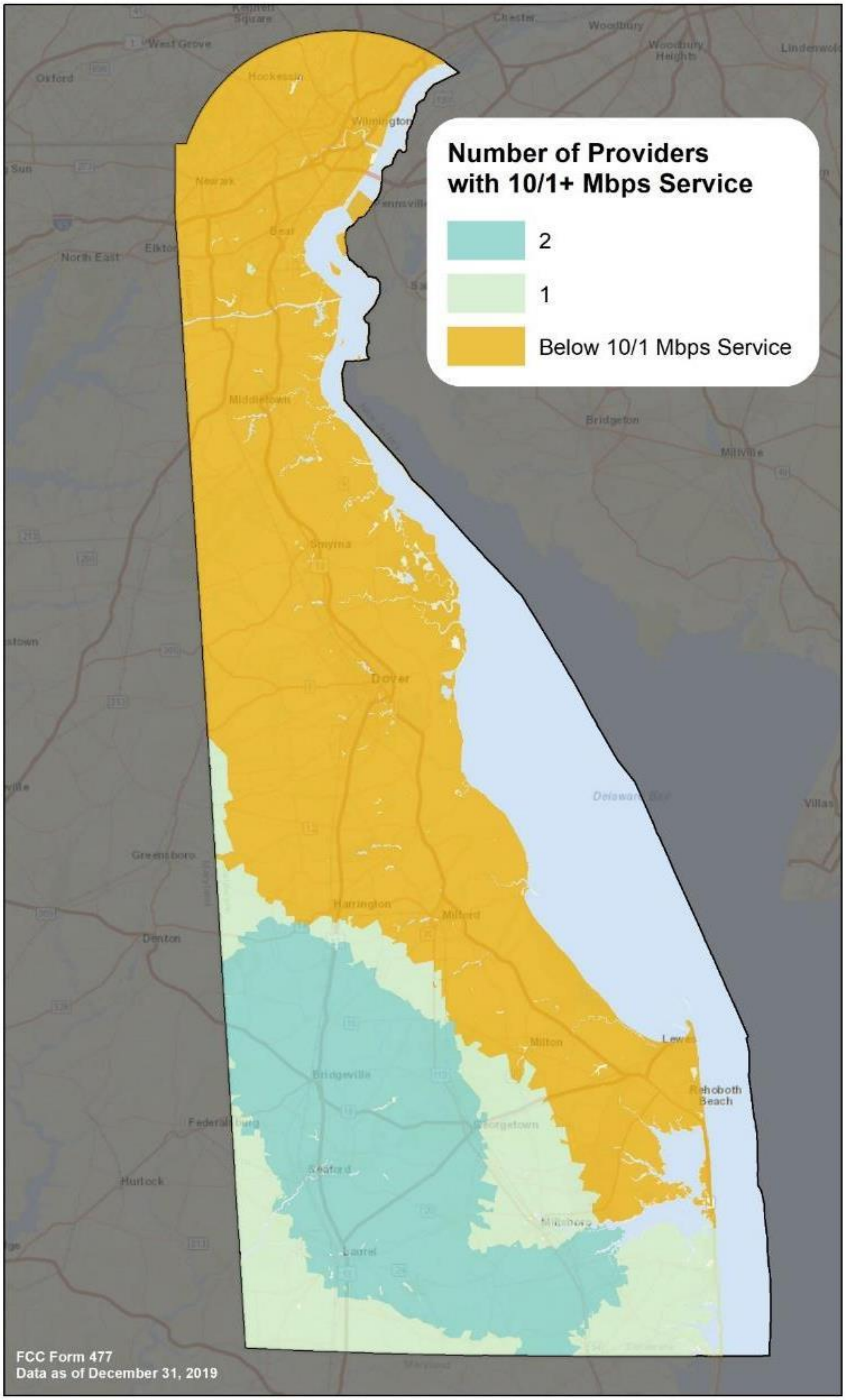


**Figure 15: Number of Providers (10/1), Fixed Wireless Only**



## 3.2 Field surveys validated federal service availability data

To spot-check and verify the availability of telecommunications service determined in our desk survey, and to analyze make-ready conditions for fiber construction, CTC engineers performed a week of field surveys of randomly selected, representative portions of State roadways. The engineers reviewed available green space and the presence and condition of utility poles.

Based on our field survey work we found that the unserved and served areas generally track with the information available in the Form 477 data. We found some areas, particularly around Georgetown where the Form 477 data claim service, but the field inspection found no service. For the most part, this is due to the fact that the providers do serve part of the census block, and therefore count the entire block as served.

We also observed that in the unserved areas the make-ready required on existing utility poles would generally be minimal due to the lack of attachments in the communications space.[11]

### 3.2.1 Map overviews of field survey findings

Figure 16 illustrates our field survey areas statewide as compared to the reported Form 477 data. The subsequent maps illustrate the same data on a more granular level.

[11] As a best practice, for areas where make-ready and pole replacement costs are substantial, we recommend that recipients of State funds conduct outreach to pole owners in the proposed service area to explore any opportunity for reduced cost through project coordination.

**Figure 16: Field Survey Results as Compared to Form 477 Data**

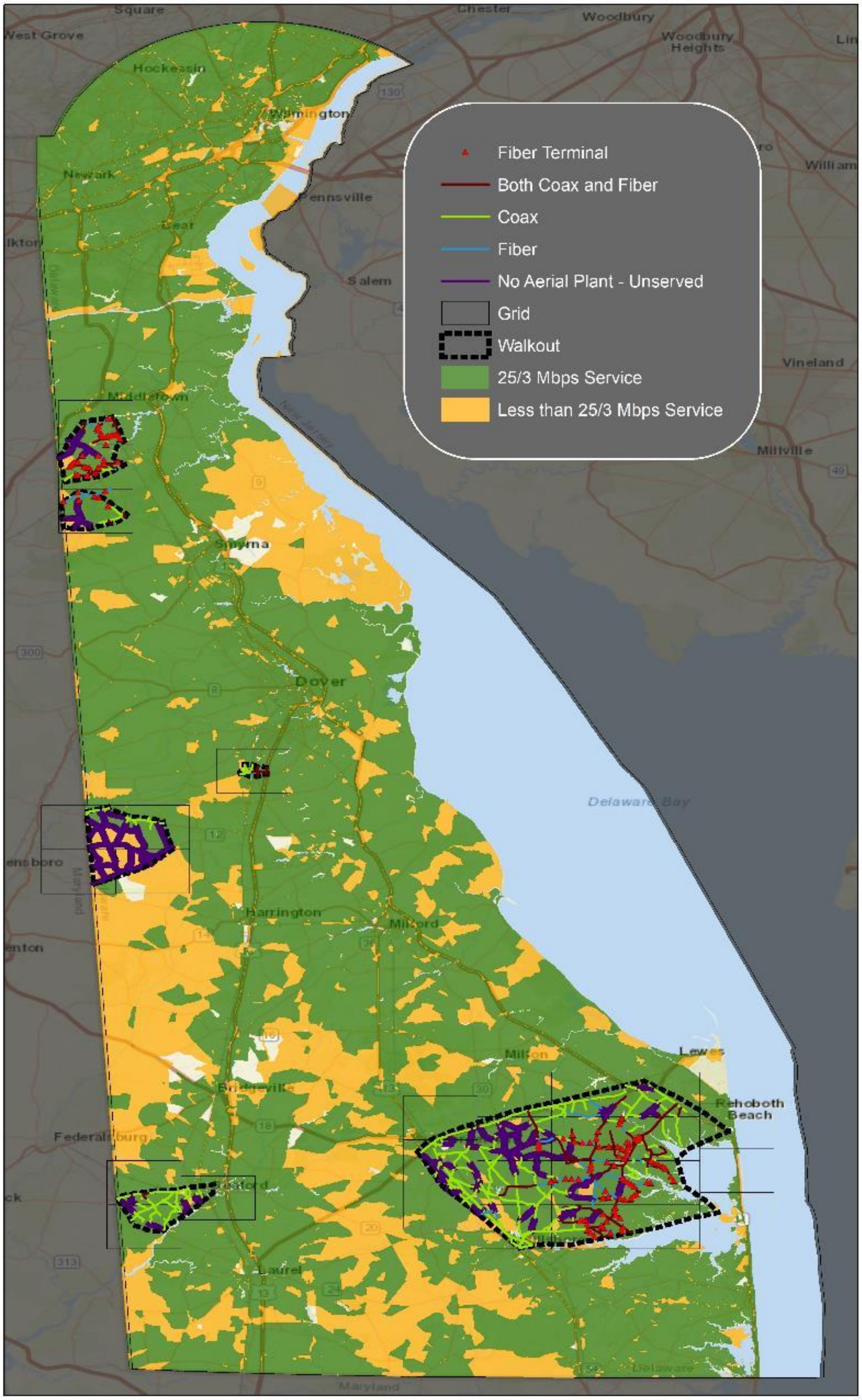


**Figure 17: Field Survey Results as Compared to Form 477 Data – Felton**

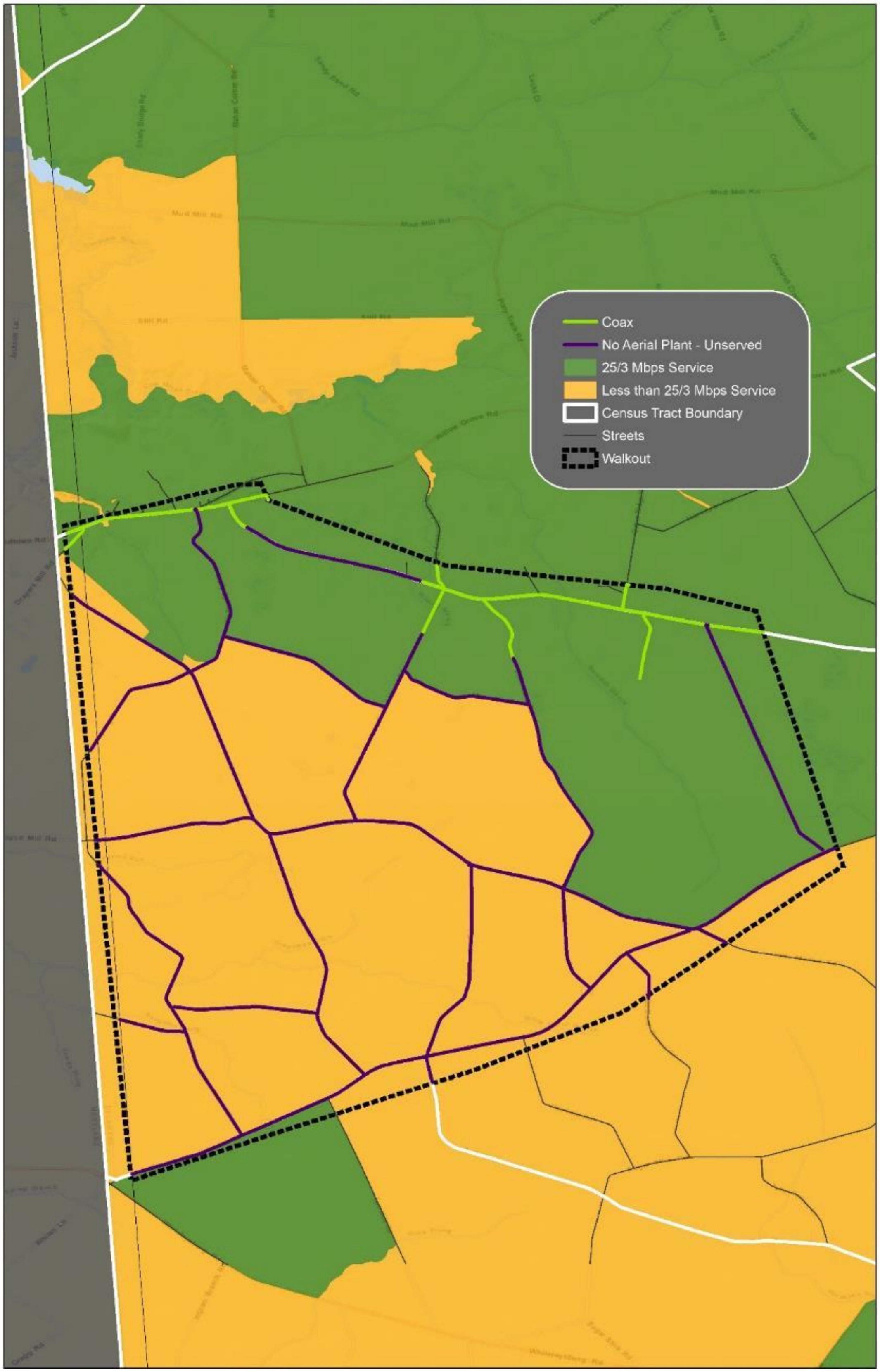


**Figure 18: Field Survey Results as Compared to Form 477 Data – Georgetown**

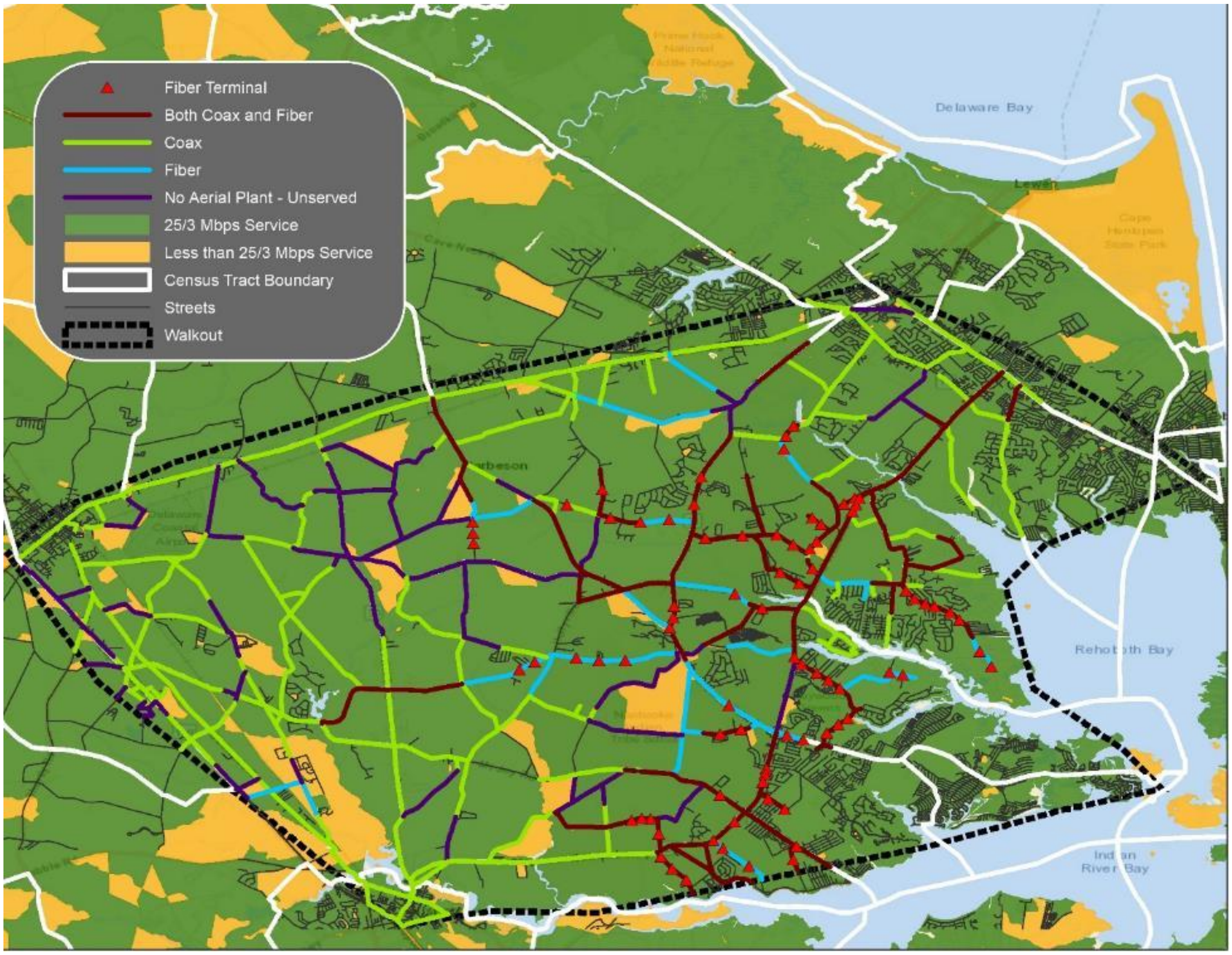


**Figure 19: Field Survey Results as Compared to Form 477 Data – Seaford**

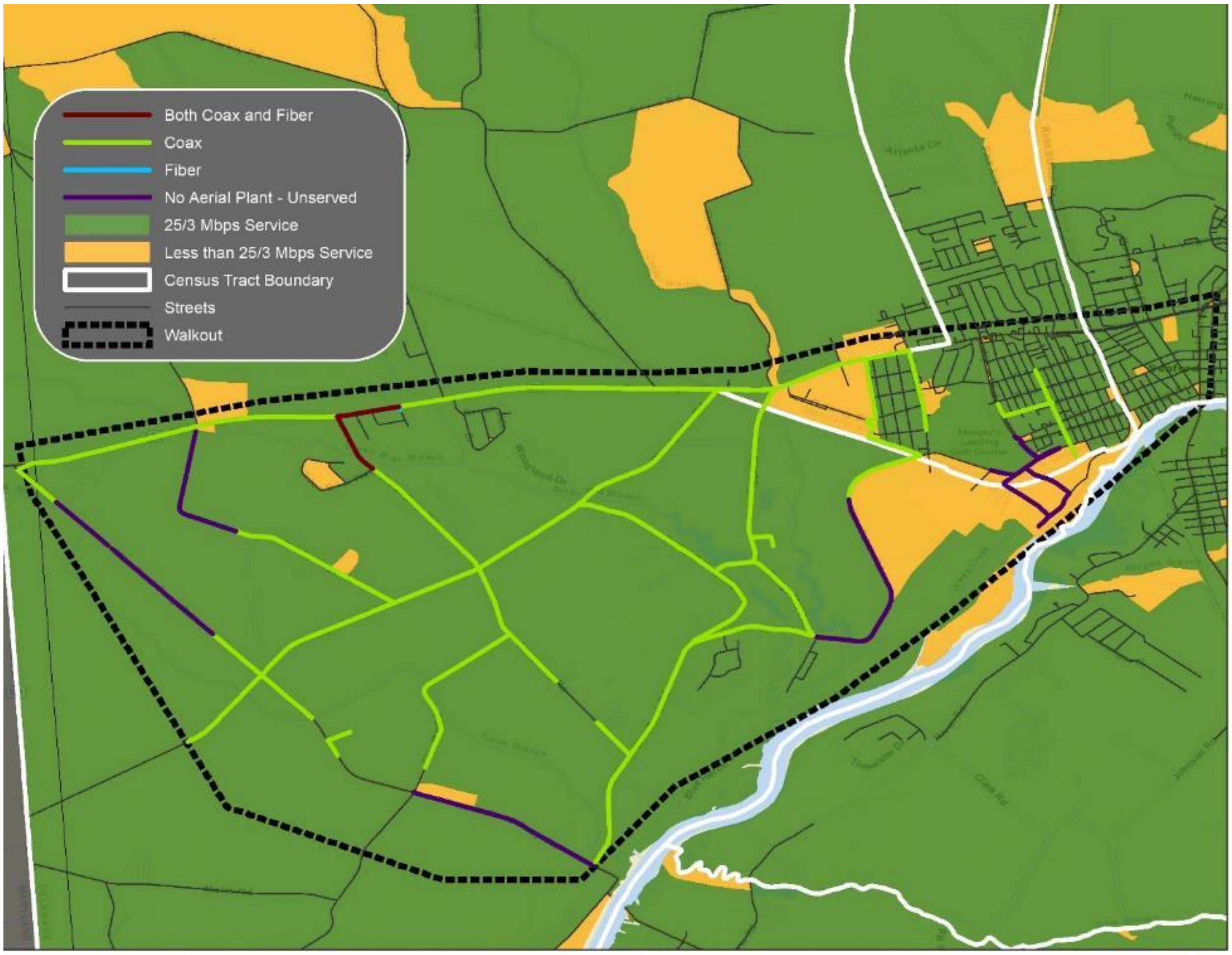


**Figure 20: Field Survey Results as Compared to Form 477 Data – Townsend**

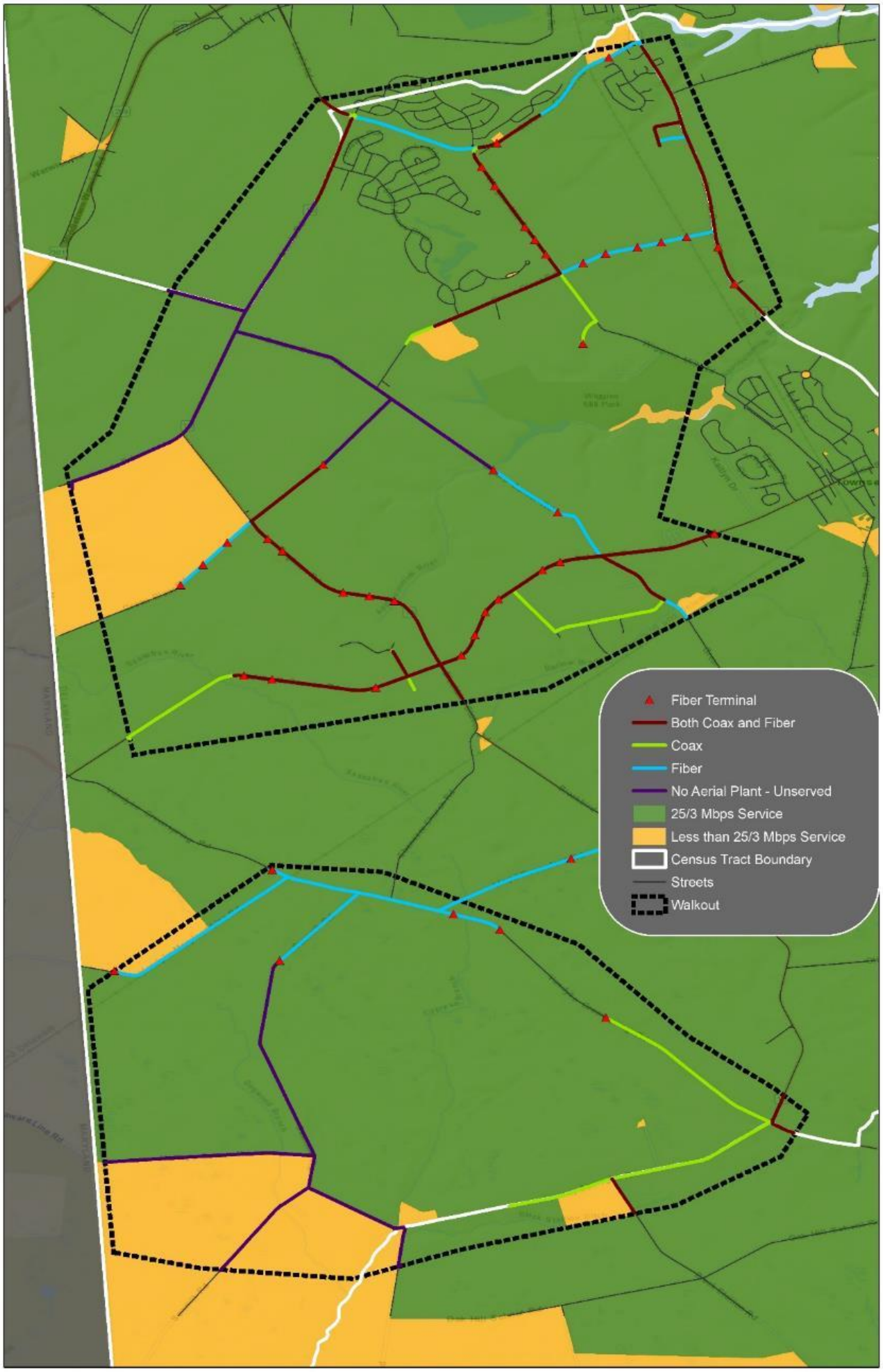


**Figure 21: Field Survey Results as Compared to Form 477 Data – Woodside**

### 3.2.2 Sample field survey findings related to pole lines

The purpose of the field survey was to determine where cable service ends to determine which streets and neighborhoods have service and which do not. Cable service is generally identified by locating the taps and amplifiers used to provide service. Figure 22 is a picture of an amplifier.

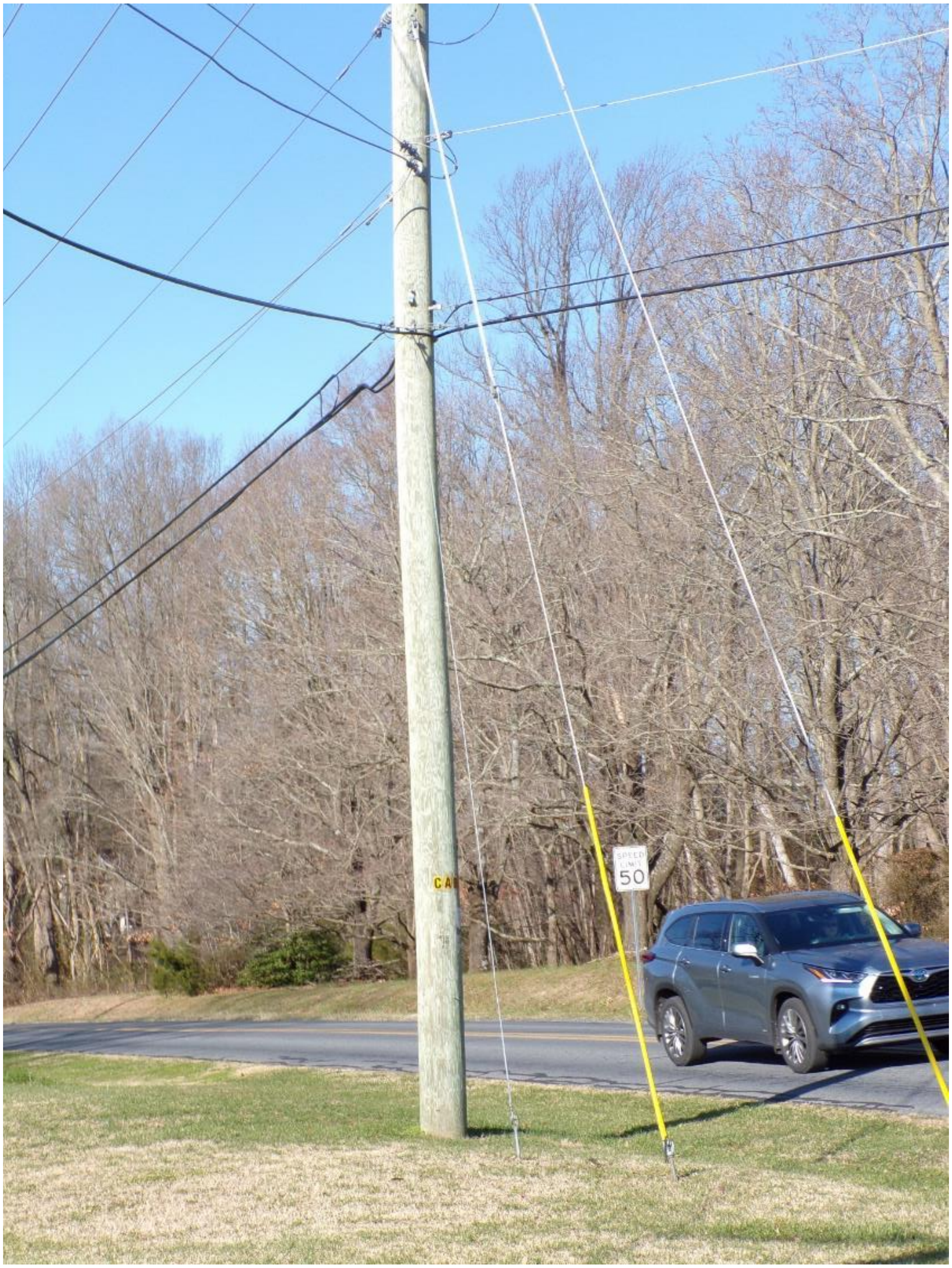
**Figure 22: Cable Amplifier Showing Cable TV Service**

Especially in served areas, the communications space on the utility poles can get congested with multiple attachments and cables in the space. This can make it difficult to add new attachments with performing make ready or pole replacement. Figure 23 is an example of a congested communications space.

**Figure 23: Multiple Attachments and Cable in the Communications Space**

However, our field survey found that generally the communications space on utility poles is in good shape in comparison to other jurisdictions we have surveyed. Even where there are multiple attachments in the communications space, many poles could support an additional attachment (Figure 24).

**Figure 24: Clean Pole Line with Multiple Communications Attachments**



In the unserved areas where cable service does not exist, the telephone service may be on separate telecommunications poles or buried underground, leaving the communications space on the electric utility poles completely open. This situation makes it very easy for a provider to attach to the pole with little or no make-ready (Figure 25).

**Figure 25: Little or No Make-Ready Required in Unserved Areas**

## 3.3 Online speed test survey data provide insight on residents’ experiences with broadband service

The Delaware Speed Survey and speed test went live on August 19, 2020. A promotional email was disseminated to Delaware State employees on September 3, 2020 encouraging them to take the speed survey and test (see Appendix B). During the course of the 45-day test period, 2,366 speed surveys and tests were completed (Figure 26). The test was organized to capture both information regarding *lack of service* as well as *service experience* and included a brief set of questions in addition to the associated speed test.

**Figure 26: Online Speed Survey Website**


### 3.3.1 Speed Tests Largely Confirm Served and Unserved Delineations

Of those surveys completed, 9 percent (211) of respondents replied they did not have service. As depicted in Figure 27 and Figure 28, the tests largely align with our served and unserved maps, although they do show some smaller pockets and edge areas that could be slightly larger than currently. Such pockets of unserved areas inside large blocks of otherwise served areas are fairly typical, as housing developments arise a bit farther than existing network infrastructure is able to reach cost effectively.

**Figure 27: Speed Test Results – Average Download Speeds**

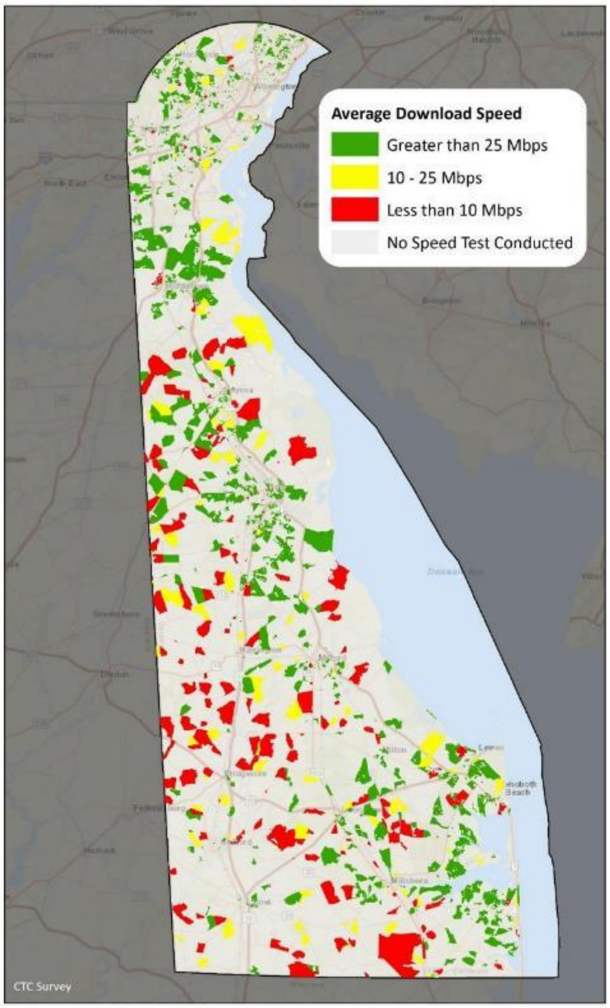
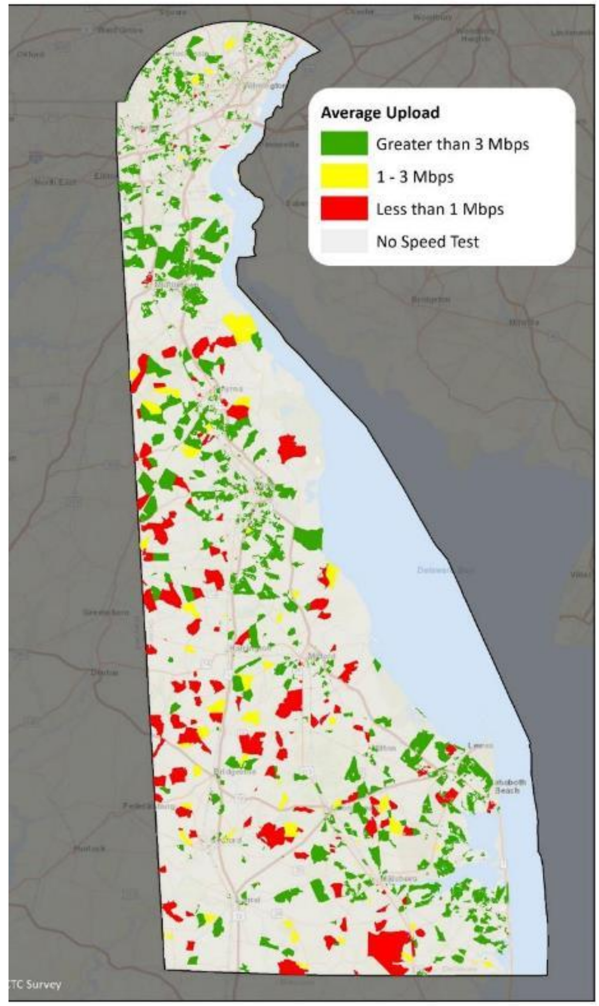


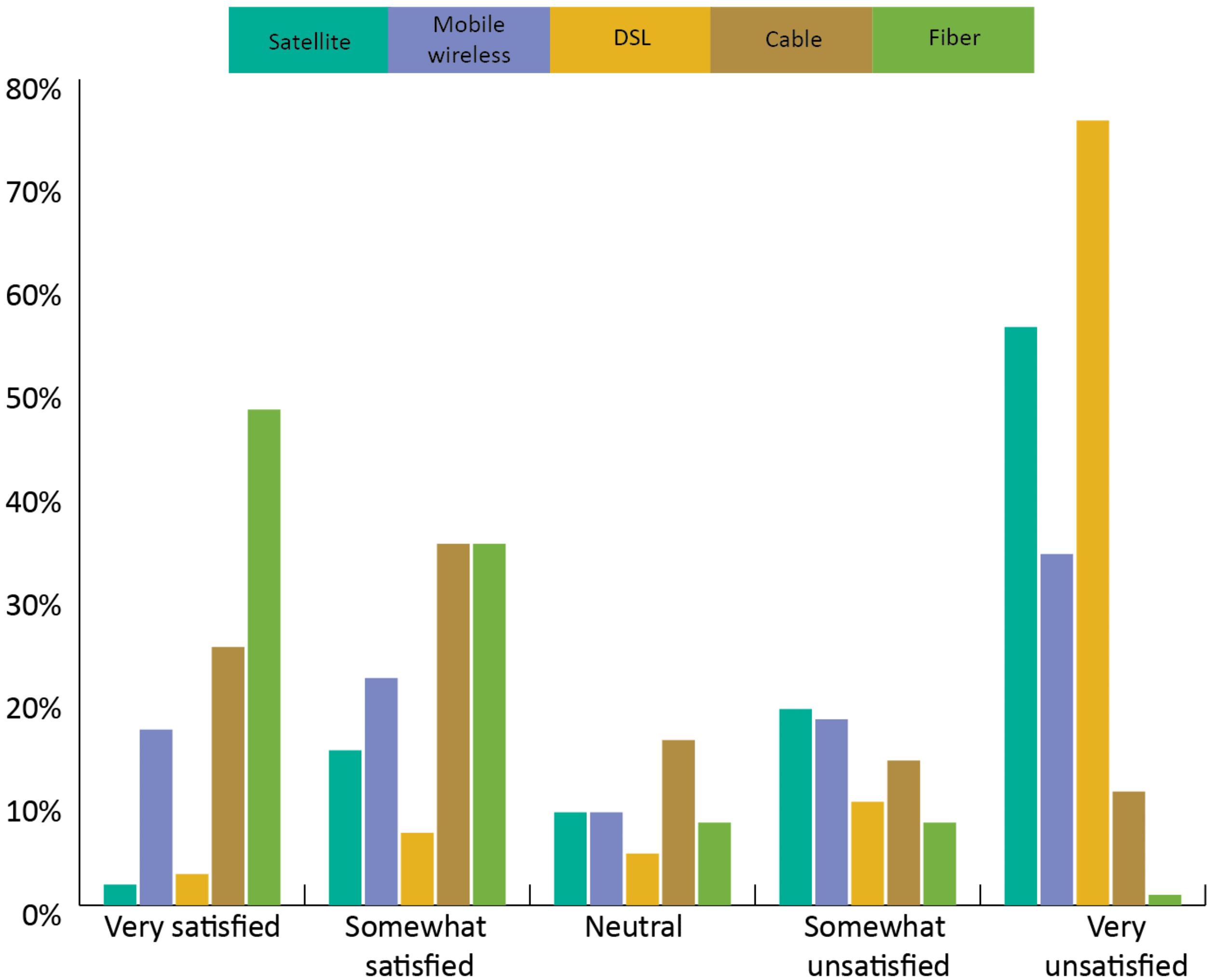

**Figure 28: Speed Test Results – Average Upload Speeds**




### 3.3.2 Fiber Optic Connections Receive the Highest Scores by Far on Speed and Satisfaction

Of the 2,155 respondents who were able to take the speed test, nearly 22 percent (480) were "very unsatisfied" with their Internet Service Provider (ISP), 13 percent (272) were "somewhat unsatisfied," 11 percent (236) identified as feeling "neutral" with their ISP, 24 percent (525) were "very satisfied" with their ISPs, and 1 percent (28) did not provide their satisfaction with their ISPs. Figure 29 illustrates these results by the users' technology types. We broke down levels of satisfaction by technology type and provider. Figure 29 illustrates the results. From a technology perspective, fiber gets the highest satisfaction by far, followed by cable. DSL receives the highest dissatisfaction rates, worse than even high latency Satellite connections, reflecting not just the dismal speeds, but also the lack of investment in and customer support of the aging copper infrastructure. Mobile gets generally poor marks but has fewer neutral responses. This could potentially reflect more variability around cell phone reception and location rather than technology type and speed capability.

**Figure 29: Speed Test Results—Customer Satisfaction by Technology (Excluding Fixed Wireless)**




We omitted fixed wireless from this analysis because we found that most respondents who classified their service as fixed wireless conducted their speed tests from their place of work rather than home, confused a home Wi-Fi router with fixed wireless service (which would involve an antenna mounted on a rod or other structure), or were using a one-off business point-to-point solution and not residential fixed wireless. We noted that there was not a single speed test result or declared customer of the two main fixed wireless providers serving rural areas of the State (Bloosurf or BridgeMAXX). There were a few test points by WhyFly (which operates in Wilmington), but not enough to draw conclusions.

When measuring speeds by connection type, DSL performed the lowest with average download/upload speeds of 28/18, while fiber connections yielded near symmetric speeds of 189/181, as shown in Figure 30.

This actually significantly overstates actual DSL speeds, given that this type of upload speed is not generally technically obtainable with DSL. We suspect that cable respondents may have incorrectly picked DSL as their technology and Comcast as their provider, for example, with the result that the average speed on tests categorized as DSL was inflated. We also included "Other."

We also note a large proportion of respondents seem to have conducted tests over high-capacity government network links—many of them likely fiber—but answered the questionnaire about their home address.

**Figure 30: Speed Test Results – Average Speeds by Technology Type**

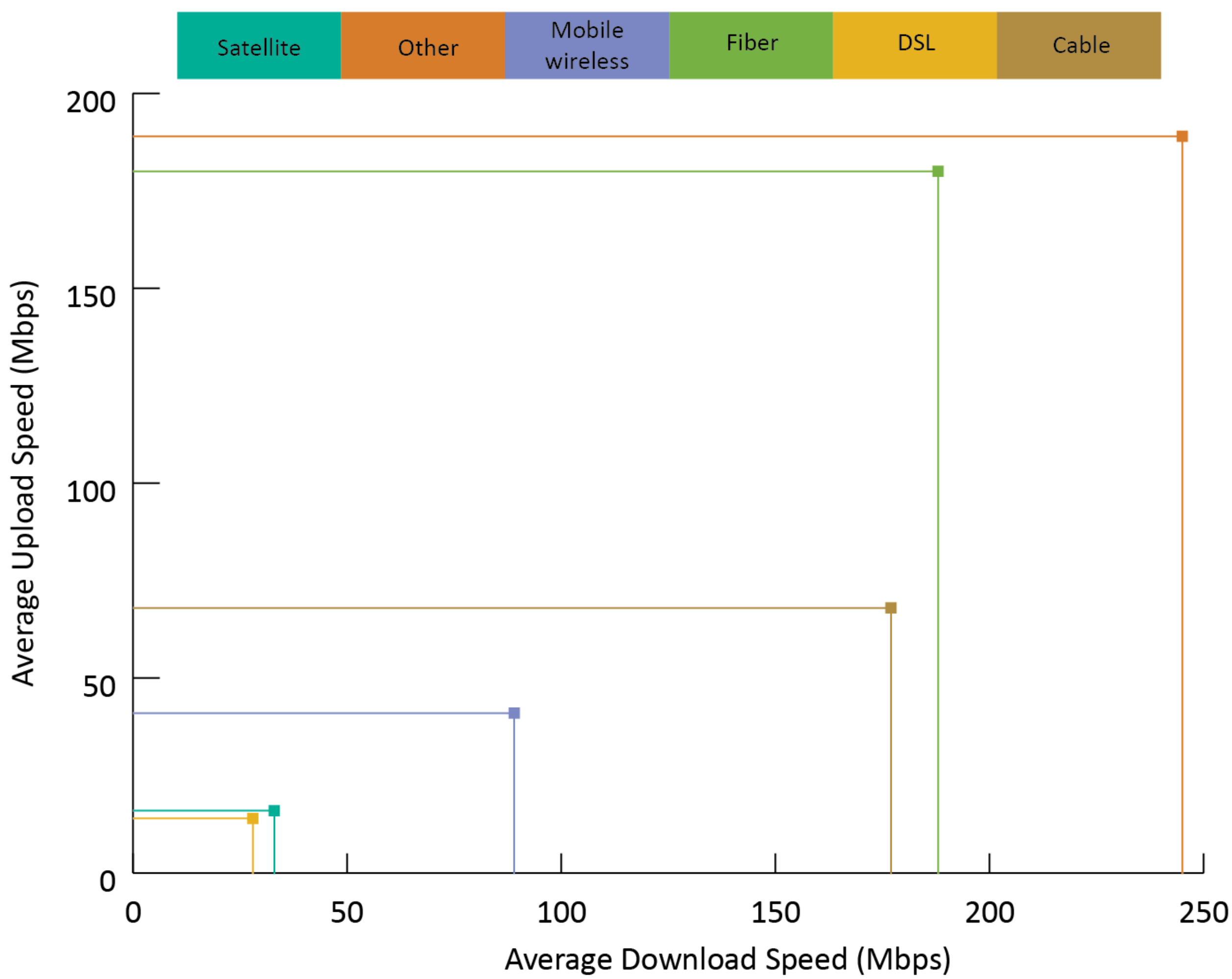
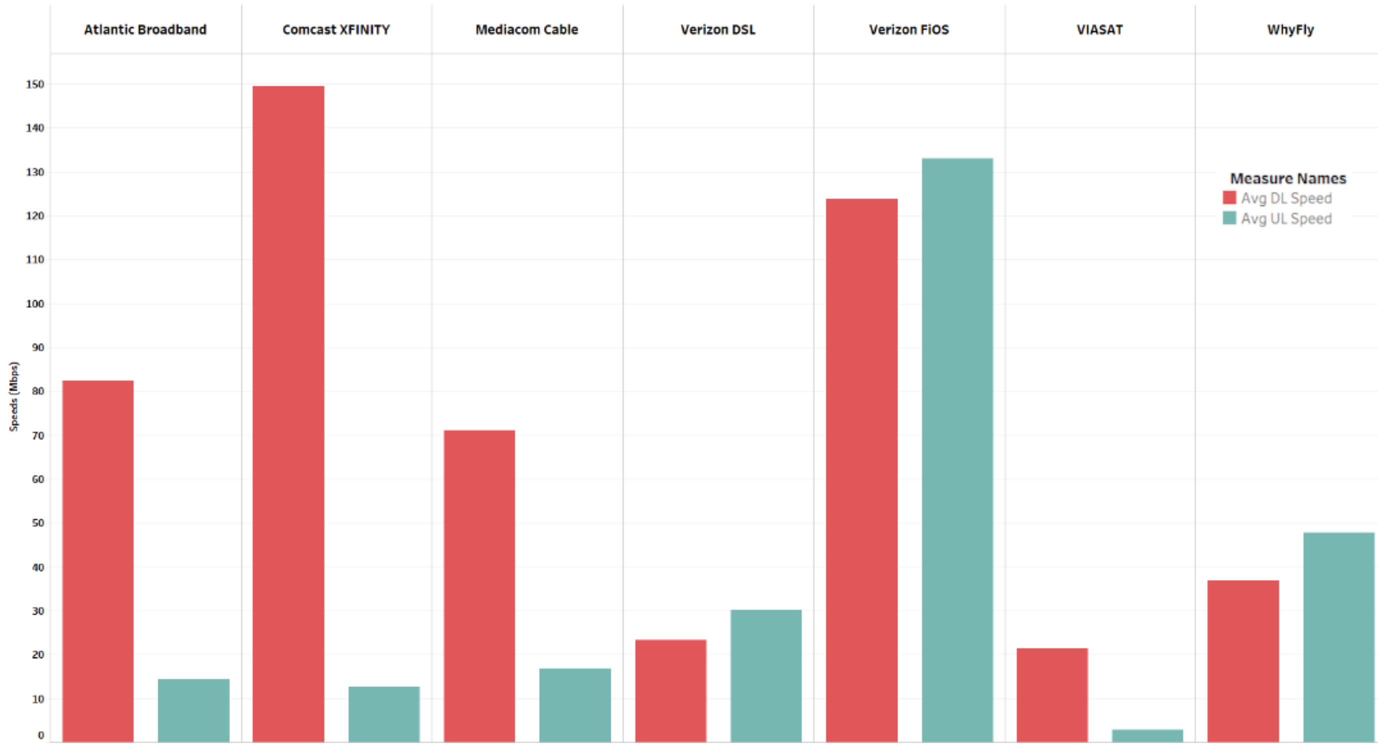


Figure 31 shows the speed test result by provider. These results track well with the technology.

**Figure 31: Speed Test Results – Average Download Speeds by Provider**




What these results show is that fiber is king when it comes to experienced performance. It has the highest customer satisfaction, download speeds in the same general range as cable and—by far—the fastest upload speeds. While this is not surprising, it illustrates a critical point, when zeroing in on the distribution of these technologies geographically, and socioeconomically.

Figure 27 and Figure 28 (above) show speed test results in unserved areas, and upload and download speed results that meet different speed tier criteria. Not surprisingly, these maps confirm our findings regarding the unserved areas, but they also illustrate the risk of a potentially increasing geographic divide by virtue of differing technology infrastructure distributions within the State.

The wide gap in upstream speeds—critical for telemedicine, distance learning, and telework, is one of the most important differentiators in the type of broadband services in the Covid and post-Covid eras. This is where fiber shines and presents itself as the most future-proof sustainable broadband infrastructure.

While cable cannot provide the levels of service that fiber can, it significantly outperforms DSL. Satellite brings up the rear, while mobile generally performs inconsistently. As mentioned we excluded fixed wireless because we could not identify verifiable residential fixed wireless responses; we would expect to have high variance in responses with some customers with clear line of sight and close proximity to a tower reporting relatively high satisfaction while many others would report frustration with legacy fixed wireless technologies.

Notably, only fiber delivers symmetric performance. Some cable connections even fail to deliver on the modest promised upstream capacity. That is not necessarily a permanent limitation of the technology: the division between capacity allocations between downstream and upstream could theoretically be adjusted by cable providers to meet the need of high-bandwidth telehealth and videoconferencing applications, but would require some changes in equipment.

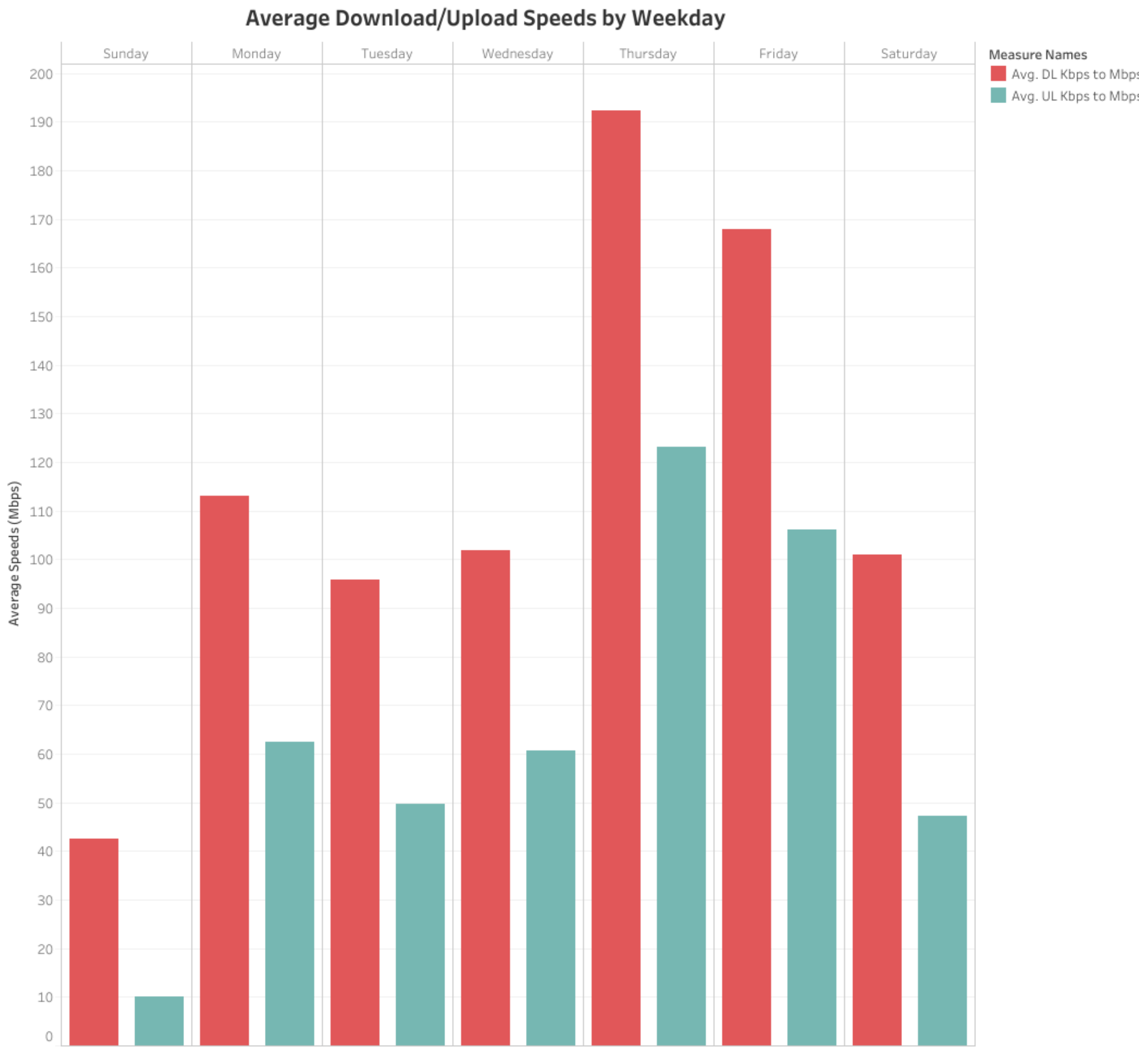
In Delaware, Comcast offers no more than 35 Mbps upstream on its fastest connections according to FCC data. Mediacom offers a more generous 50 Mbps, as does Atlantic Broadband. These are pretty typical speed allocations in the cable industry. DOCSIS 4.0 will offer symmetrical-speed broadband over existing hybrid fiber-coax networks, but it is under development by the cable industry and is likely five to 10 years away; it also is unlikely that rural areas would be the first in line to receive such upgrades.

For Delaware residents that have access to it, fiber is still the best option for handling both downstream as well as upstream requirements.

### 3.3.3 COVID-19 Did Not Have a Significant Effect on ISP Performance

While the start of the school year (September 8, 2020) did not seem to affect respondents' average speeds (i.e., increased network use by students working from home did not reduce service speeds), the data revealed that both the average download and upload speeds spiked to 192/123 on Thursdays and plummeted to 42/10 on Sundays. This was across all ISPs and connection types (Figure 32).

**Figure 32: Speed Test Results – Average Speeds by Day**

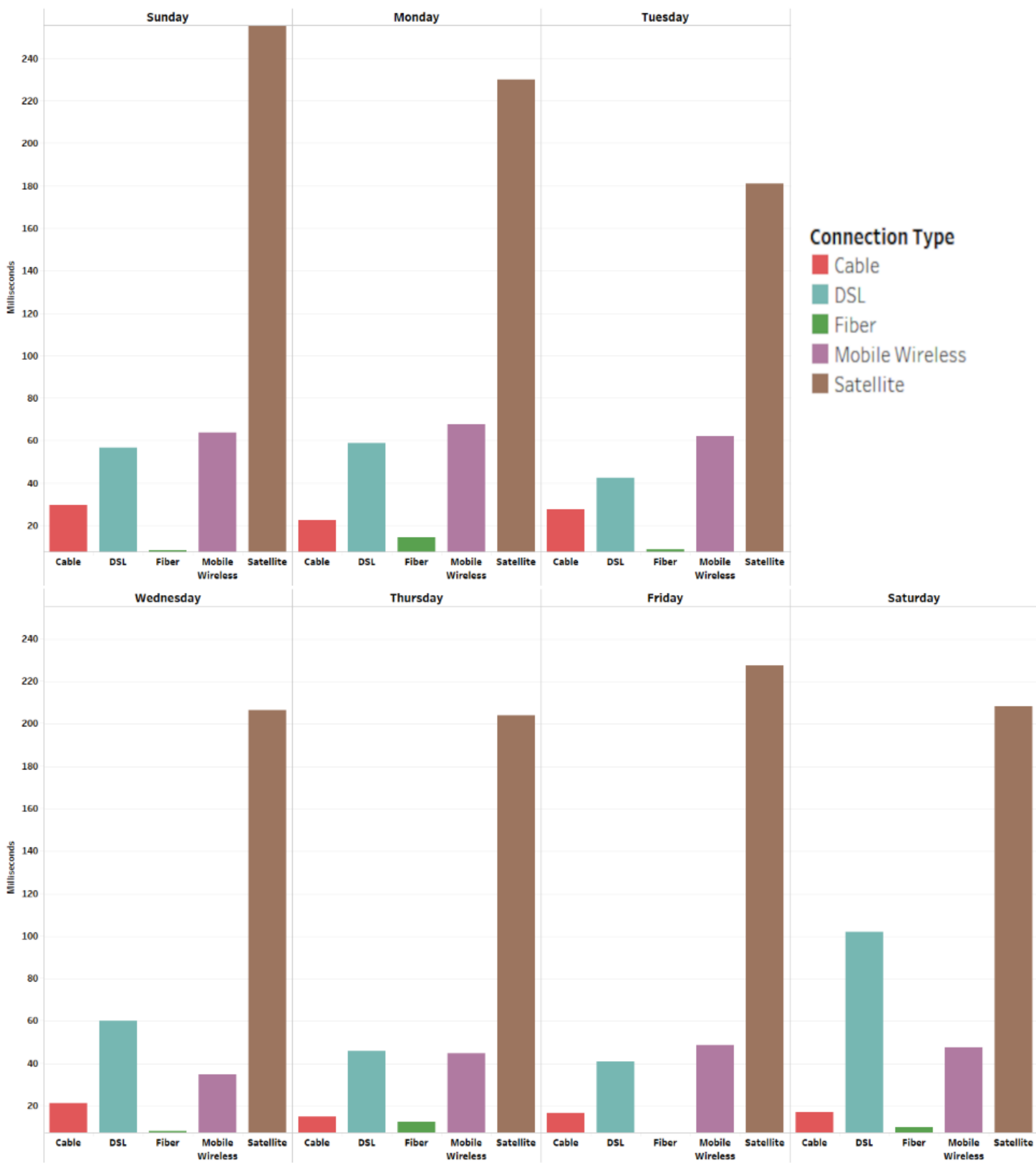



We believe the variation in average speeds is an effect of the loading of the network, with the average speeds an inverse reflection of the strain/demand on network capacity. Highest speeds on Thursday and Friday therefore means these days see the least amount of network traffic.

To understand if any increased demand had other performance effects on various provider technologies, we graphed latency. Latency is round trip travel time of a data packet making its way from the measurement location to a test server and back again to the measurement point. High latency may impact the performance of interactive applications, such as Zoom and streaming video.

Figure 33 illustrates the gap between different technologies when there is pressure on capacity. As expected, fiber optic customers receive the best performance. But even cable is not performing ideally. Latency should be under 30 to 40 ms for good-quality VoIP and videoconferencing. But Sunday and Tuesday averages are already around 30 ms. That means there are plenty of customers experiencing fluctuations above those values. As indicated earlier, we do not have enough verifiable fixed wireless speed tests to show its performance, but inconsistent signal strength and random interference could easily frustrate lower speed connections.

**Figure 33: Latency Performance by Technology and Weekday**



# 4 Delaware's Level of Service Availability and Competition Compares Favorably to Levels in Nearby States

CTC performed research to see how Delaware compares to four nearby states—Maryland, New Jersey, Connecticut, and Rhode Island—with respect to access to broadband. We reviewed FCC Form 477 data and data from the U.S. Census Bureau.

As described earlier, the FCC collects data through a required filling called Form 477, in which broadband providers state whether service is available in census blocks. In spite of the data's shortcomings,[12] the metric of number of providers providing service can be considered a rough, if exaggerated, proxy for how well a state is served. Form 477 data also serve a valuable purpose in providing a dataset that uses standardized processes and definitions across all states, allowing for comparison.

In all five states, the FCC says that the entire state has access to 10/1 Mbps and 25/3 Mbps service, and that few areas are unserved by 100/10 Mbps or 250/25 Mbps service. However, in each state, very few—if any—premises are served by 1,000/100 Mbps service. The patterns of availability across each speed tier are consistent among all five states, and Delaware ranks comparably (Table 2).

**Table 2: Percent of Premises With Access to Various Speed Tiers (FCC Form 477 Data)**

| State | 10/1 Mbps | 25/3 Mbps | 100/10 Mbps | 250/25 Mbps | 1,000/100 Mbps |
|---|---|---|---|---|---|
| Delaware | 100 | 100 | 96 | 96 | 0 |
| Maryland | 100 | 100 | 96 | 93 | 1 |
| New Jersey | 100 | 100 | 99 | 97 | 1 |
| Connecticut | 100 | 100 | 99 | 94 | 4 |
| Rhode Island | 100 | 100 | 99 | 99 | 0 |

In all five states, the FCC says there are at least two broadband providers reaching all residents with 25 Mbps download, 3 Mbps upload (25/3) service. Delaware ranks comparably among the other states with respect to what percentage of the State has access to three providers according to FCC data. Table 3 shows these data for both 25/3 service and 10/1 service.

[12] Although the reporting is mandatory, the data overstate actual availability because the FCC considers a census block served if only a single location within the block is served.

**Table 3: Percent of Premises With Three or More Broadband Providers (FCC Form 477 Data)**

| State | 25/3 Service | 10/1 Service |
|---|---|---|
| Delaware | 98 | 98 |
| Maryland | 97 | 98 |
| New Jersey | 99 | 99 |
| Connecticut | 99 | 100 |
| Rhode Island | 99 | 99 |

The percentage served by 25/3 and 10/1 service dropped significantly across all five states when satellite providers were removed—or, stated otherwise, when only fixed terrestrial services were considered. In this scenario, the percentage served in Delaware fell in the middle or close to the middle of the rankings. Table 4 shows these data for both 25/3 service and 10/1 service.

**Table 4: Percent of Premises with Fixed Terrestrial Broadband Providers (FCC Form 477 Data)**

| State | 25/3 Service<br>*Percent of Population with Two or More Providers* | 25/3 Service<br>*Percent of Population with Three or More Providers* | 10/1 Service<br>*Percent of Population with Two or More Providers* | 10/1 Service<br>*Percent of Population with Three or More Providers* |
|---|---|---|---|---|
| Delaware | 63 | 5 | 70 | 9 |
| Maryland | 62 | 12 | 66 | 18 |
| New Jersey | 65 | 4 | 77 | 4 |
| Connecticut | 15 | 1 | 87 | 7 |
| Rhode Island | 87 | 0 | 87 | 2 |

In all five states, nearly all premises are served by wireline (cable or fiber) service at 100/10 Mbps speeds, according to the FCC's data (Table 5).

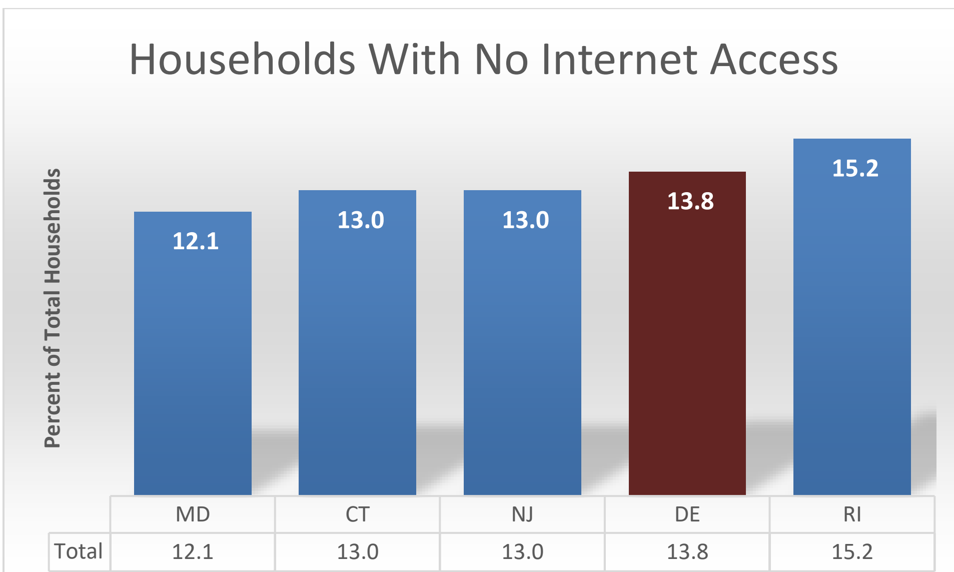
**Table 5: Percent of Premises Served by Cable or Fiber Service at 100/10 Mbps**

| State | 100/10 Mbps Cable or Fiber |
|---|---|
| Delaware | 96 |
| Maryland | 96 |
| New Jersey | 98 |
| Connecticut | 99 |
| Rhode Island | 99 |

An analysis of U.S. Census data finds that by many measures related to digital equity, Delaware is also comparable to those other states.

Data from the American Community Survey (2014 – 2018) show that 13.8 percent of households in Delaware reported they did not have internet access, comparable to the rates reported in other states (Figure 34).

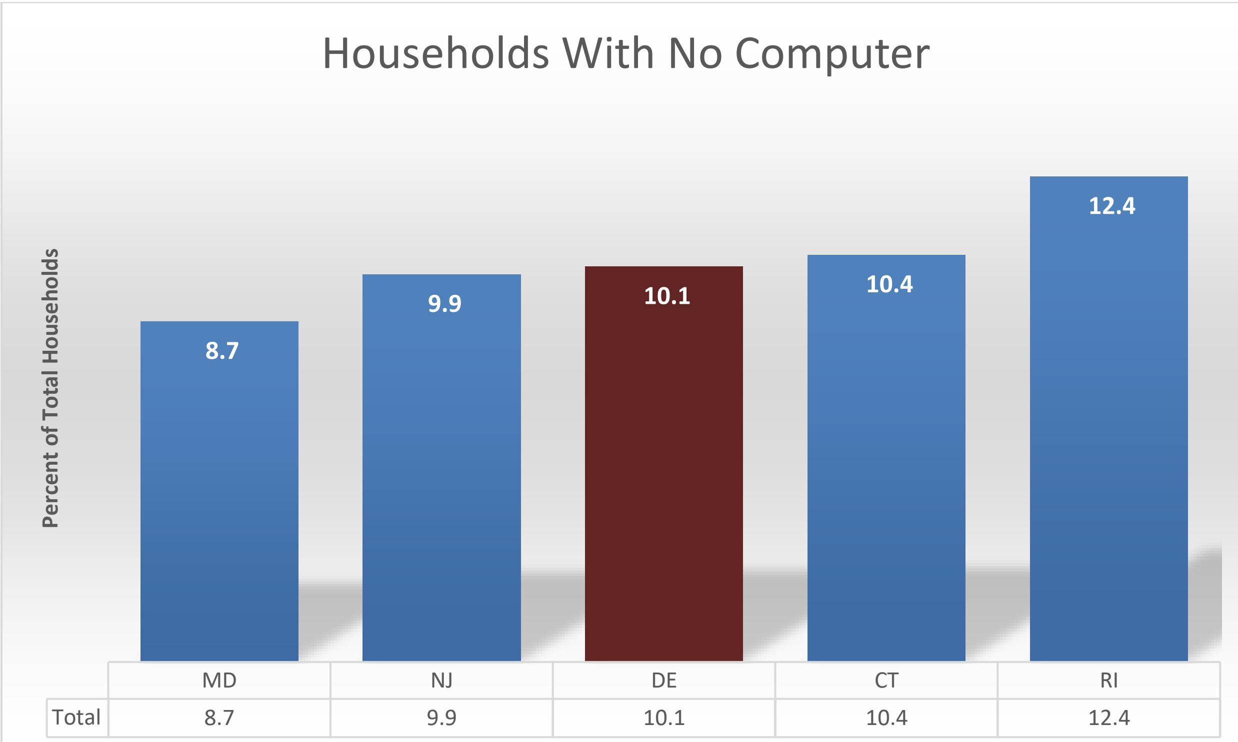
**Figure 34: Comparison of Households With No Internet Access[13]**




Additionally, about 10 percent of households in Delaware reported that they did not have a computer in the household. Lack of access to a computer could impede families' ability to leverage the internet, even if they do have home broadband (Figure 35).

[13] U.S. Census Bureau, American Community Survey (2014-2018), https://data.census.gov/cedsci/ (accessed December 2020).

