ctc technology & energy

engineering & business consulting

Fiber-to-the-Premises Feasibility Study

Prepared for Multnomah County, Oregon
September 2020

Columbia Telecommunications Corporation

10613 Concord Street • Kensington, MD 20895 • Tel: 301-933-1488 • Fax: 301-933-3340 • www.ctcnet.us

Contents

Figures

Tables

1 Executive Summary

Multnomah County and the cities of Fairview, Gresham, Portland, Troutdale, and Wood Village (collectively, "Partner Agencies") commissioned this study in fall 2019 to consider the feasibility of a publicly owned and operated fiber-to-the-premises network to serve residential and business customers throughout Multnomah County.

This report represents the outcome of that engagement and is based on research, fieldwork, and analysis conducted by analysts and engineers from CTC Technology & Energy in late 2019 and the first half of 2020, including the following tasks:

- Conducted statistically valid market research of the residential and business communities
- Researched the broadband services available to County residents
- Consulted extensively with Partner Agencies and their affiliates, including educational and other entities
- Explored the potential for collaboration with jurisdictions that border Multnomah County
- Engaged with existing and potential service providers to discuss their regional plans and their potential interest in partnering with the Partner Agencies
- Developed candidate fiber-to-the-premises network designs and cost estimates for both countywide infrastructure and infrastructure in unserved areas, including the potential to use existing public fiber assets
- Developed candidate wireless network designs and cost estimates for reaching members of the community who cannot afford currently available broadband services
- Developed financial analysis to illustrate the projected outcomes of pursuing various business models for fiber-to-the-premises deployment
- Evaluated the potential for public financing and federal and state funding options

Based on these tasks and other research undertaken, we found the following:

1.1 Stakeholders Consistently Identify Equity and Affordability as Priorities

The Partner Agencies and their stakeholders articulated throughout this process their interest in exploring the feasibility of deploying a ubiquitous fiber-to-the-premises network that would serve every home and business in the County. We heard these themes in every meeting we conducted.

The Partner Agencies themselves communicated their collective goals to ensure that:

- All residents have equal access to broadband (i.e., bridge the digital divide in terms of service availability)
- All residents can afford broadband (i.e., bridge the digital divide in terms of service affordability)
- All residents have unfettered access to information over broadband (i.e., net neutrality principles apply to their network)

Interviews with key stakeholders during this engagement identified their support for public intervention to achieve these goals so long as the strategy would be financially sustainable. A wide range of stakeholders consulted during this process—including businesses, advocates, local officials, and school officials—emphasized in particular the critical need for affordable service and equity in broadband; that is, the primary goal is to ensure that all members of the community could realize the benefits of the broadband internet for such fundamental needs as education, healthcare, and receipt of government services.

In addition to the data collected to prepare this report, local advocacy organization Municipal Broadband PDX facilitated two town hall meetings and a companion survey to "better understand the needs of communities in Portland's inner east side and eastern Multnomah County as we consider making large investments in our digital future."[1] The organization's data and findings are consistent with the data collected by CTC and further reinforce the importance the broader Multnomah community places on broadband, particularly in terms of affordability, equity, and equitable access.

1.2 The Covid-19 Crisis Has Exacerbated the Affordability Challenge and Illustrated the Scale of the Equity Divide

The Covid-19 pandemic reached the United States while this study was underway[2]—and amplified the Partner Agencies' goals. This ongoing health and economic crisis created unprecedented demand for broadband access for K-12 education, telehealth, and employees who can work remotely—while exacerbating the challenges of broadband deployment and demonstrating the enormous need for services at an affordable price.

[1] Municipal Broadband PDX's report is attached as Appendix C.

[2] Much of the data in this document was developed before the pandemic began to impact Multnomah County. The business and residential surveys were completed in the week preceding widespread U.S. shutdowns. An unforeseen benefit of the data, as a result, is that they represent a baseline to understand broadband use immediately before the pandemic.

In Multnomah County, as throughout the country, the epidemic laid bare the stark broadband inequities faced by many households. While counties and cities have for many years sought to develop broadband infrastructure to address gaps in affordability and availability, the pandemic has illuminated the scale of the challenge—with remarkable numbers of households lacking broadband internet service—even as broadband has become a lifeline for distance learning, work from home, and telemedicine.

Indeed, affordability and equity were universally identified as the critical needs in every process of data collection undertaken for this effort. And the impact of the pandemic was noted universally, including in the Municipal Broadband PDX report.[3]

1.3 Residential Market Research Confirms a Digital Divide Based on Income Level

The residential market research conducted in early 2020 confirm the data and concerns reported by stakeholders.[4] Through a statistically valid mail survey, CTC developed data regarding (immediate pre-pandemic) broadband needs, usage, demand, and perceptions of the need for public efforts to improve broadband outcomes.[5] Key survey findings include the following:

Multnomah County households are highly connected, but lower-income households are left behind. Almost all households (96 percent) have some form of internet connection. Specifically, 90 percent of residents have home internet service and 84 percent have a cellular/mobile telephone with internet. Only 4 percent lack any form of access to the internet at home. Low-income residents are less connected, and connect at lower speeds, than higher-income residents. Lower-income households (less than $50,000 annual income) are less likely than households with a higher income to have internet access at home or via smartphone; 13 percent of low-income households do not have any internet access. The gap grows wider as the internet technology gets faster: Only 11 percent of those earning $50,000 or less have fiber optic connections, while the

[3] See Appendix C.

[4] Detailed residential survey results and methodology are described in Section 3 below and the residential survey instrument is appended to this report as Appendix A. The residential survey was complemented by a survey of businesses, whose results and methodology are described in Section 4 below. The business survey instrument can be found in Appendix B.

[5] The residential market research was begun in February and completed in mid-March, immediately before the Covid-19 shutdowns began. A total of 6,666 survey packets were mailed first-class in February to a random selection of households stratified into three regions: 1) Portland, 2) Gresham, Fairview, Troutdale, Wood Village, and 3) other towns and unincorporated areas. A total of 1,125 useable survey responses were received by the date of analysis, providing a gross response rate of 16.9 percent. The margin of error for aggregate results at the 95 percent confidence level for 1,125 responses is ±2.9 percent. That is, for questions with valid responses from all survey respondents, one can be 95 percent confident (19 times in 20) that the survey responses lie within ±2.9 percent of the target population as a whole (roughly 322,000 households in Multnomah County). The survey responses were weighted based on the age of the respondent and region.

overall average is 17 percent. Further, respondents with just one type of internet connection (either a home internet connection or a smartphone only) are also disproportionately lower income; 6 percent of all respondents, and 12 percent of those earning under $50,000 annually, use only a mobile connection for home internet. Respondents with both fixed and mobile connections have higher household incomes.

Even so, those **lower-income households that have internet pay the same as higher-income earners**. Household earning $50,000 or less pay on average the same amount as the overall average, around $70. They are also just as likely to have cable as higher earners (56 percent), but they are less likely to have fiber as their primary Internet service (11 percent vs. 17 percent).

Only four in 10 respondents agreed or strongly agreed that the market currently provides high-speed internet at prices they can afford, suggesting some need for affordable broadband internet among a segment of respondents. Just four in 10 are willing to pay a premium for access to high-speed internet.

Cable is the most-used internet technology, but fiber performs the best. Cable modem (56 percent) is the leading internet service used, while 17 percent of households have fiber and 17 percent have DSL. Fiber is somewhat more prevalent in the greater Gresham, Fairview, Troutdale, and Wood Village areas (24 percent). Respondents report higher satisfaction with fiber customer service and price of service compared with DSL and cable modem services. Cable modem subscribers are more likely than those with other internet services to consider switching to another provider.

Connection reliability ranks as the most important internet service aspect among the County's residential internet subscribers, followed by price and connection speed. Internet users also value net neutrality; 53 percent say that confidence in their service provider treating all traffic in a net neutral way is extremely important.

High-speed, reliable broadband at home is critical for work, healthcare, and education. More than one-half of respondents (55 percent) said their job requires them to have internet access at home. Those residing in the Gresham, Fairview, Troutdale, and Wood Village region as a whole (49 percent) are less likely to have a job that requires home internet access, compared with Portland residents (59 percent) and those who live in unincorporated/other areas of the County (62 percent). Additionally, 69 percent of respondents use the internet for healthcare services, and 46 percent use the internet for educational purposes. With the exception of education, those in the Gresham, Fairview, Troutdale, and Wood Village region reported lower usage of the internet for these activities.

Respondents demonstrate strong support for government playing a role in ensuring access to affordable broadband. Approximately six in 10 respondents strongly agree, though residents of

the Gresham, Fairview, Troutdale, and Wood Village region were less likely to agree that the Partner Agencies should play a role as compared with those who reside in Portland and other areas. Nearly one-half of respondents feel the Partner Agencies should build a broadband network, and 36 percent of respondents feel the Partner Agencies should operate the network. This opinion is more popular among Portland residents compared with residents of other areas.

Support for a government-operated network is fairly strong countywide but lower in the eastside cities. Support for a publicly built and operated network is reported by more than half the respondents countywide. In contrast, a quarter of respondents oppose that idea outright. Among supporters, it is specifically the publicly operated aspect of this approach that respondents like. Support drops a bit if a private entity operates a publicly built and owned network, suggesting Multnomah County residents trust public institutions more than private companies when it comes to delivering an essential utility fairly and effectively. However, that support is significantly less robust in the Cities than countywide. Less than half the Cities' populations support the publicly run model, as is illustrated below. Further, the appetite for a government-operated network depends heavily on price point. When respondents were asked the price point at which fiber would be desirable, $50 was the sweet spot. After that, interest faded rapidly with each $10 increment.

Figure 1: Support of the County's Role in Broadband Internet – Countywide Respondents

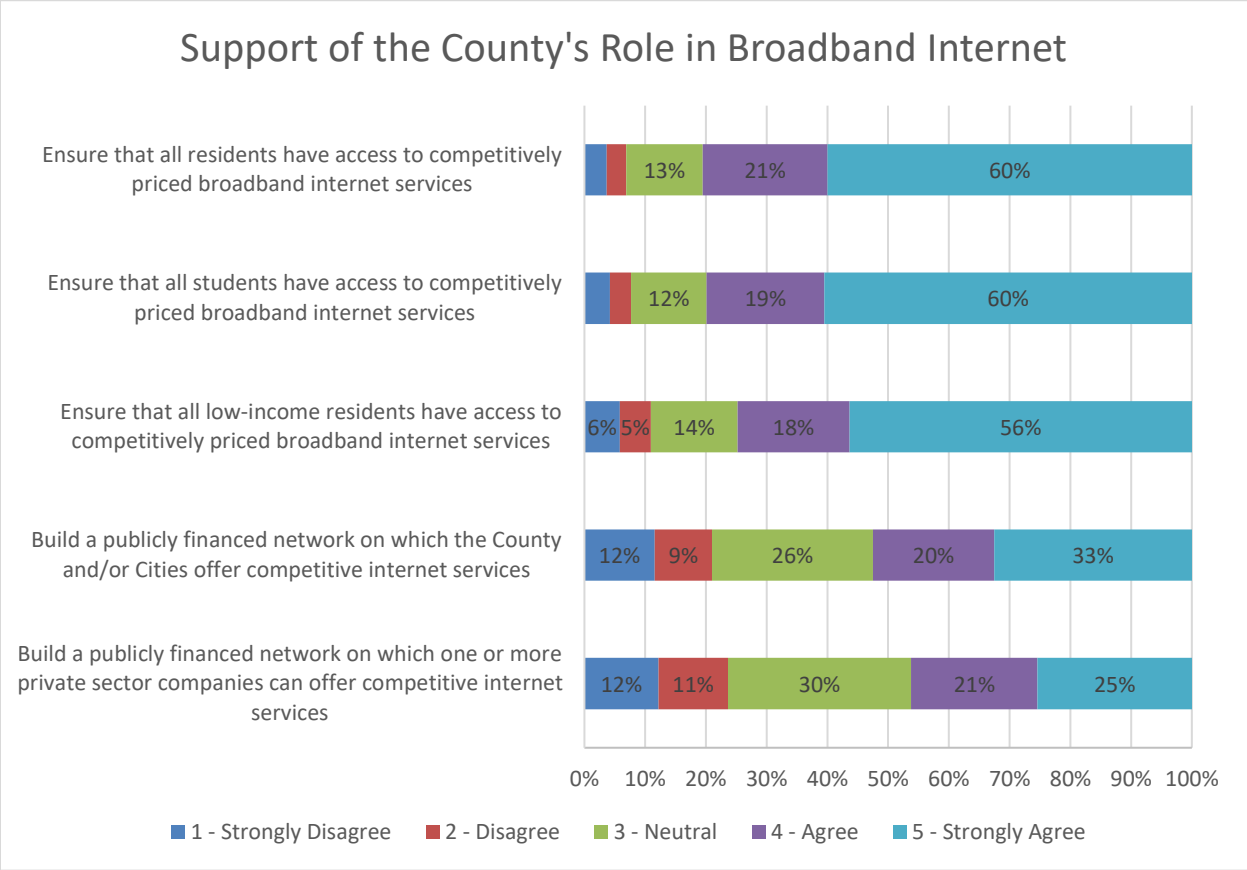
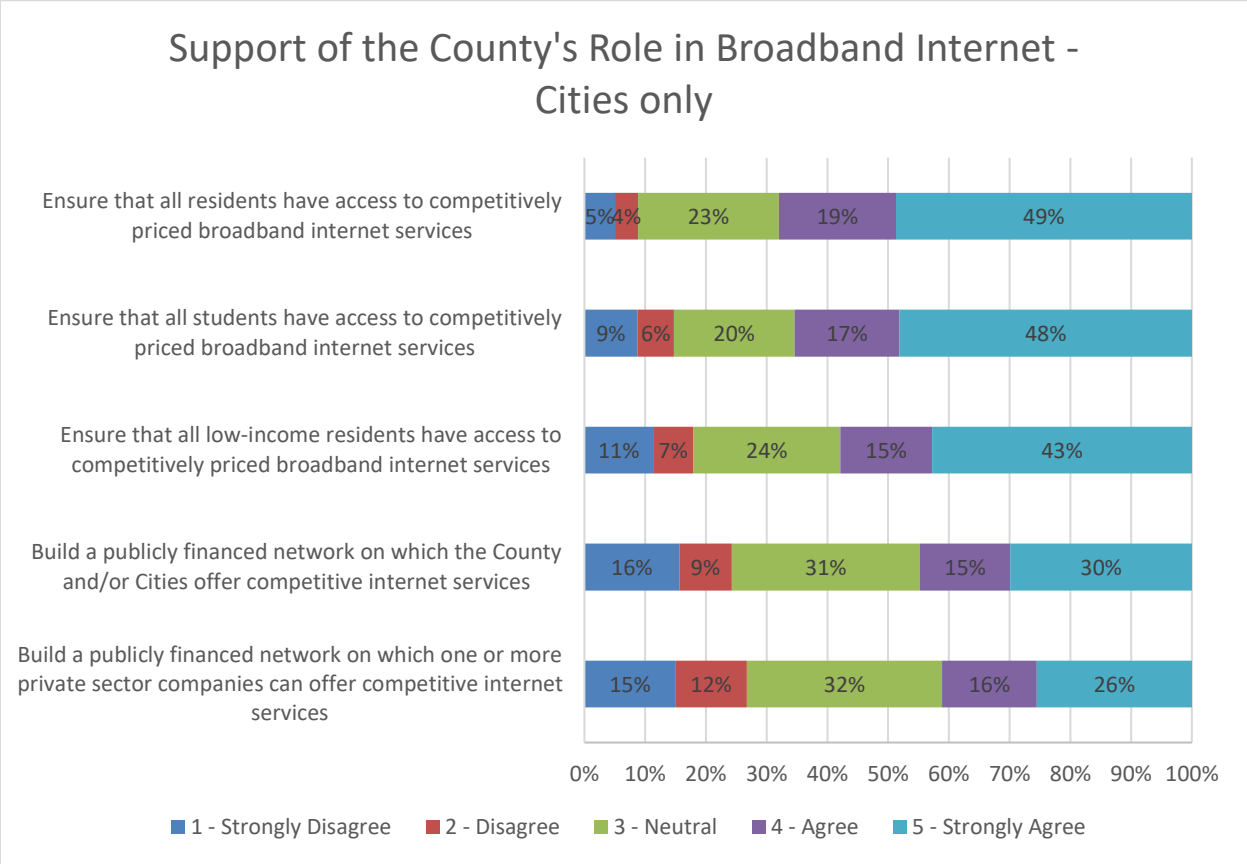


Figure 2: Support of the County's Role in Broadband Internet – City-only Respondents

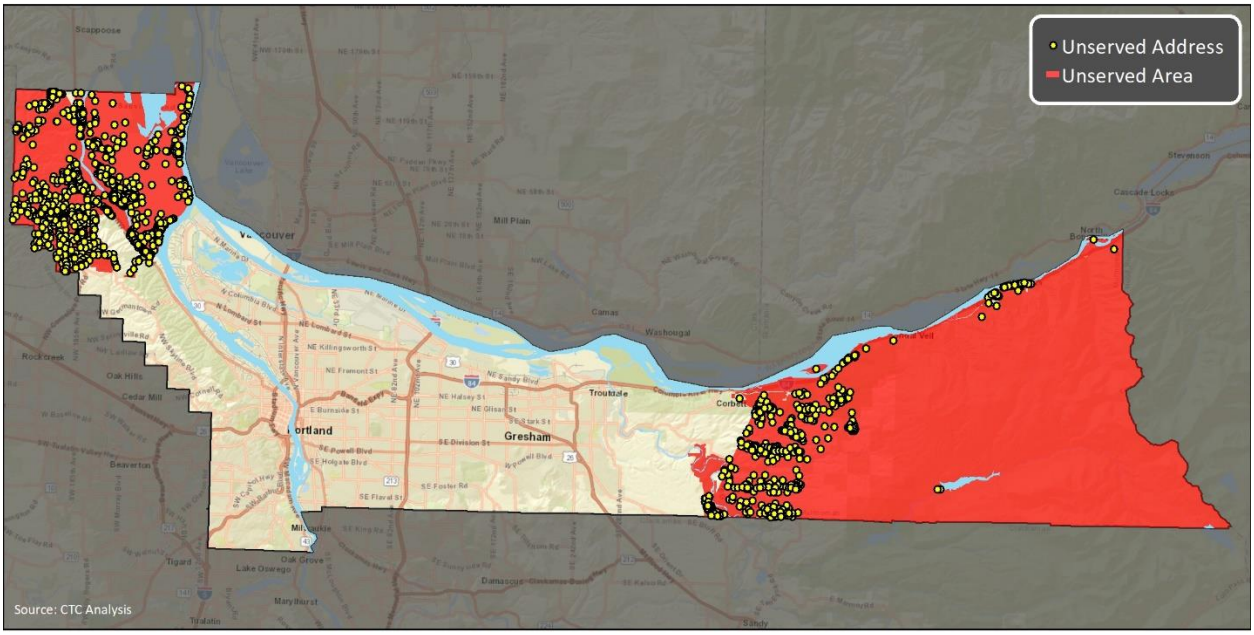


1.4 Broadband Is Available in Most of the County but Some Remote Areas Are Unserved

Broadband is available in the population centers of Multnomah County—and there is some measure of broadband competition given the presence of two providers in most areas.

However, approximately 2,800 homes and businesses are entirely unserved with broadband, representing 1 percent of the County's total premises. These premises are concentrated in sparsely populated unincorporated areas of the northwest portion of the County, as well as in pockets in the east. Figure 3 illustrates those unserved address points and the County's unserved areas.

Figure 3: Unserved Addresses in the County



Unserved portions of Multnomah County face the same challenges as other low-density communities to attract broadband infrastructure investment. Areas with high capital costs per user, particularly rural areas, struggle to attract private investment in infrastructure. The challenging economics result from the lack of density of potential customers—and, in many cases, the fact that homes are located far from arterial roads or on large parcels of land; long driveways or setbacks from the road greatly increase the cost to deploy infrastructure to those locations.

1.5 Countywide Fiber-to-the-Premises Would Cost Approximately $1 Billion

CTC engineers estimate that construction of countywide fiber-to-the-premises would cost approximately $1 billion, inclusive of fiber-to-the-premises infrastructure, all electronics, and service drops and customer premises equipment to 35 percent of premises.[6]

This model assumes a 35 percent take-rate—the percentage of residents and businesses that subscribe to the service (Table 1). On a per-passing[7] basis, the countywide deployment would

[6] The network conceptual design and cost estimates are described in detail in Section 5 of this report.

[7] 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.

cost about $1,710—a number comparable to other communities with a high percentage of underground infrastructure and relatively high housing density.

Table 1: Countywide Fiber-to-the-Premises Costs

Street Miles	Passings	Passings Per Mile	Outside Plant Cost	Outside Plant Cost per Passing	Equipment Cost	Subscriber Costs	Total Cost
3,643.0	389,993	107	$668,333,100	$1,710	$66,298,810	$232,045,835	$966,422,165

A network designed to pass only the County's unserved premises would cost $47 million to reach the approximately 2,800 unserved homes and businesses in unincorporated Multnomah County, again assuming a 35 percent take-rate (Table 2). That total represents an almost-$16,000 per-passing cost, with this considerably higher cost (about six times the per-passing cost for the ubiquitous fiber-to-the-premises model) reflecting the low densities of the unserved areas.

Table 2: Unserved Areas Fiber-to-the-Premises Costs

Street Miles	Passings	Passings Per Mile	Outside Plant Cost	Outside Plant Cost per Passing	Equipment Cost	Subscriber Costs	Total Cost
355.0	2,800	8	$44,375,000	$15,848	$476,000	$1,666,000	$46,517,000

Portland will be the most expensive part of the County in which to build—at an estimated fiber construction cost of $200,000 per mile—due to the prevalence of underground utilities and crowded rights-of-way and utility poles. We assume the remaining cities and unincorporated parts of the County will have lower per mile construction costs—an estimated cost of $150,000 per mile—because more of these areas have aerial utilities and the poles and rights-of-way are less congested. If the County were to construct fiber only in the unserved portions of the County, we assume construction costs would be even lower because there are fewer existing attachments on the utility poles in those areas, resulting in a cost of $125,000 per mile.

The proportional breakdown of costs by area is summarized in Table 3, assuming a 35 percent take-rate:

Table 3: Fiber-to-the-Premises Costs by Jurisdiction

Jurisdiction	Street Miles	Passings	Passings per Mile	Outside Plant Cost	Outside Plant Cost per Passing	Core Equipment Cost	Distribution Electronics	Subscriber Costs	Total Cost
Fairview	42.3	2,176	51	$6,343,050	$2,915	$217,600	$152,320	$1,294,720	$8,290,570
Gresham	323.8	45,417	140	$48,565,350	$1,069	$4,541,700	$3,179,190	$27,023,115	$89,213,565
Portland	2,615.3	327,011	125	$523,067,800	$1,600	$32,701,100	$22,890,770	$194,571,545	$815,742,645
Troutdale	68.5	6,440	94	$10,279,200	$1,596	$644,000	$450,800	$3,831,800	$16,043,000
Wood Village	17.2	944	55	$2,583,300	$2,737	$94,400	$66,080	$561,680	$3,428,180
Unincorporated Served	220.8	5205	24	$33,119,400	$6,363	$520,500	$364,350	$3,096,975	$37,101,225
Unincorporated Unserved	355.0	2,800	8	$44,375,000	$15,848	$280,000	$196,000	$1,666,000	$46,517,000
Countywide	**3,643.0**	**389,993**	**107**	$668,333,100	**$1,710**	$38,999,300	$27,299,510	$232,045,835	$966,422,165

1.6 Countywide Fiber-to-the-Premises Would Require a 36 Percent or Higher Take-Rate to Achieve Positive Cash Flow, Depending on Pricing

The financial analysis developed for this report suggests that **the countywide strategy would be self-sustaining at a take-rate of 36 percent, assuming a 4 percent bond interest rate and residential service fees of $80 per month**, comparable to those offered by prominent competitive gigabit providers such as Google Fiber ($70 per month), Allo Communications ($99 per month), and Ting Internet ($89 per month), and prominent municipal providers elsewhere in the country, such as Chattanooga EPB ($68 per month).[8]

This level of take-rate is feasible. Municipal networks in many parts of the country have reached this and higher take-rates in some cases, take-rates are considerably higher than 40 percent)—though none to our knowledge have achieved that level in markets where there is already fiber-to-the-premises, as exists in substantial parts of Multnomah County.

However, the financial model suggests that a take-rate of 70 percent is required to achieve positive cash flow if the residential gigabit product is priced at $50, demonstrating that the financial viability of the initiative is very sensitive to pricing and the willingness of consumers to pay more for fiber-based services. This suggests some level of risk given that the residential market research participants, when asked if they would be willing to purchase 1 Gbps high-speed internet service from a new provider at various price levels, demonstrate limited interest at monthly fees in the higher ranges.

Indeed, the residential market research suggests that consumer willingness to pay for fiber-based services falls off considerably above monthly costs of $50. The responses are illustrated below, with mean willingness to purchase across this array of questions illustrated in Figure 4 and detailed responses illustrated in Figure 5.

[8] A detailed financial analysis is included in Section 8 of this report.

Figure 4: Willingness to Purchase from Another Provider (Mean Ratings)

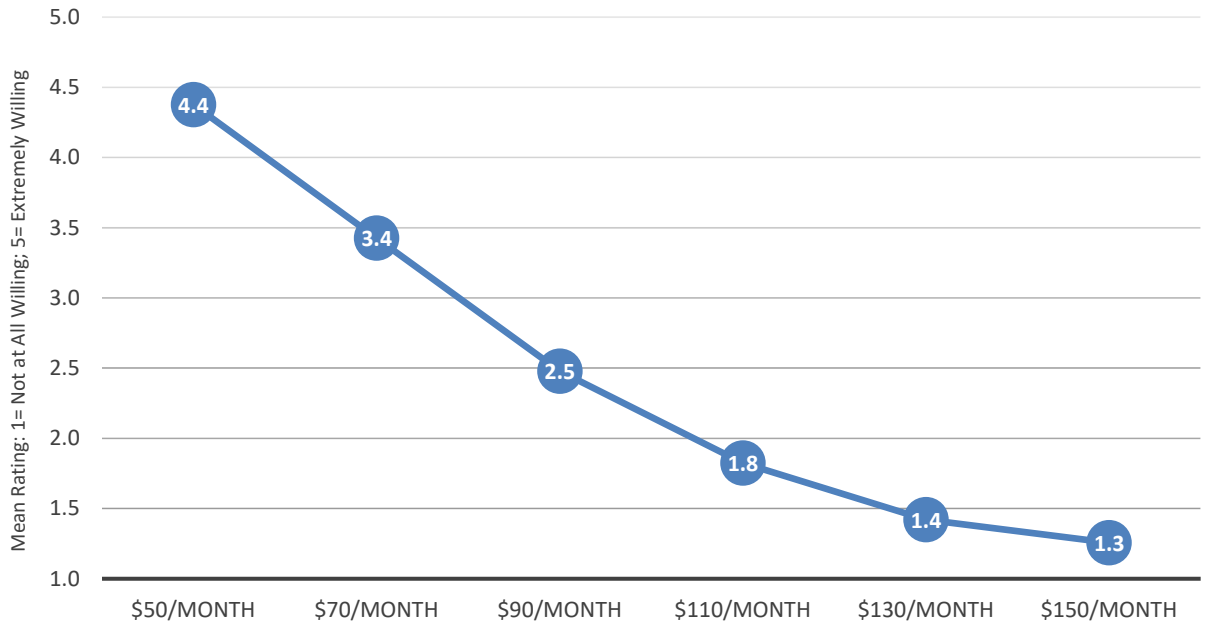
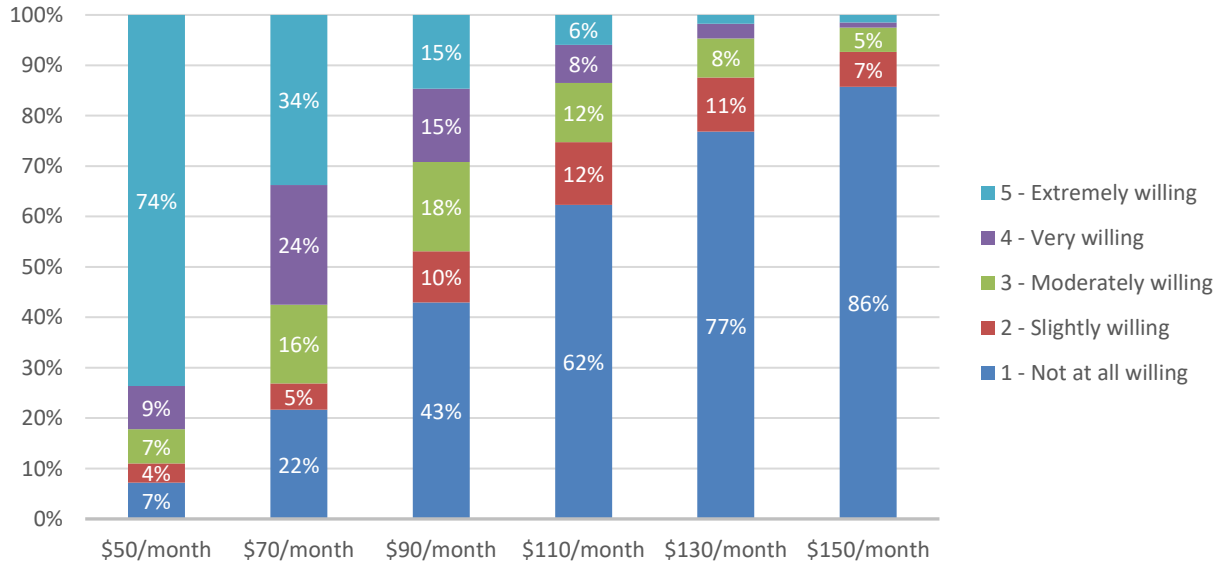


Figure 5: Willingness to Purchase from Another Provider

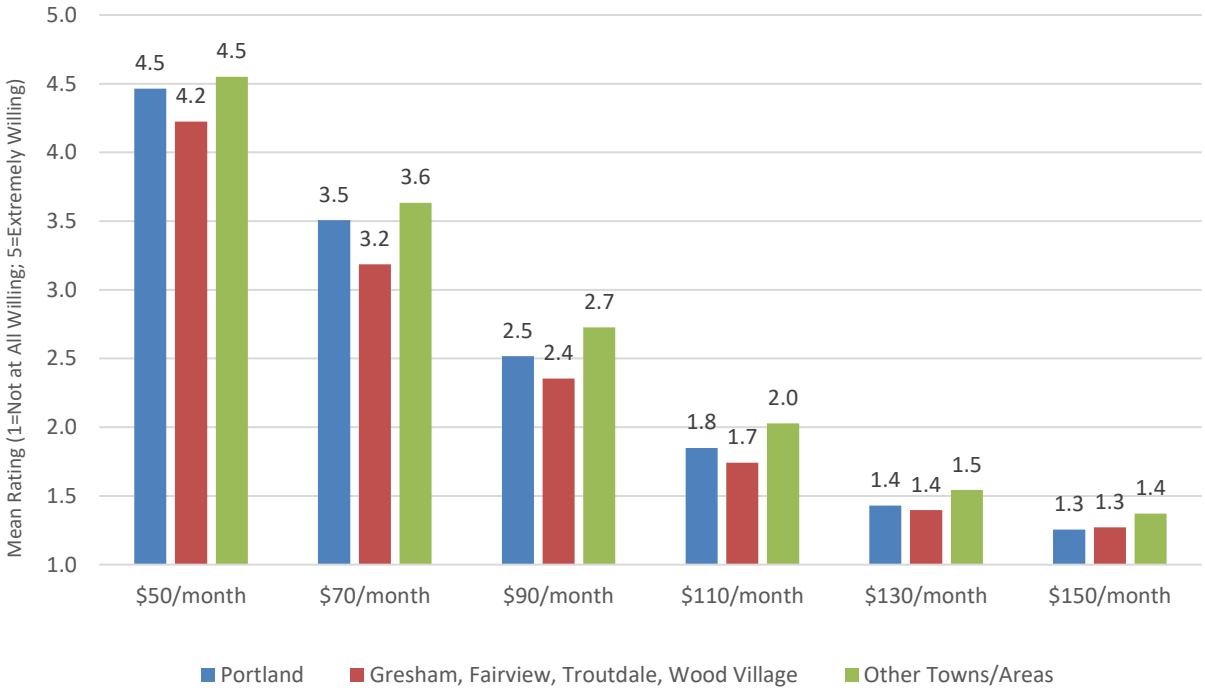


As the graphics illustrate, respondents' willingness to purchase 1 Gbps internet service from another commercial provider is high at $50 per month, but it drops considerably as the price increases. The mean rating falls to 3.4 at a price point of $70 per month and 2.5 (i.e., slightly to moderately willing) at a price point of $90 per month.

Stated otherwise, 74 percent of respondents are extremely willing to purchase 1 Gbps internet for $50 per month, dropping to 34 percent at $70 per month and 15 percent at $90 per month.

The numbers are less robust among respondents from the Gresham, Fairview, Troutdale, and Wood Village region for most price points (see Figure 6).

Figure 6: Willingness to Purchase from Another Provider by Region



The willingness to purchase high-speed internet service is also correlated with some demographic characteristics of the respondents, including household income (see Figure 7). The likelihood of purchasing high-speed internet tends to increase as household income increases.

Figure 7: Willingness to Purchase from Another Provider by Household Income

The model is also sensitive to the cost of capital. Our base case analysis requires a 36.5 percent take-rate at a 4 percent bond financing—but increases to a 44 percent required take-rate in the event that the interest rate increases to 6 percent. The take-rate requirement is reduced to 31 percent if the bond rate is reduced to 2 percent, suggesting a lower level of risk if the cost of capital is greatly reduced.

The model is also sensitive to the capital cost of building the network. Our base case assumes the approximate $1 billion capital costs estimated by our engineers. An increase of 15 percent in capital costs would increase the take-rate requirement from 36.5 percent to 44 percent, while a 15 percent reduction in capital costs would reduce the take-rate requirement to 30.5 percent.

The sensitivity analysis is summarized in the following tables:

Table 4: Bond Rate Sensitivity Analysis Summary

Scenario	Bond Rate	Required Take-Rate
Base Case - 2.0 percentage points	2.0%	31.0%
Base Case	***4.0%***	***36.5%***
Base Case + 2.0 percentage points	6.0%	44.0%

Table 5: Capital Cost Sensitivity Analysis Summary

Scenario	Required Take-Rate
Base Case -15% CapEx	30.5%
Base Case	***36.5%***
Base Case + 15% CapEx	44.5%

In addition to the pure municipal broadband model, we also evaluated the feasibility of a public-private collaboration model in which the Partner Agencies would build, own, and maintain the fiber infrastructure with one or more private entities leasing access to that infrastructure on a countywide basis in order to provide services.[9]

In our view, this collaboration model offers an innovative and important way for local governments to own long-term infrastructure and secure their policy objectives in broadband—including such goals as service affordability and net neutrality—while enabling the private sector to assume much of the risk of operations and undertake such elements of service provision as customer service, marketing, and sales.

This model represents a promising strategy for public efforts in broadband and has been pioneered in a substantial handful of innovative cities. In Westminster, Maryland, for example, the city has built an underground fiber-to-the-premises network with Ting Internet as its citywide fiber lessee for a 20-year term. In Huntsville, Alabama, the city's municipal electric utility has leased citywide fiber to Google Fiber for a 20-year term, while using additional fiber capacity for utility and city needs. Similar lease arrangements exist between Allo Communications and the Colorado cities of Breckenridge and Fort Morgan and between CenturyLink and Springfield, Missouri. And, most recently, the city of West Des Moines, Iowa, announced that it will build citywide conduit with Google Fiber as its first citywide lessee of conduit space.

Our analysis, however, is that this model would likely require substantial subsidy, at least in the early years of operation. Based on the payment terms we have analyzed for some of the existing programs of this sort, payments from a single citywide fiber lease are unlikely to be sufficient to cover the Partner Agencies' costs. (In this model, those costs would be made up primarily of debt service as well as fiber maintenance and some administration expenses.)[10]

[9] This collaboration model is described in some detail, with case studies, in Section 7 of this report.

[10] It will likely require at least two and possibly more citywide lessees for the revenues under this model to cover Partner Agency costs. For example, based on the fee structure between Ting Internet and Westminster, the fees could cover at least 40 and as much as 80 percent of the Partner Agencies' annual costs, depending on how many customers subscribe to service. (The Westminster/Ting fee structure is based in part on the number of passings and in part on the number of subscribers.) Other examples are less promising. The Huntsville-Google Fiber fee

As a result, the Partner Agencies would need to secure additional dark fiber lessees or other forms of revenue for the network to sustain itself. While it is not inconceivable that additional internet service providers (ISP) would be interested in leasing fiber assets, there has not yet been a citywide project of this sort in the U.S. in which a second provider has agreed to a citywide lease.

1.7 Targeted Wireless Solutions Could Deliver Broadband to Low-Income Households

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 wireless approaches to meet the most critical broadband needs in the short term—in particular, providing basic connectivity to lower-income residents who may otherwise have no affordable options. In short, the Partner Agencies can use cost-effective wireless to bridge affordability gaps and support lower-income households.[11]

We examined two conceptual approaches using Wi-Fi and fixed wireless technologies that can be scaled to accommodate a wide budgetary range, can be deployed relatively quickly, are impactful at any funding level, and that 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 targeted broadband solutions could they provide a lifeline reaching across the digital divide to facilitate distance learning for students, job searches, access to government services, and access to healthcare professionals in the ongoing pandemic crisis.

1.7.1 Expansive Public Wi-Fi

Strategically placed Wi-Fi hotspots throughout the County, particularly in low-income areas, is a least-cost solution with high impact, leveraging existing County and municipal fiber and facility assets to provide reliable internet access in close proximity to all residents. The Partner Agencies can install wireless access points at any or all of the more than 600 government, schools, and library locations in the County. Members of the community could then connect to the internet using their own mobile devices from their vehicles or in outdoor spaces. In addition, the Partner Agencies could allow community sponsors who have an unrestricted internet connection (i.e., that allow them to provide free Wi-Fi to the public) to also host access points. These community sponsors could be non-profit agencies, religious institutions, and community centers such as the Boys and Girls Club or the YMCA.

---

structure would likely cover only 50 percent of the Partner Agencies' costs, far less than is the case in Huntsville itself, where capital costs are much lower than in Multnomah County. These projects are described in more detail in Section 7 of this report.

[11] The wireless conceptual designs and cost estimates are described in detail in Section 6 of this report.

The estimated cost per location is $4,700. The model assumes that the County or Partner Agencies would manage and maintain the network at a best-effort level. The communities can scale the program as budgets and need require. For example, if the County were to use its 600 government, schools, and library locations, the cost would be $2.8 million and would support many thousands of concurrent users limited primarily by the size of the physical spaces available.

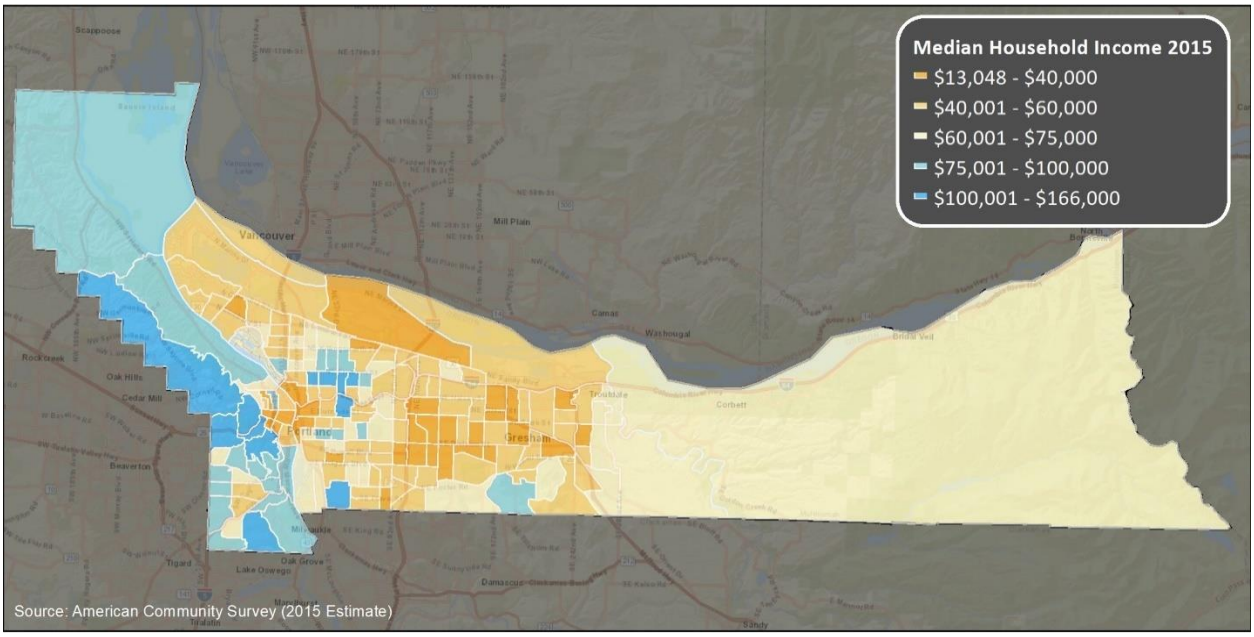
1.7.2 Targeted Fixed Wireless

As another alternative to deploying fiber-to-the-premises, the Partner Agencies could consider a fixed-wireless network to deliver broadband services to targeted areas of the community that are most in need. The goal would be to provide an affordable or no-cost alternative even where service availability is not a barrier. To that end, CTC's engineers developed a fixed wireless network model to assess the viability of serving the County's lowest income areas using existing siting locations (i.e., equipment mounted on towers or the rooftops of tall buildings) within the County.

Our analysis found that, although it would have clear technical limitations relative to a fiber optic network, a fixed wireless network may be able to provide service to approximately 25 percent of residents throughout the lower-income areas of the County—a figure that takes into account the achievability of wireless coverage using non-commercial wireless spectrum and service eligibility criteria likely based on federal poverty level, eligibility under the National School Lunch Program (NSLP), or similar criteria.

In total, we estimate this approach could deliver service to approximately 13,000 of the households in census block groups having the lowest average median income level in the range of $13,048 to $40,000 (Figure 8) for an estimated deployment cost of approximately $36 million, or approximately $2,700 per home.

Figure 8: Median Household Income Map for Multnomah County



The network would leverage existing siting locations where available and would require new construction of mounting structures (towers and/or utility poles) where needed. Our model assumes the requirement for approximately three towers per square mile to provide capacity and coverage of the neighborhoods. It would use point-to-point wireless connections to locations where the Partner Agencies have fiber to provide backhaul to the internet.

The following table shows the cost breakdown for the strategy:

Table 6: Cost to Serve 25 Percent of Households in Census Block Groups Below $40,000 Median Household Income (Fixed Wireless Model)

Item	Cost
Total Distribution Network Cost	$12.2 million
Total Incremental Customer Costs (13,000 @ $1,800 per Customer)	$23.4 million
Total:	$35.6 million

1.8 Where Affordability Prevents Residents From Using Broadband, the Partner Agencies Could Take Low-Cost Approaches to Maximizing Existing Services

Beyond the infrastructure solutions described above, the Partner Agencies might consider other low-cost or no-cost approaches to helping residents for whom affordability, not availability, is the hurdle preventing them from using broadband services.

One option would be to help eligible residents apply for an existing low-cost or subsidized service offered by a local service provider. For example, in Montgomery County, Maryland—a large jurisdiction outside of Washington, D.C.—the locality's Office of Broadband Programs launched a program to help any eligible resident enroll in a low-cost internet service like Comcast's Internet Essentials[12] or sign up for Verizon service using the federal Lifeline program.[13]

While that local government has devoted staff resources to providing one-on-one guidance to interested residents, it has no ongoing costs for delivering service. And residents who enroll in a low-cost program might have a multiplier effect—telling eligible neighbors or classmates about the low-cost programs, with no additional staff time required. The Partner Agencies could take a similar approach with Comcast or CenturyLink (which is a Lifeline participant).[14]

Going a step further, if the Partner Agencies had a pool of funding but did not want to embark on an infrastructure program, they could use those funds to subsidize residents' use of Comcast Internet Essentials or Lifeline services. (At $10 per month per household for Internet Essentials, a relatively small amount of funding could have a big impact—either in a bulk-buy approach negotiated with Comcast, or via direct reimbursement to eligible residents.)

This approach could be limited or it could be quite expansive. In Alabama, the governor earmarked $100 million of funding the State received from the federal Coronavirus Aid, Relief, and Economic Security (CARES) Act to deliver free internet access to eligible low-income K-12 students in their homes during the fall school semester. The state issued a request for information (RFI) to engage private providers who would commit to providing service at a set price, then mailed prepaid vouchers to every eligible household.[15]

1.9 Federal and State Funding Programs Can Address Unserved and Lower-Income Areas but Will Not Fund Countywide Fiber

The existing broadband infrastructure in the County effectively precludes the possibility of significant federal grant funding to support the countywide fiber network contemplated here, though there do exist federal and state programs that can support deployment to the unserved areas and possibly to targeted lower-income and economic development areas.[16]

---

[12] "Internet Essentials," Comcast, https://www.internetessentials.com/ (accessed September 8, 2020).
[13] "Low Cost Internet," Office of Broadband Programs, Montgomery County, Maryland, https://www.montgomerycountymd.gov/obp/low-cost-internet.html (accessed September 8, 2020).
[14] "Lifeline," CenturyLink, https://www.centurylink.com/aboutus/community/community-development/lifeline.html (accessed September 8, 2020).
[15] "Alabama Broadband Connectivity for Students," State of Alabama, https://abcstudents.org/ (accessed September 8, 2020).
[16] The various federal funding sources are described in Appendix D to this report.

1.9.1 Funding Programs for Unserved Rural Areas

For unserved areas, federal and state funding sources represent an important source of broadband funding. While these programs tend to have restrictions that affect their potential breadth of impact, our analysis is that a number of programs—including the grant funding that the State of Oregon has made available, as well as federal programs run by the Federal Communications Commission (FCC) and U.S. Department of Agriculture (USDA)—could assist the County's efforts to reduce the number of unserved homes and businesses.[17]

Given these funding sources, the County could focus on itself building and operating network infrastructure in unserved Multnomah County, or collaborating with private sector partners to apply for grants. In either case, this effort may require multiple years and is unlikely to be resolved in the short-term, given the high cost of serving the remote areas of the County.

This effort could begin in 2020, with the understanding that there likely will be state and federal broadband funding in 2021 and beyond—and it may take years to access sufficient grant funds to address the entirety of the unserved areas in the remote parts of the County. In the next year, multiple federal agencies will fund construction of broadband facilities in unserved areas of rural America. The State of Oregon may also allocate further funding for rural broadband grant programs like that it undertook in June.[18] Pockets of the eastern and western parts of the County will qualify for these programs, which generally require a showing that the area is currently unserved with 25 Mbps/3 Mbps (download/upload) service.

The County itself is eligible for all of these programs and could compete for funds to begin to reduce the number of unserved locations. Alternatively, if the County's preference is to enable private ISPs to reach these remote areas, the County could leverage federal and state funding by committing funds necessary to enable applications that require a match. The County can incent providers to apply for these grants by committing to pay some of the match for successful grantees. This commitment will make the grant applications more competitive and viable—and will likely increase the number of applications filed for Multnomah County. At the same time, the federal or state government will bear the cost and the effort of enforcing grant requirements.

---

[17] For example, USDA's ReConnect and Community Connect programs award loans, grants, or a combination of the two for last-mile connections in rural areas. While ReConnect has not yet seen an appropriation for next year, we anticipate that Community Connect will be opened for applications in the fall. Similarly, the FCC's Rural Digital Opportunity Fund is an auction that will take place in late October and November to award $16 billion over the next decade to support the buildout of high-speed broadband networks in unserved areas of the country. These and other programs are discussed at some length in the appendices to this report.

[18] Even more promising, the State of Oregon recently released the application for a broadband grant initiative focused on local government recipients that was intended to fund broadband infrastructure in areas unserved with 25 Mbps down/3 Mbps up (https://www.oregon4biz.com/Broadband-Office/Rural-Broadband-Capacity-Program/). While that grant opportunity closed last month, the County could consider similar state opportunities that arise in the future to address the unserved locations in the east and west of the County.

Committing to fund the match on any successful application will also enable the County to avoid having to pick and choose among ISPs, as it would effectively be committing to fund all ISPs whose applications are successful. Given that both the state and federal governments will only fund a single project in any given geography—and will very carefully vet those geographies to ensure that the area is indeed unserved—the County has a built-in set of protections against the risk of having to fund too many projects.

1.9.2 Funding Programs for Lower-Income and Economic Development Areas

While the great majority of federal broadband funding programs are targeted at unserved, remote areas of the country, there do exist some funding programs that can be applied to address broadband affordability and access needs in urban and suburban areas. These are programs we recommend that the Partner Agencies monitor and consider for such efforts as the digital inclusion wireless initiatives (i.e., targeted broadband solution) described above.

For example, the Coronavirus Aid, Relief, and Economic Security (CARES) Act added $1.5 billion to an existing grant program of the U.S. Department of Commerce's Economic Development Administration (EDA)—creating a significant opportunity, both because of the size of the allocation and its breadth of eligibility.[19] The grants are available to local and state governments, non-profits, and other non-commercial entities that have a compelling case for using infrastructure projects (including broadband initiatives) to ameliorate the economic effects of the Covid-19 crisis. Broadband projects—including in non-rural areas—that will help address coronavirus challenges are eligible so long as they will strengthen economic resilience, diversify the economy and workforce, or support recovery. As of the date of this writing, this opportunity is still open but it demands quick action to submit an application before funds are fully expended.

Given the economic challenges created by the Covid-19 emergency, we anticipate future rounds of economic stabilization and recovery funding. New programs may include additional funding to EDA or other agencies in ways that address broadband affordability and inequities.

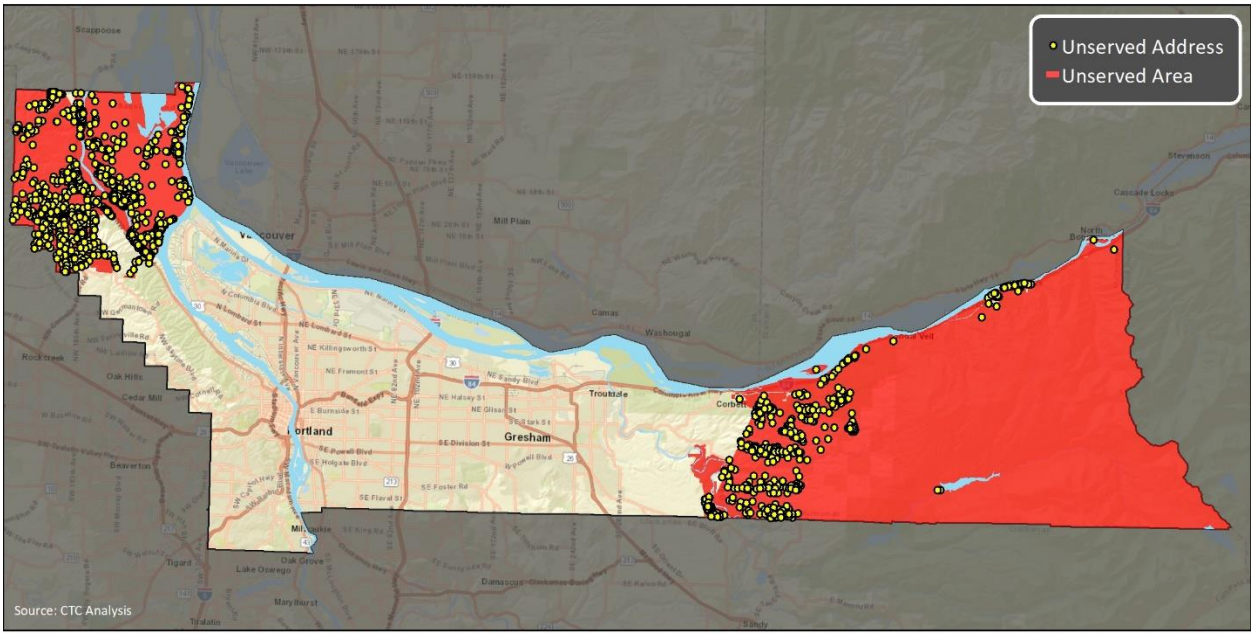
[19] More detailed guidance regarding this program is included in the appendices to this report and at https://www.ctcnet.us/blog/1-5-billion-in-new-grant-funding-available-from-economic-development-administration-for-broadband-other-projects/.

2 Approximately 1 Percent of Homes and Businesses Are Unserved

Research conducted for this report found an estimated 2,800 homes and businesses in the County (i.e., about 1 percent of the County's total premises) that are unserved with broadband, based on the current federal definition of broadband (25 Mbps download and 3 Mbps upload).

Figure 9 illustrates those unserved addresses and the County's unserved areas.

Figure 9: Unserved Addresses in the County



To establish a comprehensive overview of service availability in the County (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 Communication'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 County that are shown as being unserved, then we could be certain that the residents there truly are unserved.

We also evaluated the FCC's Connect America Fund (CAF II) funding documentation to identify areas deemed unserved or underserved by that program (both to validate Form 477 data and to establish eligibility for the federal ReConnect program). Given the 10-year buildout window for entities receiving CAF II funding, we note that unserved areas in the County that are subject to an award may still be unserved for many years to come.

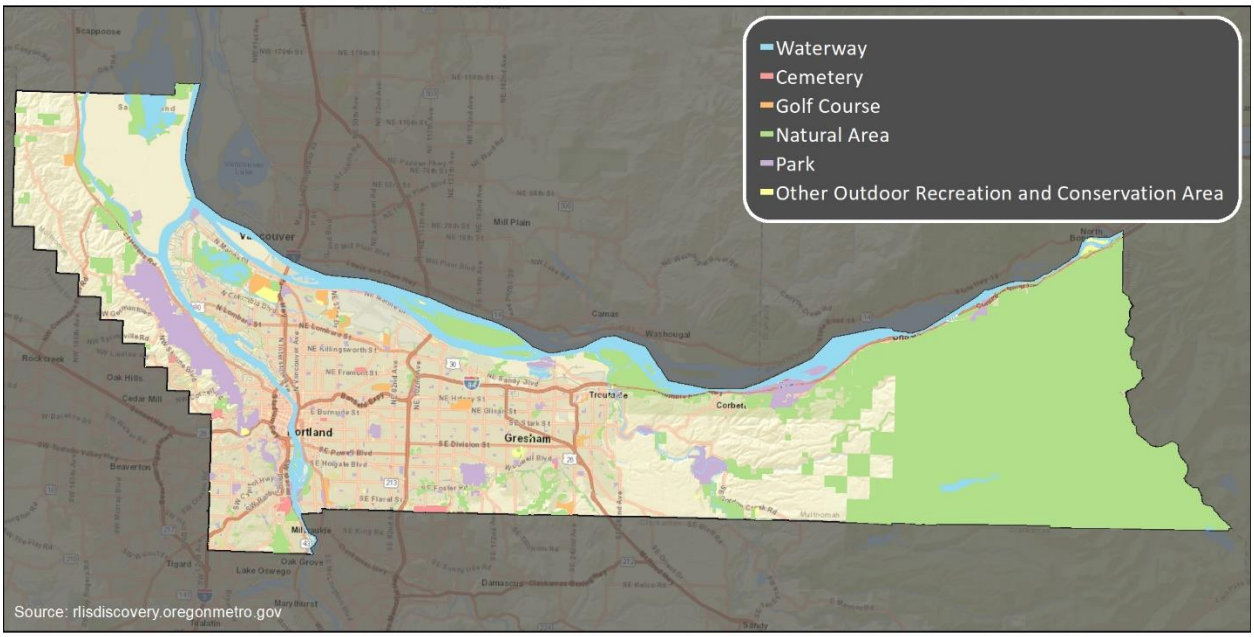
Next we evaluated the U.S. Department of Agriculture's Rural Utilities Service's (RUS) map of served and unserved areas, which is based on a range of different datasets. In our view the RUS map is under-inclusive of the unserved portions of the country as a whole—but it provides another set of insights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

Then, using the Partner Agencies' 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 County roadways for the presence of broadband infrastructure such as cable attachments on poles for aerial construction and handholes and pedestals for underground construction.)

Finally, for purposes of evaluating another potentially relevant federal funding opportunity, we evaluated the portions of the County deemed eligible for the FCC's Rural Digital Opportunity Fund.

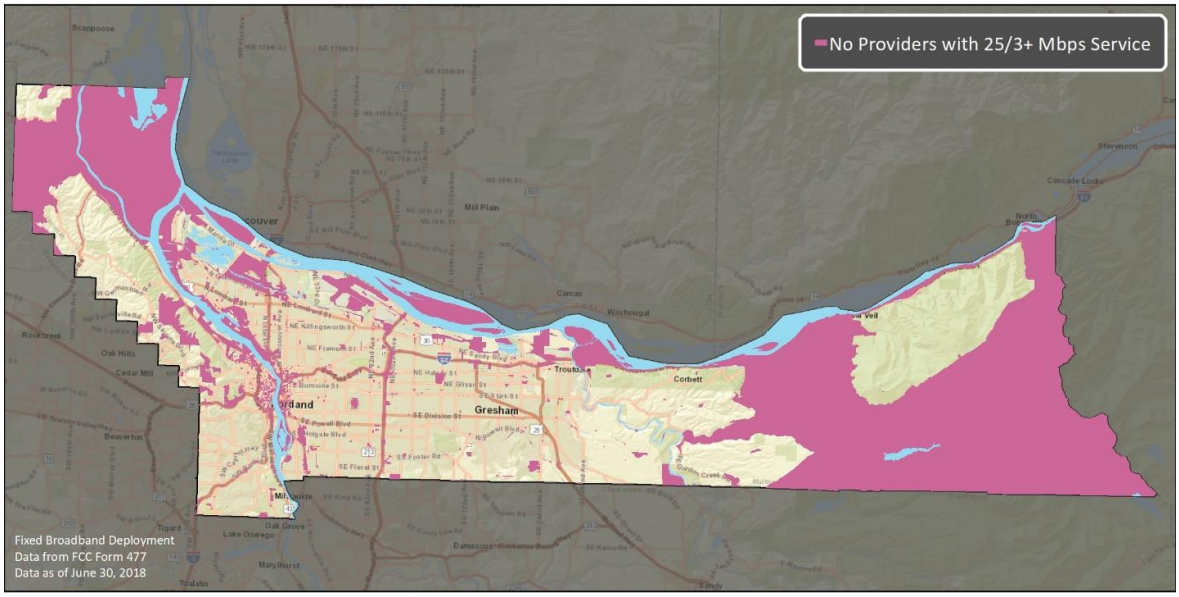
We identified the County's uninhabited areas so we could exclude those areas from our later analysis (Figure 10).

Figure 10: Uninhabited Portions of the County



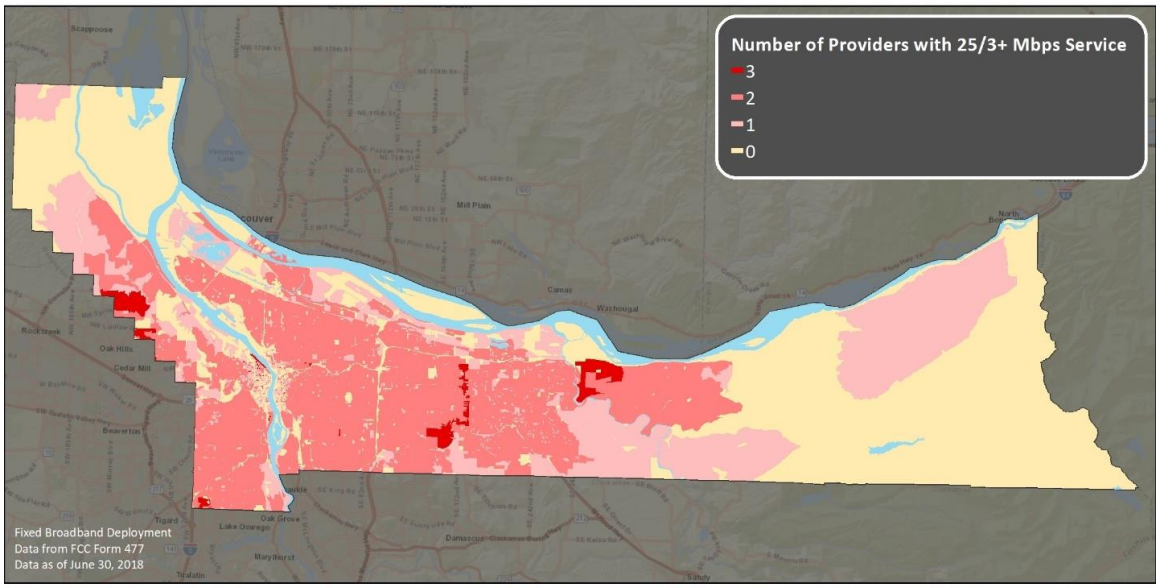
Using the FCC's Form 477 data, we identified census blocks in the County where no provider claims to offer 25/3 broadband service (Figure 11). At a high level, the shaded portions of the map represent the County's unserved geography.

Figure 11: Areas with No Providers Offering 25/3 Service



Looking at the Form 477 data for claimed service, we find that most of the County's served premises have more than one option (Figure 12). We note, too, that CenturyLink recently announced that it would be expanding its fiber service in Portland, among other markets—so this map will change over time.[20]

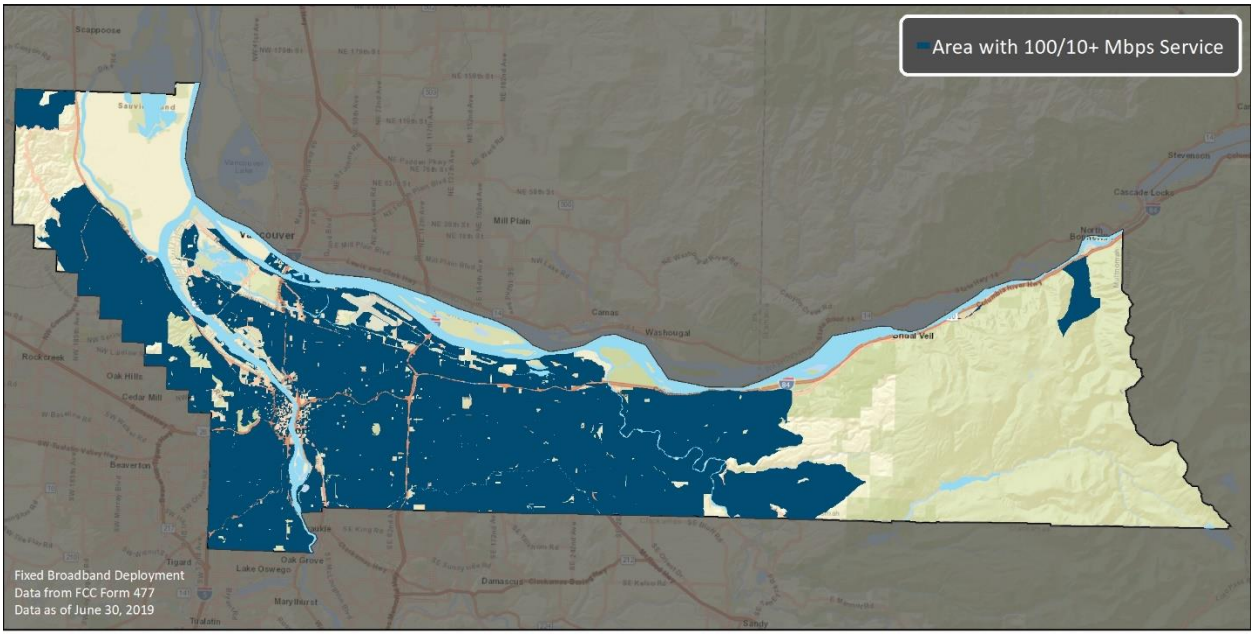
Figure 12: Number of ISPs Reporting 25/3 Service



[20] Stephen Hardy, "CenturyLink expands residential, business fiber-optic network footprints," *Lightwave*, May 19, 2020, https://www.lightwaveonline.com/fttx/ftth-b/article/14176272/centurylink-expands-residential-business-fiberoptic-network-footprints (accessed June 23, 2020).

Because this feasibility study focuses on a scenario in which a competitive fiber-to-the-premises network might be built across the County, we also evaluated the availability of 100/10 or greater service (Figure 13). That map shows that not only do most residents have access to cable and fiber networks, but in the County's more dense areas, the cable is high speed as well.

Figure 13: Areas with 100/10 Service



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. Most areas unserved with 10/1 align with the County's uninhabited areas (Figure 14)—and most areas served by 10/1 have multiple providers (Figure 15).

Figure 14: Areas with No Providers Offering 10/1 Service

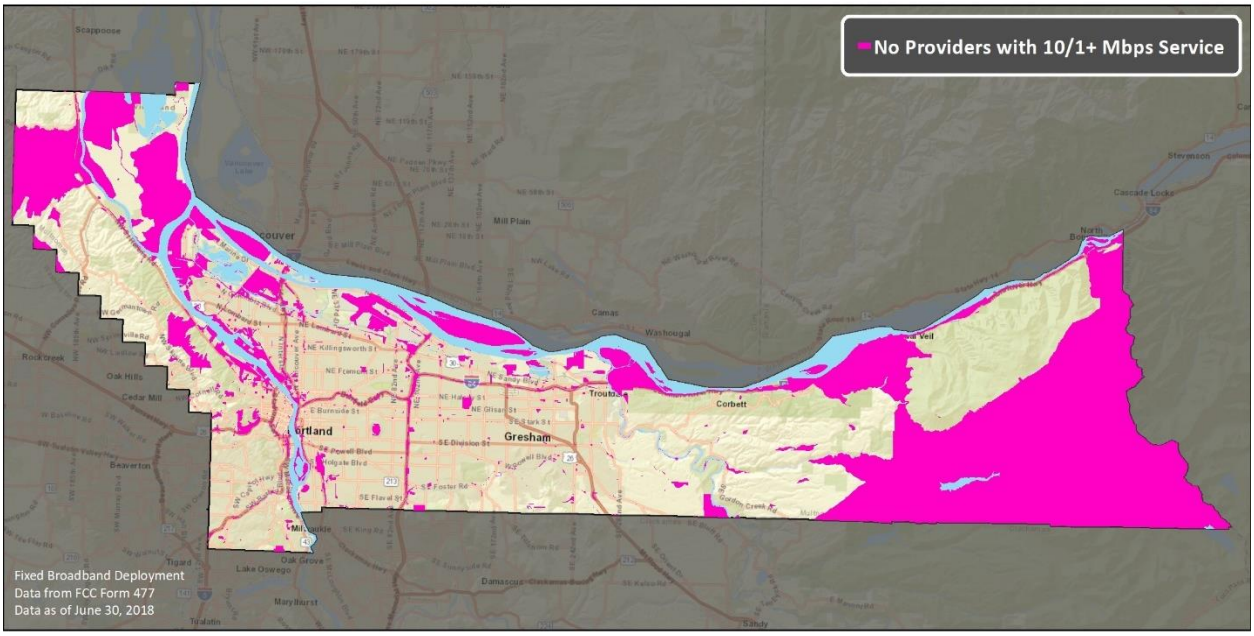
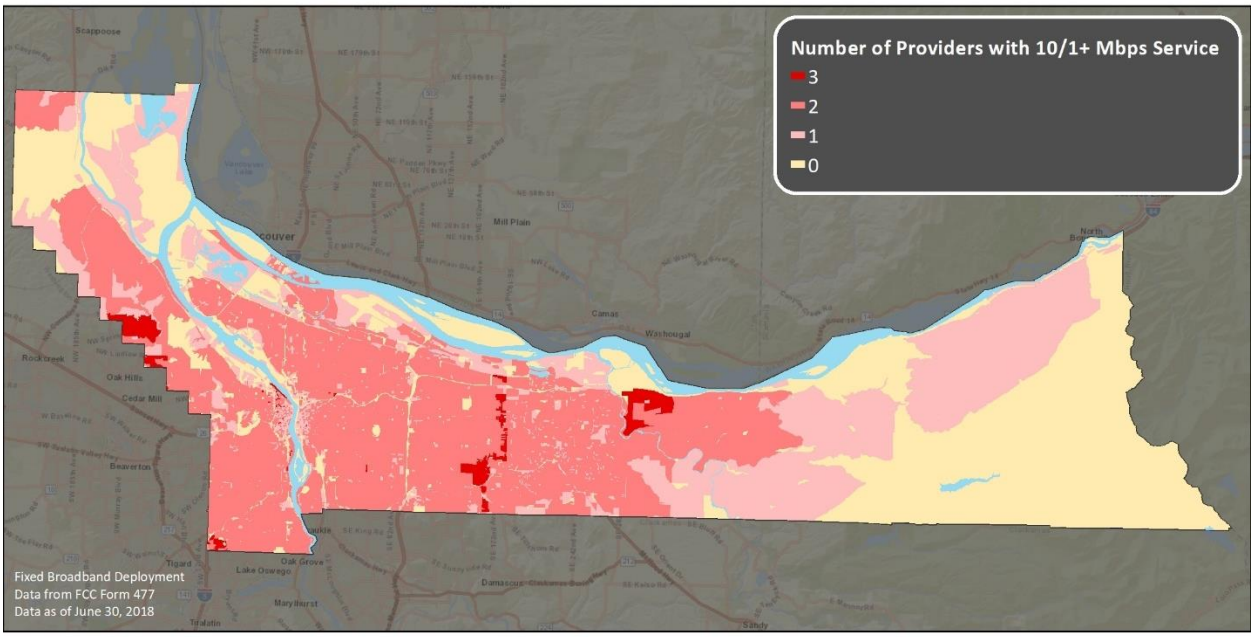


Figure 15: Number of ISPs Reporting 10/1 Service



Drawing on the full range of data we analyzed, we conclude that the County is primarily served (Figure 16) and that a relatively small number of unserved addresses are located in the unserved areas (Figure 17).

Figure 16: Served Areas

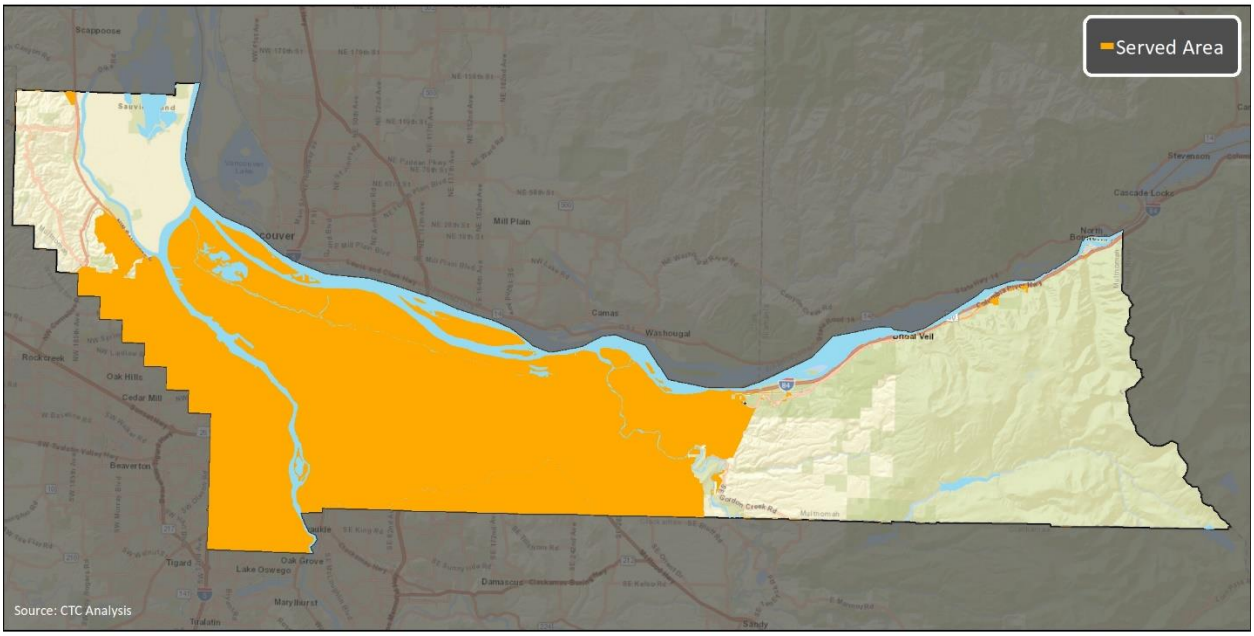
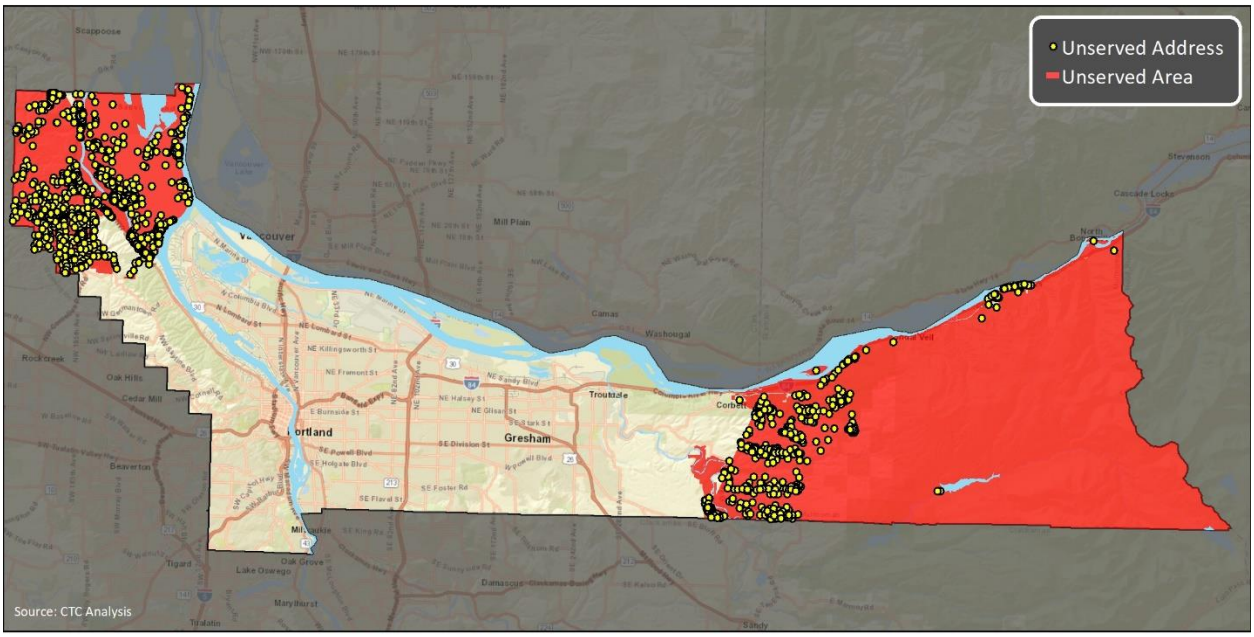


Figure 17: Unserved Addresses in the County



We evaluated the geographic presence of individual broadband providers at a relatively high level using a spot-check methodology based on jurisdictional boundaries. We checked service availability and pricing at a range of randomly selected addresses and found that residential broadband services available at each test address are at speeds and prices comparable to other served markets.

3 Most Households Are Highly Connected but Lower-Income Households Are Less So

The Partner Agencies conducted a survey of residents in February of 2020. A key focus of the survey was to assess residents' internet needs, current use of internet services, demand for high speed broadband, and the role of local government is supporting high speed broadband.

3.1 Key Findings

Key survey findings include the following:

- **Households are highly connected.** 96 percent of households have some form of internet connection. Specifically, 90 percent of residents have home internet service and 84 percent have a cellular/mobile telephone with internet. Only 4 percent lack any form of access to the internet at home.

- **Low-income households are left behind.** Low-income residents are less connected, and connect at lower speeds, than higher-income residents. Lower-income households (less than $50,000 annual income) are less likely than households with a higher income to have internet access at home or via smartphone; 13 percent of low-income households do not have any internet access. The gap grows wider as the internet technology gets faster: only 11 percent of those earning $50,000 or less have fiber optic connections, while the overall average is 17 percent.

  Respondents with just one type of internet connection (either a home internet connection or a smartphone only) are also disproportionately lower income; 6 percent of all respondents, and 12 percent of those earning under $50,000 annually, only use a smartphone for home internet access. This may limit their ability to fully utilize online services at home. Respondents with both types of connections have a higher household income.

  The lower-income households that do have internet connections pay the same as higher-income earners. Household earning $50,000 or less pay on average the same amount as the overall average, around $70. They are also just as likely to have cable as higher earners (56 percent), but they are less likely to have fiber as their primary Internet service (11 percent vs. 17 percent). That said, they are also much less likely to have DSL.

- **Only four in 10 respondents agreed or strongly agreed that the market currently provides high-speed internet at prices they can afford**, suggesting some need for affordable broadband internet among a segment of respondents. Just four in 10 are willing to pay a premium for access to high-speed internet.

- **Cable is the most-used internet technology, but fiber performs the best.** Cable modem (56 percent) is the leading internet service used, while 17 percent of households have fiber and 17 percent have DSL. Fiber is somewhat more prevalent in the greater Gresham, Fairview, Troutdale, Wood Village areas (24 percent).

- **Connection reliability ranks as the most important internet service aspect** among the County's internet subscribers, followed by price and connection speed. Internet users are moderately to very satisfied with their internet service, but the extremely high importance placed on some factors may signal some willingness to switch providers if needs are not being met.

  Fiber optic providers are better at meeting customer expectations for customer service and price of service, compared with DSL and cable modem providers. The leading provider types are performing equally as well for connection speed and reliability.

- **Reliability, speed, and price can all be factors in considering switching to fiber**, but less likely if a resident is already a fiber customer. Cable modem subscribers are more likely than those with other internet services to switch their provider and are less likely to renew their contract. Fiber subscribers are more likely than others to recommend their provider to someone else.

- **Net neutrality could be a factor in considering switching ISPs.** Three-fourths of respondents would consider net neutrality when selecting an ISP. Those who reside in the Gresham, Fairview, Troutdale, and Wood Village region would be less likely to consider net neutrality (57 percent) and are more likely to be unsure (34 percent).

  More than one-half of respondents (53 percent) said that confidence in their service provider treating all traffic in a net neutral way is extremely important. Importance is somewhat higher among respondents with an annual household income under $50,000 (76 percent extremely important).

- **High-speed, reliable broadband at home is increasingly critical for work and other purposes.** More than one-half of respondents (55 percent) said their job requires them to have internet access at home. Those residing in the Gresham, Fairview, Troutdale, Wood Village region as a whole (49 percent) are less likely to have a job that requires home internet access, compared with Portland residents (59 percent) and those who live in unincorporated/other areas of the County (62 percent).

  Additionally, 34 percent of Multnomah County residents telework, 69 percent use the internet for healthcare services, and 46 percent use the internet for educational

purposes. With the exception of education, those in the Gresham, Fairview, Troutdale, Wood Village region expressed lower usage of the internet for these activities.

- **There is strong support for governments to play an active role in delivering broadband.** Overall, there is strong support for ensuring access to competitively priced broadband services. Approximately six in 10 respondents strongly agreed with these statements. Residents of the Gresham, Fairview, Troutdale, Wood Village region were less likely to agree that the Partner Agencies should ensure access to competitively priced broadband internet services, compared with those who reside in Portland and other areas.

  Nearly one-half of respondents feel the Partner Agencies should build a broadband network, including 36 percent of respondents who feel the Partner Agencies should operate the network. This opinion is somewhat more popular among Portland residents compared with residents of other areas.

- **The appetite for a government-operated network likely depends heavily on price point.** As mentioned, reliability, speed, and price were rated the most important aspect of service by far. This was most pronounced for cable subscribers. But when existing subscribers were asked the price point at which fiber would be desirable, $50 was the sweet spot. After that, interest faded rapidly with each $10 increment. This suggests that the most likely consumers to consider switching would be cable customers, and if the price is low enough, DSL costumers.

  While costumers rated reliability and speed higher in importance, the gap between performance of service and satisfaction of service was highest on price—suggesting that price may be the primary mover in switching decisions. (Considering that a government-run network would be a second, third, and sometimes even fourth entrant into high-speed broadband delivery, it would be difficult to price service at $50 or lower to translate into a serious consideration to switch.)

- **Support for a government-operated network is fairly strong countywide, but drops for the Cities.** Support for a publicly built and operated network is supported by more than half the respondents countywide. That is fairly high, especially considering that, theoretically, most of the population has access to high-speed internet. Conversely, only a quarter oppose that idea outright.

  And it is specifically the publicly operated aspect of this approach that respondents like. Support drops a bit if a private entity operates a publicly built and owned network, suggesting Multnomah County residents trust public institutions more than private companies when it comes to delivering an essential utility fairly and effectively.

However, that support is significantly less robust in the Cities than countywide. Less than half the Cities' populations support the publicly run model. (See charts below.)

Figure 18: Support of the County's Role in Broadband Internet – Countywide Respondents

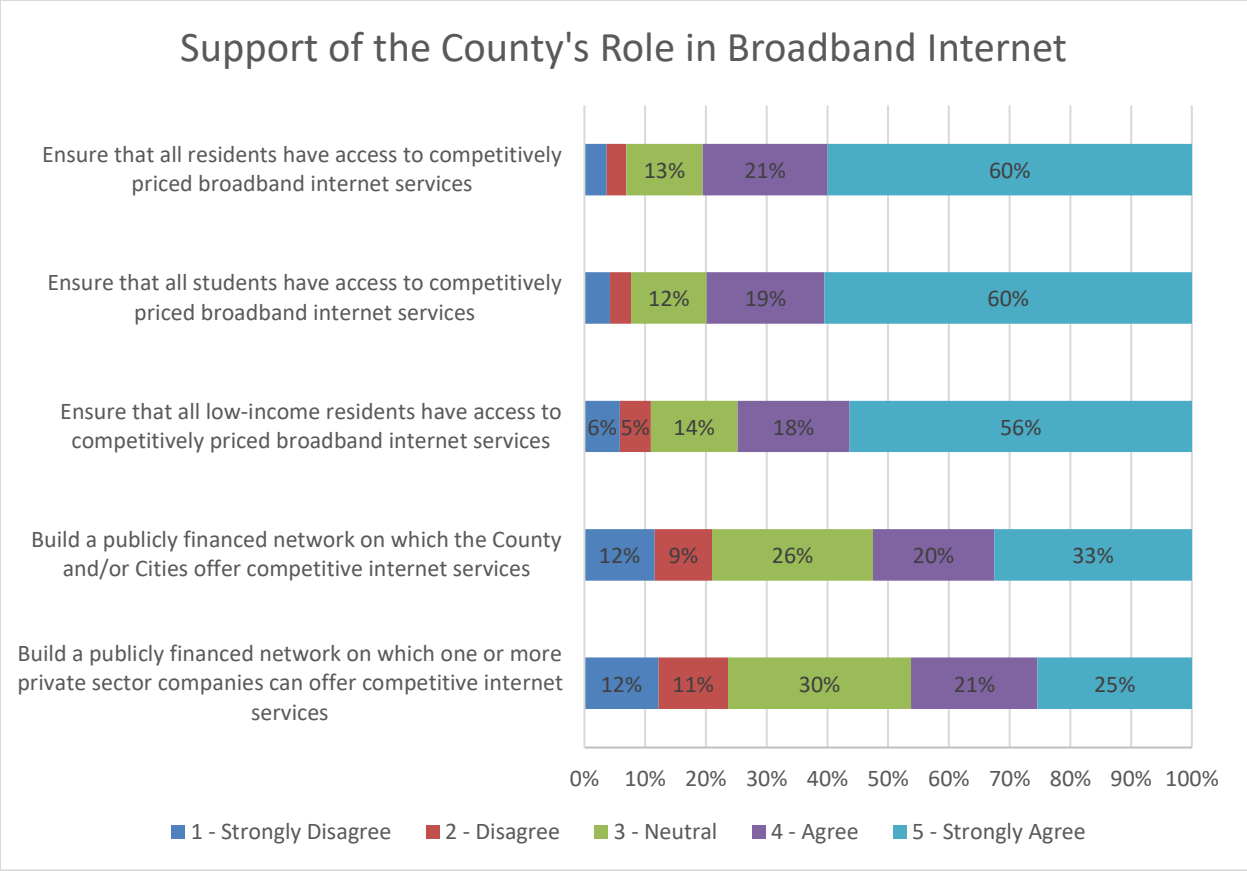
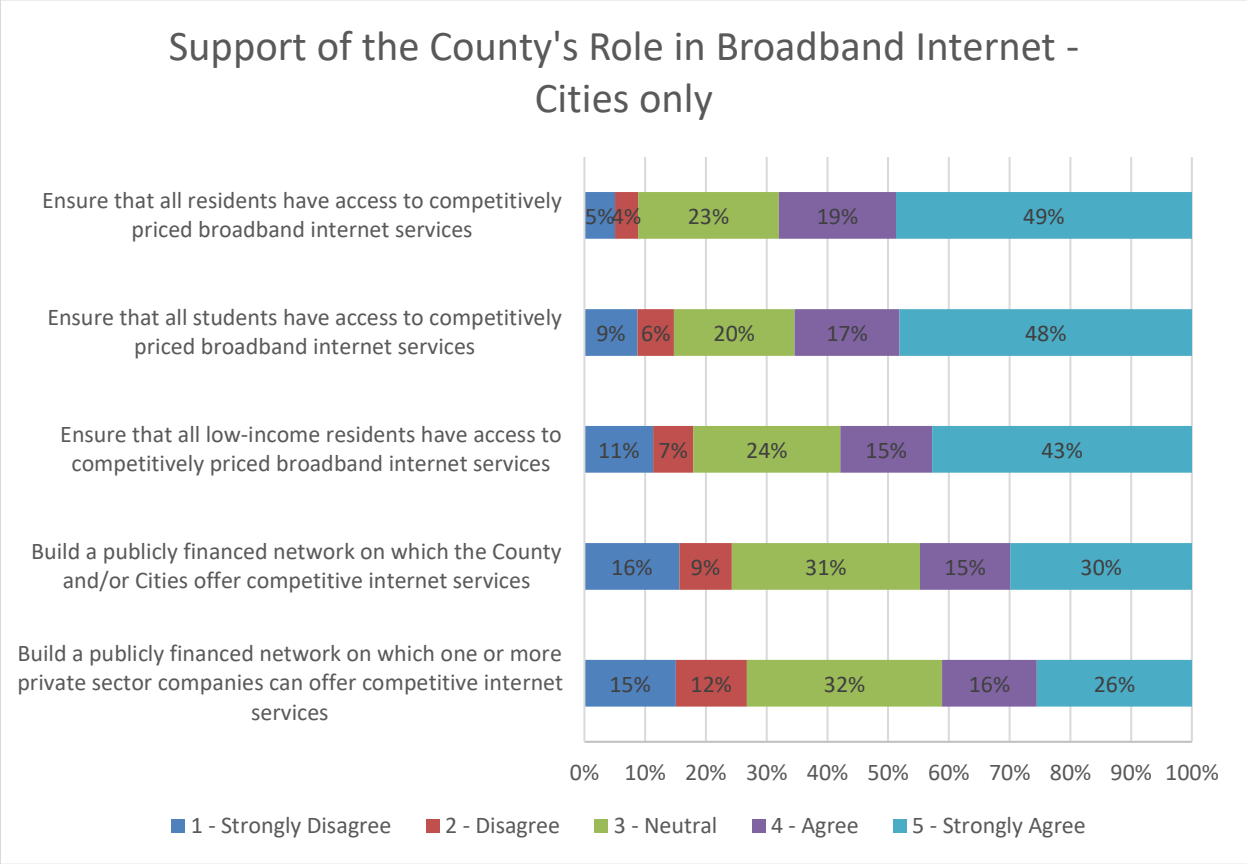


Figure 19: Support of the County's Role in Broadband Internet – City-only Respondents



- **Public perceptions of local government's role would depend on a range of factors.** The distribution of fiber-to-the-premises service is not uniform. Residents of the Cities are significantly more likely to have fiber than those in Portland, suggesting a government-operated solution would have less support and less appetite for public subsidy in those areas. And in Portland, much of the inequality in high-speed broadband provision tracks with low-income populations and areas—suggesting that a targeted approach would be more effective.

  The County's unincorporated areas have the lowest penetration of fiber, but they would also be the most expensive to build—and the economics of extending fiber to those areas is not terribly favorable. At the same time, a government-operated network that picks and choses the areas in which to operate—focusing on areas without fiber competition—would fit poorly into a universal service model of delivery that underpins support for a strong government role in equitable broadband provision.

3.2 Survey Process

A total of 6,666 survey packets were mailed first-class in February to a random selection of residential households with a goal of receiving at least 800 valid responses. Recipients were provided with a postage-paid business reply mail envelope in which to return the completed questionnaire.

The sample was stratified into three regions, with the goal of receiving 400 questionnaires per region: 1) Portland, 2) Gresham, Fairview, Troutdale, Wood Village, and 3) other towns and unincorporated areas. Key comparisons by region are presented in the report.

A total of 1,125 useable surveys were received by the date of analysis, providing a gross response rate of 16.9 percent. The margin of error for aggregate results at the 95 percent confidence level for 1,125 responses is ±2.9 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 ±2.9 percent of the target population as a whole (roughly 322,000 households in Multnomah County).

The survey responses were entered into SPSS[21] software and the entries were coded and labeled. SPSS databases were formatted, cleaned, and verified prior to the data analysis. Address information was merged with the survey results using the unique survey identifiers printed on each survey. 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 region. 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 County's adult population.

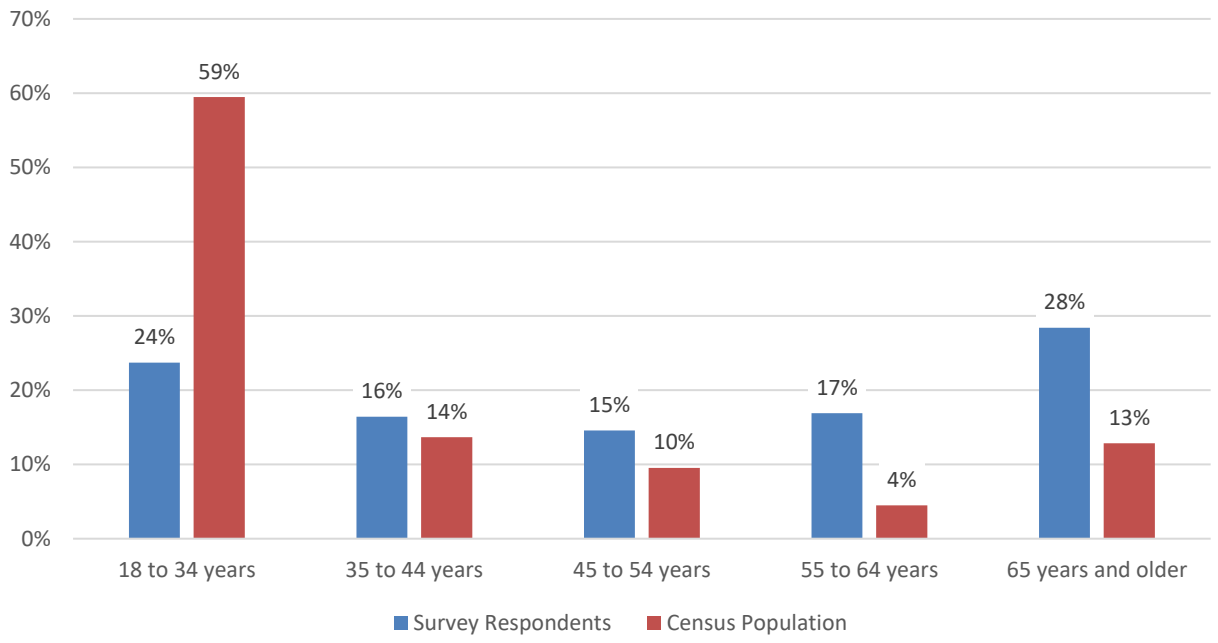
Table 7 and Figure 20 summarize the sample and population distributions by region and age.