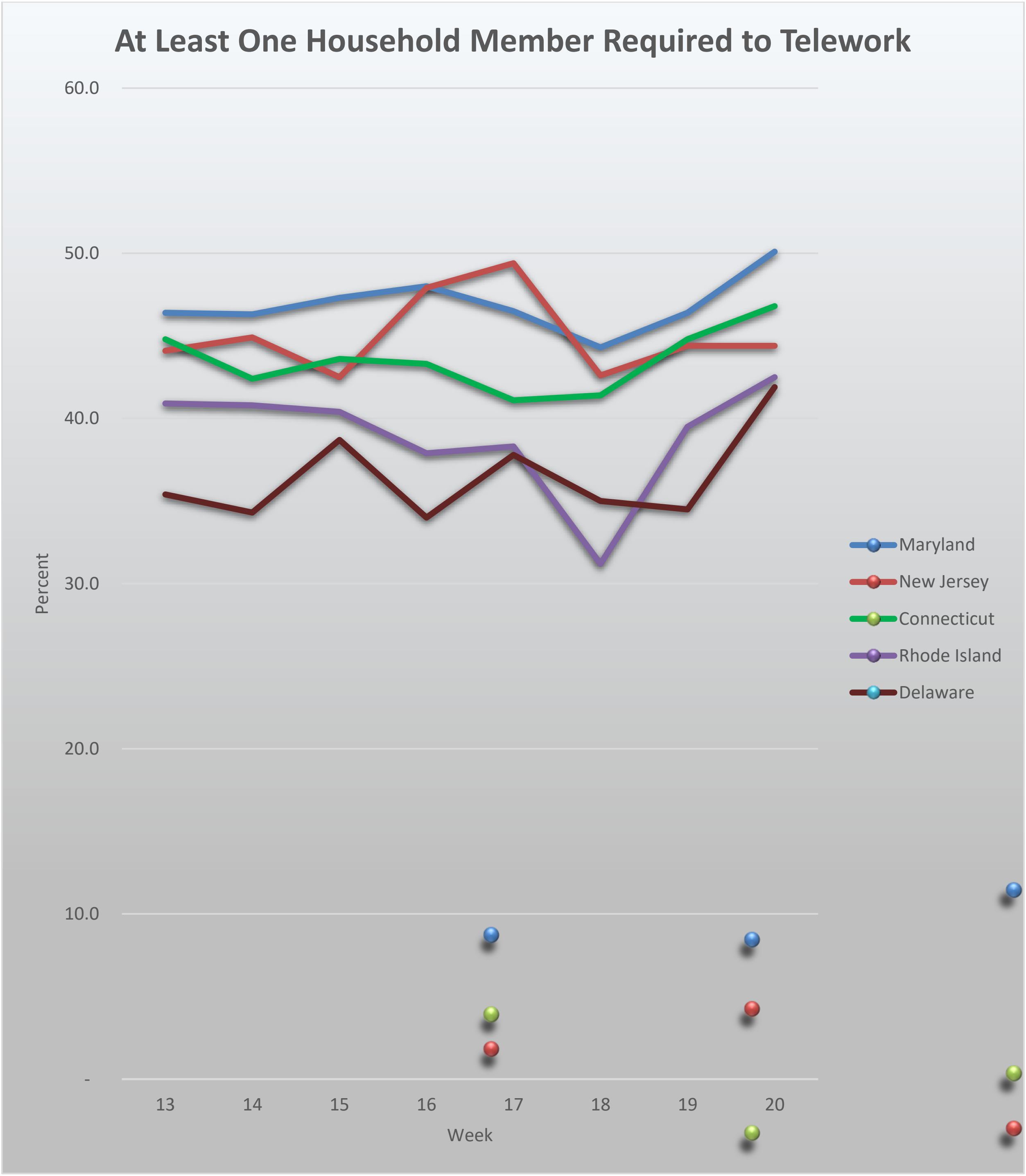
**Figure 35: Comparison of Households With No Computer**[14]




Analysis of the Census Bureau's Pulse Survey from August 19 to December 7, 2020, reveals a steady percentage of households in Delaware with a member that is required to telework. In the last week of this time period, this figure rose above 40 percent, indicating that broadband is essential for many individuals in Delaware working remotely throughout the Covid-19 pandemic and otherwise (Figure 36).

[14] U.S. Census Bureau, American Community Survey (2014-2018), https://data.census.gov/cedsci/ (accessed December 2020).

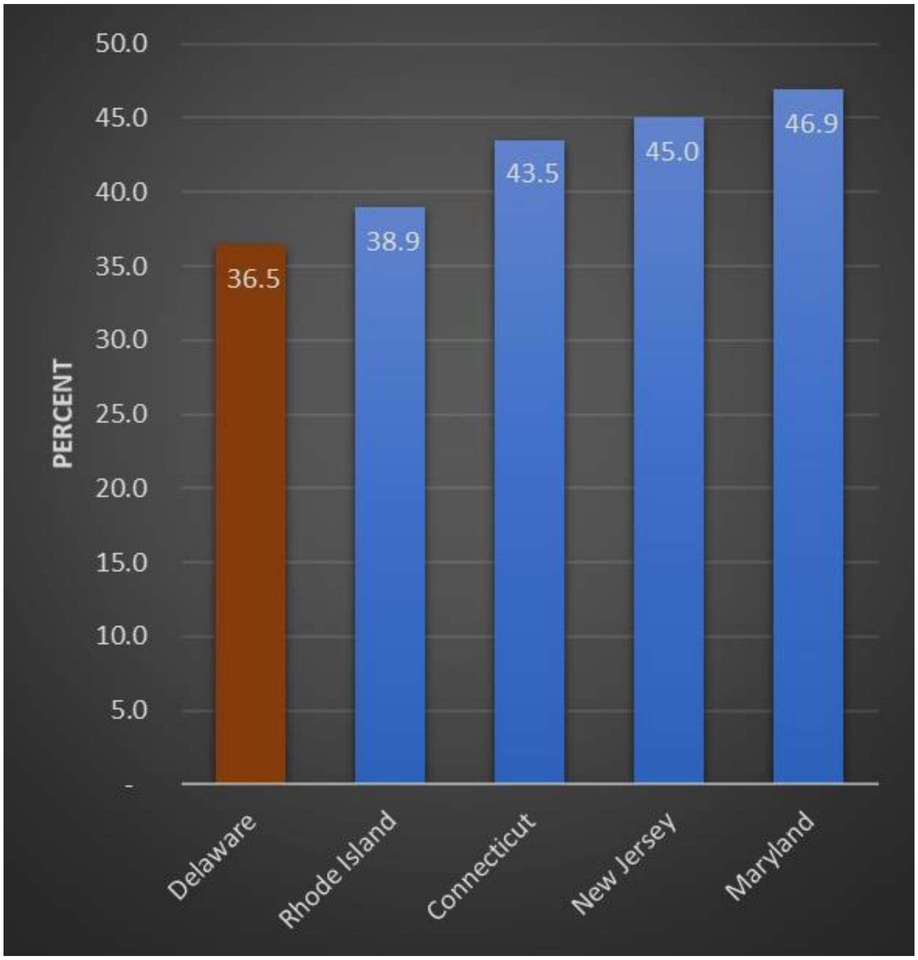
**Figure 36: Comparison of Households with Required Telework[15]**




[15] U.S. Census Bureau, Household Pulse Survey, Phases 2 and 3 (August 19 to December 7, 2020), https://www.census.gov/programs-surveys/household-pulse-survey/data.html (accessed December 2020).

Delaware had a slightly lower period average of households in which at least one member was required to telework, when compared to the other four states (Figure 37).

**Figure 37: Comparison of Households with Required Telework (Average)[16]**

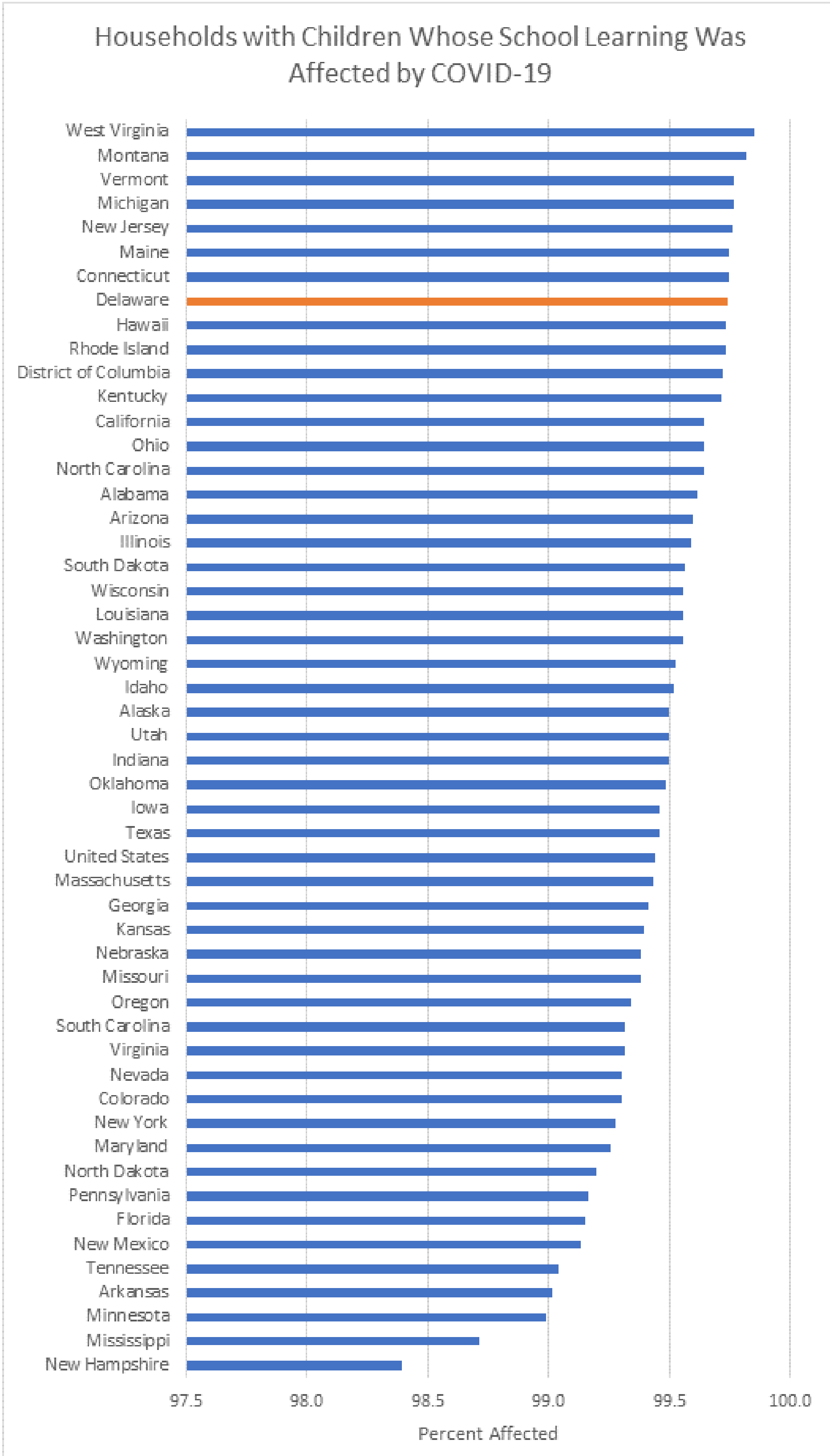



In Delaware, 99.7 percent of households with children reported that students' school learning was affected by the pandemic, the eighth-highest in the country (see Figure 38, below).

While the FCC's data do not offer a perfect representation of broadband access, they do provide an opportunity for comparison between Delaware and similar states in the region. Overall, Delaware ranked comparably to the four other states analyzed in terms of broadband availability, competition, and choice. Additionally, Census Bureau data placed Delaware among its peers with respect to various broadband adoption and use statistics, including home computer ownership, teleworking trends, and recent disruptions in students' education.

[16] U.S. Census Bureau, Household Pulse Survey, Phases 2 and 3 (August 19 to December 7, 2020), https://www.census.gov/programs-surveys/household-pulse-survey/data.html (accessed December 2020).

**Figure 38: Comparison of Households with Children Whose Learning Was Affected by Covid-19[17]**



# 5 The State's Survey of Residents Identified Key Issues Related to Broadband Use and Adoption

As part of its efforts to perform a comprehensive evaluation of broadband gaps during the Covid-19 pandemic, the State of Delaware commissioned a mail survey of households (Appendix A). The survey was intended to gather basic data about the types of services to which residents subscribe and their use of these services (including subsidized programs such as Comcast Internet Essentials). Moreover, the survey was designed to provide insights about how the pandemic has impacted residents' use of the internet at various locations inside and outside the home and whether internet service is sufficient to meet the needs of households across the State.

This report documents the survey process, discusses methodologies, and presents results intended to assist the State in developing strategies to close the identified gaps.

## 5.1 Key findings

Key findings are here presented thematically in three subsections: broadband access gaps, device utilization gaps, and skills gaps in broadband and computer use. These and other findings are presented in greater detail below. Findings related to Covid-19 impacts on broadband use are presented in Section 6.

### 5.1.1 Broadband access gaps

The survey found very few gaps in acquisition of residential internet access services, but also that relatively few residents are taking advantage of available subsidized programs. The following are key findings:

- **Most residents consider internet and high-speed internet in particular to be very important**. A high-speed data or internet connection is extremely important for most of those who currently telework or would like to telework (93 percent) and for those who have a planned or existing home-based business (82 percent). Among those who use the internet for educational purposes, eight in 10 said a high-speed internet connection is extremely important for their education needs.
- **Most residents reported having internet access** (98 percent), including 89 percent who have both home internet service and a cellular/mobile telephone service with internet (smartphone).
- **Five percent of all respondents only use a smartphone for home internet access.** This may limit their ability to fully utilize online services at home.
- **Verizon and Comcast are the leading internet service providers.** Saturation of Comcast customers is highest in Kent County, and saturation of Verizon customers is highest in New

Castle County. Mediacom has a significant share of the Sussex County market (26 percent of households).

- **Most households with children have internet access, but it may not be sufficient for some families.** Although most respondents strongly disagreed that their children cannot complete their homework because they do not have internet access (i.e., broadband access is not a concern), one in 10 agreed or strongly agreed that lack of access is a barrier. Even during the pandemic, with schools and libraries largely closed, 18 percent of respondents agreed or strongly agreed that their children access the internet at a public or school library (and 18 percent agreed or strongly agreed that their children can safely access public libraries).
- **Residents may be significantly underutilizing existing broadband subsidy programs.** Just four percent of all Comcast customers are enrolled in the ISP's Internet Essentials program for low-income households and two thirds of Comcast customers earning under $25,000 per year said they have never heard of the program. Just three percent of low-income subscribers receive the $9.25 subsidy under the FCC's Lifeline program, and 30 percent are unsure if they receive the subsidy.
- **Many respondents say they find broadband unaffordable. O**nly 15 percent of respondents strongly agreed that the market currently provides high-speed internet at prices they can afford, while 26 percent agreed. Another 27 percent disagreed or strongly disagreed, suggesting some need for affordable broadband internet.
- **Cost is a factor affecting broadband adoption.** More than one-fourth (27 percent) of respondents are unwilling or unable to pay a premium for access to high-speed internet, while 28 percent were neutral. Willingness to purchase high-speed internet for $10 a month is high (85 percent were extremely willing) but this willingness drops sharply at higher price points.
- **At the same time, most respondents are willing to pay up to $50 more for gigabit service if it were available.** 65 percent are at least moderately willing, and almost half are very or extremely willing. This suggests that residents hunger for not just fast, but very fast broadband connections and are willing to pay if they can afford it. Among those who may not be able to afford the costs, most are willing to pay at least some premium on top of current costs.
- **There is strong support for ensuring all residents have access to competitively priced broadband services**, with 73 percent strongly agreeing. One-half strongly agreed that the State should help ensure that all residents know how to make effective use of the internet, and 57 percent strongly agreed the State should provide free Wi-Fi in public areas.

### 5.1.2 Device utilization gaps

Most respondents have access to home internet service and computers, but a sizeable segment may face significant challenges in using, maintaining, and potentially repairing these devices. The following are key findings:

- **Most respondents have access to computers in the home.** Almost all (94 percent) respondent indicated they have a computer in the home (desktop, laptop, tablet) with internet access.
- **Many households have experienced frequent issues with their computing devices not working properly.** Seven in 10 respondents with internet access have experienced trouble with their computer not working properly; one-fifth experience problems at least weekly.
- **One-fourth of respondents may have trouble maintaining their computers.** Twenty-five percent disagreed or strongly disagreed that they know how to troubleshoot issues with technology.
- **One-fourth of respondents would not be able to quickly replace non-working computers.** Six percent of respondents said they could not replace their computer in the foreseeable future if it became unusable, and another 19 percent said it would take one to six months to replace it. Adding these two datapoints, 25 percent of households with home internet service are at risk of not being able to use broadband for very long periods because of computer problems, rather than residential internet connectivity problems.

### 5.1.3 Skills gaps in using broadband and computers

Most respondents have adequate internet and computer skills. However, a small segment of respondents reported significant challenges with respect to their ability to perform basic functions online and avoid harms. Respondents also expressed interest in improving those skills. Key findings include:

- **Some respondents may be vulnerable to online harms and disinformation.** When asked if they knew how to recognize and avoid a phishing attack, 14 percent disagreed or strongly disagreed. Eight percent disagreed or strongly disagreed that they knew how to recognize false information online and find credible sources of information.
- **Most respondents have the skills to perform basic tasks on the internet.** Overall, most internet subscribers strongly agreed that they know how to use the internet for various functions, including: accessing a bank account online (79 percent), bookmarking a website (70 percent), purchasing groceries online (67 percent), uploading content to a website (63 percent), creating/managing a social media profile (60 percent), and connecting with a doctor/medical support online (58 percent). Respondents were less likely to agree that they

are skilled in creating their own personal website or in troubleshooting issues with technology.

- **Most caregivers report that children under their care have adequate broadband skills.** Among those with children, 63 percent agreed or strongly agreed they are sufficiently skilled in computer use to complete their homework on their own.
- **Most caregivers have adequate skills to help their children when needed.** Nearly one-half of respondents with children strongly agreed that their computer skills are good enough to help their children complete their homework, and one-fourth agreed. However, one-fifth disagreed or strongly disagreed that they have sufficient computers skills.
- **Many respondents are interested in becoming more confident in using computers, smartphones, and the internet.** Specifically, 48 percent of respondents agreed or strongly agreed that they would like to become more confident in using computers and related technology, and 33 percent agreed or strongly agreed they would like to attend training.
- **Many respondents disagreed that their children are able to minimize or avoid specific online risks.** Many respondents disagreed or strongly disagreed that their children have the skills to identify false or misleading information (45 percent), avoid online bullying by peers (41 percent), detect and avoid online scams and predators (51 percent), or avoid exposure to graphic violence or pornography online (34 percent). However, six in 10 respondents agreed or strongly agreed that they have the time and skills to protect their children from online risks.

## 5.2 Survey process

In close coordination with the State of Delaware, CTC managed the survey project, including development of the questionnaire, sample selection, mailing and data entry coordination, survey data analysis, and reporting of results.

CTC developed the draft survey instrument based on the project objectives and provided it to State staff for review and comment. The State provided revisions and approved the final questionnaire. (A copy of the survey instrument is included in Appendix A.)

A total of 6,666 survey packets were mailed first-class in December to a random selection of residential households with a goal of receiving at least 1,200 valid responses (400 from each county). Recipients were provided with a postage-paid business reply mail envelope in which to return the completed questionnaire.

A total of 785 useable surveys were received by the date of analysis, providing a gross response rate of 11.8 percent. The margin of error for aggregate results at the 95 percent confidence level for 785 responses is ±3.5 percent. That is, for questions with valid responses from all survey respondents, one would be 95 percent confident (19 times in 20) that the survey responses lie within ±3.5 percent of the target population as a whole.

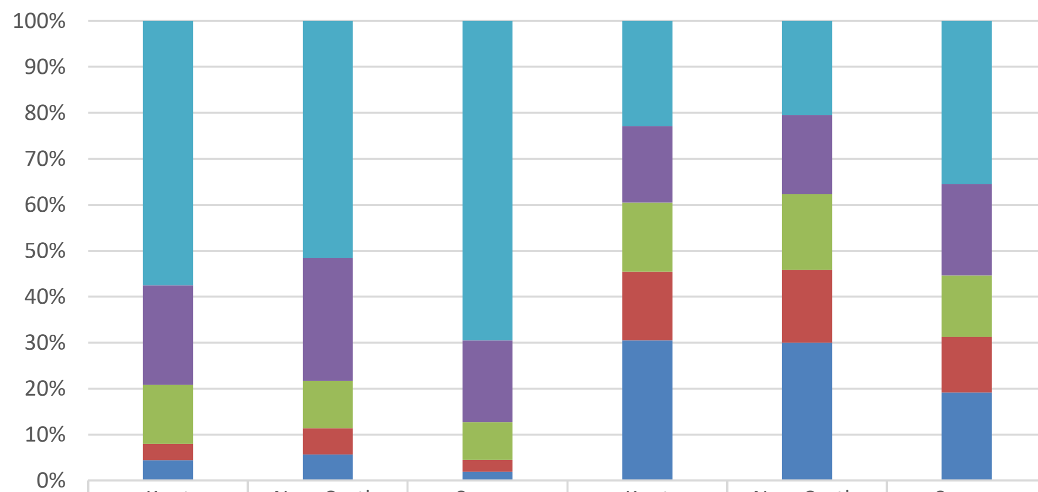
## 5.3 Data analysis

The survey responses were entered into SPSS[18] software and the entries were coded and labeled. SPSS databases were formatted, cleaned, and verified prior to the data analysis. The survey data was evaluated using techniques in SPSS including frequency tables, cross-tabulations, and means functions. Statistically significant differences between subgroups of response categories are highlighted and discussed where relevant.

The survey responses were weighted based on the age of the respondent and county. The sample was stratified by county to ensure a sufficient number of responses to analyze data at the county-level. Also, since older persons are more likely to respond to surveys than younger persons, the age-weighting corrects for the potential bias based on the age of the respondent. In this manner, the results more closely reflect the opinions of the State's adult population.

Figure 39 summarizes the sample and population distributions by county and age.

**Figure 39: Age of Respondents and Adult Population**




| | Survey Respondents | | | Census Population | | |
|---|---|---|---|---|---|---|
| | Kent | New Castle | Sussex | Kent | New Castle | Sussex |
| 65 years and older | 58% | 52% | 70% | 23% | 20% | 36% |
| 55 to 64 years | 22% | 27% | 18% | 17% | 17% | 20% |
| 45 to 54 years | 13% | 10% | 8% | 15% | 16% | 13% |
| 35 to 44 years | 4% | 6% | 3% | 15% | 16% | 12% |
| 18 to 34 years | 4% | 6% | 2% | 31% | 30% | 19% |

[18] Statistical Package for the Social Sciences ( http://www-01.ibm.com/software/analytics/spss/).

The following sections summarize the survey findings.

## 5.4 Survey results

The results presented in this report are based on analysis of information provided by 785 State of Delaware residents. Unless otherwise indicated, the percentages reported are based on the "valid" responses from those who provided a definite answer and do not reflect individuals who said "don't know" or otherwise did not supply an answer because the question did not apply to them. Key statistically significant results ($p \leq 0.05$) are noted where appropriate.

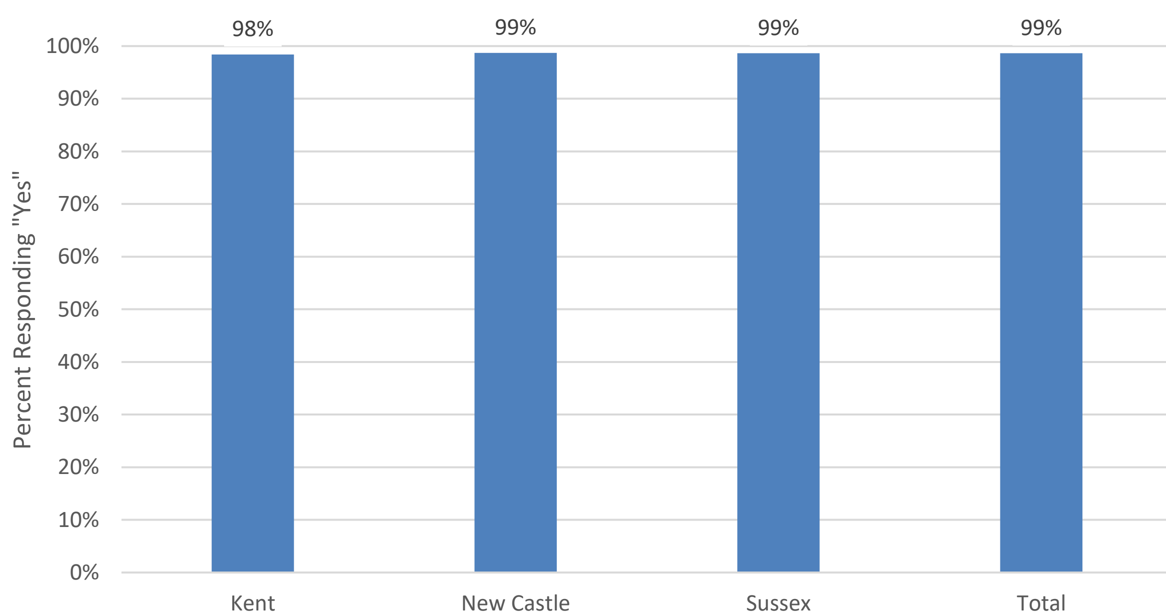
### 5.4.1 Internet connection and use

Respondents were asked about their use of the internet, including home internet connection providers, internet costs and enrollment in programs for low-income subscribers, and devices used. This information provides valuable insight into residents' need for various internet and related communications services.

#### *5.4.1.1 Internet usage*

Almost all (99 percent) respondents make some use of the internet, on any device from any location, as shown in Figure 40. Usage is high across all demographic groups, including low-income households (97 percent).

**Figure 40: Internet Usage by County**




Agreement with reasons for not accessing the internet are highlighted in Figure 41 and Figure 42. The leading barriers to internet access include concern with safety and privacy (8 out of 17 strongly agree) and cost of internet service (5 out of 16 strongly agree).

**Figure 41: Reasons for Not Using the Internet (Mean Ratings)**

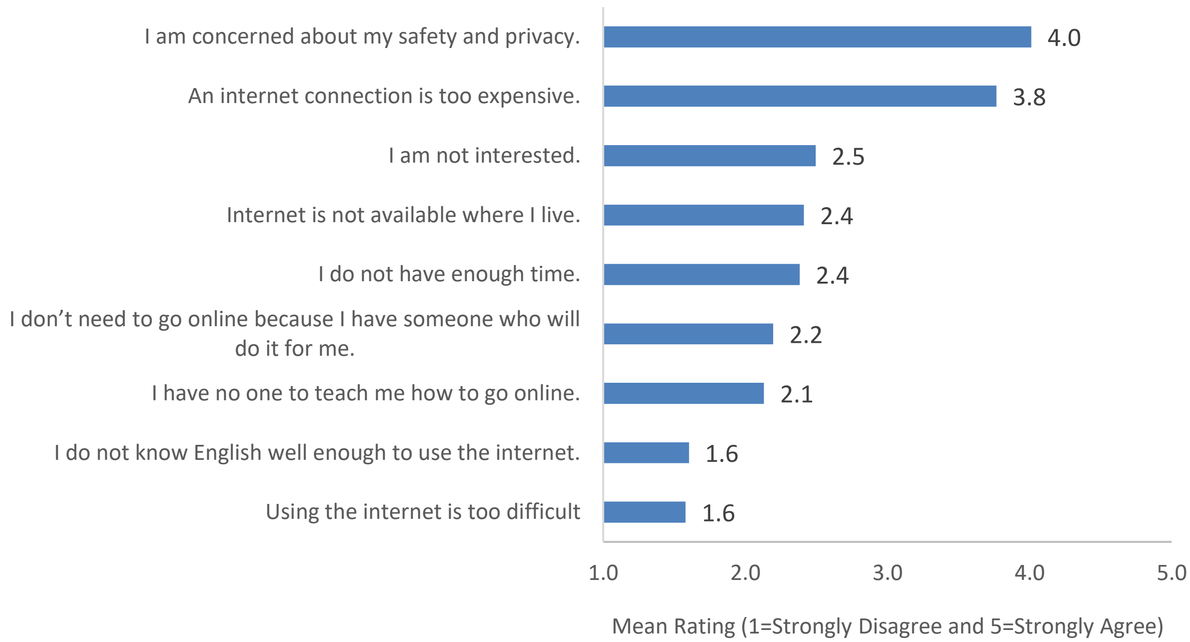
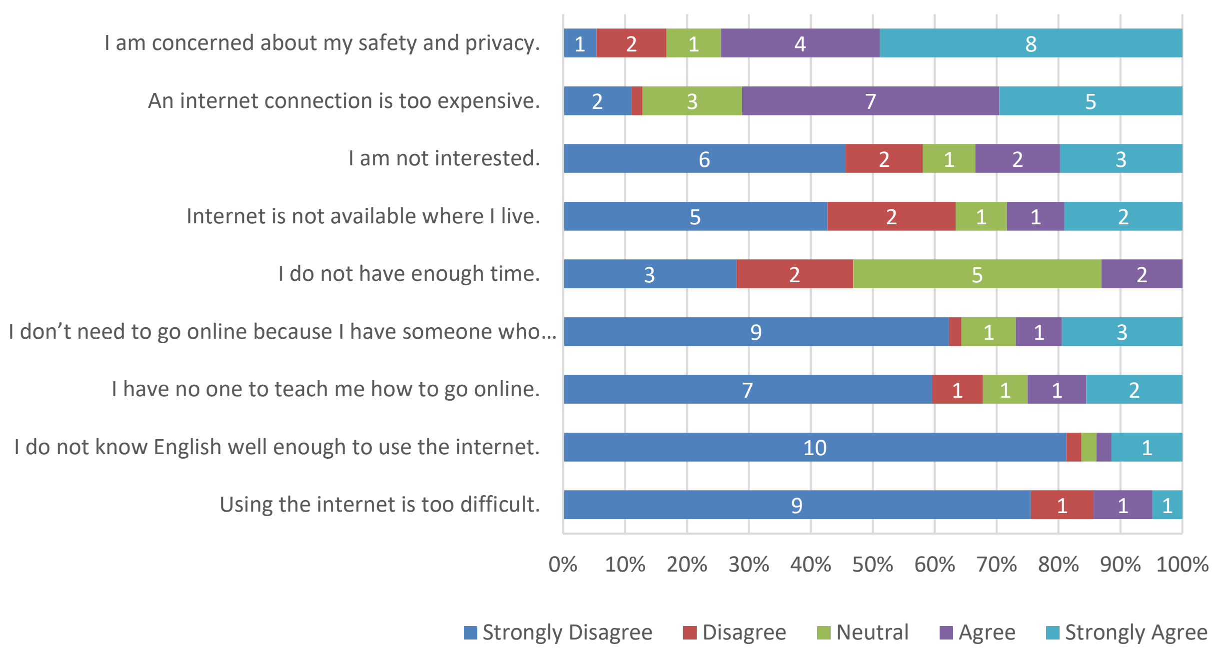



**Figure 42: Reasons for Not Using the Internet**




### *5.4.1.2 Importance of communications services*

Respondents were asked to indicate the importance of various communication services to their household, using a scale where 1=Not at all important and 5=Extremely important. The mean importance of various service aspects is illustrated in Figure 43, while detailed responses are illustrated in Figure 44.

**Figure 43: Importance of Communication Service Aspects (Mean Ratings)**

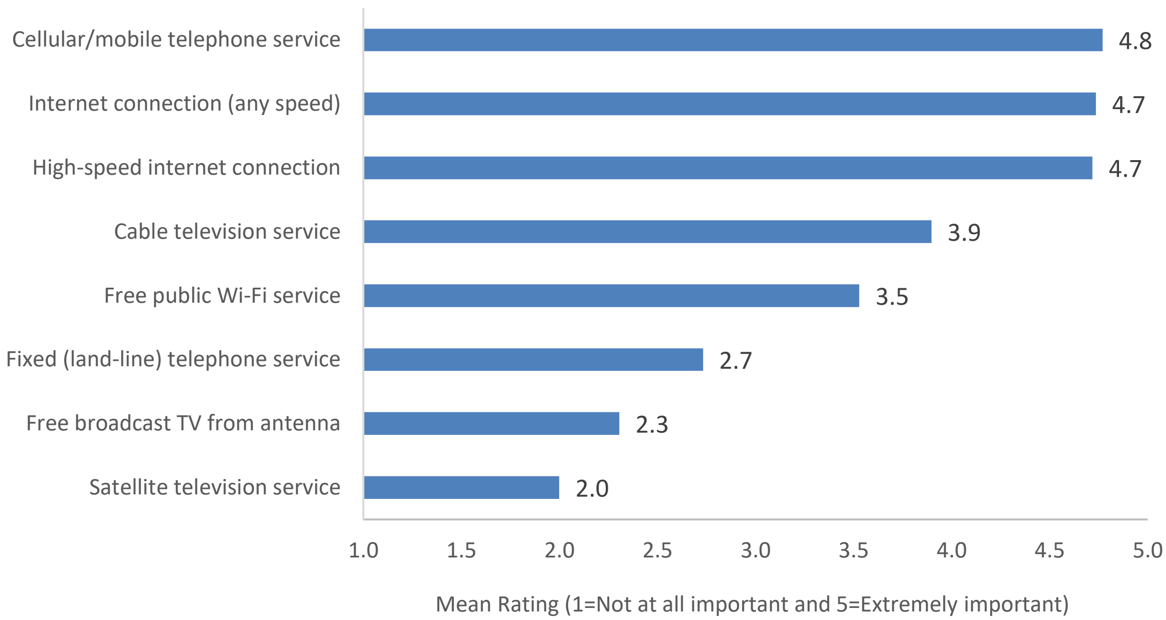
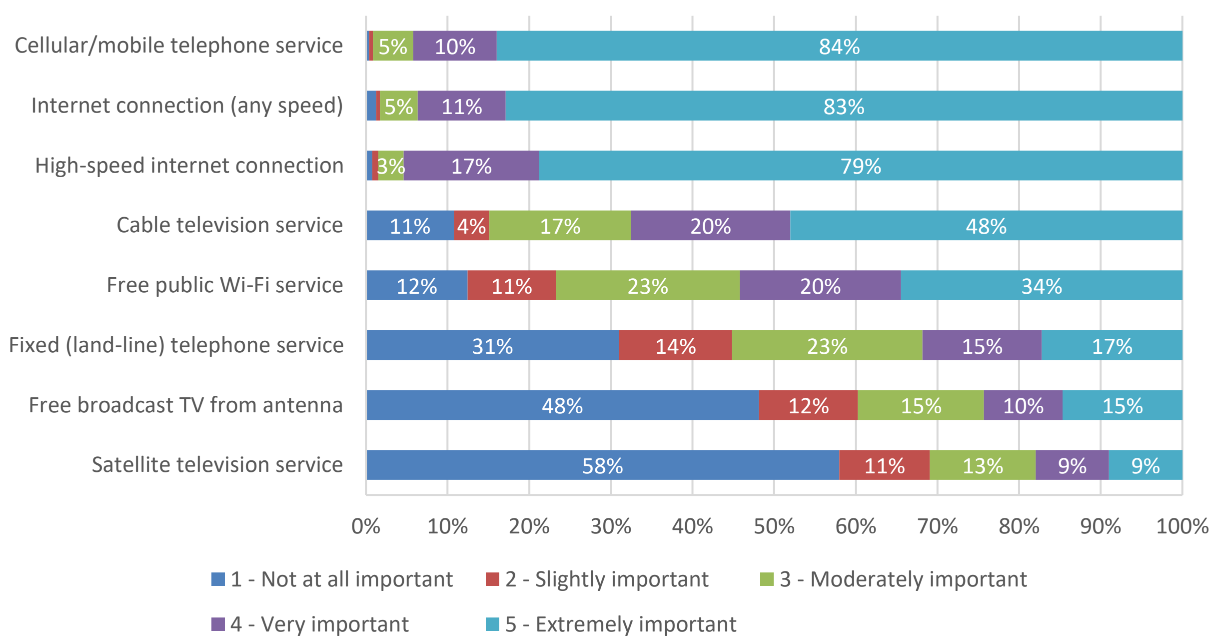



**Figure 44: Importance of Communication Service Aspects**




Cellular/mobile telephone and internet services are extremely important to respondents, while broadcast television service and satellite television service are significantly less important.

Specifically, 84 percent said cellular/mobile phone service is extremely important, and 83 percent said an internet connection of any speed is extremely important. Another 79 percent of respondents said high-speed internet is extremely important.

Figure 45 and Figure 46 illustrate the importance of internet services and mobile telephone service by the age of the respondent and by household income. The importance of these services is slightly lower for those ages 65+ and those in low-income households compared with their counterparts.

**Figure 45: Importance of Communication Services by Respondent Age**

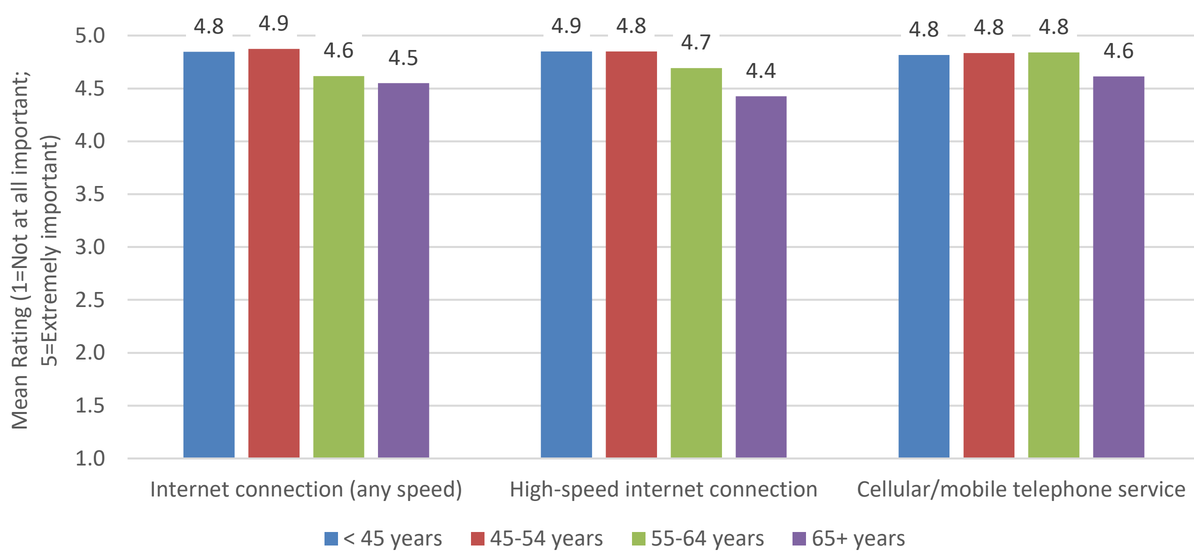
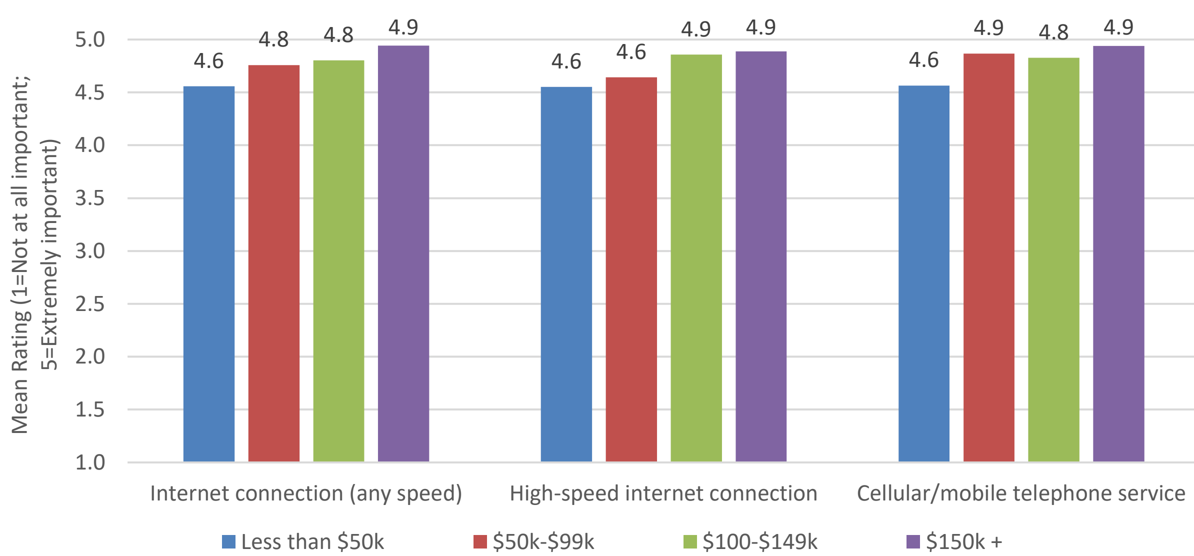



**Figure 46: Importance of Communication Services by Household Income**



#### *5.4.1.3 Communications services*

Saturation of communications services currently purchased for the household is illustrated in Figure 47 and Figure 48. Overall, 98 percent of respondents indicated having some internet access—either a home connection or via cellular/mobile service. Specifically, 95 percent have cellular/mobile telephone service with internet and 93 percent have internet service in the home. Fewer households have cable/satellite television service, landline telephone service, cellular/mobile telephone service without internet, and free Wi-Fi service.

**Figure 47: Communication Services Purchased**

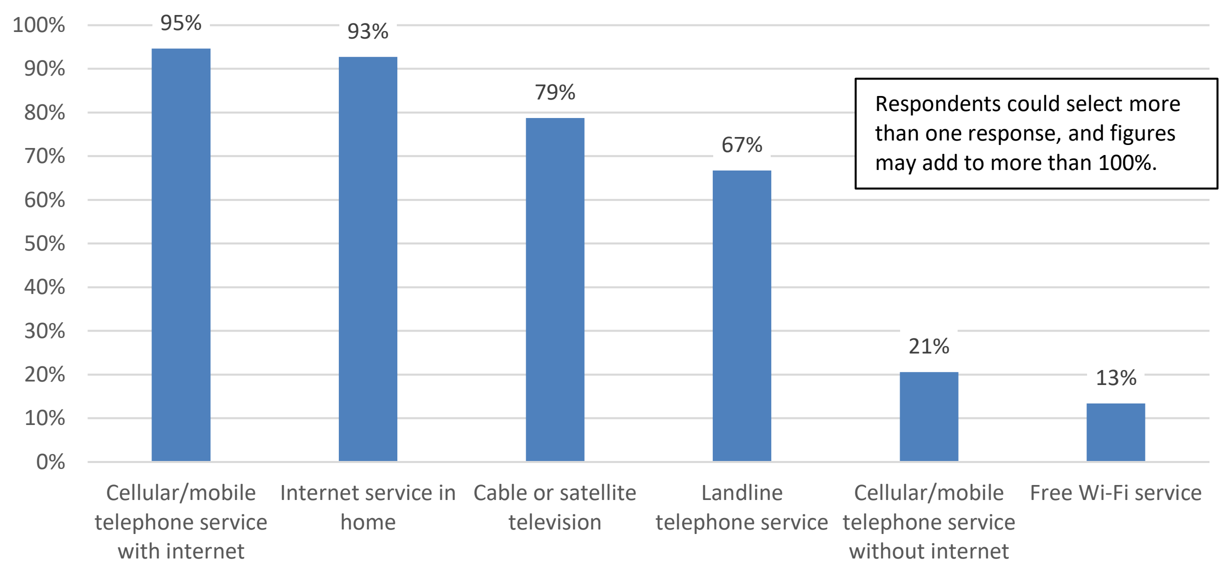
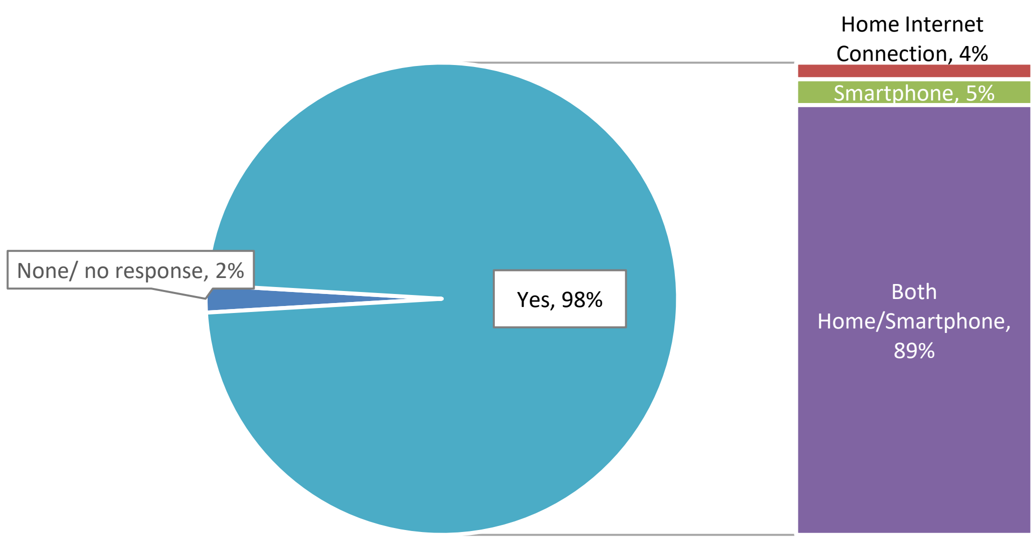



**Figure 48: Internet Services Purchased**



As discussed previously, most respondents have some internet access, including 89 percent who have both home internet service and a cellular/mobile telephone service with internet (smartphone). Total internet access is high across all demographic groups, as shown in Table 6. Older respondents and those in lower income households are more likely to have a home internet connection only, and they are less likely to have both a home internet connection and cellular/mobile telephone service.

**Table 6: Internet Access by Key Demographics**

| | None/No Response | Home Internet Connection | Smartphone | Both Home/ Smartphone | Total Internet Access | *Total Count* |
|---|---|---|---|---|---|---|
| **TOTAL** | **2%** | **3%** | **5%** | **89%** | **98%** | ***785*** |
| **County** | | | | | | |
| **Kent** | 1% | 7% | 6% | 85% | **99%** | *149* |
| **New Castle** | 2% | 2% | 5% | 91% | **98%** | *435* |
| **Sussex** | 2% | 4% | 6% | 87% | **98%** | *199* |
| **Respondent Age** | | | | | | |
| **< 45 years** | 0% | 0% | 10% | 90% | **100%** | *196* |
| **45 to 54 years** | 0% | 2% | 3% | 95% | **100%** | *227* |
| **55 to 64 years** | 2% | 5% | 1% | 92% | **98%** | *132* |
| **65 years and older** | 4% | 8% | 6% | 81% | **96%** | *182* |
| **Education** | | | | | | |
| **HS education or less** | 2% | 6% | 7% | 85% | **98%** | *146* |
| **Two-year/technical degree** | 2% | 4% | 6% | 87% | **98%** | *136* |
| **Four-year college degree** | 0% | 3% | 5% | 91% | **100%** | *244* |
| **Grad, prof, doctorate** | 2% | 2% | 4% | 93% | **98%** | *215* |
| **Income** | | | | | | |
| **Less than $50,000** | 4% | 9% | 5% | 83% | **96%** | *148* |
| **$50,000 to $99,999** | 1% | 4% | 10% | 85% | **99%** | *194* |
| **$100,000 to $149,999** | 1% | 1% | 5% | 93% | **99%** | *136* |
| **$150,000 or more** | 1% | 0% | 1% | 98% | **99%** | *146* |
| **Race/Ethnicity** | | | | | | |
| **Other race/ethnicity** | 1% | 3% | 7% | 90% | **99%** | *141* |
| **White/European American** | 2% | 3% | 5% | 90% | **98%** | *594* |
| **Gender Identity** | | | | | | |
| **Woman** | 1% | 3% | 7% | 89% | **99%** | *453* |
| **Man** | 2% | 4% | 3% | 91% | **98%** | *288* |
| **Children in Household** | | | | | | |
| **No children in HH** | 2% | 5% | 4% | 89% | **98%** | *509* |
| **Children in HH** | 0% | 0% | 8% | 92% | **100%** | *231* |
| **Own Residence** | | | | | | |
| **Own** | 2% | 4% | 5% | 90% | **98%** | *657* |
| **Rent/live with family/other** | 0% | 3% | 8% | 89% | **100%** | *120* |
| **Years in Residence** | | | | | | |
| **< 5 years** | 1% | 1% | 8% | 90% | **99%** | *137* |
| **5 or more years** | 2% | 4% | 5% | 89% | **98%** | *639* |

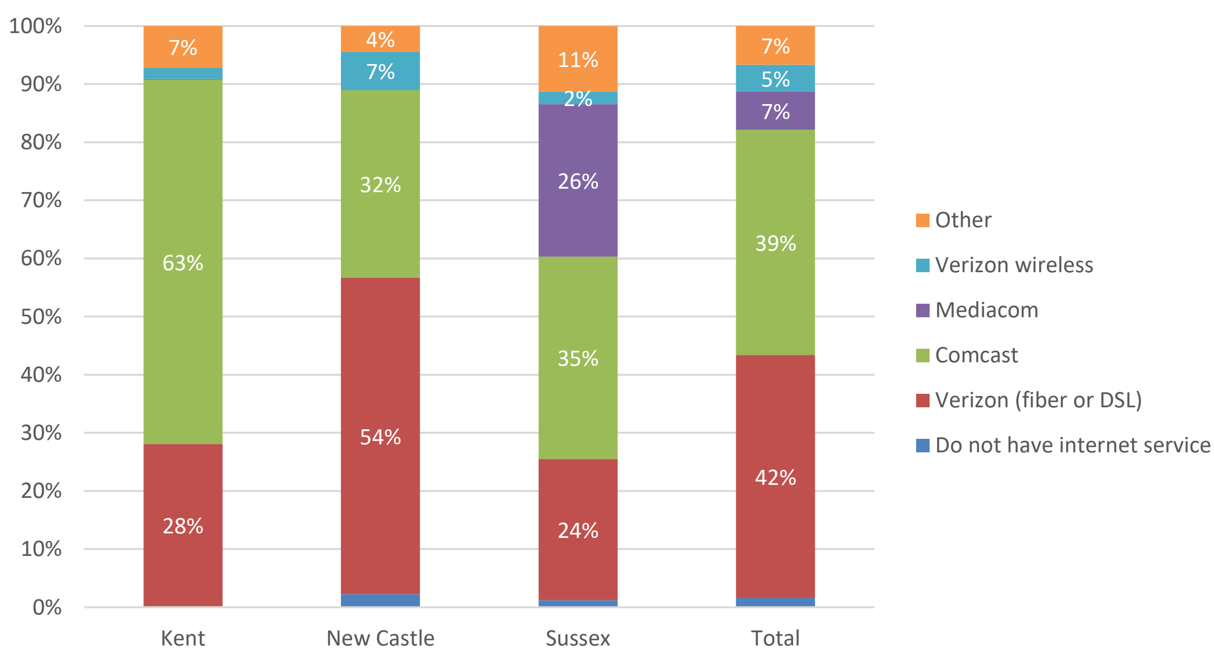
Respondents without internet service were asked their main reason for not purchasing mobile or home internet service, what would making them consider signing up for broadband service, and if they plan to sign-up for mobile or home internet service in the next 12 months. Very few respondents said they do not have internet service; however, some individuals with either cell phone or home internet service did provide a response.

Specifically, 37 percent of those who responded (79 individuals) said the cost of internet service is too high, and 22 percent said no good internet service is available (keeping in mind that 75 of 79 respondents do have some form of internet service). Five percent of all respondents said they plan to sign up for cellular/mobile service in the next 12 months, and five percent plan to sign up for broadband internet service.

### *5.4.1.4 Internet service provider*

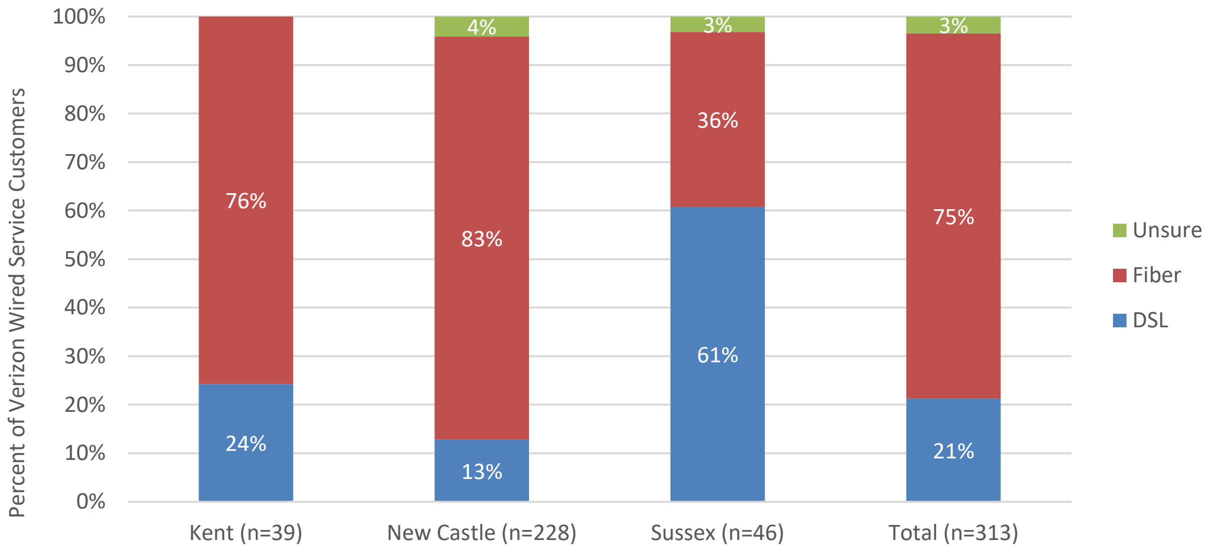
As illustrated in Figure 49, Verizon and Comcast are the leading ISPs overall in the Delaware market area. This varies significantly by county of residence, with saturation of Comcast customers highest in Kent County and saturation of Verizon customers highest in New Castle County. Mediacom has a significant share of the Sussex County market, used by 26 percent of households in that county.

**Figure 49: Primary Internet Service Provider**




Three-fourths of Verizon (wired service) subscribers indicated having fiber optic service, while 21 percent have DSL and three percent were unsure, as illustrated in Figure 50. Verizon wired service subscribers in Sussex County are more likely to use DSL and less likely to have fiber service compared with subscribers in other counties.

**Figure 50: Type of Verizon Wired Service**




### *5.4.1.5 Internet service cost and programs for low-income subscribers*

Respondents were asked to give the cost of their home internet service. Estimated monthly price of internet is shown in Figure 51, for customers who bundle (80%) or do not bundle (20%) internet service. The estimated monthly average cost for internet service is $79. One in 10 respondents with unbundled internet service pay $10 or less per month. The estimated monthly priced for bundled internet service is higher for Comcast internet service, compared with Verizon (see Figure 52).

Figure 51: Monthly Price for Internet Service

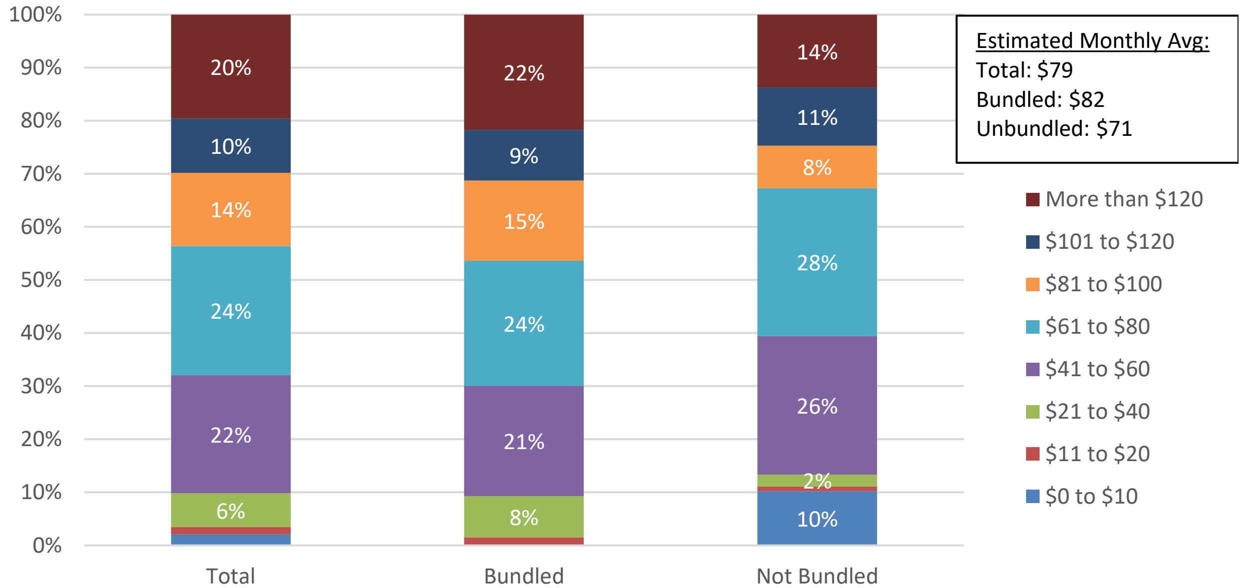
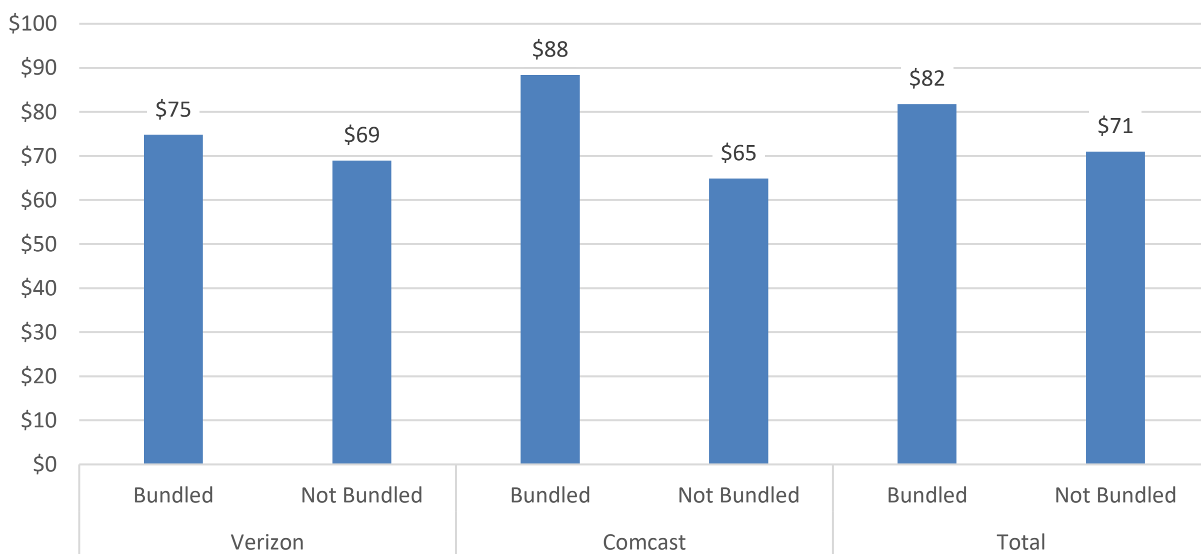
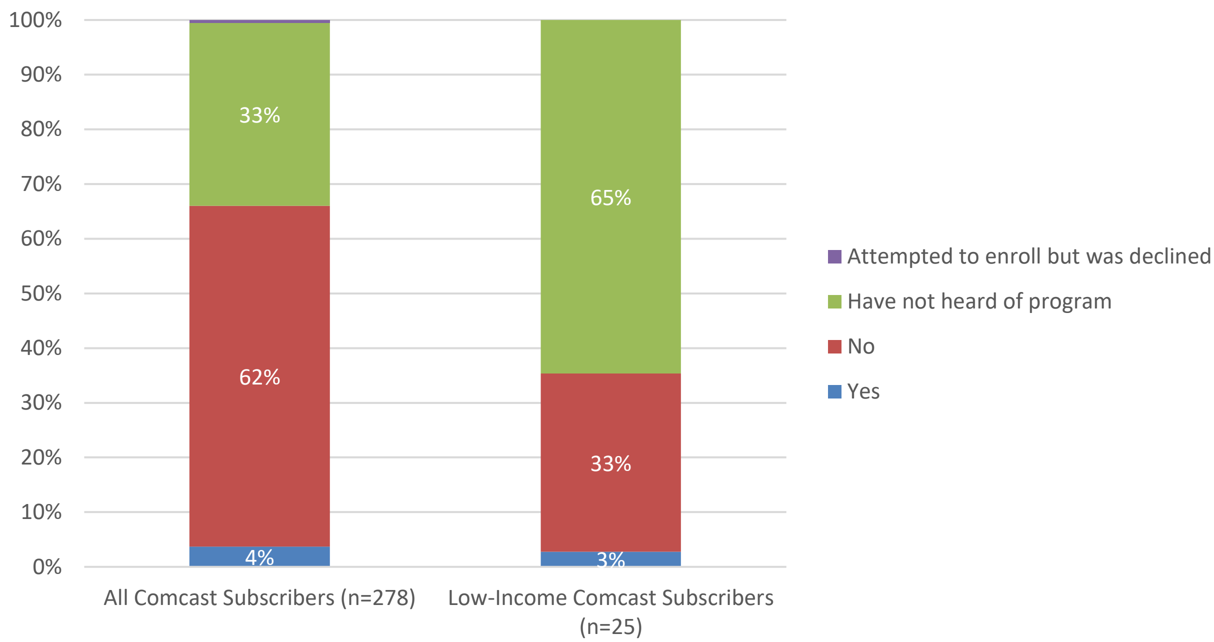



Figure 52: Estimated Monthly Price for Internet Service by Provider




As illustrated in Figure 53, just four percent of all Comcast customers are enrolled in the ISP's Internet Essentials program for low-income households. Sixteen of 25 (65%) Comcast customers earning under $25,000 per year said they have never heard of the program.

**Figure 53: Participate in Comcast's Internet Essentials Program**



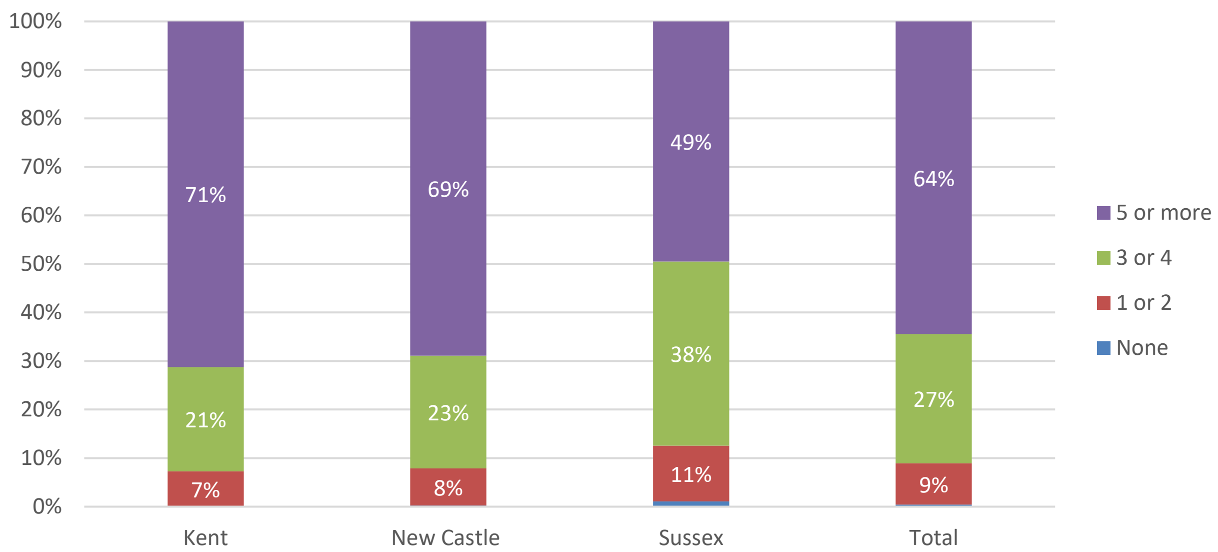

Just three percent of low-income subscribers (earning under $25,000 per year) receive the $9.25 subsidy under the FCC's Lifeline program, and 30 percent are unsure if they receive the subsidy. Most households are not receiving the subsidy (see Figure 54).

**Figure 54: Receive $9.25 Subsidy Under FCC's Lifeline Program**

### *5.4.1.6 Personal computing devices*

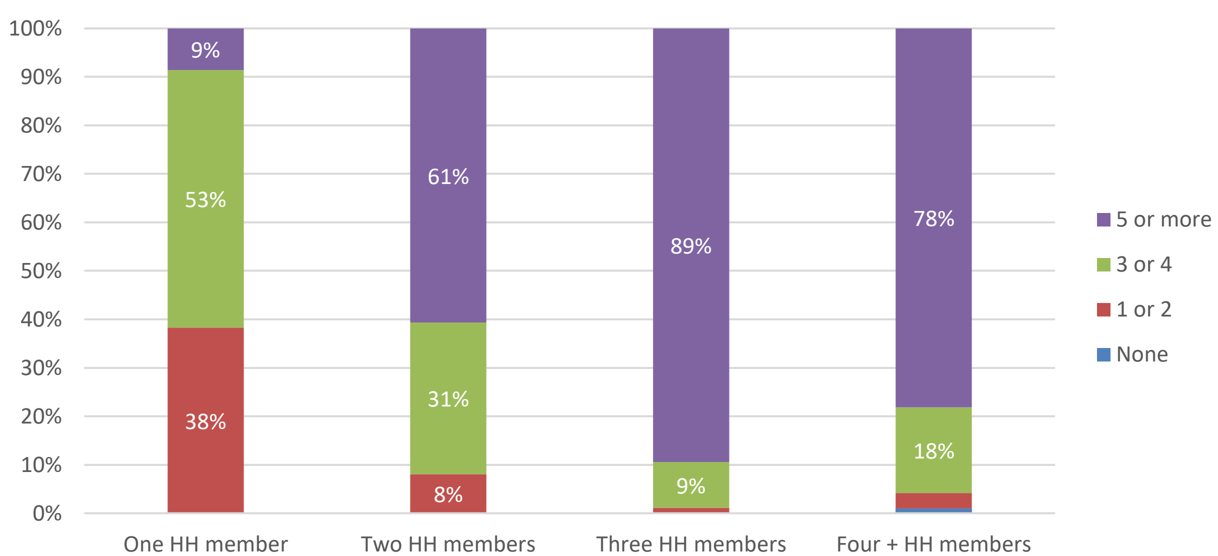
Respondents were asked to indicate the number of personal computing devices they have in the home. As shown in Figure 55, 64 percent of households with internet service have five or more devices. Sussex County households have fewer devices compared with Kent County and New Castle County households; they have somewhat fewer household members on average.