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

Table 7: Region of Respondents and Population

Region	Population	Population %	Sample**	Sample %
Portland	650,000	79.3%	401	35.9%
Gresham, Fairview, Troutdale, Wood Village	145,000	17.7%	308	27.6%
Other towns/unincorporated areas	25,000	3.0%	407	36.5%
Total	820,000		1,116	
**Not all respondents provided their age.				

Figure 20: Age of Respondents and Adult Population



The following sections summarize the survey findings.

3.3 Survey Results

The results presented in this report are based on analysis of information provided by 1,125 respondents from an estimated 322,000 residences in Multnomah County. Results are representative of the set of households with a confidence interval of ±2.9 percent at the aggregate level.

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.

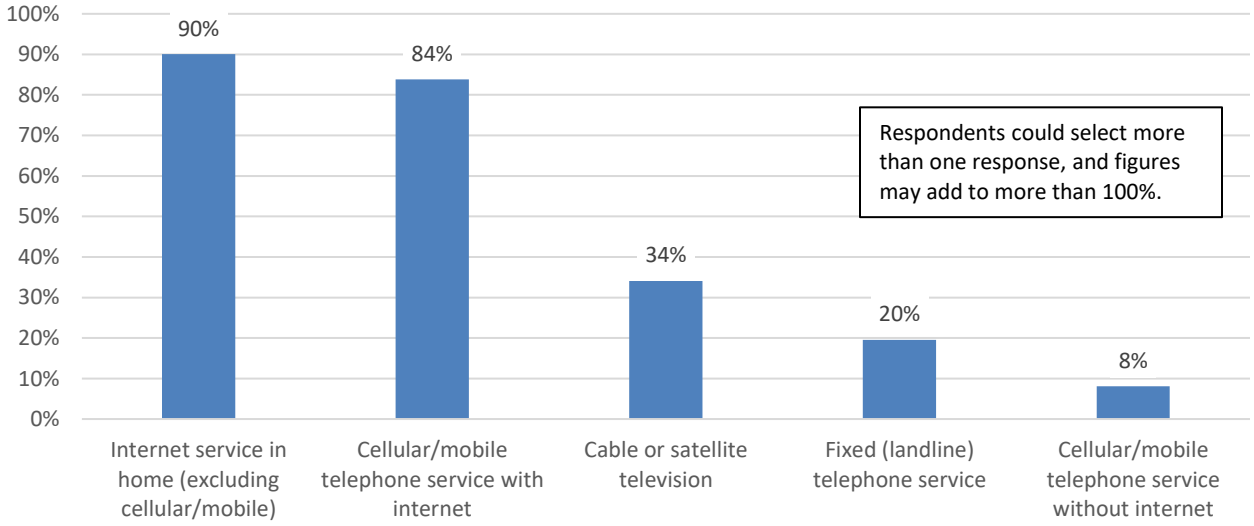
3.3.1 Home Internet Connection and Use

Respondents were asked about their home internet connection types and providers, use of the internet for various activities, and satisfaction and importance of features related to internet service. This information provides valuable insight into residents' need for various internet and related communications services.

3.3.1.1 Communications Services

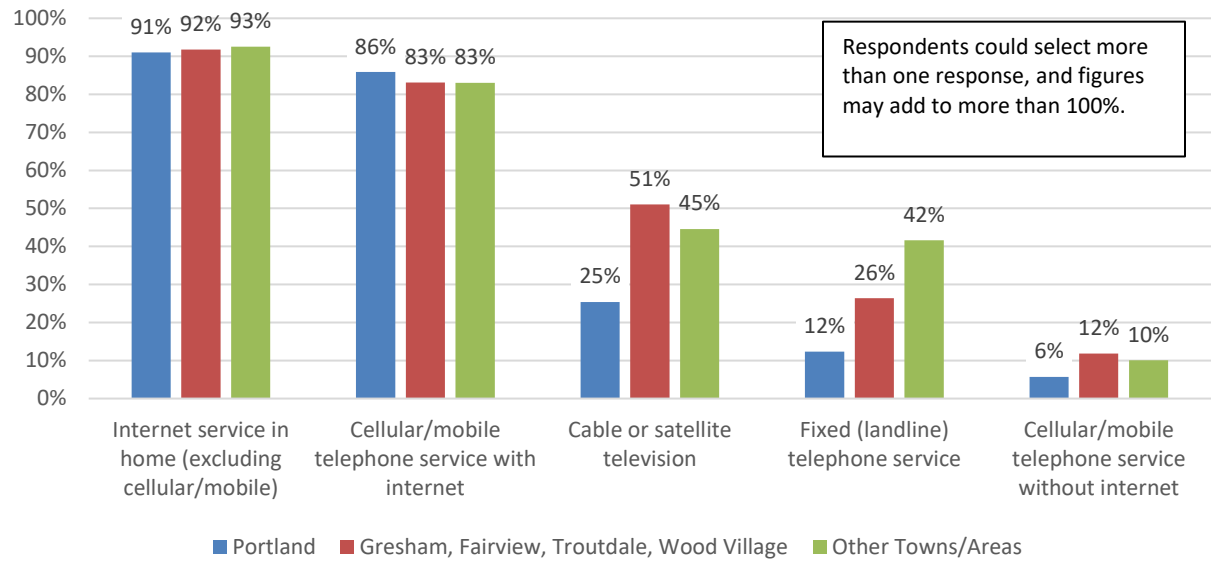
Respondents provided information about the communications services currently purchased for their household. As illustrated in Figure 21, almost all households have internet access, including nine in 10 with internet service in the home and 84 percent with cellular/mobile telephone service with internet. Fewer households have cable/satellite television service, landline telephone service, or cellular/mobile telephone service without internet. Overall, 96 percent of respondents indicated having some internet access—either a home connection or via smartphone.

Figure 21: Communication Services Purchased



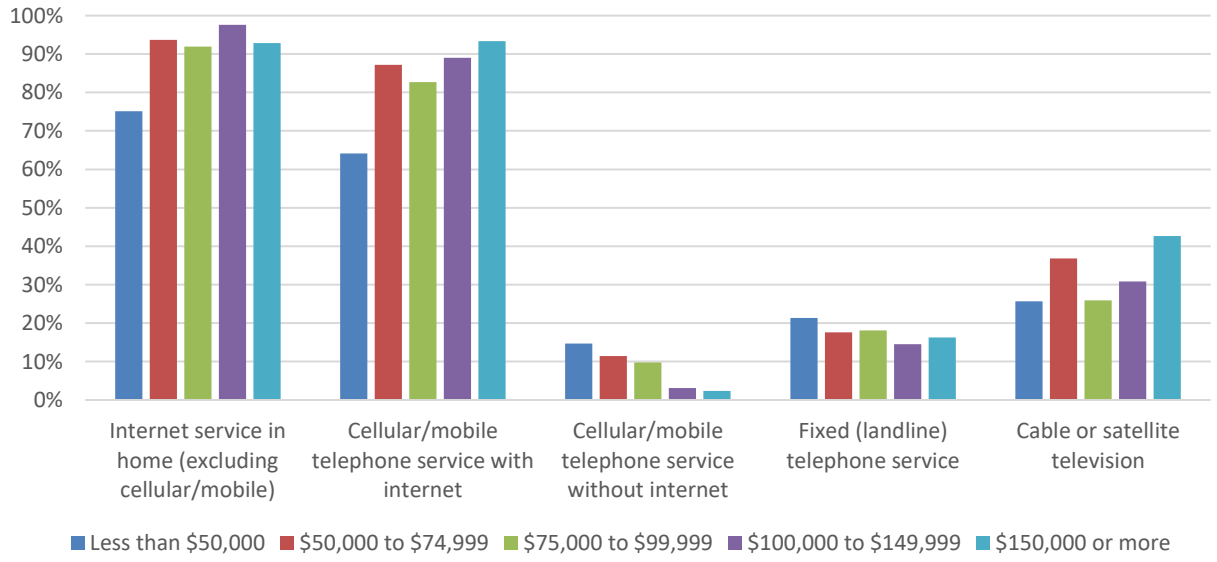
As illustrated in Figure 22, Portland residents are less likely than residents of other areas to have cable or satellite television, landline telephone service, or cellular/mobile telephone service without internet. Notably, the Portland area has a greater share of younger respondents under age 45 who in turn are less likely to purchase these services.

Figure 22: Services Purchased by Region



Use of internet service is correlated with household income. Lower-income households (less than $50,000 annual income) are less likely than households with a higher income to have internet access at home or via smartphone, as illustrated in Figure 23.

Figure 23: Services Purchased by Household Income



As discussed previously, most respondents have some internet access, including 77 percent who have both home internet service and a cellular/mobile telephone service with internet (smartphone). Another 6 percent of respondents have a smartphone only (no home internet), and 13 percent have a home connection only (no smartphone). Total internet access by demographics is illustrated in Table 8.

Table 8: Internet Access by Key Demographics

	No Internet Service	Home Internet Connection	Smartphone	Both Home/ Smartphone	Total Internet Access	*Total Weighted Count*
TOTAL	**4%**	**13%**	**6%**	**77%**	**96%**	***1,125***
Respondent Age						
18 to 34 years	2%	12%	2%	84%	98%	*232*
35 to 44 years	1%	7%	2%	90%	99%	*353*
45 to 54 years	2%	10%	13%	74%	98%	*176*
55 to 64 years	6%	17%	10%	67%	94%	*165*
65 years and older	8%	22%	10%	60%	92%	*168*
Education						
HS education or less	12%	19%	14%	55%	88%	*156*
Two-year college/tech	2%	18%	8%	72%	98%	*151*
Four-year college degree	1%	11%	5%	84%	99%	*402*
Graduate, prof, doc degree	2%	9%	5%	83%	98%	*386*
Household Income						
Less than $50,000	13%	23%	12%	52%	87%	*180*
$50,000 to $74,999	1%	12%	5%	82%	99%	*198*
$75,000 to $99,999	1%	16%	7%	76%	99%	*173*
$100,000 to $149,999	0%	11%	2%	87%	100%	*224*
$150,000 or more	2%	5%	5%	88%	98%	*222*
Race/Ethnicity						
Other race/ethnicity	6%	10%	7%	77%	94%	*178*
White/Caucasian only	3%	12%	7%	78%	97%	*910*
Total Household Size (Adults + Children)						
1	10%	17%	11%	61%	90%	*245*
2	1%	11%	6%	82%	99%	*483*
3	0%	12%	6%	82%	100%	*187*
4 or more	3%	11%	2%	84%	97%	*191*
Children in Household						
No Children in HH	4%	14%	7%	74%	96%	*853*
Children in HH	0%	6%	4%	90%	100%	*253*
Own/Rent Residence						
Own	3%	12%	6%	80%	97%	*792*
Rent	5%	14%	8%	73%	95%	*313*
Years at Residence						
Less than 1 year	5%	20%	3%	72%	95%	*136*
1 to 2 years	1%	11%	5%	84%	99%	*152*
3 to 4 years	0%	5%	5%	90%	100%	*216*
5 or more years	5%	14%	8%	74%	95%	*600*

3.3.1.2 Importance of Communication 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 24, while detailed responses are illustrated in Figure 25.

Figure 24: Importance of Communication Service Aspects (Mean Ratings)

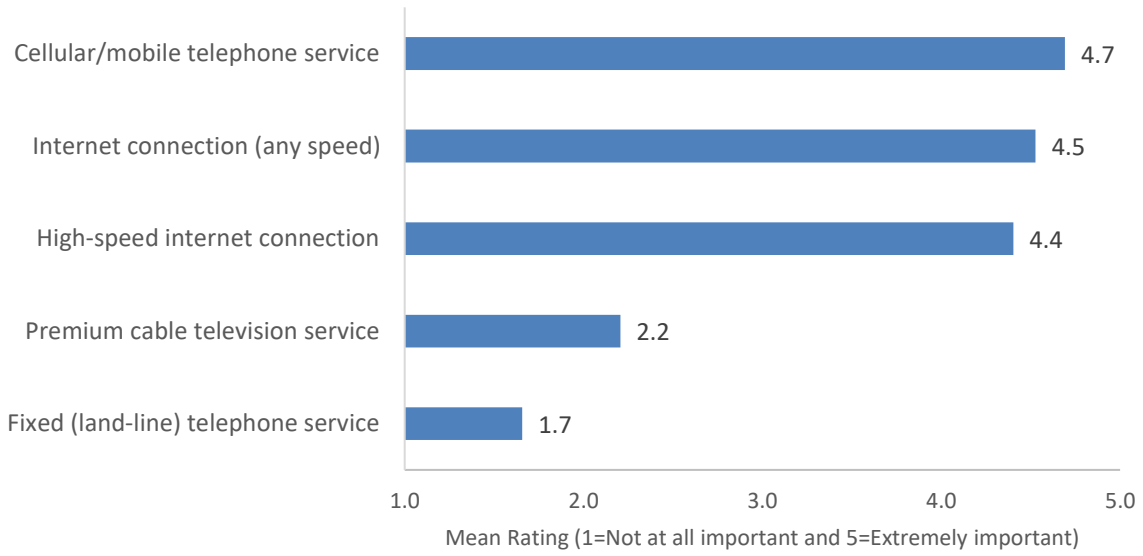
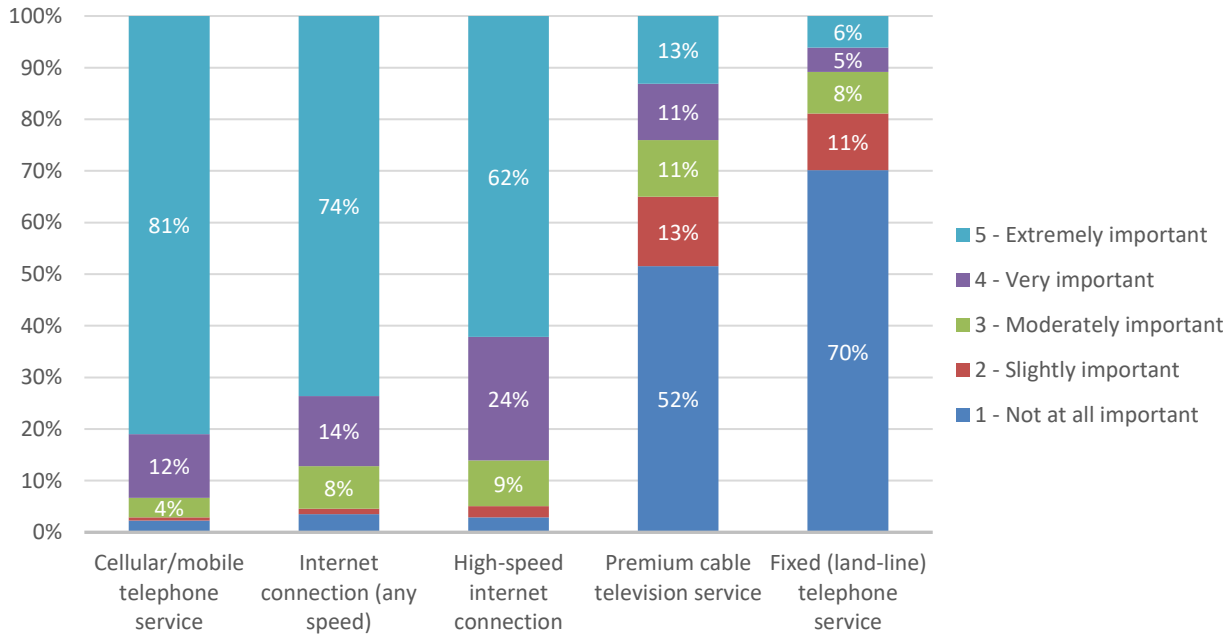


Figure 25: Importance of Communication Service Aspects



Cellular/mobile telephone and internet services are extremely important to respondents, while premium cable television service and fixed (landline) telephone service are significantly less important. Specifically, 81 percent said cellular/mobile phone service is extremely important, and 74 percent said an internet connection of any speed is important. Another 62 percent of respondents said high-speed internet is extremely important.

Figure 26: Importance of Communication Services by Respondent Age

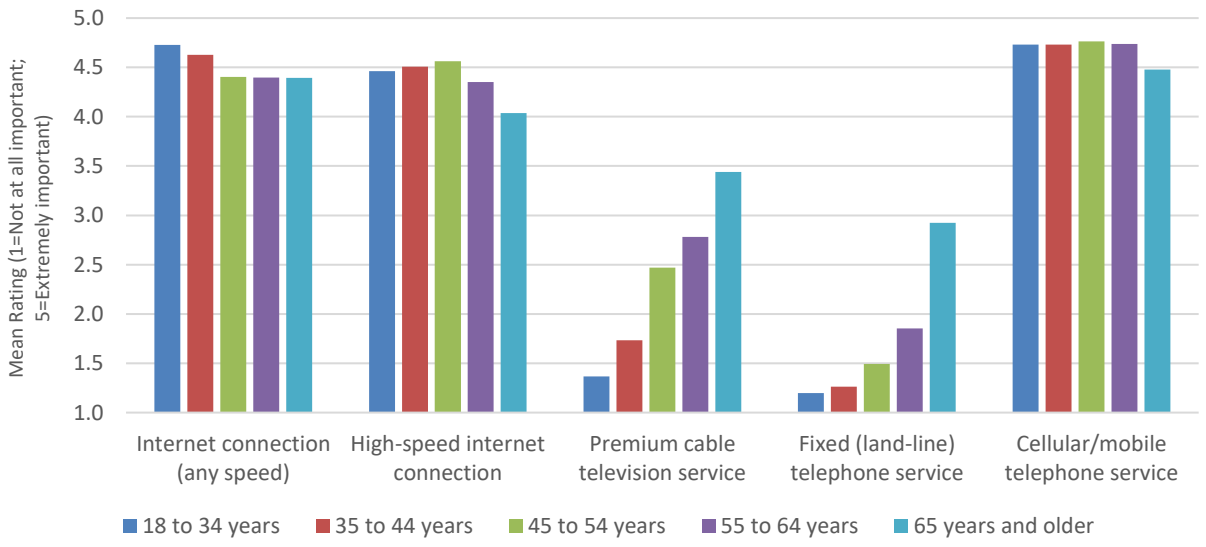


Figure 27: Importance of Communication Services by Household Income

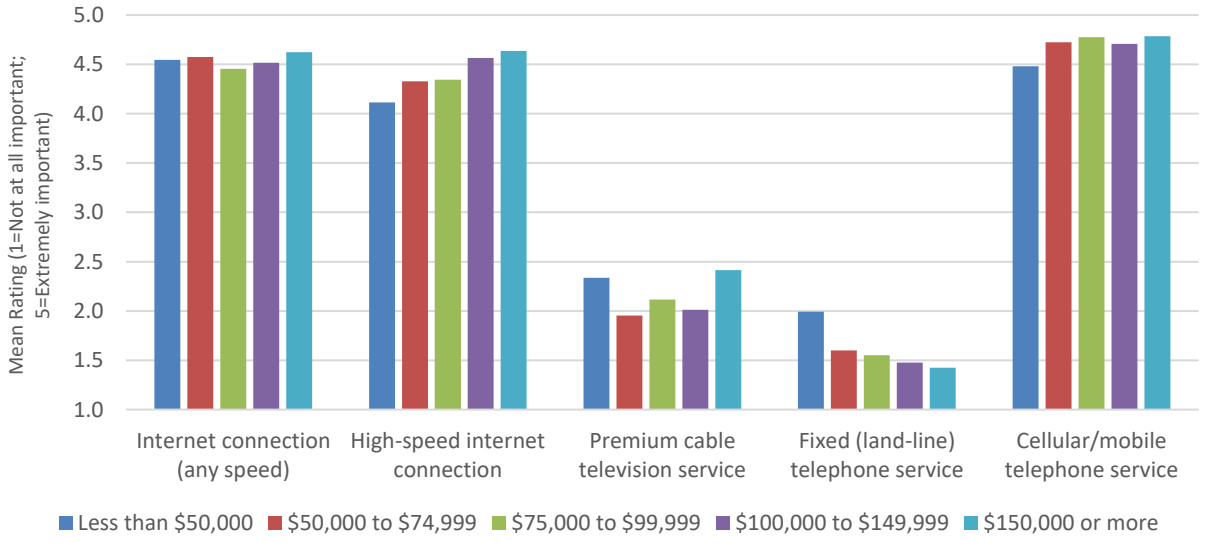


Figure 26 and Figure 27 illustrate the importance of high-speed internet service by the age of the respondent and by household income. The importance of internet services is slightly lower for older and lower-income households compared with their counterparts.

3.3.1.3 Internet Services Purchased

Respondents were asked about their purchase of internet services for their home. As shown in Figure 28, a majority of homes (96 percent) reported having home internet service, consistent with 96 percent reporting internet access via a home connection or via a smartphone in Question 1. Cable modem (56 percent) is the leading internet service used, while 17 percent of households have fiber and 17 percent have DSL. Fiber is somewhat more prevalent in the greater Gresham, Fairview, Troutdale, Wood Village area (see Figure 29).

Figure 28: Primary Home Internet Service

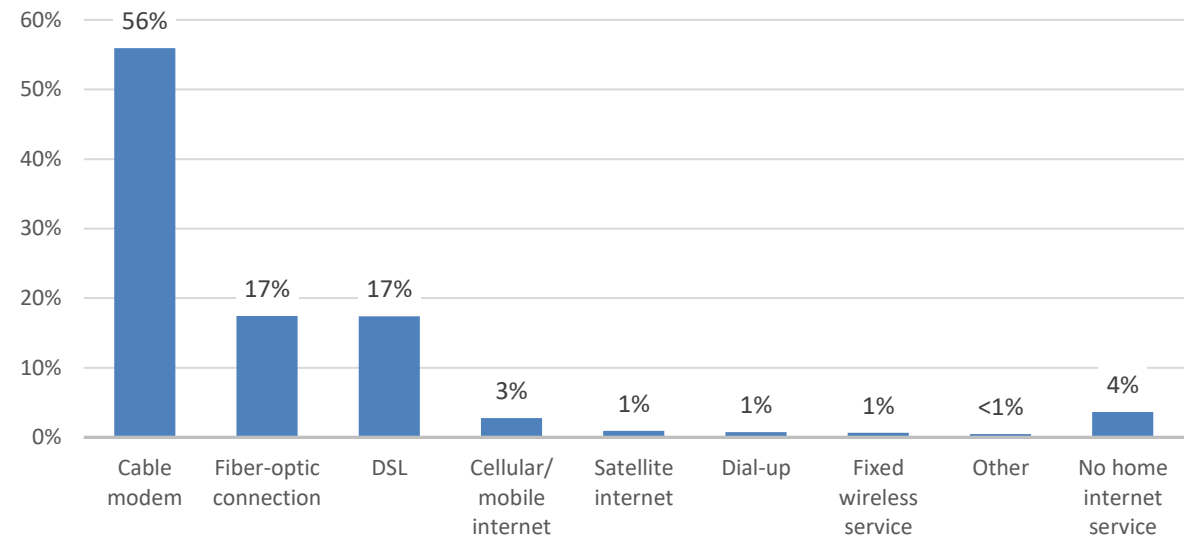
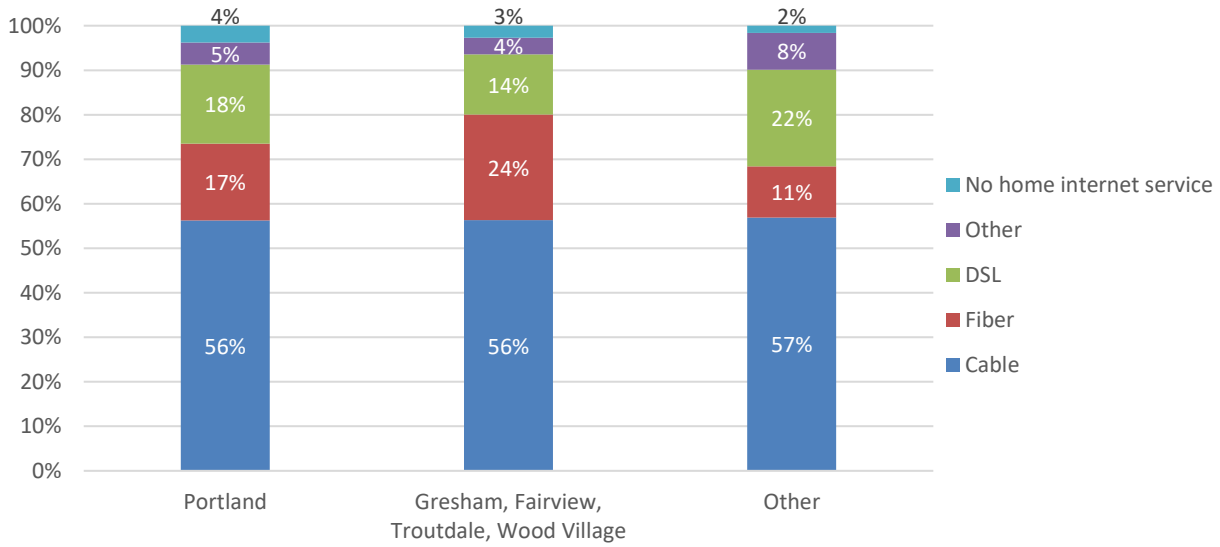


Figure 29: Primary Home Internet Service by Region



3.3.1.4 Internet Service Aspects

Home internet subscribers were asked to evaluate their satisfaction with various internet service aspects. This was compared with importance ratings given for these same aspects. The importance and satisfaction levels among internet users are compared in the following tables and graphs.

3.3.1.4.1 Importance

Respondents rated connection reliability as the most important home internet service aspect, with almost nine in 10 saying it is extremely important, as shown in Table 9. Approximately six in 10 said price of services and connection speed are extremely important. The ability to bundle with television and phone service is not important compared with other service aspects.

Table 9: Importance of Internet Service Aspects

Service Aspect	Mean	Percentages
Speed of Connection	4.4	9% 32% 58%
Reliability of Connection	4.9	10% 88%
Price of Services	4.4	14% 25% 60%
Overall Customer Service	4.0	25% 32% 37%
Ability to Bundle with TV and Phone	2.0	55% 15% 16% 7% 8%

1 - Not at all important; 2 - Slightly important; 3 - Moderately important; 4 - Very important; 5 - Extremely important

3.3.1.4.2 Satisfaction

Overall, respondents are very satisfied with speed and reliability of their internet connection, as shown in Table 10. They are less satisfied with price, customer service, and ability to bundle with TV and phone service. The lower satisfaction levels could indicate a desire for improved service offerings or a willingness to switch internet service providers if needs are not being met.

Table 10: Satisfaction with Internet Service Aspects

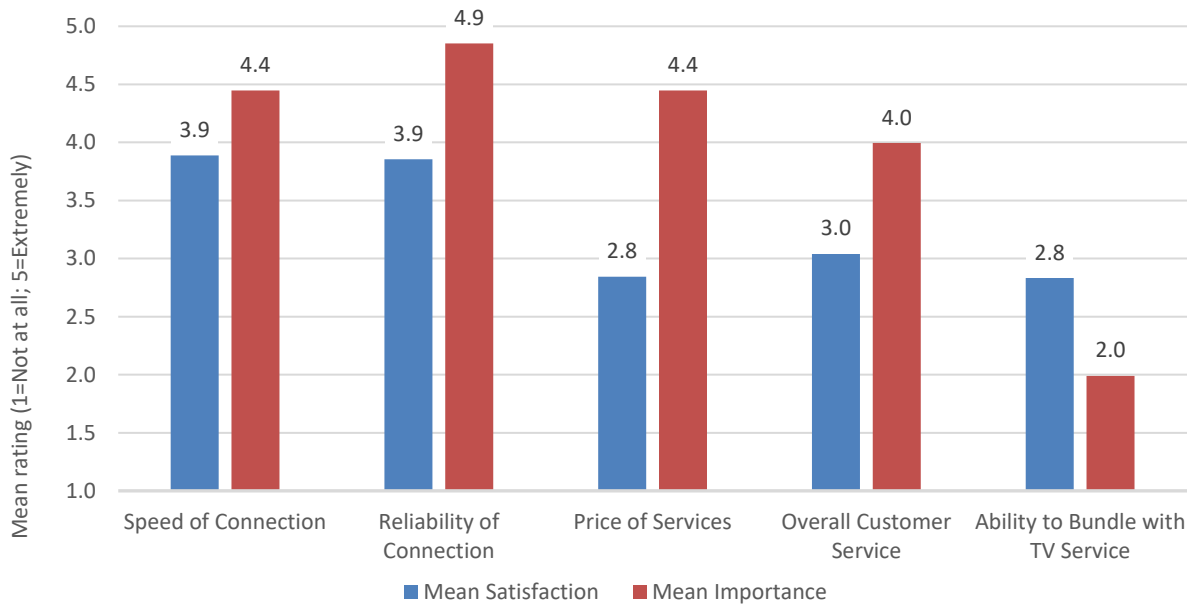
Service Aspect	Mean	Percentages
Speed of Connection	3.9	4% 25% 43% 27%
Reliability of Connection	3.9	8% 19% 43% 28%
Price of Services	2.8	16% 22% 34% 19% 9%
Overall Customer Service	3.0	10% 18% 37% 26% 8%
Ability to Bundle with TV and Phone	2.8	23% 8% 42% 18% 9%

1 - Very dissatisfied; 2 - Slightly satisfied; 3 - Moderately satisfied; 4 - Very satisfied; 5 - Extremely satisfied

3.3.1.4.3 Performance

Comparing respondents' stated importance and satisfaction with service aspects allows an evaluation of how well internet service providers are meeting the needs of customers (see Figure 30). Aspects that have higher stated importance than satisfaction can be considered areas in need of improvement. Aspects that have higher satisfaction than importance are areas where the market is meeting or exceeding customers' needs. However, it should be cautioned that the extremely high level of importance placed on some aspects (such as reliability) may make it nearly impossible to attain satisfaction levels equal to importance levels.

Figure 30: Importance of and Satisfaction with Internet Service Aspects



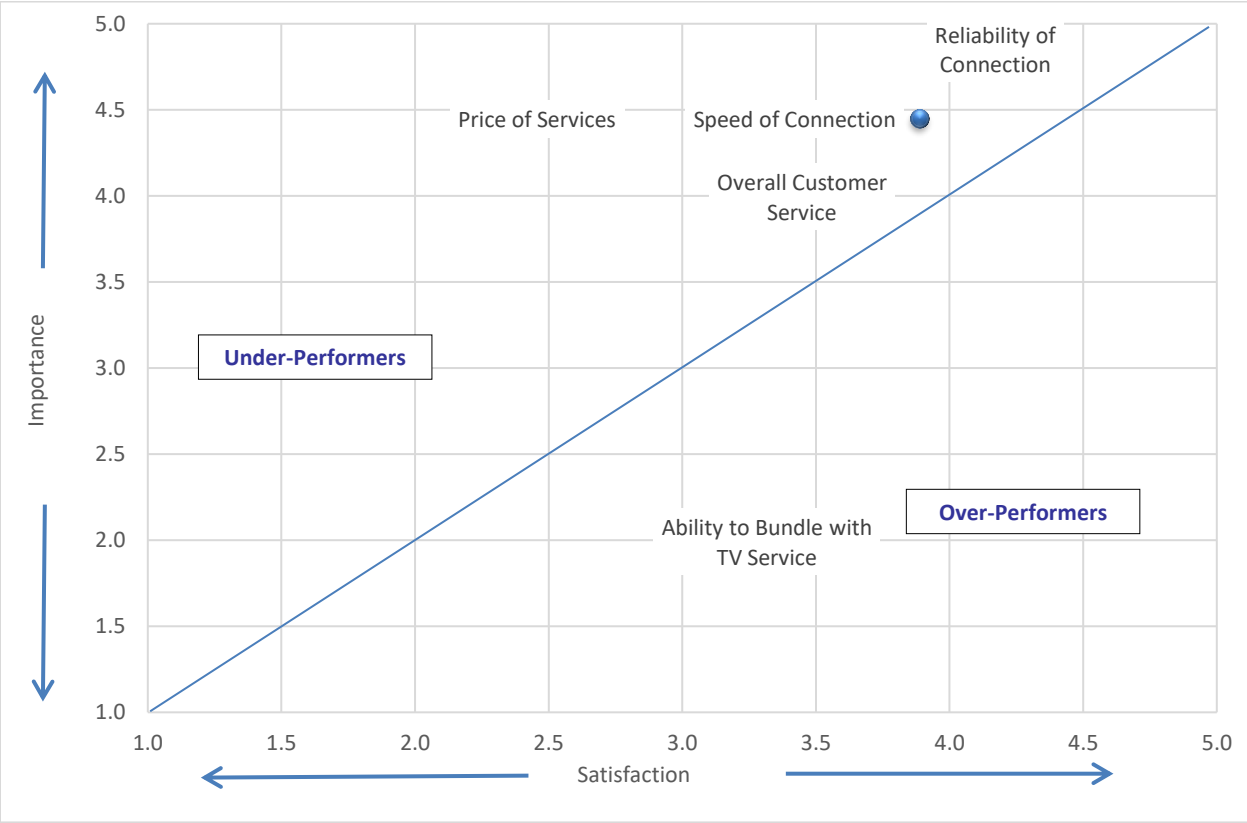
The difference between importance and satisfaction of home internet aspects is also presented in the "gap" analysis table (see Table 11). The largest gaps between importance and performance is for price of services, followed by reliability of connection and overall customer service. The ability to bundle exceeded expectations, given the low importance placed on this service aspect.

Table 11: Internet Service Aspect "Gap" Analysis

	Mean Satisfaction	Mean Importance	GAP < = >	Customer Expectations
Price of Services	2.8	4.4	-1.6	Not Met
Reliability of Connection	3.9	4.9	-1.0	Not Met
Overall Customer Service	3.0	4.0	-1.0	Not Met
Speed of Connection	3.9	4.4	-0.6	Not Met
Ability to Bundle with TV Service	2.8	2.0	0.8	Exceeded

The importance scores and performance scores were plotted to help visually determine areas in which internet service providers are doing well and areas that might need improvement. Figure 31 compares the importance and satisfaction in a "quadrant" analysis. Those aspects for which importance is higher than satisfaction are above the equilibrium line and are defined as "underperformers." As is typical, the cost of internet service is well off the line, as satisfaction with costs is typically low. Reliability, connection speed, and customer service are other under-performing service areas. The low satisfaction levels could indicate a desire for improved service offerings or a willingness to switch internet service providers if needs are not being met.

Figure 31: Internet Service Aspect "Quadrant" Analysis



Specifically, fiber optic subscribers have a higher level of satisfaction with price of services and overall customer service, compared with DSL and cable modem users (the leading connection types in the market area) as shown in Figure 33. DSL users are somewhat less satisfied with connection speed, but this service aspect is also less important to them compared with other internet subscribers (see Figure 32).

Figure 32: Importance of Internet Service Aspects by Primary Home Internet Service

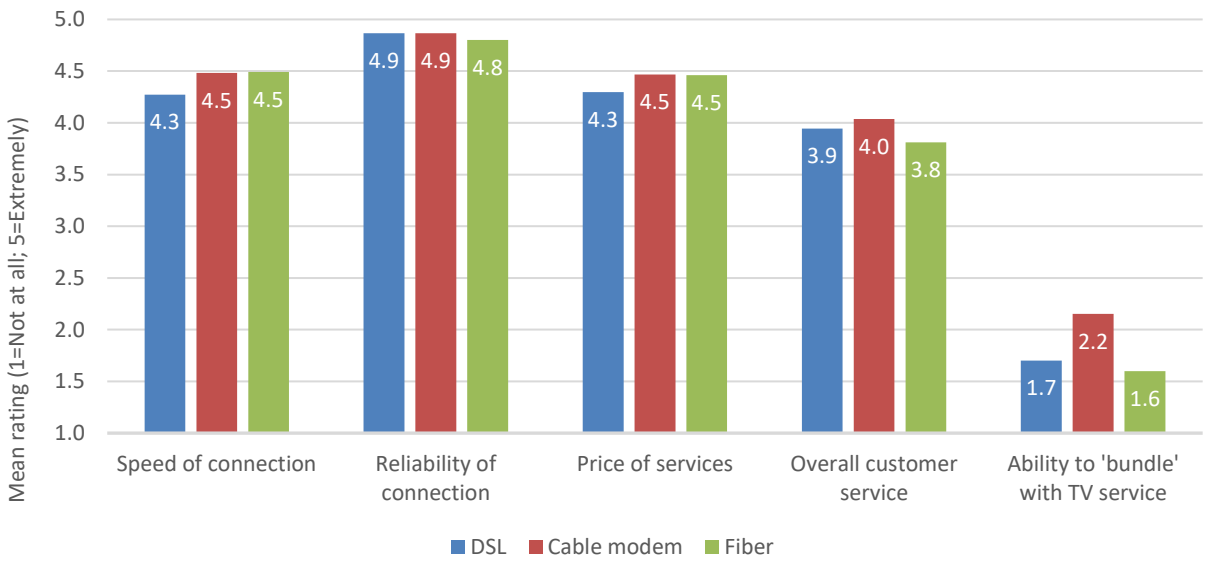
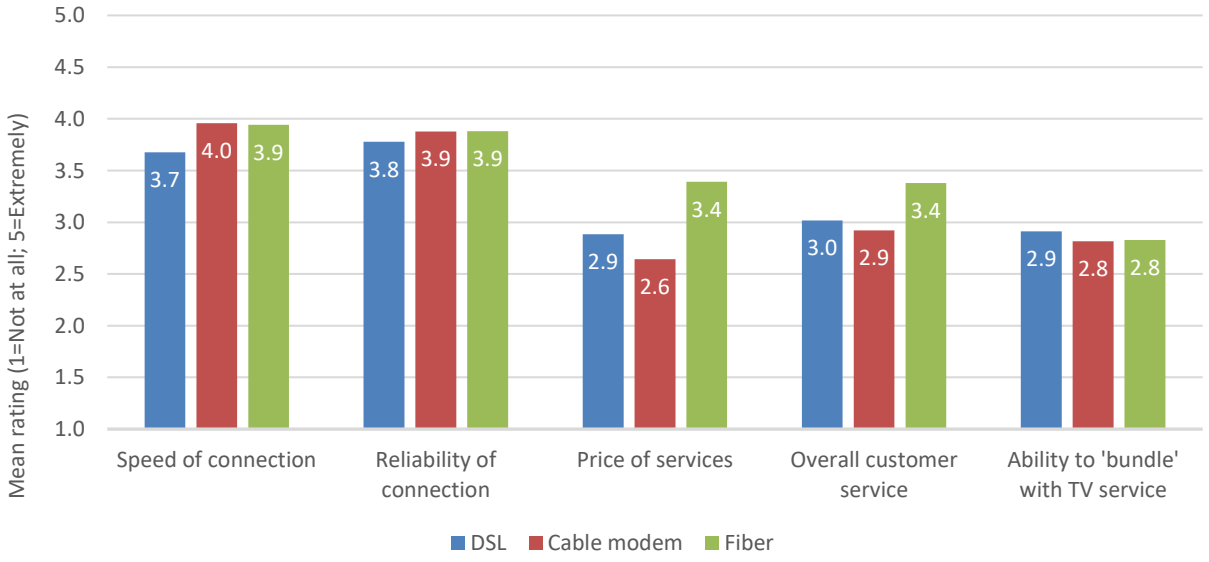


Figure 33: Satisfaction with Internet Service Aspects by Primary Home Internet Service



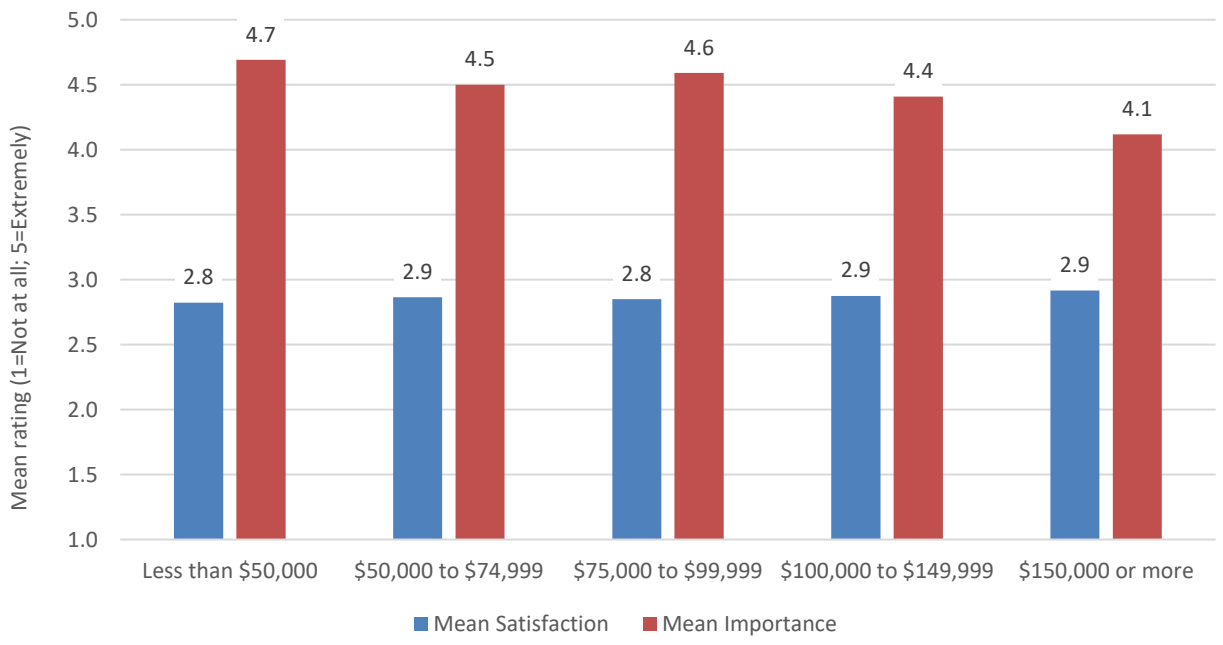
As indicated above and illustrated in Table 12, fiber optic providers are better meeting customer expectations compared with DSL and cable modem providers for customer service and price of service. The leading provider types are performing equally as well for connection speed and reliability.

Table 12: Gap Index Score by Primary Home Internet Service

	Satisfaction / Importance Gap Index*				
	Connection Speed	Connection Reliability	Price of Service	Customer Service	Ability to Bundle
DSL	86%	78%	67%	77%	171%
Cable modem	88%	80%	59%	72%	131%
Fiber	88%	81%	76%	89%	177%
ISP Average	87%	79%	64%	76%	142%
Percent of expectations met = Satisfaction / Importance					

The importance placed on price of services is correlated with household income. The overall satisfaction level with this service aspect does not vary significantly by income; however, lower income households have a larger gap in expectations given the higher importance placed on this item (see Figure 34).

Figure 34: Importance of and Satisfaction with Price of Internet Service by Household Income



3.3.1.5 Internet-Enabled Devices

Respondents were asked to indicate the number of personal computing devices and other smart devices they have in the home. Almost all respondents with internet service have a personal computing device, and 25 percent have seven or more devices in the home. Additionally, 87 percent of connected respondents have other smart devices in the home (see Figure 35 and Figure 36).

Figure 35: Number of Personal Computing Devices

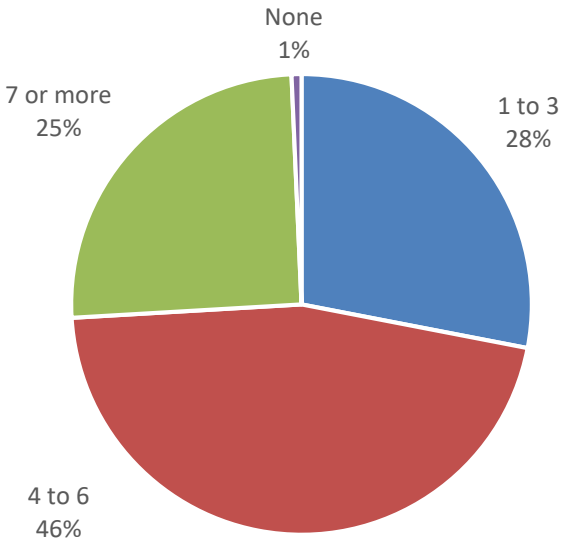
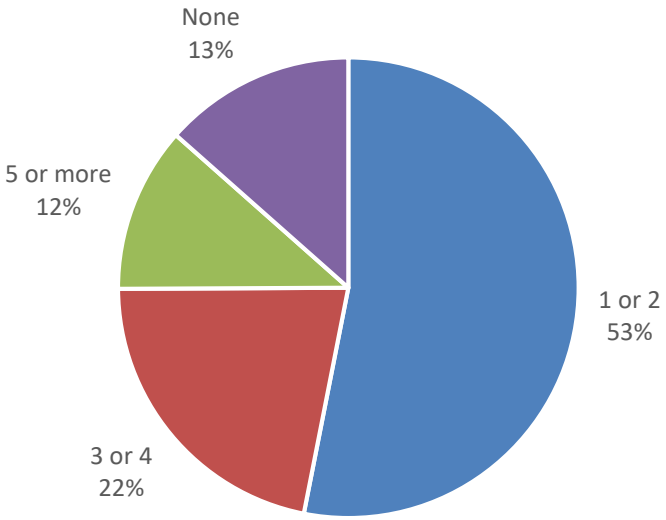


Figure 36: Number of Other Smart Devices



Saturation of personal computing devices and other internet-enabled devices is high among households with multiple members. Households with at least four members are significantly more likely than smaller households to have at least seven personal computing devices. Three-fourths of households with one member have one to three personal computing devices, and they are less likely than larger households to have any other smart devices (see Figure 37 and Figure 38).

Figure 37: Number of Personal Computing Devices in Home by Household Size

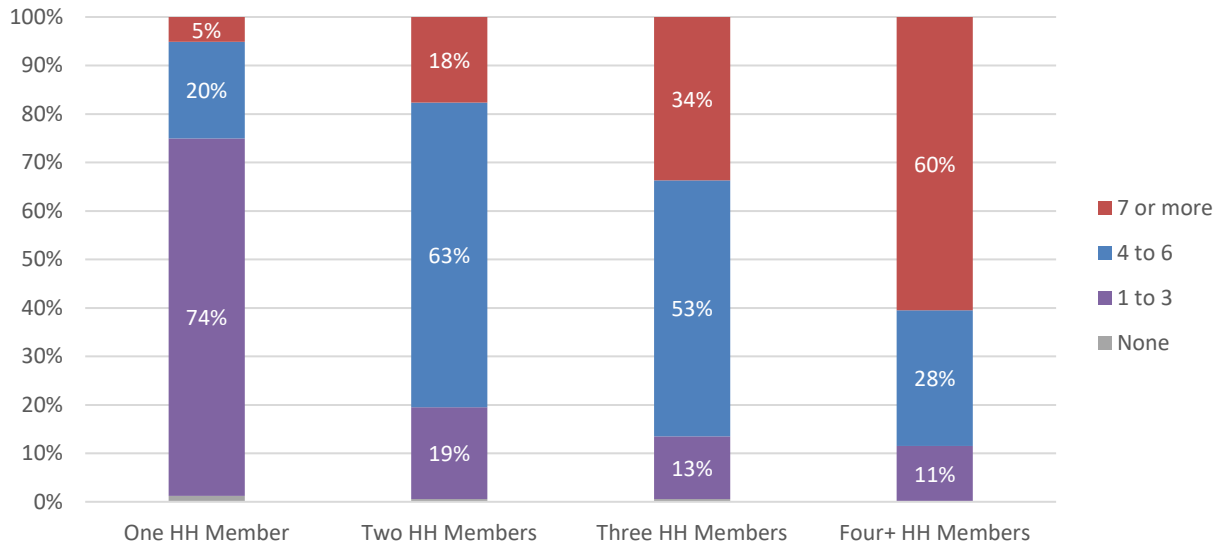
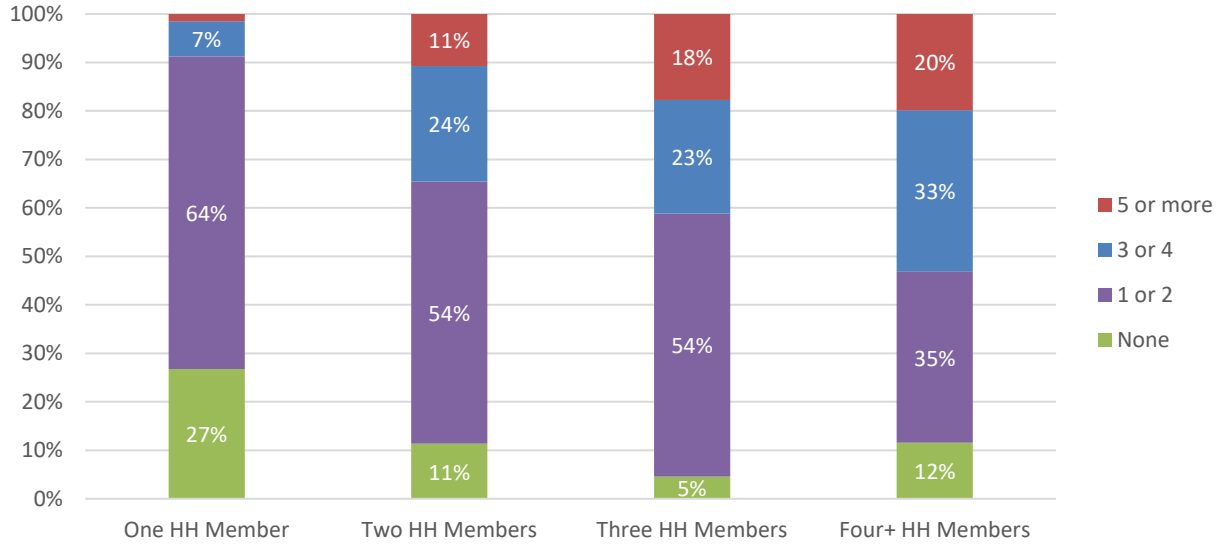


Figure 38: Number of Other Smart Devices in Home by Household Size



Lower-income households have somewhat fewer internet-enabled devices than do higher income households, as shown in Figure 39 and Figure 40.

Figure 39: Number of Personal Computing Devices in Home by Household Income

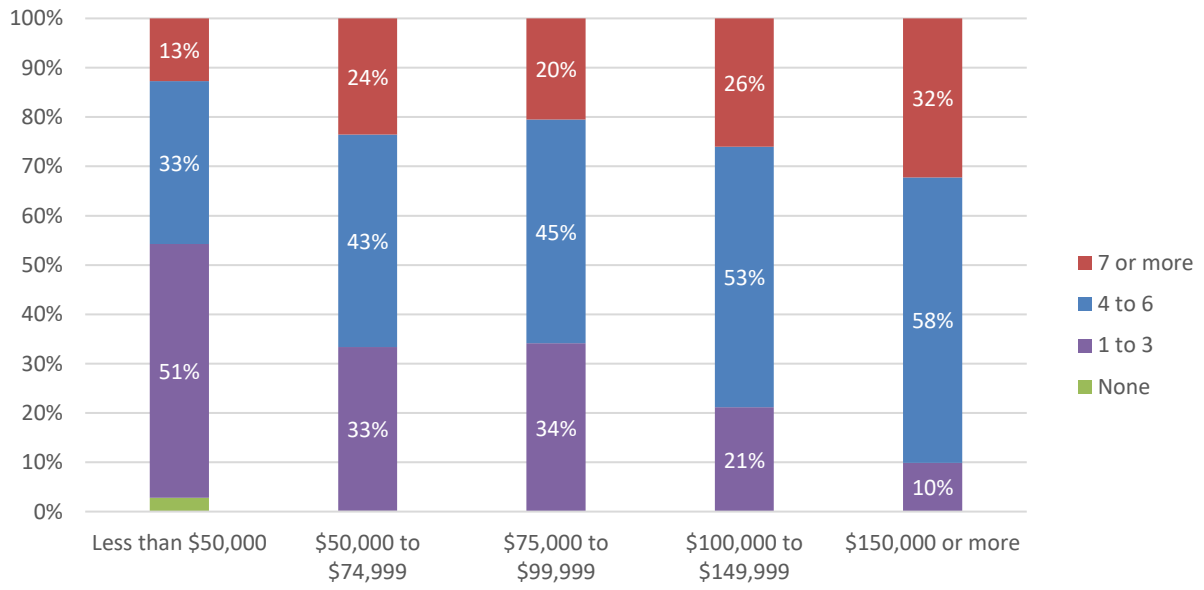
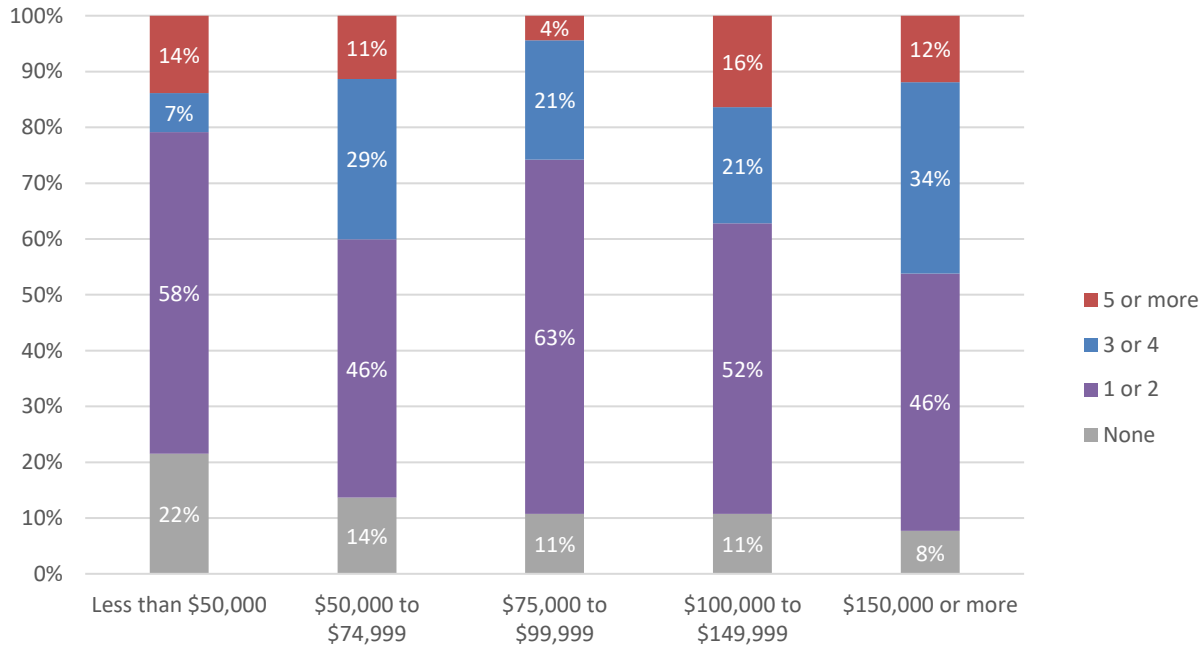


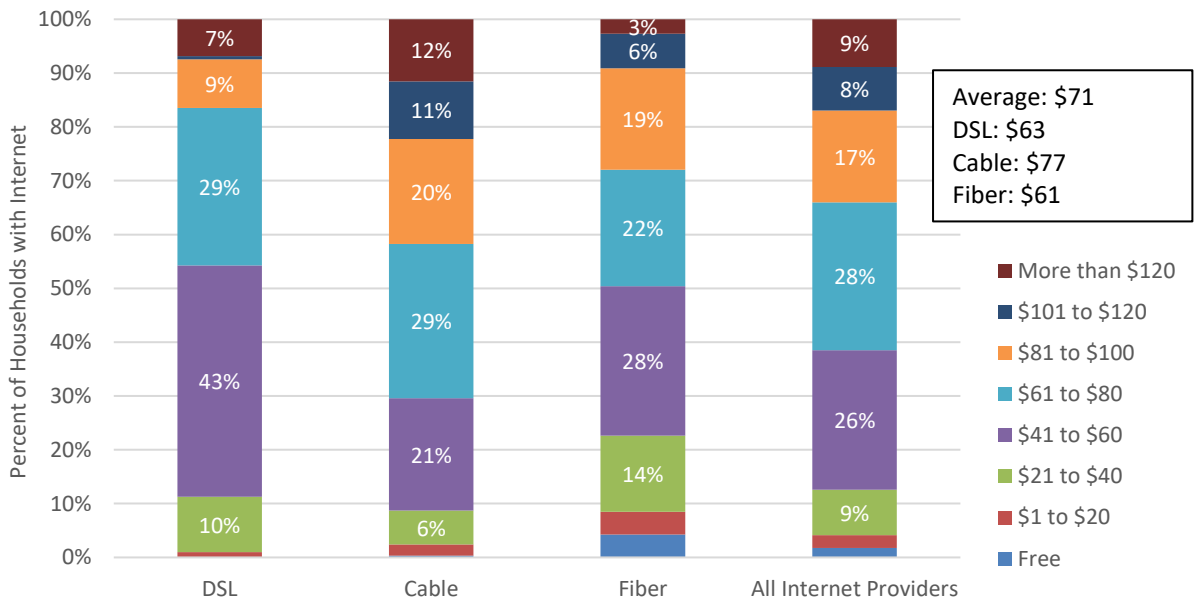
Figure 40: Number of Other Smart Devices in Home by Household Income



3.3.1.6 Cost of Internet Service

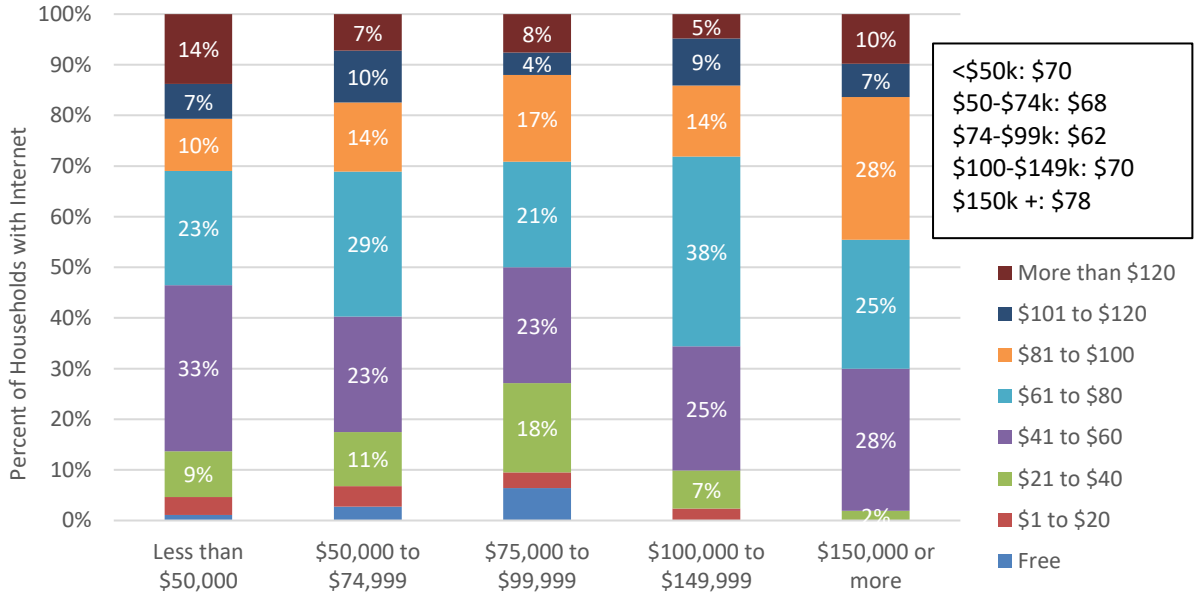
As Figure 41 illustrates, 17 percent of subscribers pay over $100 per month for home internet, with the estimated monthly average cost for internet service being $71. Cable modem subscribers pay more per month on average compared with other internet services.

Figure 41: Monthly Price for Internet Service



Low-income households pay an estimated average monthly price of $70 for internet service. Just one percent of those earning under $50,000 per year receive free internet service, while one-fifth pay over $100 per month (see Figure 42).

Figure 42: Monthly Price for Internet Service by Household Income



Nearly one-half of cable modem subscribers (37 percent of all internet subscribers) said their monthly internet fee is part of a bundled service (see Figure 43). Estimated monthly prices for bundled and unbundled services are shown in Figure 44. As would be expected, bundled services cost more in total than do unbundled services.

Figure 43: Monthly Internet Fee Is Part of Bundled Service

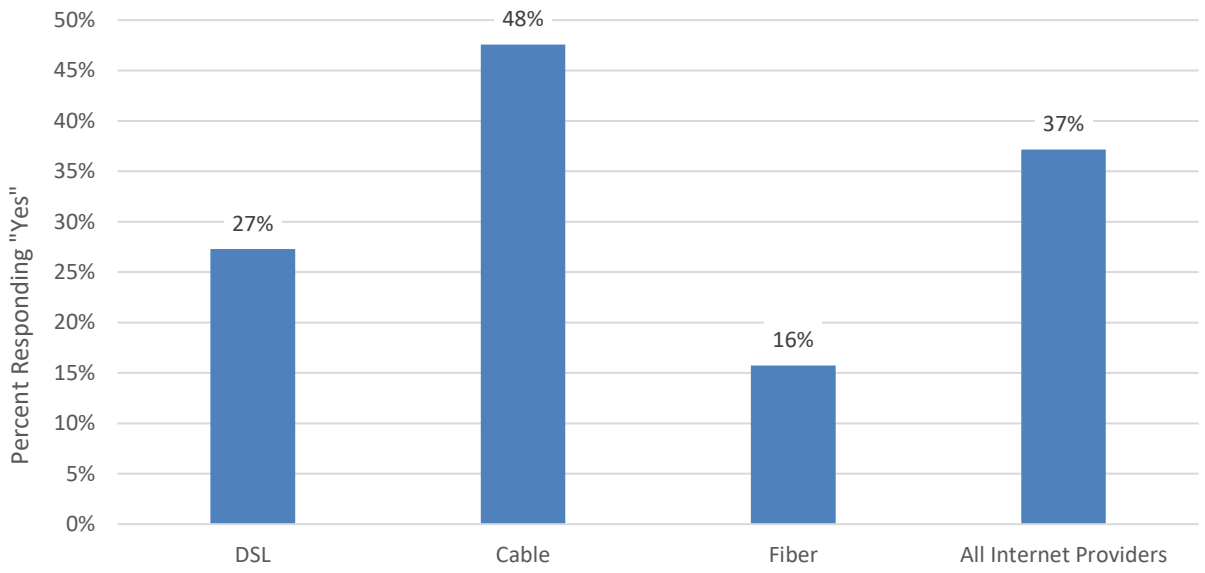
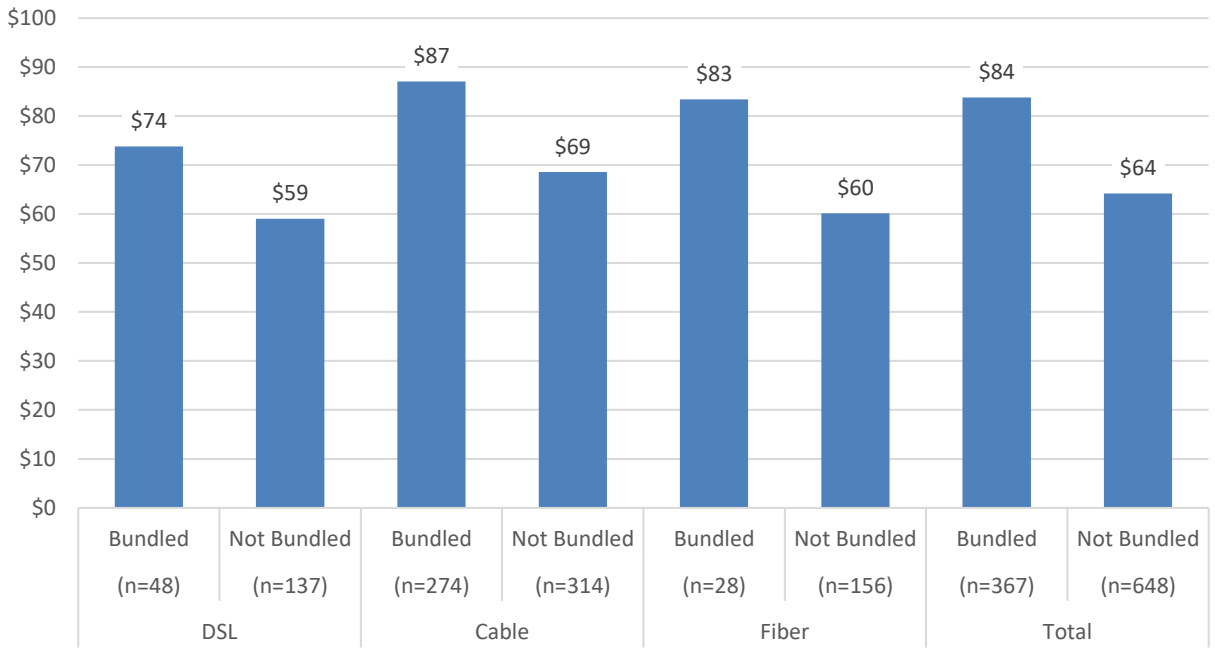


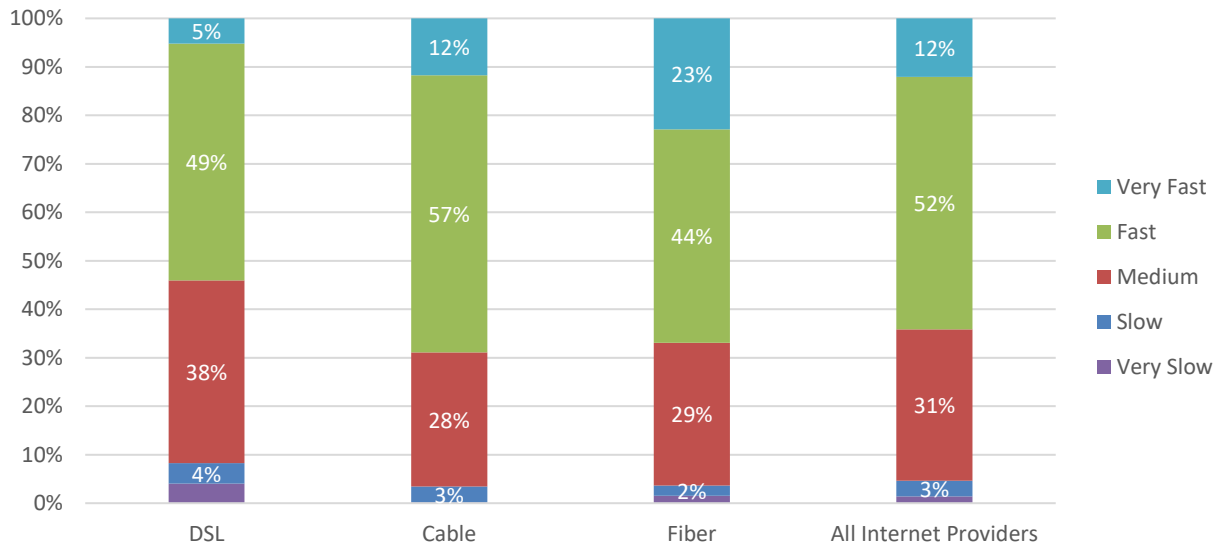
Figure 44: Estimated Average Monthly Price for Bundled and Non-Bundled Internet Service



3.3.1.7 Speed of Internet Service

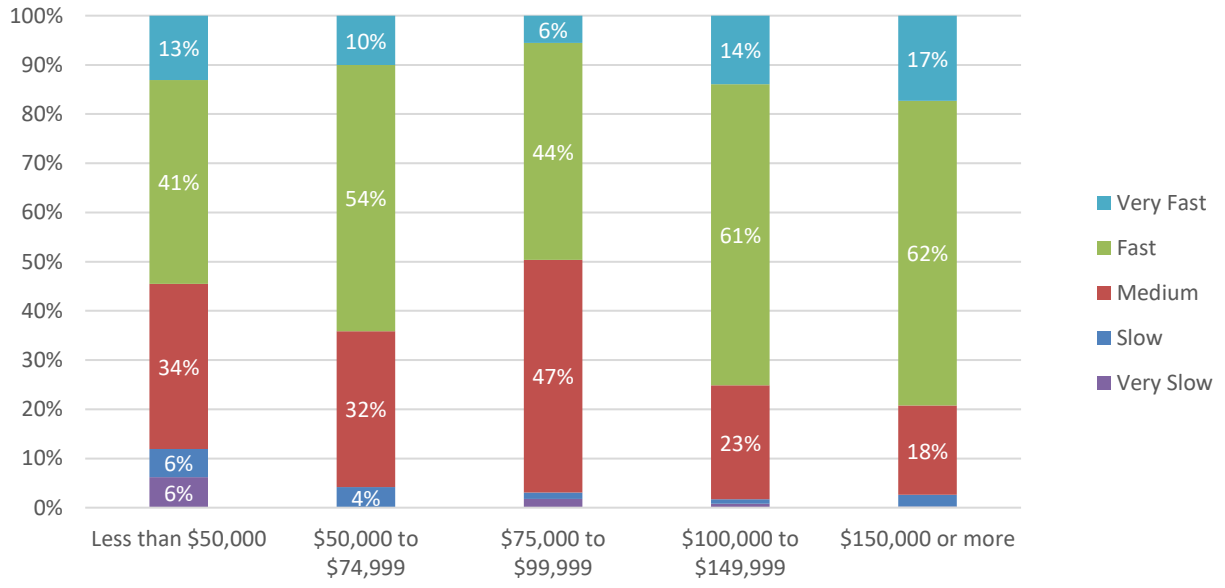
Overall, most internet subscribers in the market area have "medium" or "fast" internet service, according to respondents. Fiber-optic subscribers were more likely than DSL and cable modem describers to describe their connection as "very fast" (see Figure 45).

Figure 45: Internet Speed (Respondent Opinion) by Primary Home Internet Service



Lower income households were more likely than others to describe their internet speed as "slow" or "very slow," although the majority have "medium" or "fast" internet across all income groups (see Figure 46).

Figure 46: Internet Speed (Respondent Opinion) by Household Income



3.3.1.8 Customer Loyalty

Respondents were asked a series of questions to help assess customer loyalty, including likelihood of recommending their internet service provider, likelihood of renewing their contract, and likelihood of switching providers if an alternative provider were less expensive. The average likelihood scores are illustrated in Figure 47, while detailed responses are illustrated in Figure 48.

Figure 47: Likelihood of Recommending, Renewing, or Switching Providers (Mean Ratings)

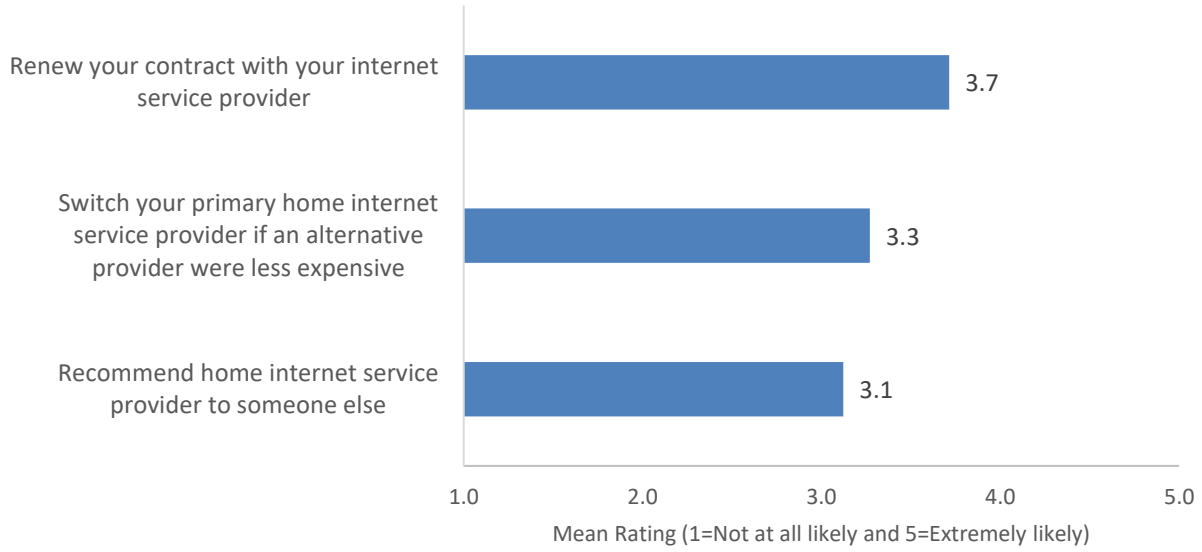
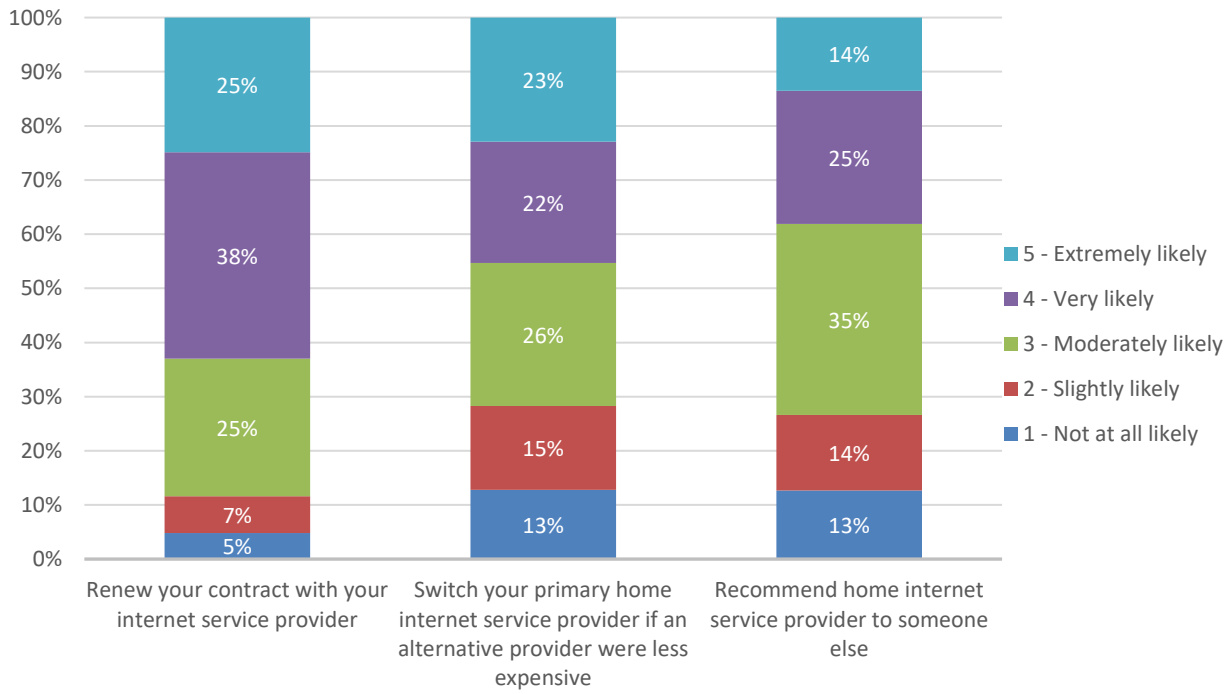


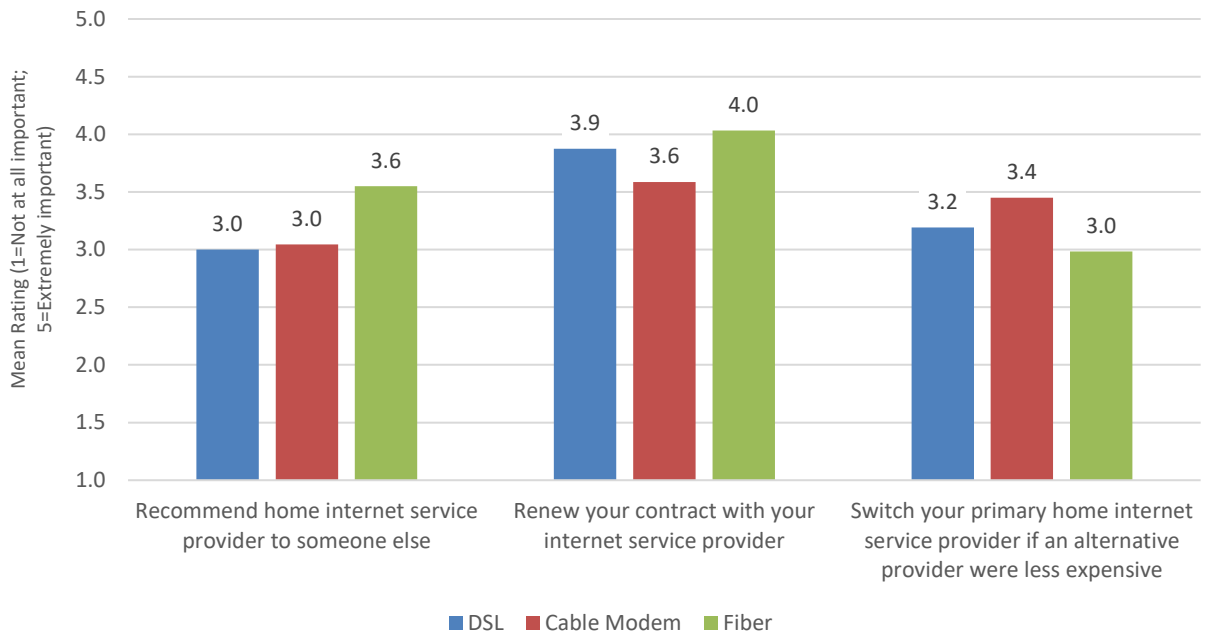
Figure 48: Likelihood of Recommending, Renewing, or Switching Providers



Overall, customers are moderately loyal to their provider, with a mean loyalty score of 3.2 and a median of 3.0 (average score given to all three rating items on a scale of 1 to 5).[22]

Forty-five percent of respondents would be very or extremely likely to switch providers if an alternative provider were less expensive. Six in 10 are very or extremely likely to renew their contract with their current internet service provider, but only four in 10 are very or extremely likely to recommend their provider.

Figure 49: Likelihood of Recommending, Renewing, or Switching Providers by Connection



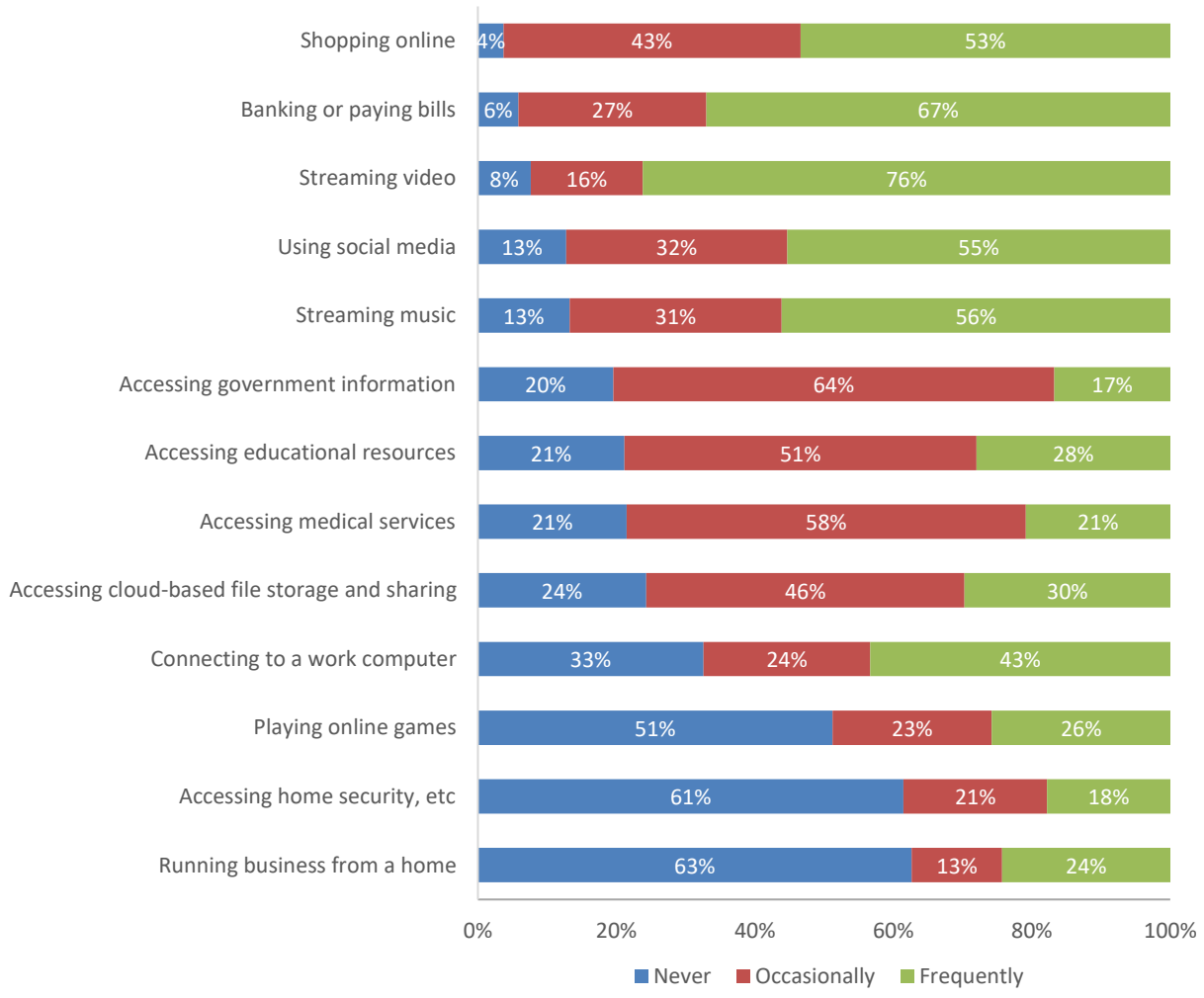
As illustrated in Figure 49, cable modem subscribers are more likely than those with other internet services to switch their provider and are less likely to renew their contract. Fiber optic subscribers are more likely than others to recommend their provider to someone else.

[22] The loyalty scores were calculated by taking the average of all three aspects (recommend, renew, switch). When calculating the score, the likelihood of switching scale was reversed so the higher score represents greater loyalty or less likelihood of switching.

3.3.1.9 Internet Uses

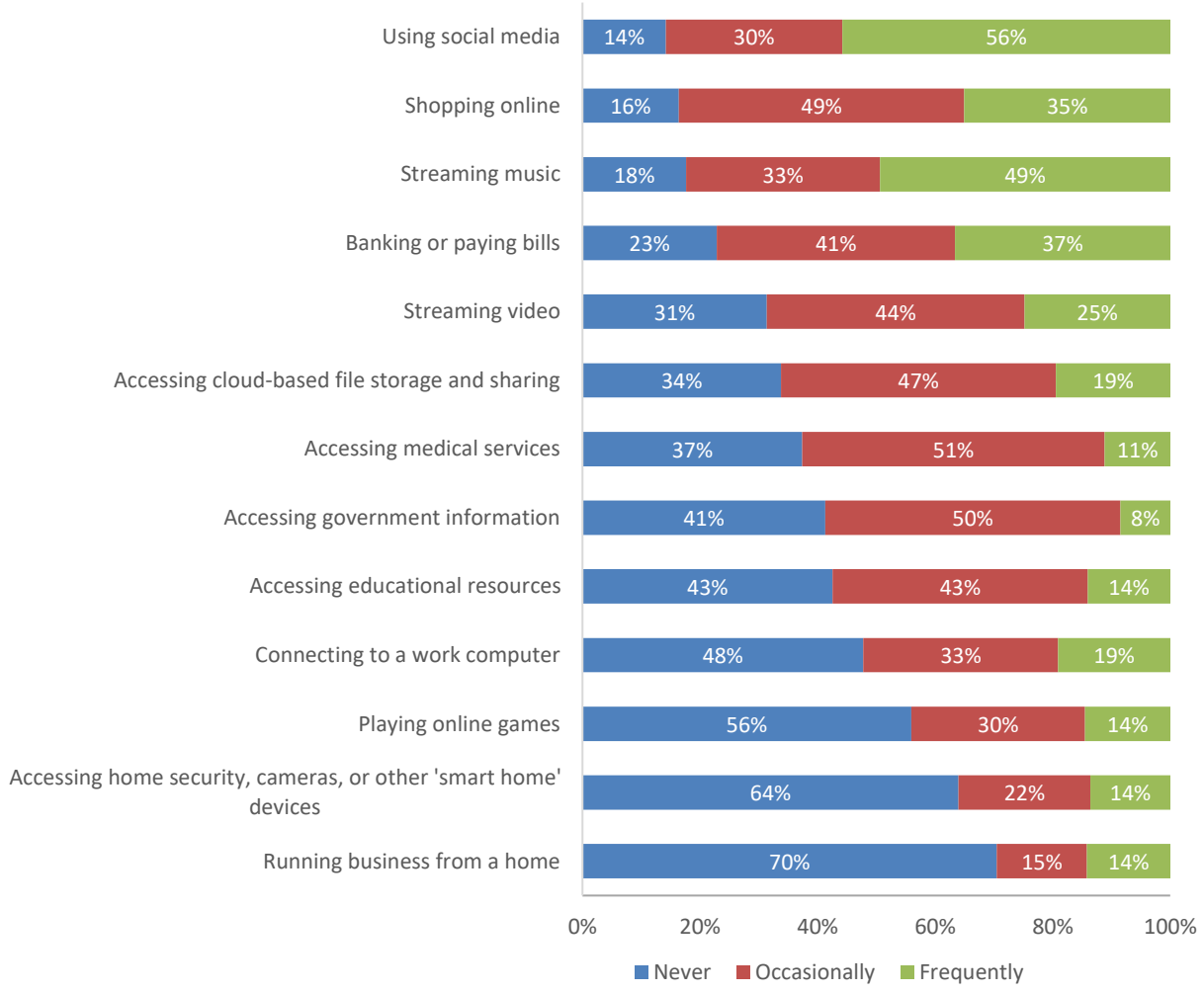
Respondents were asked about their use of their home internet connection and of their cellular/ mobile internet connection for various activities, as illustrated in Figure 50 and Figure 51. Among those items listed, the home internet connection is most frequently used for shopping online, banking or paying bills, and streaming video. Almost all respondents do these activities at least occasionally. A home internet connection is also used by most subscribers for social media and streaming music. It is less frequently used for other activities.

Figure 50: Home Internet Connection Use for Various Activities



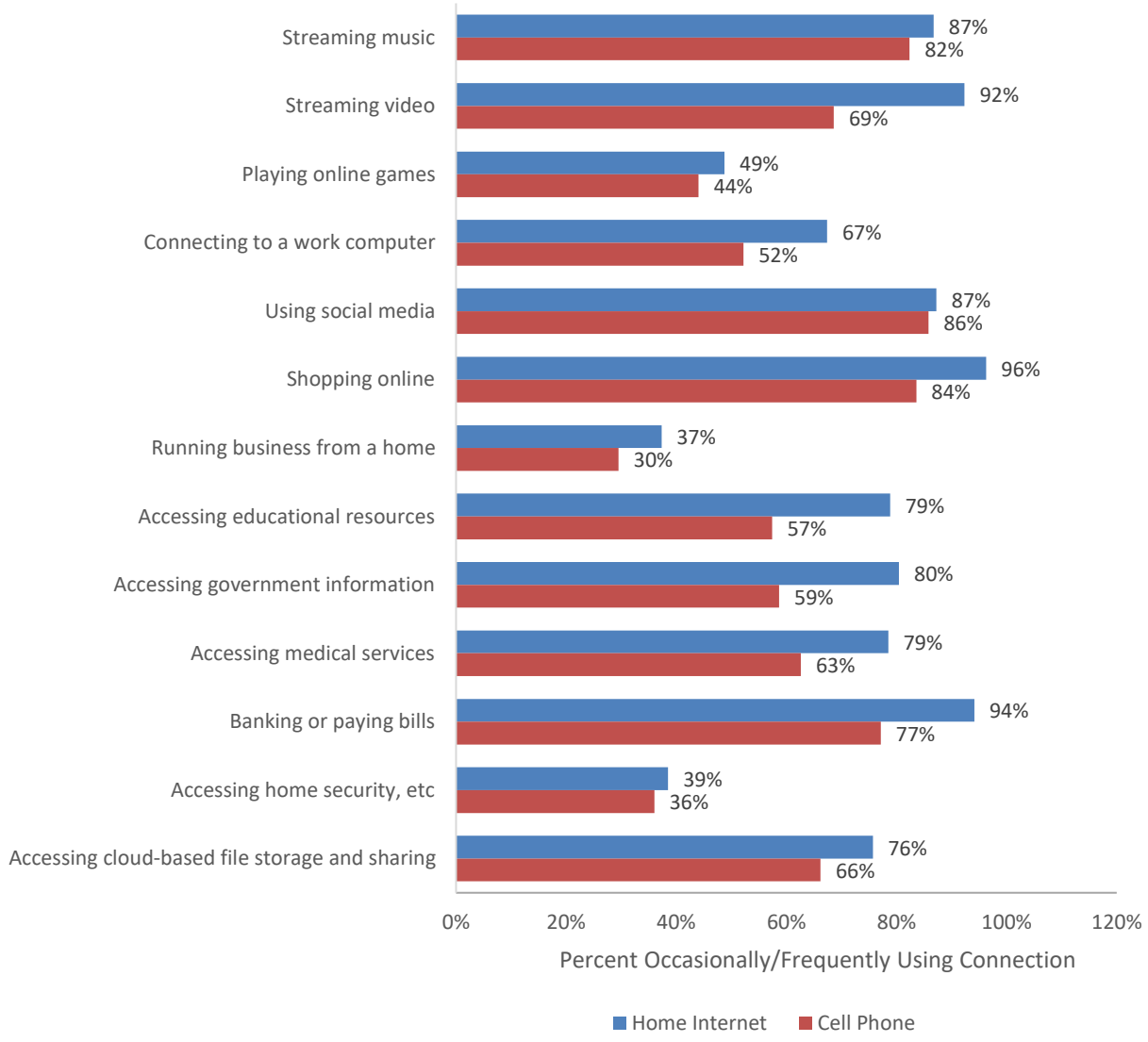
A smartphone is used most frequently for social media, shopping online, streaming music, and banking or paying bills, as shown in Figure 51. A sizeable segment of respondents frequently uses a cellular/mobile internet connection for other activities.