**Figure 55: Number of Personal Computing Devices**




The number of personal computing devices in the home is strongly associated with household size. Nine percent of one-member households have five or more devices, compared with 89 percent of those with three household members and 78 percent of those with four or more household members (see Figure 56).

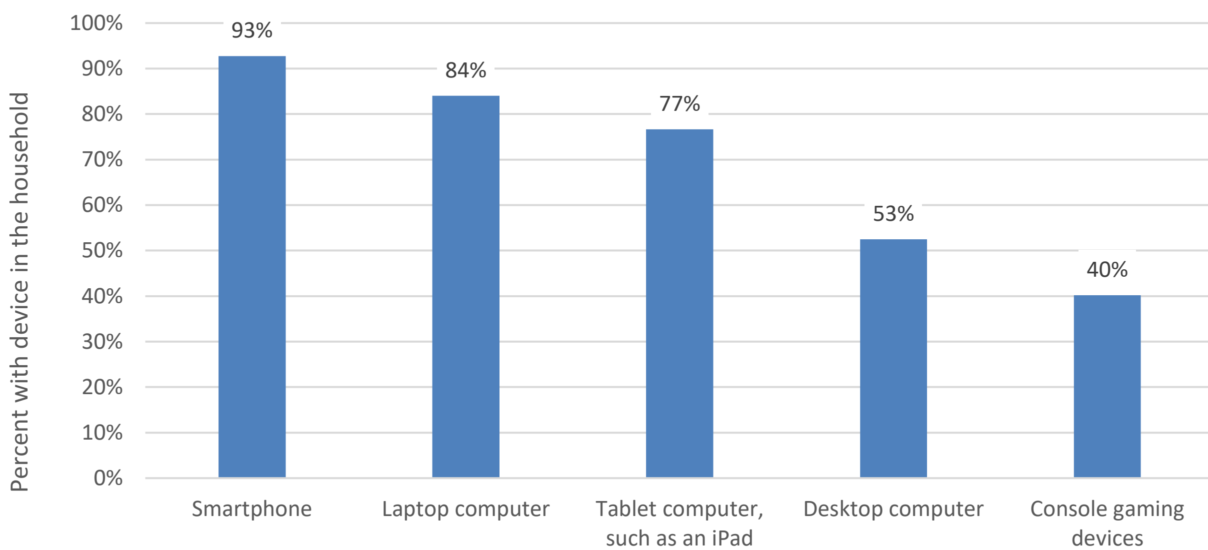
**Figure 56: Number of Personal Computing Devices in Home by Household Size**



#### *5.4.1.7 Devices in the home*

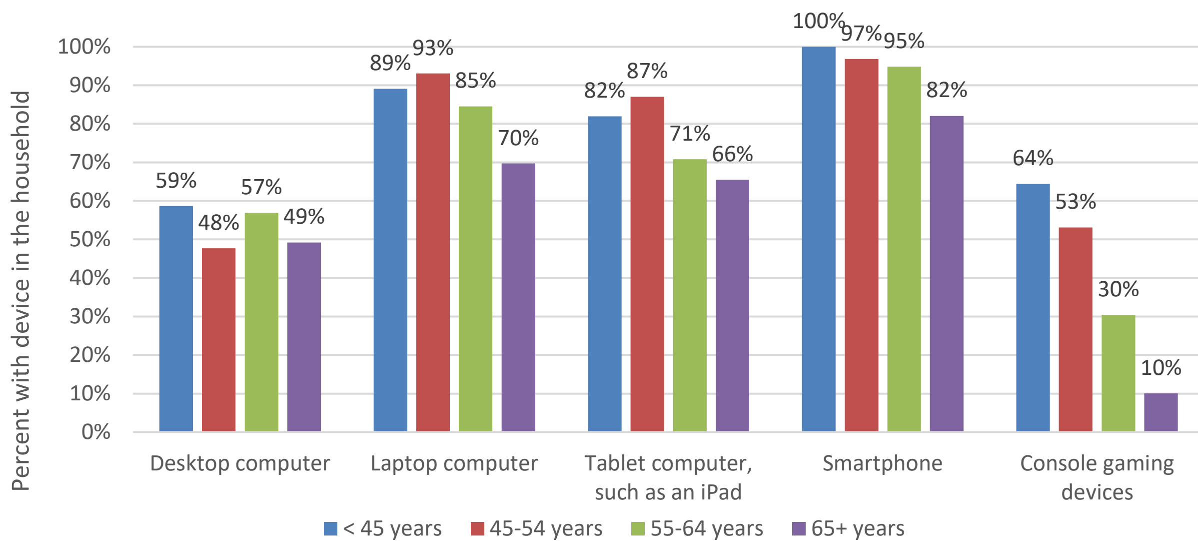
Availability of devices is relatively high in households with internet access, with respondents selecting an average of 3.5 types of devices in the home and only five percent not selecting any device.

**Figure 57: Devices Available in the Home**



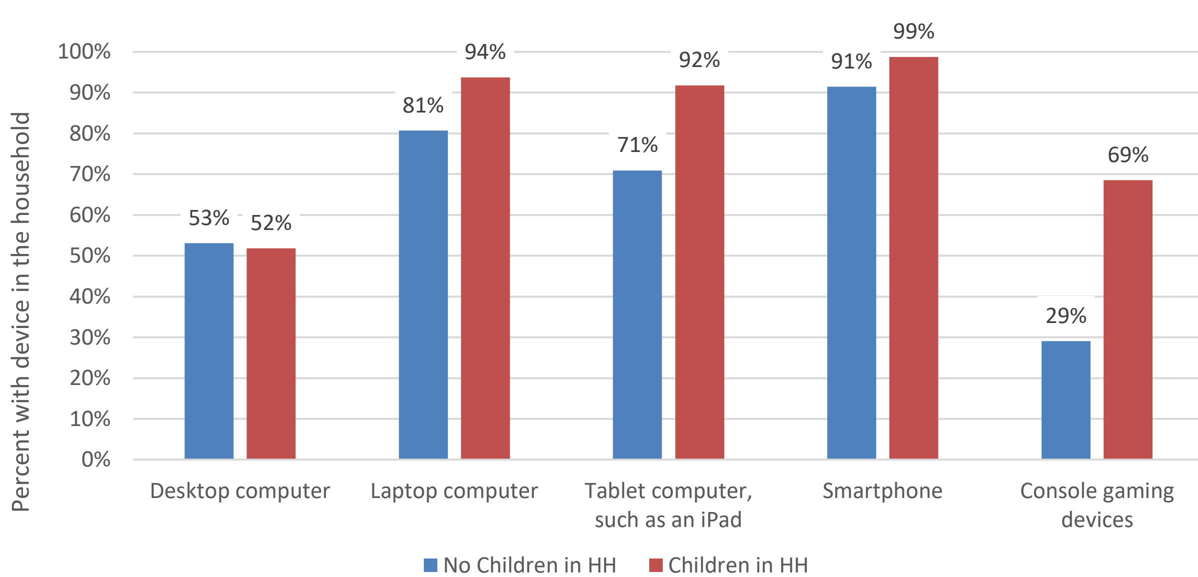

Use of smartphone is highest, with 93 percent of internet users having one, followed by laptops (84%) and tablets (77%). More than one-half of respondents with home internet have a desktop computer, and 40 percent have console gaming devices (see Figure 57). Respondents age 65 and older are less likely than younger respondents to have various devices except desktop computers, as illustrated in Figure 58.

**Figure 58: Devices Available in the Home by Respondent Age**




Households with children in them make strong use of key devices, as shown in Figure 59. Almost all of the households with children have a smartphone, tablet, or laptop computer, and seven in 10 have a console gaming device.

**Figure 59: Devices Available in the Home by Children in Household**




Respondents with home internet service were asked how often their primary computer becomes inaccessible or unusable, and how long it would take to replace the computer if it became lost or damaged beyond repair. Seven in 10 respondents have had some issues with their computer, including one-fifth who experience problems at least once per week (see Figure 60). Six percent of respondents said they could not replace their computer if it became unusable, and another 19 percent said it would take one to six months to replace it (see Figure 61).

**Figure 60: Computer Becomes Unusable**

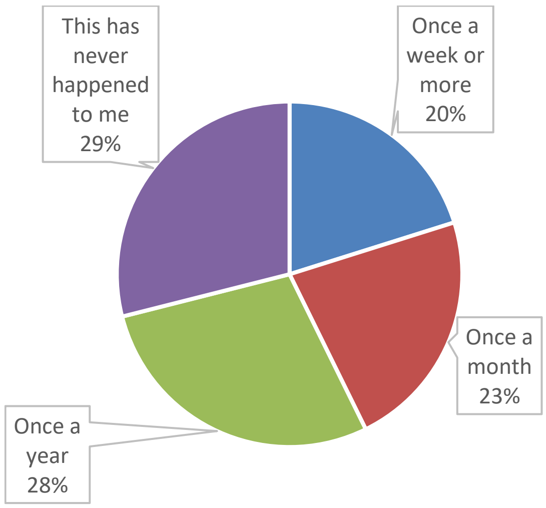
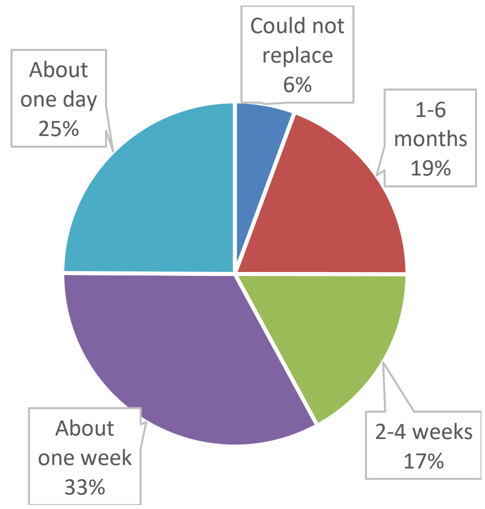
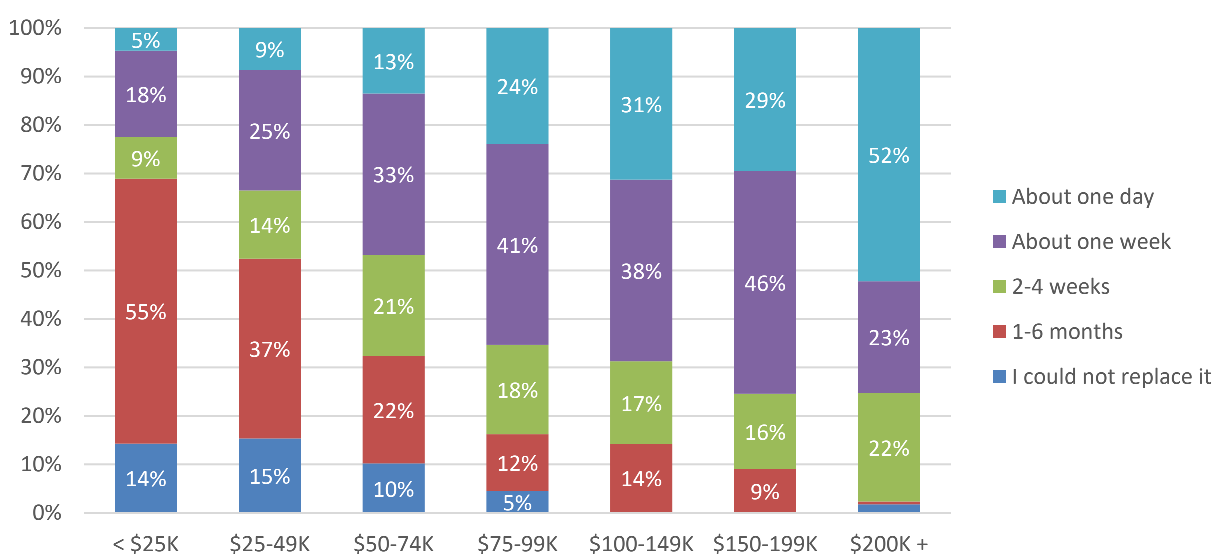



**Figure 61: When Could Replace Computer**




More than one-half of respondents earning under $25,000 said it would take one to six months to replace a lost or damaged computer, and another 14 percent said they would not be able to replace it (see Figure 62).

**Figure 62: When Could Replace Computer by Household Income**

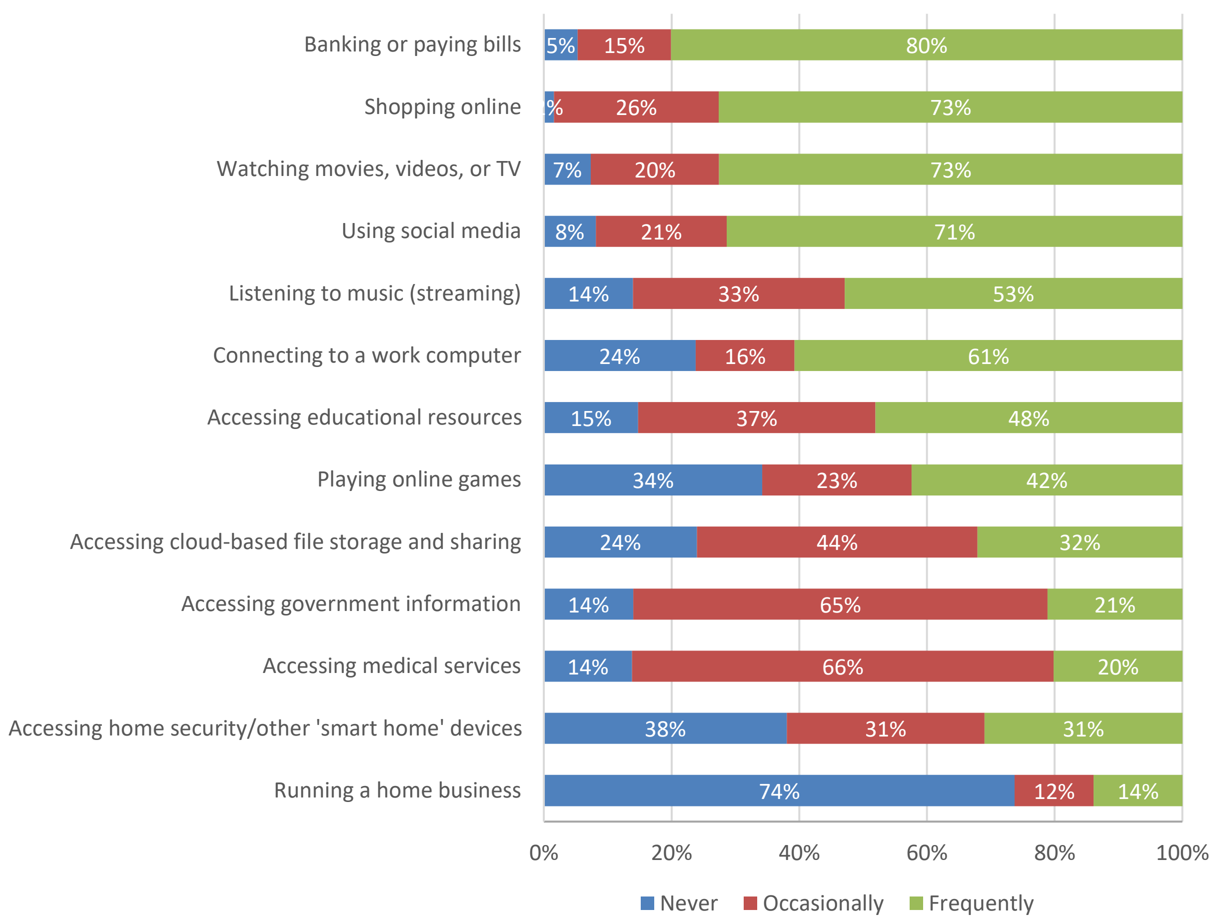



## 5.4.1.8 Internet Uses

Respondents were asked about their use of their home internet connection for various activities. Among those items listed, a home internet connection is most frequently used for banking or paying bills, shopping online, watching videos, and using social media, as shown in Figure 63. At least seven in 10 respondents engage in these activities frequently. A majority of respondents also frequently use a home internet connection for streaming music and for connecting to work; nearly one-half frequently use it to access educational resources.

Some respondents use a home internet connection to access other key information and services. Approximately two-thirds of subscribers occasionally use a home internet connection to access government information or to access medical services. One-fourth of respondents at least occasionally use a home internet connection for running a home-based business (26%).

**Figure 63: Home Internet Connection Use for Various Activities**




### 5.4.1.8.1 Internet uses by respondent age

Respondents under age 65 are more likely than older respondents to ever use their home internet connection for key activities, as illustrated in Table 7. Respondents under age 65 are more likely than older respondents to ever use their home internet connecti*on* for playing online games and connecting to a work computer in particular. At the same time, most seniors use a home internet connection at least occasionally for various activities, and many seniors use it frequently for key activities like shopping online, using social media, and watching movies, videos, or TV (see Table 8).

**Table 7: Home Internet Connection Ever Used for Various Activities by Respondent Age**

| | < 45 years | 45-54 years | 55-64 years | 65+ years |
|---|---|---|---|---|
| Listening to music (streaming) | 92% | 96% | 81% | 70% |
| Watching movies, videos, or TV | 99% | 98% | 89% | 81% |
| Playing online games | 76% | 69% | 63% | 50% |
| Connecting to work | 90% | 95% | 74% | 37% |
| Using social media | 99% | 93% | 92% | 85% |
| Shopping online | 100% | 100% | 98% | 95% |
| Running a home business | 17% | 35% | 39% | 14% |
| Accessing educational resources | 86% | 93% | 80% | 77% |
| Accessing government information | 84% | 82% | 92% | 90% |
| Accessing medical services | 79% | 89% | 90% | 86% |
| Banking or paying bills | 98% | 97% | 97% | 87% |
| Accessing home security/other 'smart home' devices | 65% | 72% | 60% | 44% |
| Accessing cloud-based file storage and sharing | 80% | 84% | 74% | 63% |

**Table 8: Home Internet Connection Frequently Used for Various Activities by Respondent Age**

| | < 45 years | 45-54 years | 55-64 years | 65+ years |
|---|---|---|---|---|
| Listening to music (streaming) | 73% | 64% | 42% | 25% |
| Watching movies, videos, or TV | 85% | 74% | 72% | 57% |
| Playing online games | 52% | 53% | 30% | 26% |
| Connecting to work | 76% | 76% | 58% | 23% |
| Using social media | 75% | 80% | 70% | 61% |
| Shopping online | 77% | 80% | 71% | 62% |
| Running a home business | 7% | 17% | 24% | 9% |
| Accessing educational resources | 54% | 69% | 37% | 21% |
| Accessing government information | 16% | 30% | 19% | 15% |
| Accessing medical services | 18% | 22% | 20% | 20% |
| Banking or paying bills | 80% | 90% | 74% | 73% |
| Accessing home security/other 'smart home' devices | 26% | 44% | 27% | 19% |
| Accessing cloud-based file storage and sharing | 27% | 46% | 31% | 22% |

### 5.4.1.8.2 Internet uses by children in household

As shown in Table 9, most households with children in them ever use a home internet connection for key activities. Almost all (99%) households with children (and that have internet service) ever use a home internet connection to access educational resources, including 85 percent who access it frequently. Households with children in them are also more likely than households without children to frequently use a home internet connection for other activities like streaming music, playing online games, and connecting to work (see Table 10).

**Table 9: Home Internet Connection Ever Used for Various Activities by Children in Household**

| | No Children in HH | Children in HH |
|---|---|---|
| **Listening to music (streaming)** | 82% | 95% |
| **Watching movies, videos, or TV** | 90% | 99% |
| **Playing online games** | 57% | 84% |
| **Connecting to work** | 68% | 96% |
| **Using social media** | 90% | 98% |
| **Shopping online** | 98% | 100% |
| **Running a home business** | 27% | 25% |
| **Accessing educational resources** | 79% | 99% |
| **Accessing government information** | 87% | 84% |
| **Accessing medical services** | 84% | 91% |
| **Banking or paying bills** | 93% | 99% |
| **Accessing home security/other 'smart home' devices** | 54% | 76% |
| **Accessing cloud-based file storage and sharing** | 71% | 89% |

**Table 10: Home Internet Connection Frequently Used for Various Activities by Children in Household**

| | No Children in HH | Children in HH |
|---|---|---|
| **Listening to music (streaming)** | 44% | 74% |
| **Watching movies, videos, or TV** | 66% | 87% |
| **Playing online games** | 33% | 62% |
| **Connecting to work** | 52% | 81% |
| **Using social media** | 69% | 80% |
| **Shopping online** | 69% | 82% |
| **Running a home business** | 13% | 14% |
| **Accessing educational resources** | 31% | 85% |
| **Accessing government information** | 18% | 27% |
| **Accessing medical services** | 19% | 22% |
| **Banking or paying bills** | 77% | 87% |
| **Accessing home security/other 'smart home' devices** | 25% | 42% |
| **Accessing cloud-based file storage and sharing** | 28% | 42% |

### 5.4.2 Computer and internet skills

Respondents were asked a series of questions on how skilled they are using computers and the internet, as well as their interest in training to learn more about these topics. This information provides valuable insight into where there may be gaps in abilities and opportunities to educate residents.

### *5.4.2.1 Internet skills*

Respondents were asked to indicate their level of agreement with various statements about their computer and internet skills. Average rating scores are highlighted in Figure 64, while Figure 65 shows detailed responses.

**Figure 64: Agreement with Statements About Internet Skills (Mean Ratings)**

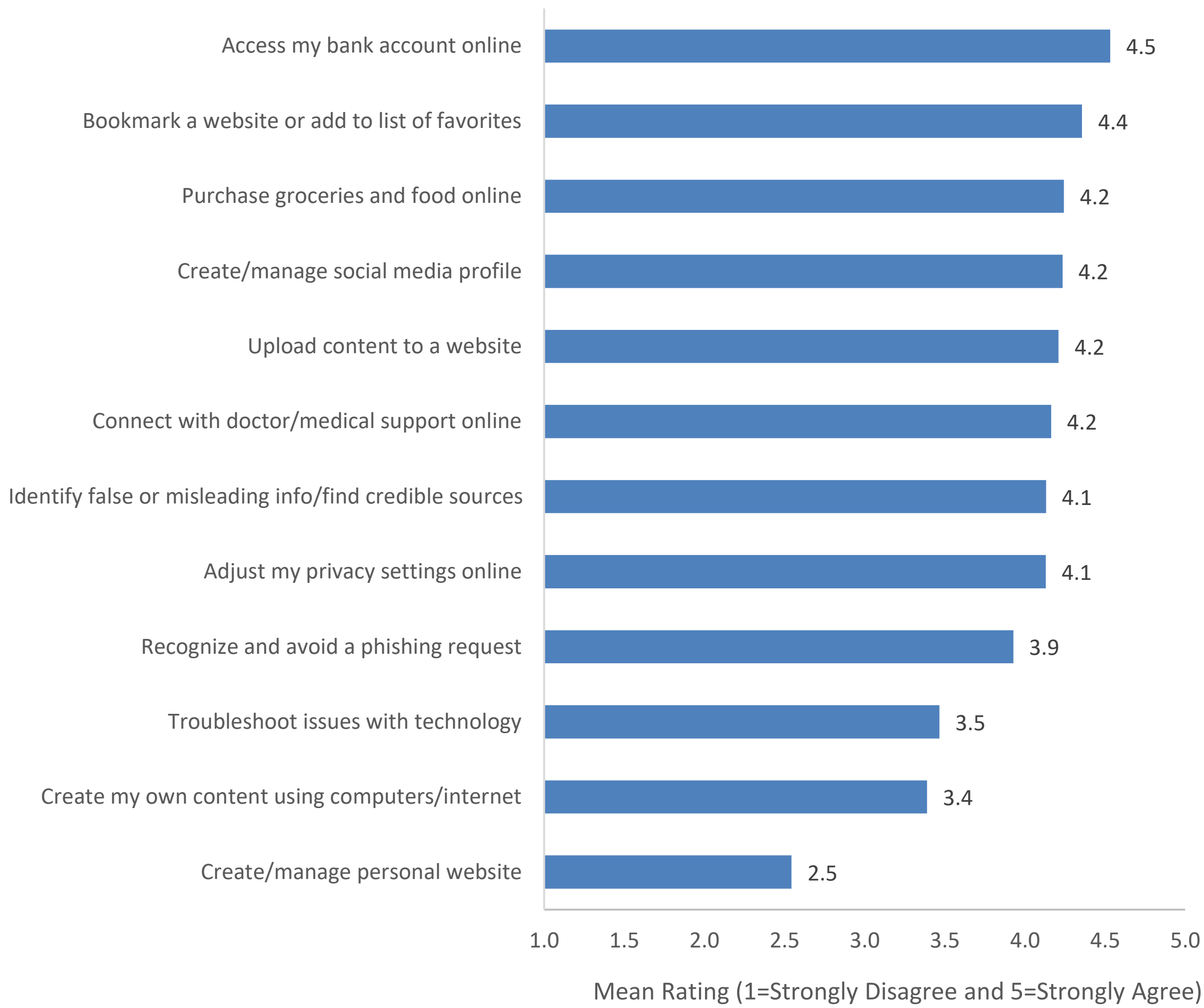
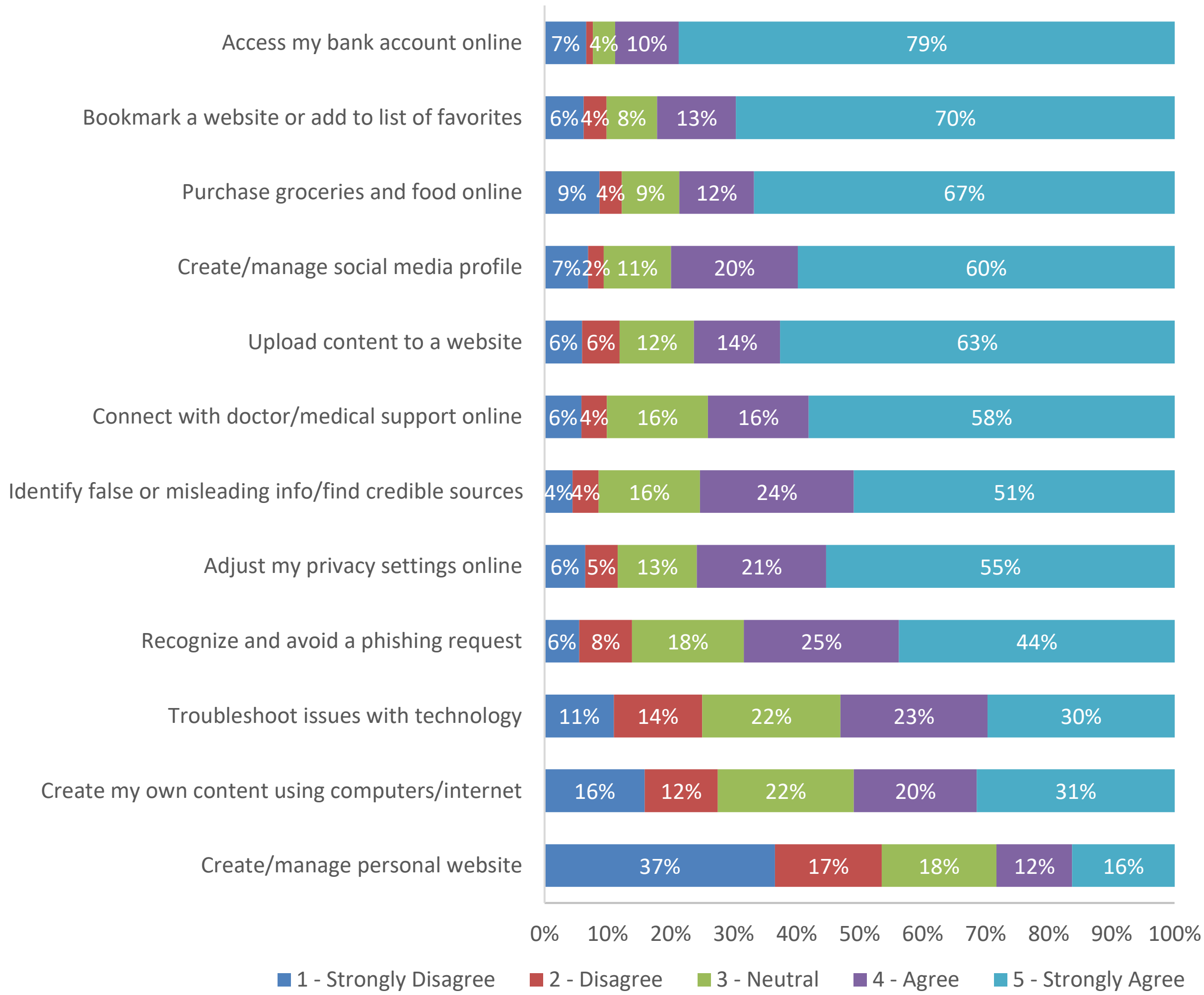


**Figure 65: Agreement with Statements About Internet Skills**




Overall, most internet subscribers agree that they know how to use the internet for various functions. Nearly eight in 10 respondents strongly agreed they can use the internet for accessing a bank account online. Seven in 10 strongly agreed they can use it for bookmarking a website, and two-thirds strongly agreed they can purchase groceries and food online.

At least one-half of respondent strongly agreed they can use the internet for managing their own profile on social media, uploading content to a website, connecting with doctors or other medical support online, identifying false or misleading information, and adjusting privacy settings online.

Respondents were less likely to agree that they are skilled in creating content or their own personal website or troubleshooting issues with technology.

Specifically, respondents ages 65 and older were less likely to agree that they are skilled in various uses of the internet (see Table 11 and

Table 12). Respondents under age 45 are particularly skilled in internet uses compared with older respondents, especially for identifying false information, recognizing phishing scams, and creating content. Nearly three-fourths of respondents under age 45 agreed or strongly agreed they are confident in their ability to troubleshoot issues with technology.

**Table 11: Agreement with Statements About Internet Skills (Mean Ratings) by Age**

| | < 45 years | 45-54 years | 55-64 years | 65 + years |
|---|---|---|---|---|
| I know how to upload content to a website | 4.5 | 4.4 | 4.3 | 3.6 |
| I know how to adjust my privacy settings online | 4.5 | 4.4 | 4.1 | 3.4 |
| I know how to bookmark a website or add to favorites | 4.8 | 4.5 | 4.4 | 3.8 |
| I know how to identify false or misleading information online and find credible sources of information | 4.5 | 4.2 | 4.1 | 3.7 |
| I know how to create and manage my own personal profile on Facebook or other social network site | 4.7 | 4.5 | 4.2 | 3.5 |
| I know how to create and manage my own personal website | 3.0 | 2.6 | 2.3 | 2.0 |
| I know how to recognize and avoid a phishing scam | 4.4 | 3.9 | 3.9 | 3.5 |
| I know how to create my own content using computers and the internet | 4.1 | 3.5 | 3.2 | 2.7 |
| I know how to access my bank account online to perform tasks such as paying bills or depositing checks with my phone | 4.8 | 4.6 | 4.5 | 4.1 |
| I feel confident in my ability to troubleshoot issues with technology when they arise | 4.1 | 3.6 | 3.2 | 2.9 |
| I know how to purchase groceries and food online | 4.5 | 4.5 | 4.3 | 3.6 |
| I know how connect with my doctor or other medical support online | 4.5 | 4.1 | 4.2 | 3.8 |

**Table 12: Agreement with Statements About Internet Skills (% Strongly Agree) by Age**

| | < 45 years | 45-54 years | 55-64 years | 65 + years |
|---|---|---|---|---|
| I know how to upload content to a website | 79% | 65% | 62% | 40% |
| I know how to adjust my privacy settings online | 64% | 65% | 55% | 33% |
| I know how to bookmark a website or add to favorites | 88% | 71% | 71% | 50% |
| I know how to identify false or misleading information online and find credible sources of information | 65% | 52% | 51% | 37% |
| I know how to create and manage my own personal profile on Facebook or other social network site | 75% | 68% | 56% | 37% |
| I know how to create and manage my own personal website | 27% | 17% | 11% | 8% |
| I know how to recognize and avoid a phishing scam | 70% | 42% | 36% | 24% |
| I know how to create my own content using computers and the internet | 52% | 31% | 20% | 17% |
| I know how to access my bank account online to perform tasks such as paying bills or depositing checks with my phone | 90% | 80% | 78% | 67% |
| I feel confident in my ability to troubleshoot issues with technology when they arise | 52% | 31% | 18% | 13% |
| I know how to purchase groceries and food online | 79% | 76% | 66% | 46% |
| I know how connect with my doctor or other medical support online | 69% | 59% | 57% | 48% |

Additionally, respondents in households earning under $50,000 were less likely to agree that they are skilled in various uses of the internet (see Table 13 and

Table 14). Just one-third of respondents earning under $50,000 per year agreed or strongly agreed they are confident in their ability to troubleshoot issues with technology.

**Table 13: Agreement with Statements About Internet Skills (Mean Ratings) by Income**

| | < $50k | $50-$99k | $100-$149k | $150k + |
|---|---|---|---|---|
| I know how to upload content to a website | 3.7 | 4.1 | 4.3 | 4.7 |
| I know how to adjust my privacy settings online | 3.7 | 4.0 | 4.2 | 4.6 |
| I know how to bookmark a website or add to favorites | 4.0 | 4.3 | 4.5 | 4.7 |
| I know how to identify false or misleading information online and find credible sources of information | 3.7 | 4.1 | 4.3 | 4.4 |
| I know how to create and manage my own personal profile on Facebook or other social network site | 4.0 | 4.2 | 4.3 | 4.4 |
| I know how to create and manage my own personal website | 2.3 | 2.6 | 2.5 | 2.9 |
| I know how to recognize and avoid a phishing scam | 3.5 | 3.8 | 4.2 | 4.2 |
| I know how to create my own content using computers and the internet | 3.0 | 3.3 | 3.4 | 3.9 |
| I know how to access my bank account online to perform tasks such as paying bills or depositing checks with my phone | 4.1 | 4.5 | 4.7 | 4.9 |
| I feel confident in my ability to troubleshoot issues with technology when they arise | 2.9 | 3.4 | 3.5 | 4.0 |
| I know how to purchase groceries and food online | 3.6 | 4.2 | 4.4 | 4.7 |
| I know how connect with my doctor or other medical support online | 3.7 | 4.2 | 4.3 | 4.4 |

**Table 14: Agreement with Statements About Internet Skills (% Agree/Strongly Agree) by Income**

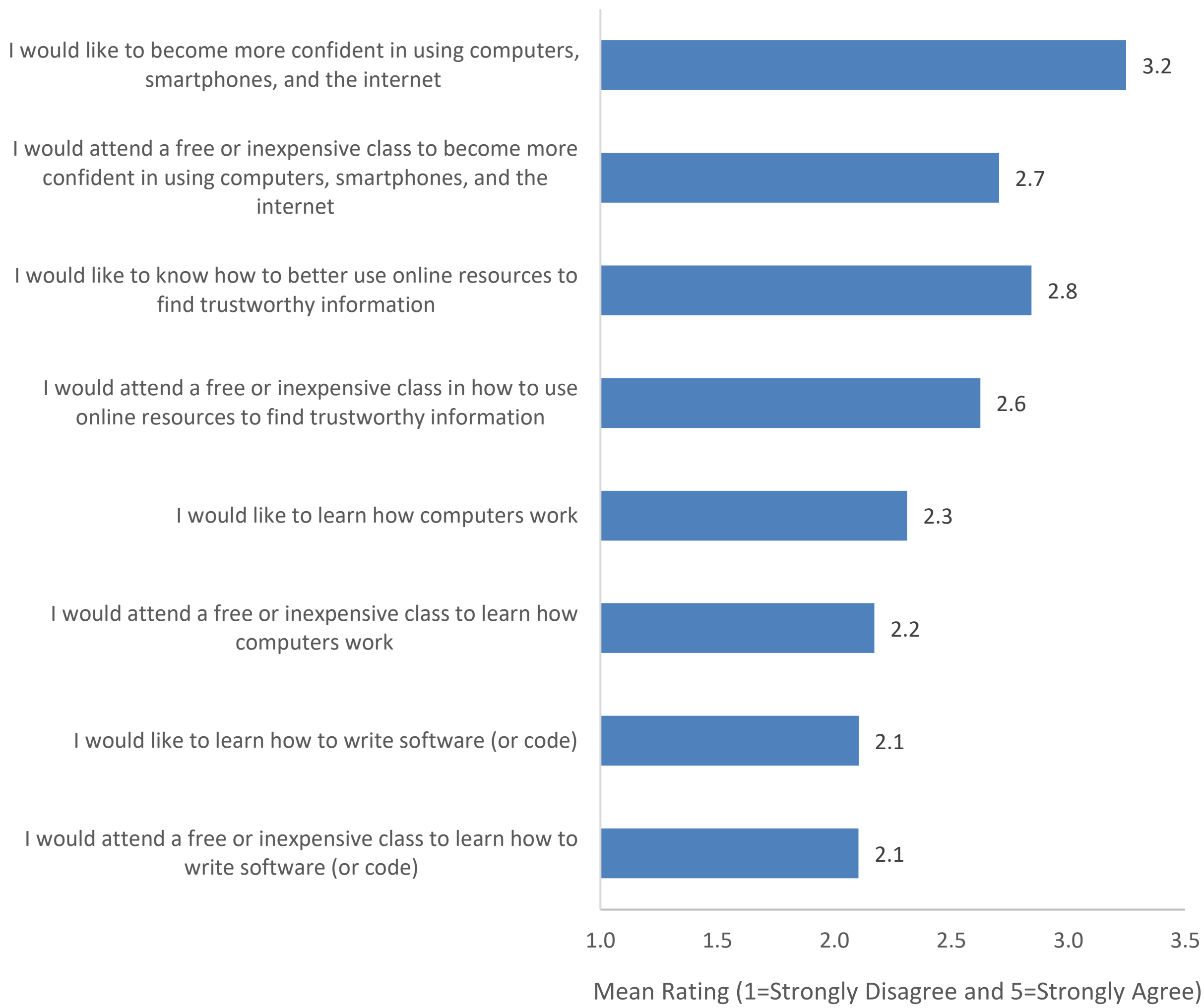
| | < $50k | $50-$99k | $100-$149k | $150k + |
|---|---|---|---|---|
| I know how to upload content to a website | 59% | 72% | 81% | 88% |
| I know how to adjust my privacy settings online | 63% | 76% | 75% | 87% |
| I know how to bookmark a website or add to favorites | 70% | 81% | 85% | 90% |
| I know how to identify false or misleading information online and find credible sources of information | 61% | 70% | 84% | 83% |
| I know how to create and manage my own personal profile on Facebook or other social network site | 77% | 79% | 81% | 81% |
| I know how to create and manage my own personal website | 23% | 29% | 21% | 41% |
| I know how to recognize and avoid a phishing scam | 55% | 65% | 76% | 72% |
| I know how to create my own content using computers and the internet | 41% | 49% | 49% | 71% |
| I know how to access my bank account online to perform tasks such as paying bills or depositing checks with my phone | 78% | 88% | 96% | 97% |
| I feel confident in my ability to troubleshoot issues with technology when they arise | 34% | 51% | 57% | 73% |
| I know how to purchase groceries and food online | 63% | 78% | 80% | 92% |
| I know how connect with my doctor or other medical support online | 58% | 75% | 74% | 87% |

### *5.4.2.2 Computer and internet training*

Respondents were also asked their level of agreement with various statements about receiving training related to computers and the internet. Average rating scores are highlighted in Figure 66, while Figure 67 shows detailed responses.

Overall, there is only slight to moderate interest in learning about or in attending a class about writing software/code or in learning how computers work. On average, there is moderate interest in becoming more confident in using computers, smartphones, and the internet, or in using online resources to find trustworthy information. However, there is less interest in attending a free or inexpensive class about these topics.

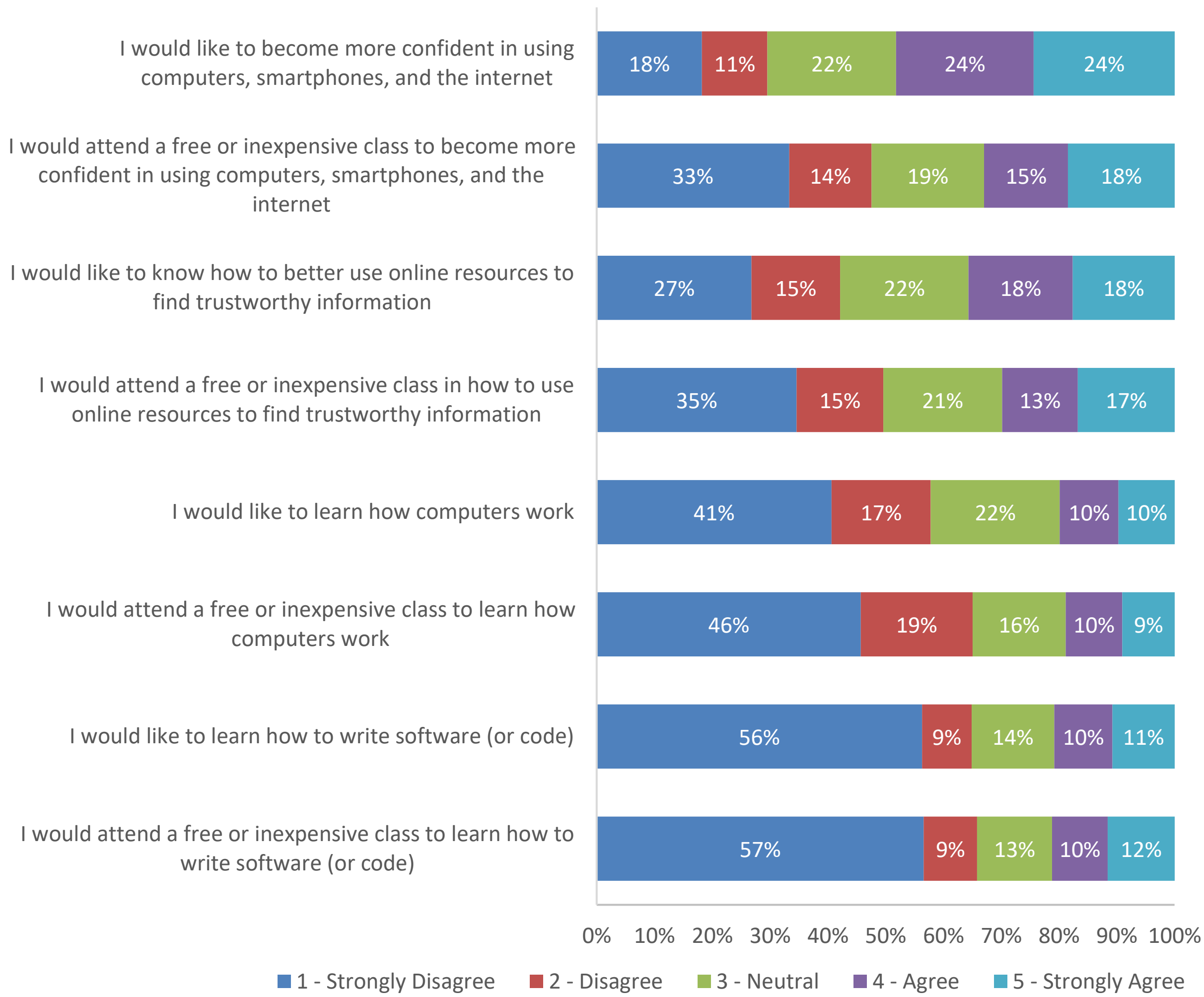
**Figure 66: Agreement with Statements About Training Related to Computers and the Internet (Mean Ratings)**



Specifically, nearly one-half of respondents agreed or strongly agreed that they would like to become more confident in using computers and related technology, but just 33 percent agreed or strongly agreed they would like to attend training.

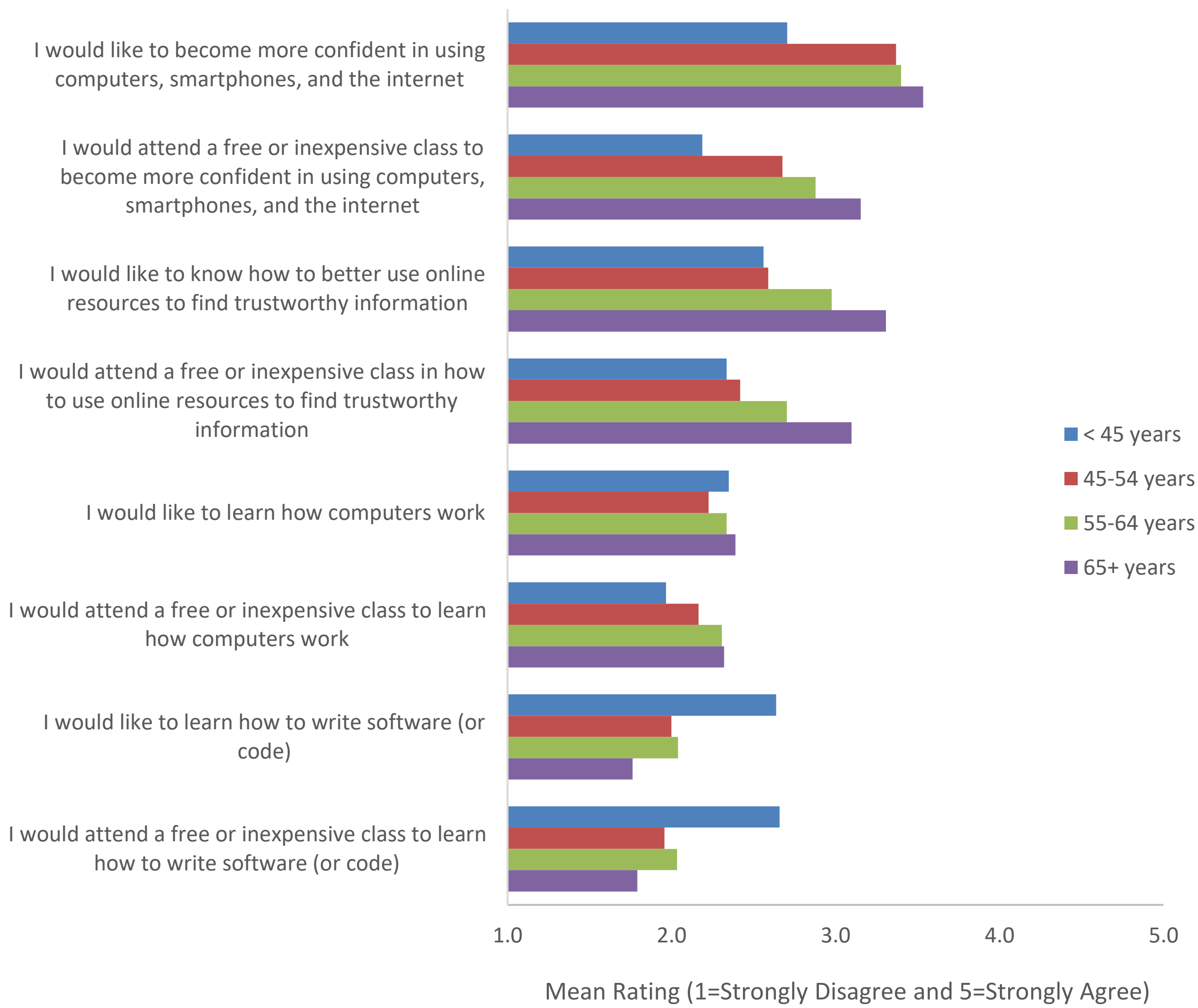
Similarly, 36 percent of respondents agreed or strongly agreed about wanting to know how to better use online resources to find trustworthy information, and 30 percent agreed or strongly agreed they are interested in training while 35 percent strongly disagreed.

**Figure 67: Agreement with Statements About Training Related to Computers and the Internet**



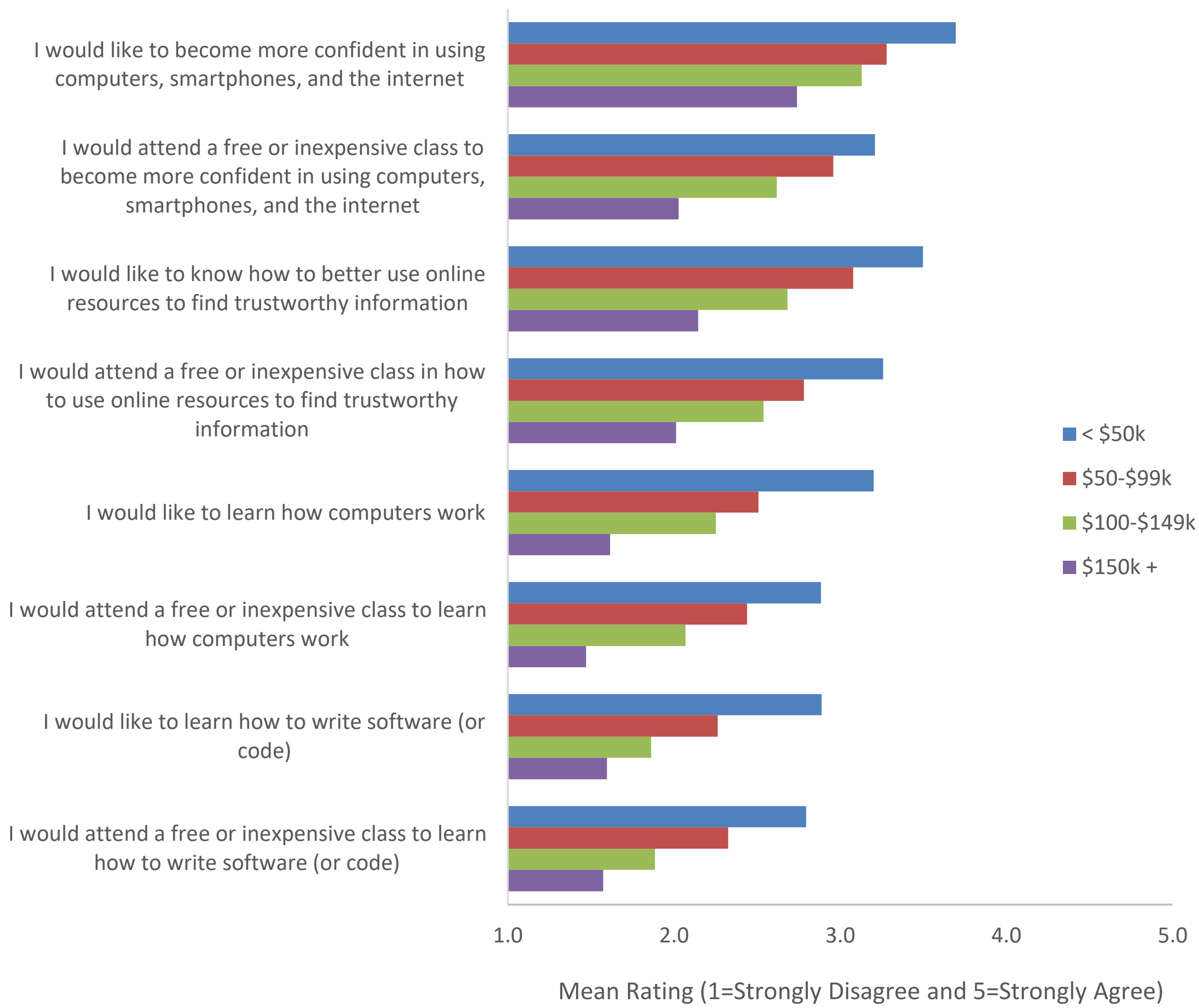
Interest in training varies significantly by age of respondent. As illustrated in Figure 68, those ages 65 and older expressed greater interest in becoming more confident in using computers and related technology and in learning how to better use online resources, as well as attending a class about these topics, compared with younger respondents. Those under age 45 are more likely than older respondents to agree they would like to learn how to write code or to take a class about this topic.

**Figure 68: Agreement with Statements About Training by Respondent Age**



As illustrated in Figure 69, agreement with the various statements about computer and internet training are correlated with household income. Those in lower-income households were more likely to agree that they would like to learn more or would attend training.

**Figure 69: Agreement with Statements About Training by Household Income**



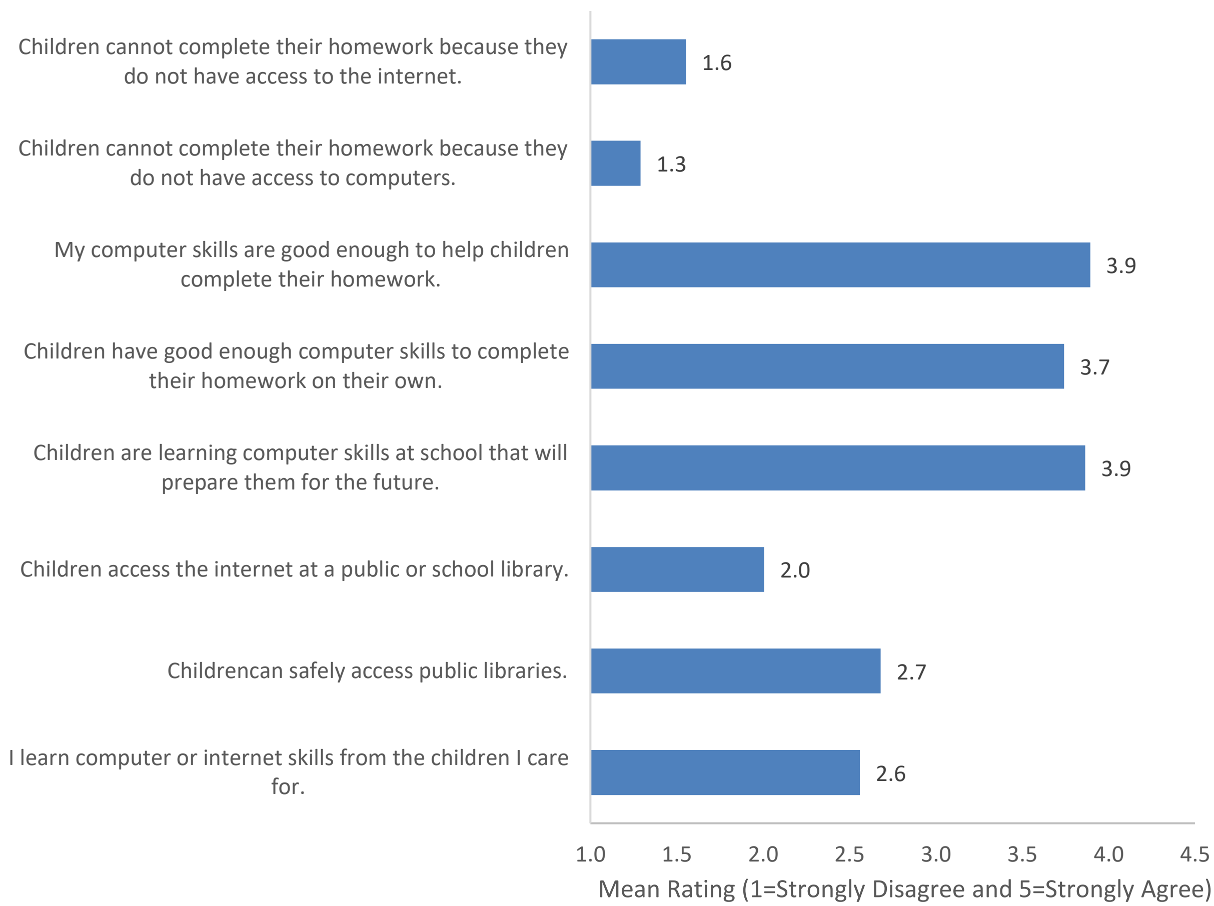
### 5.4.3 Technology for minor children

Just 29 percent of respondents said they are the parent, guardian, or primary caretaker of children or grandchildren under the age of 18. Approximately one-half of respondents under age 55 and one-half of respondents with a household income of $150,000 or more are a parent, guardian, or caretaker.

#### *5.4.3.1 Use of technology*

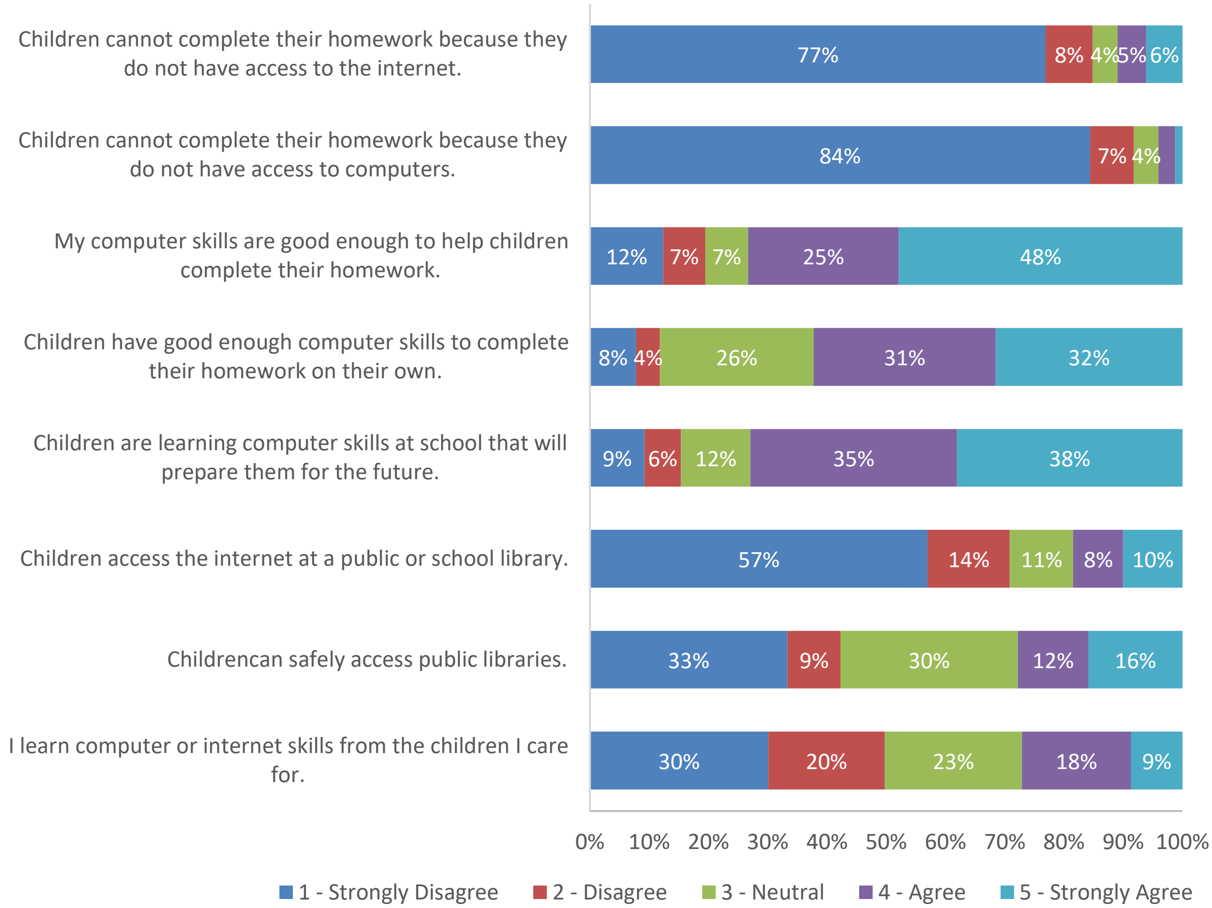
Respondents who are the parent, legal guardian, or primary caretaker for any child or grandchild under the age of 18 were asked their level of agreement with statements about how their minor child is able to make beneficial use of technology. Average rating scores are highlighted in Figure 70, while Figure 71 shows detailed responses.

**Figure 70: Agreement with Statements About Children's Use of Technology (Mean Ratings)**




A majority of respondents indicated that the children in their care have sufficient internet access. Most respondents strongly disagreed that the children in their care cannot complete their homework because they do not have access to the internet (77 percent) or computers (84 percent).

**Figure 71: Agreement with Statements About Children's Use of Technology During the Covid-19 Pandemic**




Still, accessibility may be an issue for a small segment of households without access to internet or computers. One in 10 respondents agreed or strongly agreed that the children in their care cannot complete their homework because they do not have access to the internet. Also, just 18 percent of respondents agreed or strongly agreed that their children access the internet at a public or school library, and just 18 percent agreed or strongly agreed that their children can safely access public libraries.

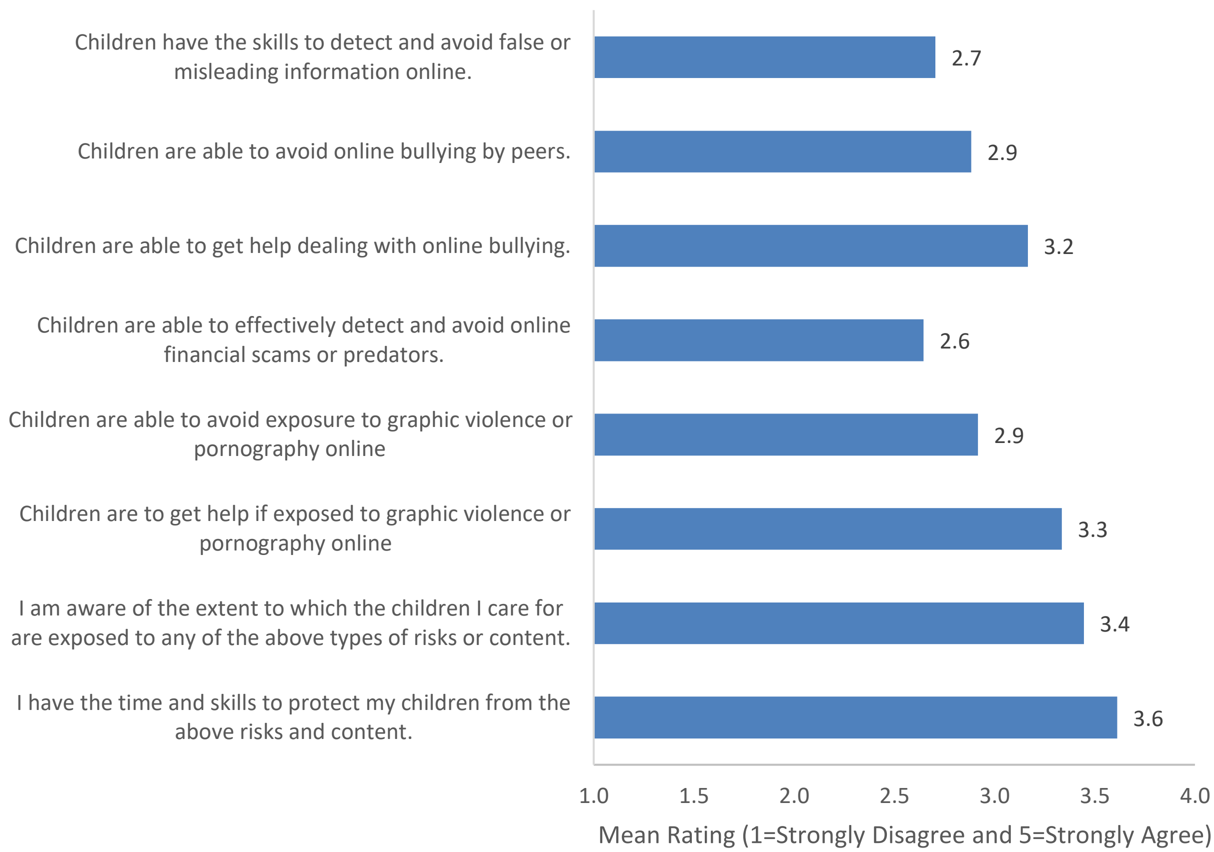
Most respondents agreed that they and their children have sufficient computer skills. Nearly one-half of respondents strongly agreed that their computer skills are good enough to help their children complete their homework, and one-fourth agreed. However, one-fifth of respondents disagreed or strongly disagreed that they have sufficient computers skills.

More than six in 10 respondents agreed or strongly agreed that that their children have good enough computer skills to complete their homework on their own. Nearly three-fourths of respondents agreed or strongly agreed that their children are learning computer skills at school that will prepare them for the future.

#### *5.4.3.2 Minimize online risks*

Respondents with minor children were also asked their level of agreement with statements about the skills they or their children possess to avoid or minimize online risks. Average rating scores are highlighted in Figure 72, while Figure 73 shows detailed responses.

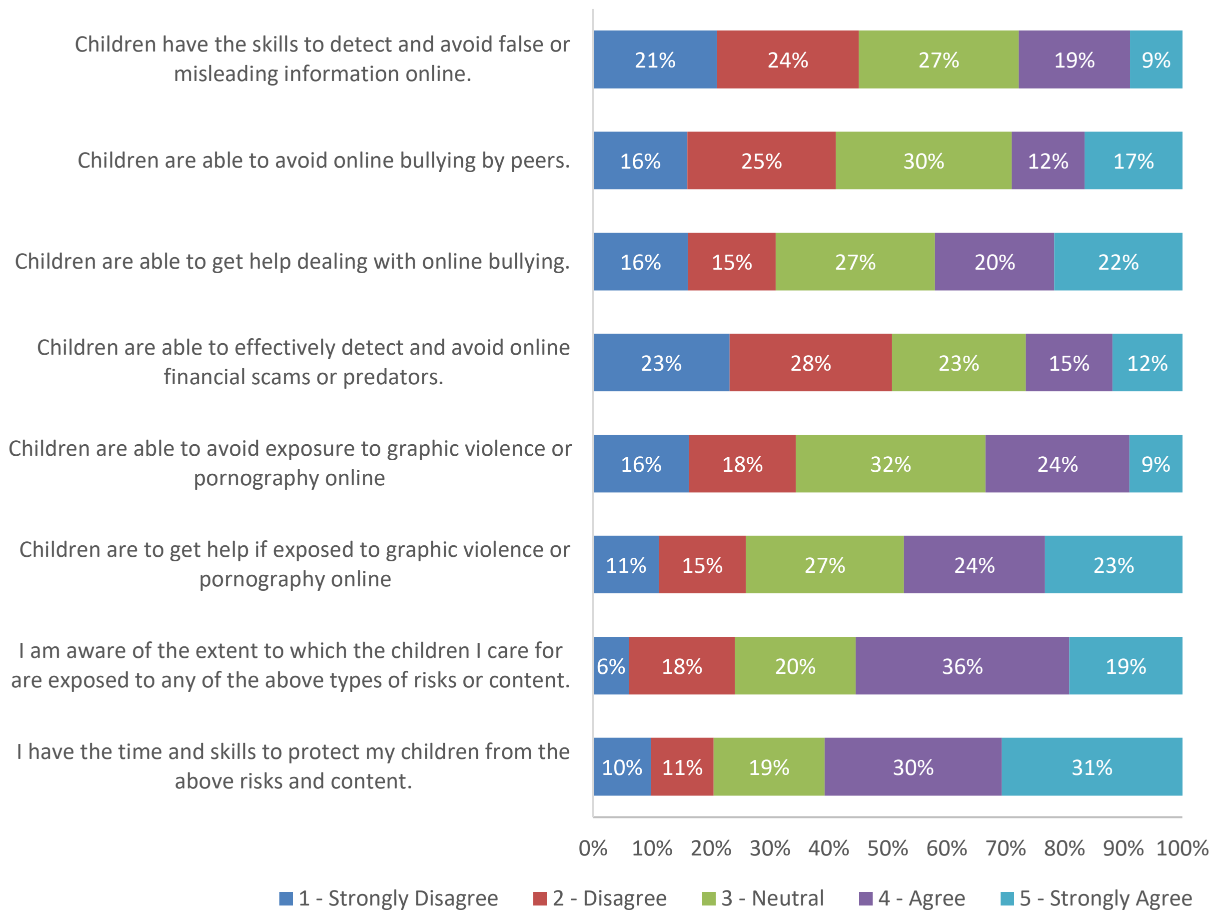
**Figure 72: Agreement with Statements About Minimizing Online Risks (Mean Ratings)**




Although most households with minor children do have access to the internet and computers, respondents agree that there are some risks associated with internet use. Overall, more than one-half of respondents agreed or strongly agreed that they are aware of the extent their children are exposed to various risks or content, and six in 10 agreed or strongly agreed that they have the time and skills to protect their children or grandchildren from risks.

At the same time, a sizeable segment of respondents disagreed that their children are able to minimize or avoid specific online risks. Specifically, many respondents disagreed or strongly disagreed that their children can detect and avoid false or misleading information (45%), avoid online bullying (41%), get help for online bullying (31%), detect and avoid financial scams and predators (51%), avoid exposure to graphic violence or pornography online (34%), and get help if exposed to graphic violence or pornography online (26%).

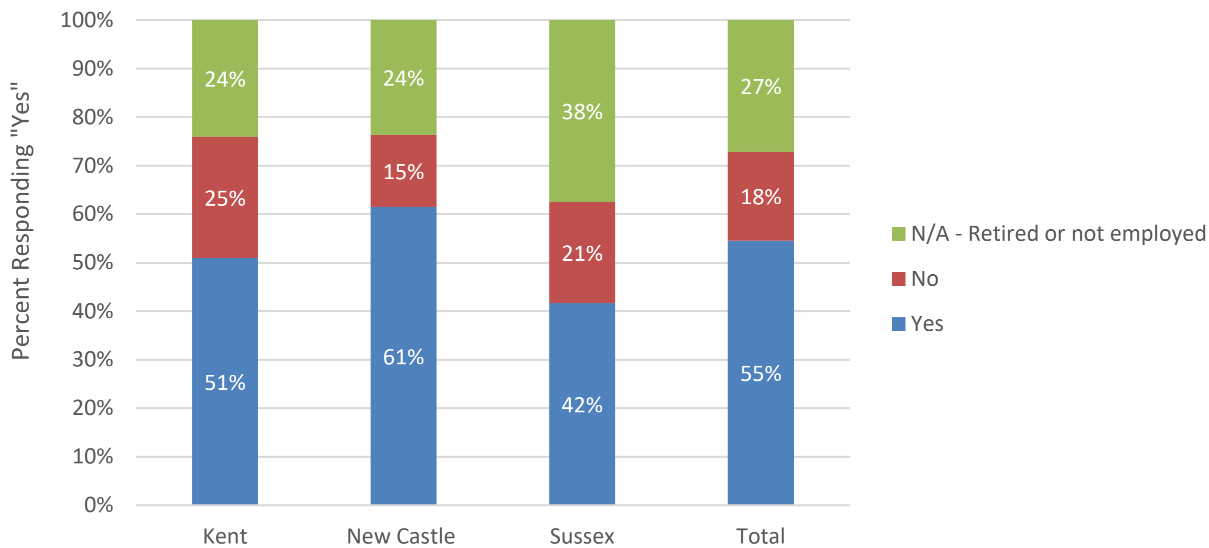
**Figure 73: Agreement with Statements About Minimizing Online Risks**




### 5.4.4 Internet use for jobs/careers

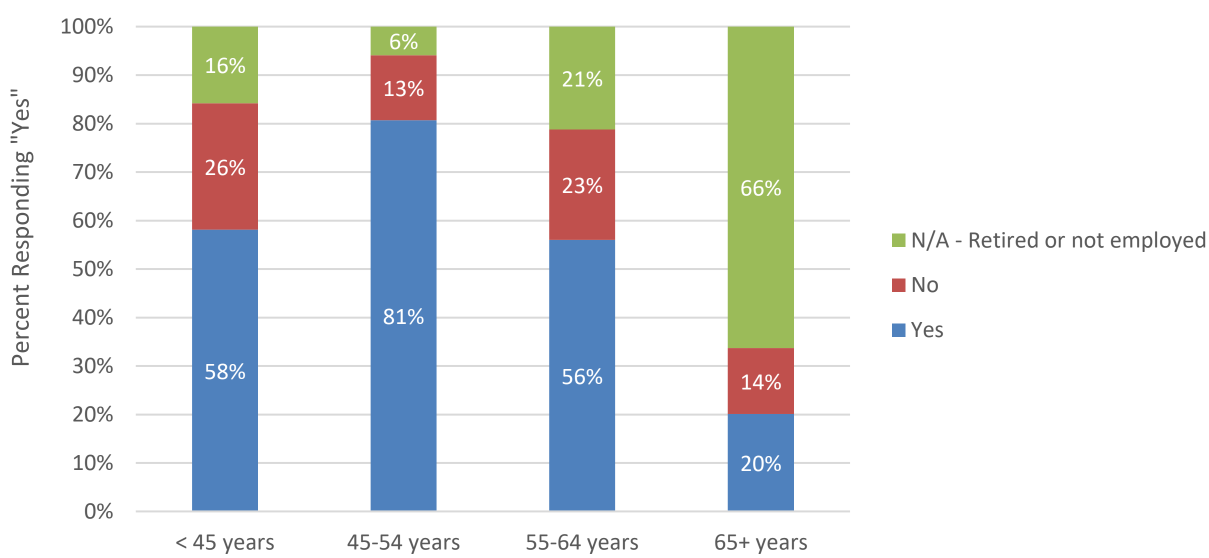
More than one-half (55%) of respondents said they have a job that requires them to have internet access at home. New Castle residents are somewhat more likely to need internet access at home, while Sussex residents are somewhat more likely to be retired or not employed (see Figure 74).

**Figure 74: Job Requires Homes Internet Access**



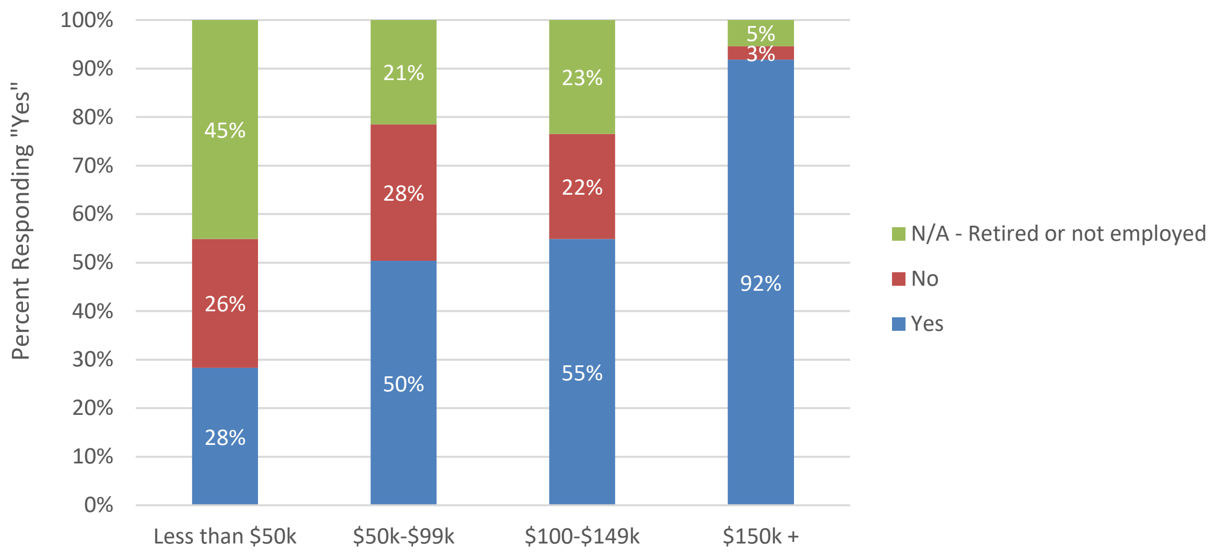

Also, need for internet access for a job is highly associated with respondent age, as may be expected, with the majority of those ages 65+ retired or not employed (see Figure 75). Eight in 10 respondents ages 45-54 years have a job that requires internet access.

**Figure 75: Job Requires Homes Internet Access by Respondent Age**



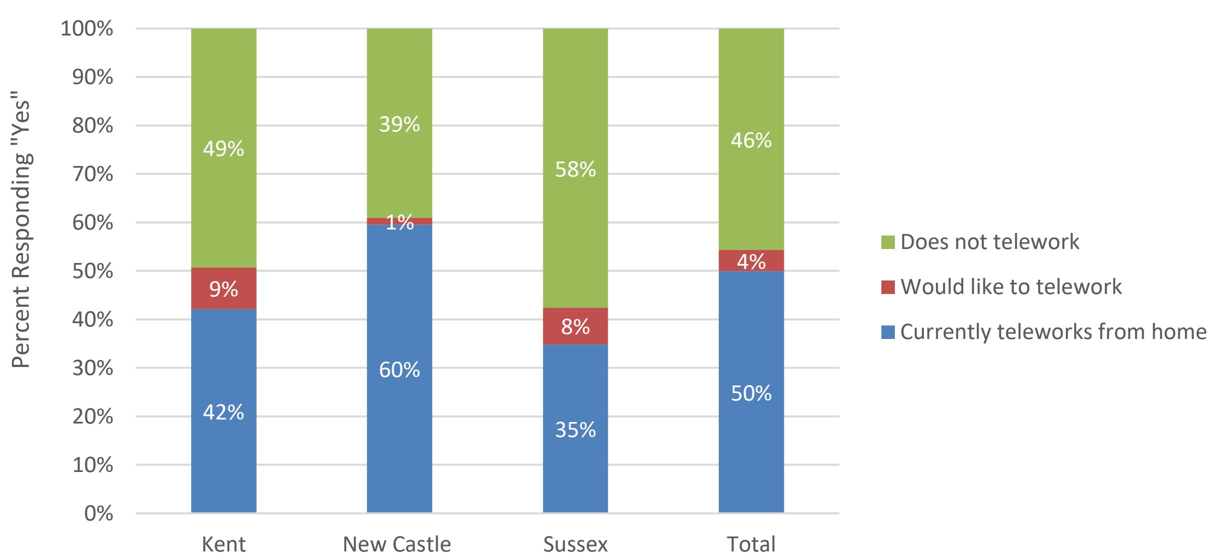

Also, need for internet access for a job is correlated with household income, as shown in Figure 76. More than nine in 10 respondents with a household income of $150,000 or more have a job that requires internet access. More than one-fourth of respondents in lower-income households need internet access for their job.

**Figure 76: Job Requires Homes Internet Access by Household Income**



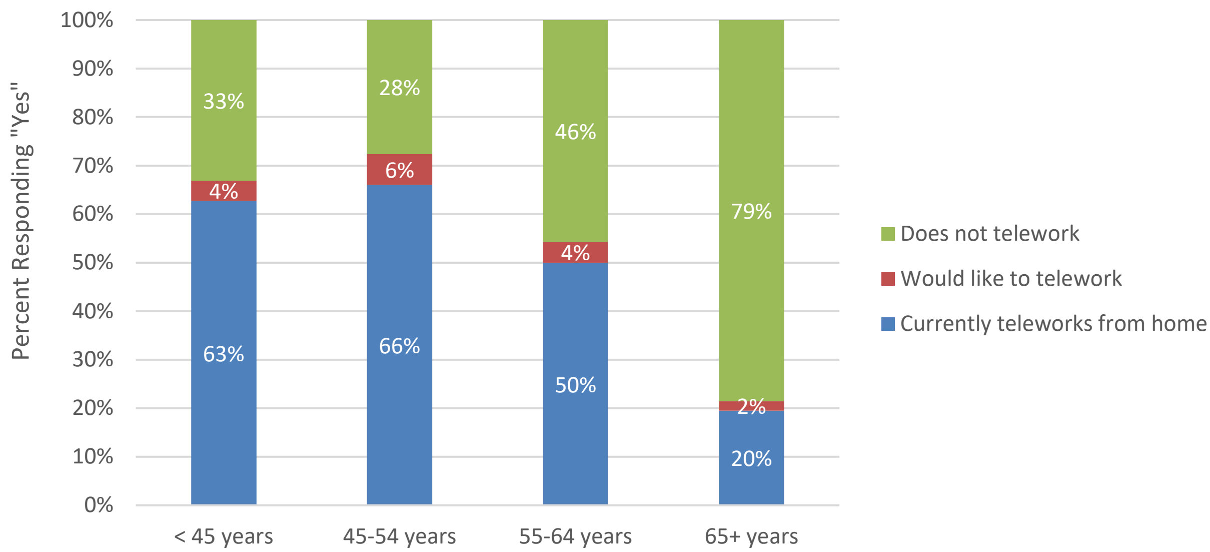

As shown in Figure 77 below, one-half of respondents indicated that someone in their household already teleworks from home, and another four percent would like to telework. Residents of New Castle County were somewhat more likely to report having a household member who currently teleworks.

**Figure 77: Household Member Teleworking**



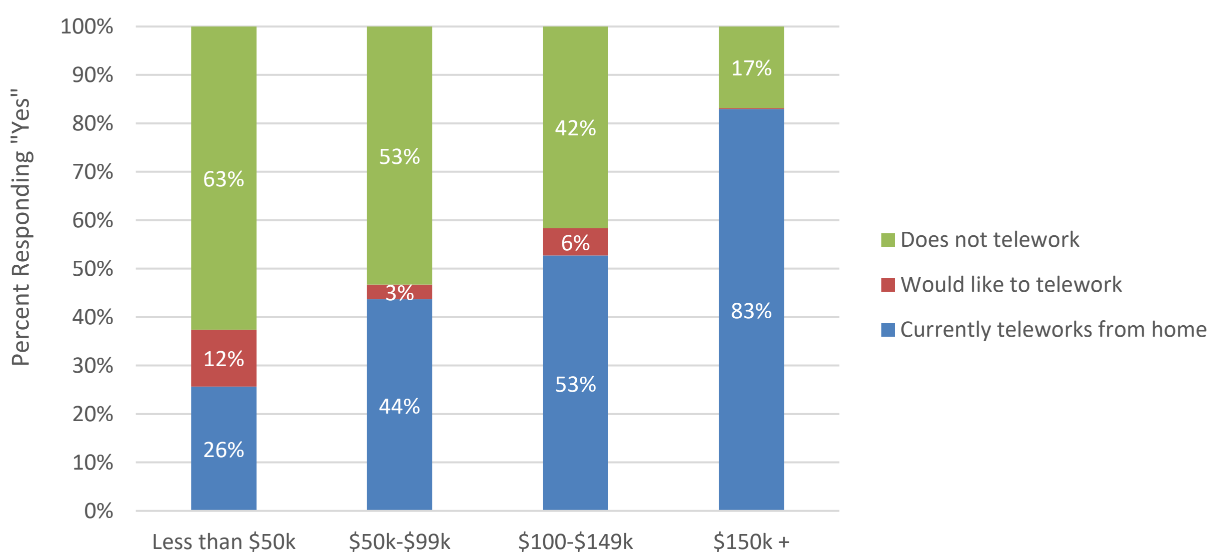

Respondents ages 65 and older are less likely than younger respondents to have a household member who currently teleworks (see Figure 78). As indicated earlier, this age cohort is much more likely to be retired or not working.

**Figure 78: Teleworking Status by Respondent Age**



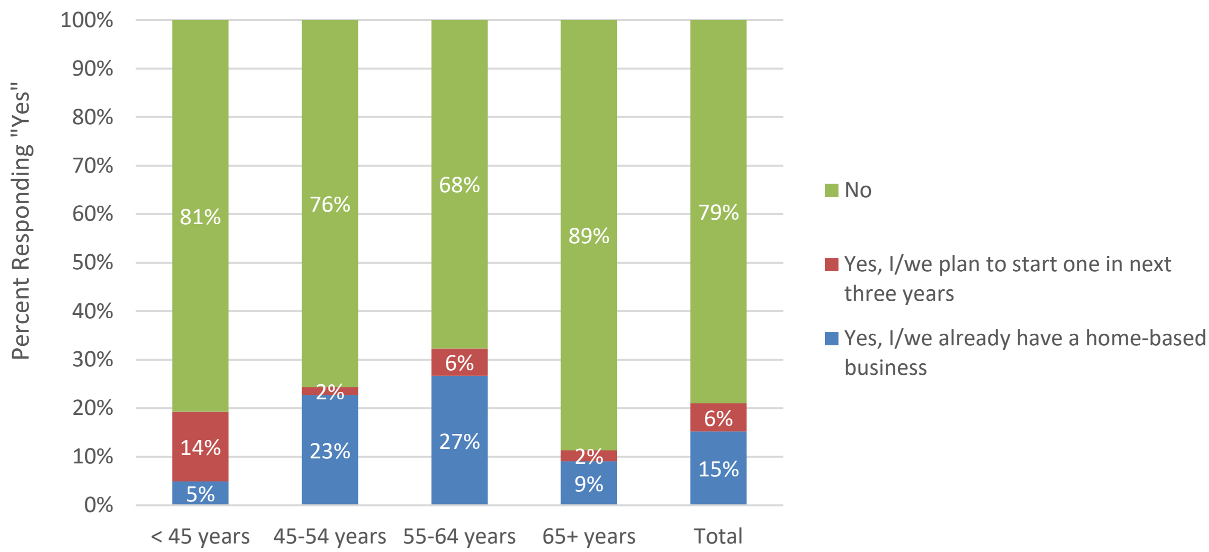

More than eight in 10 respondents earning $150,000 or more per year have a household member who currently teleworks, compared with just 26 percent of those earning less than $50,000 per year (see Figure 79). Twelve percent of households with an annual income less than $50,000 have a member who would like to telework.

**Figure 79: Teleworking Status by Household Income**



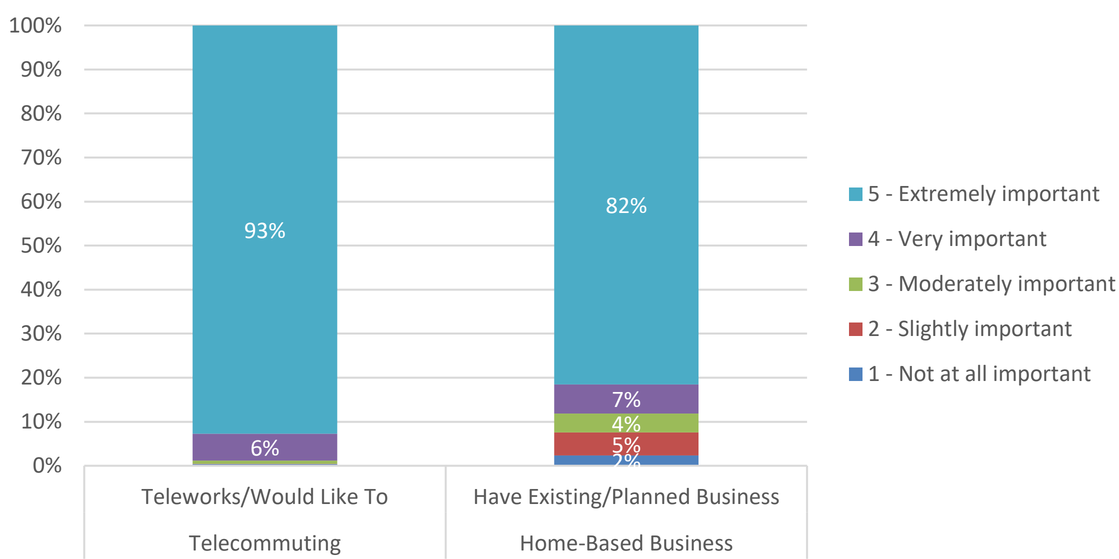

One-fifth of households either have a home-based business or are planning to start one within the next three years, as illustrated in Figure 80. Fourteen percent of respondents under age 45 said they or a household member plans to start a home-based business.

Figure 80: Own or Plan to Start a Home-Based Business




A high-speed data or internet connection is extremely important for most of those who currently telework or would like to telework (93 percent) and for those who have a planned or existing home-based business (82 percent), as shown in Figure 81. Intuitively, those who do not telework or have a planned/existing home-based business find the need for high-speed internet for these aspects to be less important.

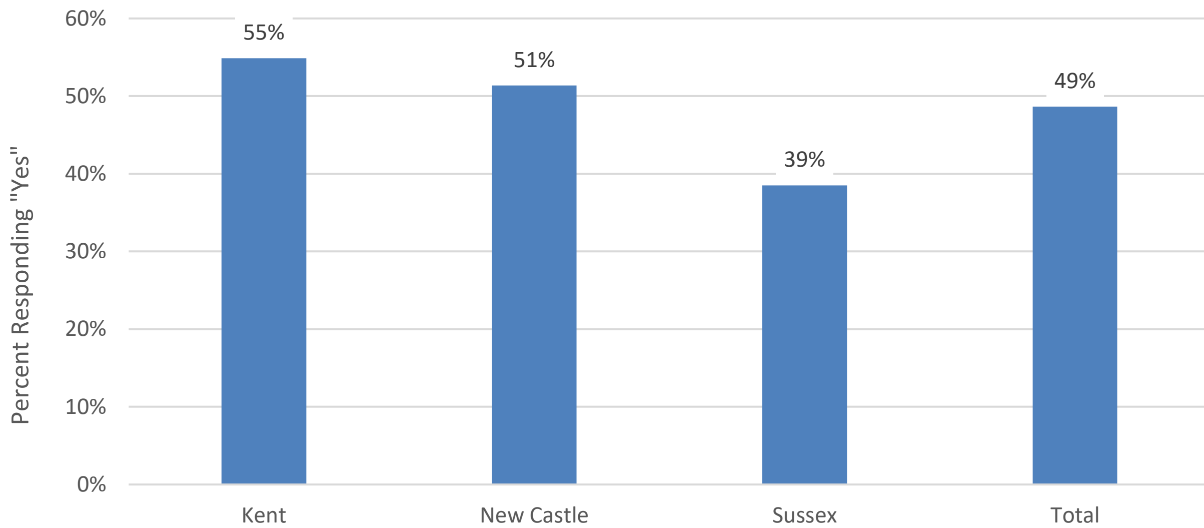
Figure 81: Importance of High-Speed Internet




### 5.4.5 Internet use for education

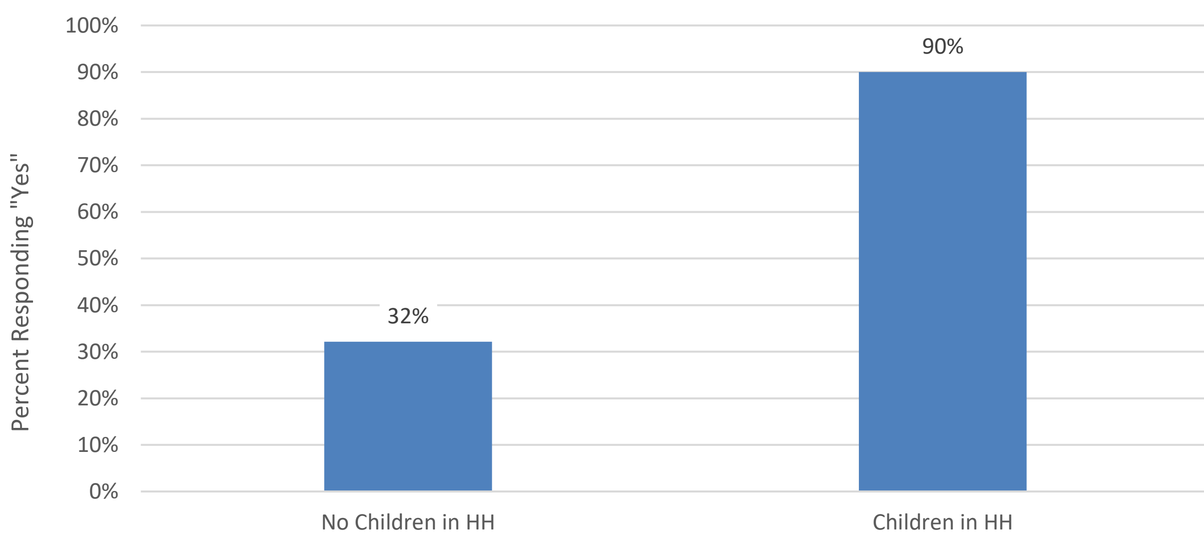
Respondents were asked if they or a household member use an internet connection for educational purposes, such as completing assignments, research, or study related to coursework or formal education. Overall, 49 percent of respondents reported using the internet for educational reasons. Usage is lower in Sussex County, where respondents are somewhat older and less likely to have children in the household (see Figure 82).

**Figure 82: Use of Internet for Educational Purposes**



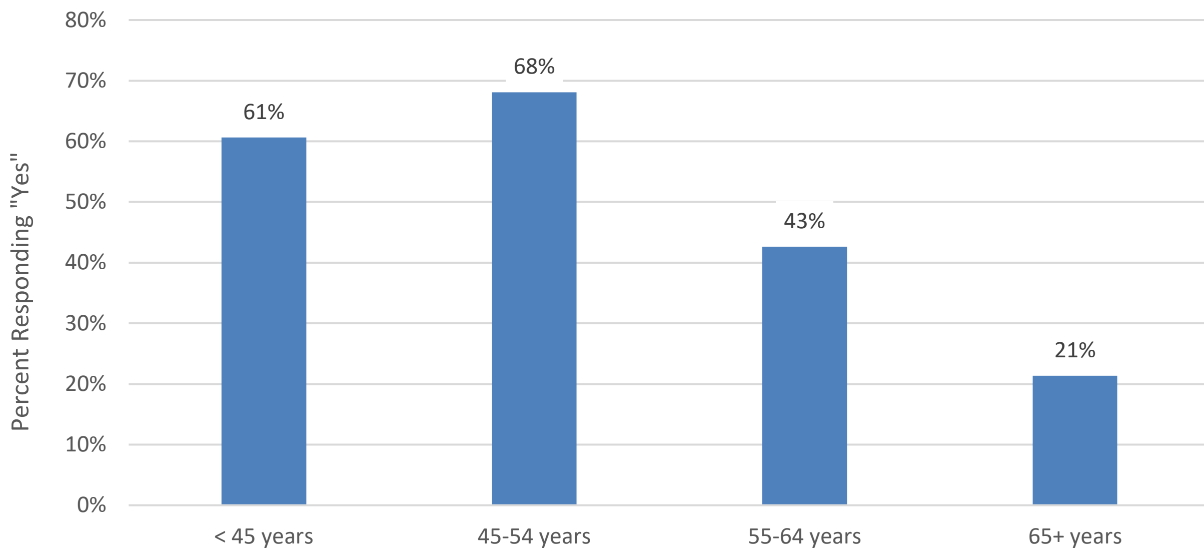

Nine in 10 households with children in them have a household member who uses the internet for educational purposes (see Figure 83).

**Figure 83: Use of Internet for Educational Purposes by Children in Household**



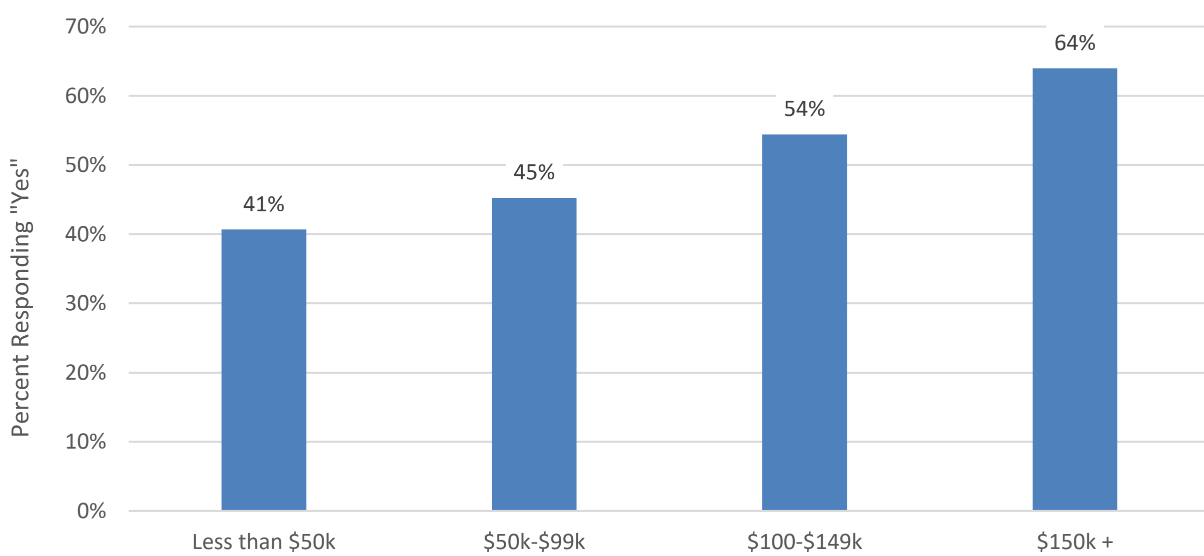

Use of the internet for educational purposes is lower for respondents ages 55 and older. Six in 10 respondents less than age 45 have a household member who uses the internet for educational purposes, as do two-thirds of respondents ages 45-54 years (see Figure 84).

**Figure 84: Use of Internet for Educational Purposes by Respondent Age**



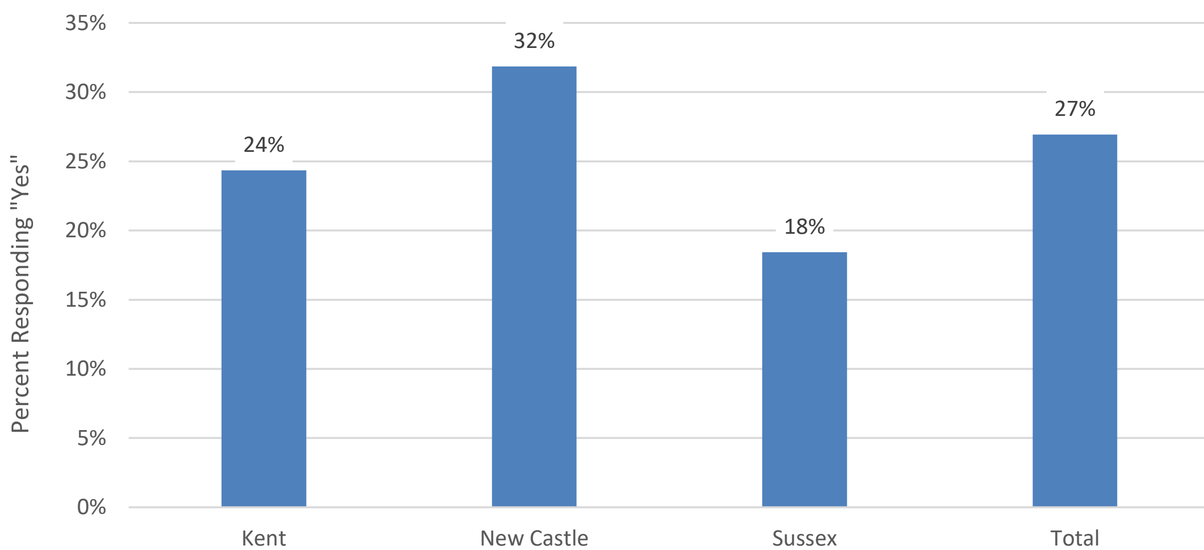

Respondents with a household income of $150,000 or more are the most likely to use the internet for educational purposes, as shown in Figure 85. Four in 10 lower-income households use the internet for educational purposes.

**Figure 85: Use of Internet for Educational Purposes by Household Income**



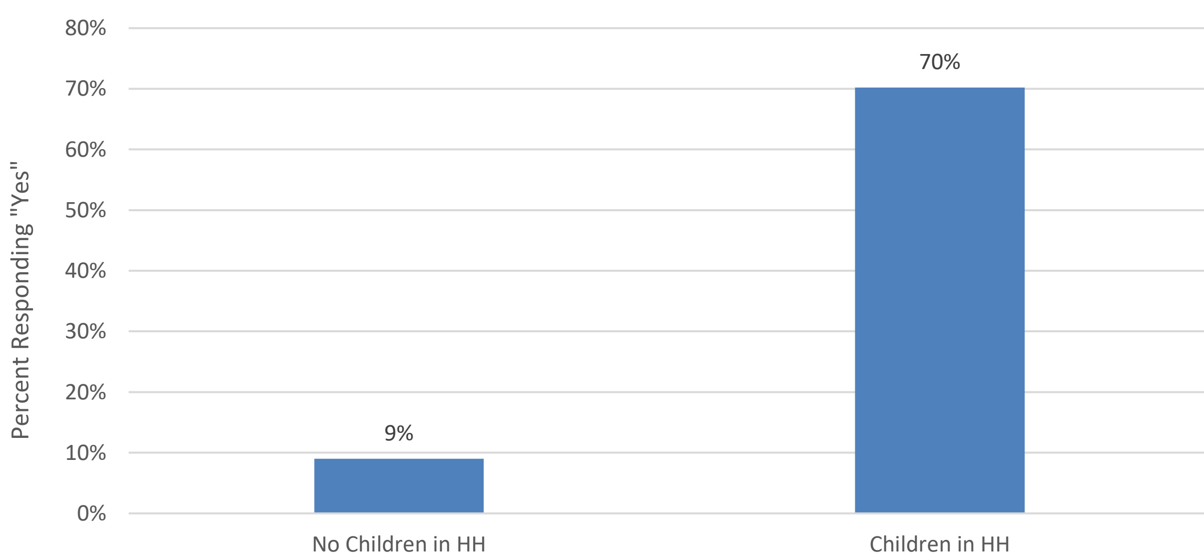
As shown in Figure 86, 27 percent of households have a member who uses the internet for homeschooling. Usage is highest in New Castle County and lowest in Sussex County (again where respondents are somewhat older and less likely to have children in the household).

**Figure 86: Use of Internet for Homeschooling**



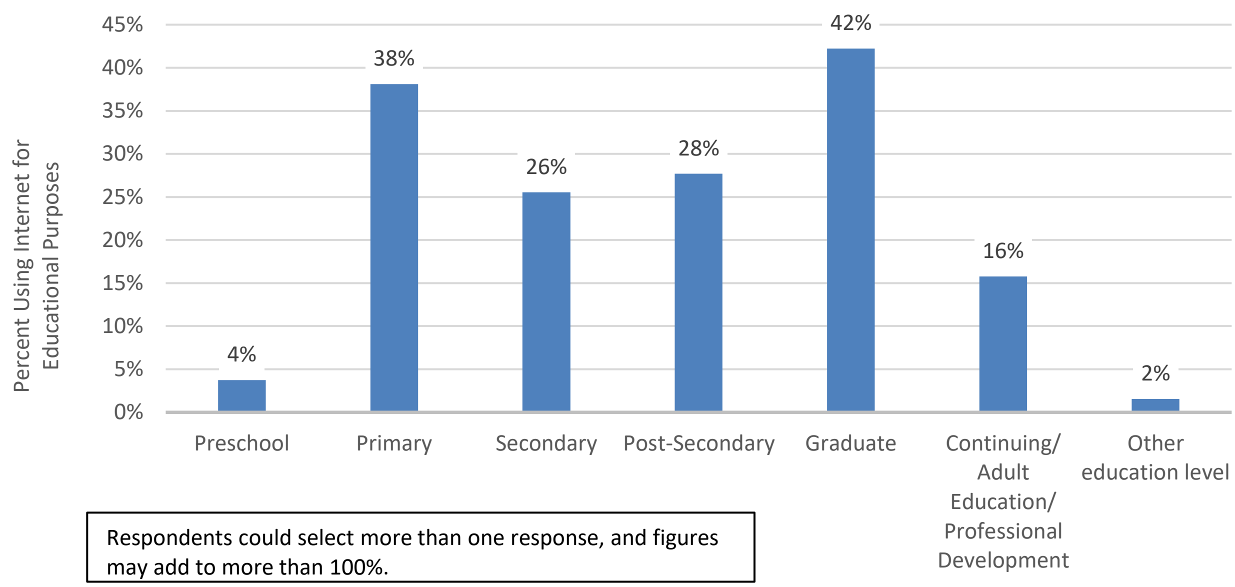

Seven in 10 households with children in them have a household member who uses the internet for homeschooling (see Figure 87).

**Figure 87: Use of Internet for Educational Purposes by Children in Household**



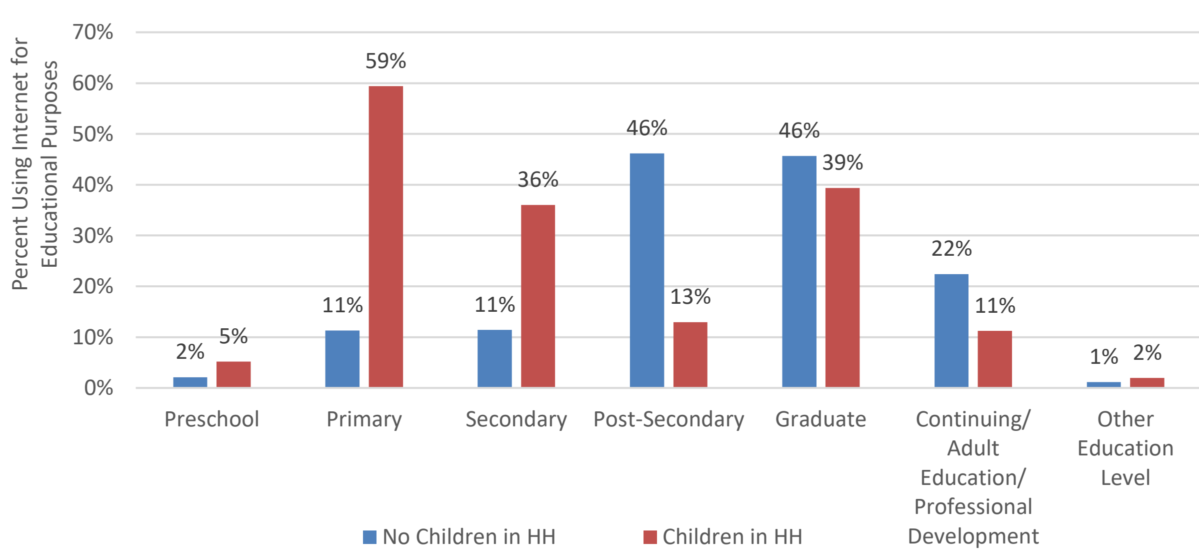
Respondents use the internet across a range of education levels, as shown in Figure 88. Among those who use the internet for educational purposes, 42 percent use it for graduate level education and 38 percent use it for primary education (kindergarten – Grade 8).

**Figure 88: Education Level for Which Internet Connection Is Used**



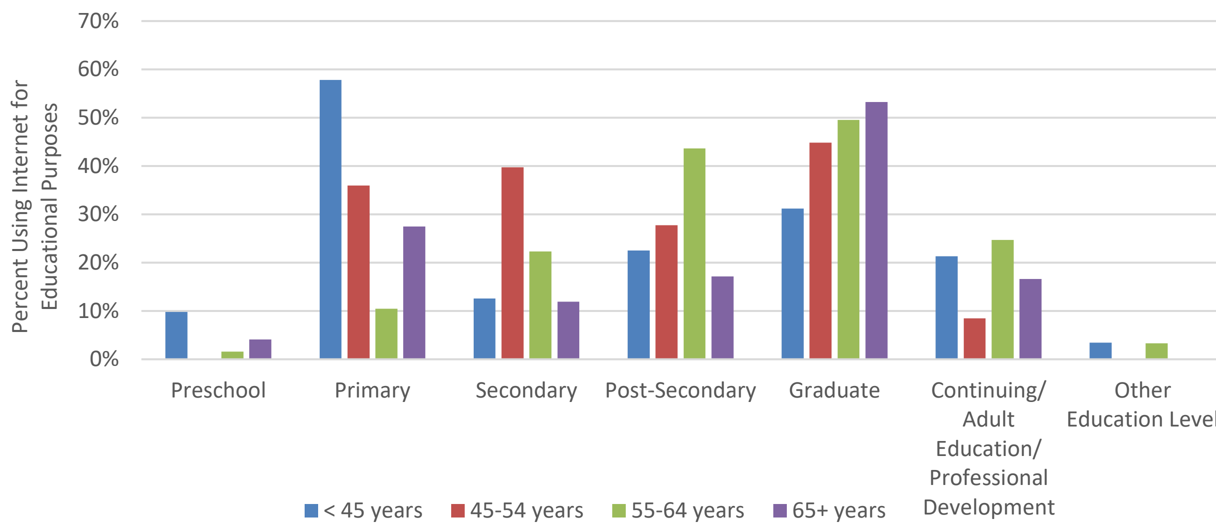

Use of the internet for educational purposes is related to presence of children in the household, as might be expected, particularly for primary and secondary education needs. Those without children in the home are more likely to use the internet for post-secondary education (see Figure 89).

**Figure 89: Education Level for Which Internet Connection Is Used by Children in Household**



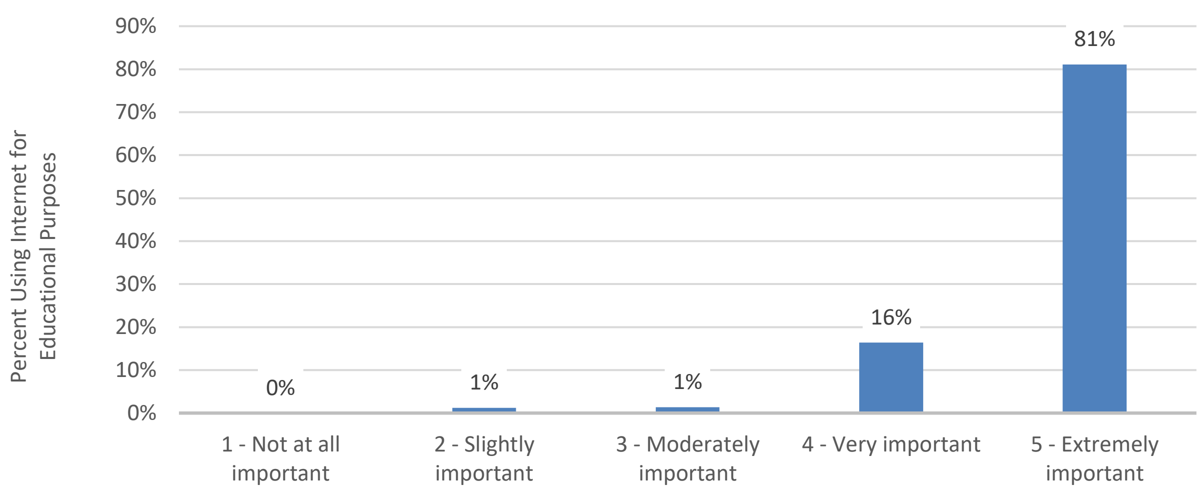
Similarly, use of the internet for educational purposes is correlated with respondent age, as illustrated in Figure 90. Respondents under age 45 are more likely than older respondents to have a household member who uses the internet for primary education; those ages 45-54 years are more likely to have a household member who uses the internet for secondary education. Household use of the internet for post-secondary education is highest among respondents ages 55-64 years. Use of the internet for graduate education increases as age group increases.

**Figure 90: Education Level for Which Internet Connection Is Used by Respondent Age**




Among those who use the internet for educational purposes, eight in 10 said a high-speed internet connection is extremely important for their education needs (see Figure 91). Nine in 10 of those with children in the household said high-speed internet is extremely important.

**Figure 91: Importance of High-Speed Internet for Education Needs**



### 5.4.6 Respondent opinions

Respondents were asked their opinions about the State's role in providing or promoting broadband communications services within the area. Figure 92 illustrates the mean ratings, while Figure 93 provides detailed responses to each portion of the question.

**Figure 92: Opinions About the Role(s) for State of Delaware (Mean Ratings)**

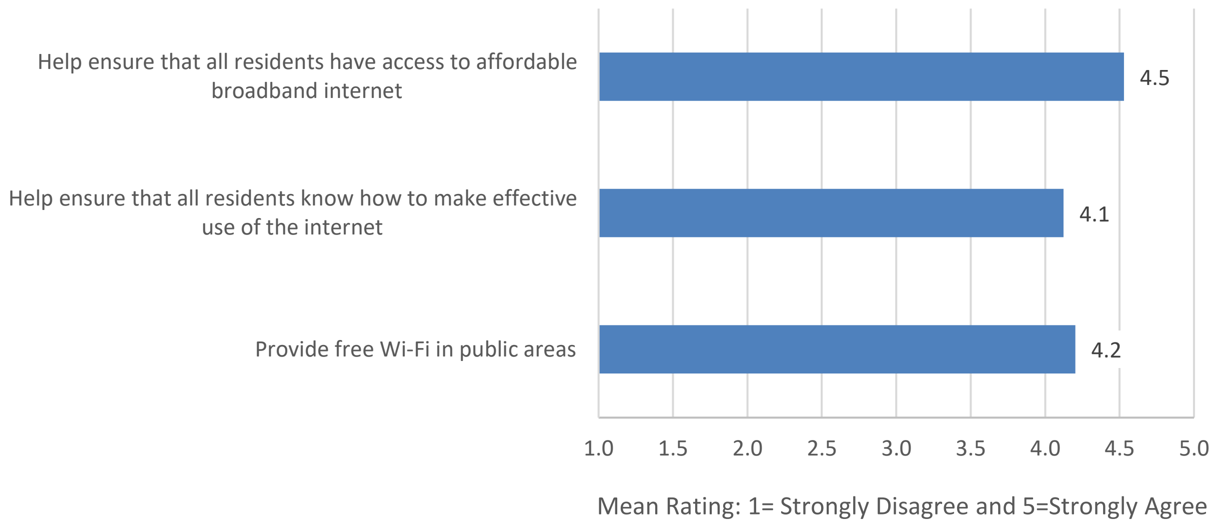
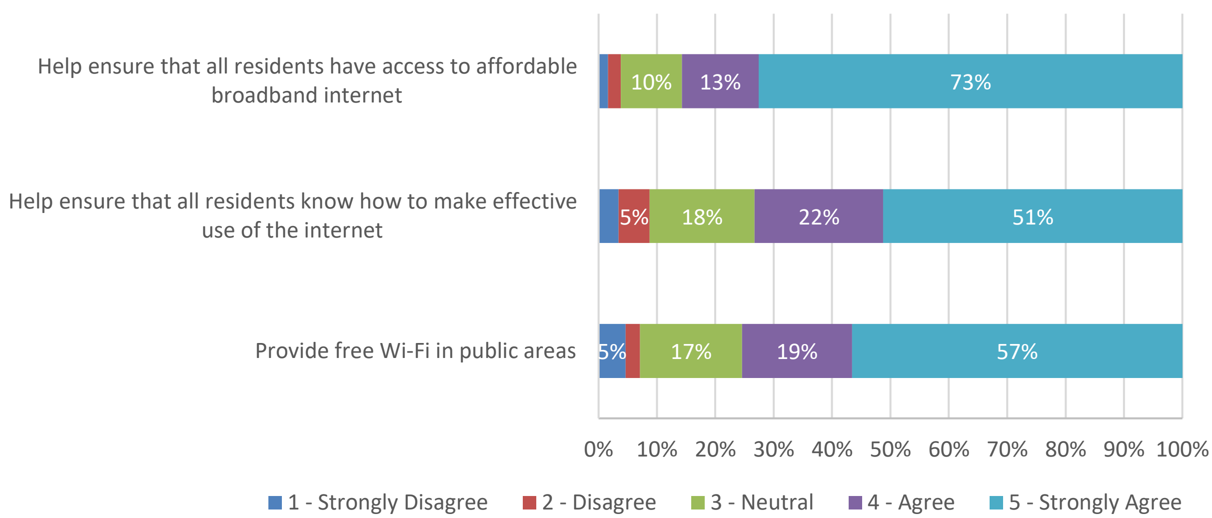


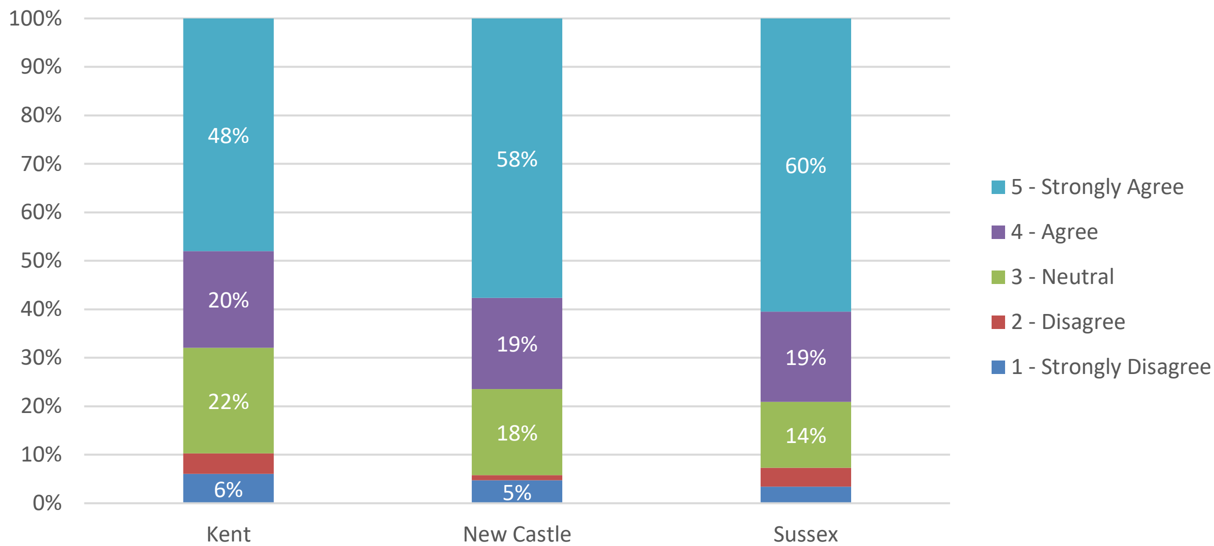

**Figure 93: Opinions About the Role(s) for State of Delaware**




Overall, there is strong support for ensuring all residents have access to competitively priced broadband services, with 73 percent strongly agreeing. One-half strongly agreed that the State should help ensure that all residents know how to make effective use of the internet, and 57 percent strongly agreed the State should provide free Wi-Fi in public areas.

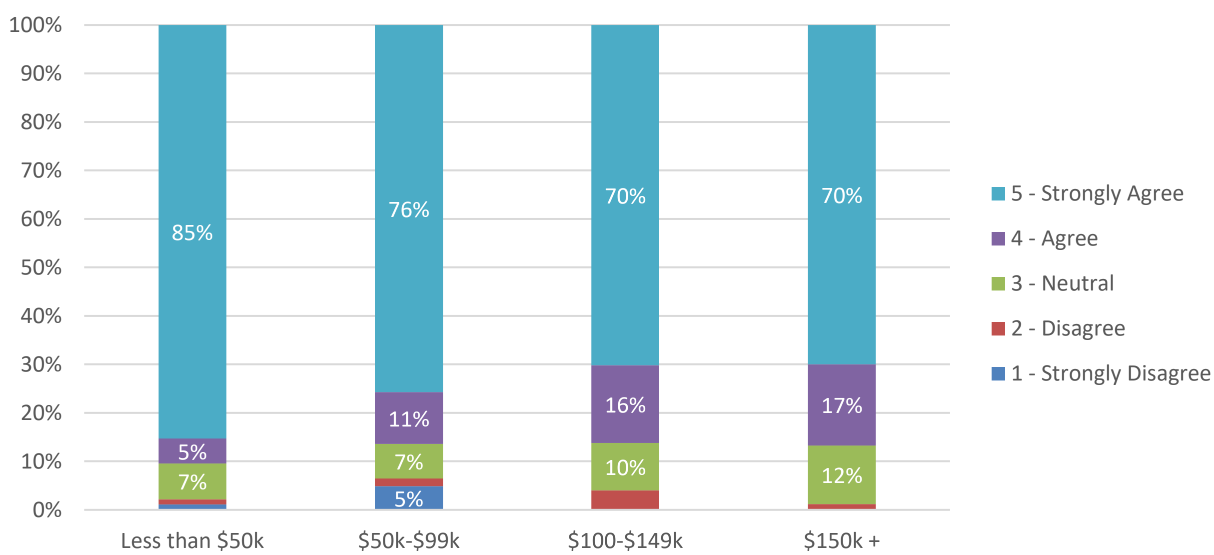
Kent County residents were somewhat less likely than residents of other counties to agree that the State should provide free Wi-Fi in public areas, although agreement was high across areas (see Figure 94).

**Figure 94: Provide Free Wi-Fi in Public Areas by County**



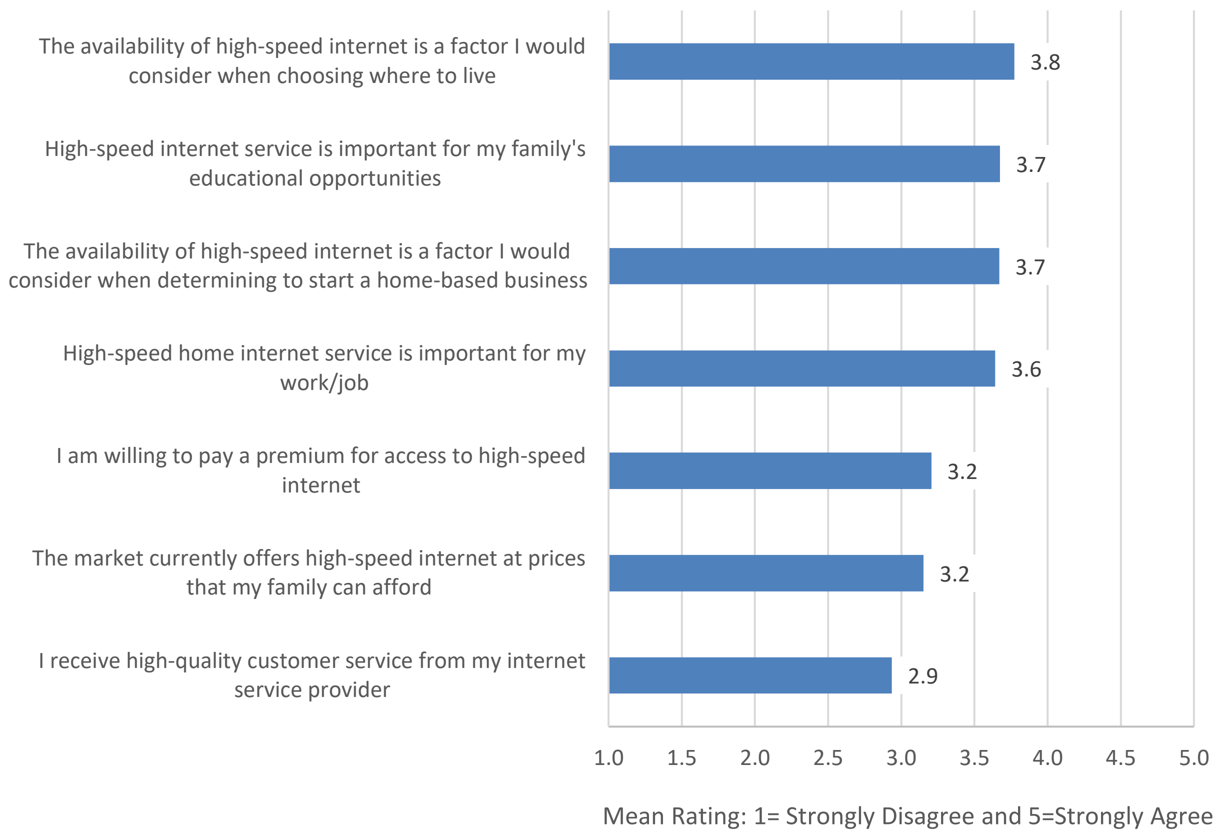

As illustrated in Figure 95, 85 percent of respondents in households earning less than $50,000 per year strongly agreed that the State should help ensure that all residents have access to competitively priced broadband internet in their homes.

**Figure 95: Ensure That All Residents Have Affordable Broadband Internet Access by Income**



Respondents were also asked their opinion of the current broadband market. Overall, respondents moderately to strongly agreed with most statements. The average agreement with broadband availability statements is shown in Figure 96. Detailed responses to statements about broadband availability are illustrated Figure 97.

**Figure 96: Opinions About the Broadband Internet Market (Mean Ratings)**

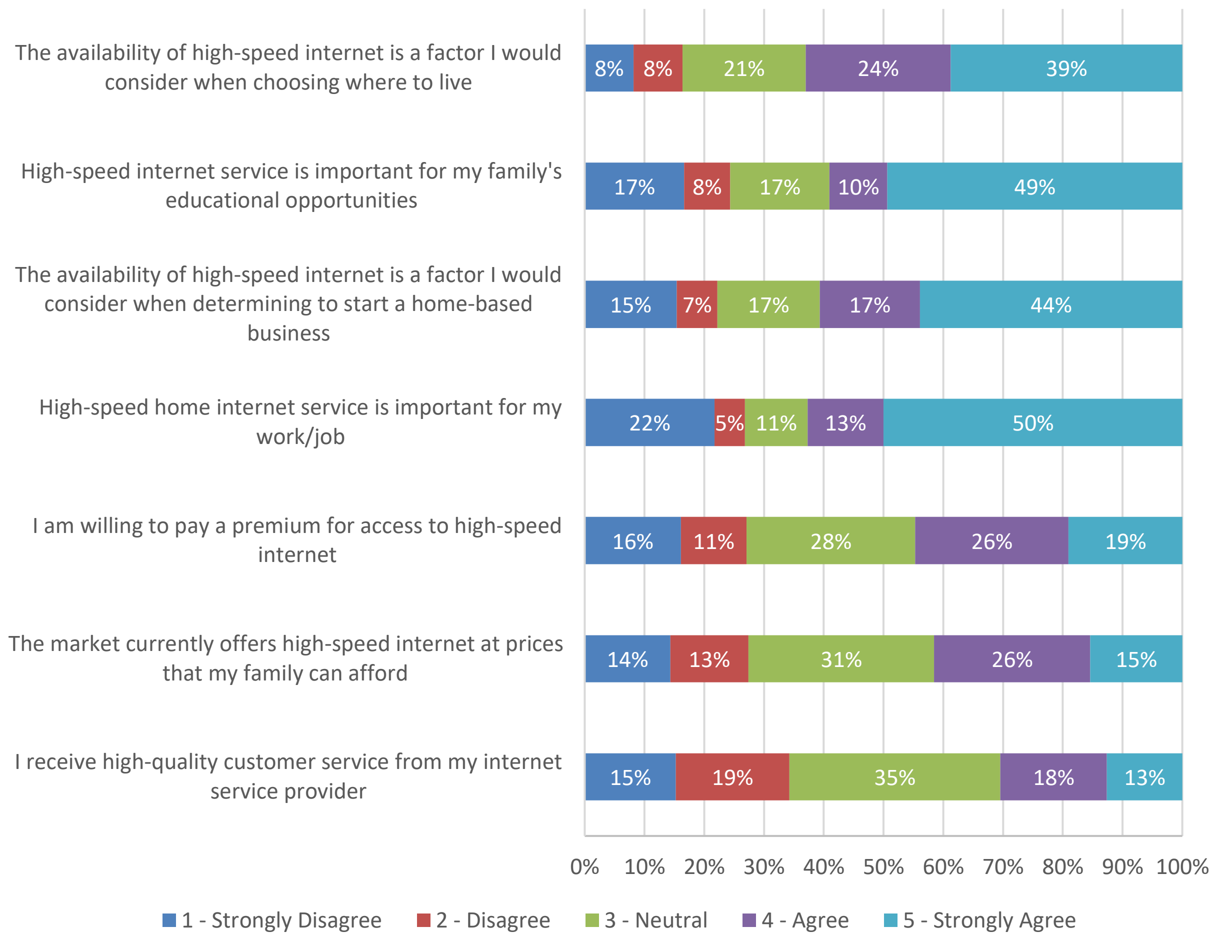



One-half of respondents strongly agreed that high-speed internet is important for their work/job or for their family's educational opportunities, but approximately one-fourth disagreed or strongly disagreed. Approximately four in 10 strongly agreed that the availability of high-speed internet service is a factor they would consider when determining where to live or whether to start a home-based business.

At the same time, only 15 percent of respondents strongly agreed that the market currently provides high-speed internet at prices they can afford, while 26 percent agreed. Another 27 percent disagreed or strongly disagreed, suggesting some need for affordable broadband internet.

Just three in 10 respondents agreed or strongly agreed that they receive high-quality customer service from their internet service provider. One-fifth strongly agreed, and 26 percent agreed, that they are willing to pay a premium for access to high-speed internet.

**Figure 97: Opinions About the Broadband Internet Market**




As illustrated in Figure 98, respondents ages 65+ were less likely to agree with various statements about the broadband internet market, particularly that high-speed internet is important for a job or educational opportunities. They are also less willing to pay a premium for access to high-speed internet. Respondents earning $100,000 or more per year were more likely than those with lower household income to agree with these statements (see Figure 99).

**Figure 98: Opinions About the Broadband Internet Market by Respondent Age**

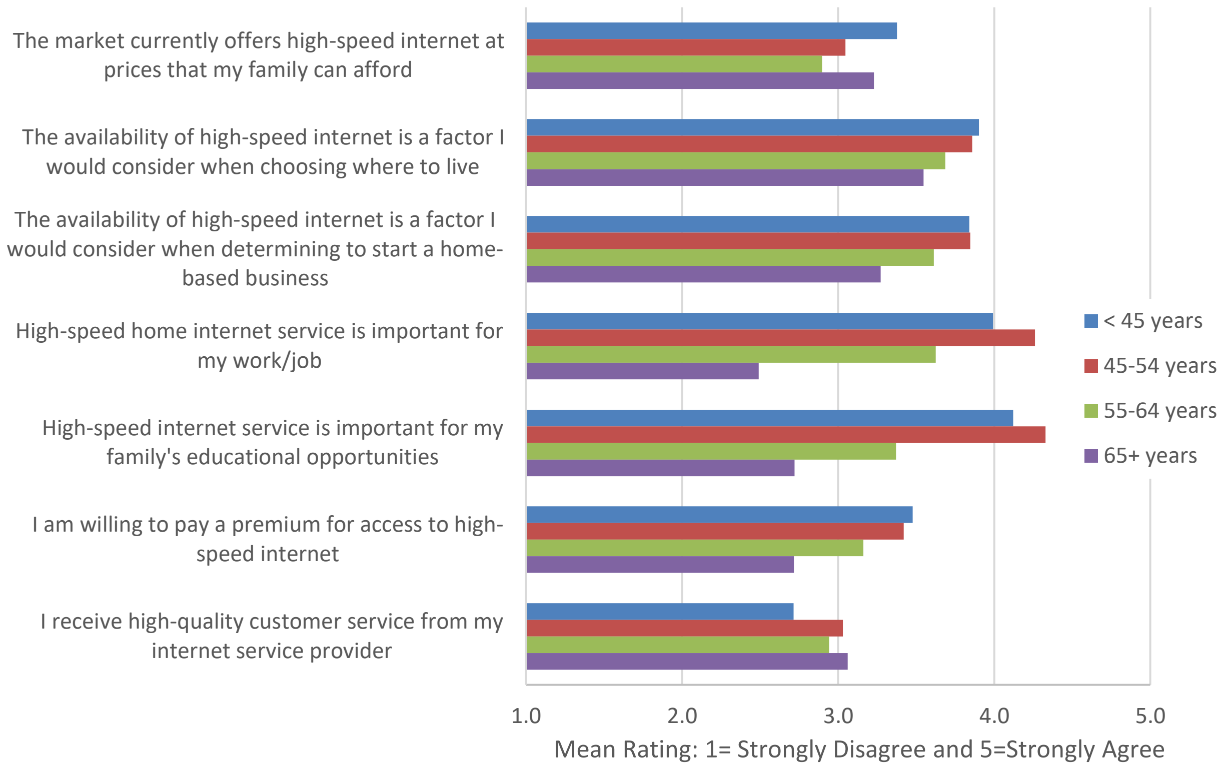
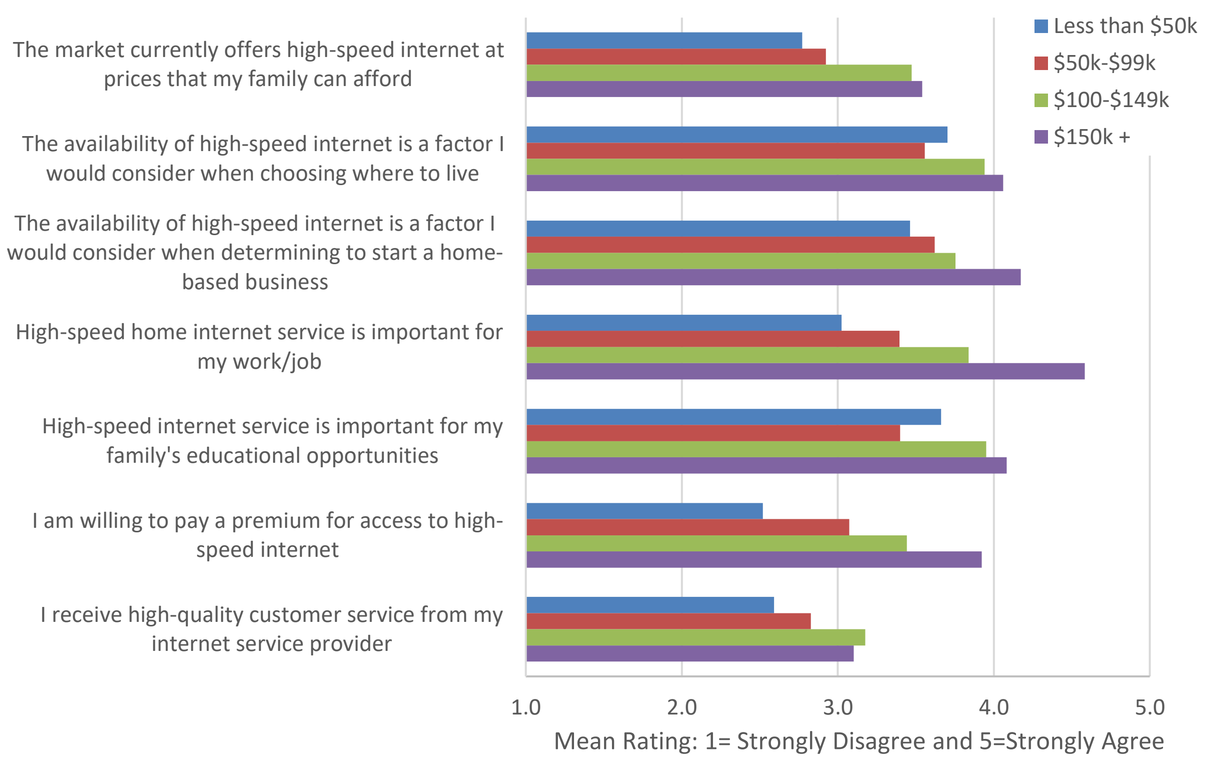



**Figure 99: Opinions About the Broadband Internet Market by Household Income**



### 5.4.7 Willingness to purchase high-speed internet service

Respondents were asked if they would be willing to purchase extremely fast internet service (defined as 1 Gbps) for various price levels. The mean willingness to purchase across this array of questions is illustrated in Figure 100, while detailed responses are illustrated in Figure 101.