Figure 51: Cellular/Mobile Connection Use for Various Activities



Respondents are far less likely to use a cellular/mobile connection than a home internet connection for many of the activities listed, except for streaming music, playing online games, using social media, and accessing home security and similar devices. Figure 52 compares the percentage of respondents by connection type who ever use their connection for key activities.

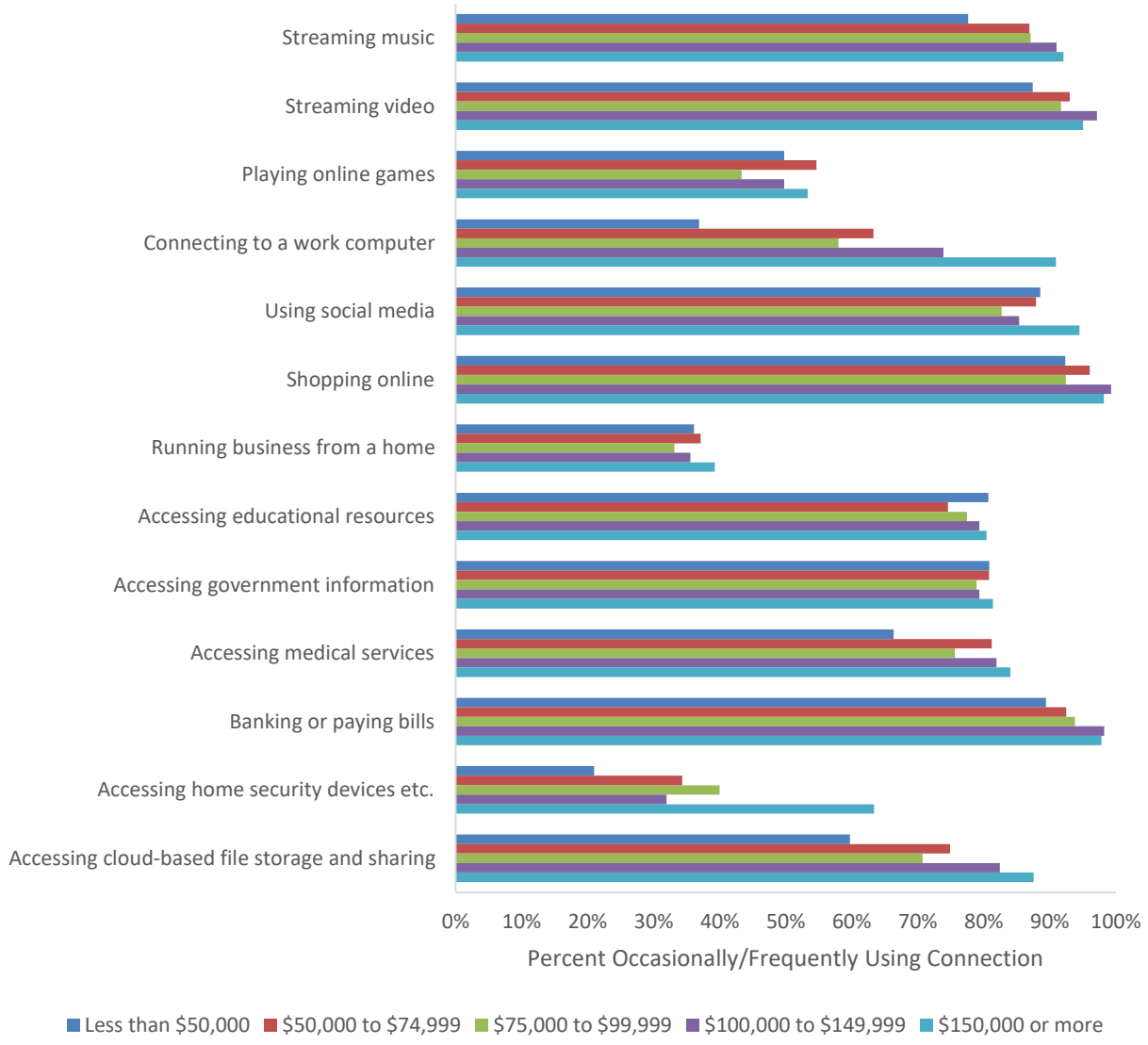
Figure 52: Internet Connection Ever Used for Various Activities by Connection Type



3.3.1.9.1 Internet Uses by Income Groups

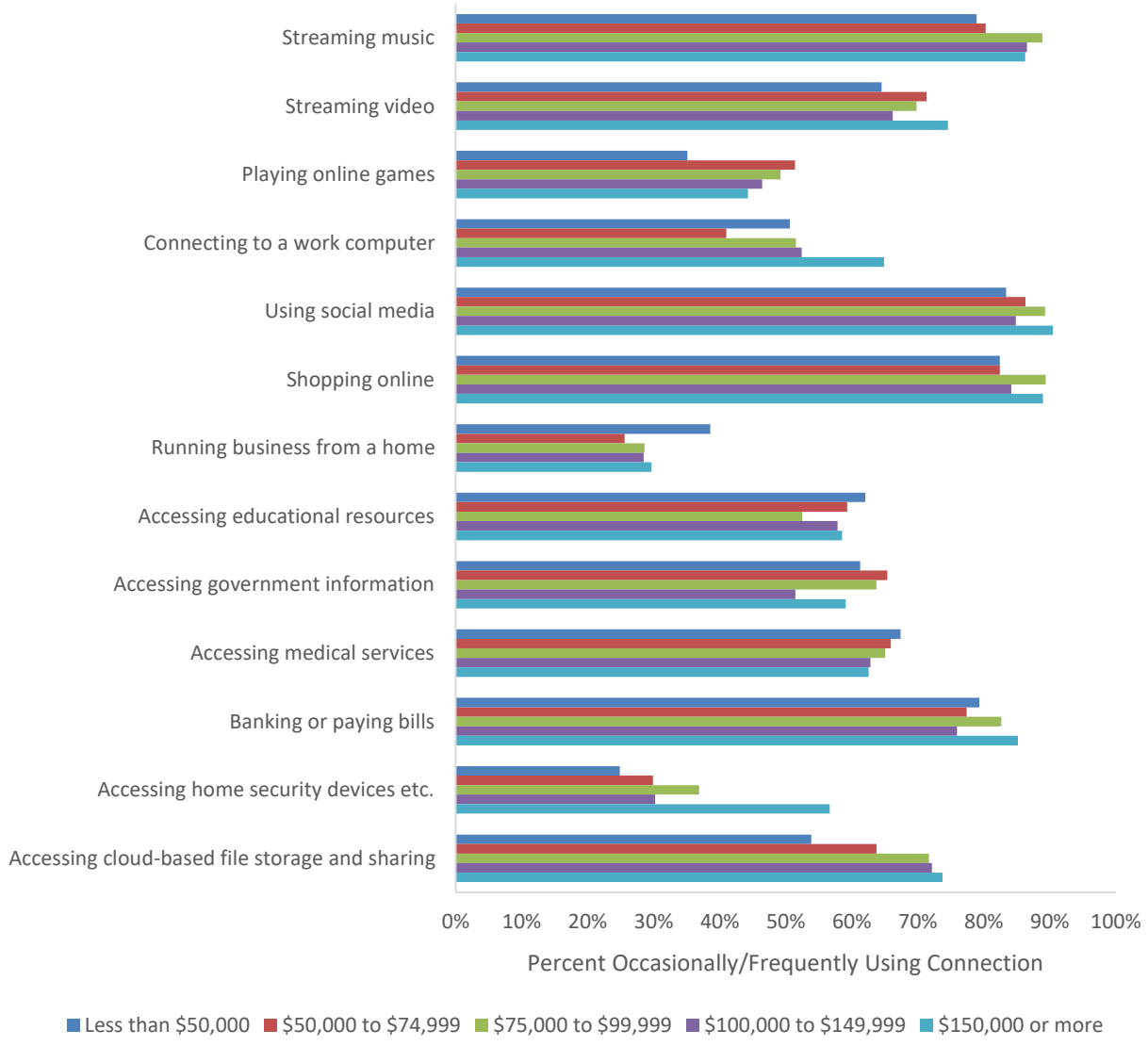
Households earning under $50,000 per year are less likely than higher income households to ever use their *home internet connection* for key activities, such as streaming music, streaming video, connecting to a work computer, accessing medical services, banking or paying bills, accessing home security and similar devices, and accessing cloud-based file storage and sharing (see Figure 53). Keep in mind that the low-income cohort has a higher share of respondents ages 65+ (one fourth are 65 or older).

Figure 53: Home Internet Connection Ever Used for Various Activities by Household Income



Similarly, households earning under $50,000 per year are less likely than higher income households to ever use their *cellular/mobile internet connection* for streaming music and video, playing online games, connecting to a work computer, online shopping, accessing home security and similar devices, and accessing cloud-based file storage and sharing (see Figure 54).

Figure 54: Cellular/Mobile Connection Ever Used for Various Activities by Household Income



3.3.1.9.2 Smartphone User Segments

Individuals were classified into one of three groups, based on their overall usage of a smartphone for various activities. Four in 10 internet subscribers frequently use their smartphone for key activities, as shown in Figure 55.

These highly connected individuals are using their smartphone for social media, streaming music, banking or paying bills, and shopping online (see Figure 56). A sizable percentage use their smartphone for other functions, including 36 percent who frequently connect to a work computer via their smartphone.

Figure 55: Smartphone User Segments

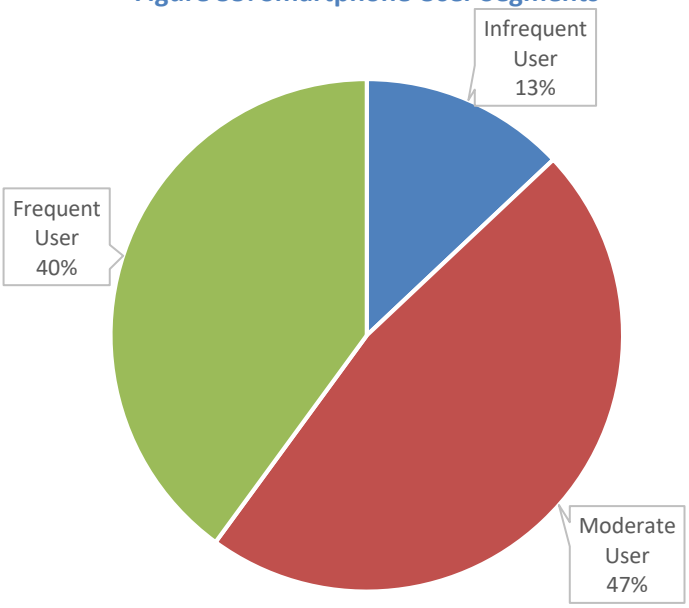
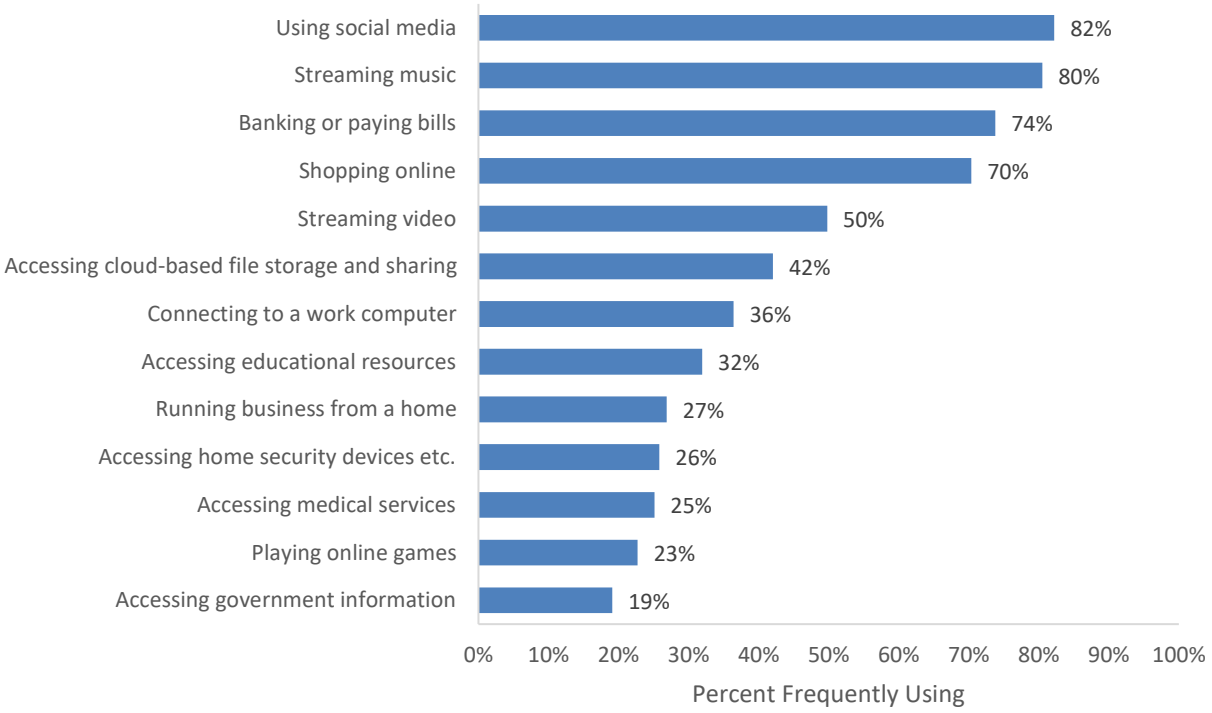


Figure 56: Smartphone Activity for Frequent Users



Usage is highly correlated with age of respondent. Most frequent smartphone users are ages 18 to 44. Table 13 shows the demographic profile of the various segments of smartphone users.

Table 13: Demographic Profile of Smartphone User Segments

		Infrequent User	Moderate User	Frequent User	Total
Internet Service in Home	None/no response	2%	1%	1%	4%
	Home Internet Connection	26%	11%	9%	13%
	Smartphone	5%	7%	4%	6%
	Both Home/Smartphone	67%	82%	87%	77%
	Total	*129*	*468*	*397*	*1125*
Respondent Age	18 to 34 years	3%	23%	26%	21%
	35 to 44 years	16%	31%	43%	32%
	45 to 54 years	10%	20%	15%	16%
	55 to 64 years	27%	13%	10%	15%
	65 years and older	43%	13%	6%	15%
	Total	*123*	*459*	*393*	*1094*
Highest Level of Education	HS education or less	20%	9%	14%	14%
	Two-year college or technical degree	14%	13%	14%	14%
	Four-year college degree	34%	38%	39%	37%
	Graduate degree	31%	40%	33%	35%
	Total	*121*	*460*	*393*	*1095*
Household Income	Less than $50,000	20%	13%	16%	18%
	$50,000 to $74,999	26%	17%	24%	20%
	$75,000 to $99,999	13%	21%	15%	17%
	$100,000 to $149,999	28%	22%	22%	22%
	$150,000 or more	13%	28%	23%	22%
	Total	*99*	*417*	*370*	*997*
Race/Ethnicity	Other race/ethnicity	8%	16%	19%	16%
	White/Caucasian only	92%	84%	81%	84%
	Total	*121*	*460*	*391*	*1089*
Children in Household	No Children in HH	94%	75%	72%	77%
	Children in HH	6%	25%	28%	23%
	Total	*125*	*463*	*394*	*1106*
Own/Rent Residence	Own	81%	77%	66%	72%
	Rent	19%	23%	34%	28%
	Total	*126*	*460*	*394*	*1105*
Years at Current Residence	Less than 1 year	5%	15%	11%	12%
	1 to 2 years	8%	13%	16%	14%
	3 to 4 years	17%	19%	26%	20%
	5 or more years	71%	52%	47%	54%
	Total	*124*	*462*	*393*	*1104*

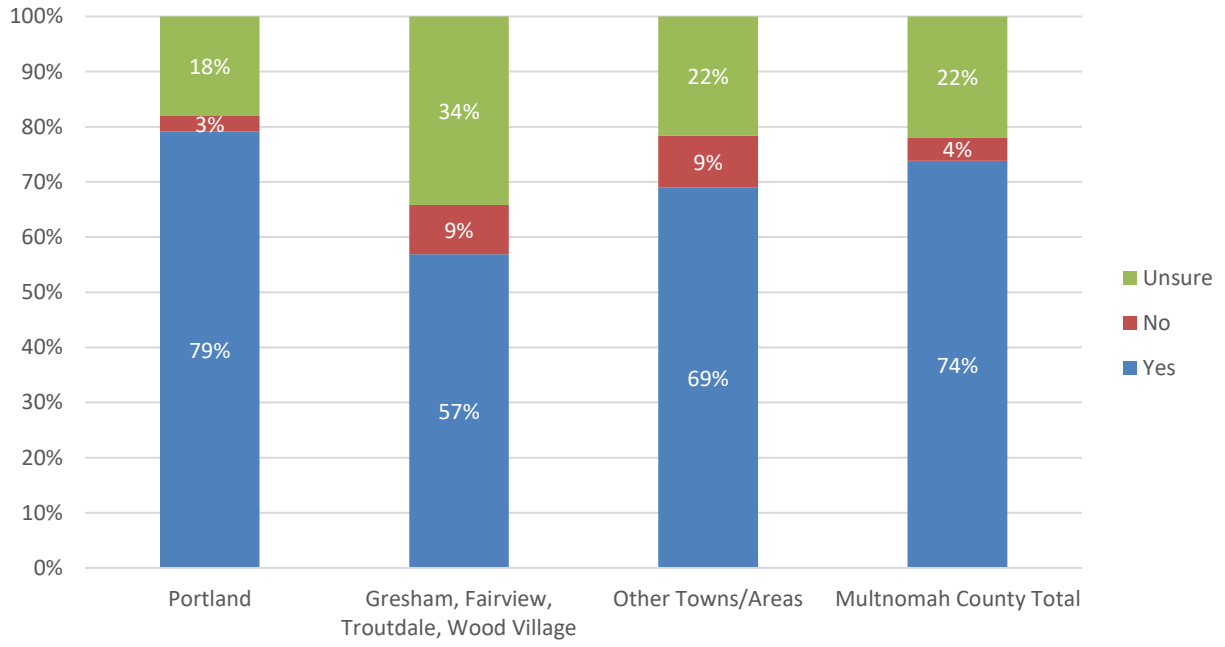
Key points:

- Nearly three-fourths of infrequent smartphone users do have a smartphone; one-fourth have only a home internet connection. Nearly nine in 10 frequent smartphone users have both home internet and a cellphone.
- Seven in 10 frequent smartphone users are ages 18 to 44. Seven in 10 infrequent smartphone users are ages 55+.
- Similarly, infrequent cell phone users are less likely to have children in the household and are somewhat less educated (although two-thirds have at least a four-year college degree). Nearly one-half of infrequent users earn under $75,000 per year.

3.3.1.10 Net Neutrality

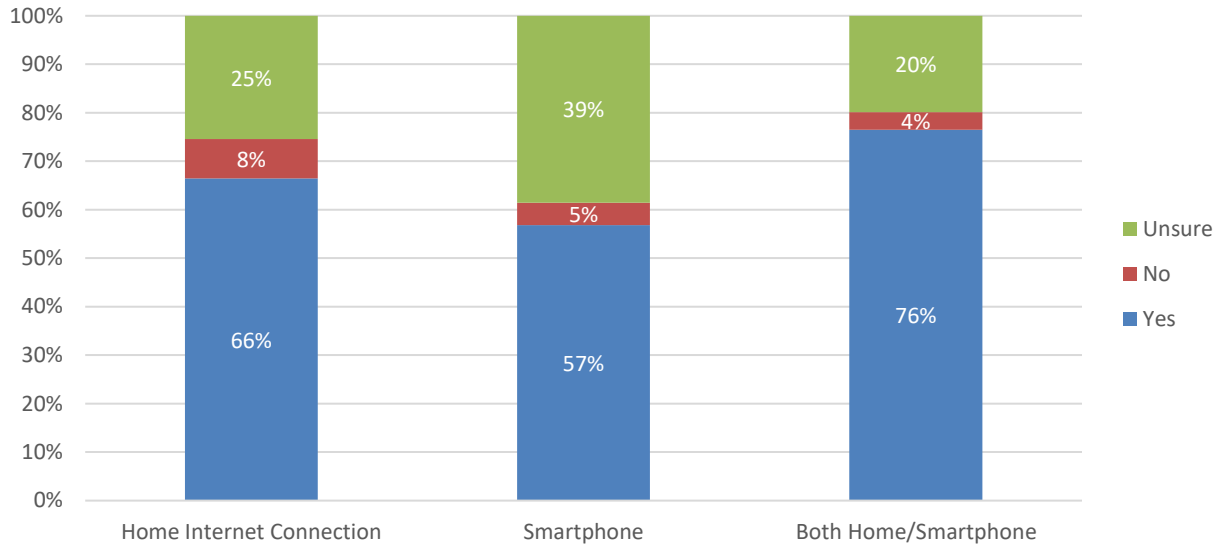
As illustrated in Figure 57, three-fourths of respondents would consider net neutrality when selecting an ISP. Those who reside in the Gresham, Fairview, Troutdale, Wood Village region would be less likely to consider net neutrality and are more likely to be unsure.

Figure 57: Would Consider Net Neutrality When Selecting ISP



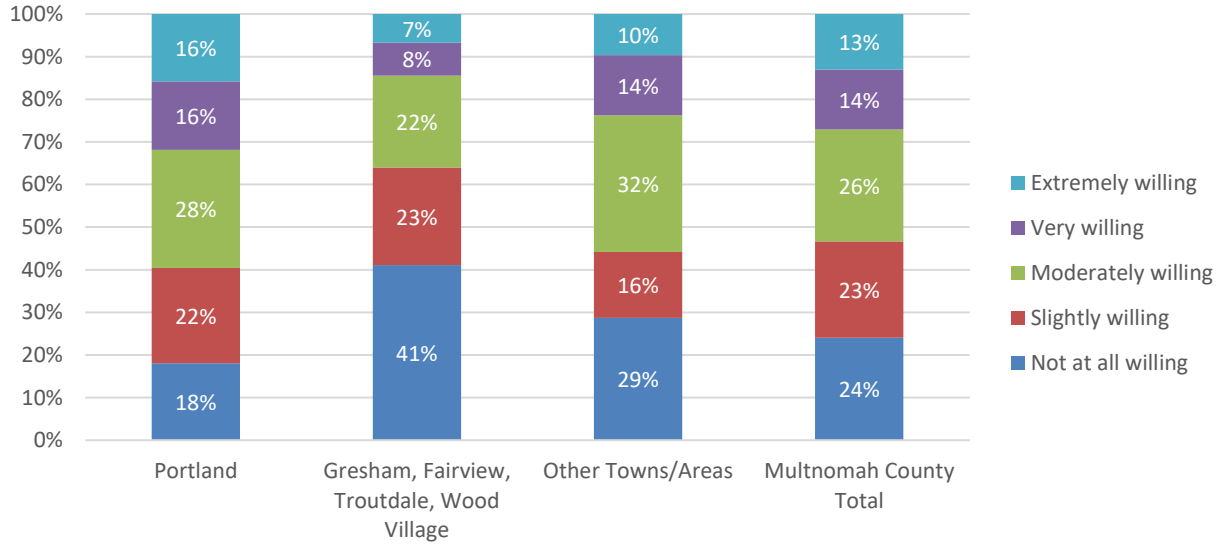
Two-thirds of respondents with a home internet connection only, plus three-fourths of those with both a home internet connection and a smartphone, would consider net neutrality in selecting an ISP. Four in 10 respondents with a smartphone only were unsure (see Figure 58).

Figure 58: Would Consider Net Neutrality When Selecting ISP by Internet Connection



Respondents were asked their willingness to switch their current ISP to a net neutral ISP for $15 more than their current payment. Overall, respondents would be moderately willing to switch with a mean rating of 2.7 and a median of 3.0 on a scale where 1=Not at all willing and 5=Extremely willing. Specifically, 27 percent of respondents would be very or extremely willing to switch, as shown in Figure 59. Four in 10 of those who reside in the Gresham, Fairview, Troutdale, Wood Village region would be not at all willing to switch.

Figure 59: Willingness to Switch to a Net Neutral ISP for $15 More



Additionally, younger respondents and those with a fiber connection (who are somewhat younger on average) would be more likely to switch to a net neutral ISP (see Figure 60 and Figure 61).

Figure 60: Willingness to Switch to a Net Neutral ISP for $15 More by Home Internet Service

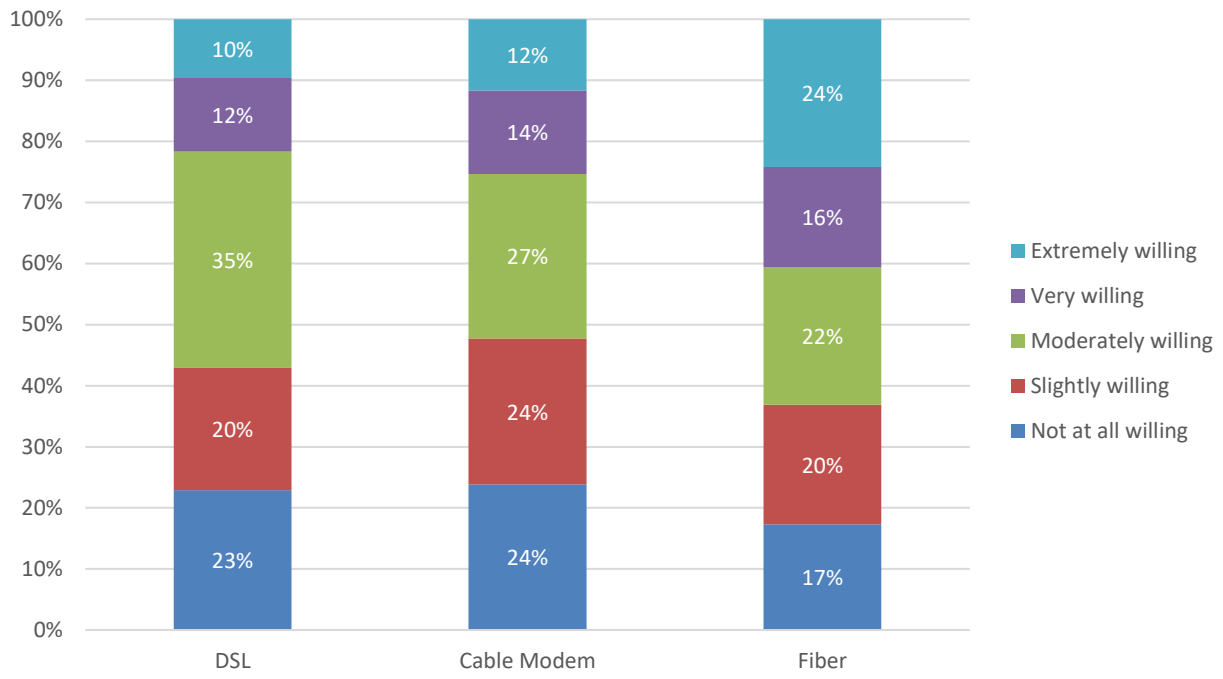
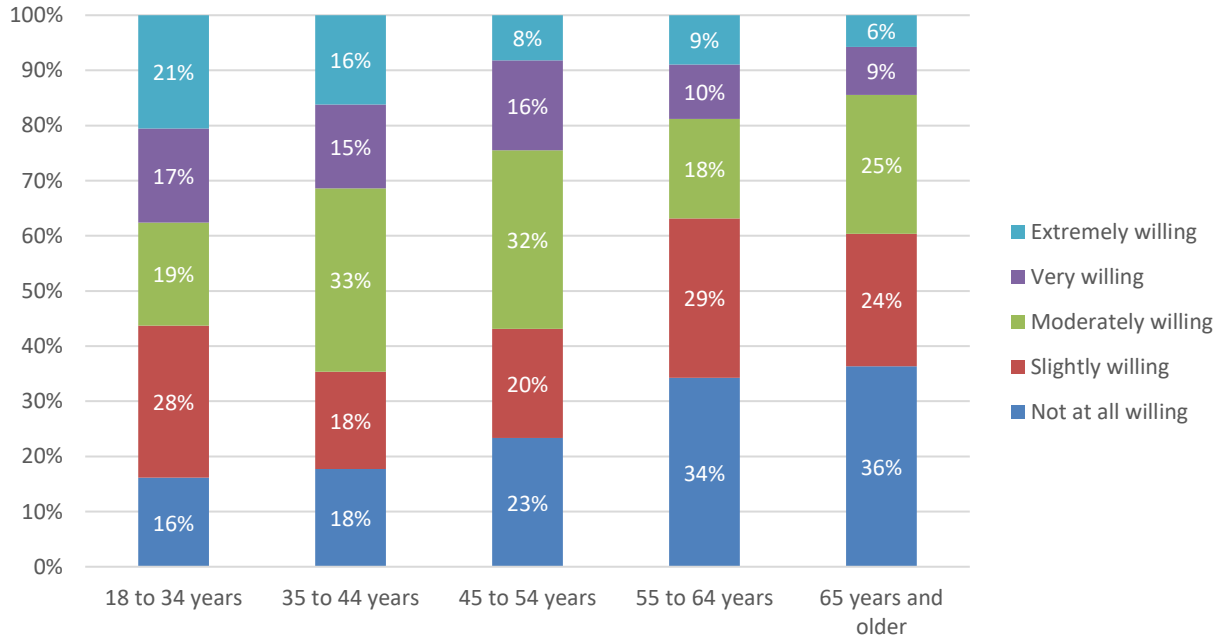
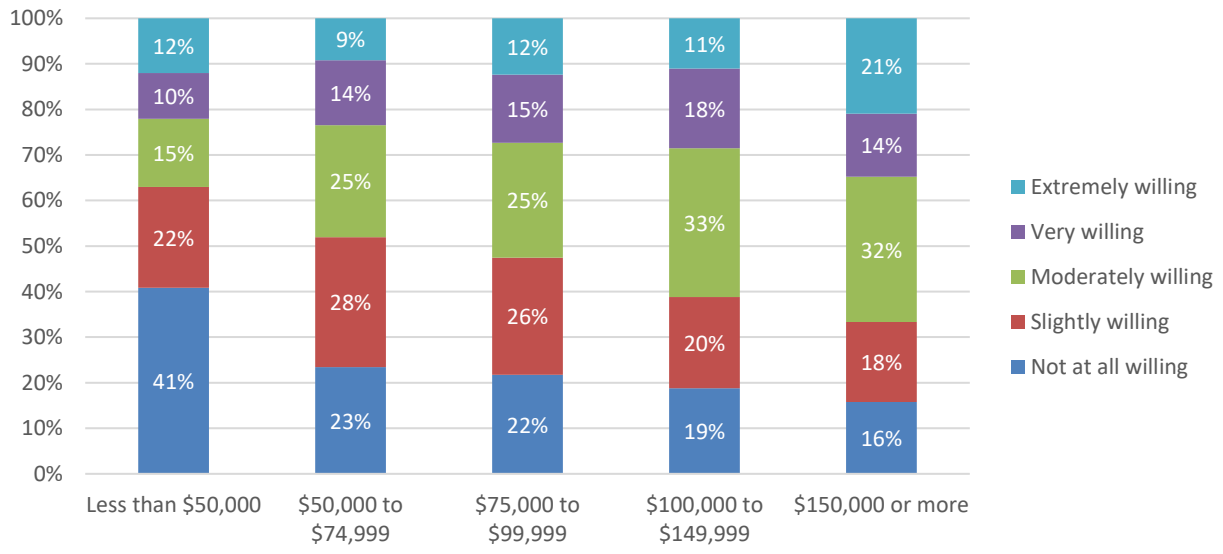


Figure 61: Willingness to Switch to a Net Neutral ISP for $15 More by Respondent Age



Those earning under $50,000 per year would be less likely to switch to a net neutral ISP for $15 more, as shown in Figure 62.

Figure 62: Willingness to Switch to a Net Neutral ISP for $15 More by Household Income



3.3.1.11 Home Internet Features

Respondents were asked to evaluate the importance of various features of their home internet service. The mean importance ratings are shown in Figure 63, while detailed responses are shown in Figure 64.

Figure 63: Importance of Home Internet Features (Mean Ratings)

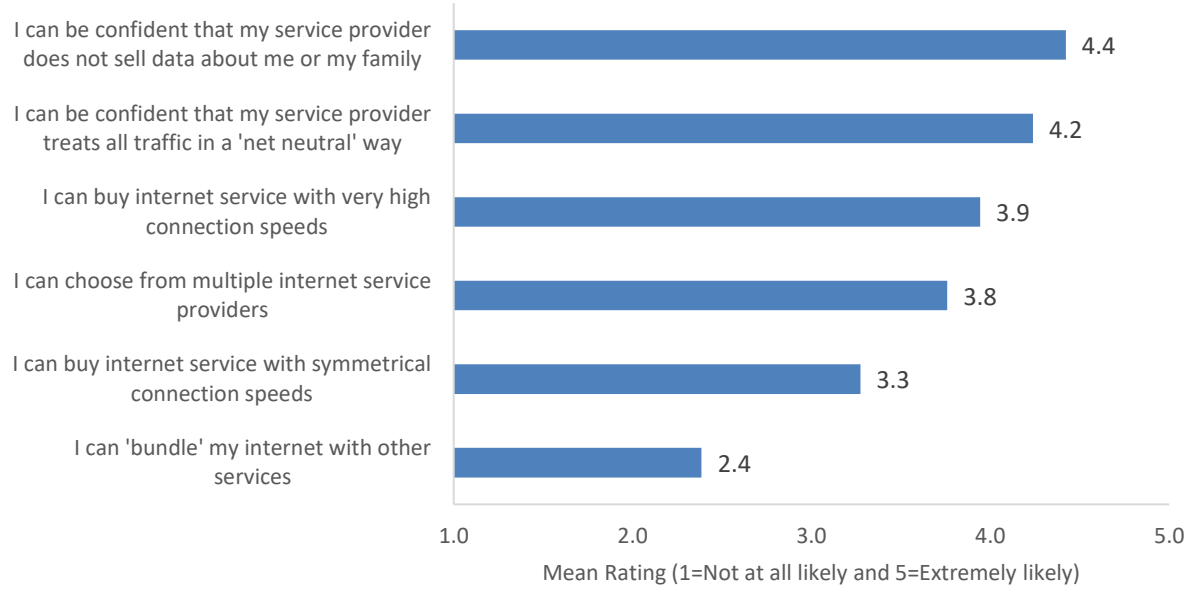
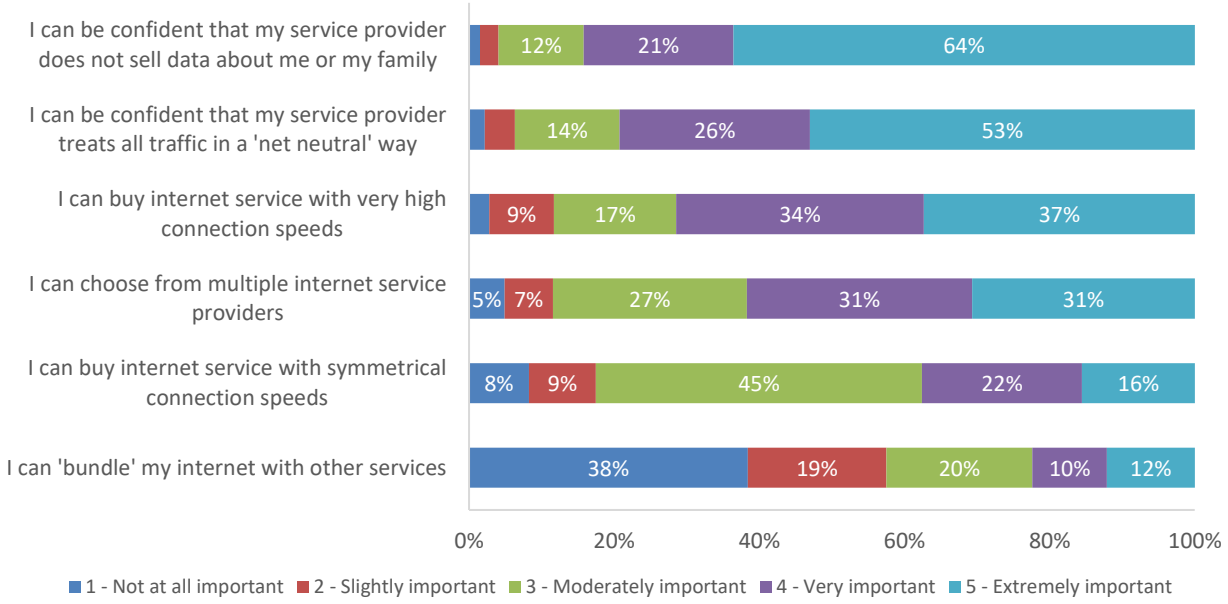
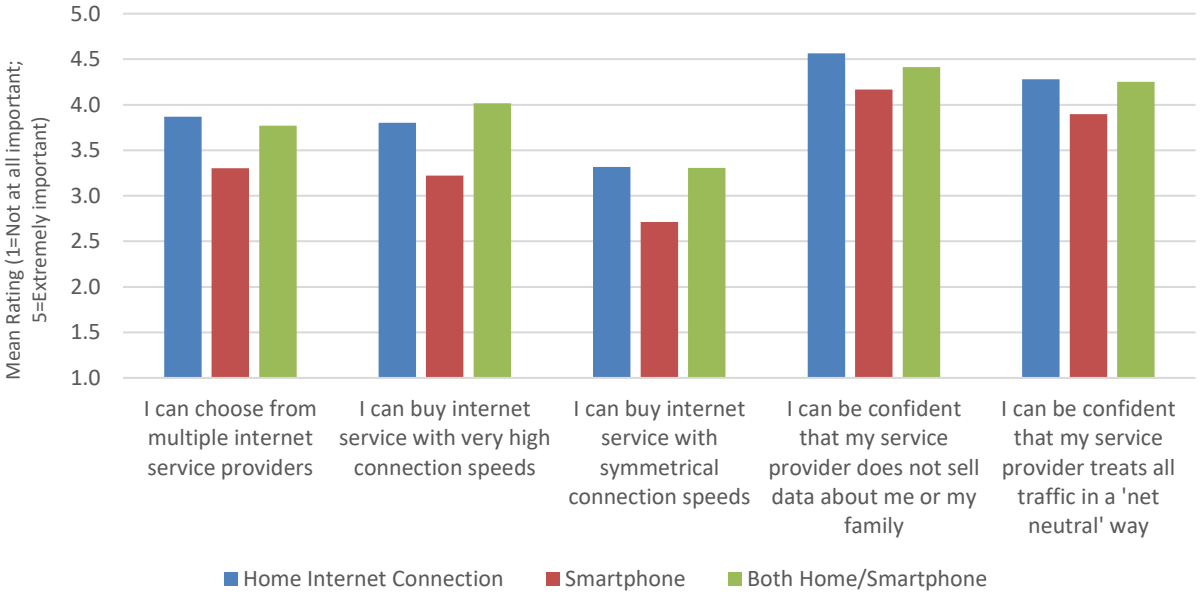


Figure 64: Importance of Home Internet Features



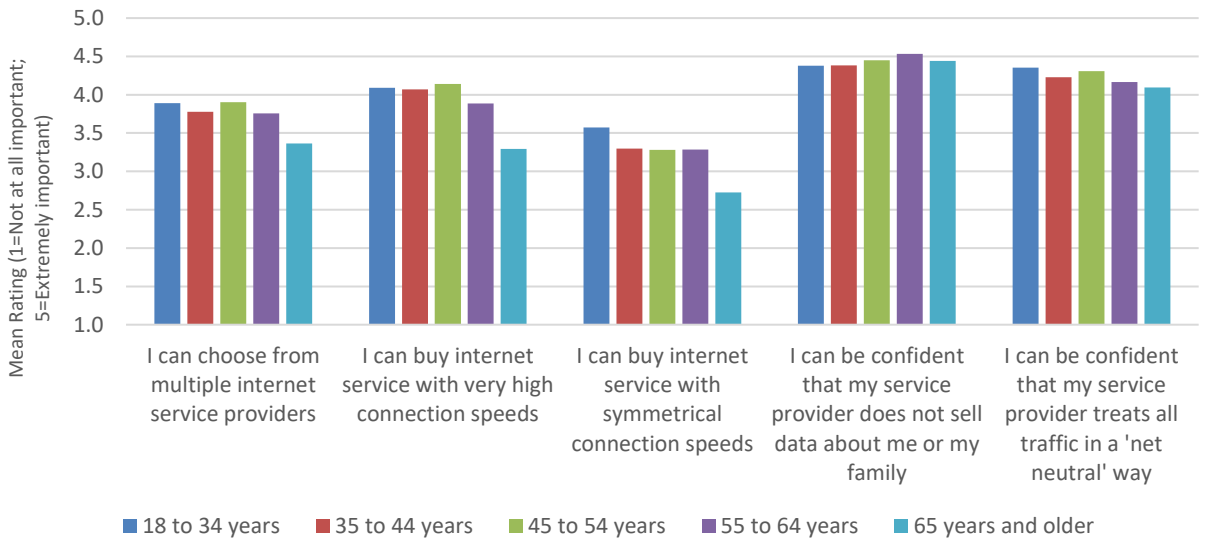
The most important home internet feature among those evaluated is confidence that ISP does not sell data, with 64 percent saying this aspect of service is extremely important. More than one-half of respondents said that confidence in service provider treating all traffic in a net neutral way is extremely important. The ability to bundle with other services is the least important feature, with nearly six in 10 respondents saying it is not at all important or slightly important.

Figure 65: Importance of Home Internet Features by Internet Connection



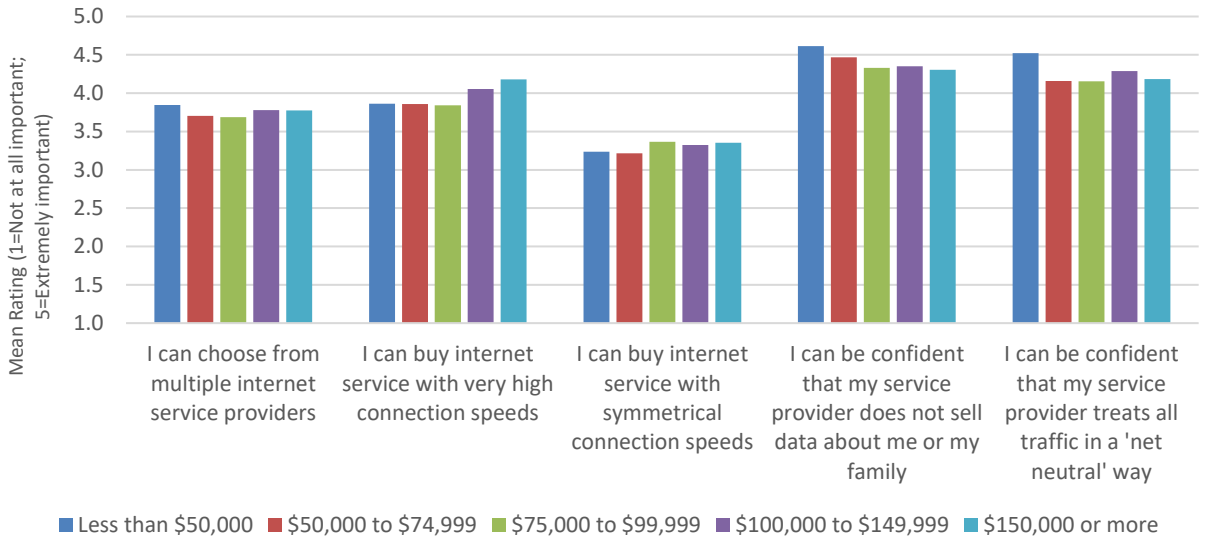
Internet service features are more important among respondents with some home internet connection compared with those with a smartphone only, as shown in Figure 65. Additionally, certain features (ability to choose from multiple service providers, ability to buy internet service with very high connection speeds, and ability to buy internet service with symmetrical connection speeds) are less important to respondents ages 65+ (see Figure 66).

Figure 66: Importance of Home Internet Features by Respondent Age



Respondents earning under $50,000 per year placed more importance on confidence in ISP treating all traffic in a net neutral way, compared with respondents with a higher household income (see Figure 67).