Figure 100: Willingness to Purchase 1 Gbps Internet at Price Levels (Mean Ratings)

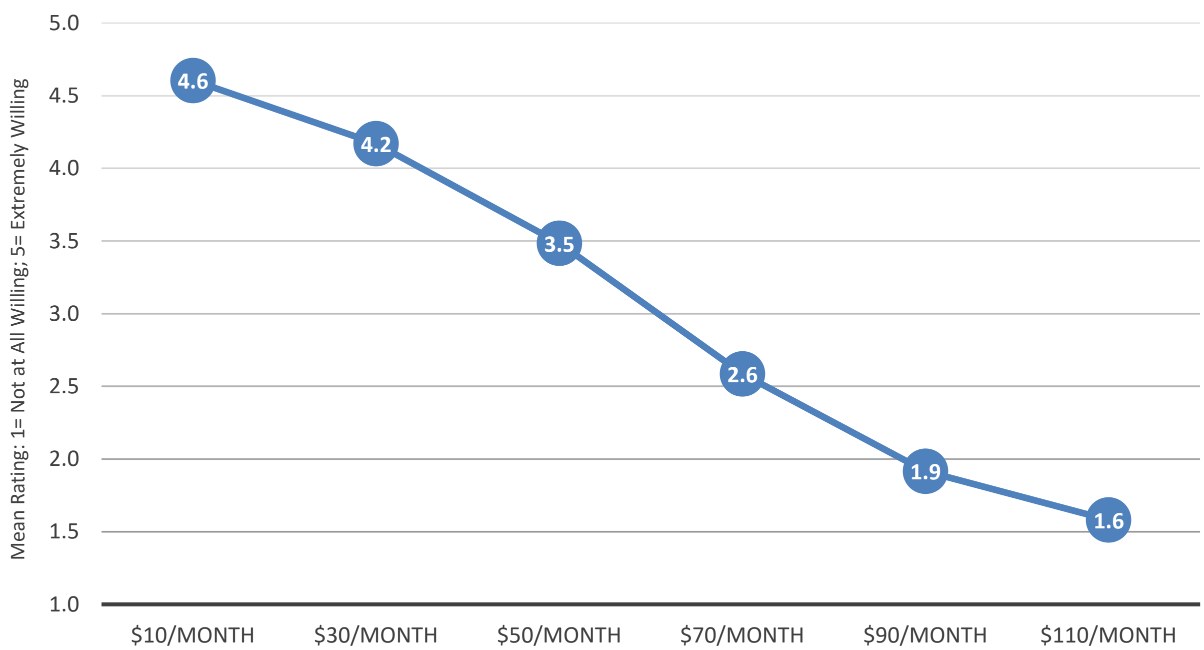
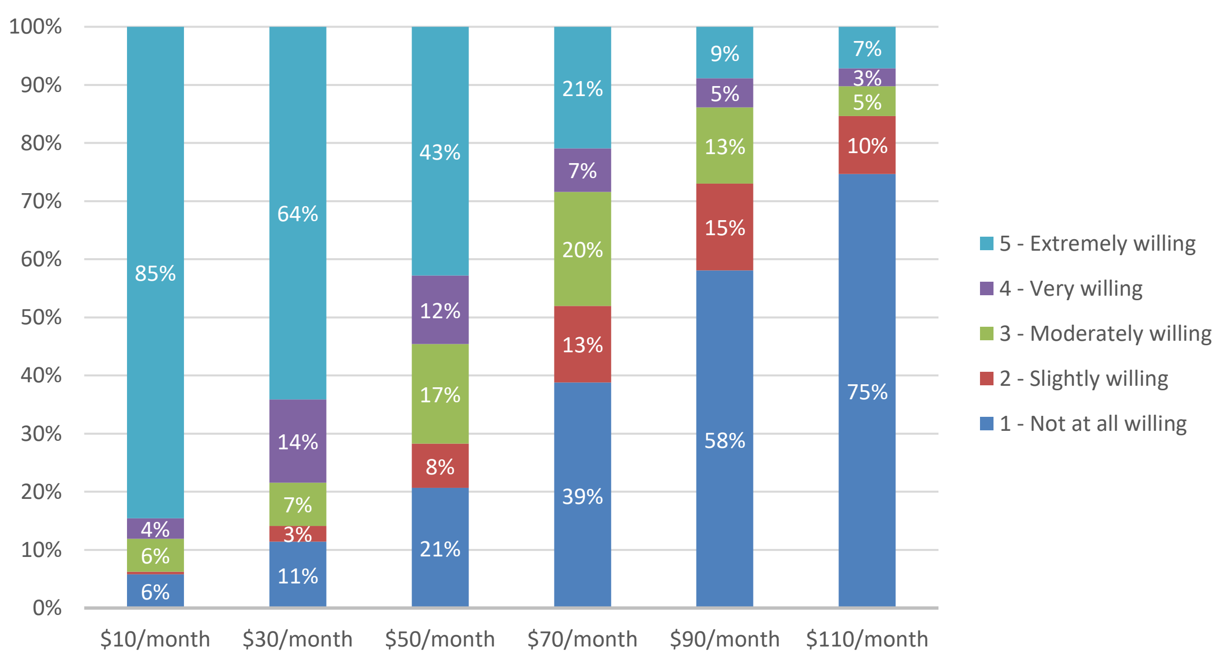



Figure 101: Willingness to Purchase 1 Gbps Internet at Various Price Levels

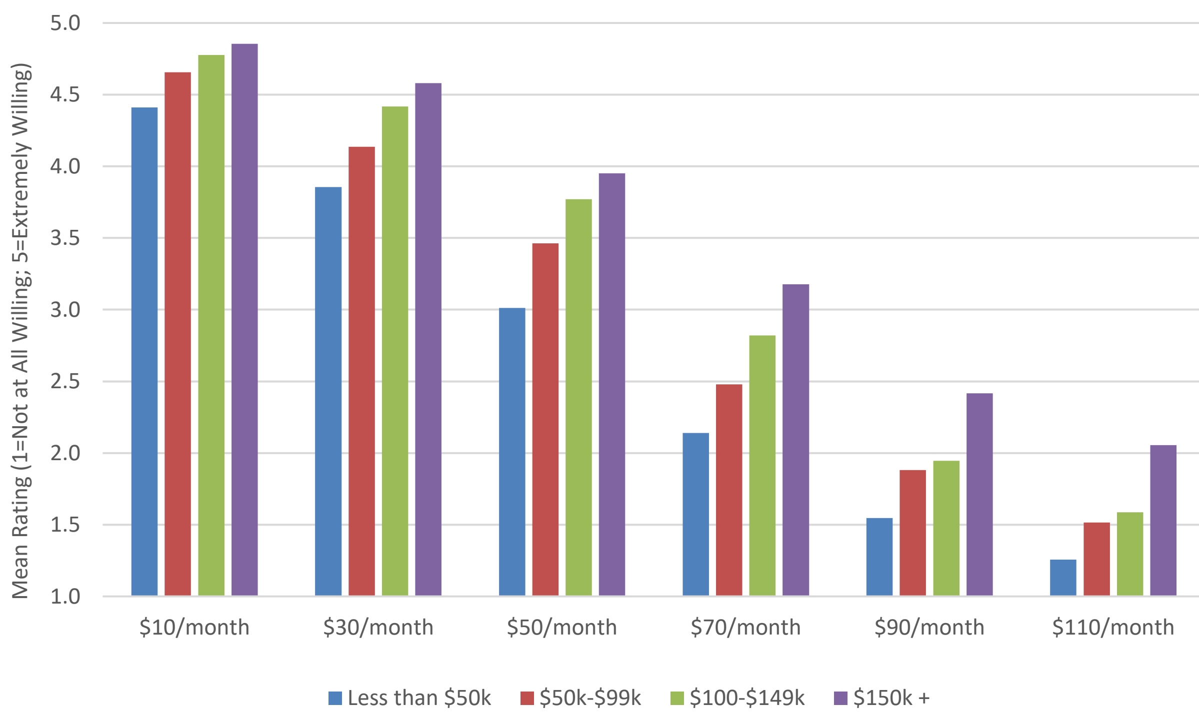


Respondents' willingness to purchase 1 Gbps internet service is high at $10 per month (4.6 mean), but it drops considerably as the price increases. The mean rating falls to 4.2 at a price point of $30 per month, 3.5 at a price point of $50 per month, and 2.6 at a price point of $70 per month (slightly to moderately willing). Respondents would only be slightly willing to switch for price points of $90 per month or $110 per month.

From another perspective, 85 percent of respondents are extremely willing to purchase 1 Gbps internet for $10 per month, dropping to 64 percent at $30 per month, 43 percent at $50 per month and 21 percent at $70 per month. Just nine percent strongly agreed at a price point of $90 per month, and seven percent strongly agreed at a price point of $110 per month.

The willingness to purchase high-speed internet service is also correlated with some demographic characteristics of the respondents, including household income (see Figure 102). The likelihood of purchasing high-speed internet tends to increase as household income increases.

**Figure 102: Willingness to Purchase 1 Gbps Internet Service by Household Income**

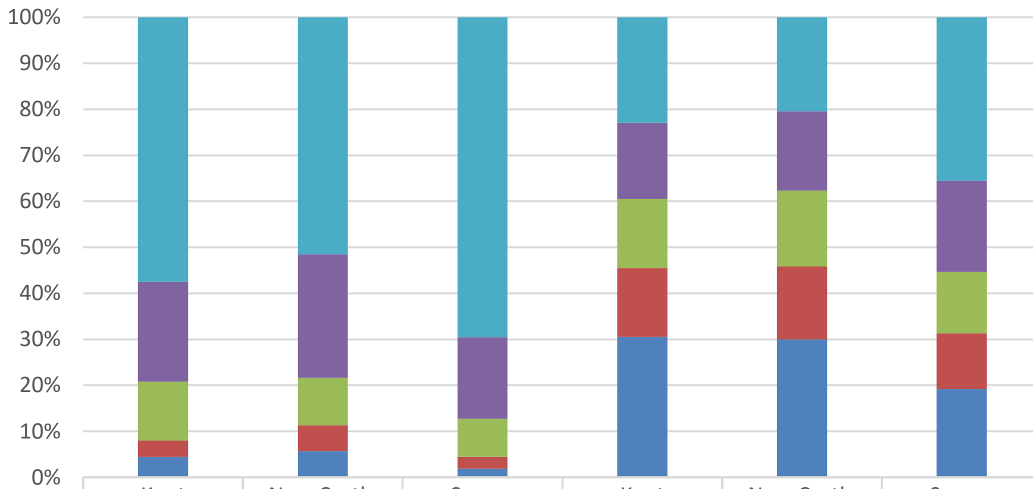


### 5.4.8 Respondent information

Basic demographic information was gathered from survey respondents and is summarized in this section. Several comparisons of respondent demographic information and other survey questions were provided previously in this report.

As indicated previously in Figure 1 regarding age-weighting, disproportionate shares of survey respondents were in the older age cohorts relative to the State's adult population as a whole (see Figure 103). Similarly, the data were weighted to account for differences in response by county. The weighted survey results presented in this report are adjusted to account for these differences and to provide results that are more representative of the State's population, as discussed previously.

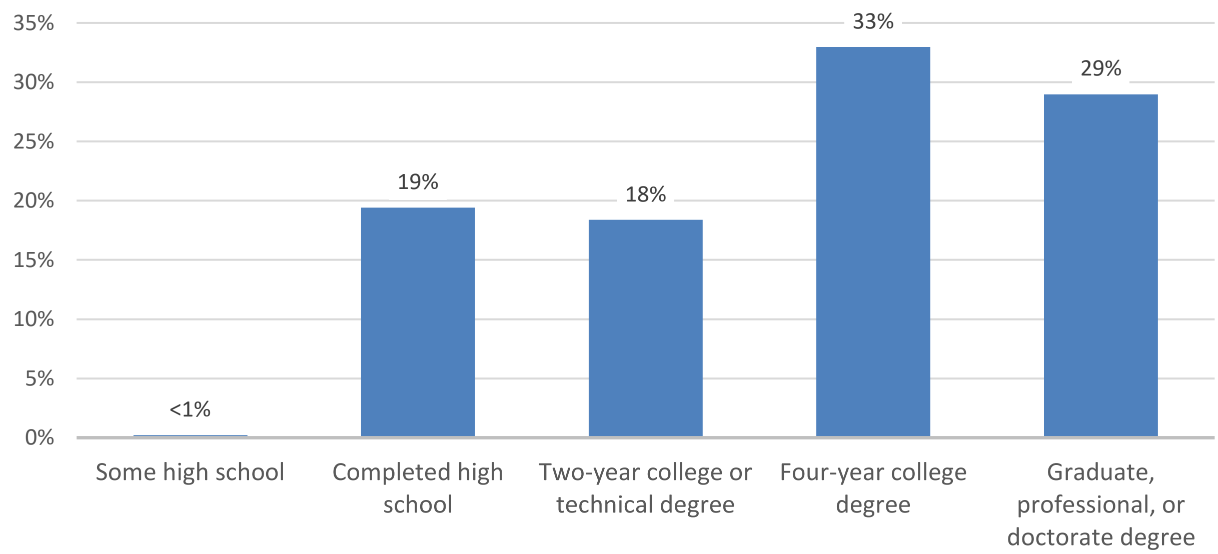
Figure 103: Age of Respondents and State of Delaware Adult Population




| | Survey Respondents | | | Census Population | | |
|---|---|---|---|---|---|---|
| | Kent | New Castle | Sussex | Kent | New Castle | Sussex |
| 65 years and older | 58% | 52% | 70% | 23% | 20% | 36% |
| 55 to 64 years | 22% | 27% | 18% | 17% | 17% | 20% |
| 45 to 54 years | 13% | 10% | 8% | 15% | 16% | 13% |
| 35 to 44 years | 4% | 6% | 3% | 15% | 16% | 12% |
| 18 to 34 years | 4% | 6% | 2% | 31% | 30% | 19% |

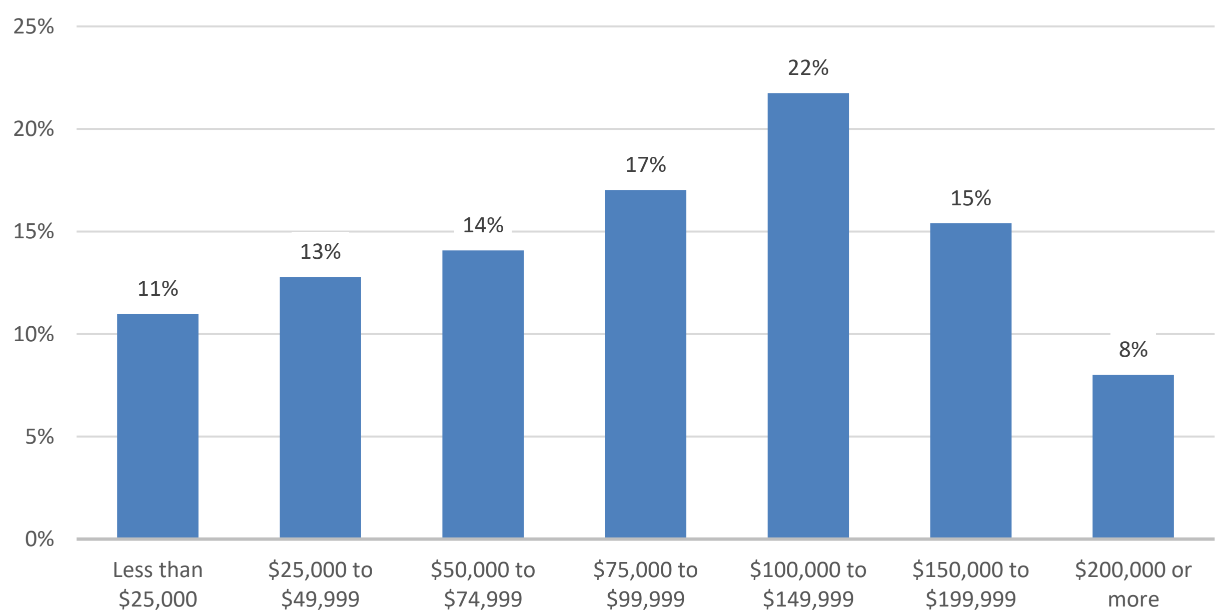
The respondents' highest level of education attained is summarized in Figure 104. Most respondents have a four-year college degree (33%) or a graduate, professional, or doctorate degree (29%). One-fifth of respondents have a high school education or less.

**Figure 104: Education of Respondent**




One-fourth of respondents earn less than $50,000 per year, including 11 percent who earn under $25,000. Three in 10 earn $50,000 but less than $100,000, 22 percent earn $100,000 but less than $150,000, and 23 percent earn $150,000 or more per year (see Figure 105).

**Figure 105: Annual Household Income**



As illustrated in Figure 106 and Figure 107, the majority of respondents are White/European American and identify most strongly with that race/ethnicity.

**Figure 106: Race/Ethnicity**

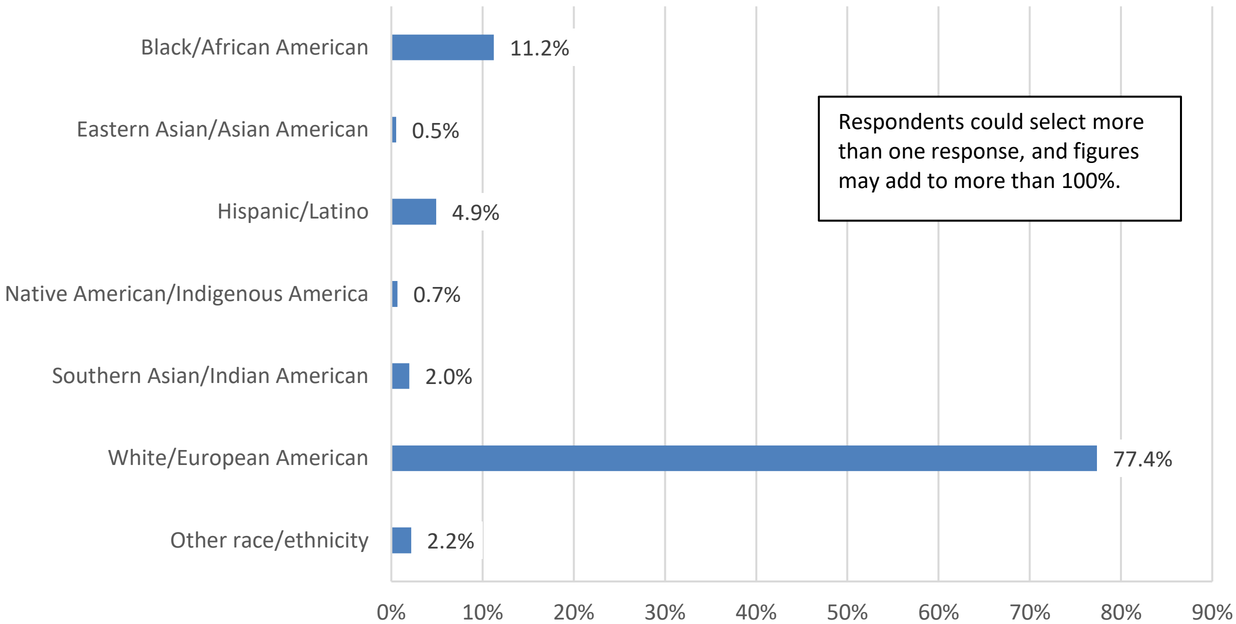
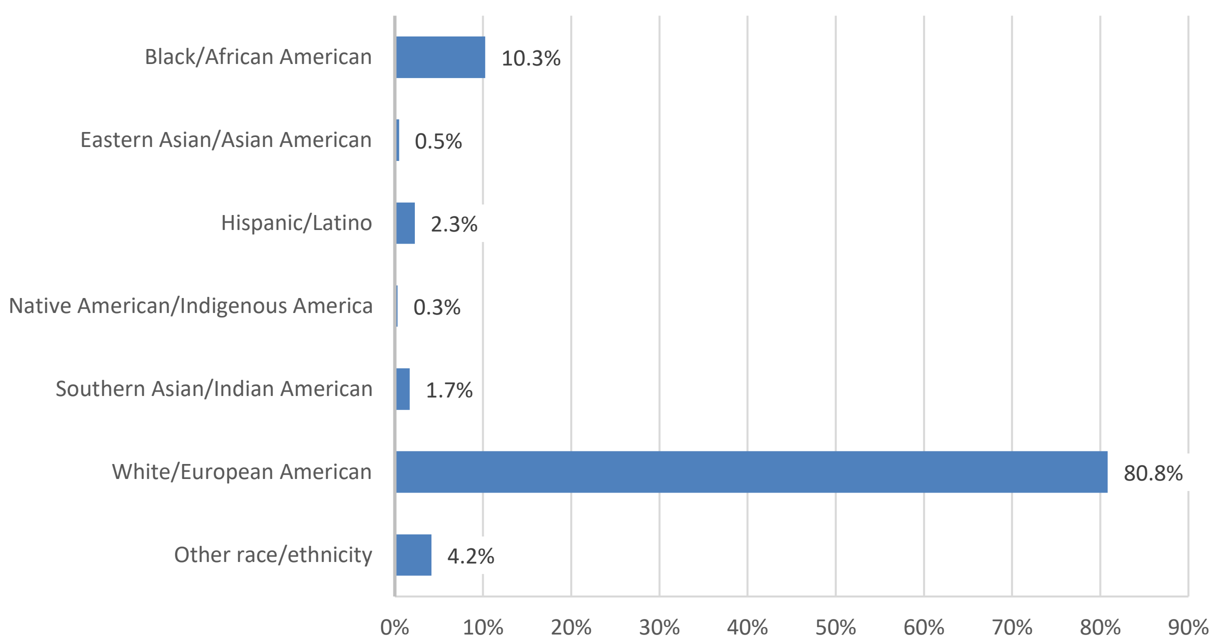
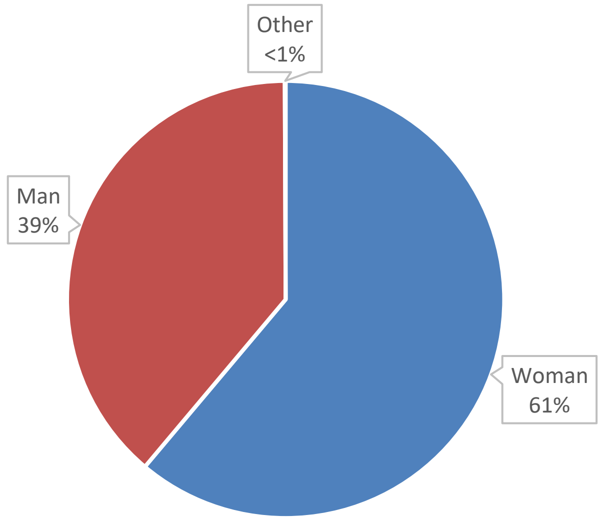



**Figure 107: Race/Ethnicity Most Strongly Identify With**



Six in 10 respondents (61%) identify as female, and 39 percent identify as male (see Figure 108).

**Figure 108: Gender Identity**




Respondents were asked to indicate the number of adults and children in their household. More than one-half of households have two members, and 31 percent have three or more members. Just 15 percent of respondents live alone (see Figure 109). Three in 10 respondents have children living in the household (see Figure 110).

**Figure 109: Total Household Size**

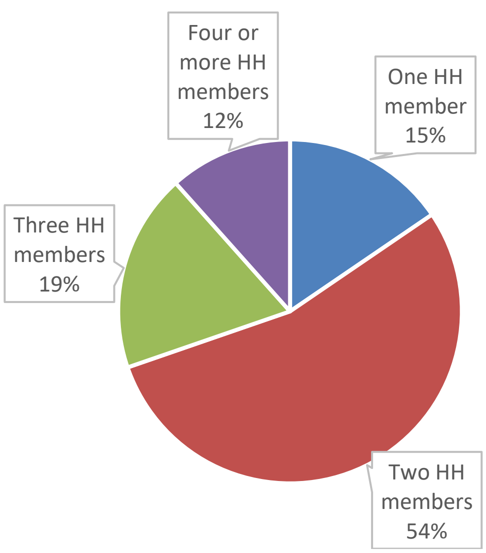
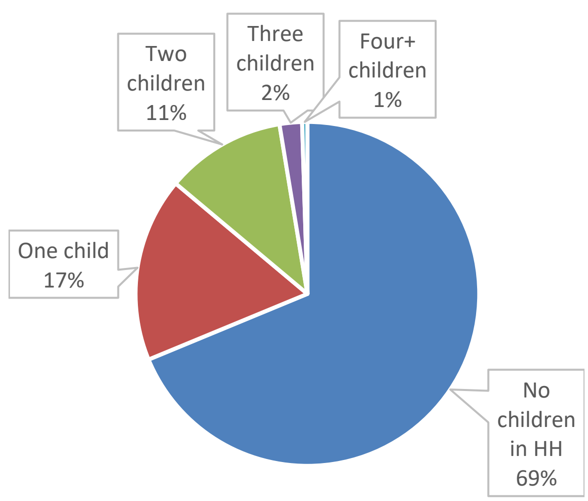
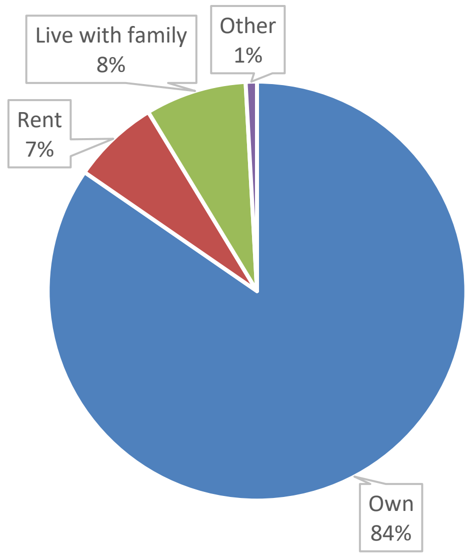



**Figure 110: Number of Children in HH**



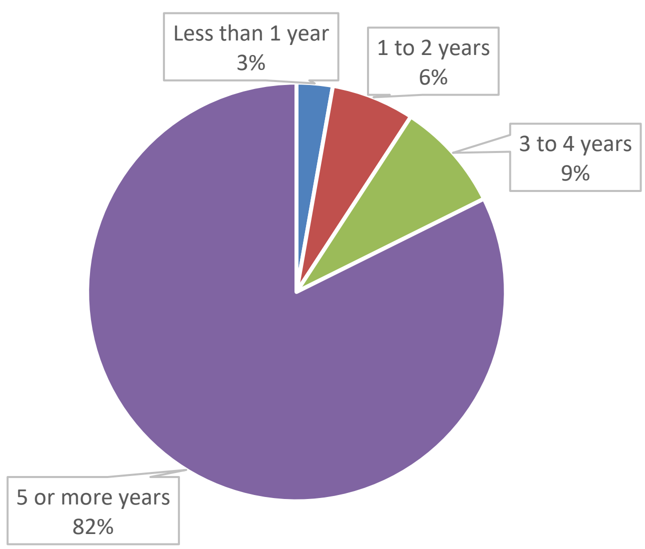

Most respondents (84%) own their residence, while seven percent rent and eight percent live with family (see Figure 111).

**Figure 111: Own or Rent Residence**




Most respondents (82%) have lived at their current residence for five or more years. Another 15 percent have resided at the home for one to four years, while three percent have lived at the residence for less than one year (see Figure 112).

**Figure 112: Number of Years Lived at Current Residence**



# 6 Survey Results Indicate Covid-19 Has Had an Impact on Residents' Broadband Use and Needs

Survey respondents were asked a series of questions on how their broadband use changed during the Covid-19 pandemic, including impacts on location of internet use, engagement in various internet activities, and usage during peak times. This information provides valuable insight into demand for broadband service during the pandemic.

Almost all respondents have access to the internet. At the same time, internet service may be inadequate to meet the needs of some respondents during the pandemic. Usage in the home for various activities has increased significantly during the pandemic, at the same time that many respondents disagreed that the market currently provides affordable high-speed internet.

## 6.1 Key findings: Covid-19 impacts on broadband use

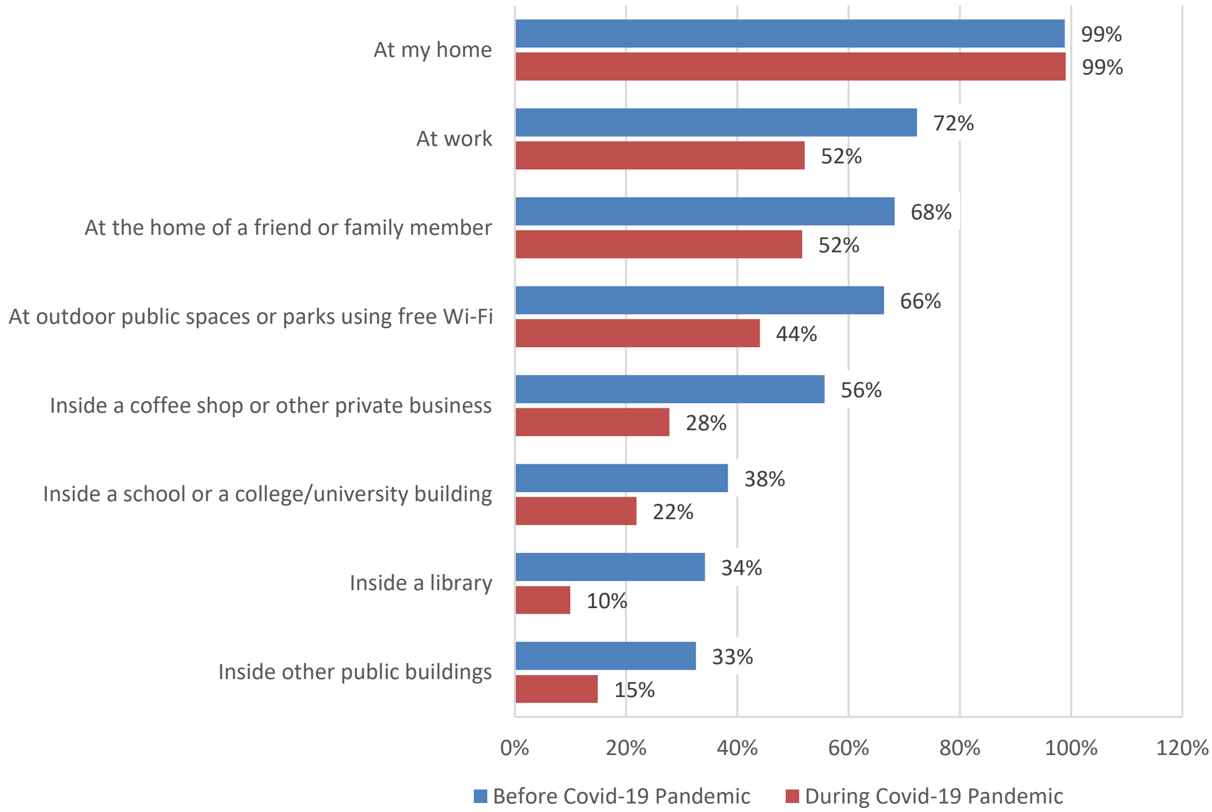
Respondents reported increased use of and demand for broadband services during the Covid-19 pandemic. They are utilizing the internet more at home and less often outside the home, as may be expected, and they are engaged in more online activities for work and education. The following are key findings:

- **Internet usage has changed due to the impact of Covid-19.** Almost all (99 percent) respondents access the internet from any location, including a range of locations outside the home. However, use of the internet outside of the home has declined significantly during the Covid-19 pandemic.
- **Use of internet services outside of the home has declined significantly during the Covid-19 pandemic.** Use of the internet in key areas decreased significantly when comparing figures pre-Covid and during-Covid, including in work settings (72% vs. 52%), private businesses (56% vs. 28%), schools or colleges (38% vs. 22%), public buildings (33% vs. 15%), outdoor public spaces (66% vs. 44%), and home of a friend or family (68% vs. 52%).
- **Engagement in online activities has increased significantly during the Covid-19 pandemic.** Use of the internet for telemedicine or medical appointments (31% vs. 75%), homework (30% vs. 37%), attending online classes (22% vs. 45%), and attending homeschool (6% vs. 24%) increased substantially from pre-pandemic to during-pandemic, Additionally, 45 percent of respondents use the internet for teleworking on a daily basis, compared with 16 percent of respondents before the pandemic.

## 6.2 Internet use by location

Respondents were asked to indicate how often they use the internet in various locations before and during the Covid-19 pandemic. As shown in Figure 113, use of internet services outside of the home has declined significantly during the pandemic, which makes sense as many public areas and work settings have not been accessible.

**Figure 113: Ever Use the Internet in Various Locations Before and During Covid-19 Pandemic**




Significantly, use of the internet declined in work settings (72% vs. 52%) and private businesses (56% vs. 28%) when comparing pre-Covid and during-Covid figures. Use of the internet at schools or colleges declined from 38 percent of respondents pre-Covid to 22 percent currently. Use in libraries (34% vs. 10%), public buildings (33% vs. 15%), and outdoor public spaces (66% vs. 44%) also declined. Use of the internet at the home of a friend or family member declined from 68% of respondents pre-pandemic to 52% of respondents during the pandemic. Usage inside the home remained flat at 99 percent.

Figure 114 and Figure 115 show detailed usage of the internet at various locations, before and during the pandemic.

**Figure 114: How Often Use the Internet in Various Locations Before Covid-19 Pandemic**

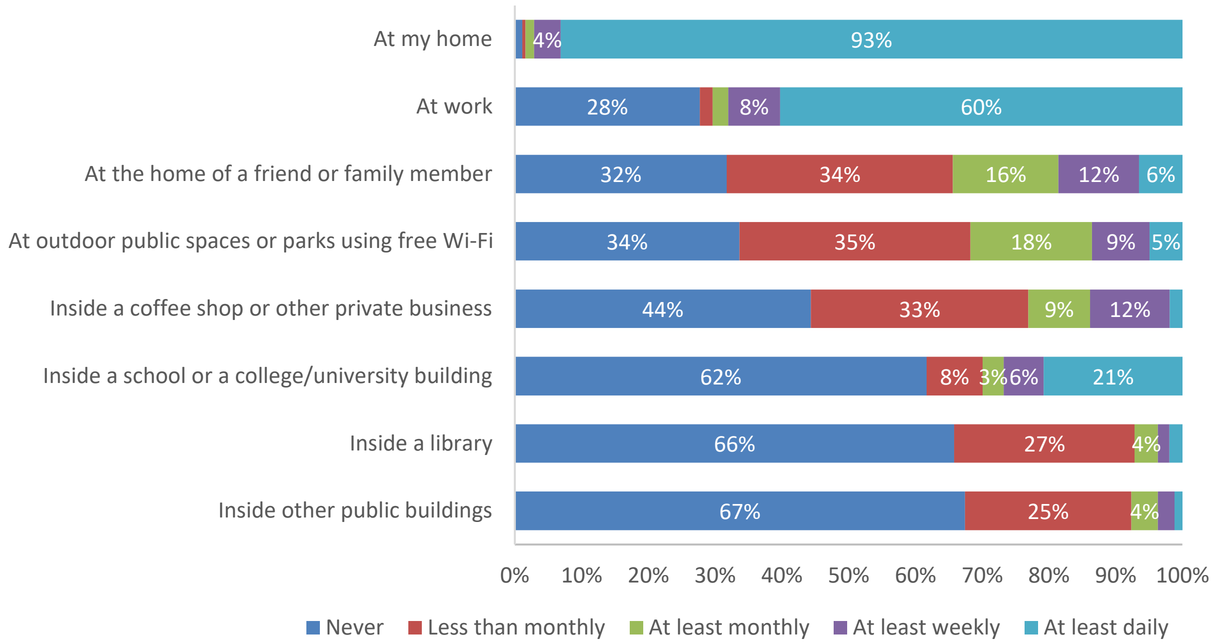
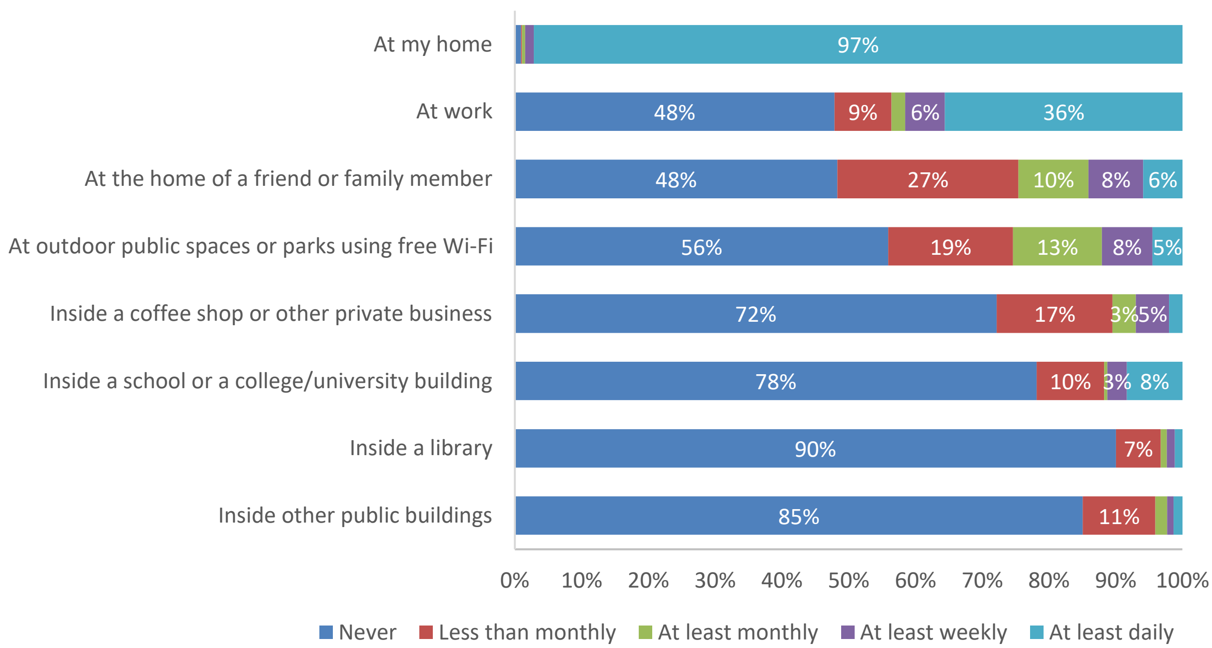



**Figure 115: How Often Use the Internet in Various Locations During Covid-19 Pandemic**




As illustrated in Table 15, respondents ages 65+ are less likely than younger respondents to ever use the internet at various locations outside the home, both before and during the covid-19 pandemic. Middle-age respondents (ages 45-54 years) are more likely to use the internet at work, inside a school or college, or inside other public buildings. Respondents under age 45 saw the largest drop in usage from before the pandemic to during the pandemic for key locations, such as at work, private businesses, other public buildings, and outdoor public spaces.

**Table 15: How Often Use the Internet in Various Locations by Respondent Age**

| | < 45 years | | 45-54 years | | 55-64 years | | 65+ years | |
|---|---|---|---|---|---|---|---|---|
| | Before Covid | During Covid | Before Covid | During Covid | Before Covid | During Covid | Before Covid | During Covid |
| **At my house** | 100% | 100% | 99% | 99% | 99% | 99% | 97% | 98% |
| **At the home of a friend or family member** | 75% | 55% | 77% | 62% | 69% | 48% | 50% | 39% |
| **At work** | 89% | 60% | 93% | 70% | 75% | 57% | 28% | 17% |
| **Inside a school or a college/university building** | 39% | 17% | 65% | 40% | 37% | 22% | 7% | 5% |
| **Inside a coffee shop or other private business** | 64% | 25% | 74% | 41% | 48% | 28% | 33% | 15% |
| **Inside a library** | 38% | 12% | 43% | 9% | 33% | 11% | 21% | 7% |
| **Inside other public buildings** | 37% | 8% | 42% | 23% | 27% | 16% | 19% | 10% |
| **At outdoor public spaces using free Wi-Fi** | 75% | 41% | 79% | 57% | 59% | 39% | 49% | 36% |

## 6.3 Engaged in internet activities

Respondents were asked about how they engaged in various internet activities before and during the Covid-19 pandemic. As shown in Figure 116 and Figure 117, engagement in online activities has increased significantly during the Covid-19 pandemic, with more respondents making daily use of the internet for key activities.

Six in 10 respondents have ever teleworked during the pandemic, compared with 53 percent before the pandemic. Teleworkers are making more regular use of working from home during the pandemic, with 45 percent of respondents engaging daily, compared with only 16 percent prior to the pandemic.

Three-fourths of respondents have used the internet for telemedicine or medical appointments during the Covid-19 pandemic (most on a monthly or less than monthly basis), compared with just 31 percent before the pandemic.

Use of the internet has also increased substantially for educational purposes. Use of the internet for online classes has increased from 22 percent of respondents pre-pandemic to 45 percent during the pandemic. Similarly, use of the internet for homeschooling increased from six percent before the pandemic to 24 percent during the pandemic. Use of the internet for homework increased slightly during the pandemic, from 30 percent to 37 percent of respondents. The percentage of respondents making daily use of the internet for homework increased from 16 percent pre-pandemic to 27 percent during the pandemic.

**Figure 116: Ever Used the Internet for Various Activities Before and During Covid-19 Pandemic**

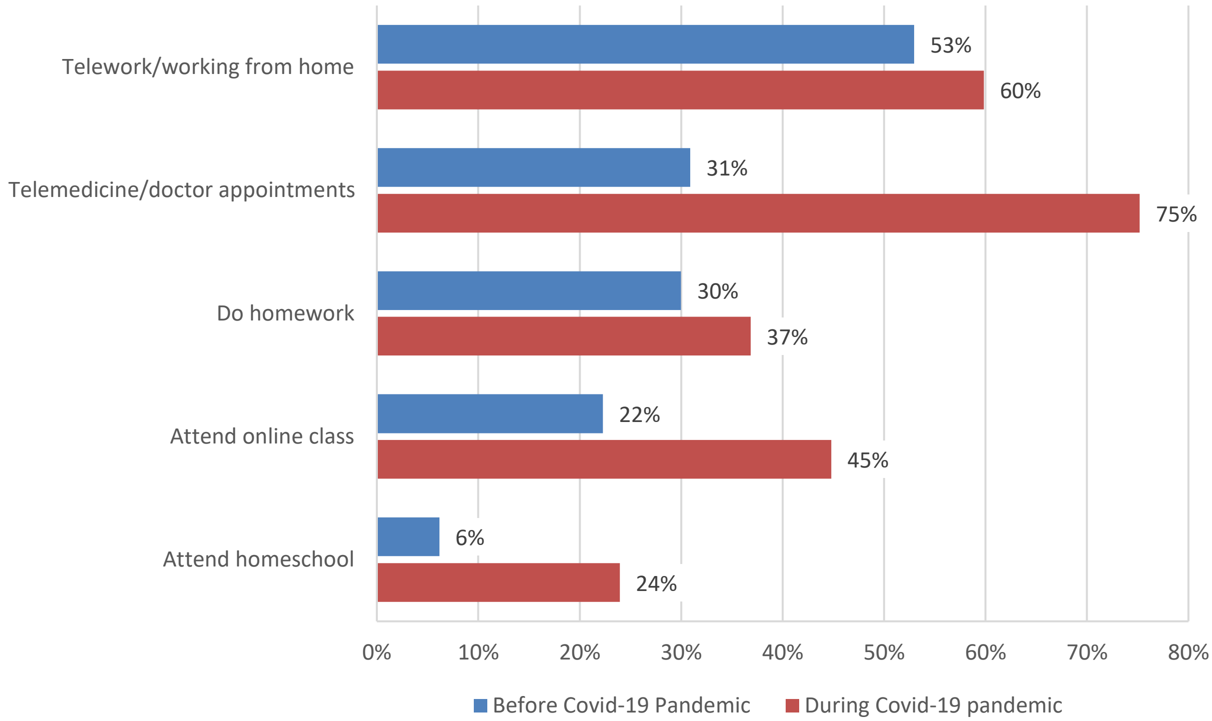



**Figure 117: Use the Internet Daily for Various Activities Before and During Covid-19 Pandemic**

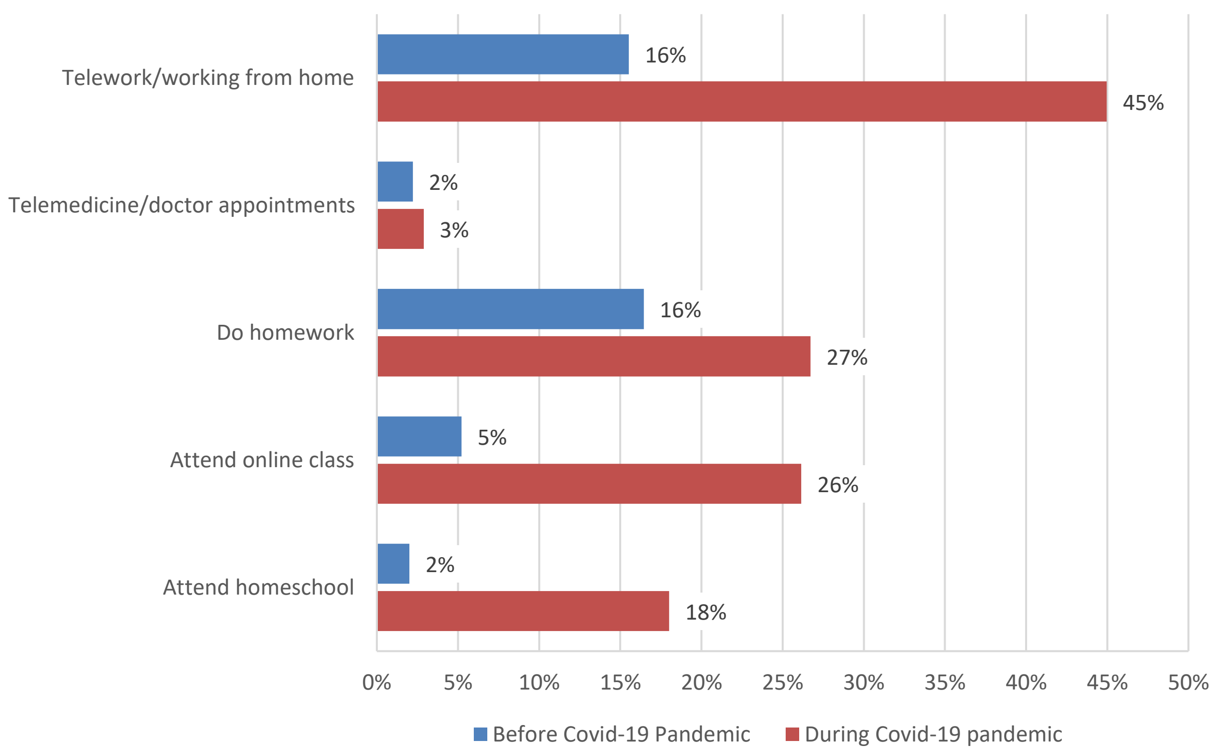


Figure 118 and Figure 119 show detailed usage of the internet for various activities, before and during the pandemic.

**Figure 118: How Often Used the Internet for Various Activities Before Covid-19 Pandemic**

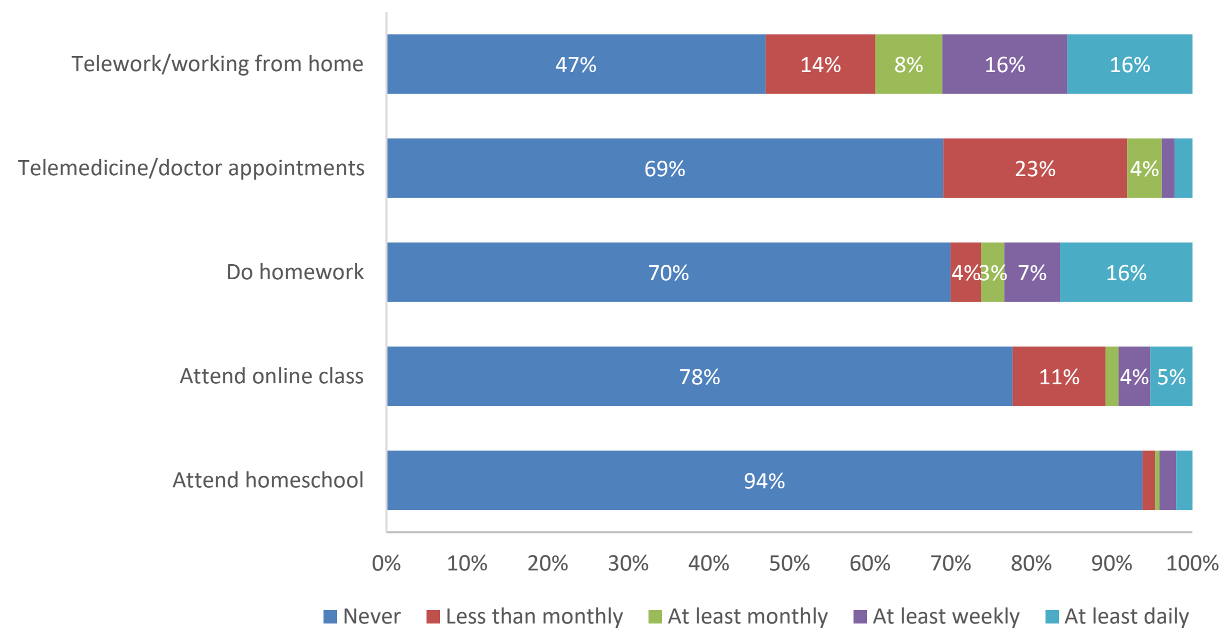
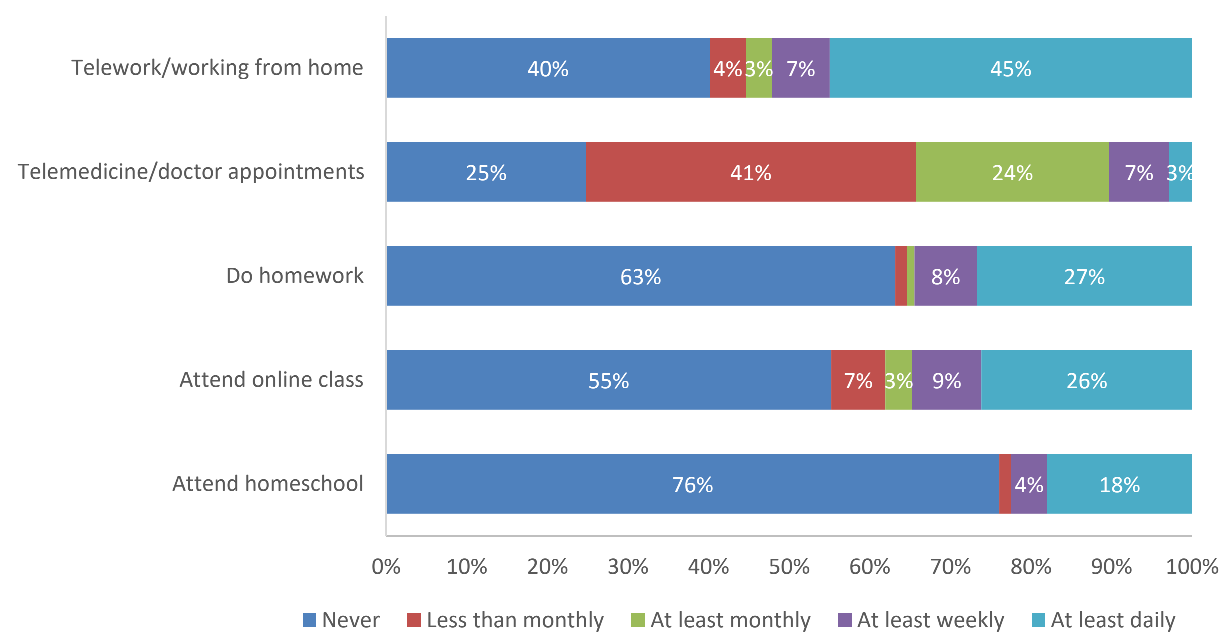



**Figure 119: How Often Used the Internet for Various Activities During Covid-19 Pandemic**




As illustrated in Table 16, respondents ages 65+ are less likely than younger respondents to ever use the internet for work or education, both before and during the covid-19 pandemic.

Respondents under age 45 saw the largest increase in use of the internet for telemedicine/doctor appointments from before the pandemic to during the pandemic, compared with older respondents.

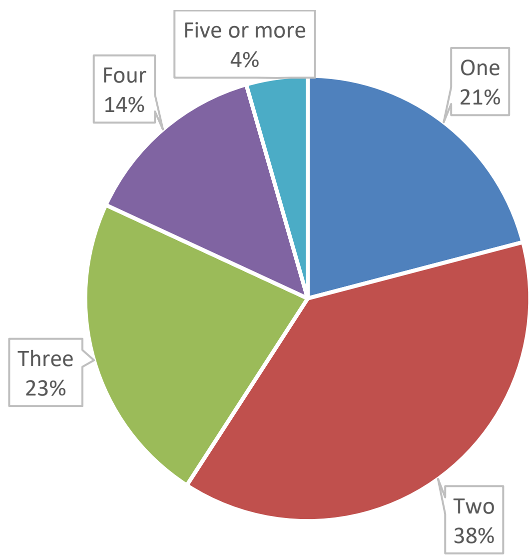
**Table 16: How Often Use the Internet for Various Activities by Respondent Age**

| | < 45 years | | 45-54 years | | 55-64 years | | 65+ years | |
|---|---|---|---|---|---|---|---|---|
| | Before Covid | During Covid | Before Covid | During Covid | Before Covid | During Covid | Before Covid | During Covid |
| **Telework/working from home** | 61% | 63% | 65% | 81% | 58% | 65% | 25% | 27% |
| **Telemedicine/doctor appointments** | 20% | 79% | 35% | 77% | 27% | 70% | 40% | 75% |
| **Do homework** | 41% | 50% | 46% | 59% | 23% | 23% | 6% | 8% |
| **Attend online class** | 21% | 52% | 26% | 64% | 26% | 37% | 18% | 21% |
| **Attend homeschool** | 7% | 31% | 10% | 43% | 5% | 12% | 2% | 5% |

## 6.4 Number of household members online during peak usage times

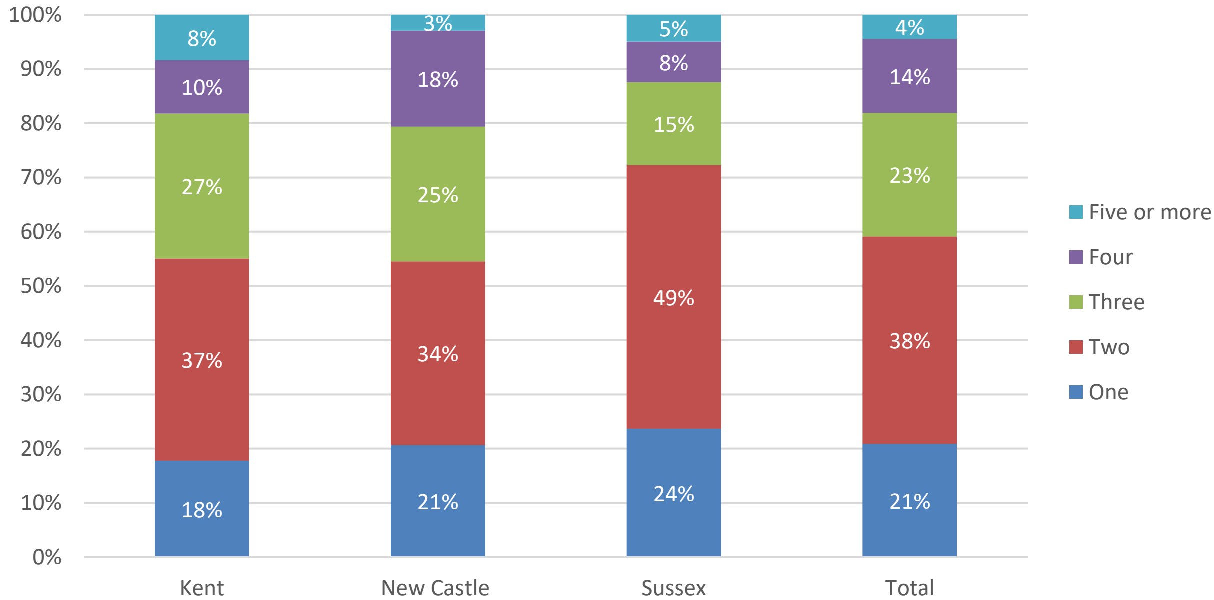
Eight in 10 households have multiple members online during peak usage times during the Covid-19 pandemic, including four in 10 households with at least three members online (see Figure 120).

**Figure 120: Number of Households Members Online During Peak Usage Times**



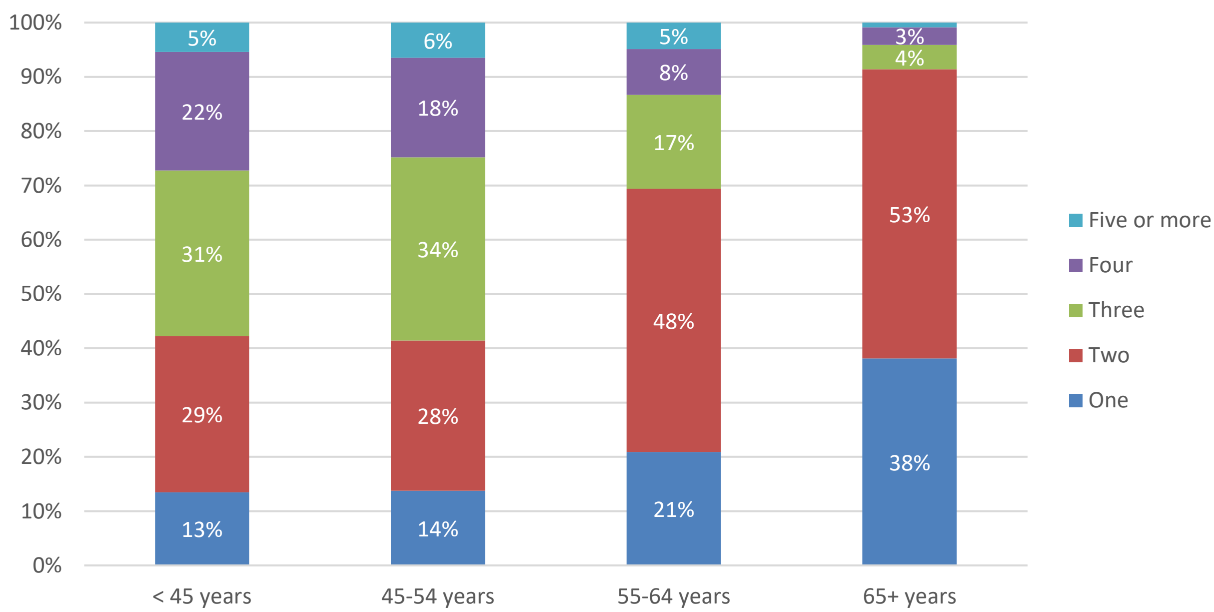

As illustrated in Figure 121, the majority of all counties have at least two household members using the internet during peak usage times, and a sizeable percentage have three or more members online at the same time. Sussex County households have fewer members online during peak usage times, but respondents in this county are also somewhat older and have fewer household members.

**Figure 121: Number of Households Members Online During Peak Usage Times by County**




Respondents under age 55 years have the most members online during peak usage, with nearly six in 10 reporting they have three or more members online at the same time. Respondents ages 65 and older have fewer members online during peak usage; however, the majority have at least two members using the internet (see Figure 122). This age cohort is also less likely to have children in the home or more than two household members.

**Figure 122: Number of Households Members Online During Peak Usage Times by Age**



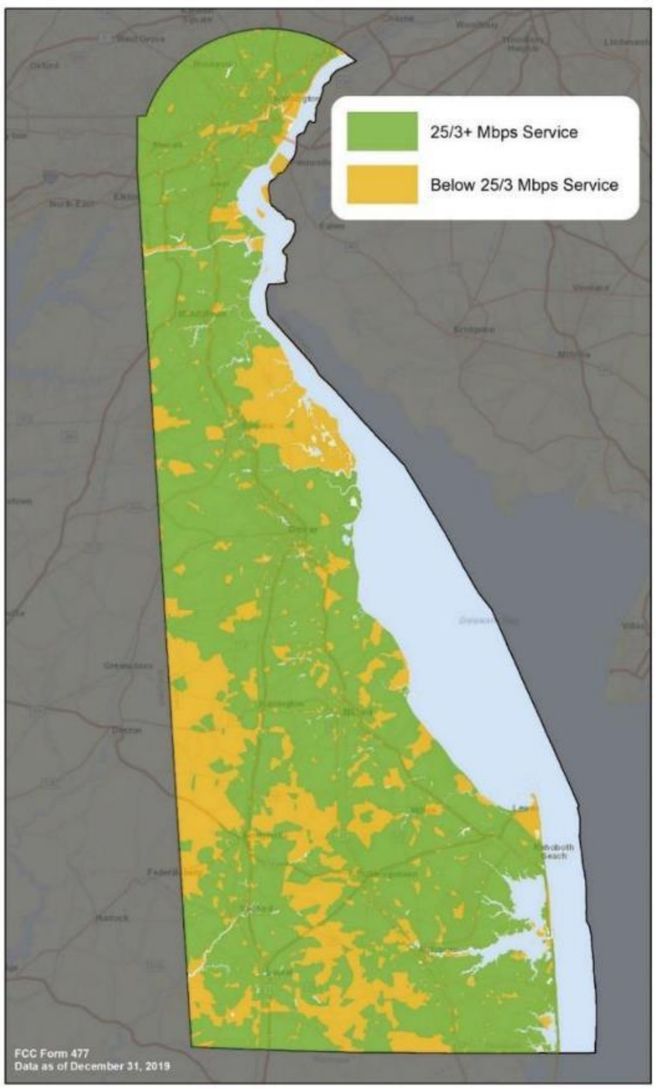
# 7 Fiber-to-the-Premises and Fixed Wireless Technologies Could Fill the State's Broadband Gaps

CTC's engineers designed candidate fiber-to-the-premises and fixed wireless networks to illustrate and estimate the costs for potential solutions to fill the State's broadband gaps.

## 7.1 Fiber-to-the-premises infrastructure to fill gaps in unserved areas would cost about $75 million but have relatively low ongoing operating costs

CTC's analysis of State-provided data and our extensive desk and field surveys identified an estimated 11,600 homes and businesses unserved with wired broadband (Figure 123) that could be served by a new ISP or by the incumbent providers (i.e., extending their service areas). We found approximately 450 homes and businesses are unserved in New Castle County, 3,800 in Kent County, and 7,350 in Sussex County.

**Figure 123: Served Areas – 25/3 Mbps (Wired Only, FCC Form 477 Data)**



As a candidate solution, CTC's engineers prepared a high-level network design for the deployment of a gigabit-capable fiber-to-the-premises network to serve homes and businesses. We then estimated the cost for deploying that network, including a network backbone, assuming the construction was performed by the State or a partner entity that is not the incumbent telephone, power, or cable company.

The total estimated capital cost for the State or a partner to construct a fiber-to-the-premises network to serve the unserved areas is $74.6 million, assuming a take-rate (i.e., percentage of potential customers subscribing to the service) of 60 percent; details are shown in Table 17.[19]

**Table 17: Estimated Total Fiber Deployment Cost for the Unserved Areas**

| Cost Component | Estimated Cost |
|---|---|
| Outside Plant | $64.6 million |
| Central Network Electronics | $2.8 million |
| Fiber Service Drop Installations | $3.7 million |
| Customer Premises Equipment | $3.5 million |
| *Total Estimated Cost* | *$74.6 million* |

We estimated a cost per passing—essentially the cost of building a network independent of connections to any specific homes or business—by dividing the outside plant cost (i.e., the cost of constructing fiber alongside the roads in front of the 11,634 unserved homes and businesses) by the number of homes and businesses. We estimate the average outside plant cost per passing will be approximately $5,550 (Table 18).

**Table 18: Estimated Outside Plant Cost per Passing for the Unserved Areas[20]**

| Cost Component | Estimated Cost |
|---|---|
| Outside Plant | $64.6 million |
| Passings | 11,634 |
| *Outside Plant Cost per Passing[21]* | *$5,550* |

These cost estimates provide data relevant to assessing the financial viability of network deployment; they enable financial modeling to determine the approximate revenue levels

[19] These numbers have been rounded. The take-rate affects the electronics and drop costs, but also may affect other parts of the network, because the State or its partner may make different design choices based on the expected take-rate. A 60 percent take-rate is possible in environments where a new provider delivers service in a previously unserved area. Market research would be required to estimate a more accurate take-rate at assumed service costs.

[20] Unrounded numbers are used in the engineering calculations; these are then rounded in the discussion.

[21] This is the average cost to construct the outside plant portion of the fiber-to-the-premises network for each home and business in the unserved areas.

necessary for the State or a partner to service any debt incurred in building the network. They also provide a baseline against which to evaluate the cost of incremental and non-fiber optic approaches.

### 7.1.1 Capital cost estimates are derived from a customized outside plant network design

To develop and refine the range of assumptions that will have an impact on the network design and construction costs, CTC engineers performed a desk survey of the State using Google Earth Street View and performed in-field surveys. The engineers reviewed available green space and the presence and condition of utility poles. Based on this analysis, we developed customized estimates of per-mile costs for construction on utility poles and for underground construction where poles are not available.

Table 19 summarizes the conditions determined through our desk survey; the factors are described in detail below.