Figure 67: Importance of Home Internet Features by Household Income



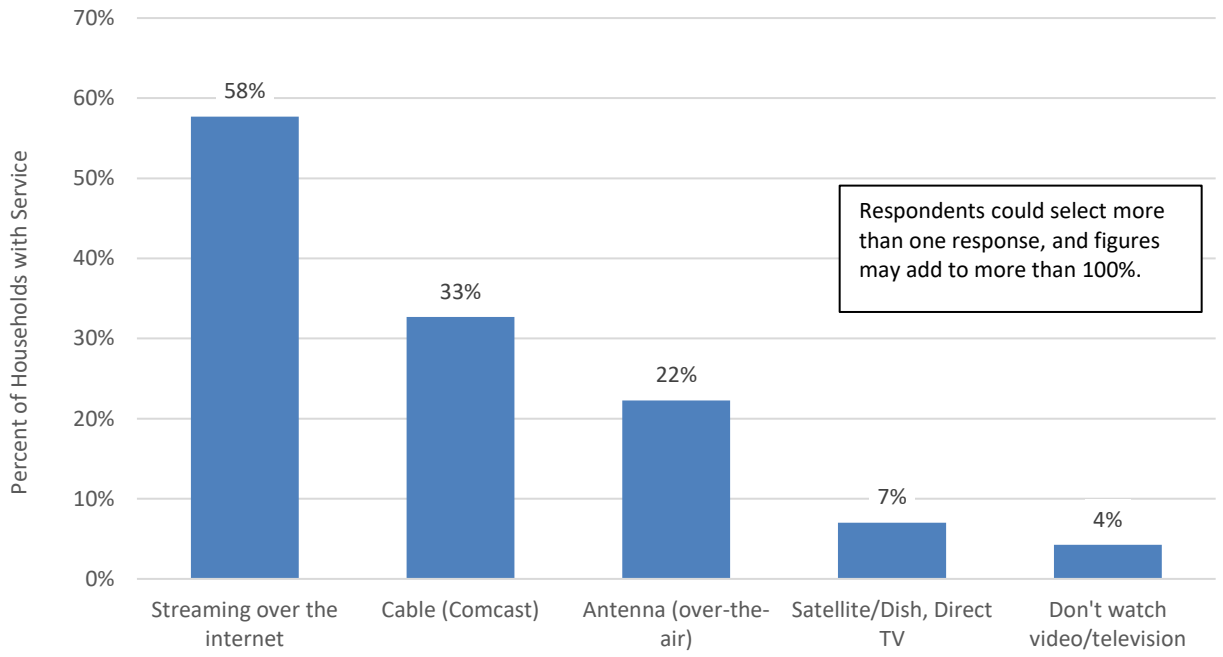
3.3.2 Television and Telephone Service

Respondents were asked to indicate what television and telephone services are used, as well as cost of services.

3.3.2.1 Television Service

Fifty-eight percent of respondents stream television over the internet, and 33 percent have cable television. Much smaller shares of the market have antenna (over-the-air) service (22 percent) or satellite/Dish or Direct TV service (7 percent). Just four percent do not watch television (see Figure 68).

Figure 68: Types of Television Service in Home



Portland residents are more likely than residents of other areas to stream over the internet or have antenna television, and they are less likely to subscribe to cable or satellite television service (see Figure 69). Additionally, those who subscribe to fiber internet service are more likely than other internet subscribers to stream television over the internet, as illustrated in Figure 70.

The use of television service is also correlated with respondent age. Older respondents are less likely to stream over the internet, and they are more likely to subscribe to cable TV compared with younger respondents (see Figure 71).

Figure 69: Types of Television Service in Home by Region

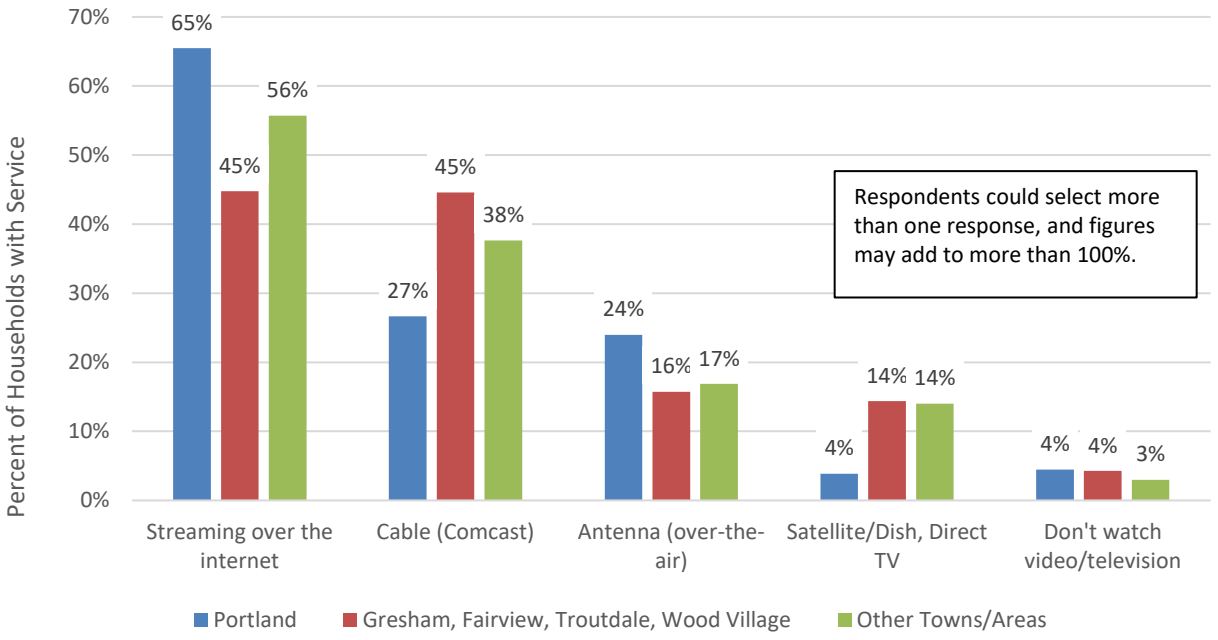


Figure 70: Types of Television Service in Home by Primary Home Internet Service

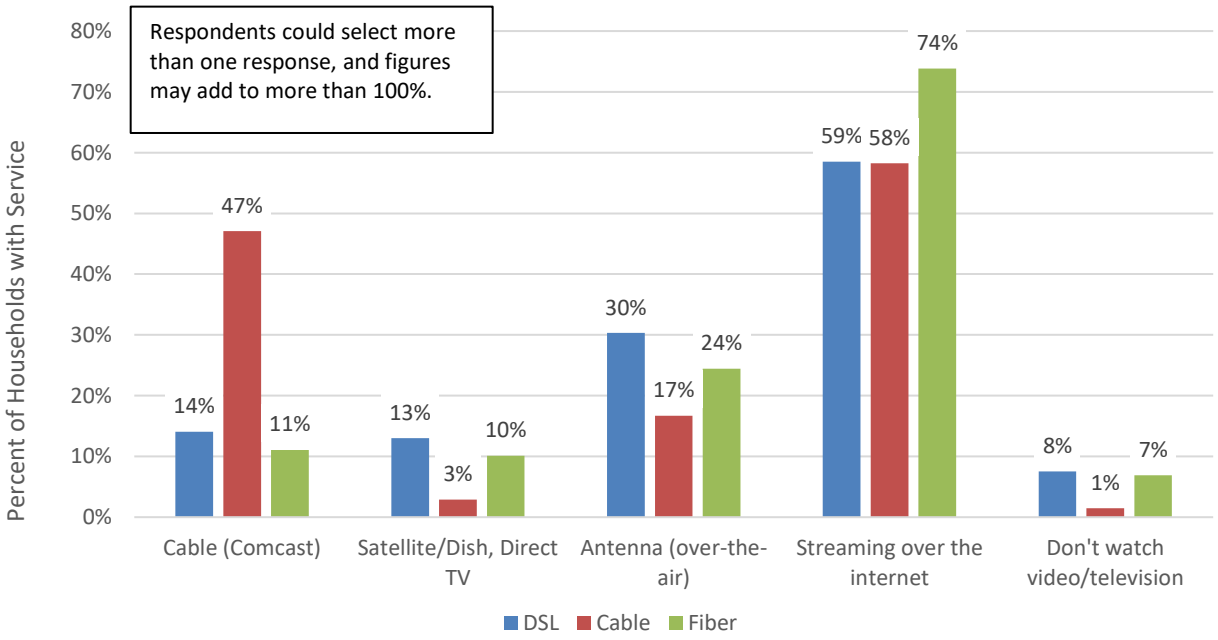
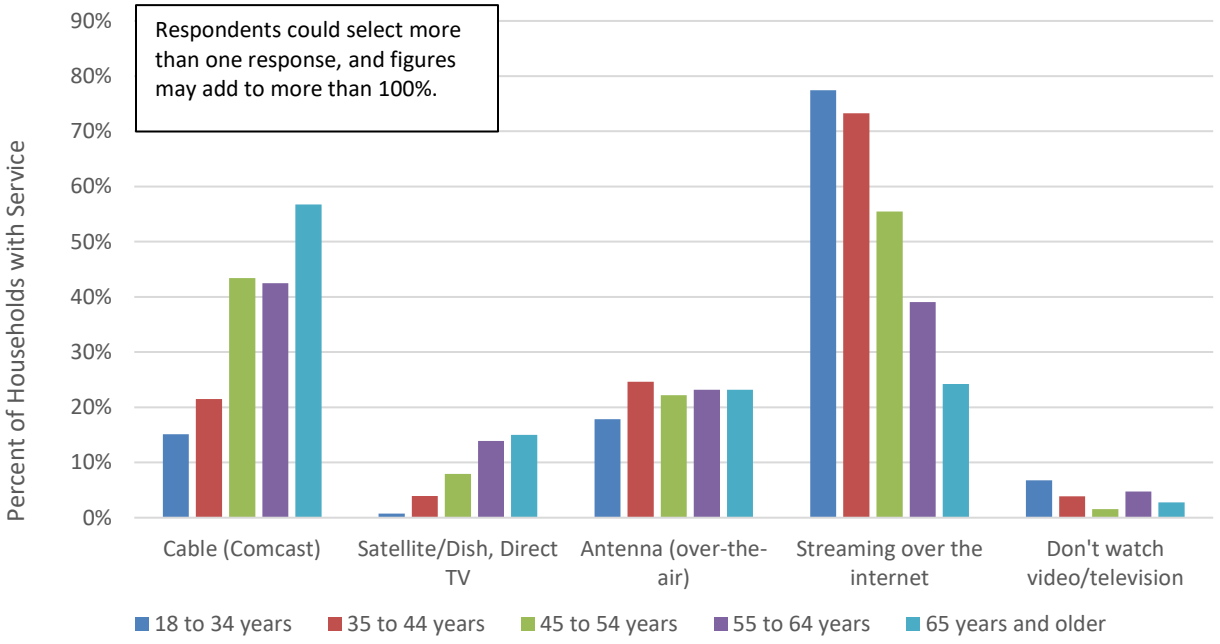
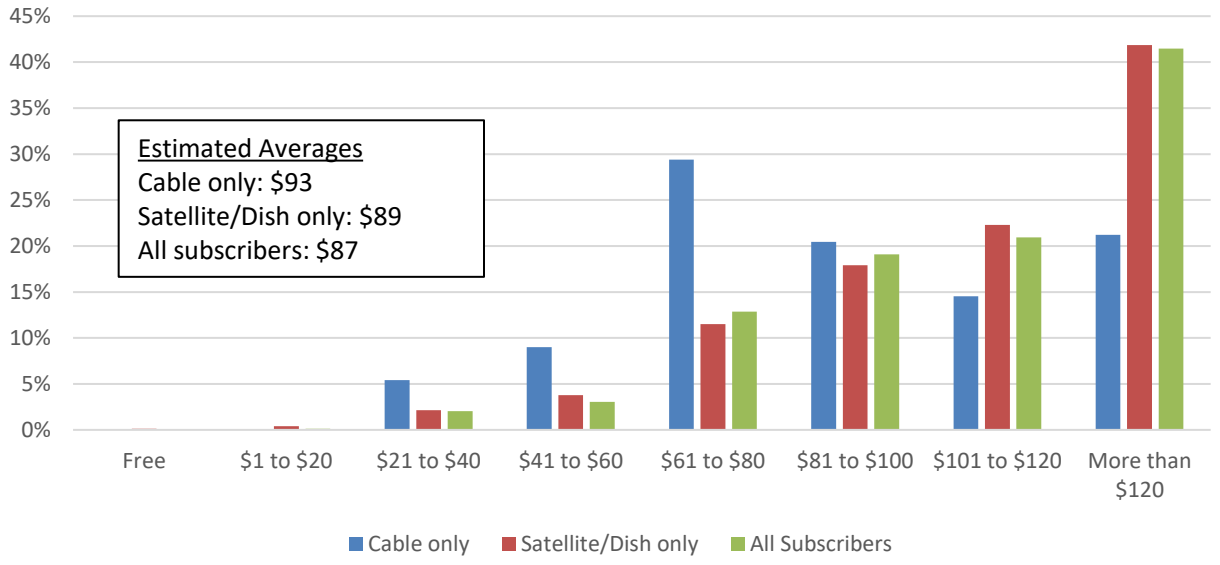


Figure 71: Types of Television Service in Home by Respondent Age



The estimated average monthly price for satellite/Dish or DirecTV service is $87, with more than four in 10 paying over $120 per month, as illustrated in Figure 72. The estimated average monthly price is slightly higher for cable and satellite services, while those who have multiple services pay an estimated average of $72 per month.

Figure 72: Monthly Price of Cable or Satellite TV by Service



3.3.2.2 Telephone Service

Respondents were asked about their home and mobile telephone services. Nearly nine in 10 respondents have a cellular/mobile telephone (see Figure 73). Portland residents are somewhat more likely than residents of other areas to have a cellphone (see Figure 74). Just a small share of respondents has other types of telephone service.

Figure 73: Home Telephone Service(s)

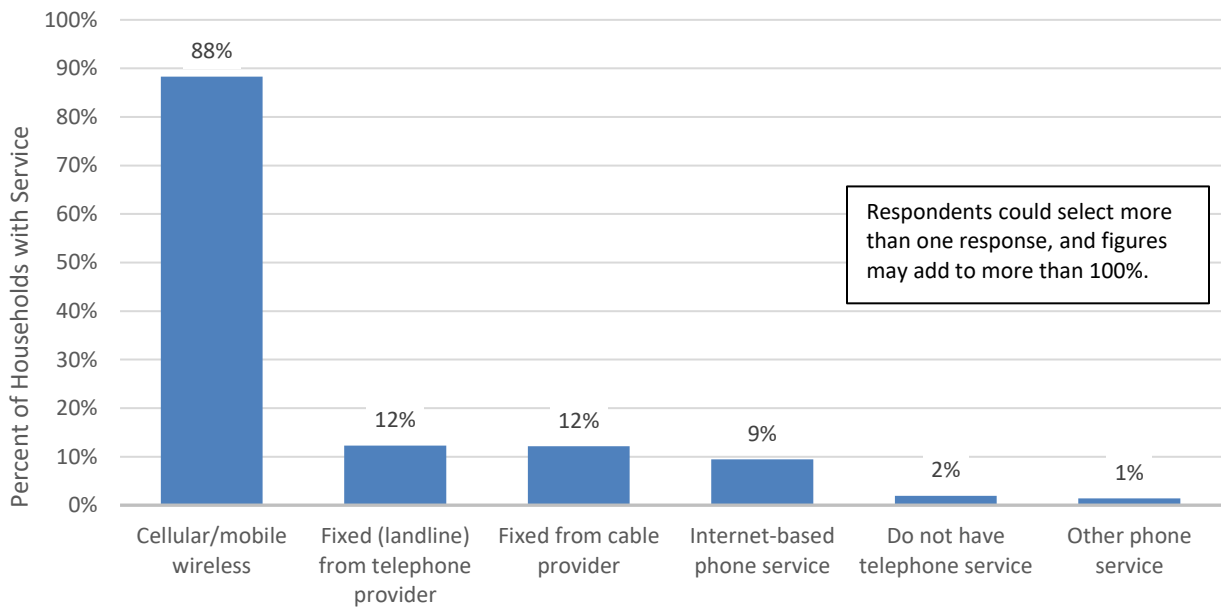
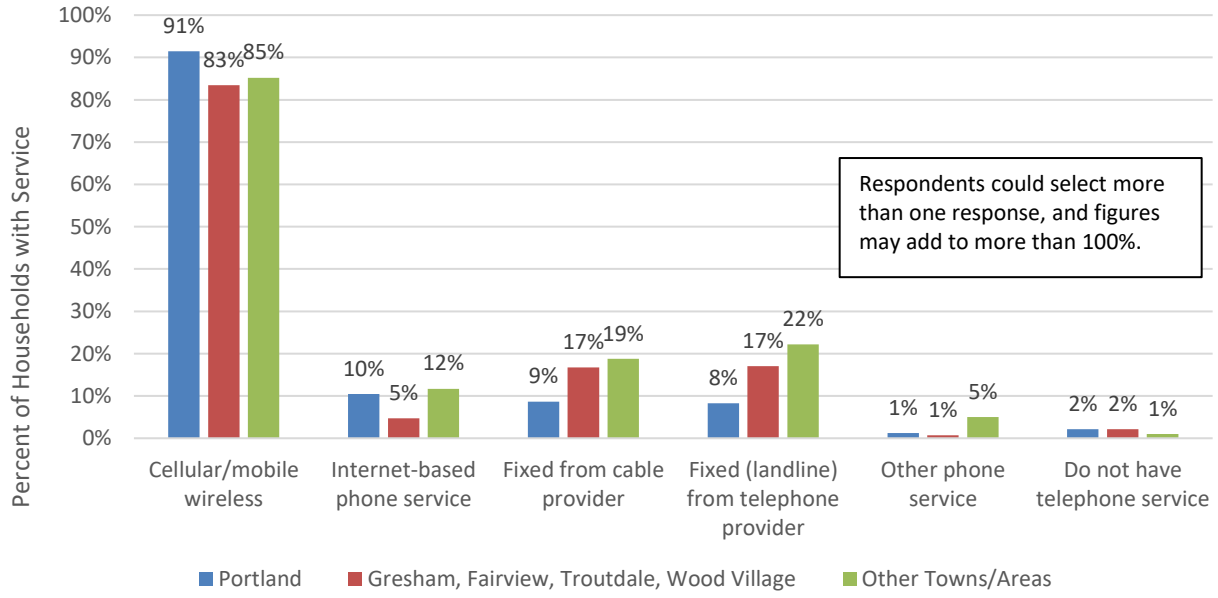
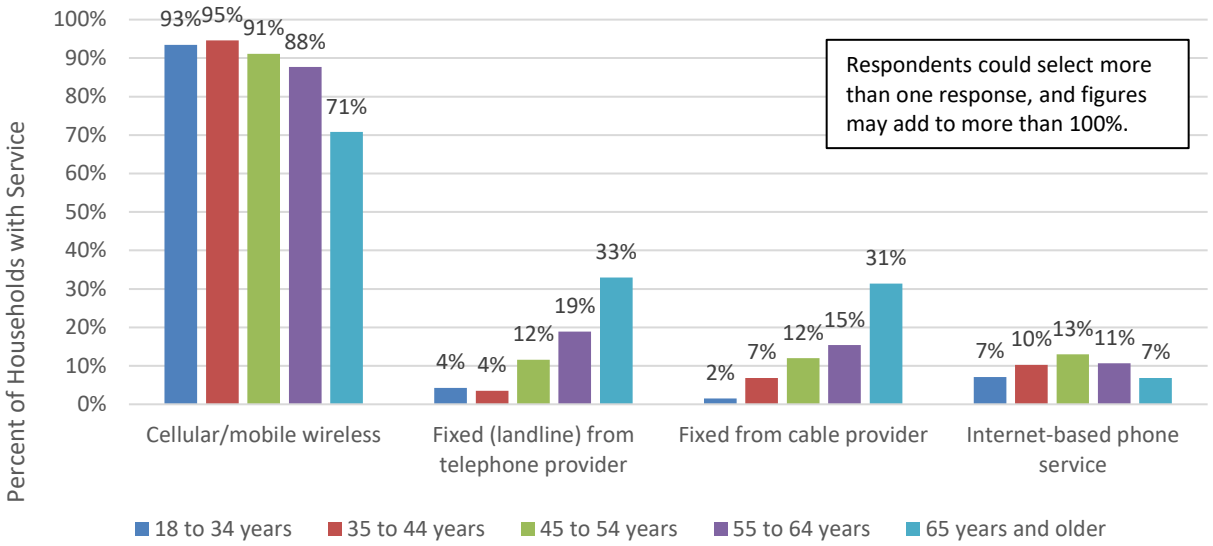


Figure 74: Home Telephone Service(s) by Region



As shown in Figure 75, usage of cellular/mobile wireless telephone service is lower among those ages 65+ compared with young respondents, while usage of landline telephone service is higher. Still, cellular/mobile is the leading service across all age cohorts.

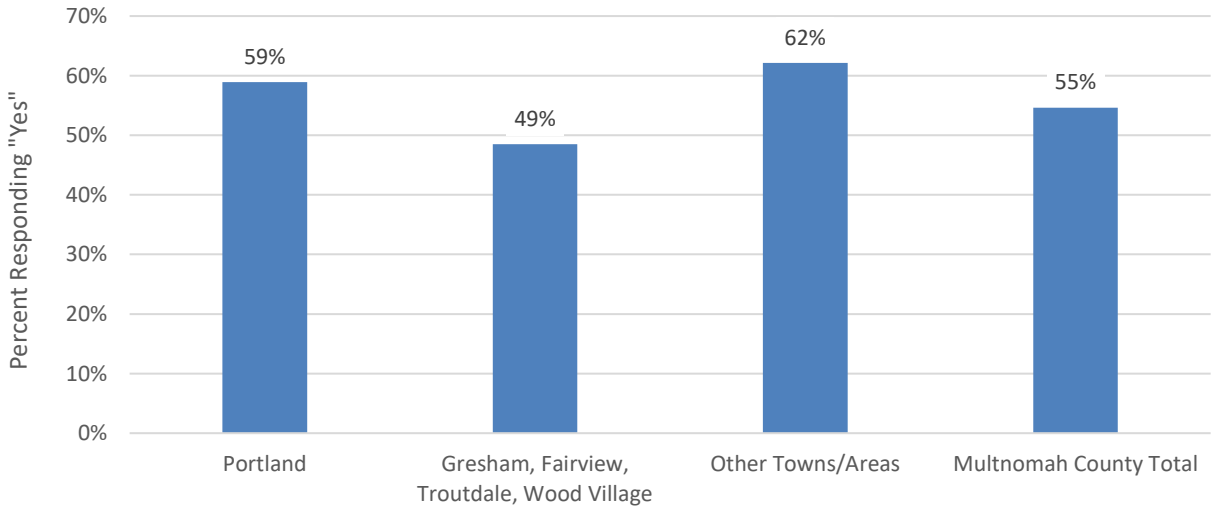
Figure 75: Home Telephone Service(s) by Respondent Age



3.3.3 Internet Use for Jobs/Careers

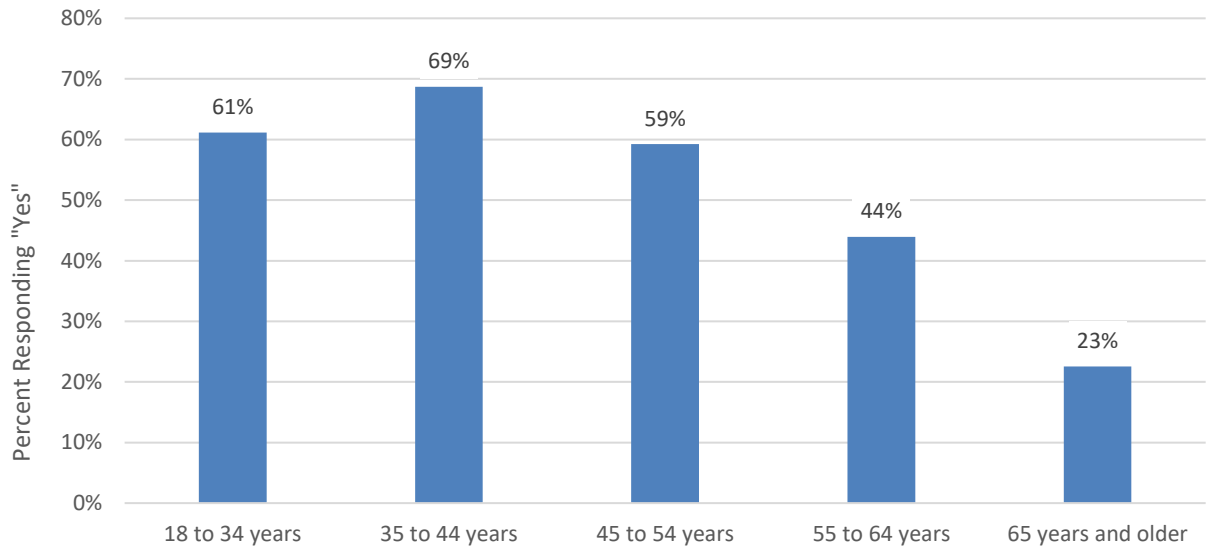
More than one-half of respondents said their job requires them to have internet access at home (see Figure 76). Those residing in the Gresham, Fairview, Troutdale, Wood Village region as a whole are less likely to have a job that requires home internet access, compared with Portland residents and those who live in unincorporated/other areas of the County.

Figure 76: Job Requires Homes Internet Access



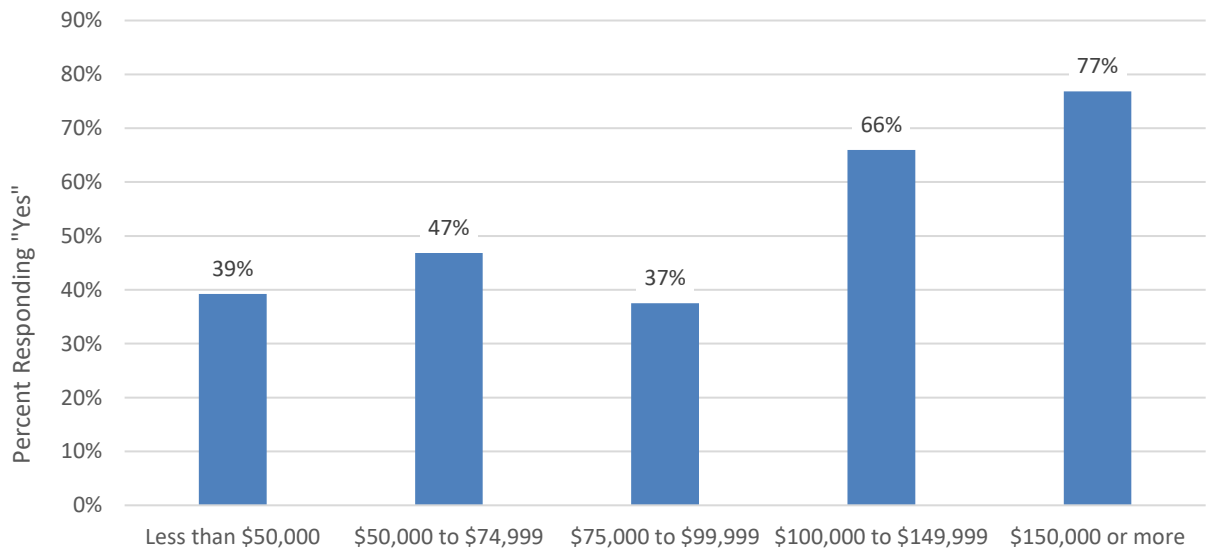
As illustrated in Figure 77, respondents under age 65 are more likely than those ages 65+ to have a job that requires internet access from home.

Figure 77: Job Requires Homes Internet Access by Respondent Age



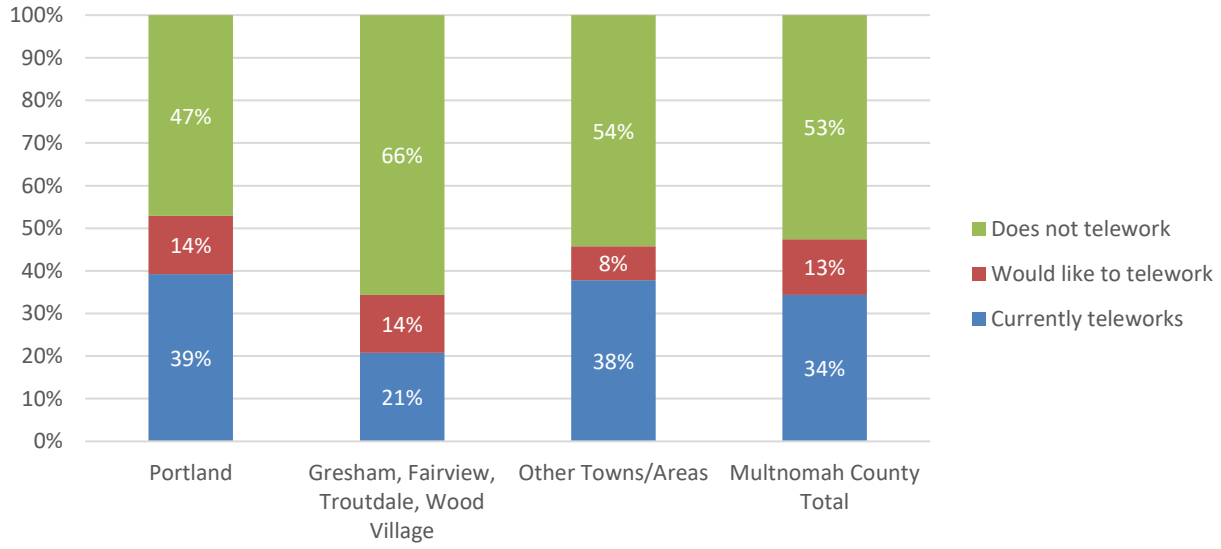
Those earning $100,000 or more per year are more likely than those with a lower household income to have a job that requires internet access (see Figure 78). Approximately four in 10 of those earning less than $50,000 need internet access for a job. Although lower income groups have a higher proportion of individuals ages 65 years and older, across age cohorts higher income individuals have a greater need for home internet access compared with lower income households.

Figure 78: Internet Access Required for Job by Household Income



As shown in Figure 79, 34 percent of respondents indicated that someone in their household already teleworks from home, and another 13 percent would like to telework. Those residing in the Gresham, Fairview, Troutdale, Wood Village region are less likely than others to currently telework.

Figure 79: Household Member Teleworking



Respondents ages 35 to 54 are more likely than younger and older respondents to telework (see Figure 80). Additionally, the percentage of households with a member who teleworks increases as household income increases, going from one in 10 households earning under $50,000 per year to six in 10 households earning $150,000 or more per year (see Figure 81).

Figure 80: Teleworking Status by Respondent Age

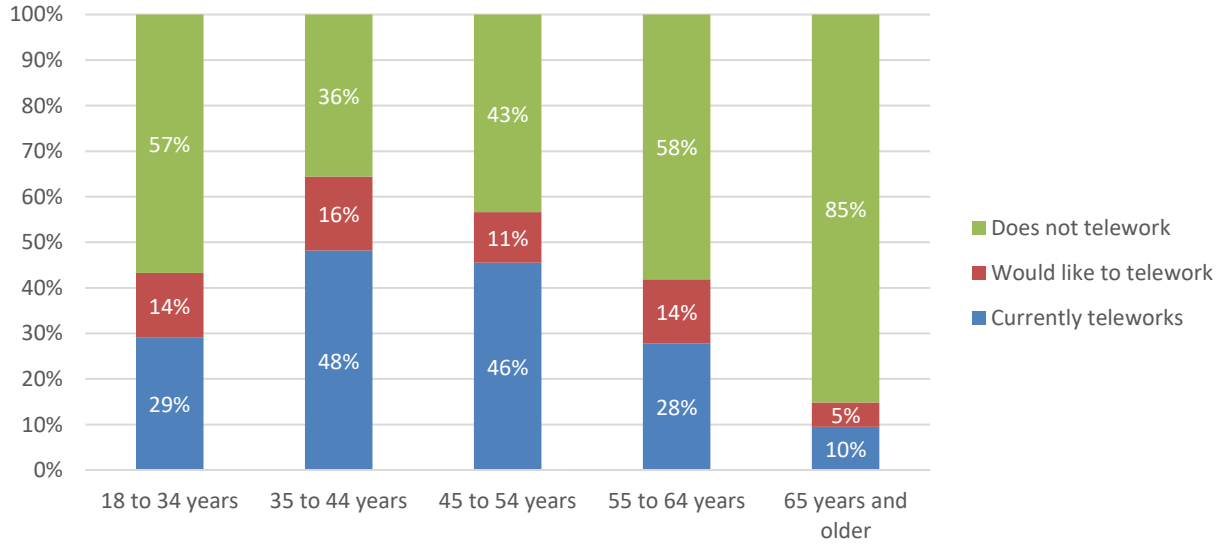
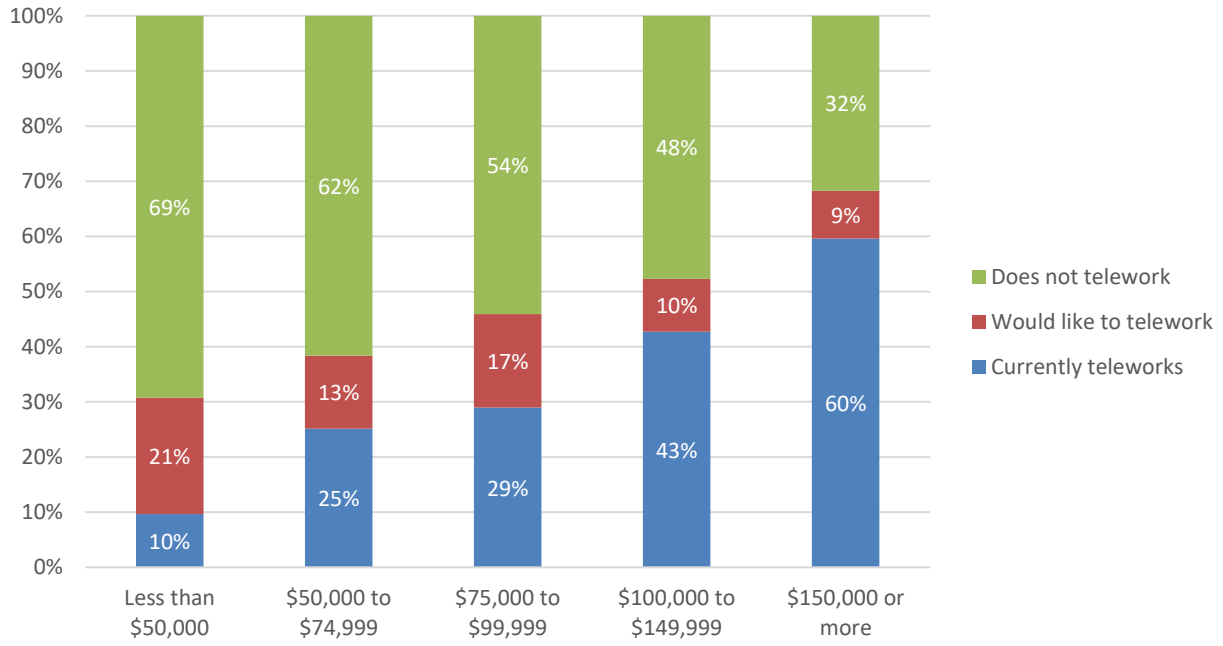
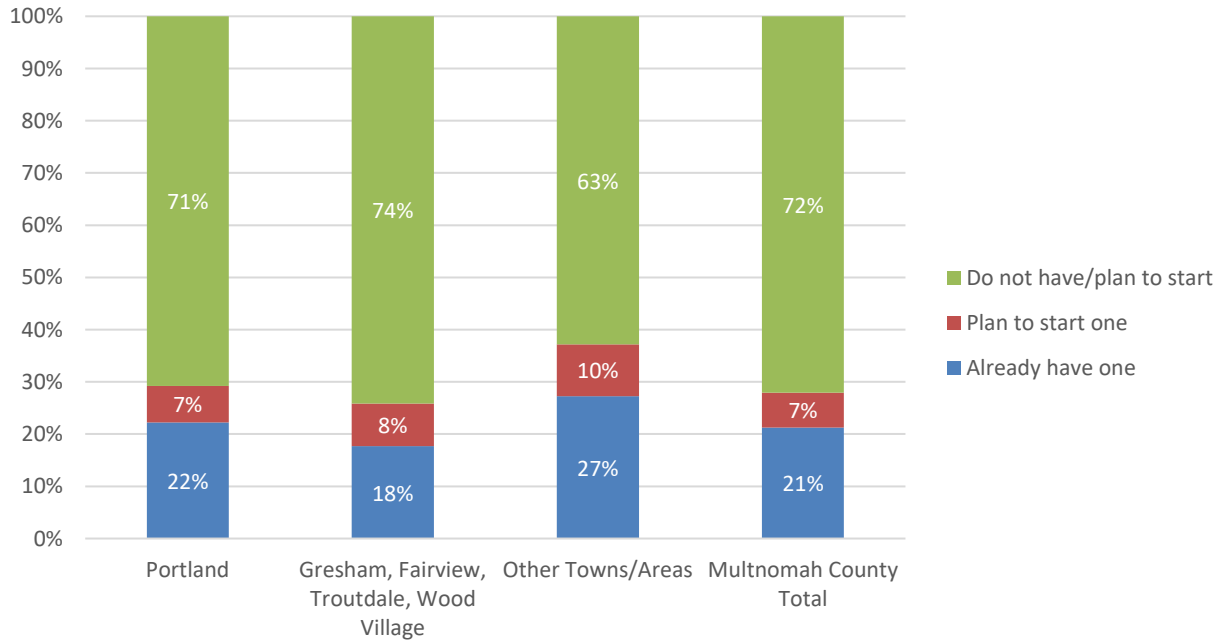


Figure 81: Teleworking Status by Household Income



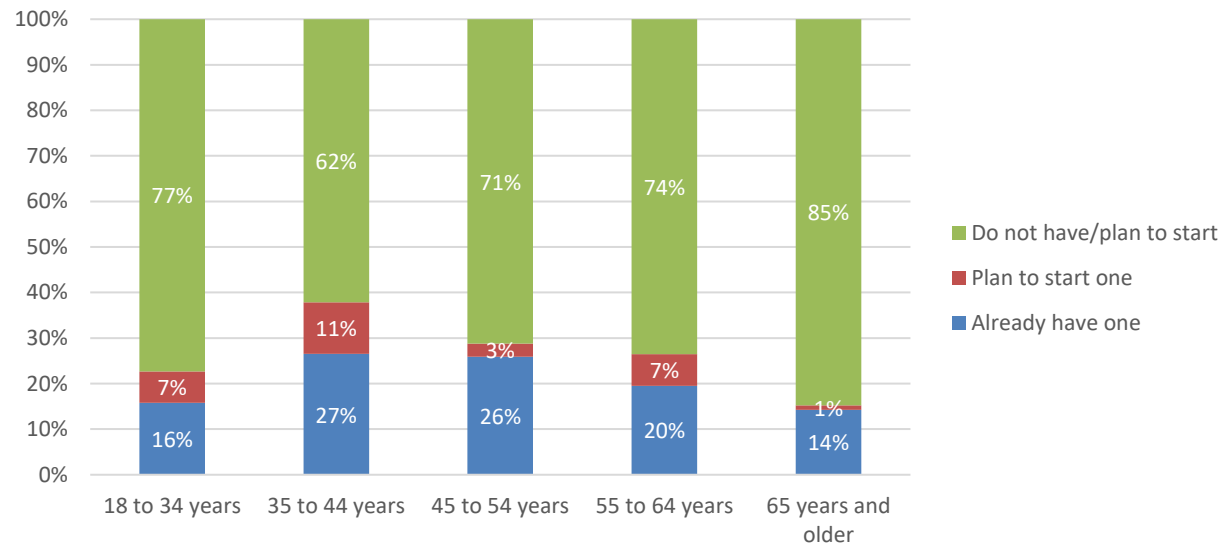
One-fifth of respondents have a home-based business and seven percent are planning to start one within the next three years, as illustrated in Figure 82.

Figure 82: Own or Plan to Start a Home-Based Business



As shown in Figure 83, respondents ages 35 to 54 years are more likely than older and younger respondents to either have a home-based business. Another 11 percent of those ages 35 to 44 years would like to start a home-based business.

Figure 83: Own or Plan to Start a Home-Based Business by Respondent Age



A high-speed data or internet connection is extremely important for most of those who telework or would like to telework (86 percent) and for those with a planned or existing home-based business (79 percent), as shown in Figure 84 and Figure 85. 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 84: Importance of High-Speed Internet for Teleworking

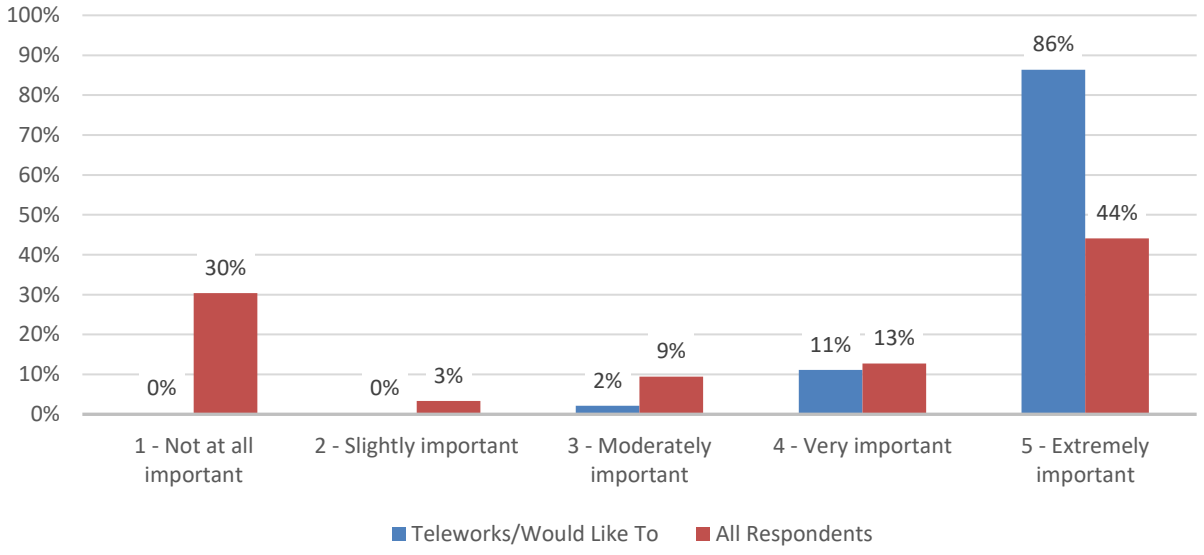
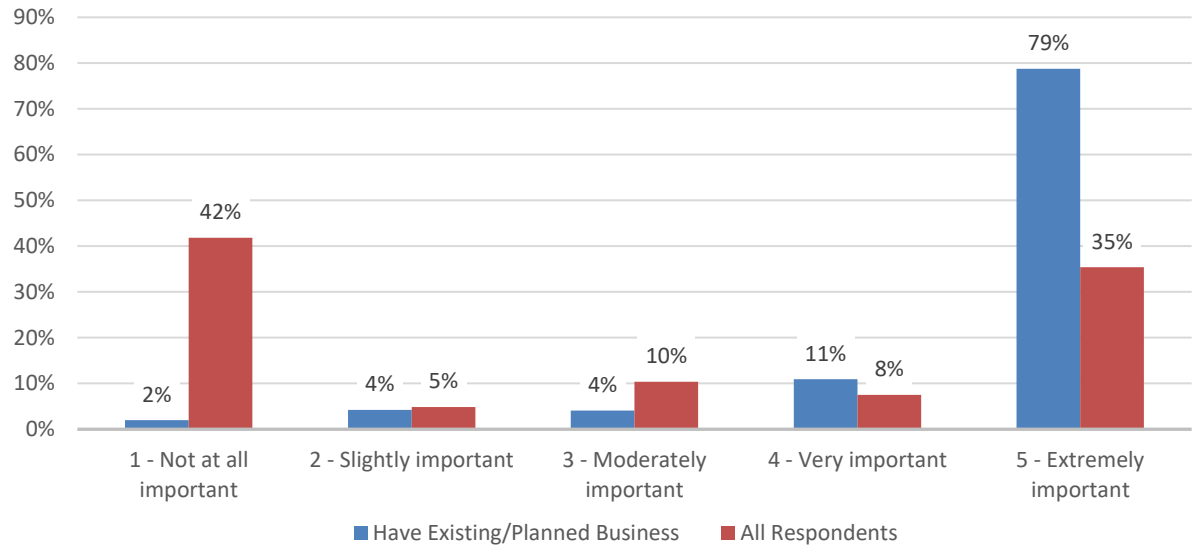


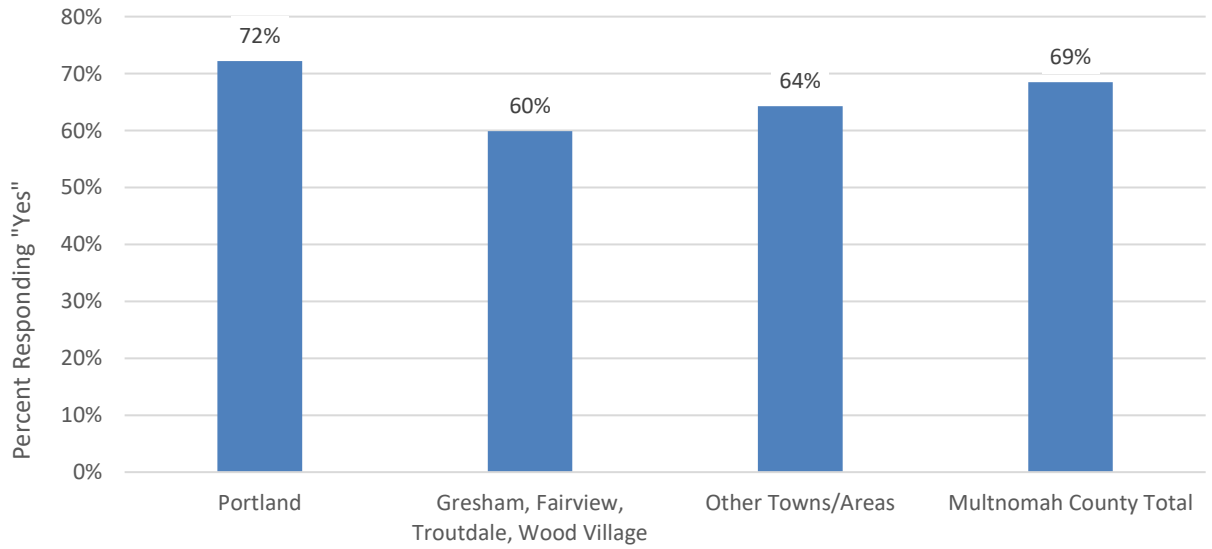
Figure 85: Importance of High-Speed Internet for Home-Based Business



3.3.4 Internet Use for Healthcare

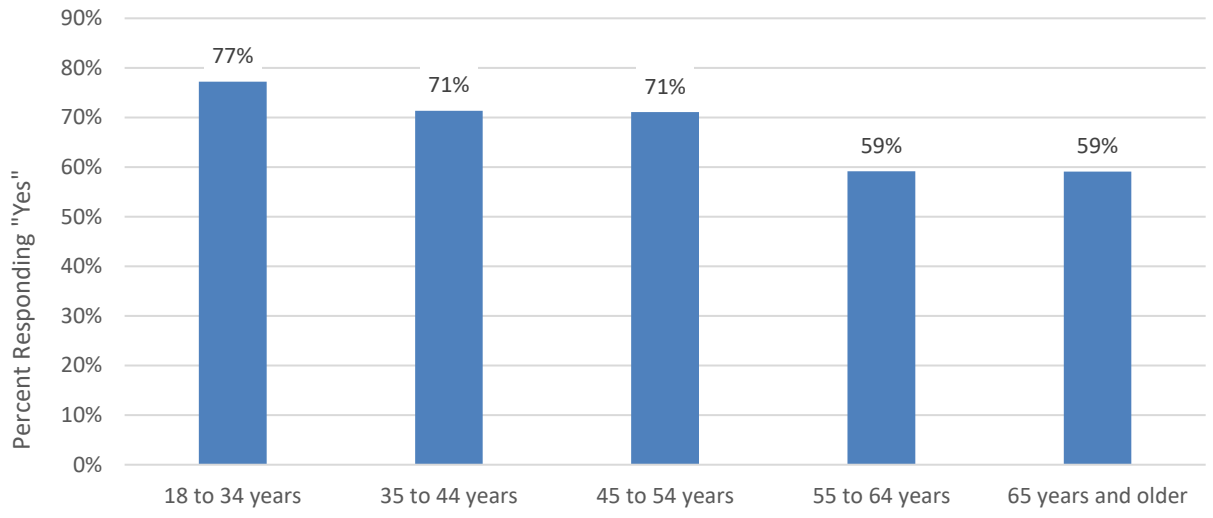
Respondents were asked if they or a household member use an internet connection to access healthcare services at home. Overall, 69 percent of households have a member who accesses healthcare services via their home internet connection, with usage highest in Portland compared with other areas (see Figure 86).

Figure 86: Use Internet to Access Healthcare Services at Home



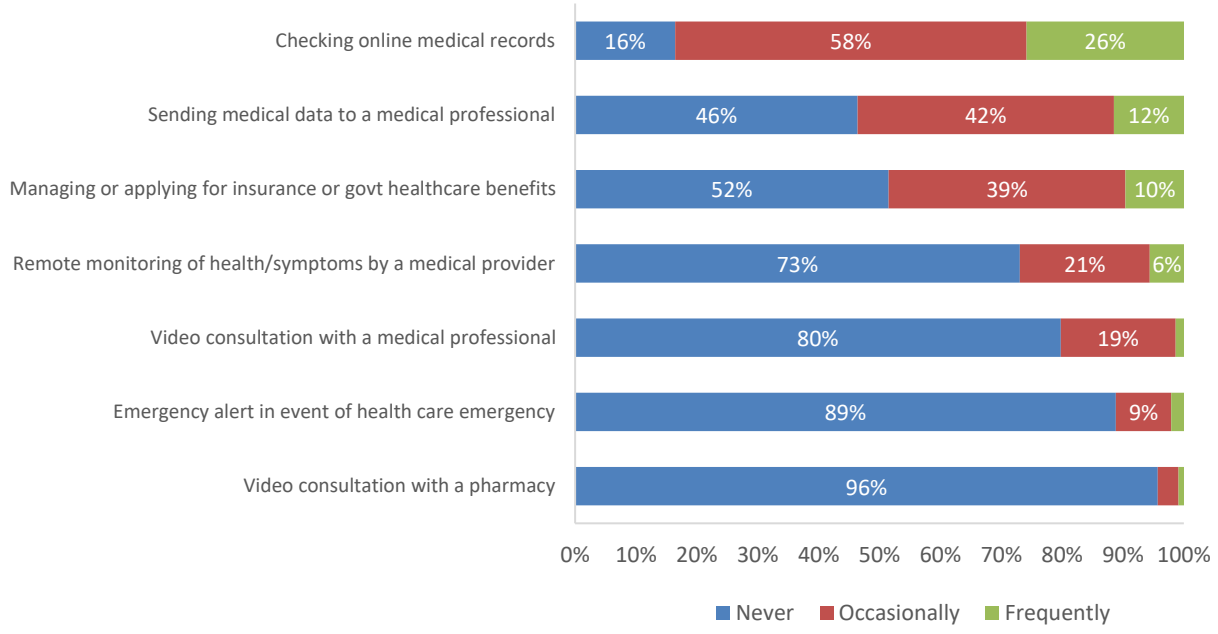
Respondents ages 55 and older are less likely than younger respondents to have a household member who accesses healthcare services via the internet (see Figure 87).

Figure 87: Use Internet to Access Healthcare Services at Home by Respondent Age



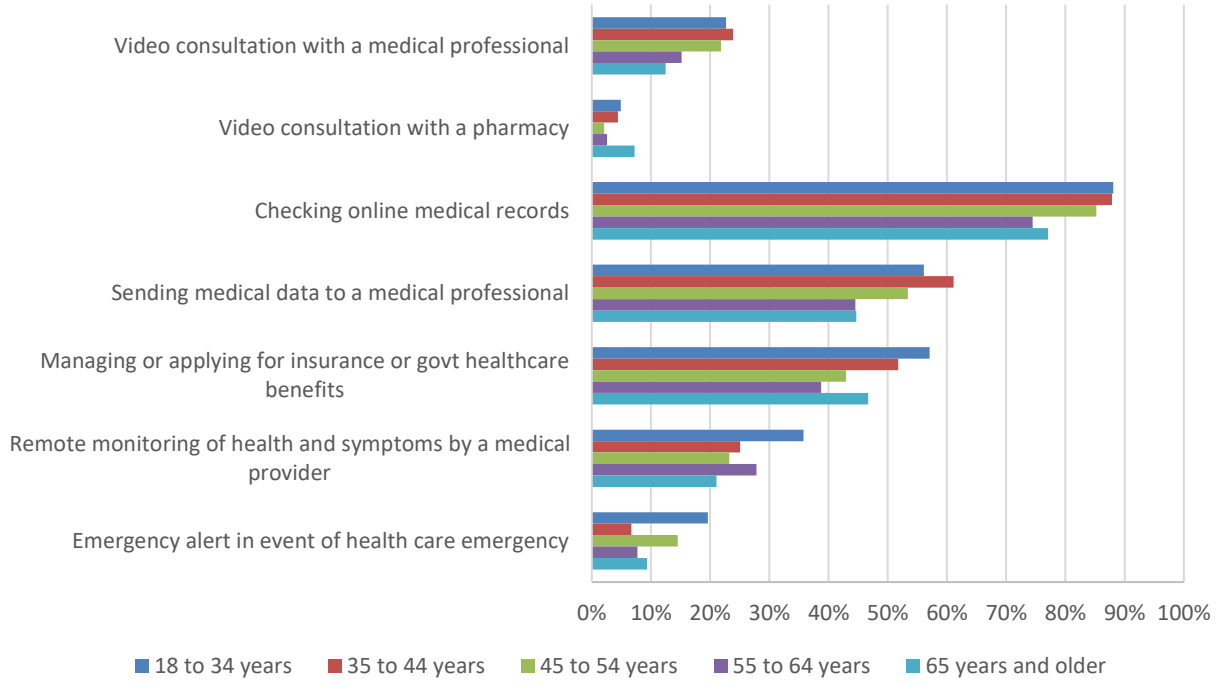
As illustrated in Figure 88, one-fourth of respondents frequently use the internet to check online medical records, and 58 percent occasionally check online medical records. Approximately one-half of respondents at least occasionally use the internet to send medical data or to manage/apply for insurance or government healthcare benefits. Only a small share of respondents use their home internet connection for other healthcare related purposes.

Figure 88: Frequency of Internet Use for Healthcare Services



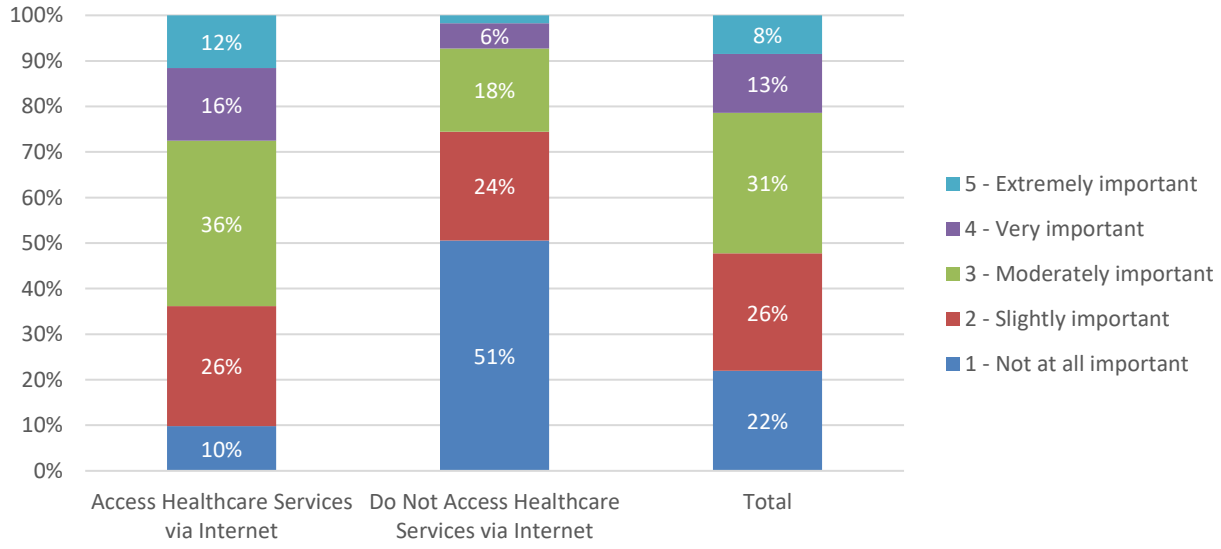
As illustrated in Figure 89, usage of the internet for various services tends to be lower for older respondents.

Figure 89: Internet Use for Healthcare Services by Respondent Age



Intuitively, those who access the internet for healthcare services placed greater importance on having a high-speed internet connection for their healthcare needs, compared with those who do not use the internet for this purpose (see Figure 90).

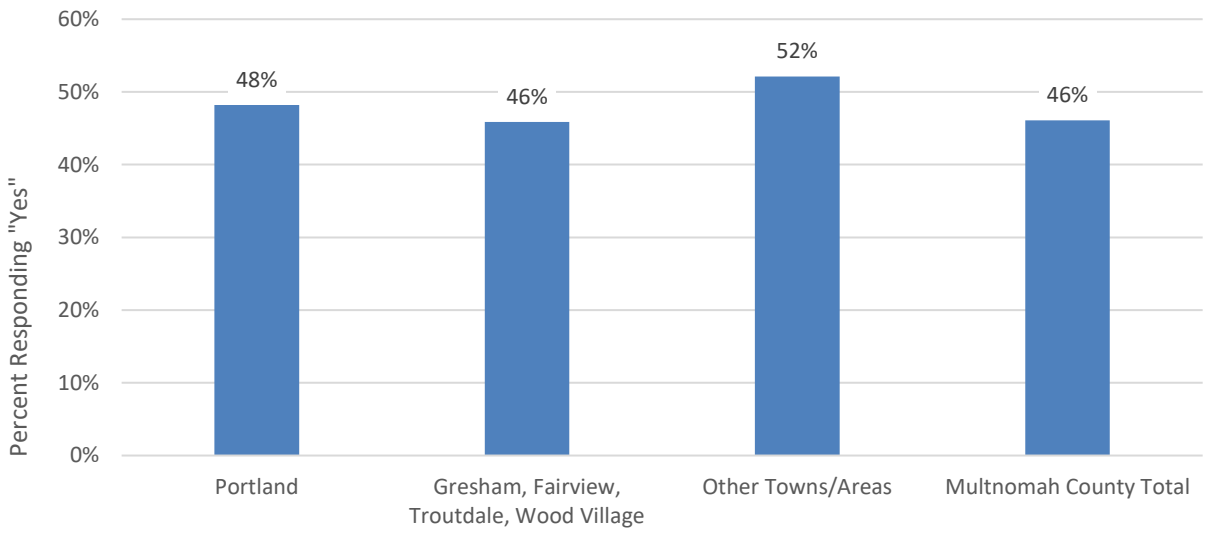
Figure 90: Importance of High-Speed Internet Connection for Healthcare Needs



3.3.5 Internet Use for Education

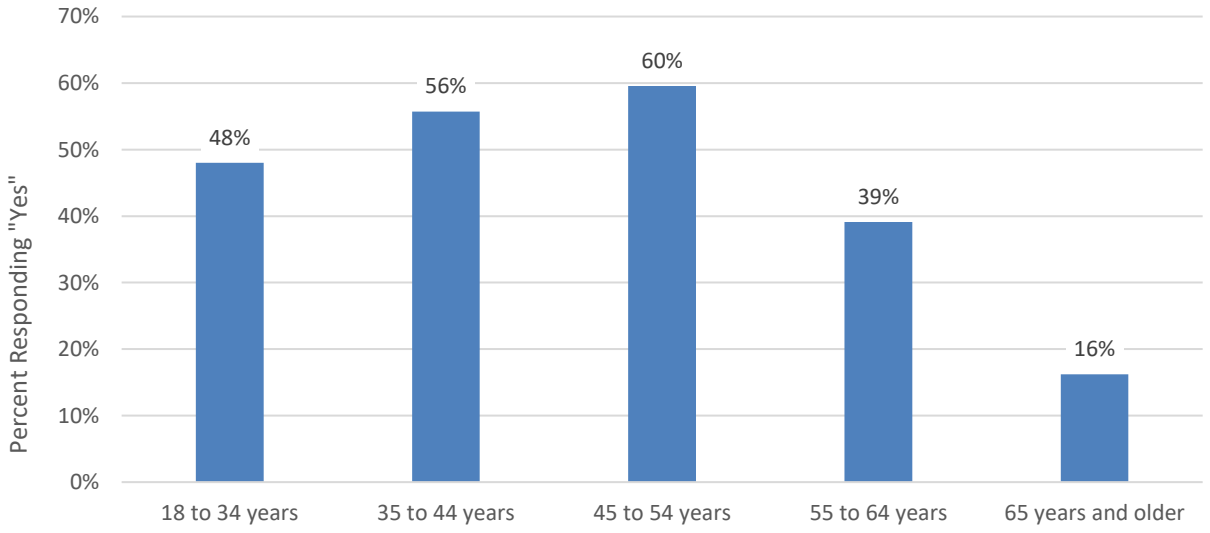
Respondents were asked if they or a household member use an internet connection for educational purposes, such as completing assignments, research, or study related to coursework or formal education. Overall, 46 percent of respondents reported using the internet for educational reasons (see Figure 91). Just five percent of all respondents (or 11 percent of those who use the internet for education) use the internet for homeschooling.

Figure 91: Use of Internet for Educational Purposes



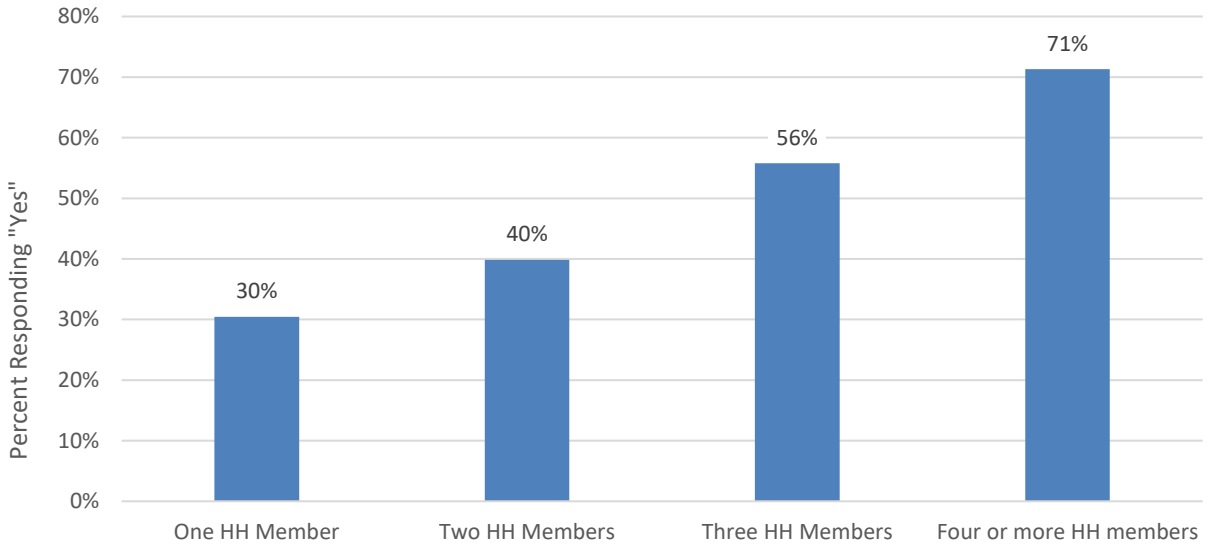
Use of the internet for educational purposes is significantly lower for respondents ages 65+ (see Figure 92).

Figure 92: Use of Internet for Educational Purposes by Respondent Age



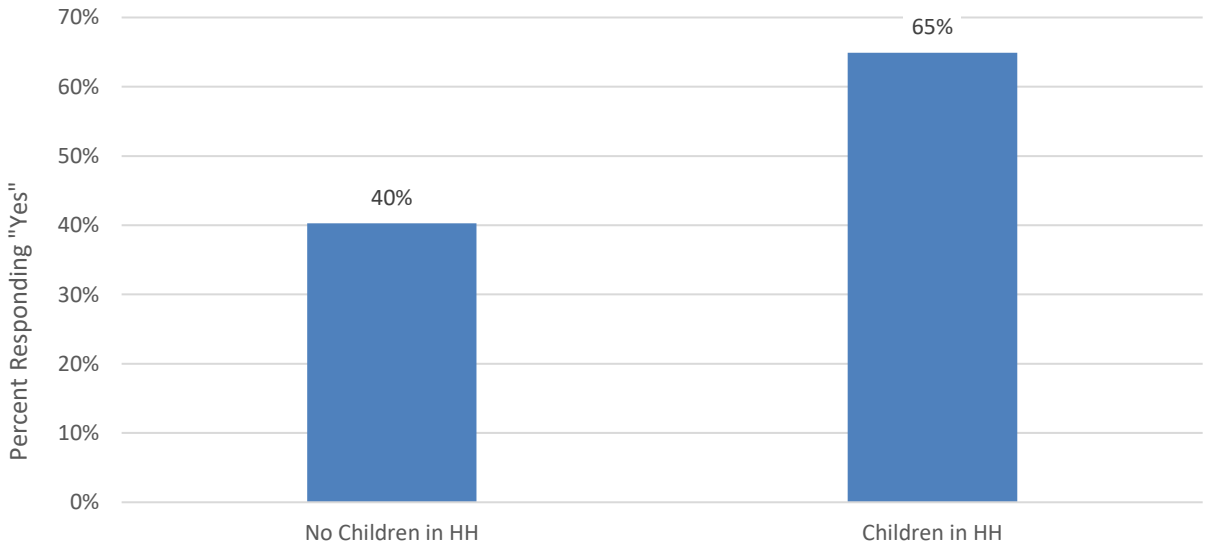
Use of the internet for educational purposes is also correlated with the number of people residing in the household (see Figure 93). Three in 10 respondents who live alone use the internet for educational purposes, compared with 71 percent of respondents in households with four or more people.

Figure 93: Use of Internet for Educational Purposes by Household Size



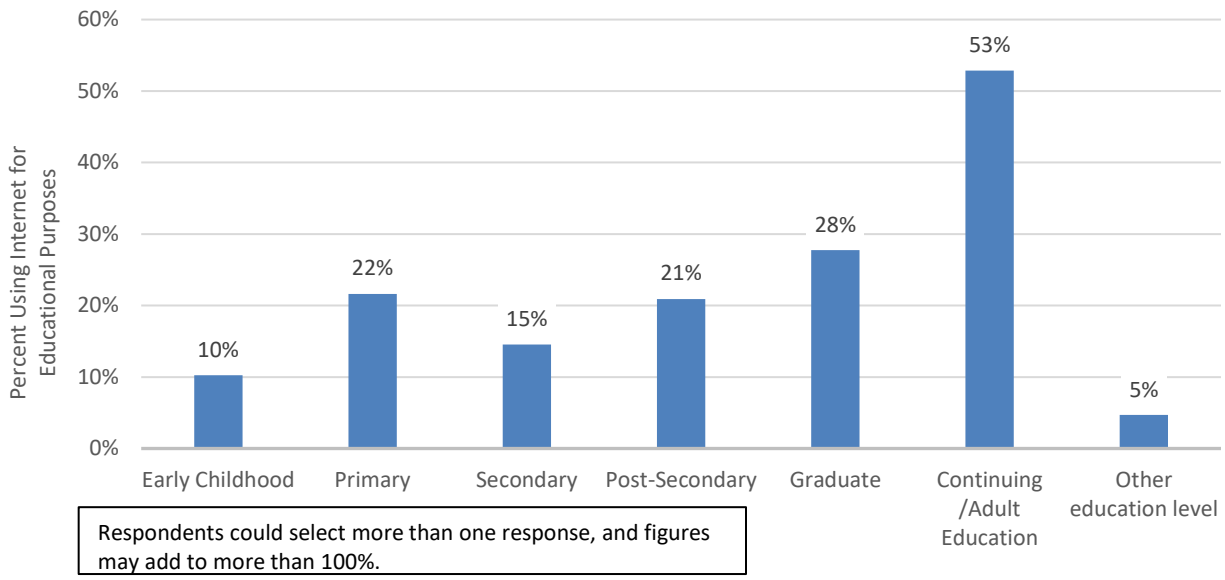
Nearly two-thirds of households with children use the internet for educational purposes, as shown in Figure 94.

Figure 94: Use of Internet for Educational Purposes by Children in Household



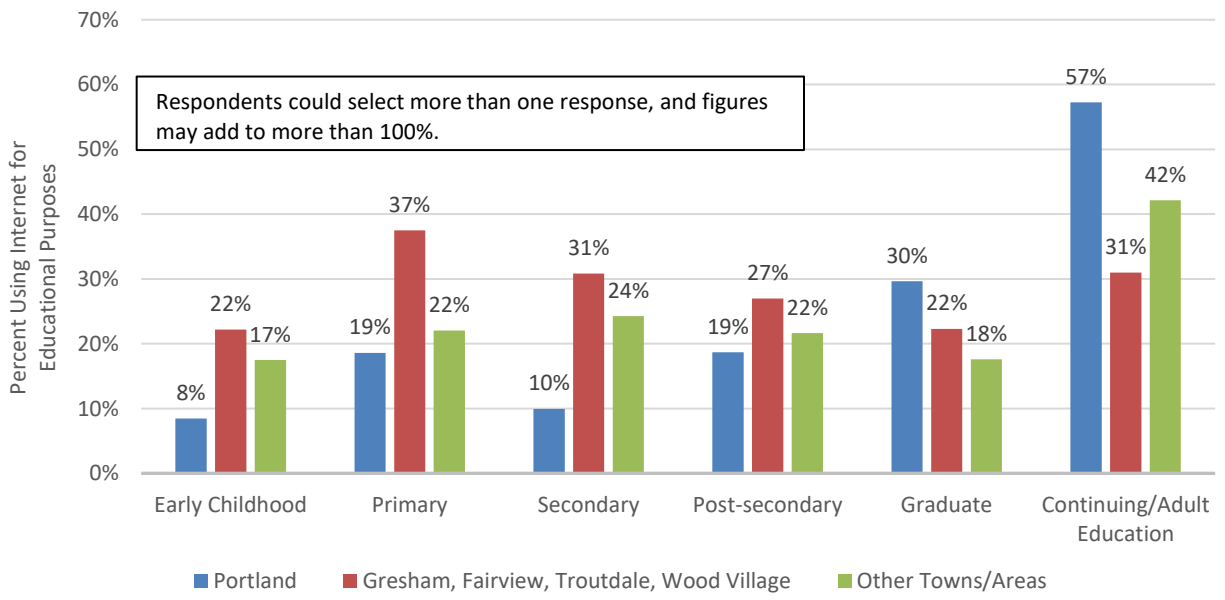
Respondents use the internet across a range of education levels. Among those who use the internet for educational purposes, 53 percent use it for continuing/adult education (see Figure 95).

Figure 95: Education Level for Which Internet Connection Is Used



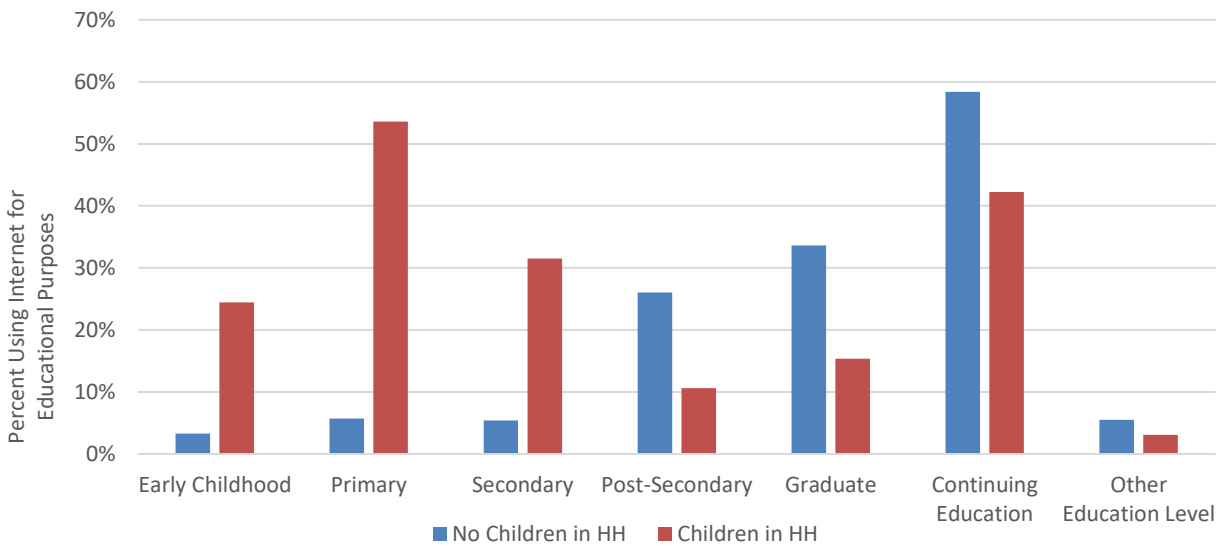
Portland residents are less likely than those who reside in the Gresham, Fairview, Troutdale, Wood Village region to use the internet for early childhood, primary, or secondary education, and they are more likely to use the internet for continuing/adult education (see Figure 96).

Figure 96: Education Level for Which Internet Connection Is Used by Region



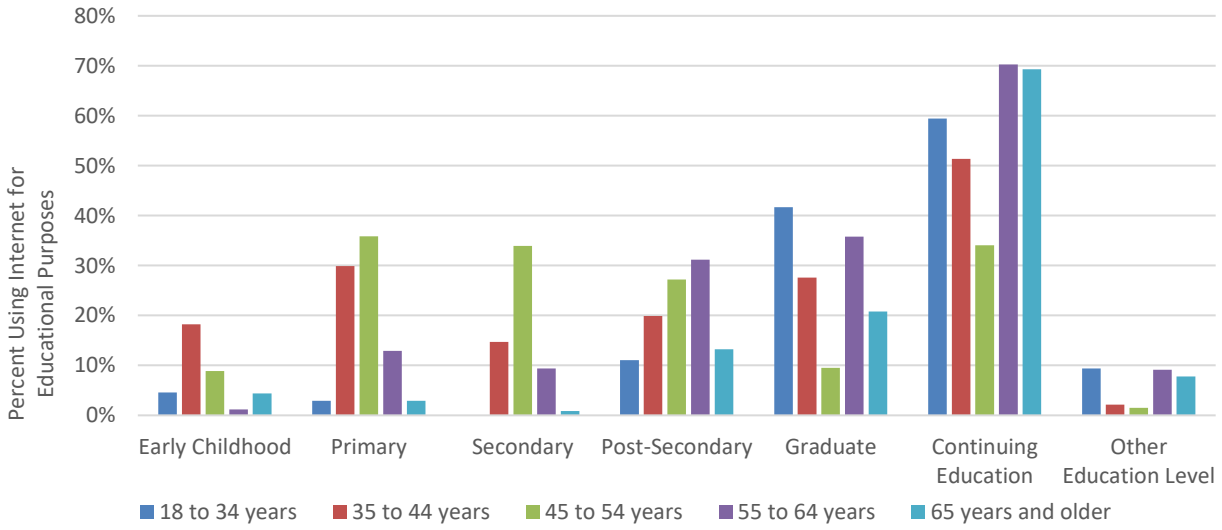
Use of the internet for educational purposes is related to presence of children in the household, as might be expected, particularly for early childhood, primary, and secondary education needs. Those without children in the home are more likely to use the internet for post-graduate, graduate, or continuing education (see Figure 97).

Figure 97: Education Level for Which Internet Connection Is Used by Children in Household



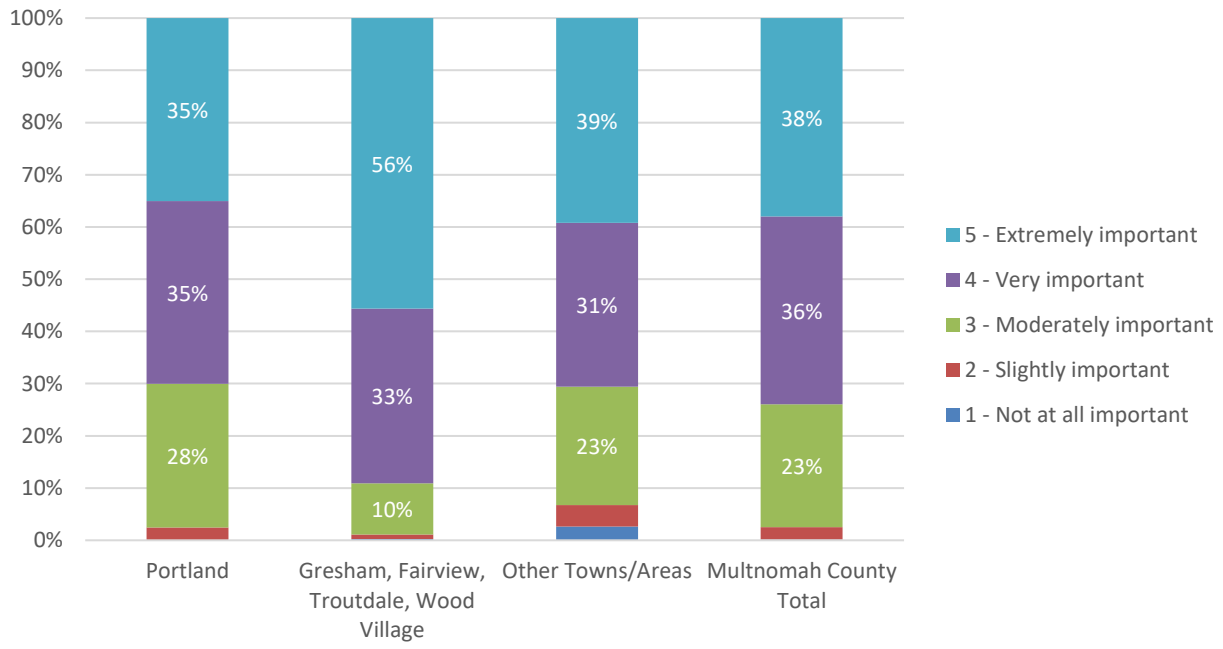
Similarly, use of the internet for educational purposes is correlated with respondent age, as illustrated in Figure 98. Respondents between ages 45 to 54 are more likely than older and younger respondents to use the internet for primary and secondary education, and they are less likely to use the internet for graduate and continuing education.

Figure 98: Education Level for Which Internet Connection Is Used by Respondent Age



Among those who use the internet for educational purposes, 38 percent said a high-speed internet connection is extremely important and 36 percent said it is very important for their education needs (see Figure 99). Importance of high-speed internet for education needs is greater among residents of the Gresham, Fairview, Troutdale, Wood Village region, compared with residents of Portland and other areas.

Figure 99: Importance of High-Speed Internet for Education Needs



3.3.6 High-Speed Broadband Market and the Role of the Government

Respondents were asked their opinions about the County's or Cities' role in providing or promoting broadband communications services within the area. Figure 100 illustrates the mean ratings, while Figure 101 provides detailed responses to each portion of the question.

Figure 100: Opinions About the Role(s) for Multnomah County and Cities (Mean Ratings)

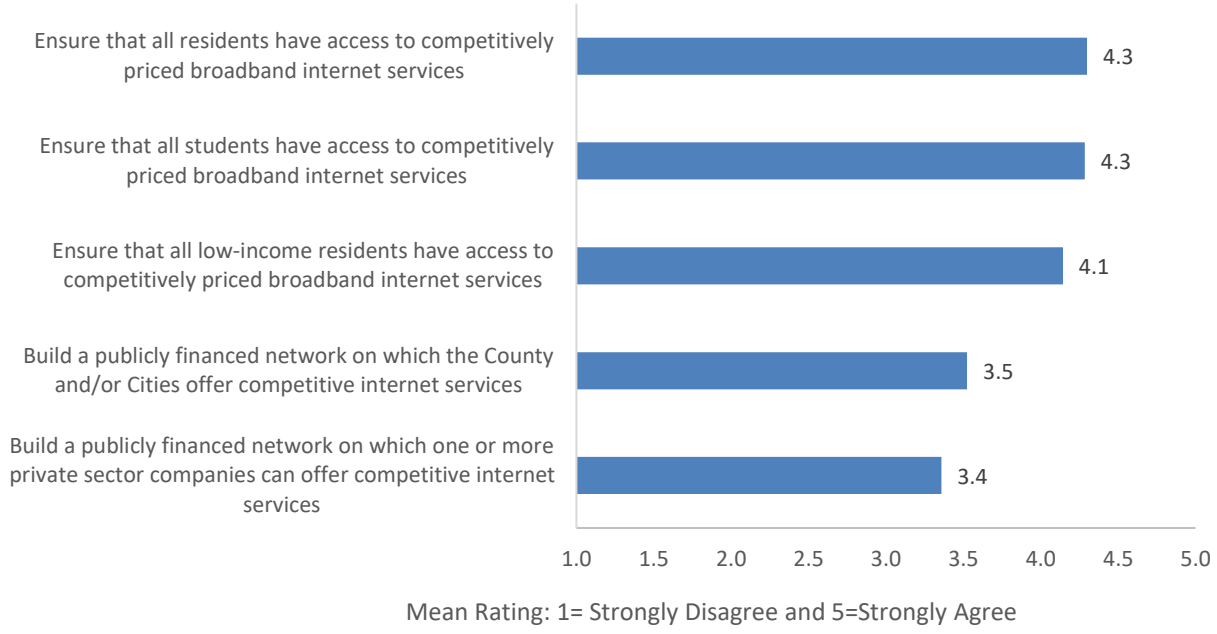
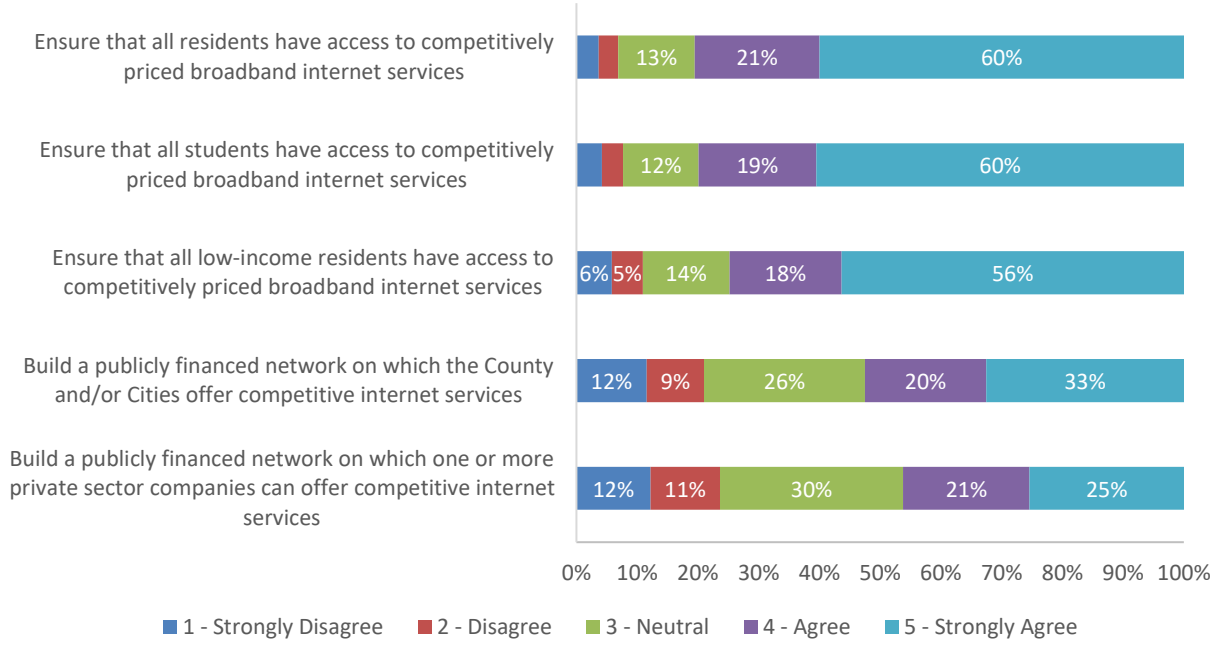


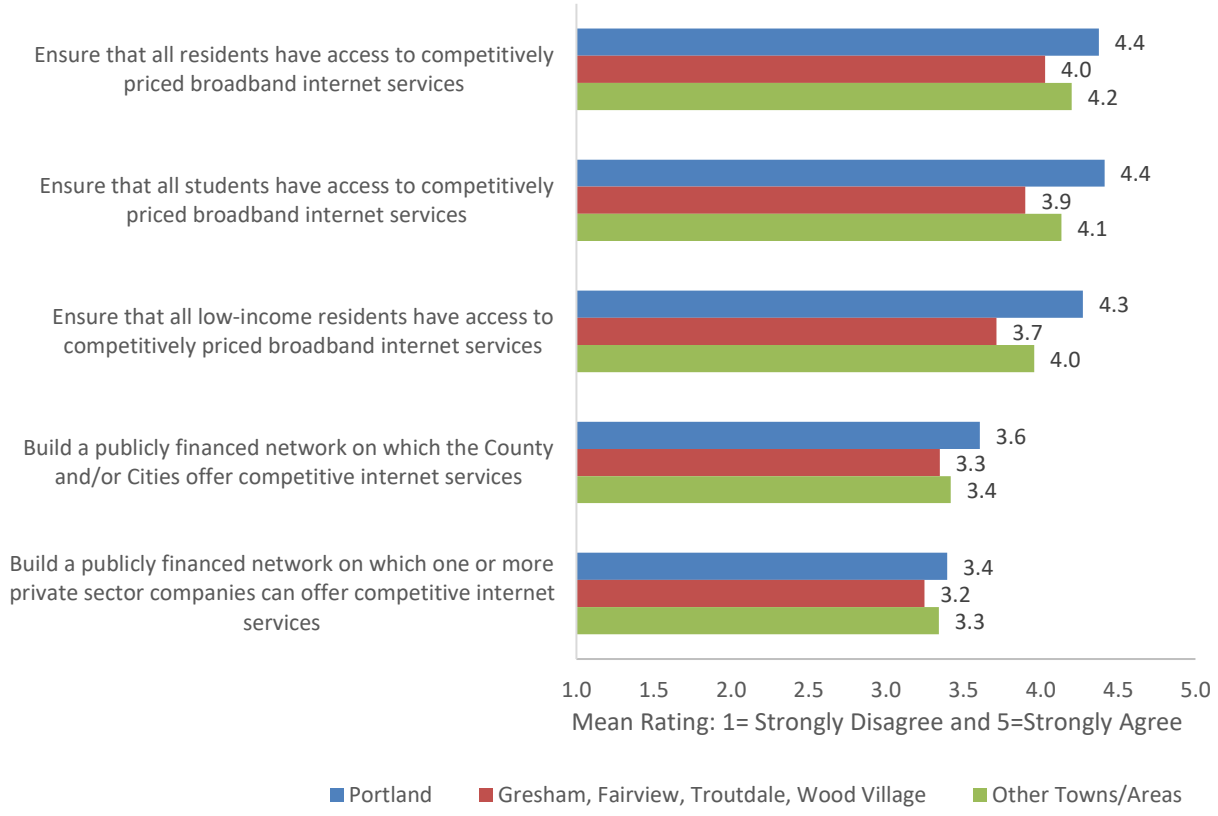
Figure 101: Opinions About the Role(s) for Multnomah County and Cities



Overall, there is support for ensuring access to competitively-priced broadband services, for all residents, students, and low-income residents, with approximately six in 10 strongly agreeing. One-third strongly agreed the Partner Agencies should provide build a publicly financed network on which the Partner Agencies offer competitive internet services, and one-fourth strongly agreed the Partner Agencies should build such a network on which private sector companies could offer internet services.

As illustrated in Figure 102, residents of the Gresham, Fairview, Troutdale, Wood Village region were less likely to agree that the Partner Agencies should ensure access to competitively priced broadband internet services, compared with those who reside in Portland and other areas.

Figure 102: Opinions About the Role(s) for Multnomah County and Cities by Region



Respondents were also asked their opinion of the current broadband market. Overall, respondents moderately to strongly agreed with most statements. Agreement was somewhat lower for the market offering high-speed internet at prices they can afford and willingness to pay a premium for access to high-speed internet. The average agreement with broadband availability statements are shown in Figure 103. Detailed responses to statements about broadband availability are illustrated in Figure 104.