**Table 19: Construction Cost Factors Developed in Desk Survey of Unserved Areas**

| Cost Factor | Finding in Unserved Areas |
|---|---|
| Aerial Construction | 99% |
| Poles per Mile | 20 |
| Average Moves Required per Pole[22] | 1 |
| Poles Requiring Make-Ready | 2% |
| Cost Per Move | $350 |
| Poles Requiring Replacement | 1% |
| Average Pole Replacement Cost | $7,000 |
| Intermediate Rock Underground | 1% |
| Hard Rock Underground | 0% |

Make-ready is the work required to create space on an existing utility pole for an additional attachment. Existing attachments often have to be moved or adjusted to create the minimum clearance required by code to add an additional attachment. Each move on the pole has an associated cost (i.e., for contractors going out to perform the move). When a utility pole is not tall enough to support another attachment or the pole is not structurally capable of supporting the attachment, a pole replacement is required. The pole replacement cost is then charged to the new attacher.

[22] The average moves per pole is the average number of existing attachments on the utility pole that need to be moved to create space and clearance in the communications space to support a new attachment for the fiber-to-the-premises network.

In the few places where utility poles do not exist, underground construction is required. We do not expect any hard rock and anticipate extremely few stones and boulders in the State. Stones and boulders (intermediate rock) require the use of a specialized boring missile that is more expensive than traditional boring. Therefore, the cost of boring through rock is added to the cost of traditional boring in 1 percent of the underground areas.

CTC's outside plant engineer noted that the quality of the poles and pole attachments in the State vary, as they do in many jurisdictions—but that overall, most of the electrical utility poles have space for an additional attachment.

In many parts of the State's unserved areas, the telecommunications cables (i.e., Verizon telephone lines) are installed on short telecommunications poles, typically on the opposite side of the road from the electric distribution cables installed on taller electric utility poles. The cost estimate assumes the State could attach fiber to the electric utility poles in the communications space below the electrical cables. Based on our experience, the State's utility pole lines appear more favorable for new pole attachment than the average utility pole—which will correspond to a lower-than-average aerial construction cost. In contrast, installing the fiber on the telecommunications poles would require substantial make-ready and poles replacements to make clearance for the attachment.

The figures below show samples of poles in various conditions in the State's unserved areas. In Figure 124, for example, make-ready is required to move the existing cable to make space for a new attachment. This new utility pole appears tall enough that—with make-ready—another entity could attach to the pole.

**Figure 124: Utility Pole Requiring Make-Ready**

Figure 125 shows a pole line that has only one existing attachment in the communications space on the power poles. Where make-ready is low, as in this case, the cost of aerial construction is less than in high make-ready areas.

**Figure 125: Low-Make-Ready Pole Line in Unserved Area**

### 7.1.2 The network architecture can support multiple subscriber models and classes of service

We developed a conceptual, high-level fiber-to-the-premises outside plant network design that is aligned with best practices in the industry and is open to a variety of electronic architecture options.[23]

Figure 126, below, shows a logical representation of the fiber-to-the-premises network architecture we recommend based on the conceptual outside plant design. The drawing illustrates the primary functional components in the fiber-to-the-premises network, their relative position to one another, and the flexibility of the architecture to support multiple subscriber models and classes of service.

The recommended architecture is a hierarchical data network that provides scalability and flexibility, both in terms of initial network deployment and its ability to accommodate the increased demands of future applications and technologies without requiring expensive new construction. This hierarchical fiber-to-the-premises data network can be described by a range of characteristics:

- **Capacity** – ability to provide efficient transport for subscriber data, even at peak levels
- **Availability** – high levels of redundancy, reliability, and resiliency; ability to quickly detect faults and re-route traffic
- **Failsafe operation** – physical path diversity in the network backbone to minimize operational impact resulting from fiber or equipment failure
- **Efficiency** – no traffic bottlenecks; efficient use of resources
- **Scalability** – ability to grow in terms of physical service area and increased data capacity, and to integrate newer technologies without new construction
- **Manageability** – simplified provisioning and management of subscribers and services
- **Flexibility** – ability to provide different levels and classes of service to different customer environments; can support an open access network or a single-provider network; can provide separation between service providers on the physical layer (separate fibers) or logical layer (separate Virtual Local Area Network (VLAN) or Virtual Private Network (VPN) providing networks within the network)

[23] The network's outside plant is both the most expensive and the longest-lasting portion. The architecture of the physical plant determines the network's scalability for future uses and how the plant will need to be operated and maintained; the architecture is also the main determinant of the total cost of the deployment.

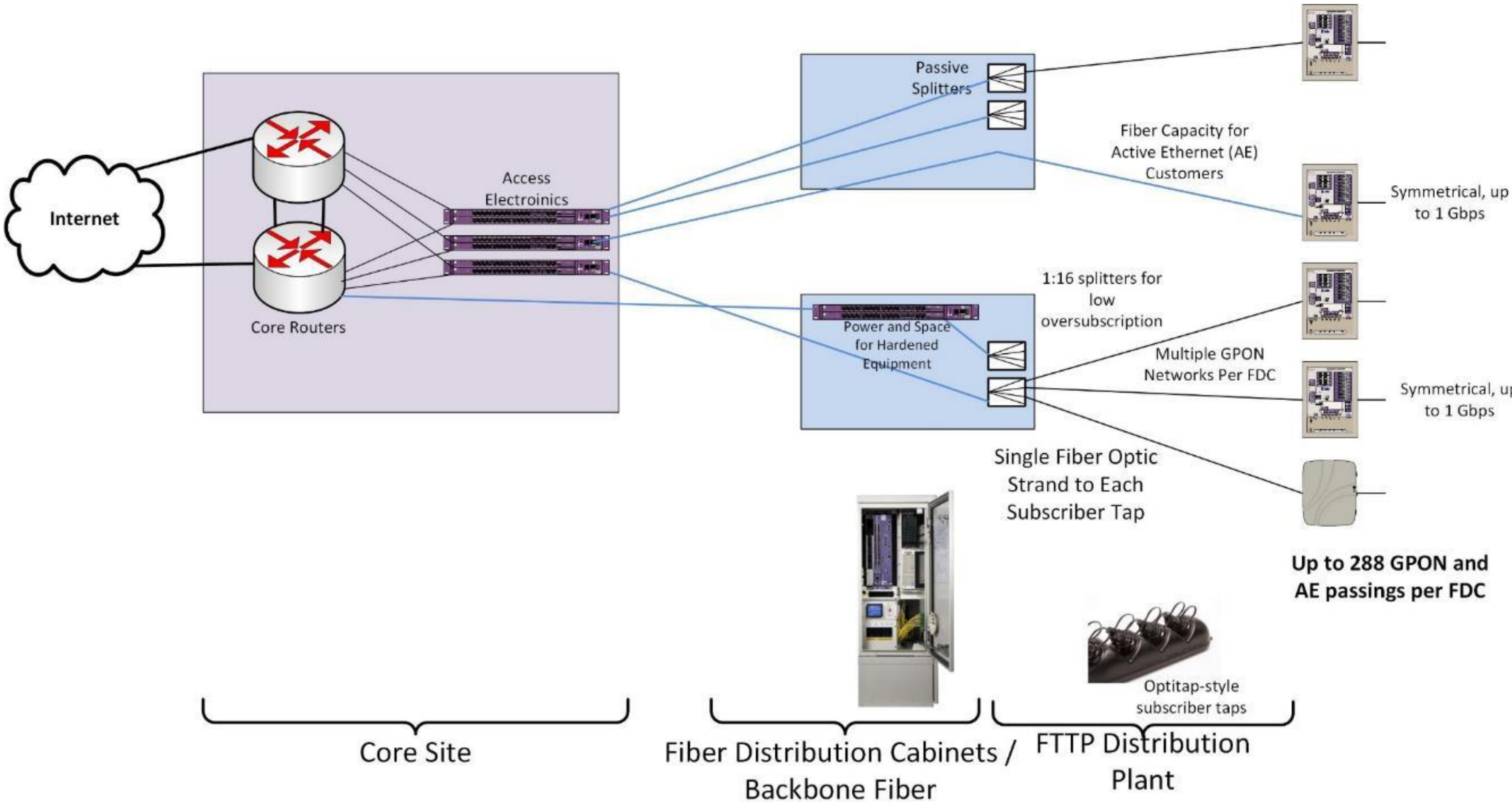
- **Security** – controlled physical access to all equipment and facilities, plus network access control to devices

This architecture offers scalability to meet long-term needs. It is consistent with best practices for either a standard or an open-access network model to provide customers with the option of multiple network service providers. This design would support the current industry standard gigabit passive optical network technology. It could also provide the option of direct Active Ethernet services.[24]

The design assumes placement of manufacturer-terminated fiber tap enclosures within the public right-of-way or easements, providing watertight fiber connectors for customer service drop cables, and eliminating the need for service installers to perform splices in the field. This is an industry-standard approach to reducing both customer activation times and the potential for damage to distribution cables and splices. The model also assumes that the State or a partner obtains easements or access rights to private drives to access homes as needed.

[24] The architecture enables the network to provide direct unshared Active Ethernet connections to 5 percent of customers, which is appropriate for a select group of high-security or high capacity commercial users (e.g., banks, wireless small cell facilities). In extreme cases, the network can provide more customers with Active Ethernet with the addition of electronics at the fiber distribution cabinets on an as-needed basis.

**Figure 126: High-Level Fiber-to-the-Premises Architecture**



### 7.1.3 Network design assumptions include constructing 1,240 miles of fiber

We used a range of unit cost assumptions when developing our estimated fiber construction costs (Table 20). Cost estimates are based on other, similar fiber-to-the-premises projects.

**Table 20: Unit Cost Estimate Assumptions**

| Description | Unit | Assumption |
|---|---|---|
| Placement of 2-inch conduit using directional boring | $/foot | $12.50 |
| Pull-box placement, 24"x36"x36" Tier 22 | each | $1,050 |
| Aerial cable installation per foot | $/foot | $1.50 |
| Traffic control and work area protection per foot | $/foot | $.25 |
| Tree trimming | $/foot | $.25 |
| Make-ready per foot | $/foot | $0.29 |
| 288-count cable | $/foot | $2.05 |
| Aerial fiber installation materials | $/foot | $1.30 |

The network design and cost estimates assume the State, or a partner will:

- Use existing State land to locate a core facility. The cost estimate includes the facility costs with adequate environmental and backup power generators to house network electronics and provide backhaul to the internet.
- Construct approximately 200 miles of backbone network[25] to connect the unserved communities to the core via 28 fiber distribution cabinets. The fiber distribution cabinets will be located in the public right-of-way or on State-owned land that provides adequate space for the hosting and maintenance of the cabinet.
- Construct approximately 1,240 miles of fiber optics from the fiber distribution cabinets to approximately 11,634 homes and businesses (i.e., from termination panels in the fiber distribution cabinet to tap locations in the public right-of-way or on easements near the home or business). The approximate fiber mileage per county is: New Castle, 48 miles; Kent, 407 miles; Sussex: 785 miles.
- Obtain easements or access rights to private roads where public rights-of-way do not exist.

The fiber-to-the-premises network design was developed with the following criteria based on the above assumptions and required characteristics of the hierarchical fiber-to-the-premises network:

[25] The backbone construction costs are included in the cost of the fiber-to-the-premises network.

- Fiber will vary between 12- and 288-count based on the projected need in the area.
- Fiber will be installed in the communications space of the electric utility poles where poles are present, and in newly constructed underground conduit in other areas.
- Fiber will be installed in the public right-of-way or in an easement on the side of the road.
- The network will target up to 288 passings per fiber distribution cabinet.
- Fiber distribution cabinets will support hardened network electronics and provide backup power and an active heat exchange.[26]
- The network routes will avoid the need for distribution plant to cross major roadways and railways.

As with any utility, the design and associated costs for construction vary with the unique physical layout of the service area—no two streets are likely to have the exact same configuration of fiber optic cables, communications conduit, underground vaults, and utility pole attachments. Costs also vary by soil conditions, such as the prevalence of subsurface rock; the condition of utility poles and feasibility of aerial construction involving the attachment of fiber infrastructure to utility poles; and crossings of bridges, railways, and highways.

A key point to understand is that aerial construction (i.e., attaching fiber infrastructure to existing utility poles) could offer significant savings compared to all-underground construction but increases uncertainty around cost and timeline. Under some circumstances, costs related to pole remediation and make-ready construction can make aerial construction cost-prohibitive in comparison to underground construction. However, as discussed in Section 7.1.1, our desk survey found that the majority of poles likely have sufficient space and capacity, and that the amount of needed make-ready is very low. We also observed that tree trimming will be very low, helping to decrease the cost of aerial construction.

We assume the fiber will be strand-mounted in the communications space on the existing electrical utility poles. Splice cases, subscriber taps, and drops will also be attached to the strand, which will facilitate maintenance and customer installation.

[26] These hardened fiber distribution cabinets reflect an assumption that the network's operational and business model will require the installation of provider electronics in the fiber distribution cabinets that are capable of supporting open access among multiple providers. We note that the overall fiber-to-the-premises cost estimate would decrease if the hardened fiber distribution cabinets were replaced with passive fiber distribution cabinets (which would house only optical splitters) and the providers' electronics were housed only at the hub facility.

While generally allowing for greater control over timelines and more predictable costs, underground construction is subject to uncertainty related to congestion of utilities in the public right-of-way—which cannot be fully mitigated without physical excavation and/or testing. In the State, however, congestion of utilities appears to be reasonable for most areas, which makes underground construction more viable than is typically the case.

While anomalies and unique challenges will arise regardless of the design or construction methodology, the relatively large scale of this project is likely to provide ample opportunity for variations in construction difficulty to yield relatively predictable results on average.

We assume underground construction will be done using an industry-standard approach for this type of environment, which consists primarily of horizontal, directional drilling to minimize public right-of-way impact and to provide greater flexibility to navigate around other utilities. The design model assumes a single 2-inch, flexible, high-density polyethylene (HDPE) conduit over underground distribution paths, and dual 2-inch conduits over underground backbone paths to provide scalability for future network growth.

Costs for aerial and underground placement were estimated using available unit cost data for materials and estimates on the labor costs for placing, pulling, and boring fiber based on construction in comparable markets. The material costs were known, with the exception of unknown economies of scale and inflation rates and barring any shortages or supply disruptions restricting material availability and increasing costs. The labor costs associated with the placement of fiber were estimated based on comparable construction projects.

### 7.1.4 Total capital costs include outside plant construction, electronics, and service drop installation

#### *7.1.4.1 Outside plant cost components*

The cost components for outside plant construction include the following tasks:

- ***Engineering*** – includes system-level architecture planning, preliminary designs, and field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction "as-built" revisions to engineering design materials

- ***Quality Control / Quality Assurance*** – includes expert quality assurance field review of final construction for acceptance

- ***General Outside Plant Construction*** – consists of all labor and materials related to "typical" underground or aerial outside plant construction, including conduit placement, utility pole make-ready construction, aerial strand installation, fiber installation, and surface restoration; includes all work area protection and traffic control measures inherent to all roadway construction activities

- ***Special Crossings*** – consists of specialized engineering, permitting, and incremental construction (material and labor) costs associated with crossings of railroads, bridges, and interstate / controlled access highways

- ***Backbone and Distribution Plant Splicing*** – includes all labor related to fiber splicing of outdoor fiber optic cables

- ***Backbone Hub, Termination, and Testing*** – consists of the material and labor costs of placing hub shelters and enclosures, terminating backbone fiber cables within the hubs, and testing backbone cables

The assumptions, sample designs, and cost estimates were used to extrapolate an outside plant infrastructure cost of $52,000 per mile.

The distribution plant covers approximately 1,240 miles, leading to a total outside plant cost of approximately $64.6 million. This leads to an average outside plant cost per passing of approximately $5,550. Table 21 and Table 22 provides a breakdown of the estimated outside plant costs. Table 23 itemizes the estimated cost by county.

**Table 21: Estimated Outside Plant Costs[27]**

| Cost Per Plant Mile[28] | Distribution Plant Mileage | Total Cost | Estimated Passings | Cost per Passing[29] |
|---|---|---|---|---|
| $52,000 | 1,240 | $64.6 million | 11,634 | $5,550 |

[27] Unrounded numbers are used in the engineering calculations; these are then rounded in the table and the discussion.
[28] The cost per plant mile is the average cost of constructing a mile of outside plant for the fiber-to-the-premises network.
[29] The cost per passing is the average cost to construct the outside plant for the fiber-to-the-premises network to pass each premises within the unserved areas.

**Table 22: Breakdown of Outside Plant Costs**

| Category | Outside Plant Costs |
|---|---|
| OSP Engineering | $8.7 million |
| Quality Control/Quality Assurance | $6.7 million |
| General OSP Construction Cost | $44.3 million |
| Special Crossings | $1.3 million |
| Backbone and Distribution Plant Splicing | $2.2 million |
| Backbone Hub, Termination, and Testing | $1.6 million |
| *Total Estimated Cost* | *$64.6 million* |

**Table 23: Breakdown of Outside Plant Costs by County**

| County | Approximate Distribution Plant Mileage | FTTP Outside Plant Cost |
|---|---|---|
| New Castle | 48 | $2.5 million |
| Kent | 407 | $21.2 million |
| Sussex | 785 | $40.9 million |

The actual cost to construct fiber-to-the-premises to every unserved premises in the State could differ from the estimate due to changes in the assumptions underlying the model. For example, if make-ready and pole replacement costs are too high, the network would have to be constructed underground—which could significantly increase the cost of construction. A non-uniform take-rate (i.e., the percentage of passed customers that choose to purchase a service) across different areas could also influence costs. Further and more extensive analysis would be required to develop a more accurate cost estimate across the entire State.

Actual costs will also vary from this estimate due to factors that cannot be precisely known until the detailed design is completed, or until construction commences. These factors include:

- Costs of private easements
- Utility pole replacement and make-ready costs
- Variations in labor and material costs
- The State or its partner's operational and business model

We have incorporated suitable assumptions to address these items based on our experience in similar markets.

### *7.1.4.2 Central network electronics costs*

Central network electronics equipment to serve the unserved area will cost an estimated $2.8 million, assuming a 60 percent take-rate.[30] (These costs may increase or decrease depending on take-rate, and the costs may be phased in as subscribers are added to the network.) The network electronics consist of the core and distribution electronics to connect subscribers to the fiber-to-the-premises network at the core and the fiber-to-the-premises access electronics located at the fiber distribution cabinets. Table 24 lists the estimated costs for each segment.

**Table 24: Estimated Central Network Electronics Costs**

| Network Segment | Cost |
|---|---:|
| Core and Distribution Electronics | $1.8 million |
| Fiber-to-the-Premises Access Electronics | $1.0 million |
| *Total Estimated Cost* | *$2.8 million* |

The electronics are subject to a seven- to 10-year replacement cycle, as compared to the 20- to 30-year lifespan of a fiber investment.

#### 7.1.4.2.1 Core and distribution electronics

The core electronics connect the network to the internet. The core electronics consist of high-performance routers, which handle all the routing on both the network and to the internet. The core routers have modular chassis to provide high availability in terms of redundant components and the ability to "hot swap" line cards in the event of an outage.[31] Modular routers also provide the ability to expand the routers as demand for additional bandwidth increases.

The cost estimate design envisions running networking protocols, such as hot standby routing protocol, to ensure redundancy in the event of a router failure. Additional connections can be added as network bandwidth increases. The core sites would also tie to the distribution electronics using 10 Gbps links. The links to the distribution electronics can also be increased with additional 10 Gbps and 40 Gbps line cards and optics as demand grows on the network. The core networks will also have 10 Gbps to ISPs that connect the network to the internet.

[30] The take-rate affects the electronics and drop costs, but also may affect other parts of the network, because the State or its partner may make different design choices based on the expected take-rate. A 60 percent take-rate is possible in environments where a new provider delivers service in a previously unserved area. Market research would be required to estimate a more accurate take-rate at assumed service costs.

[31] A "hot swappable" line card can be removed and reinserted without the entire device being powered down or rebooted. The control cards in the router should maintain all configurations and push them to a replaced line card without the need for reconfirmation.

The cost of the core routing equipment is approximately $1.8 million. In addition, the network requires operations support systems, such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for operations. For a network of this scale, an operations support system costs approximately $200,000 to acquire and configure. (We have not included that cost in the totals above because the system might be the responsibility of the State's partner.)

##### 7.1.4.2.2 Fiber-to-the-premises access electronics

The access network electronics at the fiber distribution cabinets connect the subscribers to the network by connecting the backbone to the fiber that goes to each premises. These electronics are commonly referred to as optical line terminals. We recommend deploying access network electronics that can support both gigabit passive optical network and Active Ethernet subscribers to provide flexibility within the fiber distribution cabinet service area. We also recommend deploying modular access network electronics for reliability and the ability to add line cards as more subscribers join in the service area. Modularity also helps reduce initial capital costs.

The cost of the access network electronics for the network is estimated at approximately $1.0 million. These costs are based on a take-rate of 60 percent and include optical splitters at the fiber distribution cabinets aligned to that take-rate. An alternative design places the optical line terminals at the core location, with the fiber distribution cabinets containing only splitters. As the State or its partner examines more closely the specific electronics architecture, this alternative may be a suitable approach—and would reduce the size of the fiber distribution cabinets and provide a small cost savings.

#### *7.1.4.3 Service drop installation and customer premises equipment (per-subscriber costs)*

Each activated subscriber would also require a fiber drop cable installation and related customer premises equipment, which would cost on average roughly $1,040 per subscriber, or $7.2 million total—again, assuming a 60 percent take-rate.

Customer premises equipment is the subscriber's interface to the network; for gigabit passive optical networks, these electronics are referred to as an optical node terminal. For this cost estimate, we selected customer premises equipment that both terminates the fiber from the network and provides only Ethernet data services at the premises (however, there are a wide variety of additional customer premises equipment offering other data, voice, and video services). The customer premises equipment can also be provisioned with wireless capabilities to connect devices within the customer's premises. Using the assumed take-rate of 60 percent, we estimated the cost for customer premises equipment and installation to be $500 per subscriber, or approximately $3.5 million systemwide.

The drop installation cost is the biggest variable in the total cost of adding a subscriber. A short aerial drop can cost as little as $250 to install, whereas a long underground drop installation can cost upward of $5,000. Based on the prevalence of aerial and underground utilities, and sample designs, we estimate an average of approximately $970 per drop installation (or approximately $7.4 million systemwide, assuming a 60 percent take-rate). The drop installation follows the existing utilities; if the existing utilities in the public right-of-way are aerial, the drop would be installed aerially (and vice versa for underground). Average drop distances are extrapolated from sample designs developed for similar rural fiber-to-the-premises projects. Actual drop costs will vary for each premises.

The numbers provided in Table 25, below, are averages and will vary depending on the type of premises and the internal wiring available at each premises.

**Table 25: Per-Subscriber Cost Estimates**

| Construction and Electronics Required to Activate a Subscriber | Estimated Average Cost |
|---|---|
| Drop Installation and Materials | $540 |
| Subscriber Electronics (Optical Node Terminal) | $200 |
| Electronics Installation | $200 |
| Installation | $100 |
| *Total Estimated Cost* | *$1,040* |

## 7.2 Fixed wireless infrastructure is a feasible alternative to serve homes and businesses—with a $10.6 million capital cost but high operating costs

This section describes CTC's analysis of the use of State-owned and commercial towers and other suitable structures to provide fixed wireless broadband access to unserved homes and businesses in Delaware. We found that a fixed wireless network using the Citizens Broadband Radio Service (CBRS) band at 57 tower locations could effectively serve 79 percent of the State's premises that currently are unserved by wireline networks—although, as discussed in Section 7.3, it would have clear technical limitations relative to a fiber optic network. (We note, too, that 100 percent of unserved premises could be connected using fiber.)

In a departure from many fixed wireless deployments, this model makes every effort to attain high quality and coverage—adding more towers (and thus more cost) where necessary to increase the likelihood of premises attaining 25/3 Mbps service.

This analysis demonstrates that fixed wireless technology can be a technically feasible approach to providing broadband to unserved addresses in Delaware. Although wireless technology has higher operational costs and a shorter technology lifetime than fiber optics, wireless technology has benefits in terms of lower capital costs and reduced time to deploy. Furthermore, as discussed below, new developments in wireless technology are improving the reliability and speed of wireless broadband, and therefore these technologies are a better option now than they were in the recent past.

### 7.2.1 Overview of analysis

We developed variations on fixed wireless network models that use antennas mounted on existing structures (which we refer to here, for convenience, under the catchall term "towers") to deliver service to Delaware's unserved addresses. As a starting point for our analysis, Figure 127 (below) shows the unserved addresses in Delaware, based on the analysis described in Section 3.

In the fixed wireless model, equipment mounted on 57 existing towers could deliver CBRS wireless service to an estimated 79 percent of the State's 11,600 unserved premises (see Figure 128, below). The dark blue areas illustrate the higher-speed coverage delivered with 3.5 GHz CBRS wireless technologies. Unlicensed 5 GHz wireless technology is used at two tower locations (light blue shading) where the number of potentially unserved addresses supported by the CBRS base stations would exceed specifications (i.e., the CBRS equipment alone could not serve all the premises). The green shading indicates the remaining unserved areas that could be served using TV White Spaces (TVWS) technology, which could be deployed at 13 tower locations as a less-than-25 Mbps lifeline service for those who have no better option for receiving service.

**Figure 127: Unserved Areas and Addresses in Delaware**

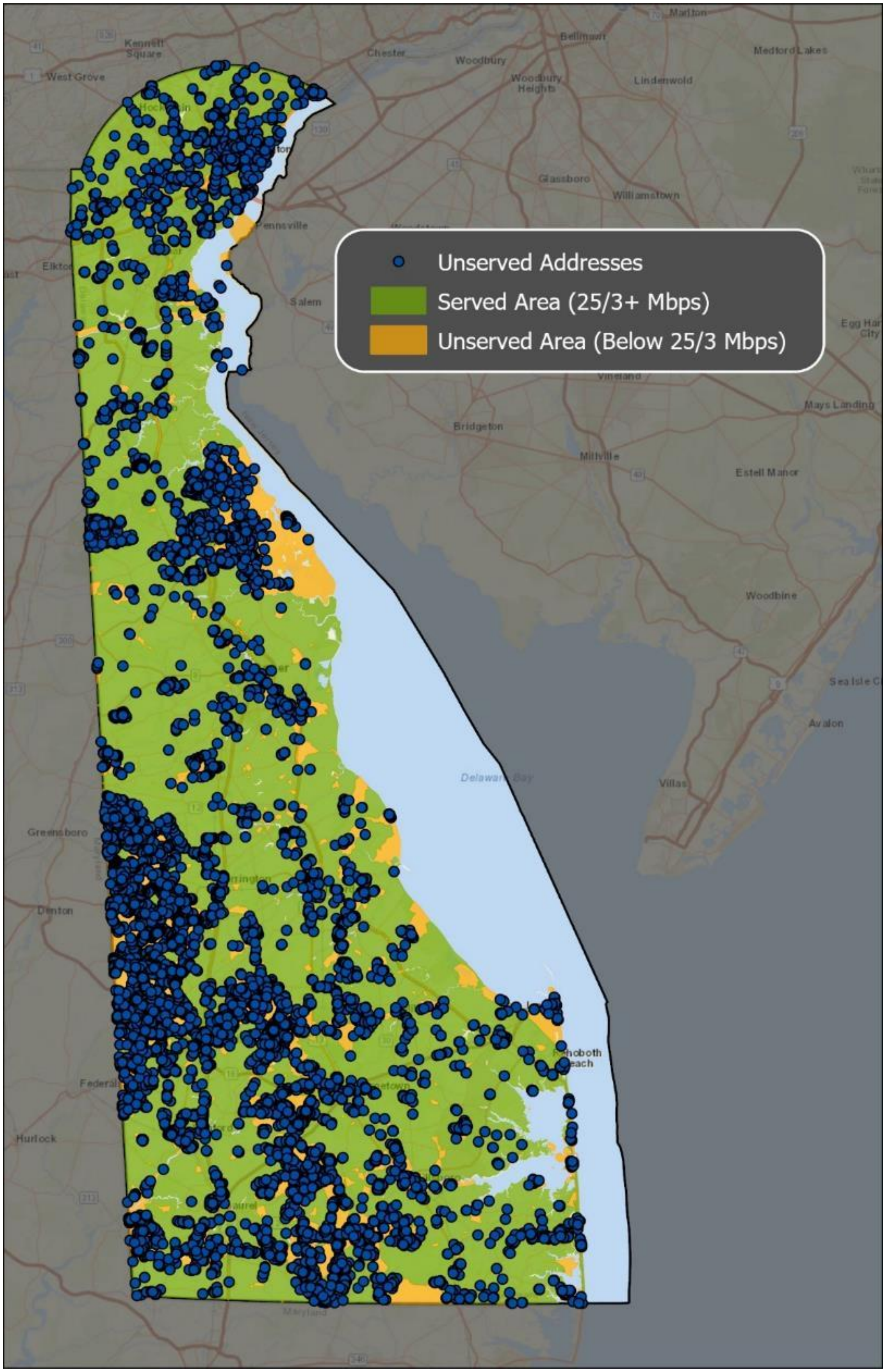


**Figure 128: Coverage Enabled by Equipment on Existing Towers**

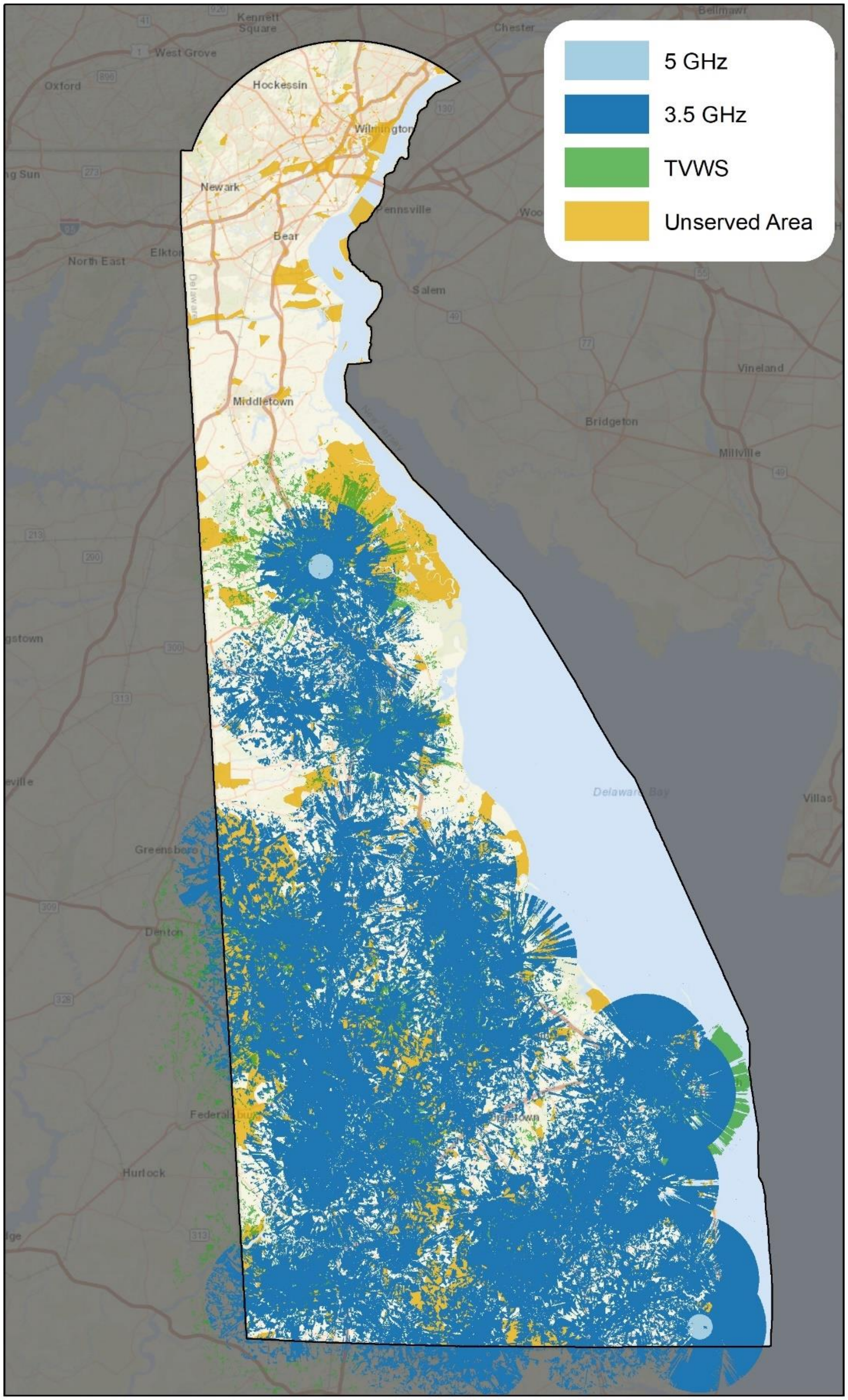


Table 26 summarizes the cost and scope of the fixed wireless model. We found that an average of more than 160 addresses were served by each of the 57 towers.

**Table 26: Fixed Wireless Coverage and Cost Estimates**

| Option | Number of Towers | Passings Served | Percent of Passings Served | Capital Cost Assuming 60% Penetration | Average Distribution Network Cost Per Wireless Passing | Installation and Electronics Per Customer |
|---|---|---|---|---|---|---|
| **Fixed Wireless Model Using CBRS** | 57 | 9,145 | 79 | $10,550,000 | $554 | $1,000 |

The following sections:

- Provide a high-level introduction to fixed wireless connectivity (including technologies, basic architecture, spectrum, and elements of costs)
- Describe the use of the existing structures within the State in a fixed wireless solution for the unserved homes and businesses.

### 7.2.2 Introduction to fixed wireless network connectivity

Broadband speeds in compliance with the FCC's definition (i.e., 25 Mbps download, 3 Mbps upload—which is also the definition of "served" approved by Delaware for this project) are more readily available from fixed wireless networks than in the past, owing to the recent introduction of the CBRS spectrum into the market and new wireless technologies. While wireless internet service providers (WISP) are typically not able to offer connection speeds on a market-wide basis comparable to cable or fiber networks built to each premises, a fixed wireless connection may be a desirable solution if cable or fiber is not cost-effective. This is especially true in low-density rural areas where there are few homes and businesses per mile, and therefore the cost of building wired networks is often high.

As opposed to an underground or aerial cable, fixed wireless broadband is provided from access point antennas on towers or rooftops. The customer antenna may be on the home or business or on a mast on the customer premises (Figure 129).

**Figure 129: Example Fixed Wireless Network with Access Point Antennas on a Monopole and Various Customer Antenna Configurations**

### *7.2.2.1 Fixed wireless spectrum and architecture*

Fixed wireless networks typically use the following spectrum:

| | |
|---|---|
| • TV White Space (TVWS) | 500 MHz |
| • Unlicensed | 900 MHz, 2.4 GHz, 5 GHz |
| • Citizens Broadband Radio Service (CBRS) | 3.5 GHz |

It is useful to determine which band may be most effective to use in different areas. Each band will need its own set of equipment; if one or more band can be eliminated from specific sites, then the overall cost of deployment and operations will be reduced.

Of these bands, only CBRS and 5 GHz technology have channel widths capable of delivering 25 Mbps down and 3 Mbps up—so those are the two primary bands we considered. The CBRS band is predicted to connect the most addresses. (In addition to the spectrum properties, the ability to connect is due to the antennas being allowed to be mounted higher than the TVWS antennas under the licensing rules of the FCC, and CBRS being allowed to have the greatest broadcast power of the three technologies.) 5 GHz is only used at tower locations where the tower could potentially serve more customers than the CBRS base stations can support. 5 GHz base stations would be used to offload customers from CBRS that can be connected at the higher frequency and lower power levels of unlicensed 5 GHz.

That said, we also considered TVWS—which delivers service over unused television frequencies (known as white space). TVWS bands have much better non-line-of-sight transmission qualities than the other bands; however, due to its narrower bandwidth, TVWS is not capable of delivering

25 Mbps down, and therefore should only be considered as a lifeline service in cases where other connectivity is not available or feasible. Also, because white space technology is still in an early phase of development, compatible equipment is far more expensive than other off-the-shelf wireless equipment.

Most fixed wireless network solutions require the antenna at the subscriber location to be in or near the line of sight of the base station antenna. While terrain does not pose a problem in Delaware, areas with dense vegetation and tall foliage can create challenges for establishing wireless connectivity. External wireless customer premises equipment attached to the top of houses or to antenna masts are often used to obtain the necessary heigh to achieve line of sight and therefore a stronger wireless connection.

WISPs often need to lease space at or near the tops of radio towers; even then, some customers may be unreachable without the use of additional repeaters. And because the signal is being sent through the air, climate conditions like rain and fog can impact the quality of service. In our model, we assumed that the top of any existing tower is already utilized, and that any new equipment would be placed at 80 percent of the current tower height.

In addition, there is a tradeoff in these bands between capacity and the ability to penetrate obstructions such as foliage and terrain. The higher frequencies have wider channels and therefore the capability to provide the highest capacity. However, the highest frequencies are those most easily blocked by obstructions.

Wireless equipment vendors offer a variety of point-to-multipoint and point-to-point solutions.

The models in this document assume point-to-multipoint equipment, which is typical for a residential or small business connection. Point-to-point service would typically be chosen by a medium-sized business because it would enable dedicated bandwidth (at a higher cost than a point-to-multipoint service); that said, point-to-point networks may have limited network capacity, particularly in the upstream, making the service inadequate for applications that require high-bandwidth connections.

#### *7.2.2.2 Fixed wireless network deployment costs*

The following factors will determine the costs associated with a fixed wireless network:

- **Wireless equipment used:** Different wireless equipment has different aggregate bandwidth capacity and use a range of different spectrum bands, each with its own unique transmission capabilities.

- **Backhaul connection**: Although the bottleneck tends to be in the last-mile connection, if a WISP cannot get an adequate connection back to the internet from its tower, equipment upgrades will not be able to increase available speeds beyond a certain point.

- **Future capacity and lifespan of investment:** Wireless equipment generally requires replacement every five to 10 years, both because exposure to the elements causes deterioration, and because the technology continues to advance at a rapid pace, making decade-old equipment mostly obsolete. The cost of deploying a wireless network is generally much lower than deploying a wireline network, but the wireless network will require more regular investment.

- **Availability of unobstructed line of sight:** Most wireless networking equipment requires a clear, or nearly clear, line of sight between antennas for optimum performance. WISPs often lease space near the tops of radio towers, to cover the maximum number of premises with each base station.

### 7.2.3 Analyzing radio frequency coverage in the State

We conducted a wireless analysis to determine how the State's unserved addresses could be served via fixed wireless. The high-level model is for planning purposes only. The RF coverage analysis was modeled using CloudRF, which is an online service available for modelling the Radio frequency propagations. The software was chosen because of its ability to output coverage maps in a GIS layer than can be overlaid on the unserved address points, and therefore identify which of the address would be covered by the wireless model.

There are various propagation models used for RF analysis. Widely used models are the line of sight (LOS) model, cost 231 model, Okumura Hata model, and Longley-Rice model (also called the Irregular Terrain Model, or ITM). For our analysis we used ITM, which is the most conservative and takes into consideration the atmospheric conditions, the ground elevation, the deployment environment, the obstacles between the base and mobile stations, and the ground clutter.

### 7.2.4 Tower selection methodology

To examine the potential of existing "towers" (which, for purposes of this analysis, included poles, buildings, and other tall mounting structures) to provide service to the State's unserved addresses, We collected data from American Tower, the Federal Communications Commission (FCC) Antenna Registration Service, and the State. We identified approximately 200 total existing tower locations in Kent and Sussex Counties that could provide connectivity to unserved addresses in the State.

We narrowed down the list of tower sites that could potentially be used as part of a fixed wireless solution based on the number of unique addresses that could be served from each tower site.

Tower selection was optimized based on the minimal number of towers needed to serve the most unserved addresses.

After all filtering, we selected 57 towers as potential siting options for fixed wireless equipment. We assessed the coverage provided by each of the selected tower sites using the CBRS wireless frequency band to determine how many of the unserved address would be within the predicted coverage area. We also analyzed which of the 57 selected towers could also support TVWS equipment to provide lifeline wireless connectivity to additional unserved residences and businesses. To conduct this analysis, CTC's engineers used the following assumptions:

- Antenna heights on the towers are assumed to be 80 percent of the tower height for CBRS, and at the maximum allowable height of 30 meters for TVWS equipment
- The broadcast power is at the FCC limit for both TVWS and CBRS equipment
- The channel width for the CBRS is set to 10 MHz of bandwidth
- CloudRF software was used to estimate the coverage areas
- The resolution of ground elevation and clutter is 30 meters
- The user antenna is 4.57 meters (15 feet) high

As a final step, we then applied an algorithm to the tower list to select the fewest towers that covered the most addresses in each model. In summary, we identified 57 existing towers to serve 79 percent of the State's unserved homes and businesses. These towers are primarily commercially owned—the Delaware Division of Communications owns only two of the towers identified in this analysis.

### 7.2.5 High-level coverage and cost estimate

Of the 200 towers analyzed, we identified 57 existing towers that could provide coverage to the unserved areas of the State. Equipment mounted on 57 existing towers could deliver service to an estimated 79 percent of the State's unserved premises (see the figures below). The dark blue shading indicates coverage using CBRS spectrum. The green areas illustrate coverage with TWVS wireless technologies. Unlicensed 5 GHz wireless technology is used at two tower locations where the number of potentially unserved addresses supported by the CBRS base stations would exceed specifications (i.e., the CBRS equipment alone could not serve all the premises); 5 GHz can be used to offload unserved homes and businesses at broadband speeds from the CBRS network.

**Figure 130: TVWS (Green) and CBRS (Blue) Coverage in Kent County**

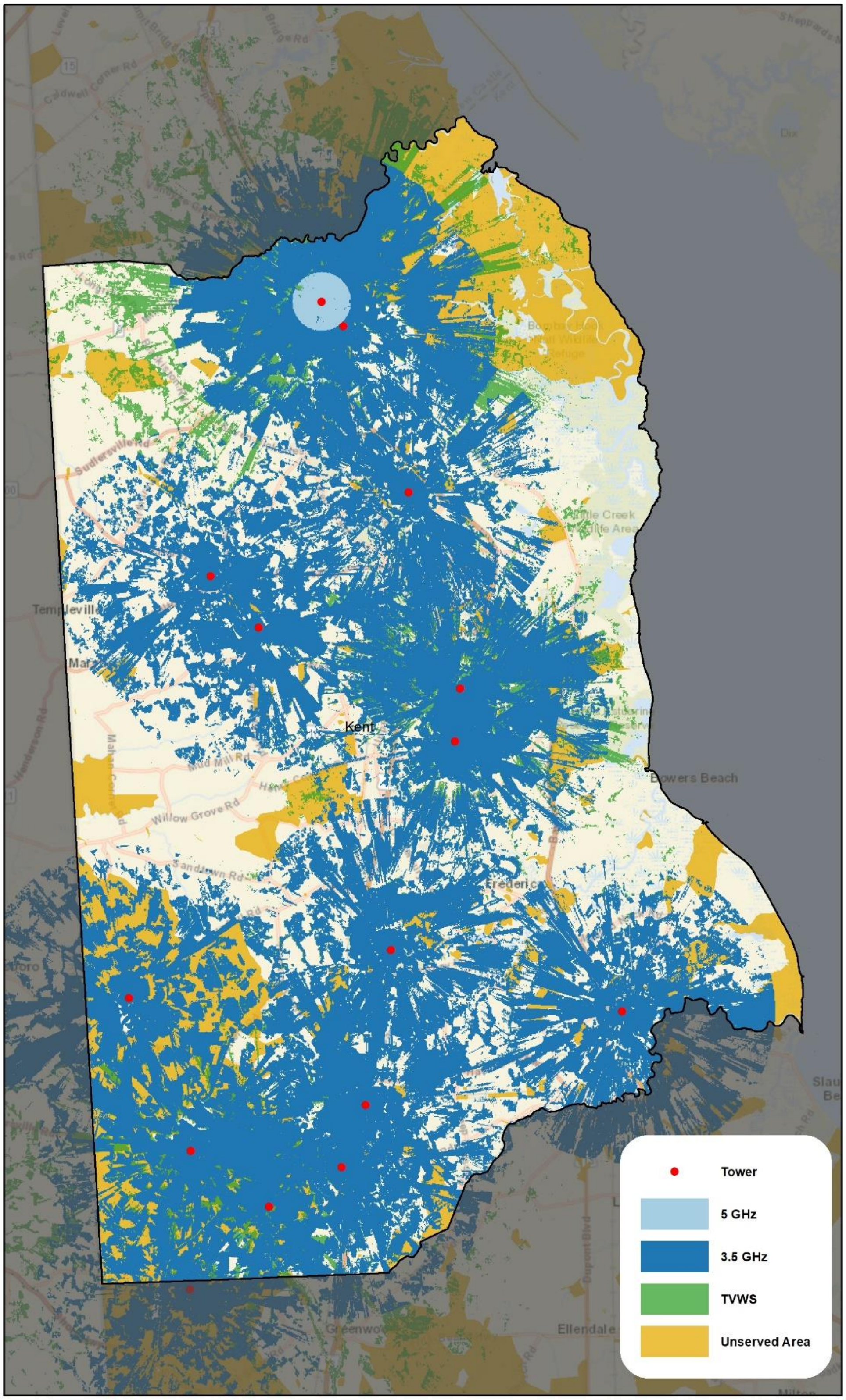
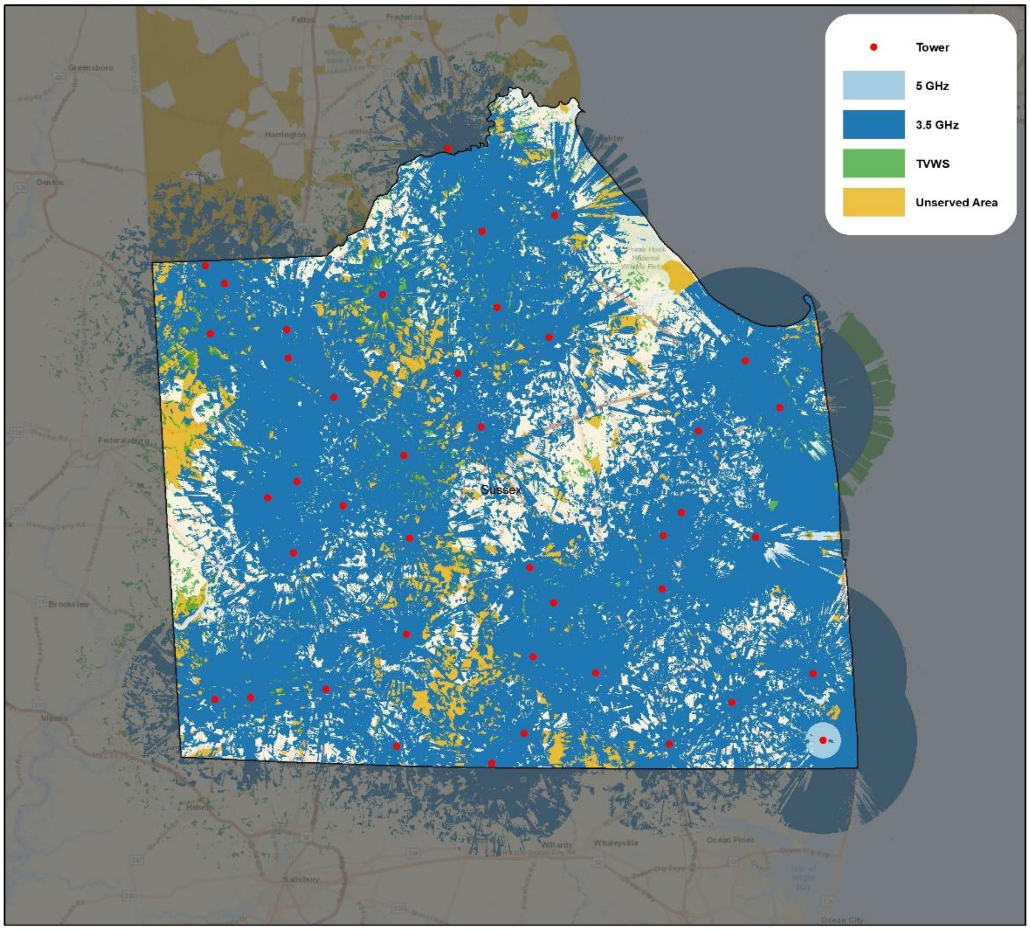


**Figure 131: TVWS (Green) and CBRS (Blue) Coverage in Sussex County**




The tables below show our cost breakdown for using the existing towers for a fixed wireless solution. Our assumptions are as follows:

- All served addresses will require subscriber equipment installed (60 percent take-rate)
- Towers will be configured with four sectors for each frequency used
- All selected towers will have CBRS deployed; two towers require 5 GHz to handle the number of potential subscribers
- 13 towers could provide lifeline connectivity using TVWS to unserved addresses where no other broadband service is available
- Towers will be connected to backhaul using microwave links; 10 percent of the sites will require an additional hop
- Engineering and design includes propagation studies, RF path analysis for point-to-point connections, structural analysis, construction plans, and permits

- Site acquisition costs include the costs of the preliminary equipment dimensioning, power needs, shelter requirements, RF suitability, escorts, and lease negotiations
- There is room within the shelter at the tower location for additional equipment
- To support a fixed wireless network, it is necessary to set up a core network to manage functions such as authentication, billing, security, and connection to the internet; in each of the cases outlined below, we assume $400,000 for equipment and setup of a core
- The costs outlined below are capital costs only and do not include operational costs

**Table 27: Capital Cost Estimate for Fixed Wireless**

| Cost Component | Cost/Number |
|---|---:|
| Network Core | $400,000 |
| Access Point Equipment | $660,000 |
| Backhaul | $860,000 |
| Installation, Engineering, and Design | $1,720,000 |
| Site Acquisition | $1,430,000 |
| **Total Distribution Network Costs** | $5,070,000 |
| Total Addresses | 9,145 |
| **Cost per Address (Distribution Network Only)** | $554 |

**Table 28: Total Cost Estimate for Fixed Wireless at Different Penetration Rates**

| Item | Cost |
|---|---:|
| Total Incremental Cost (Distribution Only) | $5,070,000 |
| Total Incremental Cost (35% Penetration) | $8,260,000 |
| Total Incremental Cost (60% Penetration) | $10,550,000 |
| Incremental Cost per Address (Distribution Only) | $554 |
| Incremental Cost per Customer (35% Penetration) | $2,582 |
| Incremental Cost per Customer (60% Penetration) | $1,923 |

Our propagation analysis predicts there would still be approximately 2,490 addresses, or 21 percent, in the unserved areas that would not be covered by CBRS from all selected existing towers. Using 13 of the selected towers, TVWS could be deployed to pick up an additional approximately 1,300 addresses, leaving only 10 percent of unserved homes and businesses with no wireless service. The following table breaks down the results.

**Table 4: Predicted Coverage for Fixed Wireless Model**

| Addresses | Number |
|---|---|
| Total addresses in unserved area | 11,634 |
| Addresses served by CBRS | 9,145 |
| Addresses not served by CBRS | 2,489 |
| Percent of addresses served | 79% |
| Additional addresses served by TVWS | 1,306 |
| Remaining unserved addresses by CBRS and TVWS | 1,183 |
| Percent of remaining unserved addresses | 10% |

The cost of adding TVWS access points to 13 towers would be $146,000. Each connected TVWS customer would also require customer premises equipment and installation at an estimated cost of $1,000 per subscriber.

## 7.3 Functional and cost comparison of technologies

### 7.3.1 Performance advantage of fiber

Both coaxial (cable-TV and cable broadband) and twisted-pair (telephone) copper cables were originally designed to provide video and voice services, respectively, and were sufficient in the early years of data communications when usage was low relative to current expectations. However, as demand for data capacity increased, networks built with these media became less capable to support demand relative to their high-speed counterparts. On an increasingly large scale, communications carriers and cable operators are deploying fiber to replace large portions of their networks—because for a given expenditure in communications hardware, fiber optics can reliably carry many times more capacity over many times greater distances than any other communications medium.

Fiber is one of the few technologies that can legitimately be referred to as "future-proof," meaning that it will be able to provide customers with larger, better, and faster service offerings to accommodate growing demand.

The biggest advantage that fiber holds is bandwidth. A strand of standard single-mode fiber optic cable has a theoretical physical capacity in excess of 10,000 GHz, and capacity can be symmetrically allocated fully symmetrically between upstream and downstream data flows using off-the-shelf technology. Fiber optics are not subject to outside signal interference and do not require amplifiers to boost signals in a metropolitan area broadband network.

Within a fiber optic strand, an optical communications signal (essentially a ray of light) behaves according to a principle referred to as "Total Internal Reflection" that guides it through the optical cable. Optical cables do not use electrical conduction, and thus do not require a metallic conductor, such as copper, as their propagation medium. Unlike electrical signals over copper cables, optical communications signals also do not experience the significantly increased losses as a function of higher higher-frequency transmission experienced by electrical signals over copper cables.

Further, technological innovations in the development of fiber optics have enabled the manufacture of very high quality, low impurity glass; these optics that can provide extremely low losses within a wide range of frequencies, or wavelengths, of transmitted optical signals, enabling long-range transmissions. Compared to a signal loss on the order of tens of decibels (dB) over hundreds of feet of coaxial cable, a fiber optic cable can carry a signal of equivalent capacity over several miles with only a few tenths of a dB in signal loss.

Moreover, weather and environmental conditions do not cause fiber optic cables to corrode in the way that metallic components can over time as a result of weather and environmental conditions, which means that fiber has further reduced maintenance costs.

One criticism often directed at fiber networks is the cost involved in constructing and deploying the network. However, while optical fiber is often more expensive per foot than many types of copper wire, the costs including construction have become almost comparable over the last decade. Despite the higher material cost of the fiber, new outside plant construction for copper and optical fiber is generally equivalent, because the vast majority of plant construction cost is due to the labor required.

### 7.3.2 Cost-effectiveness of fiber where density is sufficient

One key metric in determining the cost-effectiveness of fiber construction is the density of the area under consideration. The number of homes and businesses per mile of roadway is typically the most important factor—often more important than the condition of the right-of-way, the availability of utility poles, or unit costs of labor and materials.

One approach in technology choice is to set thresholds in density for fiber. Section 7.1.3 indicates the number of homes per mile and the estimated cost to build to the clusters. Taking into account the benefits of fiber, a grant or bid process would ideally preference fiber, but allow use of wireless technologies below certain cost and density thresholds.

### 7.3.3 Wireless cost considerations

Section 7.1 provides capital costs for fiber and Section 7.2 provides those costs for wireless networks and finds that costs are comparable on an apples-to-apples comparison. The capital costs for fiber are dominated primarily by construction labor and secondarily by outside plant materials, with network electronics making up a relatively small portion. As a result, much of the cost is incurred at the beginning of the project—with electronics, with a replacement cycle of five to 10 years, representing a small cost.

By comparison, most of the wireless capital cost is in electronics and software, with some construction or improvement of towers or antenna masts. Electronics have a lifetime of five to 10 years. What this means is that, by comparison with fiber, capital costs are incurred over the lifetime of the project, and that comparable initial capital cost of fiber and wireless will likely over time lead to a higher total cost of operations for the wireless network.

Moreover, most of the wireless electronics cost is at the user premises. As a result, the cost to build and operate a wireless network increases dramatically with growth in the number of customers. It is therefore important that, where the State considers supporting a fixed wireless model, it adequately takes into account the provider's ability to serve enough of the target population and that it designs its network to accommodate both the target population and provide sufficient capacity to give all of them the performance they need in peak conditions.

Fixed wireless providers face significant technical challenges in achieving line of sight to all potential customers and in obtaining sufficient spectrum to deliver sufficient capacity. If the provider is a small start-up (as many fixed wireless providers are), it may also have difficulty with customer support, installation and maintenance for large numbers of customers. What many fixed wireless providers have done in the past is decide not to serve customers who have challenging terrain or foliage, and potentially also target a smaller percentage of the customers, so that they can more easily manage customer support and not overload their networks.

Therefore we recommend the State clearly establish metrics for performance and customer support for all networks (fiber, cable and fixed wireless) and require potential partners to demonstrate technical capabilities (line of sight, spectrum, ability to load network, reliability of design) as well as ability and willingness to support the customers in the service area.

### 7.3.4 Technical unsuitability of DSL

Copper cable is ubiquitous throughout Delaware, but its bandwidth limitations (which are directly related to the underlying physical properties of the medium) and the age and condition of most of the copper cable limit its scalability. This is especially true as average user demand for broadband communications increases to hundreds of Mbps and, eventually, Gbps of capacity.

It's possible very-high-bit-rate digital subscriber line VDSL services can deliver 25 Mbps over a single pair of copper. However, these services are likely limited to portions of the metropolitan area Wilmington with fiber to the node—to within 3,000 feet of the customer. Most of the State has copper lines 10,000 feet to 20,000 feet. Given those distances, the average available DSL download speeds 6 Mbps for the shorter lengths and less than 1.5 Mbps for the long ones. DSL technology will not be able to increase capacity far beyond those speeds or consistently provide service across typical copper lines without substantial upgrades, such as fiber-to-the-curb or other costly re-engineering and construction.

Bandwidth limits on copper cables are directly related to the underlying physical properties of the medium. Higher data rates require a broader frequency range of operation—wider channels. Twisted-pair wire is limited to a few tens of megahertz in usable bandwidth (at most), with dramatic signal loss increasing with distance at higher frequencies. This physical limitation is why DSL service is only available within a close proximity to the telephone central office.

For these reasons, we recommend that the State deprioritize funding for options that are centered around copper line DSL technology. In contrast to fiber, hybrid fiber-coaxial (cable-TV) or even fixed wireless, the technology just barely supports 25/3 Mbps service, and funds spent on building it will not have the long-term value of funds spent on other technologies. Furthermore, DSL technologies are more difficult and costly to maintain. Because of the age of the physical cables, more maintenance is needed. Also, because higher speeds need optimal frequency response, many of the copper pairs in a given cable are not in adequate condition, and therefore DSL operators have in many cases declined to add or maintain service.

# 8 Incumbent ISPs Could Fill Almost 90 Percent of the State's Broadband Gaps by Building Out From Their Existing Networks

Using the State's GIS database, the State's data about unserved areas, and our field and desk survey results, CTC's engineers estimate that approximately 9,600 unserved homes could be served if the existing telecommunications providers would expand their network footprints by half a mile into unserved areas.

## 8.1 An edge-out strategy could be extremely effective

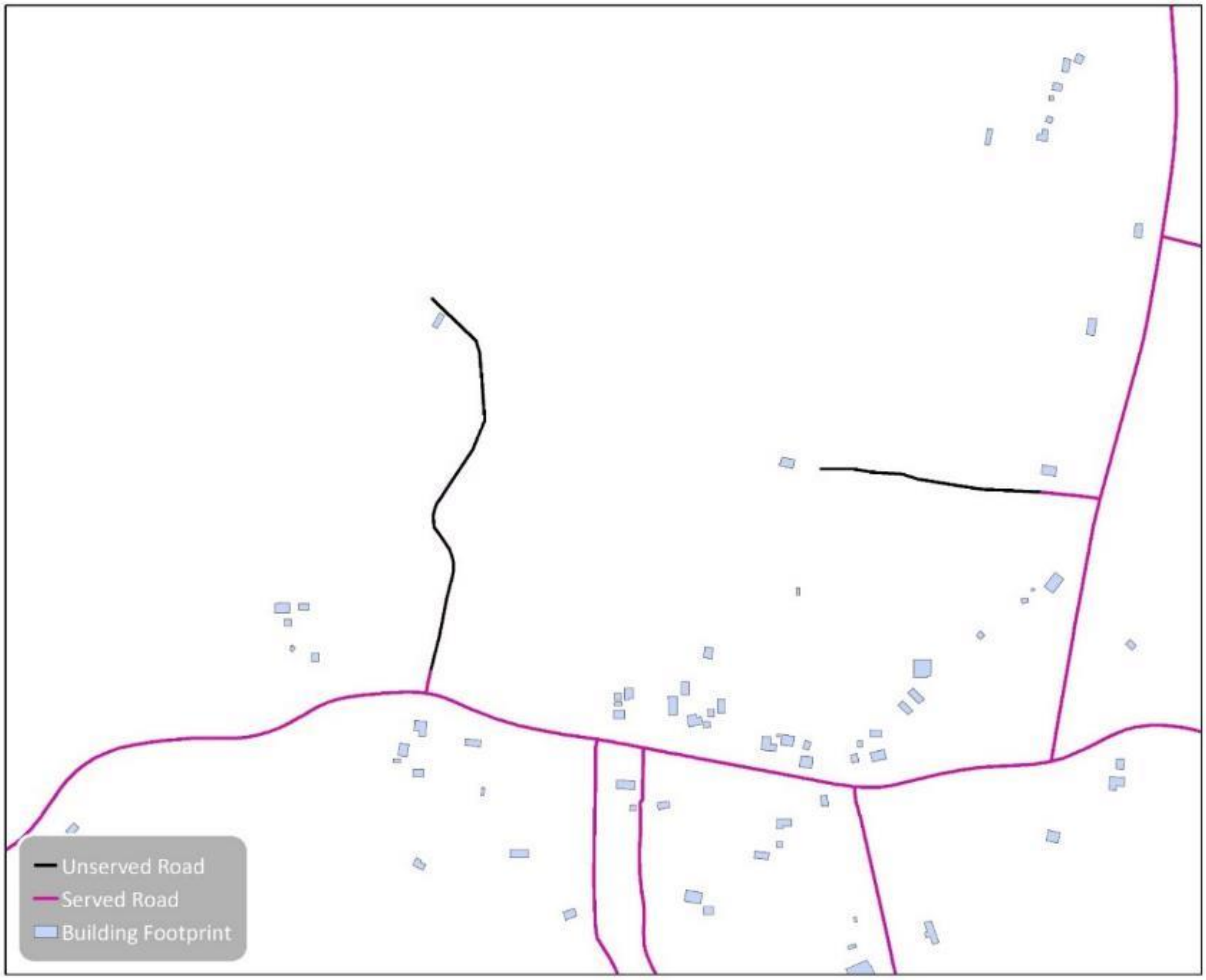
The network edge-out approach would provide service to 87 percent of the unserved homes of the State—a large proportion of the total because the State's largely suburban character means incumbent networks are relatively close to the unserved areas. Based on our estimated outside plant construction cost of $45,000 per mile, it would cost approximately $39.8 million for incumbent providers to construct the roughly 883 miles of fiber and/or coaxial cable.

This strategy would affect isolated pockets of roads and small neighborhoods that do not have service. Several common reasons why these areas might not have service include:

1. The density is too low to justify the line extension under the terms of the franchise agreement;
2. The density is too low and the cost of construction is too high (e.g., all underground utilities) for the provider to justify the line extension; and
3. The roads are private roads, lacking public right-of-way, and the provider has not negotiated an easement for installing broadband services.

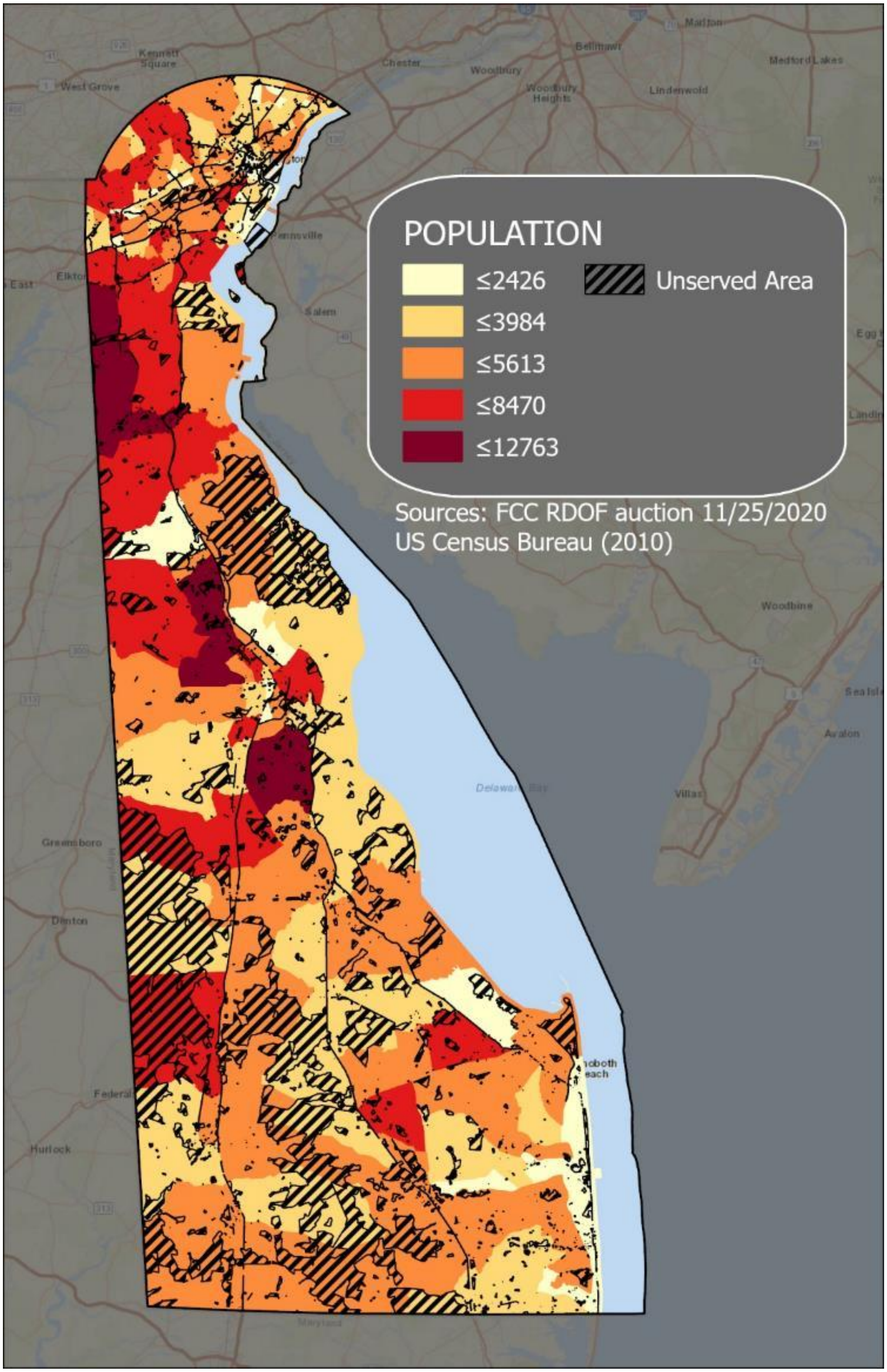
Figure 132 is an example of isolated roads in an otherwise served area. (The pink roads were determined to be served, while the two black roads do not have service.) These are examples of a lack of density not justifying the cost of expanding service.

**Figure 132: Sample Unserved Locations – Single Homes on Long Roads**




The State may be able to work with the existing providers to seek grant funding to lower the cost to the providers for extending service to these isolated areas. A new broadband provider in the State would not likely be as interested in serving these isolated areas because it would not have existing plant adjacent to the isolated roads. The map below illustrates the State's unserved areas in relation to population density.

**Figure 133: Unserved Areas in Relation to Population Density**



## 8.2 An edge-out approach is cost-effective

Where investing in new infrastructure, the State should prioritize investment in fiber optic networks. Fiber represents an infrastructure asset with a lifetime of decades that is almost endlessly upgradeable and capable of supporting any number of public or private sector communications initiatives—and fiber is a critical underlying platform for wireless networks.

For a given expenditure in communications hardware, fiber optics can reliably carry many times more capacity over many times greater distances than any other communications medium. Indeed, fiber is one of the few technologies that can legitimately be referred to as “future-proof,” meaning that, for the foreseeable future, it will accommodate growing demand and provide customers with larger, better, and faster service offerings.

While construction of fiber is costly relative to wireless alternatives, the cost advantages of wireless are reduced over time by high maintenance costs and the need for frequent equipment replacement. The capital costs for fiber are dominated primarily by construction labor and secondarily by outside plant materials, with network electronics making up a relatively small portion. As a result, much of the cost is incurred at the beginning of the project—with electronics, with a replacement cycle of five to 10 years, representing a small cost. By comparison, most of the wireless capital cost is in electronics and software, with some construction or improvement of towers or antenna masts. Electronics have a lifetime of five to 10 years. What this means is that, by comparison with fiber, capital costs are incurred over the lifetime of the project, and that comparable initial capital cost of fiber and wireless will likely over time lead to a higher total cost of operations for the wireless network.

While it is difficult to calculate exactly the total costs of operations between the three network strategies, many of which would be borne by the network operators, we can compare the capital costs that the State may assist in funding to improve broadband coverage (Table 29).

**Table 29: Comparison of Network Strategy Capital Costs**

| Network Strategy | Percent of Unserved Served | Cost Per Passing | Cost Per Connected Subscriber |
|---|---|---|---|
| Edge-Out | 90% | $4,120 | $700 |
| Fiber-to-the-Premises | 100% | $5,550 | $1,040 |
| Fixed Wireless | 69% | $1,090 | $1,815 |

The fixed wireless scenario requires the least cost per potential subscriber, however it is the most costly to add a new subscriber, which is why we recommend the State, if feasible, help fund the cost of connecting subscribers. The edge-out solution is half the cost of constructing a new fiber-to-the-premises network. Given the broadband benefits of wireline networks, we recommend the State promoting broadband edge-outs over other broadband expansion strategies.

# 9 Rural Digital Opportunity Fund auction results indicate significant future investment in Delaware, but the State should prepare for uncertainty

Our analysis of the results of the Federal Communications Commission's (FCC) Rural Digital Opportunity Fund (RDOF) auction for Delaware finds that, although the outcome for Delaware shares some features with the national results, it differs in several ways.

## 9.1 Key findings

Here are the big-picture takeaways:

- The RDOF auction provided a great opportunity with substantial portions of Delaware's unserved areas eligible for federal funding (Figure 134).
- All eligible areas in Delaware were won. More than 99 percent of eligible areas in Delaware were won by Talkie, a small fiber optic provider based in Maryland (Figure 135)
- A total of 7,757 address locations[32] were assigned in the auction at a support of $1.3 million per year over 10 years.
- Unlike almost everywhere else in the country, SpaceX did not pick up any eligible areas in Delaware. It bid on most, but not all, areas in the State. It also seems to have given up earlier than in other areas. It gave up after round 14 in Delaware.
- Talkie bid in every available census block except for one. Bloosurf picked up that census area with eight address locations.
- The auction wrapped up much earlier in Delaware than in other states; a majority of areas were assigned in the clearing round (13), and the remainder two rounds later. In most other states, some areas remained contested until the very last round (19).
- The majority of the available census areas were picked up by Talkie at the clearing round because it bid with the fastest technology. About a third of address locations centered around six census areas (out of 277) carried forward to further auction rounds because Talkie was bidding against NTRC RDOF Phase I Consortium—both with gigabit fiber.
- We do not know whether Talkie can deliver. Support levels for Talkie for the areas it won in Delaware are higher than the average support levels for fiber optic providers. At 61 percent of reserve prices—the maximum available support assigned by FCC for each

[32] The FCC calls these "locations" for short and refers to what it calls "broadband addressable locations." The FCC uses a variety of different databases to estimate numbers and locations of residential and business addresses. The FCC does not currently make these databases publicly available.

census area—it is feasible they could deliver absent any other commitments and absent any additional support. But Talkie has very large commitments in Maryland where it bid aggressively, driving support levels into single digits in some areas where it was bidding against other local fiber providers.

**Figure 134: RDOF-Eligible Areas Compared to Unserved (25/3)**

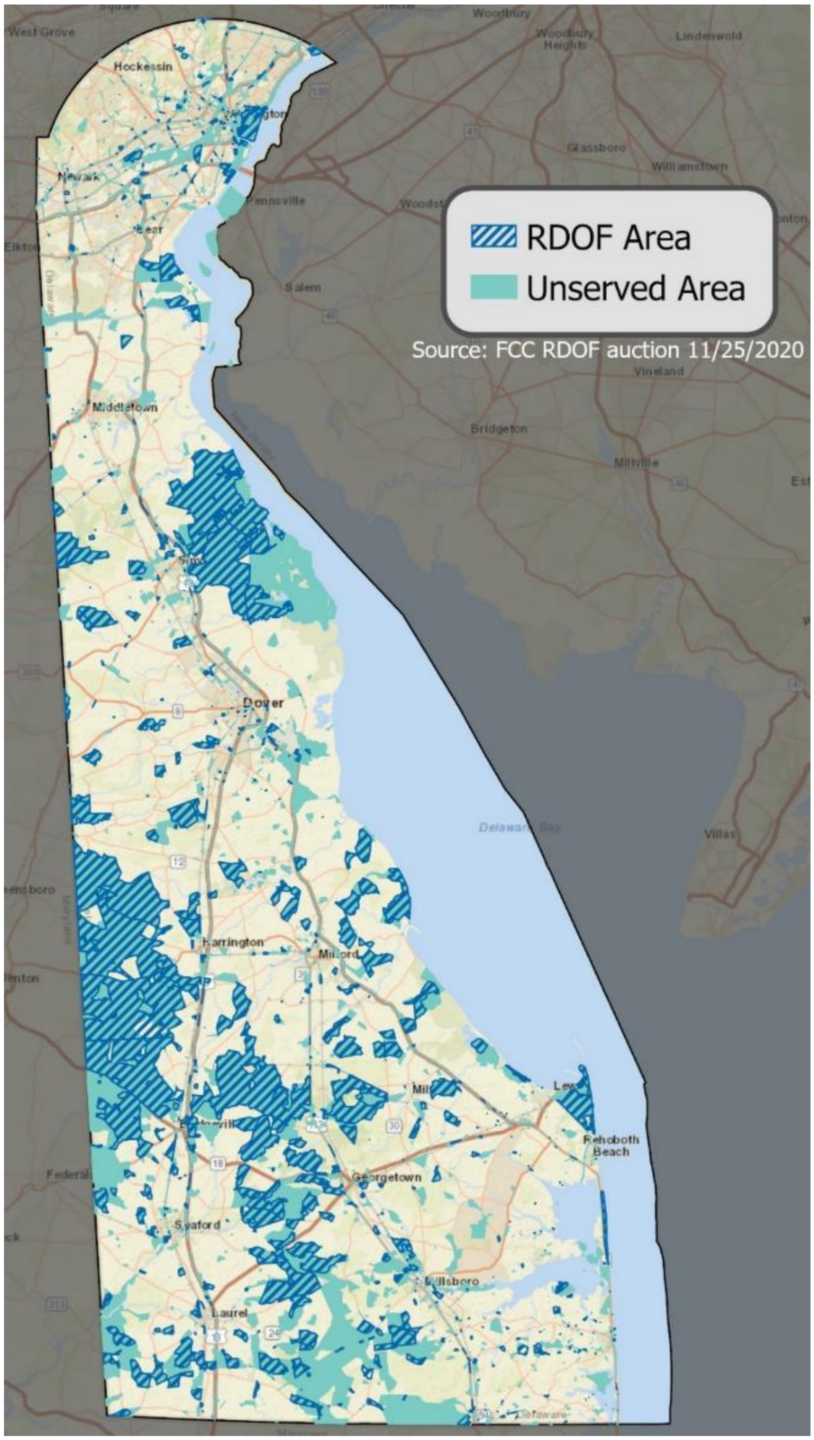
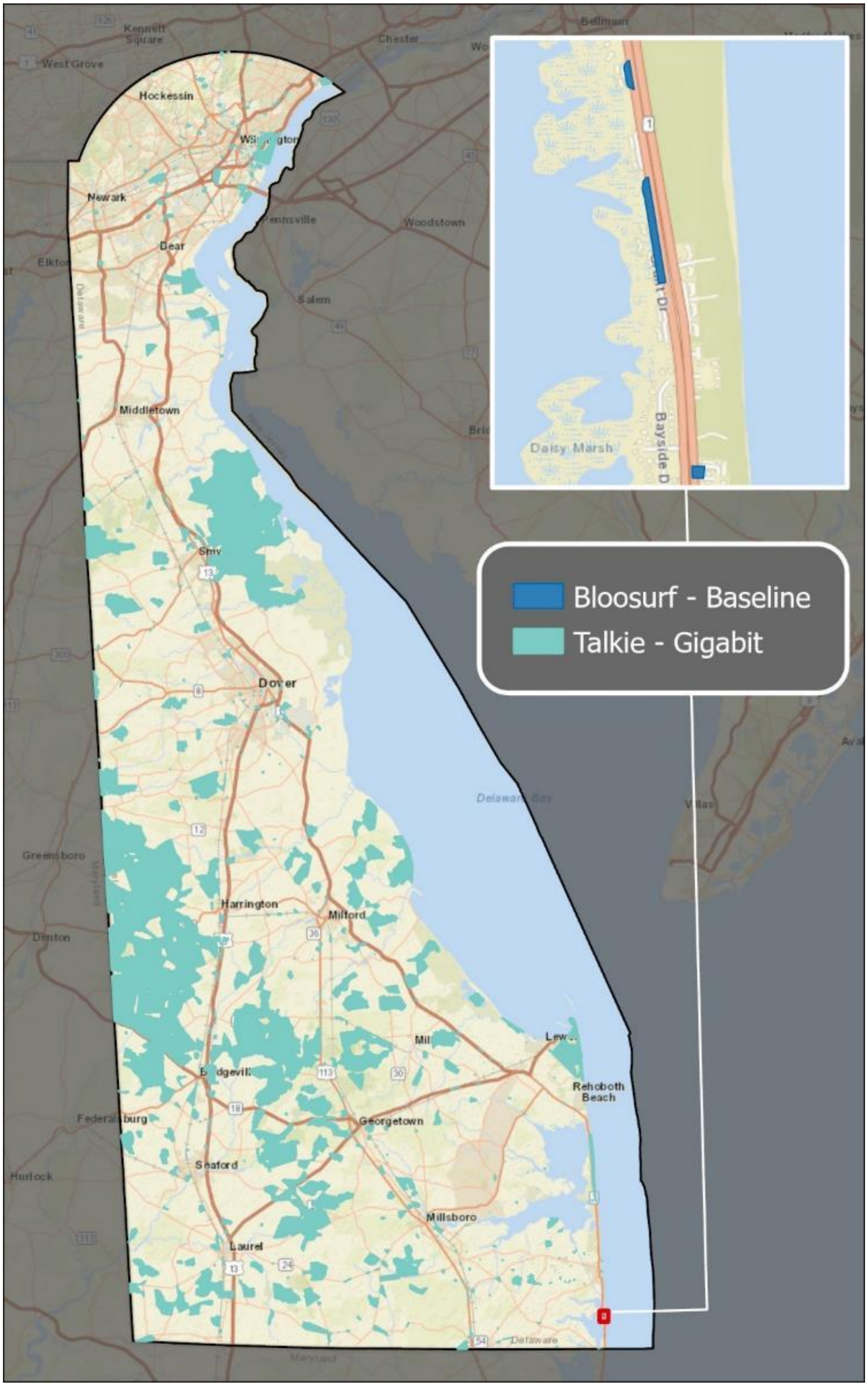


**Figure 135: All RDOF-Eligible Areas Were Assigned—Virtually All by Talkie[33]**



## 9.2 RDOF reverse auction explained

RDOF represents the latest iteration of the FCC's Universal Service Fund's (USF) high cost program. Since 1996, the FCC has used the high cost program to subsidize telecommunications services in rural and remote areas, where the return on investment would otherwise be too low to prompt companies to invest in telecommunications infrastructure.

The RDOF reverse auction comprised a series of rounds where providers bid on a progressively descending percentage of a predetermined support level (the "reserve price") for each eligible census area. Bidders were rated with weights based on the tier (speed) and latency they bid, with the lowest weight being zero for a gigabit, low-latency service, and the highest weight being 90 for a minimum speed (25/3 Mbps), high-latency service. The higher the weight, the more equivalent points were deducted from the calculated support a bidder receives. The auction was designed to target the highest possible speeds at the lowest feasible levels of support by giving built-in advantages to higher-speed and low-latency services.

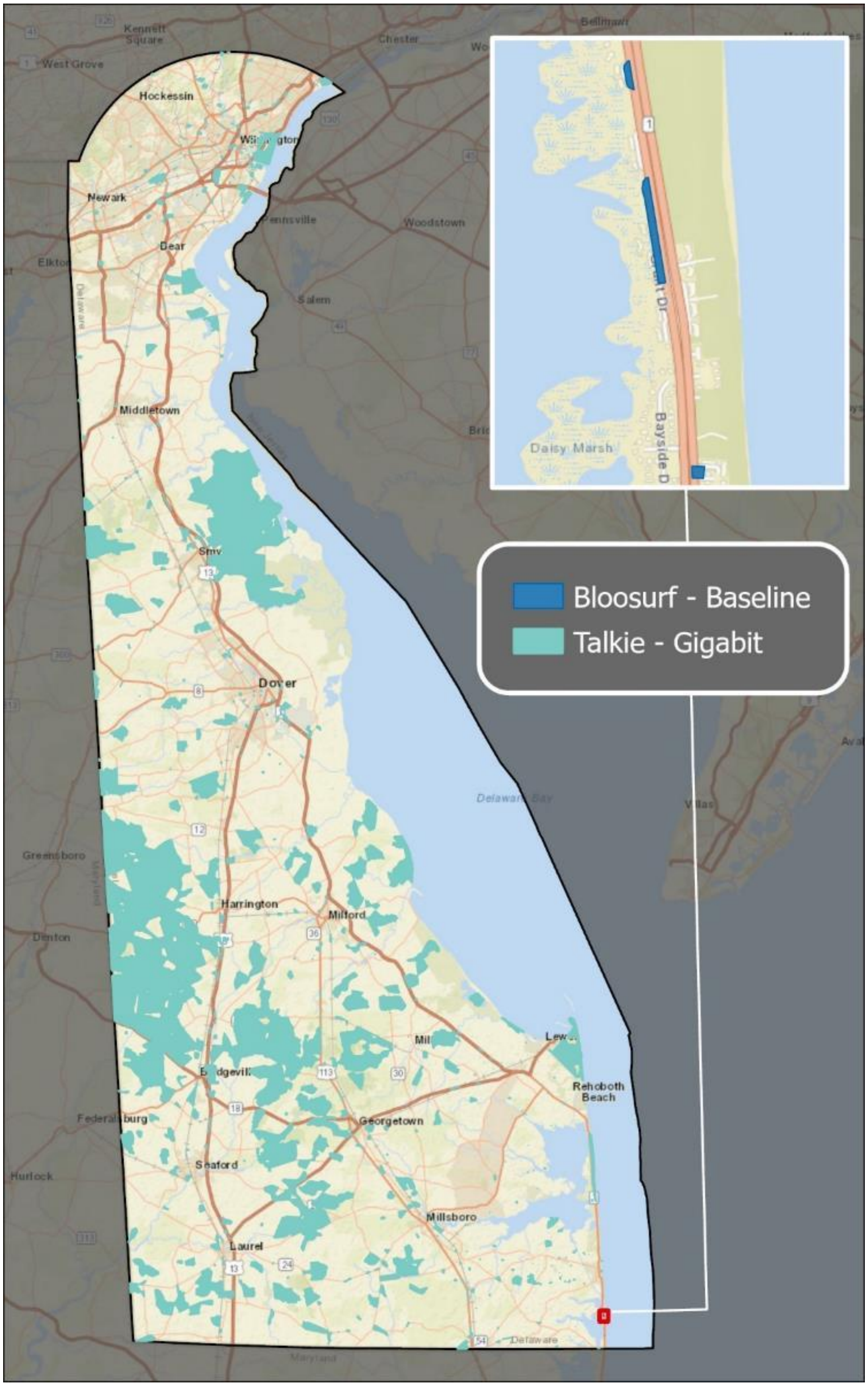
In each round of the auction, the total of support levels implied in all the bids is compared with the FCC's available budget. If the auctioned support exceeds the FCC's $16 billion budget, the auction continues. The round in which auctioned support is equal to or lower than the budget is called the "clearing round." For every area for which there is a lone bidder, winners are assigned locations accordingly. In census areas for which there are multiple bidders during the clearing round, the auction continues ("carries forward") into the next round, with one exception: The FCC acted to prevent a "race to the bottom" propelled by satellite providers such as Viasat and HughesNet. Using satellite technology that already covers all areas of the United States and therefore entails no additional costs for build-outs, Viasat and HughesNet could bid to the lowest support levels possible. Rather than allow the auction to continue for all bidders in all contested areas, the FCC assigned locations and supports to bidders who were lone bidders with the lowest weight in each census area.

## 9.3 Results in Delaware

In Delaware, Talkie bid aggressively in just about all areas and won them (Figure 136). Neither SpaceX nor fixed wireless providers bidding in the gigabit tier distorted bidding like they did in most other states.[34]

[34] For more details, see: Ziggy Rivkin-Fish, "FCC's Rural Digital Opportunity Fund Auction Was Supposed to Significantly Reduce America's Rural Broadband Gap," Benston Institute for Broadband & Society, December 21, 2020, https://www.benton.org/blog/fccs-rural-digital-opportunity-fund-auction-was-supposed-significantly-reduce-americas-rural (accessed December 2020).

**Figure 136: Delaware RDOF Results by Provider and Speed**



In fact, had SpaceX and the fixed wireless providers not participated, Talkie would still have won all the areas in the exact same rounds: it picked up 270 out of the 276 census areas it bid on in round 13 where it won by virtue of having the lowest weights (see the tables below).

**Table 30: RDOF Winners in Delaware by Locations Assigned**[35]

| Winning Bidder[36] | Number of Locations | Share of Total Locations | Census Areas | Average Winning Round | Average Price-Point Won | Support | Share of Total Support |
|---|---|---|---|---|---|---|---|
| Bloosurf | 8 | 0.1% | 1 | 15.0 | 50% | $108 | 0.0% |
| Talkie | 7,749 | 99.9% | 276 | 13.0 | 61% | $1,330,097 | 100.0% |
| *Total* | *7,757* | *100.0%* | *277* | *13.1* | *61%* | *$1,330,205* | *100.0%* |

**Table 31: Winner Technology and Speed Tier**

| Winning Bidder | Technology[37] | Speed Tier |
|---|---|---|
| Bloosurf | Fixed Wireless | 100/20 Mbps |
| Talkie | Fiber | 1 Gbps/500 Mbps |

The remaining six carried forward to further rounds of bidding since the Consortium also bid with zero weight (gigabit, low latency) in those census areas.

**Table 32: Bidders for Number of Census Areas in Selected Rounds**

| Bidder | Round 1 | Round 12 | Round 13 | Round 14 | Round 15 |
|---|---|---|---|---|---|
| **NRTC Phase I RDOF Consortium** | 6 | 6 | 6 | 6 | 5 |
| **BridgeMAXX** | 14 | 14 | 14 | 4 | 4 |
| **Bloosurf** | 134 | 134 | 134 | 7 | |
| **HughesNet** | 5 | 246 | | | |
| **Mediacom Cable** | 67 | 67 | 67 | | |
| **SpaceX** | 186 | 217 | 217 | 7 | |
| **Talkie** | 276 | 276 | 276 | 6 | 6 |
| **ViaSat** | 277 | 163 | | | |

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[35] Data on auction results from the FCC's auction public reporting dashboard at https://auctiondata.fcc.gov/ (accessed December 2020).

[36] Bidder names filed with the FCC in the short form (Form 175) often differed from database names, or common names used branded services. Where available, the common names were used. CCO Holdings, for example, is more commonly known as Charter or Spectrum. Short-form information is available at the FCC's auction application portal at https://auctionfiling.fcc.gov/form175/search175/index.htm.

[37] Information on technology deployed is derived from Form 175. Technology assignments were coded based on the available technologies listed by the bidders for the specific tiers and latencies they qualified for in the auction.

**Table 33: Locations in Densest Census Areas Bid on**

| Bidder | Round 14 | Round 15 |
|---|---|---|
| **NRTC Phase I RDOF Consortium** | 2,767 | 2,501 |
| **Talkie** | 2,767 | 2,767 |

**Table 34: Bidder Technologies and Bidding Weights**

| Bidder | Technology | Tier | Latency | Weight |
|---|---|---|---|---|
| **NRTC Phase I RDOF Consortium** | Fiber | Gigabit | Low | 0 |
| **BridgeMAXX** | Fixed Wireless | Above Baseline | Low | 20 |
| **Bloosurf** | Fixed Wireless | Baseline | Low | 35 |
| **HughesNet** | Geo Sat | Above Baseline/Baseline | High/Low | 60/35 |
| **Mediacom Cable** | Cable/Fixed Wireless | Above Baseline | Low | 20 |
| **SpaceX** | Leo Sat | Above Baseline | Low | 20 |
| **Talkie** | Fiber | Gigabit | Low | 0 |
| **ViaSat** | Geo Sat | Above Baseline | Low | 60 |

**Table 35: Bidder Locations Assigned by Round**

| Assigned Winner | Round 13 | Round 15 |
|---|---|---|
| Bloosurf | 0.0% | 0.1% |
| Talkie | 64.2% | 35.7% |
| **Total** | **64.2%** | **35.8%** |

**Table 36: Percentage of Assigned Addresses and Funding Allocated by Round in Delaware**

| Round | Addressable Locations | Share of Total Locations | Assigned Support | Share of Total Support |
|---|---|---|---|---|
| 13 | 4,982 | 64.2% | $933,101 | 70.1% |
| 14 | 0 | 0.0% | $0 | 0.0% |
| 15 | 2,775 | 35.8% | $397,104 | 29.9% |
| 16 | 0 | 0.0% | $0 | 0.0% |
| 17 | 0 | 0.0% | $0 | 0.0% |
| 18 | 0 | 0.0% | $0 | 0.0% |
| 19 | 0 | 0.0% | $0 | 0.0% |
| **Total** | **5,220,833** | **100.0%** | **$1,330,205** | **100.0%** |

Comparisons of the allocations for funding (Figure 137) and locations (Figure 138) in Delaware illustrate how early the auction wrapped up in Delaware compared to the rest of the U.S.: 70 percent of the funding allocated in Delaware and 64 percent of address locations were assigned in the clearing round with healthy level of support, and the remainder in round 15—at significantly higher level of support than the post clearing round average in the rest of the U.S.

**Figure 137: Funding Allocations in Delaware by Auction Round**

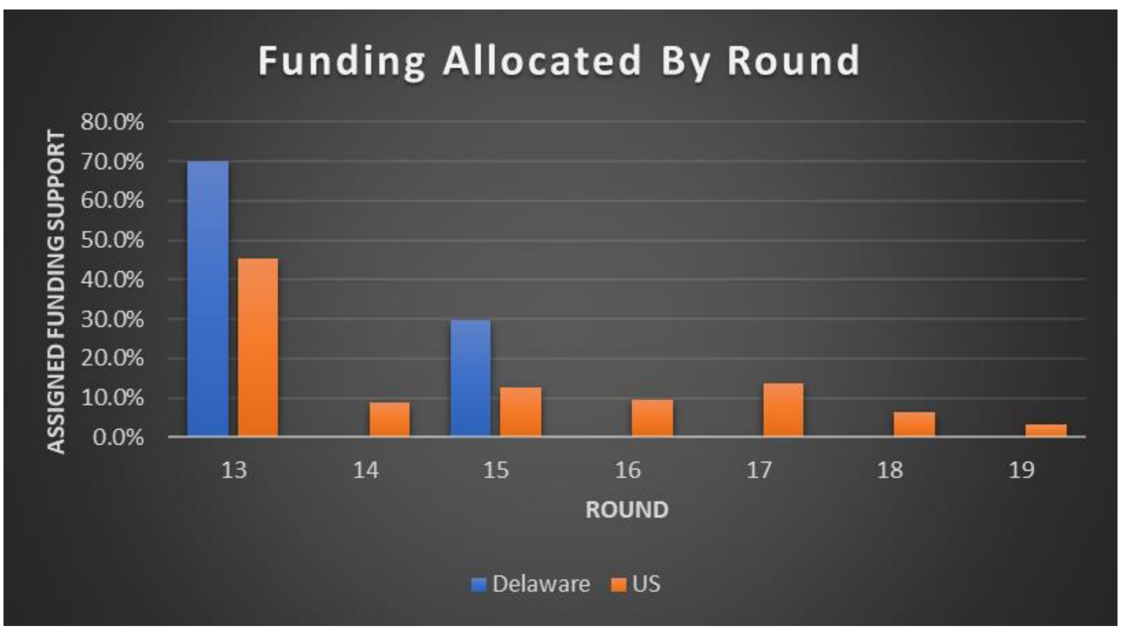
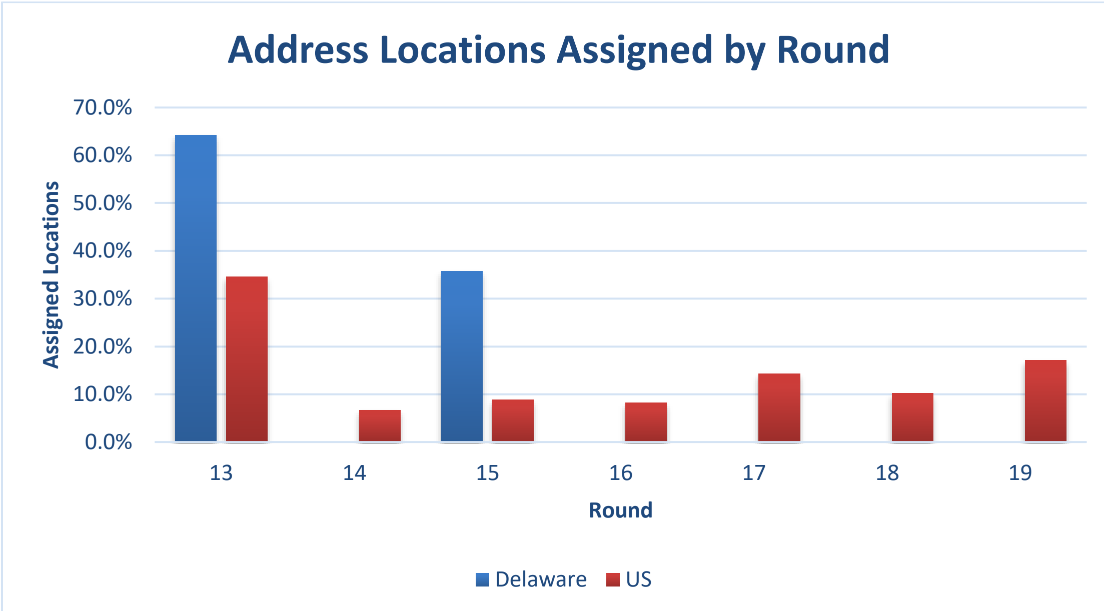


**Figure 138: Location Allocations in Delaware by Auction Round**




## 9.4 Talkie's RDOF success will require sustainability

The analysis so far indicates that the big winner, Talkie, came away with sustainable levels of support and fiber optic gigabit technology that would be highly beneficial to the State. In an ideal scenario, Talkie would not only provide fast long-term solutions for thousands of residents and business in the RDOF areas, but also gain a solid foothold from which it could expand further into unserved areas not included in RDOF and introduce welcome competition in served areas.

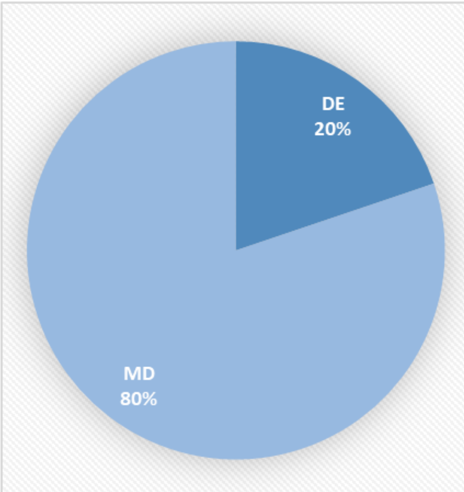
But this optimistic scenario is complicated by the fact that Talkie is a small provider with operations in only a single county in Maryland. And it is taking on capital investment commitments in the many millions of dollars, not just in Delaware, but also—and more significantly—in Maryland. Table 37 illustrate the commitments Talkie has taken on in Maryland as compared with Delaware:

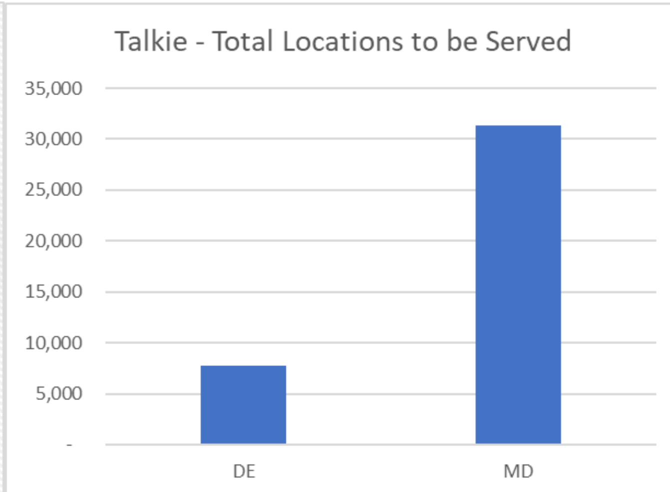
**Table 37: Talkie's Total Commitments**

| State | 10 Year Assigned Support | Address Locations Assigned |
|---|---|---|
| Delaware | $13,300,968 | 7,749 |
| Maryland | $43,764,042 | 31,349 |
| **Total** | **$57,065,010** | **39,098** |

Talkie is required to construct to substantially more locations in Maryland than in Delaware—five times as many.

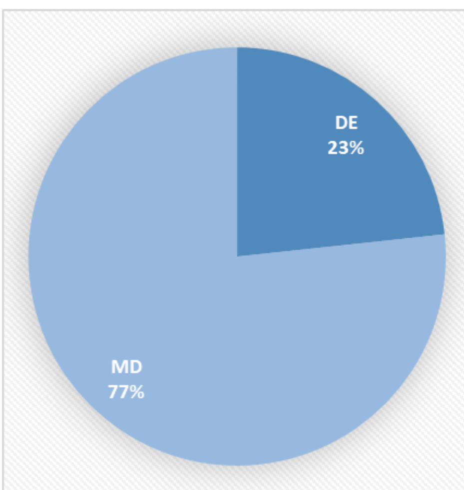
**Figure 139: Talkie's Build-out Commitments**

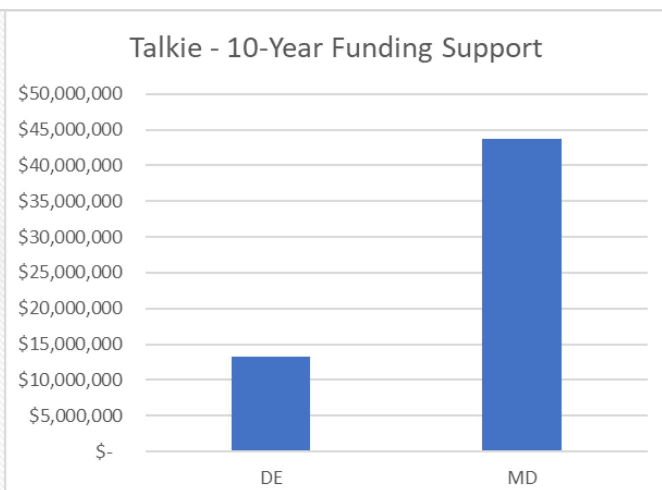



But the overall support it can expect to receive is lower in Maryland. This is due to heavy competition with a number of local fiber providers in Maryland that drove down Talkie support dramatically in select locations—with assignments only finalizing in the very last round of the auction with single digit support.

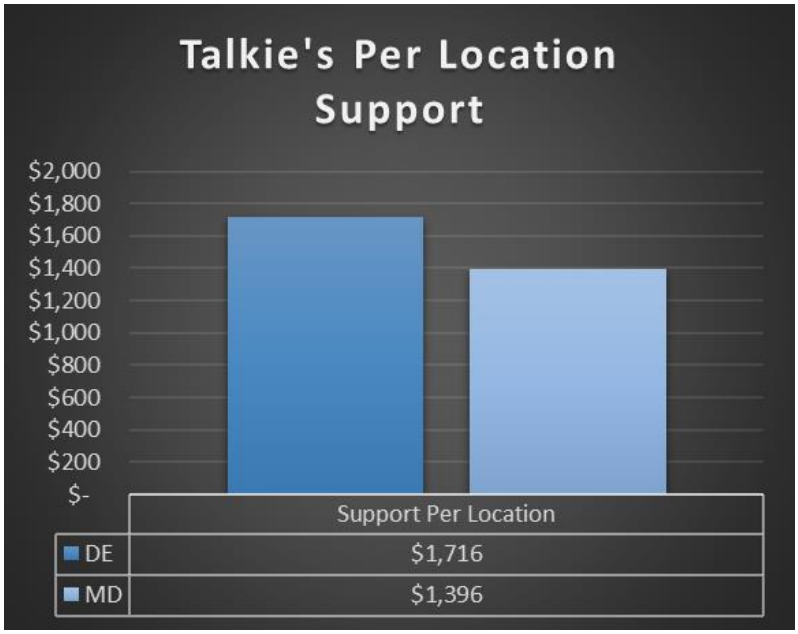
**Figure 140: Talkie's Anticipated Support Over 10 Years**




These are worrying indications. The challenge can be illustrated in support per location Talkie can anticipate:

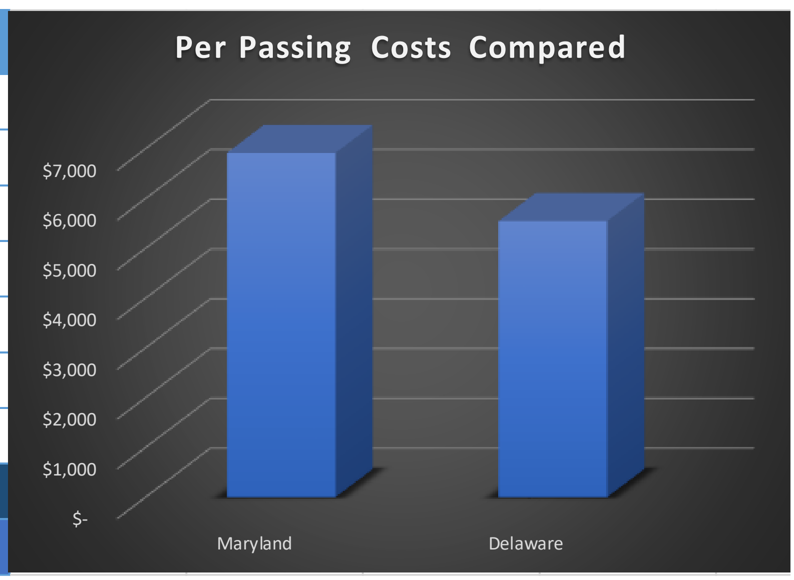
**Figure 141: Lower Support for Buildout in Maryland**




But Talkie cannot count on lower construction costs in Maryland to meet its buildout commitments. CTC conducted studies in several Maryland jurisdictions, and the build out costs Talkie can expect in Maryland are in fact significantly higher:

**Figure 142: Per Passing Costs**

| Jurisdiction | Outside Plant Cost per Passing |
|---|---|
| Charles County | $ 7,020 |
| Somerset County | $ 7,700 |
| Queen Anne's County | $ 8,250 |
| Worcester County | $ 6,500 |
| Frederick County | $ 5,250 |
| Garrett County | $ 7,270 |
| Carroll County | $ 6,450 |
| **Maryland** | **$ 6,920** |
| **Delaware** | **$ 5,550** |




Should Talkie be unable to raise sufficient capital to produce an acceptable letter of credit, which is due to the FCC on June 6th, these RDOF areas may be re-released for eligibility to future funding opportunities. However, it is unclear what criteria the FCC will apply to determine whether Talkie can deliver on its projected capital commitments. The letter of credit requirement extends only to required capital for the first year, after which Talkie has to produce an updated letter every year. And Talkie does not have to meet buildout milestones until the end of the third year, after which it must have built out to 40 percent of locations in the State. In other words, Delaware may be in limbo for many years without ability to secure federal grants for unserved residents, while at the same time not knowing whether this service will materialize or not.

## 9.5 Engage with Talkie and other providers to understand and prepare for RDOF outcome

Delaware should certainly reach out to Talkie and discuss its plans, in terms of financials and buildout milestones. This would require an understanding not just of how Talkie would raise sufficient capital and estimates of the capital required, but also how it plans to scale up construction and operations. Talkie may have been able to count on lower construction costs than competitors as it can rely on its own construction crews and heavy equipment and can avoid costly contracting and equipment lease. But if Talkie must ramp up with subcontractors, its per passing costs will increase with concomitant higher capital requirements.

Should the FCC determine that Talkie's letter of credit is insufficient and decide not to award Talkie the assigned funding, the State should engage in talks with other providers. The following maps illustrate the Round 12 status—just prior to the clearing round in which Talkie secured funding for most of the State.

**Figure 143: RDOF Round 12 Results (State-Level Overview)**

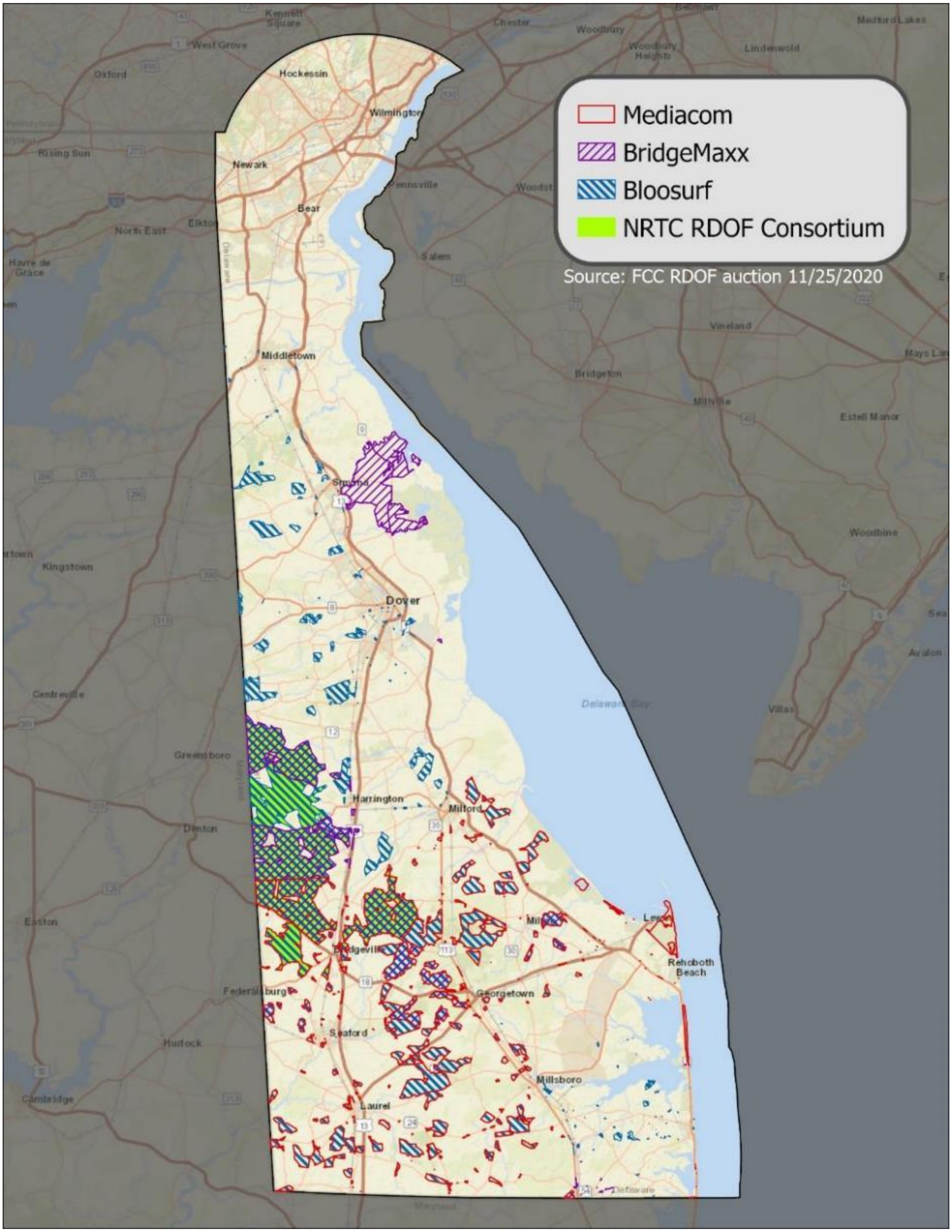
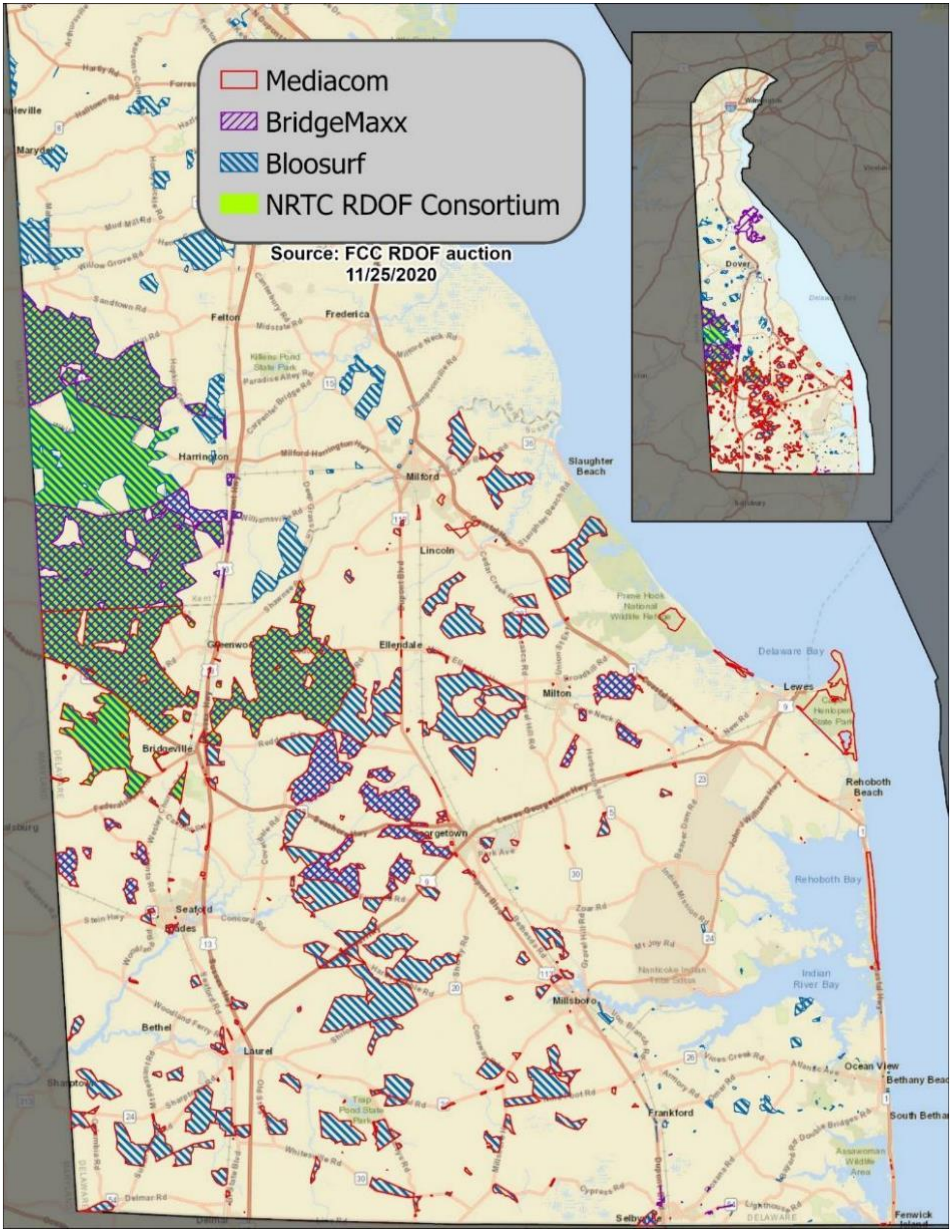


**Figure 144: RDOF Round 12 Results (Higher-Resolution)**



In that scenario, the State should reach out to the NRTC Phase I RDOF Consortium member that bid against Talkie. They could be a desirable partner since they proposed gigabit fiber just like Talkie, and their interest was relatively strong giving up only in round 15. We expect the FCC to announce the reassignments to its constituent members that consortium bidders were required to complete by December 22 in the near future. As the map in Figure 143 shows, the Consortium provider is focused on a specific service area and is unlikely to be interested in expanding much beyond it.

Another interesting provider is Mediacom, which, with sufficient support would be interested in covering a larger area of the State. The bidding areas as shown in the map illustrates the company's interest in bidding in 67 of the 277 available census areas. While they dropped out in the clearing round, this was not likely due to lack of interest. Rather, they lost by default since their weight was higher than Talkie's. If the State chooses to reach out to Mediacom, it should discuss how exactly Mediacom plans to deploy their mixture of cable and wireless to ensure their 100/20 commitments do not overly rely on problematic fixed wireless infrastructure.

If the State is open to fixed wireless, it can reach out to both BridgeMAXX and Bloosurf. BridgeMAXX bid in areas that are proximate to its current service area in Maryland (see Figure 145). While the area is specific, it bid in the 100/20 tier. Whether it can actually deliver requires a technical assessment, but could be more desirable than Bloosurf which bid extensively (Figure 143), but with a slower 50/5 solution. At the same, Bloosurf may simply have been more realistic about what speeds can be achieved without extensive fiber infrastructure for backhaul. Figure 146 illustrates the population density of the RDOF areas.

**Figure 145: RDOF Areas in Proximity to Existing Service Providers**

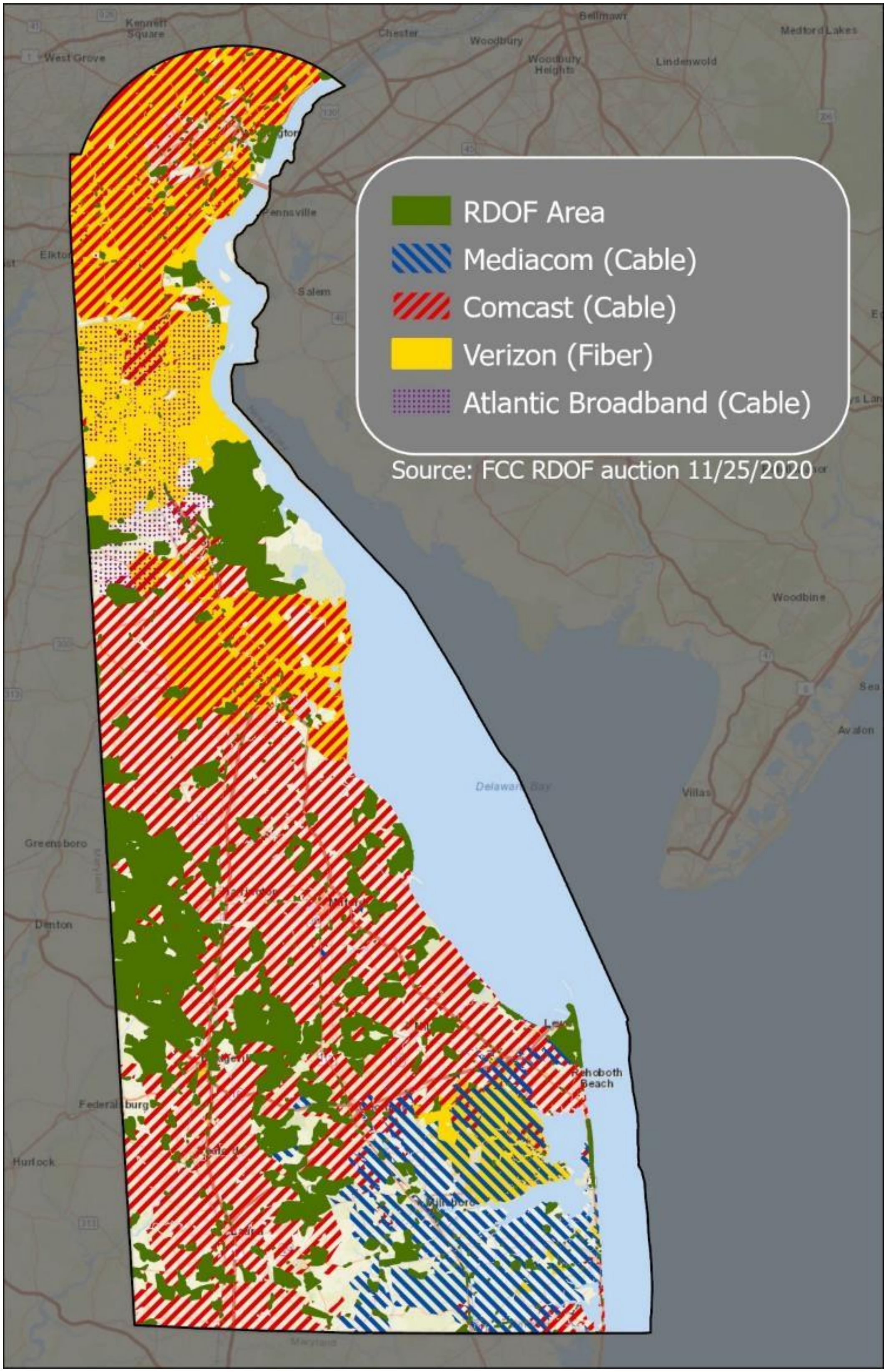
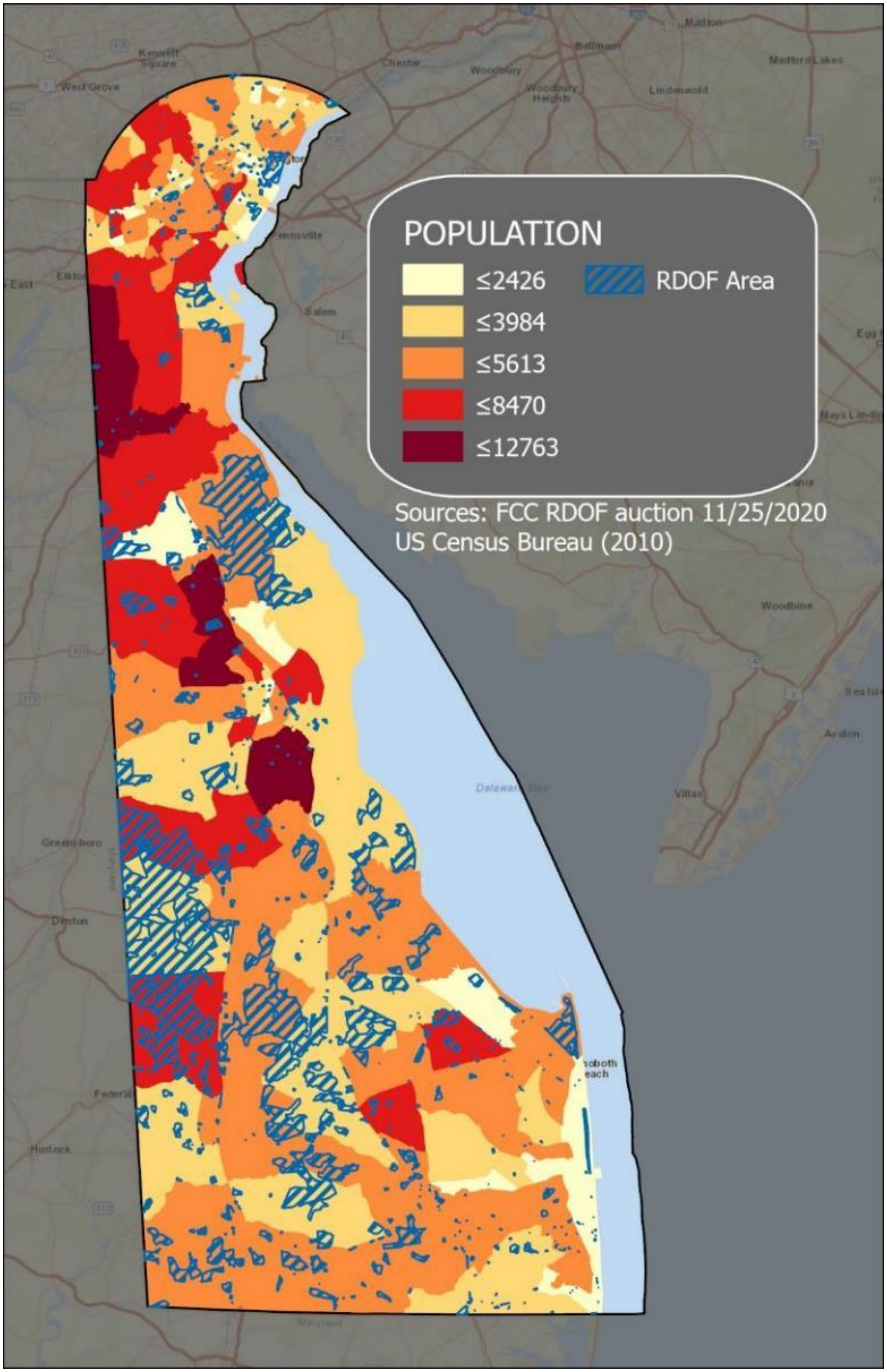


**Figure 146: RDOF Area by Population Density**



# 10 Additional federal grant opportunities are likely to appear

In addition to RDOF subsidies, we anticipate a range of federal funding opportunities for broadband in 2021 and beyond. The following sections offer insight into the just-passed appropriations package and other existing programs.

## 10.1 Broadband funding in 2021 appropriations package

The appropriations bill[38] signed into law on December 27, 2020, includes several funding streams for broadband, including a subsidy program to offset the cost of monthly internet service for low-income households, administered by the FCC, and three distinct grant programs to build new broadband infrastructure and purchase services, managed by the National Telecommunications and Information Administration (NTIA).

While the funds for the programs and the initial statutory requirements were included in the legislation, many program details have not yet been determined, because the federal agencies that will house the programs will develop implementation criteria over the first weeks of 2021. The initial statutory program structures and eligibility requirements are described below.

### 10.1.1 Emergency Broadband Benefit Program

The legislation establishes a $3.2 billion Emergency Broadband Benefit Program,[39] housed within the FCC, to provide a monthly discount to eligible households for broadband service. Service providers must elect to participate in the program, and do not need to be considered eligible telecommunications carriers (ETC) by the FCC. While ETCs are automatically eligible to participate in the program, providers that are not ETCs will receive an expedited approval process for participation from the FCC.

Participating providers may verify household eligibility in one of three ways:

1. Based on the National Verifier or the National Lifeline Accountability Database
2. Based on an alternative method that is deemed sufficient by the FCC
3. Based on a school's determination of participation in the National School Lunch Program or the School Breakfast Program

Eligible households receive a monthly discount on broadband service of up to $50 (or $75 for households on Tribal lands). If the monthly cost to the household exceeds $50, the household is responsible for the difference. Providers cannot charge households for the discount amount, nor

[38] "Consolidated Appropriations Act, 2021," December 21, 2020, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed December 2020).

[39] [39] "Consolidated Appropriations Act, 2021," December 21, 2020, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed December 2020).

can they require a household to pay an early termination fee if the household entered into a contract in order to receive the service. Additionally, households cannot be subject to a waiting period to receive service based on having previously received service from the provider.

To enact the benefit, a household must call its provider and inquire about eligibility. If the household is eligible, the participating provider applies the discount to the household's bill, and then requests to be reimbursed by the FCC. Providers may also be reimbursed up to $100 for providing one connected device to a household, if the provider charges the household between $10 and $50 for the device.

### 10.1.2 Broadband Infrastructure Program

The Broadband Infrastructure Program[40] will fund $300 million in grants from NTIA for rural broadband buildout to provide fixed service that delivers at least 25/3 Mbps, with priority given to projects that deliver 100/20 Mbps. While NTIA has yet to develop programmatic requirements, preliminary guidelines for the program were outlined in the appropriations bill.

Grants will be available for eligible partnerships, which include a service provider and a state or a political subdivision of a state. Service providers do not need to be designated as an ETC. Eligible service areas are census blocks in which one or more households or businesses does not have broadband service, as determined by the FCC's Broadband Map.

Priority for awards will be given to the following projects, in decreasing order of priority:

- Projects that provide service to the greatest number of households in an eligible service area
- Projects that provide service in an eligible service area that is entirely within an area that is not either a county, city, or town with a population greater than 50,000, or an urbanized area contiguous and adjacent to such an area
- Projects that are the most cost-effective, with priority given to areas that are the most rural
- Projects designed to provide at least 100/20 Mbps service

NTIA will open applications in early 2021, and there will be a 90-day application window. NTIA will make funding decisions within 90 days of application receipt, and applicants will be given a chance to address any application deficiencies before an application is denied. Once an

[40] "Consolidated Appropriations Act, 2021," December 21, 2020, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed December 2020).

application is approved, funds will be made available to the awardee within 14 days, and the awardee will then have a year to use the funds.

### 10.1.3 Connecting Minority Communities Pilot Program

The Connecting Minority Communities Pilot Program[41] will provide $285 million in grant funding to eligible recipients to purchase broadband or eligible equipment, or to hire and train IT personnel. The program will be administered by NTIA.

This nascent program represents an opportunity for Delaware State University to pursue funding to support instruction and remote learning capabilities, with priority placed on serving students that meet certain criteria to indicate need.

Entities eligible to receive grants through this program include:

- Historically Black colleges and universities (HBCUs)
- Tribal colleges and universities (TCUs)
- Hispanic-serving institutions (HSIs)
- Other minority serving institutions (MSIs)
    - Alaska Native-serving institution (ANSI)
    - Native Hawaiian-serving institution (NHSI)
    - Predominantly Black institutions (PBI)
    - Asian American and Native American Pacific Islander-serving institution (AANAPISI)
    - Native American-serving, nontribal institution (NASNTI)
- A consortium led by an HBCU, TCUs, HSIs or MSI, with minority business enterprises and/or nonprofit organizations in the anchor community

For higher education recipients, grants are intended to support instruction and learning, including remote learning. For minority business enterprises and nonprofits, grants are intended to support the operation of the organization. Educational institutions that receive a grant to support student connectivity must prioritize students that:

- Are eligible to receive the Pell Grant
- Receive need-based financial aid from the federal government, state, or the institution
- Qualify for the FCC's Lifeline program
- Earn less than 150% of the federal poverty line

[41] "Consolidated Appropriations Act, 2021," December 21, 2020, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed December 2020).

- Have been approved to receive unemployment insurance since March 1, 2020

Eligible equipment includes Wi-Fi hotspots; modem, routers, or combined modem/routers; laptop, tablet, or similar internet-connected device; and any other equipment used to provide broadband.

### 10.1.4 Tribal Broadband Connectivity Program

The Tribal Broadband Connectivity Program,[42] to be managed by NTIA, is the most significant infrastructure opportunity funded through the appropriations package, with $1 billion for grants to build broadband infrastructure on tribal lands and expand access to remote learning, telework, and telehealth resources. However, because Delaware is not home to any federally recognized Tribes, nor to a tribal college or university, this program is unlikely to play a meaningful role in the State's broadband strategy. Entities eligible for awards through this program include Tribal governments, Tribal Colleges and Universities, Tribal organizations, and Native Corporations.

## 10.2 USDA's ReConnect program represents a unique rural funding mechanism

The ReConnect program is a robust source of rural broadband funding. Six hundred million dollars were allocated to the initial pilot of the program in 2019, and $550 million (with an added $100 million as part of the CARES Covid-19 response package) was made available in 2020. We anticipate the next funding round will open at the end of the first quarter of 2021, with an application deadline 60 to 90 days later.

The program awards loans, grants, or a combination of the two for last-mile connections in rural areas—with priority given to private-sector applications and public-private partnerships. It is overseen by the Rural Utilities Service (RUS). The most recent round of grant applications opened on January 31, 2020, and closed April 16, 2020.

Congress created a significant barrier to ReConnect funding for the State when it wrote the legislation: It made ineligible any areas for which another grantee or loan recipient has received a previous broadband award. This eligibility is also relevant for the State's consideration of appropriate partners for ReConnect applications: A fixed wireless provider receiving an award from this program would be protected from any other subsequent applicant for the entire originally funded service area for up to 10 years.

[42] "Consolidated Appropriations Act, 2021," December 21, 2020, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed December 2020).

**Figure 147: ReConnect Eligibility –CAF II and RDOF Auctions Awarded Areas (All)**

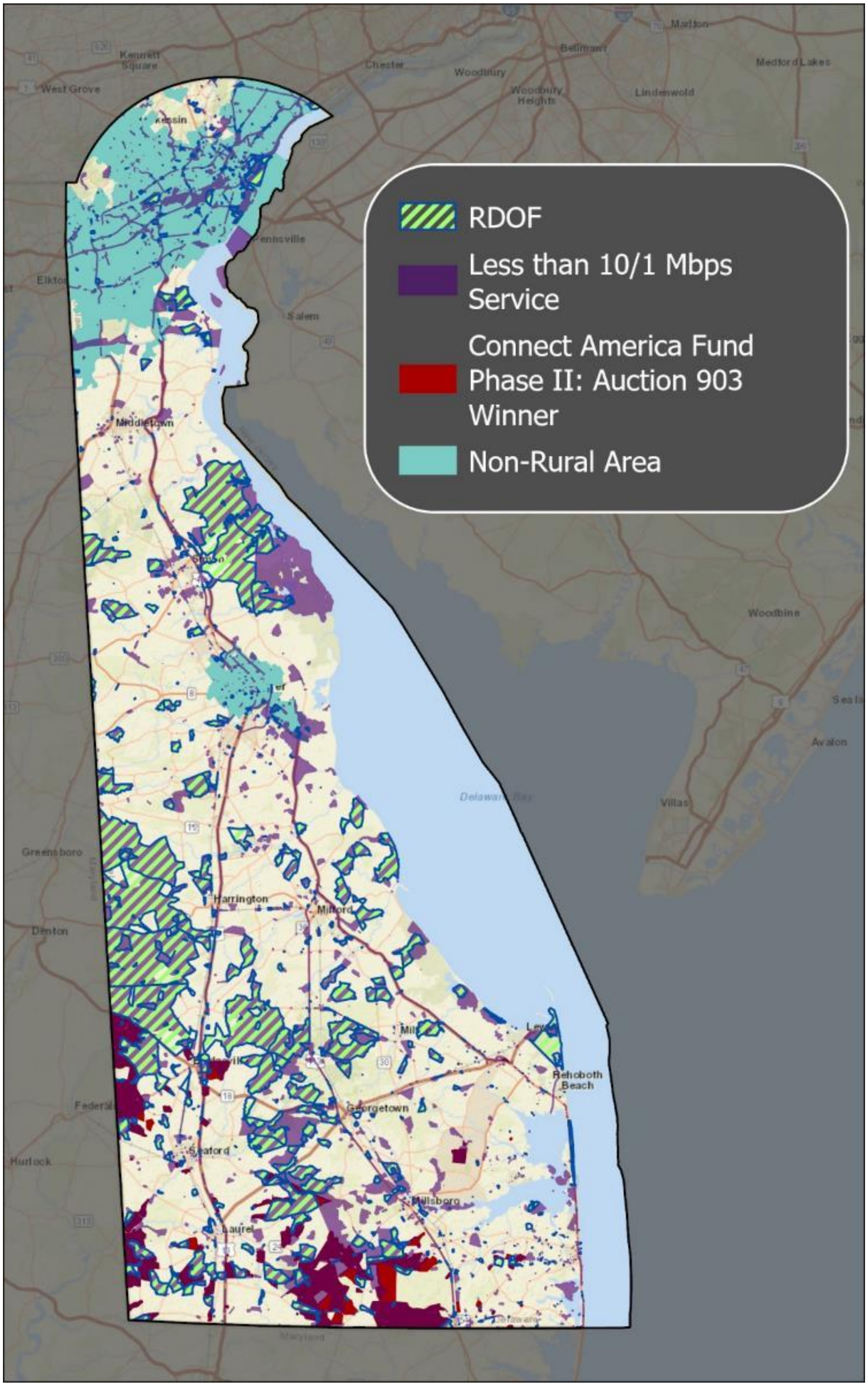
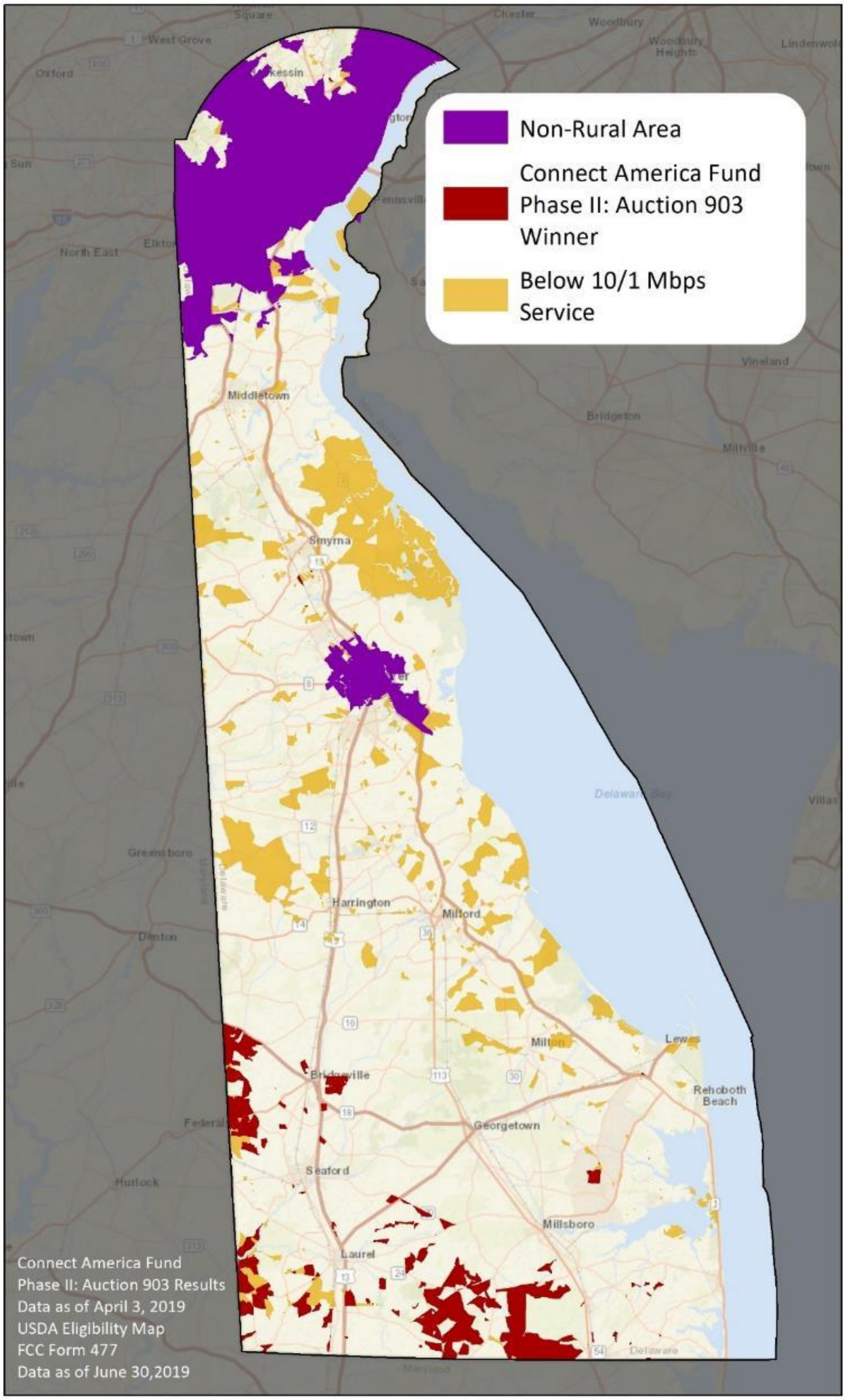


**Figure 148: ReConnect Eligibility – CAF II Awarded Areas, Non-Rural Areas, and Unserved Areas (10/1)**



Our models for fixed wireless, however, have not found a way to serve all unserved premises in a claimed service area, and the State would therefore risk having no remedy for those unserved premises for the entire, long protection period. And, as discussed, the actual network performance within a fixed wireless service area varies widely from customer to customer. We therefore recommend the State prioritize applications to ReConnect (and/or NTIA, see below) for wireline solutions, or write in robust remedies as conditions of support with the partner to manage risks.

The recent round of the ReConnect program will comprise three separate funding categories: 100 percent grants (covering up to 75 percent of eligible project costs, with a 25 percent match), 50 percent grants with a 50 percent loan or other form of match, and 100 percent loans. Funds will go to rural areas where 90 percent or more of the households lack access to broadband speeds of at least 10 Mbps download and 1 Mbps upload. (In Round 1, 100 percent of the households in the PFSA had to lack access to 10/1 Mbps broadband for 100 percent grant awards.) Applicants had to propose networks capable of providing access to every premises in the PFSA at minimum speeds of 25 Mbps downstream and 3 Mbps upstream.

Matching funds are a point of distinction. Awarded applicants for 100 percent grant awards will need to provide matching funds equivalent to 25 percent of the project's total cost—and that matching contribution must be expended first, followed by grant funds. For 50 percent grants with a 50 percent loan or other form of match, applicants could propose a cash alternative to the loan at the time of application. (For an awarded project in this scenario, all cash proposed must be expended first, followed by loan funds and then by grant funds.)

Generally, we anticipate that USDA will continue to prioritize private-sector applications and public-private partnerships, so it will be important for local governments to build a public-private partnership strategy for future rounds of this program. RUS will consider public networks that lack extensive experience to be startups and may disfavor their applications. Should the State decide to take the lead, it should partner only with entities with extensive experience as an ISP to compete for these funds. Any experienced ISP, whether public or private, will require the strong collaboration and support of its local (and state) government to present a compelling case for funding.

Applications to this program will require a detailed business plan and pro forma. RUS will grant application review points based on those plans, as well as many other factors. The rurality of the PFSA can earn almost 25 points alone. RUS will also award points to applications proposing to build networks capable of at least 100/100 Mbps. Additional points can be scored if the proposed area includes a healthcare center, education facility, or critical community facility. Furthermore, points will be awarded for projects in states with an updated broadband plan in the past five years.

We anticipate RUS will continue to make grant/loan combinations in the $3 million to $10 million range. This is quite a bit more than RUS's Community Connect grants—and, because the program's funding is considerably larger in total dollars, we anticipate that ReConnect will make more awards. Further, ReConnect does not have the low-income requirements of Community Connect, making it a more flexible program.

## 10.3 USDA's Community Connect program represents another, more modest opportunity

Community Connect is another program to which the State could apply with a partner. The USDA administers this modestly sized grant program for local and tribal governments; it targets broadband deployment to unserved (defined as speeds less than 10 Mbps download and 1 Mbps upload), low-income rural communities with fewer than 20,000 residents in a contiguous PFSA (*and* not adjacent to cities with more than 50,000 residents). To prepare the most competitive Community Connect grant application possible, we would recommend the State target the lowest-income portions of its unserved areas. The eligible areas for funding are therefore identical to the PFSAs developed for the ReConnect grant, but with an additional low-income requirement.

Grantees must ultimately offer service at the broadband grant speed (defined as 25 Mbps download, 3 Mbps upload) to *all* households and community institutions in the PFSA, with free service for at least two years to a community center.

The application process is rigorous and competitive (i.e., only about 10 percent of applicants receive an award) and once awarded, program requirements can be demanding (e.g., requiring last-mile service be available for all households in the service area). The program has been funded consistently since it was introduced in 2002 and represents an important opportunity for qualifying communities. The appropriations package that was signed by President Trump in December 2020 appropriated $35 million for the Community Connect program, to remain available until expended.[43]

Eligible applicants include local or state units of government, incorporated organizations, Indian tribes or tribal organizations, cooperatives, private corporations, and limited-liability companies organized on a for-profit or not-for-profit basis. Individuals or partnerships are not eligible. Any public or private applicant must have the legal capacity and authority to own and operate the

[43] Consolidated Appropriations Act, 2021, page 54, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed December 2020).

proposed broadband facilities, to enter into contracts, and to otherwise comply with applicable federal statutes and regulations. Thus, awards cannot be granted to a local government entity that does not want to own or operate the broadband service.

Once awarded, projects must offer last-mile service at the broadband grant speeds (25 Mbps download and 3 Mbps upload) to *all* businesses, residents, and community facilities in the PFSA, with free service provided to all critical facilities,[44] and at least one community center (with weekend hours and two to 10 public computer access points) for at least two years from the grant award. Grants can be used to offset the cost of providing such service and to lease spectrum, towers, and buildings as part of the project design.[45] The lesser of 10 percent of the grant or $150,000 can be used to construct, acquire, or expand an existing community center.[46]

## 10.4 Department of Commerce economic development grants assist distressed communities

The Department of Commerce's Economic Development Administration (EDA) oversees the Economic Development Assistance program, which has delivered funds to distressed communities for many years. Public broadband projects in economically distressed communities are eligible for funding under the Public Works and Economic Adjustment Assistance (PWEAA) programs—which do not require that an area is unserved, but do require that jobs be created or saved as a direct result of the proposed project.

While broadband funding to date through the EDA appears to be modest, both construction and technical assistance are clearly eligible. EDA's materials on Public Works funding explicitly mention broadband and EDA has already funded several broadband projects.[47] Moreover, applicants can apply existing federal funds toward the cost-share, which allows them to leverage available resources. Given this, we recommend the State consider this opportunity. Additionally, the program does not require proof of lack of service or poor service. Instead, a proposed project must demonstrate that it will positively affect the economic prospects of the area; generally, in the form of addition of or saving of jobs. A local community economic development plan that highlights a need for better broadband will be an essential first requirement.

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[44] Critical community facilities include public schools, public libraries, public medical clinics, public hospitals, community colleges, public universities, law enforcement, and fire and ambulance stations.

[45] Leasing costs can only be covered for three years.

[46] Note that additional funds can be used to provide the computer access points and their connection to the network. Applicants may use their own resources to cover costs exceeding this limit. The program historically required provision of at least 10 computer access points in a public community center; however, now requires only two such access points—with a *maximum* of 10 computers.

[47] "Broadband Funding Guide," U.S. Department of Commerce EDA, December 12, 2018, https://broadbandusa.ntia.doc.gov/sites/default/files/funding_eda_01_0.pdf (accessed December 2019).

Eligible applicants include city, township, county, or special district governments; state governments; federally recognized tribal governments; nonprofits, aside from institutions of higher education; private institutions of higher education; and public and state-controlled institutions of higher education.

The community must qualify as distressed to be eligible. Criteria for eligibility is established by providing "third-party data that clearly indicate that the region is subject to one (or more) of the following economic distress criteria: an unemployment rate that is, for the most recent 24-month period for which data are available, at least one percentage point greater than the national average unemployment rate; per capita income that is, for the most recent period for which data are available, 80 percent or less of the national average per capita income; or a "Special Need," as determined by EDA." Projects located in Qualified Opportunity Zones meet this special need eligibility criteria.

The program's 2020 funding opportunity included a determination that the economic impact of the coronavirus pandemic constituted a "special need" eligibility for the whole of the country. While it is possible that future appropriations will extend this sweeping eligibility, funding is competitive enough that applicants still need to demonstrate significant economic distress to receive an award. EDA has informed us that they will honor the 80/20 split on Covid-19-related need justifications, rather than the traditional 50/50 split on grant funding and matching funds.

The PWEAA Notice of Funding Opportunity (NOFO) emphasizes the importance of consulting with the appropriate regional EDA contacts.[48] Regional staff is available to review project proposals, assess proposed cost shares, and preview all application materials. Though optional, we believe such consultation to be essential if the State were to consider applying.[49]

[48] "Notice of Funding Opportunity – FY 2020 EDA Public Works and Economic Adjustment Assistance Programs," https://www.grants.gov/web/grants/view-opportunity.html?oppId=321695 (accessed December 2019).
[49] EDA regional contacts available online at: https://www.eda.gov/contact/ (accessed November 2019).

# 11 Recommendations

Based on our data collection and analysis, we recommend the State consider the following strategic and tactical steps toward achieving its broadband goals. From a prioritization standpoint, we recommend the State support wired infrastructure expansion, with a particular focus on edge-out of existing cable infrastructure (given the value of that approach on a per-premises basis), as well as fixed wireless expansion. In addition, we recommend the State explore the continuation or expansion of subsidy programs.

## 11.1 Support

### 11.1.1 Support residents and ISPs to maximize federal Emergency Broadband Benefit subsidies and minimize the burdens of participation

The Connect Delaware program has done an exemplary job of connecting students across the State. The impending launch of the FCC's $3.2 billion Emergency Broadband Benefit program (described in detail in Section 10.1) presents both an important opportunity and a series of potential obstacles to be overcome. The State can play an important role in enabling residents and ISPs to maximize that federal funding for shared benefit.

The FCC's program, as minimally defined in the appropriations bill,[50] is intended to subsidize broadband service and equipment for those adversely impacted by the pandemic and those who qualify as low-income.

We do not yet know what guidelines and requirements the FCC will enact—but we believe there are areas of concern in the statute depending on how the FCC structures the program. Most notably, we are concerned there could be a significant burden on families to prove their eligibility and ensure their subsidy is appropriately applied. A family may, for instance, need to call their provider to ask for service and determine how to apply the subsidy. This is not an insignificant burden for the families this subsidy is intended to help, nor is the potential financial risk to those families (i.e., that they might be responsible for charges if the subsidy is not accurately applied) a minor point.

Accordingly, we encourage the State to take a number of steps now to alleviate these barriers. Specifically, by building on the successful model crated by Connect Delaware to date—and adding a call center and other outreach—the State could potentially reduce barriers and pain points for many Delaware families.

[50] The FCC will invite multiple rounds of comments over the next 60 days as it develops guidance and stands up the program—no later than the end of February. We encourage the State to participate in the FCC's comments process.

**Public Outreach Program**: First, we recommend the State seek to maximize the participation of Delaware families in this new FCC program—and the amount of federal subsidy funds coming to residents. The State can help families understand and navigate the process by creating a social media campaign, mailing letters, and launching a call center (for both making calls and fielding residents' questions). The call center might even connect families to ISPs to facilitate their enrollment. This will require coordination with the FCC to understand the criteria the FCC will apply for determining the broader eligibility criteria in the federal subsidy program, and to communicate those criteria and any documentation requirements to eligible families.

**ISP/FCC Coordination Program:** A second pain point the State might be able to alleviate is the burden on ISPs, which will have to verify families' eligibility under the FCC rules. For big ISPs that is a relatively easy chore; they have access to the federal Lifeline verifier, as well as their own low-income programs. But for small ISPs, that could be a potentially insurmountable task. The new federal statute suggests that, to verify a resident's participation in the National School Lunch Program (and thus eligibility for the new subsidy), an ISP can call schools. Think of the burden on small ISPs (not to mention schools). The State could play a role here, for the benefit of its ISPs and residents. The State could develop materials and call center support to help ISPs and residents understand and navigate the program, ensure ISPs get qualified by FCC to participate, and then to determine that families are eligible. This approach would take some of the burden off ISPs with an eye toward benefiting small Delaware ISPs like Bloosurf, BridgeMAXX, and WhyFly.

**Bridge Program:** A third potential pain point for participation in the FCC program could be, based on our analysis, the delay in the availability of the subsidy. The president signed the bill in late December, but the FCC has 60 days from then to get the program up and running. Two months is a long time for many families to wait to enroll. It is reasonable to assume the FCC will make the program's impact retroactive—so, for example, an ISP can bill the FCC for the January and February subsidy amounts once the program launches in March. But for a low-income family or a recently unemployed person, it would be risky to sign up for service without knowing for sure the subsidy will apply. Such a bridge program could also take on expanding eligibility criteria to match those in the appropriations bill language.

We thus recommend the State establish a bridge program for residents and ISPs. The State could enter into contracts with ISPs based on the very successful Connect Delaware program (and expand to other willing companies, as well). The State would pay for residents' service for January and February. The contract would require the ISPs to become qualified for the FCC program if they are not already qualified. (ETCs are already qualified.) Then in March, the companies would be required to shift their invoicing to the FCC to the greatest extent possible, including applying for retroactive payment to reimburse the State for January and February payments, if possible.

**Advocacy Program:** The final step we recommend the State take relates to language in the statute on who qualifies for the program. If a resident already participates in the National School Lunch Program or Medicaid they will be automatically qualified. But there is also language that anyone adversely impacted by the pandemic will qualify; that is not a clear, bright-line qualification in the way that National School Lunch Program participation is. This creates a challenge for families, who likely will not participate if they cannot be sure the FCC will approve their eligibility.

To alleviate this pain point, the State could take an active step now to define what eligibility requires in Delaware, then advocate to the FCC that if the State determines who should qualify, and verifies that eligibility, the FCC should accept the State's efforts. Stated otherwise, if the State says a family qualifies, that should be enough for the FCC. There should not be any more required steps for residents or ISPs. We recommend the State make that comment to the FCC in the upcoming comment period.

### 11.1.2 Provide technical assistance to position Delaware competitively for federal funding, including from NTIA and USDA

As discussed in Section 10.1, the Consolidated Appropriations Act allocated $300 million to NTIA for broadband. NTIA will stand up the program over the next two months. As with ReConnect, we recommend Delaware collaborate with counties and ISPs to position the State competitively to receive federal funds, including by providing applicants technical assistance, letters of support, and so on.

### 11.1.3 Evaluate the impact of the Connect Delaware subsidy program and consider continuing it if successful

The State should evaluate the Connect Delaware subsidy program's impact in terms of the number of students that used services provided through the program to connect to the internet. This evaluation could also be augmented by an analysis of increased participation in distance learning.

At the time of writing, the total number of students connected to the internet via services provided by Connect Delaware was still unknown. While 25,789 connections had been requested for students, school districts and charter schools are still distributing hotspots and vouchers for fixed service. As part of the distribution process, districts and charters are also noting if they have extra hotspots and vouchers, or if they have eligible students that need service that were not included in the first request. DTI currently is capturing this information to facilitate the redistribution of excess hotspots or vouchers, or the placement of additional orders, if possible. Once the total number of distributed services is determined, the State should collect information from participating internet service providers to determine the number of students using service provided by Connect Delaware.

Additionally, the State should work with DOE, school districts, and charter schools to capture any changes in student participation in distance learning. Because access to the internet is not the only barrier to distance learning, it would be difficult to draw a direct causal relationship between Connect Delaware and participation in remote education. However, noting trends in participation and collecting qualitative data from educators about the effect of the program on remote education could augment an understanding of effectiveness.

If the State determines that the Connect Delaware subsidy program was successful, it could consider continuing the program beyond the scope of the CARES Act, as a means for students in need to receive free home broadband service for educational purposes. The State could also consider lessons learned from the initial program to adjust program scope and implementation for future iterations.

### 11.1.4 Add staff resources to manage the implementation of the State's broadband strategy

In CTC's view as an independent consultant, DTI has led broadband initiatives for the State exceptionally well. We recommend that DTI be allocated the resources necessary to support additional staff to manage the implementation of the State's broadband strategy over the next several years. Specifically, we recommend that DTI hire the following:

- A broadband program administrator to oversee and direct broadband strategy
- Two project managers to be responsible for infrastructure and programmatic initiatives
- A staff person to be responsible for managing project budgets and federal grant application processes

To ensure the State's broadband strategy is aligned with its goal of guaranteeing universal broadband access, DTI staff should track compliance with grant performance and service obligations among entities receiving State funds. They should coordinate broadband initiatives among government, private sector, and nonprofit entities, including outreach related to such low-cost and subsidy programs as the Emergency Broadband Benefit, the Lifeline program, and Comcast's Internet Essentials program. DTI staff should also oversee the collection and analysis of data related to broadband adoption and use, including the identification of barriers, and the pursuit of federal funding opportunities.

## 11.2 Infrastructure

Assuming funding is available, the State should prioritize edge-out and line extensions, as well as new fixed wireless equipment (and equipment at the home for fixed wireless).

### 11.2.1 Adopt 100 Mbps symmetric speeds as a minimum target broadband speeds for the next five years.

Most of the State has cable and fiber infrastructure that easily reaches these speeds, and some current fixed wireless technologies are also capable of reaching these speeds. We believe, however, that the State should prioritize fiber infrastructure where it can, and hybrid fiber cable as an alternative. Both technologies can attain symmetric gigabit speeds today, with fiber easily reaching higher speeds, and cable reaching at least into the few gigabit speeds. As RDOF has showed, not only in Delaware, but nationally as well, fiber can be extended to most areas with the right incentives. The symmetric requirement is particularly important. The low upstream allocation typically set today and adopted by the FCC is woefully inadequate in light of today's two-way applications such as videoconferencing and telemedicine. There is no reason to believe that in 3 or 4 years this would not become an even bigger bottleneck. [51] And the State should avoid cementing broadband inequalities into differing technology investments between different geographic or socioeconomic areas.

Delaware should adopt symmetrical Gigabit service as its preferred 5 year and planned 10-year goal. As explained above, this is perfectly doable. We recognize that there may be situations where a rapid rollout of fast fixed wireless solutions are preferable, but for today's main wireline technologies, there is virtually no difference in infrastructure between a 100 Mbps capability and a 1 Gbps capability: most of the underlying infrastructure is the same. In some areas, cable companies may elect to reach last mile customers with fixed wireless solutions, and that would be adequate for the 5-year goal as it would till extend a fiber infrastructure closer to the end user.

### 11.2.2 Invest in last-mile infrastructure

To the extent feasible, the State should invest in broadband expansion that ensures long-term benefits of the public investment. We recommend that the State encourage incumbent broadband providers to edge out their networks to provide service to the residents who live beyond the reach of existing broadband infrastructure. With the federal government's recent allocation of unprecedented levels of funding to improve broadband infrastructure, the State could be in a position to incentivize incumbent providers to extend their networks to serve every home and business in the State. We also recommend that, where possible, the State provide

[51] Separate from bandwidth constraints due to adopted technology, smaller ISPs sometimes have capacity bottlenecks. We note that there could be an opportunity for smaller ISPs to collaborate with higher education institutions in the State to develop network peering arrangements that would directly hand off remote learning network traffic to research and education destinations. By peering directly locally, such traffic would stay local for the ISP rather than going through an Internet Exchange Point. Such relationships could present opportunities for smaller ISPs to increase overall network bandwidth.

competitive options for residents by supporting the installation of wireless equipment at homes where the installation cost may be prohibitive to individual homeowners.

It is possible the recent RDOF auction will solve some of the current broadband gaps in the State. However, the State could still choose to address the current gaps head-on, either with the use of remaining CARES Act funds or through a future State appropriation. Future appropriations could provide direct support for incumbent ISPs' expansion, or they could be leveraged to support such federal grant funding as ReConnect and the nascent NTIA infrastructure program described in Section 10.1.

#### *11.2.2.1 Promote cable company edge-outs and line extensions*

Our analysis indicates that a half mile extension of the existing telecommunications networks could connect 90 percent of unserved homes and businesses—making it an ideal approach for filling in the gaps of broadband coverage in the State. We recommend the State work with the existing providers to encourage them to edge out their networks to serve these premises and, as funding allows, those beyond this radius. The State could set aside funding for providers to expand their networks or provide funding and support for the providers to pursue federal broadband funding, as discussed in Section 11.1.2.

Figure 149 illustrates existing cable service areas in proximity to non-RDOF unserved areas. Figure 150 illustrates cable service in proximity to all unserved areas in the State.

**Figure 149: Map of Cable Service Areas and Non-RDOF Unserved Areas**

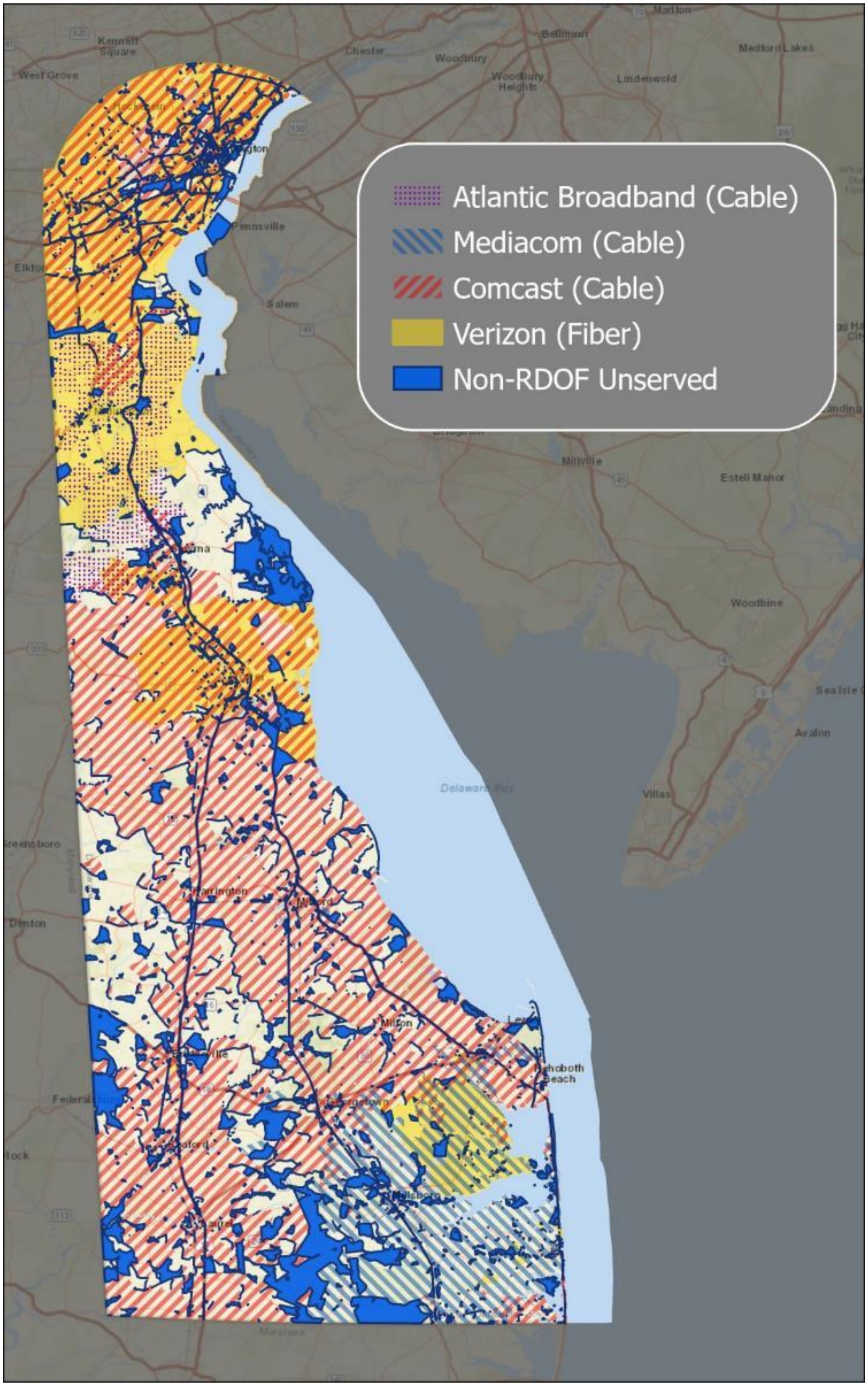
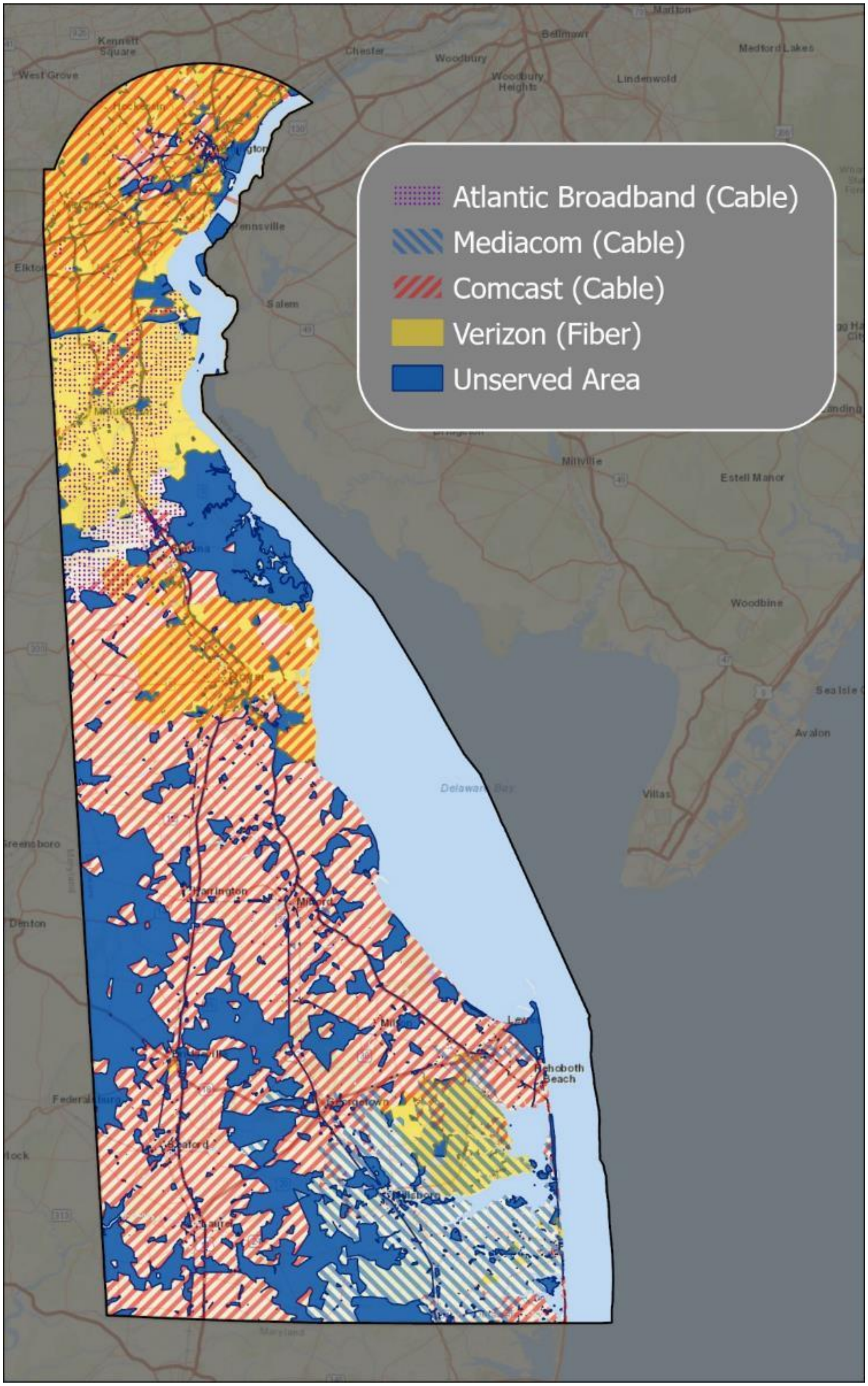


**Figure 150: Map of Cable Service Areas and Unserved Areas**



#### *11.2.2.2 Support fixed wireless companies in expanding their footprints and adding new equipment for existing towers to expand capacity*

We recommend the State continue to support fixed wireless providers in expanding their capacity and coverage in Delaware's unserved areas. While fiber-to-the-premises represents the best-in-class class technical solution to address broadband needs in the long-term, there exist a range of lower-cost last-mile fixed wireless approaches to meet the most critical broadband needs in the short term.

The limitations of fixed wireless networks arise from the need for line of sight between a network antenna and the equipment at the customer's location. Given the technical challenges (and cost) of connecting some customer locations, many fixed wireless companies throughout the country simply decline to serve customers who have challenging terrain or foliage, resulting in a network that purports to be available to all but that still leaves a substantial percentage of locations without the prospect of service. This is a rational and reasonable decision by fixed wireless companies, but it reduces the impact and reach of a public investment.

We recommend that the State, to the extent feasible, support the installation of wireless equipment at unserved homes where the installation cost may be prohibitive for many homeowners. State support may include providing access to tower siting locations or fiber backhaul; providing grants for purchasing customer premises equipment or for installation and configuration fees; and constructing mounting structures for premises where line of sight is not otherwise achievable.

#### *11.2.2.3 Adopt quality assurance, buildout milestone tracking, and performance testing and auditing of partner buildouts*

The FCC tracks buildout milestone progress of its different high cost subsidy programs including CAF II and RDOF. It also institutes a performance testing requirement to be conducted annually. We recommend the State adopt similar compliance and reporting requirements on any buildouts that are supported by the State. The State can devise requirements that mirror FCC's to minimize duplicative efforts.

## 11.3 Collaboration

**The State should—as soon as possible—partner with one or more providers to seek funding for the non-RDOF unserved areas under the new federal infrastructure grant** appropriation (see Section 10.1). Consistent with the targets described above, the State should prefer fiber and gigabit, but allow symmetric 100 Mbps if there are no other alternatives.

### 11.3.1 Expand partnerships with ISPs to maximize RDOF-funded buildout—and protect against the possibility that RDOF obligations may not be met

This project identified unserved areas that largely correspond with provider claimed coverage data via the FCC's Form 477 with regard to cable plant in particular. Without service provider data, it is virtually impossible to determine fiber coverage based solely on visual inspection, but speed test results seem to validate that the FCC data is largely accurate. The challenge is in regard to fixed wireless coverage. Federal USDA grants have—as recently as the Community Connect grant that closed in December—operated with an eligibility criteria of 10/1, but the nature of broadband—especially the older technology implemented five years or more ago—is that in reality it struggles to deliver consistent, reliable connectivity at 25/3 and even 10/1. As the State prioritizes fiber and cable as long-term solutions to resident broadband needs, and currently implemented fixed wireless solutions are not satisfying resident demands, we analyzed the options available for the State.

As the RDOF analysis illustrates, the auction had an enormous impact on the State's options for several reasons:

1. RDOF areas constituted a very high share of the State's unserved areas.
2. Talkie picked up just about all of these areas with a high-speed fiber solution.
3. We do not know whether Talkie can meet its commitments (see Section 9.4).
4. If it cannot, the State's options for federal grant funded opportunities may be limited until the areas are released for funding eligibility—something that could take many years.

A partner and grant strategy therefore will depend entirely on which of the two RDOF scenarios will unfold: Talkie can deliver or Talkie cannot deliver.

#### *11.3.1.1 Scenario 1: Talkie can deliver on its RDOF obligations*

As a first step, the State should engage with Talkie and seek conformation that Talkie has the requisite capital and operational scale to meet its RDOF obligations. This can be done with either a direct engagement with Talkie or through an RFI process that puts the same degree of financial disclosure of its buildout obligations and financial pro forma on the table.

Assuming the State is satisfied that it can, a partnership with Talkie could be an effective way to encourage the expansion of its network further into the remaining unserved areas. It would be relatively easy for Talkie to expand, and it may require minimal state support to do so. In fact, in several areas Talkie would have to cross unserved aeras in its buildouts to reach between RDOF areas anyway.

A current incumbent adjoining those areas, such as Comcast, Mediacom, and Verizon, would be another logical alternative. These are line/edge extension areas from their current footprints and would make the ROI attractive with sufficient line grant subsidies. (Verizon and Comcast adjoin most of the Kent and New Castle unserved areas. Comcast and Mediacom are good candidates for unserved areas in Sussex County. Mediacom bid against Talkie in almost all the available Sussex RDOF areas.) Any other potential partner would be concerned about the cost of building out its infrastructure to reach those areas and limits to future revenue due to low take-rates with potentially multiple future competitors.

Considering the future RDOF investments, the State has several wireline provider alternatives, and there would not be a need to seek short-term wireless solutions.

#### *11.3.1.2 Scenario 2: Talkie is unable to deliver on its RDOF obligations*

It may take a while to receive conformation that Talkie is unable to deliver. The first checkpoint will be on February 15, 2021, when a commitment to issue a letter of credit from a bank is due. We do not know how long the FCC will take to process such a required commitment and if a quick determination can be made shortly after. It may be months past the summer deadline in June when detailed financials and the actual letter of credit is due that the FCC either does or does not certify Talkie. During this time, the State will not be able to secure federal broadband grants. If the FCC determines the Letter of Credit obligation to be fulfilled—it only requires showing sufficient capital for the first year of construction—it could take many years before it is clear (to the FCC at least) that Talkie cannot deliver.

The State should seek clarification from Talkie and the FCC as soon as possible and get RDOF areas re-released for federal funding eligibility if Talkie is not certified. To manage risks and opportunities, the State should put maximal efforts into determining Talkie's ability to fulfill its commitments as soon as possible, and express its concerns with the FCC as early and frequently as possible to get clarification and potential release of eligible areas as soon as possible. Several grant opportunities are likely to pass the State by for these areas in the meanwhile, including the next phase of ReConnect and the recently created NTIA broadband infrastructure grant program. But at the very least, the State should ensure these areas will be available for the next iteration of RDOF/CAF auction.

The State should target the remaining unserved areas with incumbents as partners. Verizon and Comcast adjoin most of the Kent and New Castle unserved areas and would be logical partners there. Comcast and Mediacom are good candidates for unserved areas in Sussex County. Mediacom bid against Talkie in almost all the available Sussex RDOF areas showing their desire to expand in Sussex County.

If the State is convinced Talkie will not deliver and does not want to put residents in limbo by waiting on FCC determination of non-compliance, the State could self-fund some initiatives to encourage providers to build in the RDOF areas:

- New entrants would be hesitant to invest in those areas unless they were convinced Talkie would not build. Nobody wants to invest in an overbuild situation in such sparsely populated areas.
- In addition to the incumbents, as outlined above, the Consortium bidder was clearly interested in the western part of the State in the area straddling Sussex and Kent. These are relatively dense areas compared to other unserved areas so there is room for expanding for the ISP and for the State to get a large cluster of residents covered.
- Maryland Broadband Coop has fiber coming in from Worcester County, Maryland, and with Choptank has fiber assets in Maryland counties on its western border. That could allow a Maryland fiber optic provider such as ThinkBig to expand into a variety of areas—especially the attractive western cluster the Consortium was targeting.
- Working with Bloosurf or BridgeMAXX can present a temporary solution, but it also carries risks that the State may be barred from future federal grants since those areas will be considered served. A partnership arrangement that includes a clause that the provider not challenge eligibility of these areas for future grant funding could be one way to address the issue.

Consortia have disclosed to FCC which of their members were assigned to which areas. That means RDOF winners may still be in the quiet period where they have limits to what they can discuss. We do not believe that would prevent the State from engaging with Talkie, nor do we believe this applies to non-winners in the auction. It should therefore be possible to identify the member in the Consortium that bid in the auction for the Delaware areas, and thereby engage with this provider.

### 11.3.2 Maximize the benefits of NTIA and ReConnect funding opportunities

We recommend the State develop an RFI or directly reach out to the above-mentioned potential partners to target the NTIA funding opportunity as well as ReConnect. The areas that could be targeted would be:

- The area between Federalsburg and Bridgeville, sandwiched between RDOF areas
- South of Georgetown
- The southwestern areas between Laurel and Delmar
- Northeast and west of Smyrna

- Southwest of Smyrna
- North of Frederica and east of Dover

All of these areas potentially have backhaul paths to Maryland as well, making ThinkBig an additional non-incumbent potential grant partner (in addition to the consortium member who will be interested mostly in 1). Focusing on these areas, would leave the door open for Talkie to make good on its commitment while getting a dent into the unserved area problems and allowing partners to expand into the RDOF areas if Talkie fails with future grants or the next RDOF/CAF auction.

### 11.3.3 Partner with ISPs to promote low-cost internet programs to eligible residents

We recommend the State develop an initiative to educate residents about the availability of low-cost internet programs offered by incumbent ISPs, and to assist residents with enrollment.

Results of the residential survey indicate that residents may be significantly underutilizing existing broadband subsidy programs. For example, just four percent of all Comcast customers are enrolled in the ISP's Internet Essentials program for low-income households and two thirds of Comcast customers earning under $25,000 per year said they have never heard of the program. The ongoing promotion of such programs will be an important complement to both the FCC's nascent subsidy program and Connect Delaware.

The State could provide resources to educate residents about such programs, and to assist households with the enrollment process. Resources might include:

- A phone hotline that residents could call to learn about low-cost options in their area, and for assistance navigating enrollment, installation, and usage

- A portal hosted on Broadband.Delaware.Gov with information about available low-cost options, and links to other State resources that provide assistance navigating eligibility and enrollment

- Cross-promotion of low-cost internet programs with various state agencies and other key stakeholders, such as schools, libraries, the Department of Motor Vehicles, and public housing

- A postcard campaign to promote awareness of such programs

- A social media campaign across State and agency platforms to promote awareness of such programs

A successful initiative will require close partnership with the ISPs that offer low-cost options. We recommend that the State work with providers to develop promotional materials and resources.

## Appendix A: Residential Survey Instrument

# State of Delaware

## Internet Usage Survey

## November 2020

***Even if you do not have home internet service, please complete this survey form and return to us. Your opinions, experiences, and information are important to our efforts at closing broadband gaps in Delaware.***

***If you need help completing this survey in your language, please email Chris Cohan, chief of policy and communications, at Chris.Cohan@delaware.gov or call (302) 739-9849***

The Delaware Department of Technology and Information is sending you this survey to help the Department explore strategies to improve internet accessibility and affordability—and to ensure residents have the skills needed to make the most effective use of broadband. *The information gathered will not be used to sell you anything.* Your responses will be kept strictly confidential.

**How long will the survey take?**
This survey should take approximately 15 minutes to complete.

**What is the due date to complete the survey?**
Please return your completed form in the enclosed postage-paid envelope by **November 25, 2020**.

**What if I have questions about the survey?**
If you have questions, please contact Chris Cohan, chief of policy and communications, at Chris.Cohan@Delaware.gov or (302) 739-9849.

Please also conduct a speed test of your home or mobile broadband service.

To do so, please visit https://speedsurvey.delaware.gov/, answer the brief questions, and conduct the speed test.

Thank you in advance for your participation!

**47. Do you own or rent your residence?**

1 Own
2 Rent
3 Live with family
4 Other: ____________________

**48. How long have you lived at your current address?**

1 Less than 1 year
2 1 to 2 years
3 3 to 4 years
4 5 or more years

**49. Would you be willing to be interviewed by phone about your internet-related experiences so we can learn more about how you use the internet and your needs?**

1 No
2 Yes

If you checked "yes" please provide your name and phone number and the general topic you'd like to discuss:

Name:____________________________________
Phone number:______________________________
Topic:____________________________________

*Thank you for completing this survey!*

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## INTERNET USE AND DEVICES

**1. Do you use the internet (also known as "going online") at all on any computer or phone from any location (e.g. home, work, coffee shop, library, friend's house, etc)?**

1 Yes **(Please skip to Question 3)**
2 No

**2. Thinking about the reasons why you do NOT ever use the internet, please indicate how much you agree or disagree with the following statements** *(please circle your response for each statement, where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)*

| Aspect | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (a) An internet connection is too expensive. | 1 | 2 | 3 | 4 | 5 |
| (b) I am concerned about my safety and privacy. | 1 | 2 | 3 | 4 | 5 |
| (c) I do not have enough time. | 1 | 2 | 3 | 4 | 5 |
| (d) I am not interested. | 1 | 2 | 3 | 4 | 5 |
| (e) Internet is not available where I live. | 1 | 2 | 3 | 4 | 5 |

| Aspect | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (f) I don't need to go online because I have someone who will do it for me. | 1 | 2 | 3 | 4 | 5 |
| (g) I have no one to teach me how to go online. | 1 | 2 | 3 | 4 | 5 |
| (h) I do not know English well enough to use the internet. | 1 | 2 | 3 | 4 | 5 |
| (i) Using the internet is too difficult. | 1 | 2 | 3 | 4 | 5 |

1

**3. How important are the following services to your household?** *(please circle your response for each aspect, where 1=Not at all important, 2=Slightly important, 3=Moderately important, 4=Very important, 5=Extremely important)*

| Aspect | *Not at all important* | | | | *Extremely important* |
|---|---|---|---|---|---|
| (a) Internet connection (any speed) | 1 | 2 | 3 | 4 | 5 |
| (b) High-speed internet connection | 1 | 2 | 3 | 4 | 5 |
| (c) Cable television service | 1 | 2 | 3 | 4 | 5 |
| (d) Free broadcast TV from an antenna | 1 | 2 | 3 | 4 | 5 |
| (e) Satellite television service | 1 | 2 | 3 | 4 | 5 |
| (f) Fixed (land-line) telephone service | 1 | 2 | 3 | 4 | 5 |
| (g) Cellular/mobile telephone service | 1 | 2 | 3 | 4 | 5 |
| (h) Free public Wi-Fi service | 1 | 2 | 3 | 4 | 5 |

**4. Which of the following services do you or other household members currently use in your household? *(✓ all that apply)***

1 Internet service in my home (not including cellular/mobile)
2 Cellular/mobile telephone service with internet (smartphone)
3 Cellular/mobile telephone service without internet (basic phone)
4 Landline telephone service
5 Cable or satellite television
6 Free Wi-Fi service
7 Don't know
8 Do not have internet service (home internet or cellular/mobile) **(Please answer Questions 5 to 7, then skip to Question 19).**



**43. What is your race/ethnicity? *(✓ all that apply)***

1 Black/African American
2 Eastern Asian/Asian American
3 Hispanic/Latino
4 Native American/Indigenous American
5 Southern Asian/Indian American
6 Western Asian/Arab American
7 White/European American
8 Other (please specify): ____________________

**44. What is the race/ethnicity with which you most strongly identify? *(✓ only one)***

1 Black/African American
2 Eastern Asian/Asian American
3 Hispanic/Latino
4 Native American/Indigenous American
5 Southern Asian/Indian American
6 Western Asian/Arab American
7 White/European American
8 Other (please specify): ____________________

**45. What is your gender or gender identity?**

1 Woman
2 Man
3 Other (Neither term describes me)

(please specify): ____________________

**46. How many people reside in your home (adults and children)?**

Adults (including yourself)

1 1
2 2
3 3
4 4 or more

Children age 18 and younger

0 None
1 1
2 2
3 3
4 4 or more

## INFORMATION ABOUT YOU

*The following questions will help describe the total group of survey respondents. Your individual information will not be reported separately—it will be reported only as a part of a larger group to help ensure that the respondents are a representative sample of the residents of the State of Delaware.*

**40. Which of the following best describes your age?**

- 1 18 to 34 years
- 2 35 to 44 years
- 3 45 to 54 years
- 4 55 to 64 years
- 5 65 years and older

**41. What is the highest level of education you have completed?**

- 1 Grade School
- 2 Some high school
- 3 Completed high school
- 4 Two-year college or technical degree
- 5 Four-year college degree
- 6 Graduate, professional, or doctorate degree

**42. What is your approximate annual household income?**

- 1 Less than $25,000
- 2 $25,000 to $49,999
- 3 $50,000 to $74,999
- 4 $75,000 to $99,999
- 5 $100,000 to $149,999
- 6 $150,000 to $199,999
- 7 $200,000 or more
- 8 Prefer not to answer



**5. What is your main reason for not purchasing mobile or home internet service?** *(✓only one)*

- 1 No good internet service is available at our location
- 2 No internet-enabled devices in our home
- 3 No interest or need for the internet
- 4 Can get internet access at another location
- 5 Privacy and security concerns
- 6 Cost of internet service is too high
- 7 Don't know how/not skilled enough to use the internet
- 8 Cellular/mobile data service meets our needs
- 9 Other ____________________

**6. What, if anything, would make you consider signing up for broadband internet service in your home?**

____________________________________________

____________________________________________

____________________________________________

**7. Do you plan to sign-up for mobile or home internet service in the next 12 months** *(✓all that apply)*

- 1 Yes, cellular/mobile telephone service with internet (smartphone)
- 2 Yes, broadband internet service (fiber, DSL, cable)
- 3 Yes, other home internet service (satellite, dial-up, etc.)
- 4 Do not plan to subscribe
- 5 Unsure

**8. If you use the internet in your home, who is your primary internet service provider?** *(✓ only one)*

1 Do not have internet service (home internet or cellular/mobile) **(Please <u>skip</u> to Question 19)**
2 Verizon (wired service—fiber or DSL) **(Please <u>answer</u> Question 9)**
3 Comcast **(Please <u>answer</u> Question 10)**
4 Mediacom
5 Atlantic Broadband
6 Bloosurf
7 WhyFly
8 Dish Network
9 HughesNet
10 ViaSat
11 AT&T wireless (mobile service)
12 Verizon wireless (mobile service)
13 T-Mobile/Sprint, also called "New T-Mobile" (mobile service)
14 Mobile Wi-Fi hotspot provided to me by a school, library or other entity
15 Other (Please specify:______________________)

**9. If your home internet service provider is Verizon, is the service DSL or fiber? (If you aren't sure, check if your Wi-Fi router is connected to a phone jack. If it is, you have DSL service.)** *(✓ only one)*

1 DSL (my router is connected to a phone jack)
2 Fiber (my router is not connected to a phone jack)
3 Unsure

**10. If you are a Comcast customer, are you enrolled in Comcast's Internet Essentials program, which provides $9.95 (plus tax) home internet service and other benefits to eligible low-income subscribers?**

1 Yes
2 No
3 I have not heard of this program until now
4 I attempted to enroll in this program but was declined
5 I am not a Comcast customer

4

**39. Consider at what price level you would be interested in purchasing, from another commercial service provider, extremely fast internet service (1 gigabit per second). This speed can handle multiple high-definition video streams at the same time or transmit large video or other files near-instantaneously. How willing would be to do so for the following monthly price?** *(please circle your response at each price level, where 1=Not at all willing, 2=Slightly willing, 3=Moderately willing, 4=Very willing, 5=Extremely willing)*

| **Monthly Price** | *Not at all Willing* | | | | *Extremely Willing* |
|---|---|---|---|---|---|
| (a) $10 per month | 1 | 2 | 3 | 4 | 5 |
| (b) $30 per month | 1 | 2 | 3 | 4 | 5 |
| (c) $50 per month | 1 | 2 | 3 | 4 | 5 |
| (d) $70 per month | 1 | 2 | 3 | 4 | 5 |
| (e) $90 per month | 1 | 2 | 3 | 4 | 5 |
| (f) $110 per month | 1 | 2 | 3 | 4 | 5 |

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## YOUR OPINIONS AND ROLE OF THE STATE OF DELAWARE

**37. Please indicate to what extent you disagree or agree that the State of Delaware should do the following:** *(please circle your response for each statement, where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)*

| Aspect | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (a) Help ensure that all residents have access to affordable broadband internet services | 1 | 2 | 3 | 4 | 5 |
| (b) Help ensure that all residents know how to make effective use of the internet | 1 | 2 | 3 | 4 | 5 |
| (c) Provide free Wi-Fi in public areas | 1 | 2 | 3 | 4 | 5 |

**38. Please indicate to what extent you disagree or agree with the following statements:** *(please circle your response for each statement, where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)*

| Aspect | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (a) The market currently offers high-speed internet at prices that my family can afford | 1 | 2 | 3 | 4 | 5 |
| (b) The availability of high-speed internet is a factor I would consider when choosing where to live | 1 | 2 | 3 | 4 | 5 |
| (c) The availability of high-speed internet is a factor I would consider when determining to start a home-based business | 1 | 2 | 3 | 4 | 5 |
| (d) High-speed home internet service is important for my work/job | 1 | 2 | 3 | 4 | 5 |
| (e) High-speed home internet service is important for my family's educational opportunities | 1 | 2 | 3 | 4 | 5 |
| (f) I am willing to pay a premium for access to high-speed internet | 1 | 2 | 3 | 4 | 5 |
| (g) I receive high-quality customer service from my internet service provider | 1 | 2 | 3 | 4 | 5 |

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**11. Do you receive a $9.25 subsidy on either a wireline or wireless broadband service under the FCC's "Lifeline" program, which is available to eligible low-income subscribers?**

1 Yes  2 No  3 Don't know

**12. How many personal computing devices (desktop/laptop computers, tablets, smartphones, console gaming devices) are used in your household?**

1 1 or 2
2 3 or 4
3 5 or more
4 I do not have any personal computing devices in my home

**13. What devices are available for use in your home? Check all that apply, but only for device or devices that are in good working order.**

1 Desktop computer
2 Laptop computer
3 Tablet computer, such as an iPad
4 Smartphone
5 Console gaming devices

**14. Thinking about the computer you primarily use (desktop, laptop or tablet computer), about how often does it become inaccessible or unusable for any reason?**

1 Once a week or more
2 Once a month
3 Once a year
4 This has never happened to me

**15. Thinking about the computer you primarily use (desktop, laptop or tablet computer), if it were lost or damaged beyond repair, how long do you think it would take you to replace it?**

1 I could not do so in the foreseeable future
2 1-6 months
3 2-4 weeks
4 About one week
5 About one day

5

**16. Please estimate how much your household pays PER MONTH for your *home* internet service (not including television or phone service).**

1 $0 to $10
2 $11 to $20
3 $21 to $40
4 $41 to $60
5 $61 to $80
6 $81 to $100
7 $101 to $120
8 More than $120

**17. Is the fee in Question 16 part of a bundled package (purchased together with cable TV or phone service)?**

1 Yes
2 No

**18. How often do you and anyone in your household use your primary home internet connection for:** *(please circle your response for each activity)*

| Home Internet Activity | *Never* | *Occasionally* | *Frequently* |
|---|---|---|---|
| (a) Listening to music (streaming) | 1 | 2 | 3 |
| (b) Watching movies, videos, or TV | 1 | 2 | 3 |
| (c) Playing online games | 1 | 2 | 3 |
| (d) Connecting to work | 1 | 2 | 3 |
| (e) Using social media | 1 | 2 | 3 |
| (f) Shopping online | 1 | 2 | 3 |
| (g) Running a home business | 1 | 2 | 3 |

| Home Internet Activity | *Never* | *Occasionally* | *Frequently* |
|---|---|---|---|
| (h) Accessing educational resources | 1 | 2 | 3 |
| (i) Accessing government information | 1 | 2 | 3 |
| (j) Accessing medical services | 1 | 2 | 3 |
| (k) Banking or paying bills | 1 | 2 | 3 |
| (l) Accessing home security/other "smart home" devices | 1 | 2 | 3 |
| (m) Accessing cloud-based file storage and sharing | 1 | 2 | 3 |



## INTERNET FOR EDUCATION

**33. Does a member of your household use the internet for educational purposes, such as completing assignments, research, home-schooling, or study related to coursework or formal education?**

1 Yes
2 No **(Please skip to Question 37)**

**34. Does a member of your household use the internet for educational purposes related to homeschooling?**

1 Yes
2 No

**35. What is the current education level of those using your internet connection in your household?** *(✓ all that apply)*

1 Preschool (early childhood)
2 Primary (kindergarten – Grade 8)
3 Secondary (Grades 9 – 12)
4 Post-Secondary (Technical/vocational training, college, etc.)
5 Graduate (Graduate, post-graduate, professional degree)
6 Continuing or Adult Education/Professional Development
7 Other ______________________________

**36. How important is high-speed internet for your household educational needs?**

1 Not at all important
2 Slightly important
3 Moderately important
4 Very important
5 Extremely important

## INTERNET FOR JOBS/CAREERS

**29. Does your job require you to have internet access at your home?**

- [1] Yes
- [2] No
- [3] Does not apply: Retired or not employed at this time

**30. Are you or is any member of your household currently working remotely using computers and the internet (often known as teleworking), or interested in doing so?**

- [1] Someone in my household currently does telework from home
- [2] Someone in my household would like to telework
- [3] No

**31. Does someone in your household have a home-based business or plan to start a home-based business in the next three years?**

- [1] Yes, I/we already have a home-based business
- [2] Yes, I/we plan to start one in next three years
- [3] No

**32. How important is high-speed internet access for:** *(please circle your response for each aspect, where 1=Not at all important, 2=Slightly important, 3=Moderately important, 4=Very important, 5=Extremely important)*

| Aspect | *Not at All Important* | | | | *Extremely Important* | *N/A* |
|---|---|---|---|---|---|---|
| (a) Working from home (teleworking) | 1 | 2 | 3 | 4 | 5 | 6 |
| (b) Planned/existing home-based business | 1 | 2 | 3 | 4 | 5 | 6 |

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## COVID-19 PANDEMIC AND INTERNET USE

**19. Thinking about your normal habits BEFORE the Covid-19 pandemic, how often did you use the internet in the following locations on average?** *(please circle your response for each location, where 1=never, 2=less than monthly, 3=at least monthly, 4=at least weekly, and 5=at least daily)*

| Location | Never | Less Than Monthly | Monthly | Weekly | Daily |
|---|---|---|---|---|---|
| (a) At my home | 1 | 2 | 3 | 4 | 5 |
| (b) At the home of a friend or family member | 1 | 2 | 3 | 4 | 5 |
| (c) At work | 1 | 2 | 3 | 4 | 5 |
| (d) Inside a school or a college/university building | 1 | 2 | 3 | 4 | 5 |
| (e) Inside a coffee shop or other private business | 1 | 2 | 3 | 4 | 5 |
| (f) Inside a library | 1 | 2 | 3 | 4 | 5 |
| (g) Inside other public buildings such as a municipal office or senior center | 1 | 2 | 3 | 4 | 5 |
| (h) At any outdoor public spaces (including outside any of the above locations) using free Wi-Fi | 1 | 2 | 3 | 4 | 5 |

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**20. Now, thinking about how you have been using the internet DURING the Covid-19 pandemic, how often do you use the internet in the following locations on average?** *(please circle your response for each location, where 1=never, 2=less than monthly, 3=at least monthly, 4=at least weekly, and 5=at least daily)*

| Location | Never | Less Than Monthly | Monthly | Weekly | Daily |
|---|---|---|---|---|---|
| (a) At my home | 1 | 2 | 3 | 4 | 5 |
| (b) At the home of a friend or family member | 1 | 2 | 3 | 4 | 5 |
| (c) At work | 1 | 2 | 3 | 4 | 5 |
| (d) Inside a school or a college/university building | 1 | 2 | 3 | 4 | 5 |
| (e) Inside a coffee shop or other private business | 1 | 2 | 3 | 4 | 5 |
| (f) Inside a library | 1 | 2 | 3 | 4 | 5 |
| (g) Inside other public buildings such as a municipal office or senior center | 1 | 2 | 3 | 4 | 5 |
| (h) At any outdoor public spaces (including outside any of the above locations) using free Wi-Fi | 1 | 2 | 3 | 4 | 5 |



**28. This next set of questions asks about the skills you or children under your care possess to avoid or minimize online risks. If you are a legal guardian of a minor child still in school, these questions also apply to you.** *(please circle your response for each statement, where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)*

| Risk | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (a) I feel that my children or grandchildren have the skills to detect and avoid false or misleading information online. | 1 | 2 | 3 | 4 | 5 |
| (b) I feel that my children or grandchildren are able to avoid online bullying by peers. | 1 | 2 | 3 | 4 | 5 |
| (c) I feel that my children or grandchildren are able to get help dealing with online bullying by peers if it does occur. | 1 | 2 | 3 | 4 | 5 |
| (d) I feel that my children or grandchildren are able to effectively detect and avoid online financial scams or predators. | 1 | 2 | 3 | 4 | 5 |
| (e) I feel that my children or grandchildren are able to avoid exposure to graphic violence or pornography online. | 1 | 2 | 3 | 4 | 5 |
| (f) I feel that my children or grandchildren are able to get help if they are exposed to graphic violence or pornography online. | 1 | 2 | 3 | 4 | 5 |
| (g) I feel that I am aware of the extent to which my children or grandchildren are exposed to any of the above types of risks or content. | 1 | 2 | 3 | 4 | 5 |
| (h) I feel that I have the time and skills to protect my children or grandchildren from the above risks and content. | 1 | 2 | 3 | 4 | 5 |

## TECHNOLOGY FOR MINOR CHILDREN

**26. Are you the parent, legal guardian or primary caregiver for any child or grandchild under the age of 18 (minor child)?**

1 Yes    2 No **(Please skip to Question 29)**

**27. This next set of questions asks about how minor children under your care are able to make beneficial use of technology. If you are a legal guardian of a minor child still in school, these questions also apply to you.** *(please circle your response for each statement, where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)*

| Skill | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (a) I feel that children or grandchildren under my care cannot complete their homework because they do not have access to the internet. | 1 | 2 | 3 | 4 | 5 |
| (b) I feel that children or grandchildren under my care cannot complete their homework because they do not have access to computers. | 1 | 2 | 3 | 4 | 5 |
| (c) I feel that my computer skills are good enough to help children or grandchildren under my care complete their homework. | 1 | 2 | 3 | 4 | 5 |
| (d) The children or grandchildren under my care have good enough computer skills to complete their homework on their own. | 1 | 2 | 3 | 4 | 5 |
| (e) The children or grandchildren under my care are learning computer skills at school that will prepare them for the future. | 1 | 2 | 3 | 4 | 5 |
| (f) The children or grandchildren under my care access the internet at a public or school library. | 1 | 2 | 3 | 4 | 5 |
| (g) The children or grandchildren under my care can safely access public libraries. | 1 | 2 | 3 | 4 | 5 |
| (h) I learn computer or internet skills from family members. | 1 | 2 | 3 | 4 | 5 |

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**21. Thinking about how often you engaged in various internet activities BEFORE the Covid-19 pandemic, how often did you engage in the following activities?** *(please circle your response for each activity, where 1=never, 2=less than monthly, 3=at least monthly, 4=at least weekly, and 5=at least daily)*

| Internet activity | Never | Less Than Monthly | Monthly | Weekly | Daily |
|---|---|---|---|---|---|
| (a) Telework/working from home | 1 | 2 | 3 | 4 | 5 |
| (b) Telemedicine/ doctor appointments | 1 | 2 | 3 | 4 | 5 |
| (c) Do homework | 1 | 2 | 3 | 4 | 5 |
| (d) Attend online classes | 1 | 2 | 3 | 4 | 5 |
| (e) Attend homeschool | 1 | 2 | 3 | 4 | 5 |

**22. Now, thinking about how often you have been engaging in various internet activities DURING the Covid-19 pandemic, how often do you engage in the following activities?** *(please circle your response for each activity, where 1=never, 2=less than monthly, 3=at least monthly, 4=at least weekly, and 5=at least daily)*

| Internet activity | Never | Less Than Monthly | Monthly | Weekly | Daily |
|---|---|---|---|---|---|
| (a) Telework/working from home | 1 | 2 | 3 | 4 | 5 |
| (b) Telemedicine/ doctor appointments | 1 | 2 | 3 | 4 | 5 |
| (c) Do homework | 1 | 2 | 3 | 4 | 5 |
| (d) Attend online classes | 1 | 2 | 3 | 4 | 5 |
| (e) Attend homeschool | 1 | 2 | 3 | 4 | 5 |

**23. At peak usage times in your household DURING the Covid-19 pandemic, how many people need to be online for work, school, and other activities at the same time?**

1 1    2 2    3 3
4 4    5 5 or more

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## COMPUTER AND INTERNET SKILLS

**24. Please indicate how much you disagree or agree with the following statements regarding your skills using computers and the internet.** *(please circle your response for each statement, where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)*

| Skill | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (a) I know how to upload content (such as videos, photos, music) to a website | 1 | 2 | 3 | 4 | 5 |
| (b) I know how to adjust my privacy settings online, such as on Facebook or other sites | 1 | 2 | 3 | 4 | 5 |
| (c) I know how to bookmark a website or add a website to my list of favorites | 1 | 2 | 3 | 4 | 5 |
| (d) I know how to identify false or misleading information online and find credible sources of information | 1 | 2 | 3 | 4 | 5 |
| (e) I know how to manage my own personal profile on Facebook or other social network site | 1 | 2 | 3 | 4 | 5 |

| Skill | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (f) I know how to create and manage my own personal website | 1 | 2 | 3 | 4 | 5 |
| (g) I know how to recognize and avoid a phishing scam | 1 | 2 | 3 | 4 | 5 |
| (h) I know how to create my own content (such as videos, photos, music) using computers and the internet | 1 | 2 | 3 | 4 | 5 |
| (i) I know how to access my bank account online to perform tasks such as paying bills or depositing checks with my phone | 1 | 2 | 3 | 4 | 5 |
| (j) I feel confident in my ability to troubleshoot issues with technology when they arise | 1 | 2 | 3 | 4 | 5 |
| (k) I know how to purchase groceries and food online | 1 | 2 | 3 | 4 | 5 |
| (l) I know how connect with my doctor or other medical support online | 1 | 2 | 3 | 4 | 5 |

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**25. Please indicate how much you disagree or agree with the following statements about your interest in opportunities to obtain training related to computers and the internet.** *(please circle your response for each statement, where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)*

| Statement | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (a) I would like to become more confident in using computers, smartphones, and the internet | 1 | 2 | 3 | 4 | 5 |
| (b) I would attend a free or inexpensive class to become more confident in using computers, smartphones, and the internet | 1 | 2 | 3 | 4 | 5 |
| (c) I would like to know how to better use online resources to find trustworthy information | 1 | 2 | 3 | 4 | 5 |
| (d) I would attend a free or inexpensive class in how to use online resources to find trustworthy information | 1 | 2 | 3 | 4 | 5 |

| Statement | *Strongly Disagree* | | | | *Strongly Agree* |
|---|---|---|---|---|---|
| (e) I would like to learn how computers work | 1 | 2 | 3 | 4 | 5 |
| (f) I would attend a free or inexpensive class to learn how computers work | 1 | 2 | 3 | 4 | 5 |
| (g) I would like to learn how to write software (or "code") | 1 | 2 | 3 | 4 | 5 |
| (h) I would attend a free or inexpensive class to learn how to write software (or "code") | 1 | 2 | 3 | 4 | 5 |

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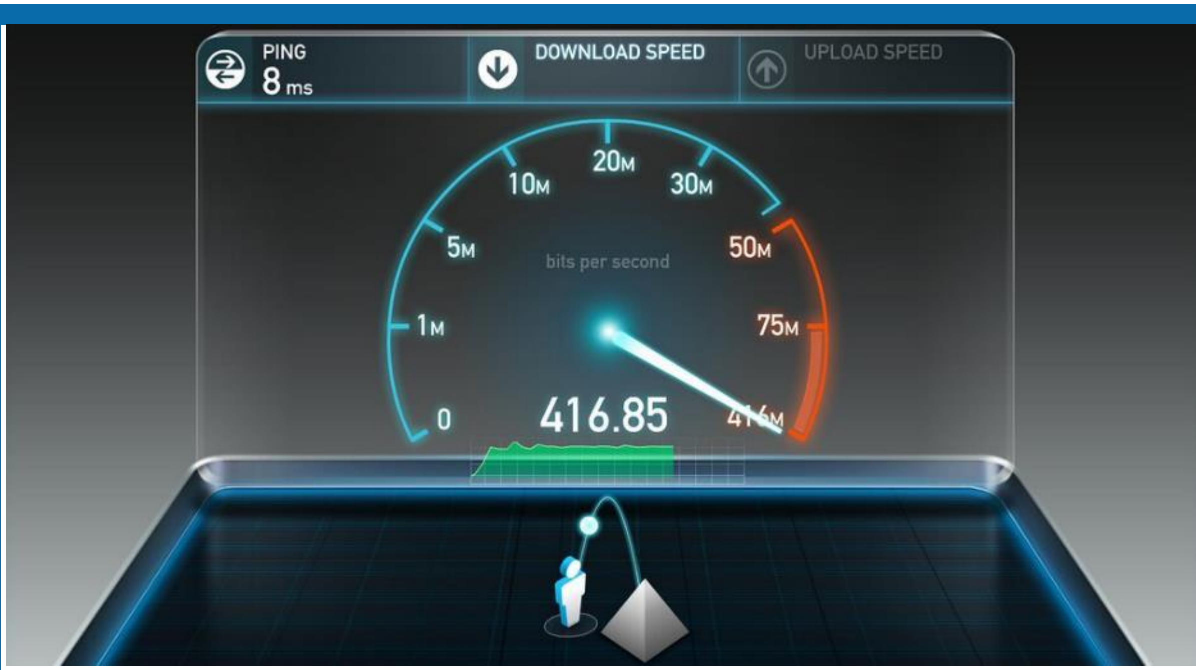
## Appendix B: Speed Test Invitation

**We need your help!** Please participate in our statewide speed survey and feel free to share with friends and family. The more, the merrier! Or, in this instance, the more the better data we have! Thank YOU!

**Delaware Speed Survey**




We're excited to announce that Delaware's Speed Survey is live! This survey and speed test are designed to gather real-time data about the availability and speed of internet service, including to identify locations that lack such service. This information will be gathered over the next 45 days and used to develop strategies to address rural and urban broadband challenges, as well as educate decision makers about where the greatest needs exist. Persons lacking access to internet service can call **(302) 739-9701** to report their address.

**Click Here for Delaware Speed Survey**