Figure 103: Opinions About the Broadband Internet Market (Mean Ratings)

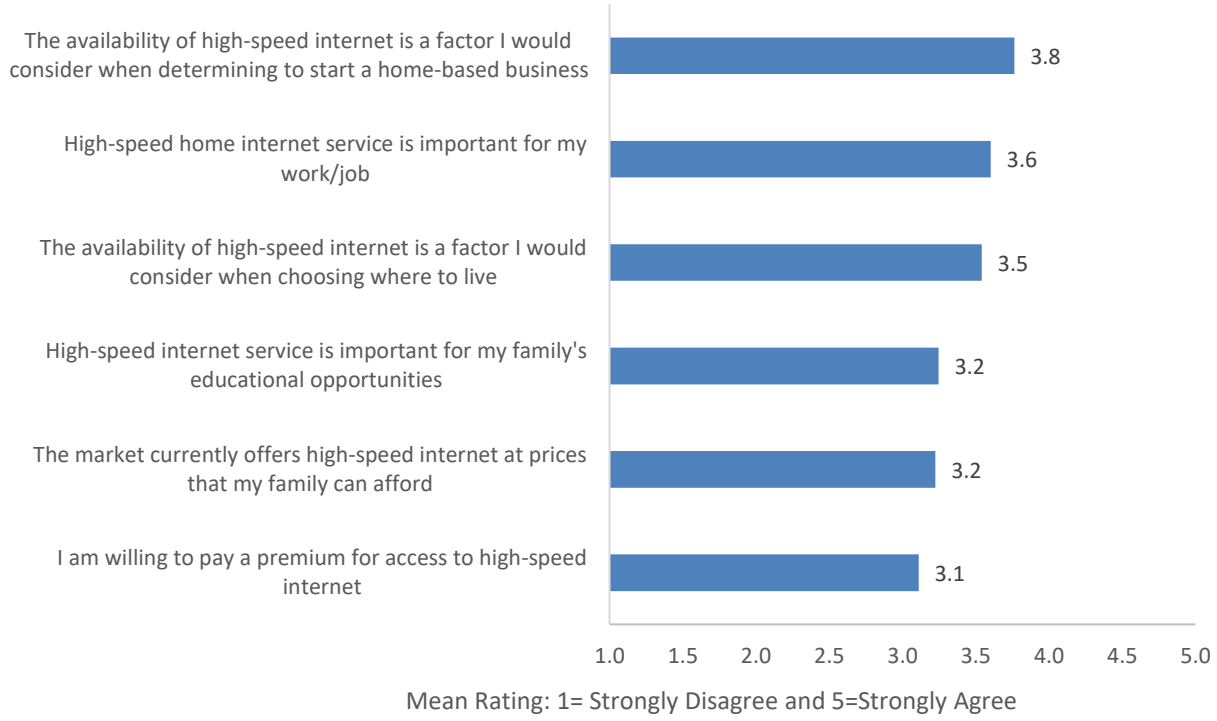
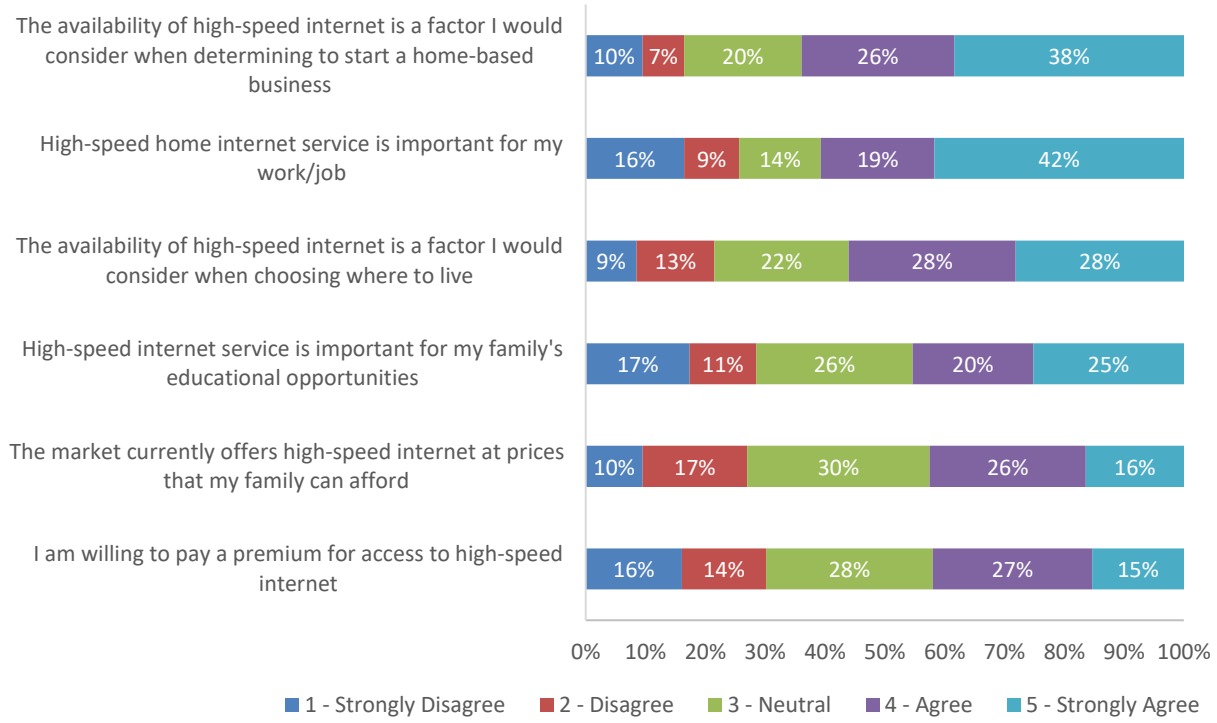


Figure 104: Opinions About the Broadband Internet Market

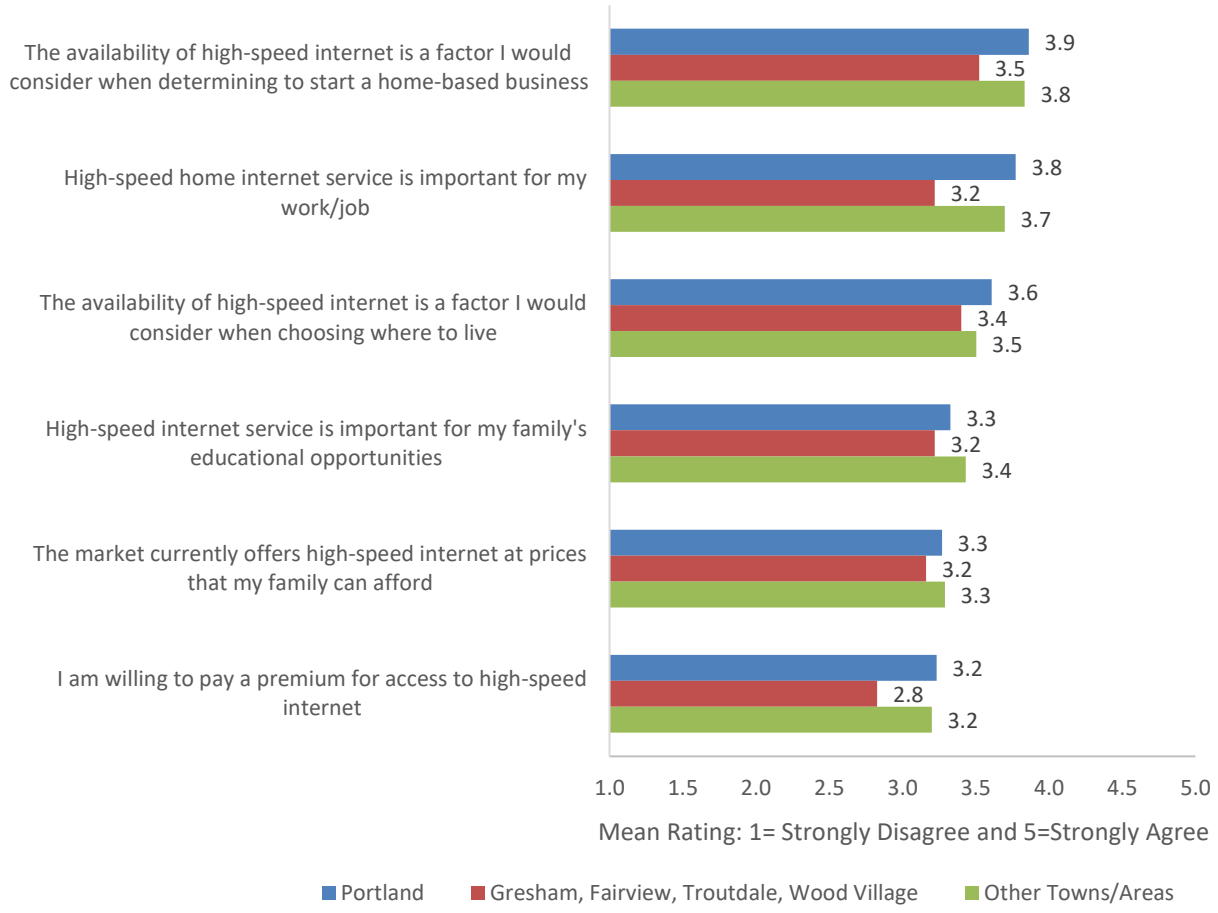


Among the factors listed, respondents were most likely to agree that the availability of high-speed internet is a factor when starting a home-based business (64% agree or strongly agree) or when choosing where to live (56% agree or strongly agree), and that high-speed home internet is important for their work/job (61% agree or strongly agree).

At the same time, only four in 10 agreed or strongly agreed that the market currently provides high-speed internet at prices they can afford, suggesting some need for affordable broadband internet among a segment of respondents. Just four in 10 are willing to pay a premium for access to high-speed internet.

Residents of the Gresham, Fairview, Troutdale, Wood Village region were less likely than residents of Portland and other areas to agree that the availability of high-speed internet is a factor they would consider when starting a home-based business, that high-speed home internet service is importance for their work/job, and that they would be willing to pay a premium for access to high-speed internet (see Figure 105).

Figure 105: Opinions About the Broadband Internet Market by Region



As illustrated in Figure 106, respondents ages 65+ were less likely to agree with statements about broadband internet service. Also, agreement with the availability of affordable high-speed internet and the willingness to pay a premium for access to high-speed internet was lower for those earning less than $50,000 per year (see Figure 107).

Figure 106: Opinions About the Broadband Internet Market by Respondent Age

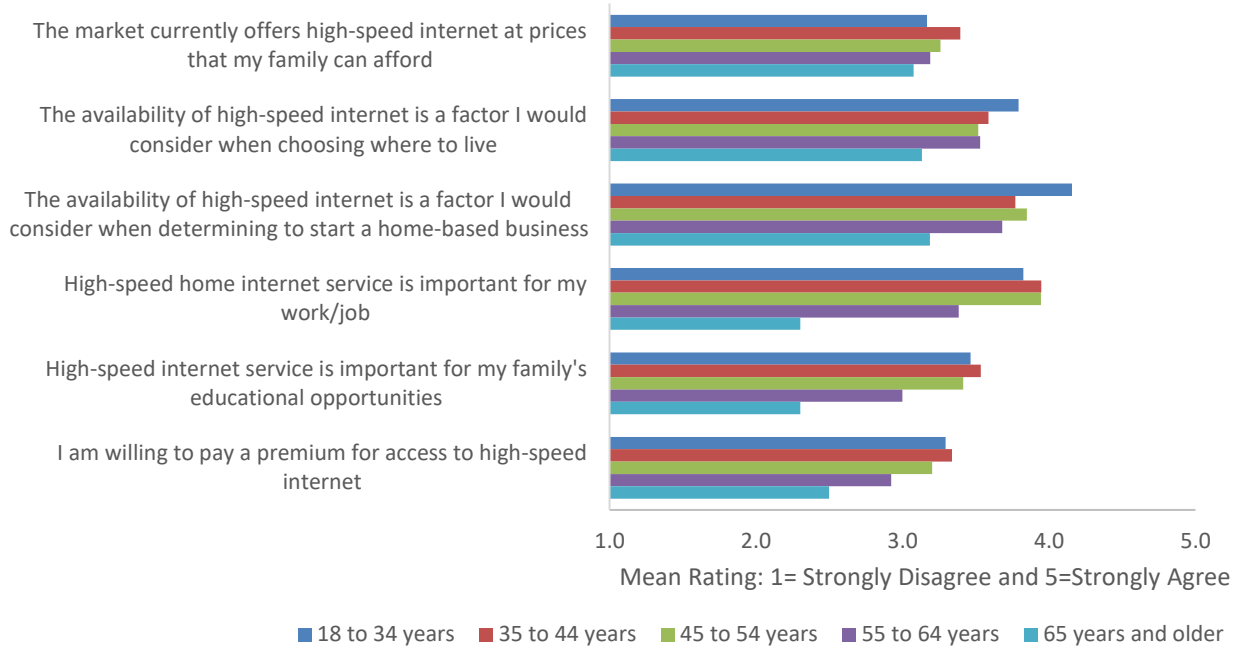
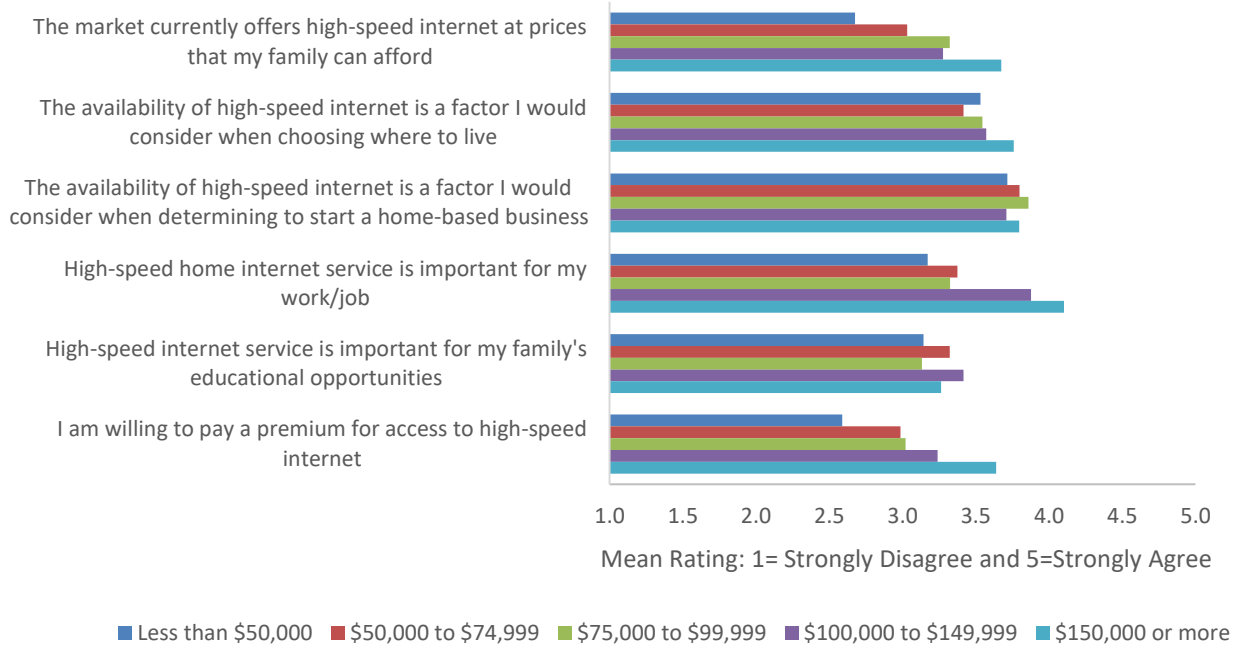
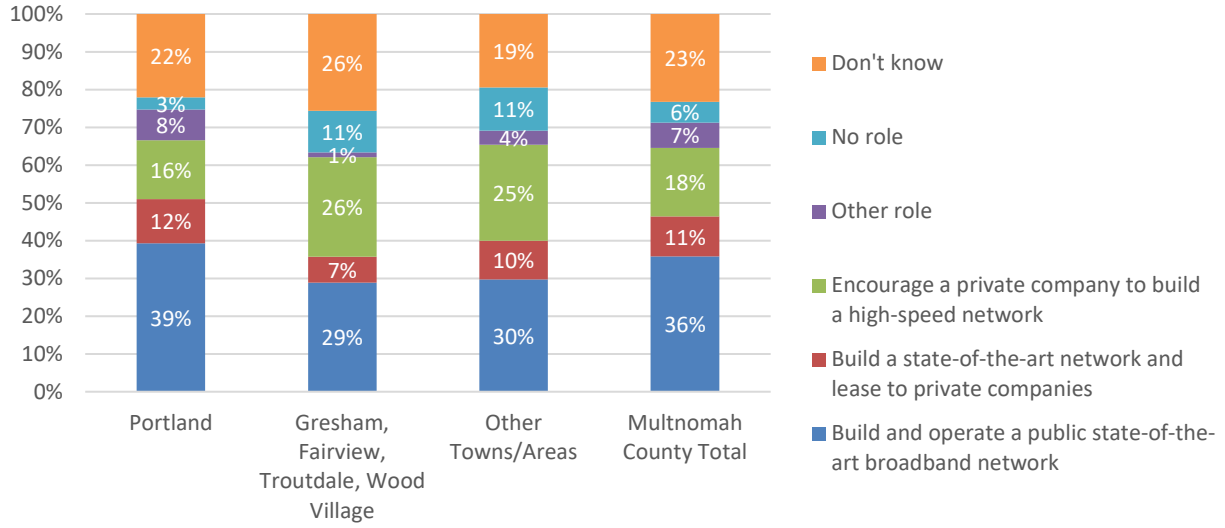


Figure 107: Opinions About the Broadband Internet Market by Household Income



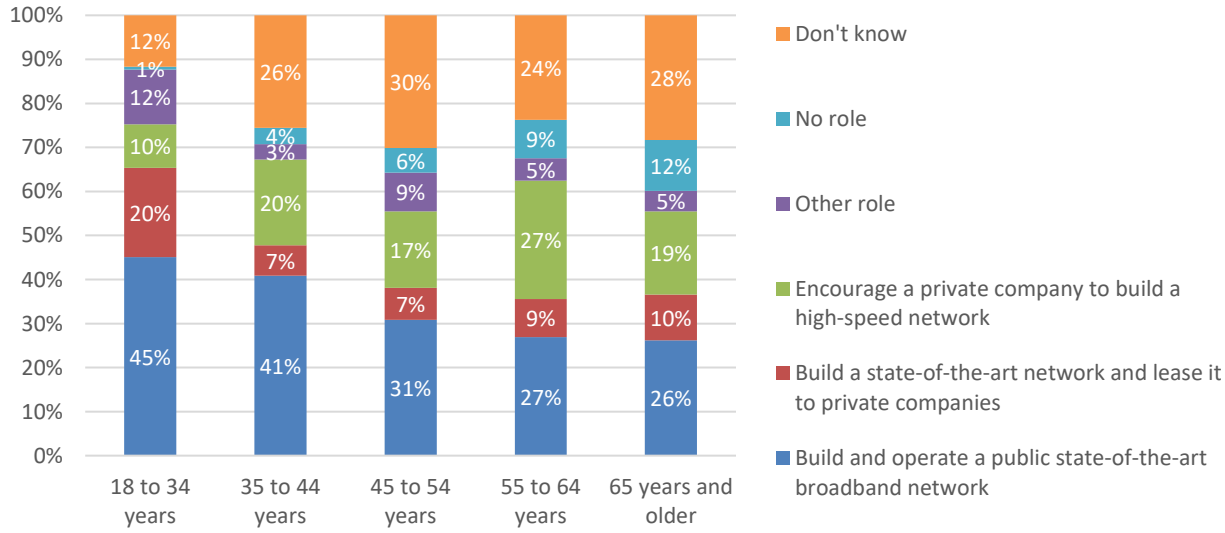
Respondents were asked their opinion on the main role for the County and/or Cities with respect to broadband access. As shown in Figure 108, nearly one-half of respondents feel the County/Cities should build a broadband network, including 36 percent of respondents who feel the County/Cities should operate the network. This opinion is somewhat more popular among Portland residents compared with residents of other areas. Just six percent of respondents said the County/Cities should have no role in broadband access, and 23 percent were unsure.

Figure 108: Role of Partner Agencies with Respect to Broadband Access



Respondents under age 35 expressed more support than did older respondents for the Partner Agencies to build a broadband network (see Figure 109).

Figure 109: Role of Partner Agencies with Respect to Broadband Access by Respondent Age



3.3.6.1 Willingness to Purchase High-Speed Internet Service

Respondents were asked if they would be willing to purchase 1 Gbps high-speed internet service for various price levels from another commercial service provider. The mean willingness to purchase across this array of questions is illustrated in Figure 110, while detailed responses are illustrated in Figure 111.

Figure 110: Willingness to Purchase 1 Gbps Internet from Commercial Service Provider (Mean Ratings)

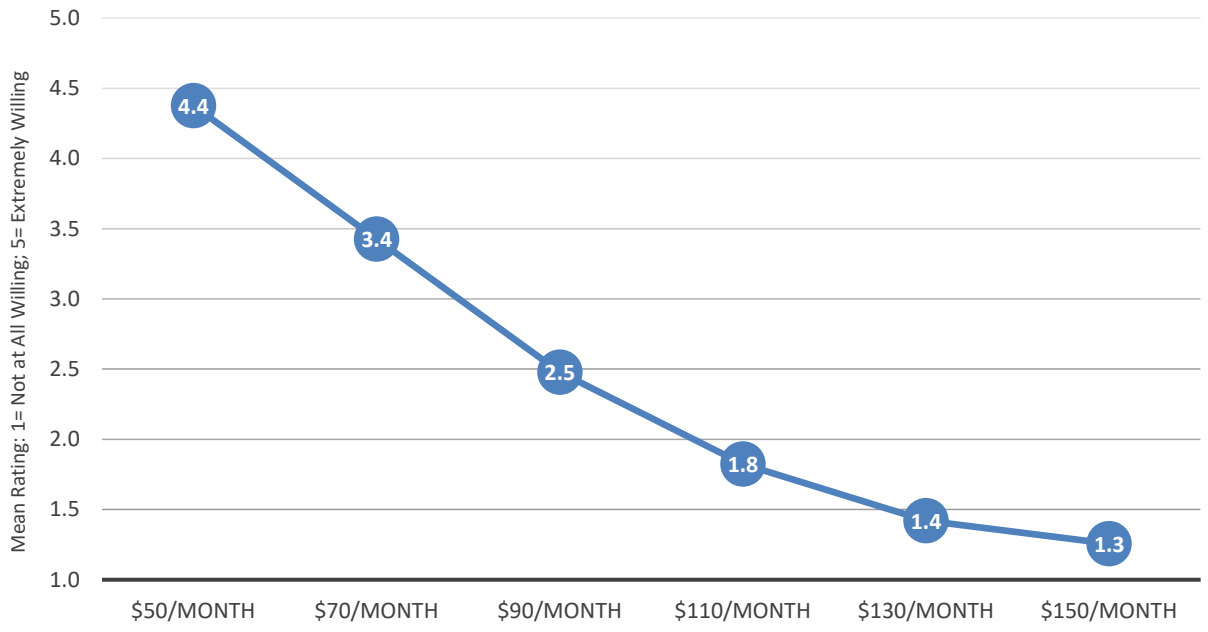
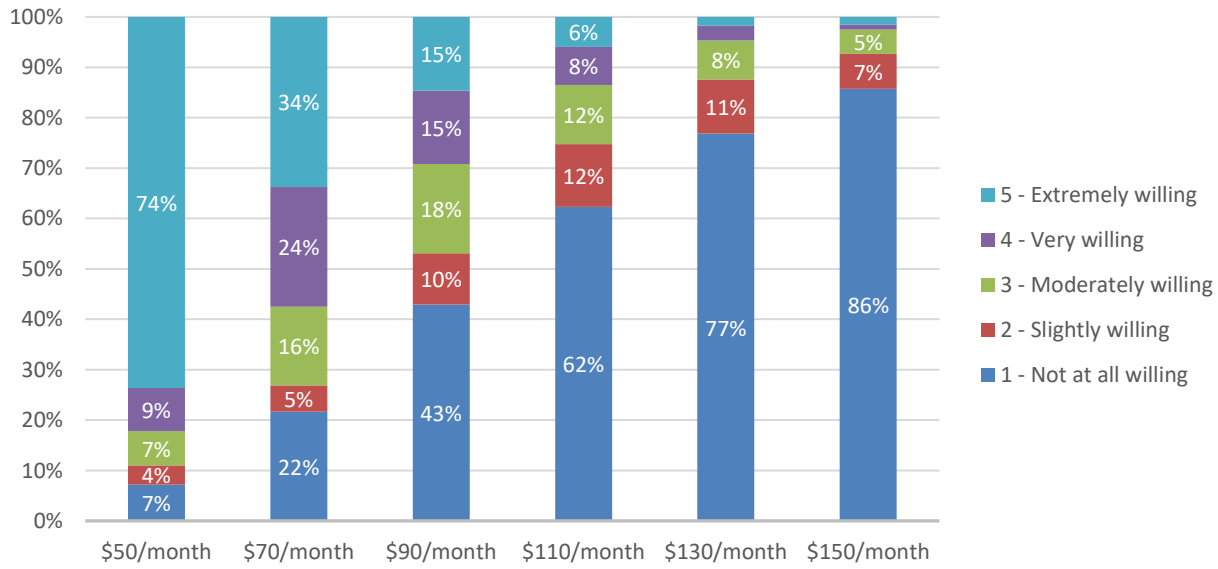


Figure 111: Willingness to Purchase 1 Gbps Internet from Commercial Service Provider

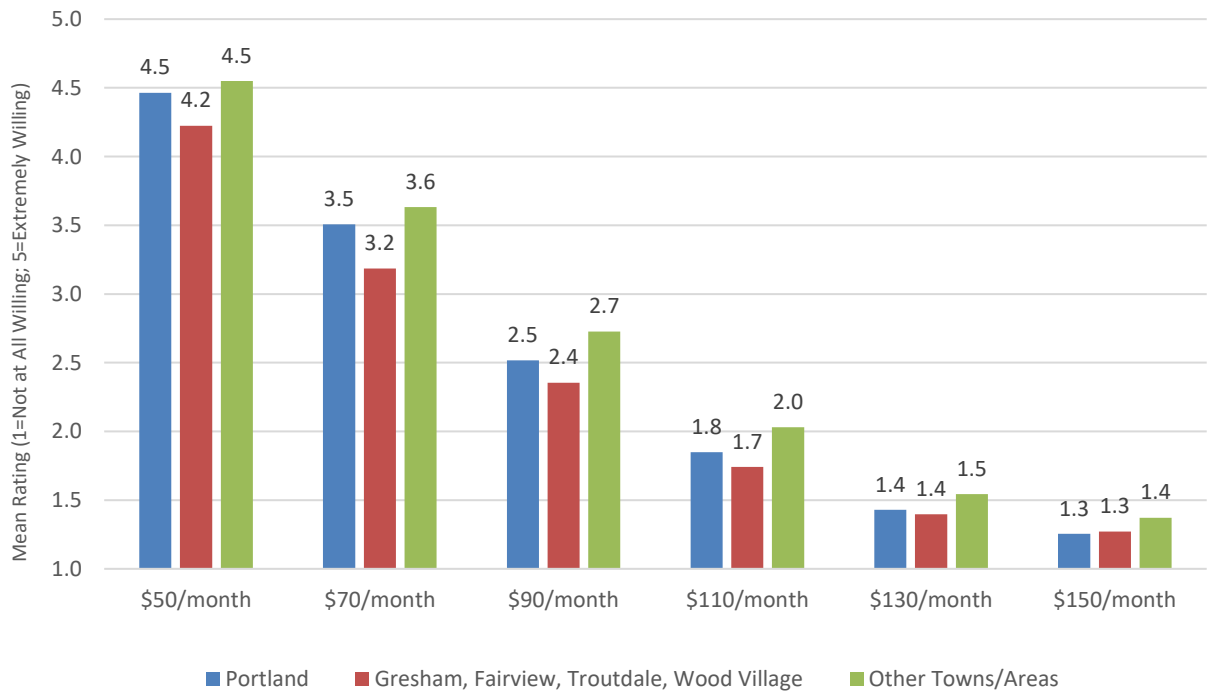


Respondents' willingness to purchase 1 Gbps internet service from another commercial provider is high at $50 per month, but it drops considerably as the price increases. The mean rating falls to 3.4 at a price point of $70 per month and 2.5 at a price point of $90 per month (slightly to moderately willing).

From another perspective, 74 percent of respondents are extremely willing to purchase 1 Gbps internet for $50 per month, dropping to 34 percent at $70 per month and 15 percent at $90 per month.

The willingness to purchase high-speed internet service from another commercial provider is somewhat lower in the Gresham, Fairview, Troutdale, Wood Village region for most price points (see Figure 112).

Figure 112: Willingness to Purchase 1 Gbps Internet from Commercial Service Provider by Region



The willingness to purchase high-speed internet service is also correlated with some demographic characteristics of the respondents, including household income (see Figure 113). The likelihood of purchasing high-speed internet tends to increase as household income increases.

Additionally, households with just one member would be less likely to purchase high-speed internet service from another commercial provider (see Figure 114).

Figure 113: Willingness to Purchase 1 Gbps Internet Service from Another Commercial Provider by Household Income

Figure 114: Willingness to Purchase 1 Gbps Internet Service from Another Commercial Provider by Household Size

Respondents were also asked if they would be willing to purchase 1 Gbps internet service at various price levels from the County and/or Cities. The mean willingness to purchase across this array of questions is illustrated in Figure 115, while detailed responses are illustrated in Figure 116.

Figure 115: Willingness to Purchase 1 Gbps Internet from the Partner Agencies (Mean Ratings)

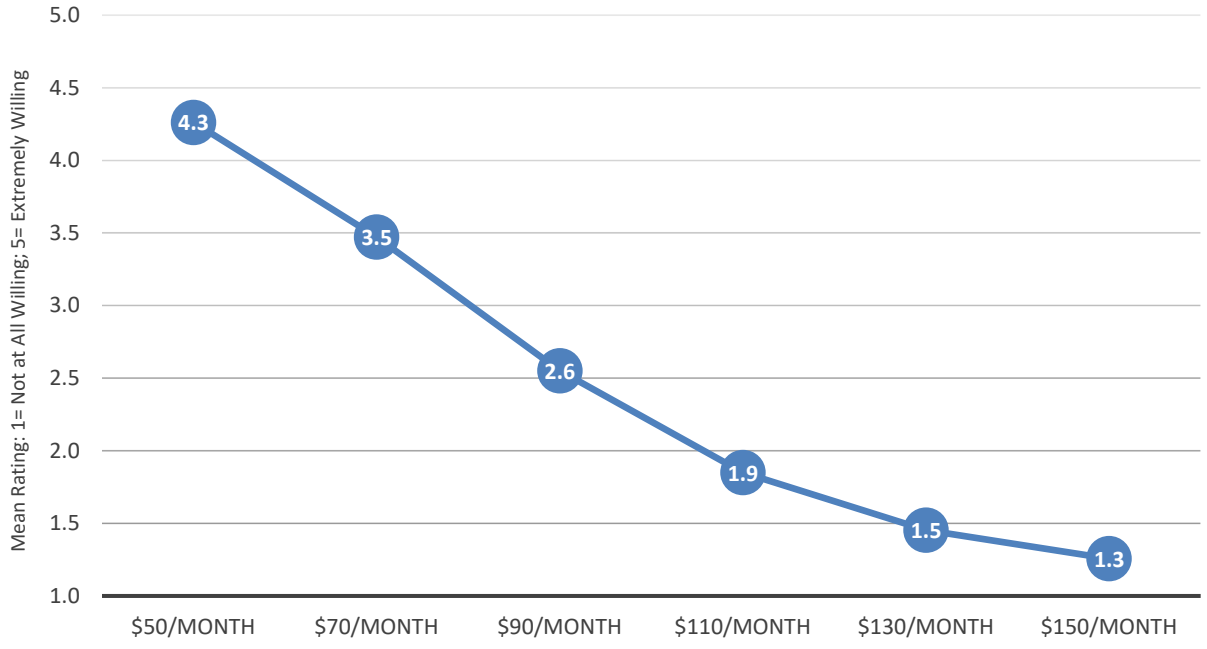
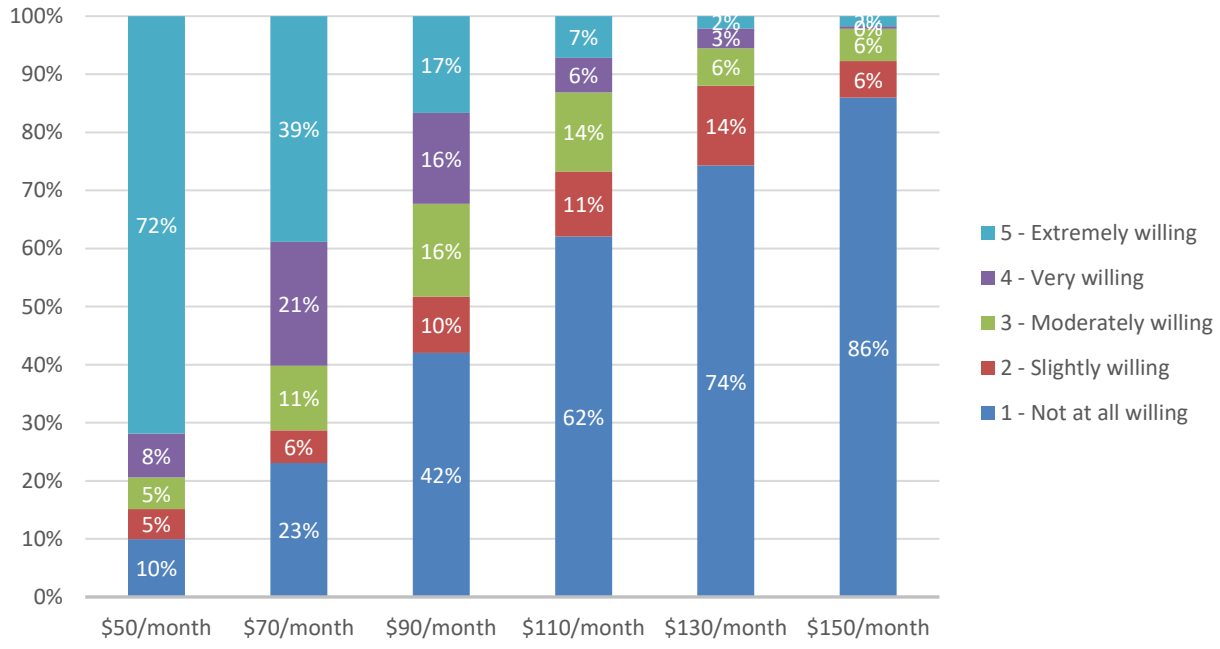
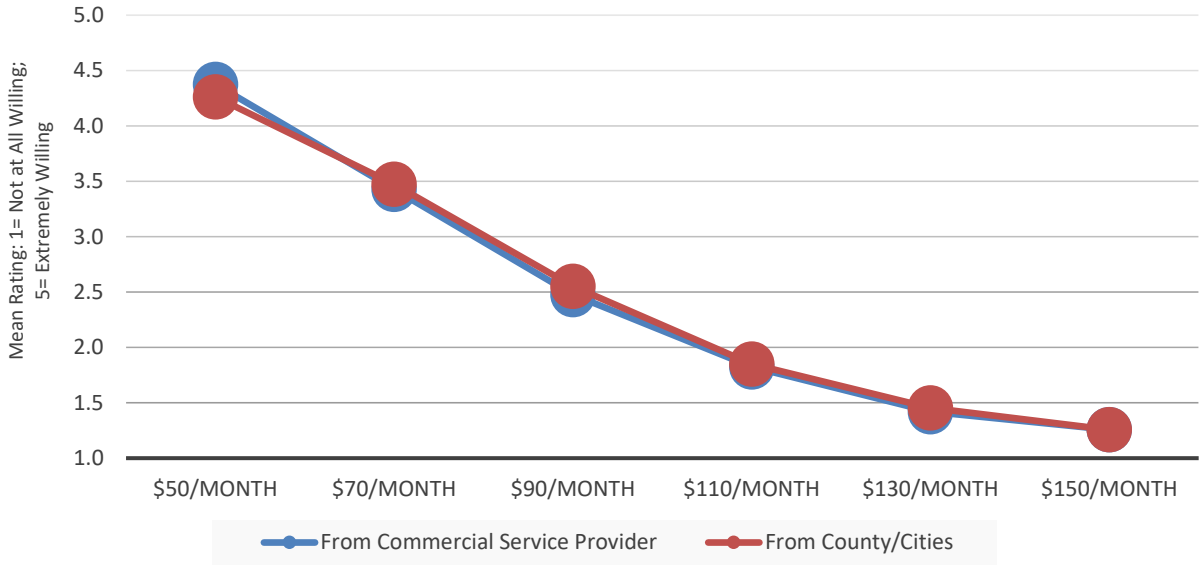


Figure 116: Willingness to Purchase 1 Gbps Internet from the Partner Agencies



Respondents would be extremely willing to purchase high-speed internet from the Partner Agencies for $50 per month, but willingness drops considerably at higher price points. Willingness to purchase does not vary significantly whether it was offered by another commercial service provider or by the County and/or Cities (see Figure 117).

Figure 117: Willingness to Purchase 1 Gbps Internet at Various Price Levels by Provider



The willingness to purchase high-speed internet service from the County is somewhat lower in the Gresham, Fairview, Troutdale, Wood Village region for most price points (see Figure 119).

Figure 118: Willingness to Purchase 1 Gbps Internet Service from Partner Agencies by Region

The likelihood of purchasing high-speed internet tends to increase as household income increases (see Figure 119). Additionally, households with just one member would be less likely to purchase high-speed internet service from the County (see Figure 120).

Figure 119: Willingness to Purchase 1 Gbps Internet Service from Partner Agencies by Household Income

Figure 120: Willingness to Purchase 1 Gbps Internet Service from Partner Agencies by Household Size

3.3.7 Respondent Demographics

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 County's adult population as a whole. Approximately 45 percent of survey respondents are ages 65 and older, compared with 15 percent of the population. Conversely, only 20 percent of survey respondents are ages 18 to 34, compared with 53 percent of the population (see Figure 121). 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 County's population, as discussed previously.

Figure 121: Age of Respondents and Multnomah County Adult Population

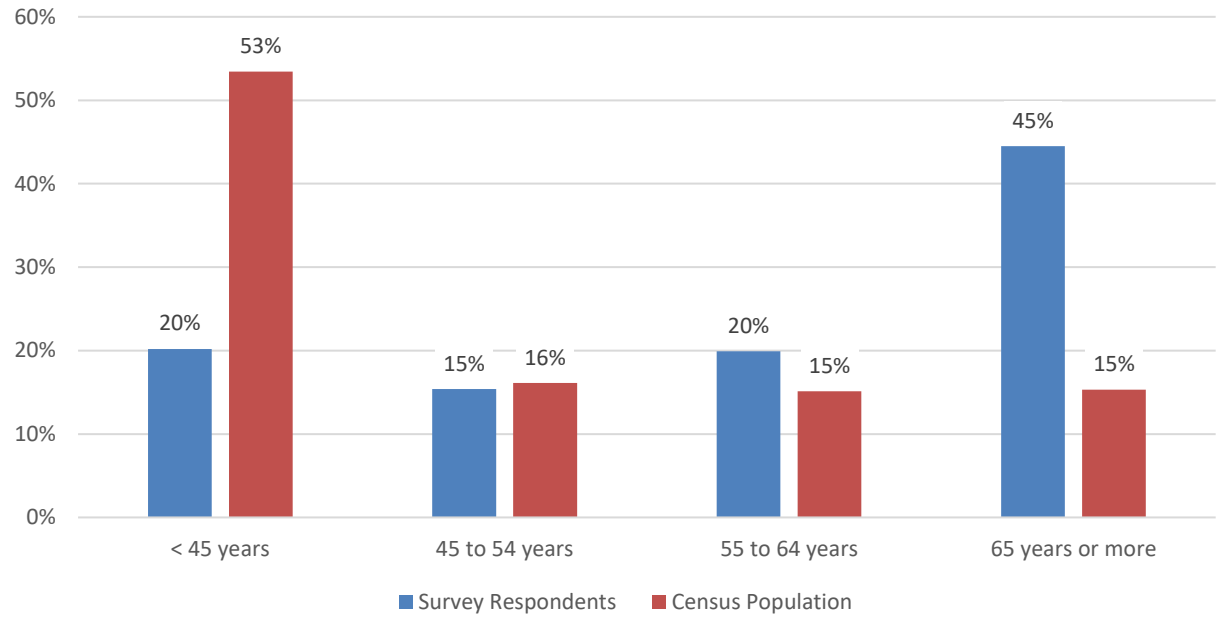


Table 14 highlights the demographic characteristics of survey respondents, broken out by respondent age. Respondents ages 35 to 54 years are more likely than older and younger respondents to have children in the household. Approximately three in 10 respondents ages 35 to 54 years have four or more household members. Respondents ages 18 to 34 years of age are more likely than older respondents to be renters. As may be expected, respondent age is correlated with years lived at residence. Four in 10 respondents ages 18 to 34 have lived at their residence for less than one year, while 84 percent of respondents ages 65+ have lived at their residence for five or more years. Respondents ages 65+ have a somewhat lower household income, with three in 10 earning under $50,000 per year. One-third of those ages 55+ live alone.

Table 14: Demographic Profile by Respondent Age

Age Cohort		18-34	35-44	45-54	55-64	65+	Total
Highest level of education	Some high school	1%	1%	0%	1%	2%	1%
	Completed high school	9%	14%	12%	16%	15%	13%
	Two-year college or technical degree	8%	11%	20%	17%	18%	14%
	Four-year college degree	49%	36%	35%	35%	23%	37%
	Graduate degree	32%	38%	33%	31%	41%	35%
	Weighted Count	*232*	*353*	*176*	*164*	*167*	*1095*
Approximate annual household income	Less than $25,000	2%	6%	2%	10%	9%	6%
	$25,000 to $49,999	14%	9%	6%	13%	22%	12%
	$50,000 to $74,999	26%	15%	17%	22%	23%	20%
	$75,000 to $99,999	17%	19%	12%	18%	20%	17%
	$100,000 to $149,999	24%	25%	27%	14%	18%	22%
	$150,000 to $199,999	4%	11%	15%	10%	4%	9%
	$200,000 or more	13%	15%	19%	13%	5%	13%
	Weighted Count	*224*	*324*	*159*	*136*	*139*	*997*
Race/Ethnicity	Other race/ethnicity	18%	21%	12%	16%	7%	16%
	White/Caucasian only	82%	79%	88%	84%	93%	84%
	Weighted Count	*228*	*347*	*174*	*159*	*162*	*1089*
Total Household Size (Adults + Children)	1	15%	18%	17%	32%	34%	22%
	2	56%	33%	39%	48%	53%	44%
	3	20%	19%	18%	14%	9%	17%
	4 or more	10%	30%	26%	7%	4%	17%
	Weighted Count	*231*	*353*	*176*	*164*	*165*	*1106*
Presence of Children in HH	No Children in HH	87%	57%	67%	94%	98%	77%
	Children in HH	13%	43%	33%	6%	2%	23%
	Weighted Count	*231*	*353*	*176*	*164*	*165*	*1106*
Own or Rent Residence	Own	42%	69%	90%	84%	86%	72%
	Rent	58%	31%	10%	16%	14%	28%
	Weighted Count	*230*	*353*	*176*	*163*	*163*	*1105*
Number of years lived at current residence	Less than 1 year	40%	7%	6%	3%	1%	12%
	1 to 2 years	21%	15%	11%	11%	7%	14%
	3 to 4 years	23%	32%	9%	11%	7%	20%
	5 or more years	16%	45%	74%	75%	84%	54%
	Weighted Count	*232*	*353*	*172*	*160*	*165*	*1104*

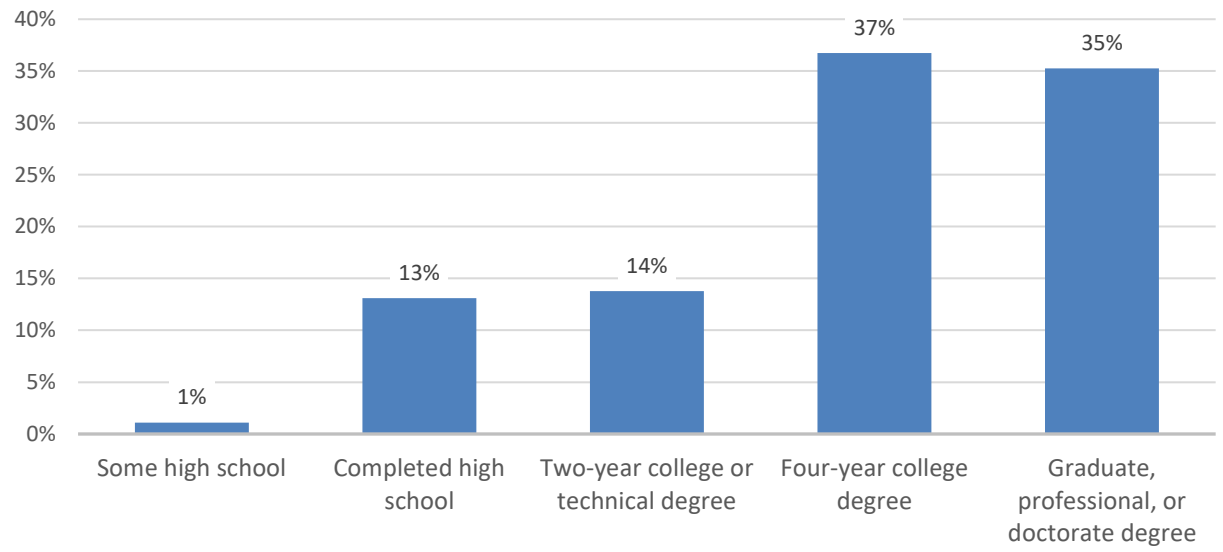
As illustrated in Table 15, residents of the Gresham, Fairview, Troutdale, Wood Village region are somewhat older than Portland residents and residents of other towns/unincorporated areas, and they have a somewhat lower level of education. Portland residents are more likely than others to be renters.

Table 15: Demographic Profile by Region

	Age Cohort	Portland	Gresham, Fairview, Troutdale, Wood Village	Other Towns/Areas
Age of Respondent	18 to 34 years	26%	19%	13%
	35 to 44 years	40%	28%	27%
	45 to 54 years	15%	17%	18%
	55 to 64 years	10%	19%	19%
	65 years and older	10%	17%	22%
	Weighted Count	*494*	*272*	*322*
Highest level of education	Some high school	1%	2%	0%
	Completed high school	10%	28%	11%
	Two-year college or technical degree	11%	24%	12%
	Four-year college degree	40%	26%	37%
	Graduate degree	38%	20%	40%
	Weighted Count	*494*	*274*	*321*
Approximate annual household income	Less than $25,000	5%	6%	3%
	$25,000 to $49,999	13%	9%	11%
	$50,000 to $74,999	17%	35%	15%
	$75,000 to $99,999	17%	19%	16%
	$100,000 to $149,999	24%	20%	24%
	$150,000 to $199,999	9%	7%	13%
	$200,000 or more	16%	4%	19%
	Weighted Count	*455*	*244*	*293*
Race/Ethnicity	Other race/ethnicity	16%	20%	16%
	White/Caucasian only	84%	80%	84%
	Weighted Count	*490*	*269*	*318*
Total Household Size (Adults + Children)	1	22%	14%	17%
	2	43%	43%	43%
	3	18%	14%	16%
	4 or more	16%	29%	24%
	Weighted Count	*497*	*278*	*322*
Presence of Children in HH	No Children in HH	76%	70%	69%
	Children in HH	24%	30%	31%
	Weighted Count	*497*	*278*	*322*
Own or Rent Residence	Own	66%	81%	88%
	Rent	34%	19%	12%
	Weighted Count	*496*	*276*	*322*
Number of years lived at current residence	Less than 1 year	15%	8%	9%
	1 to 2 years	15%	14%	12%
	3 to 4 years	22%	17%	20%
	5 or more years	48%	60%	60%
	Weighted Count	*494*	*279*	*323*

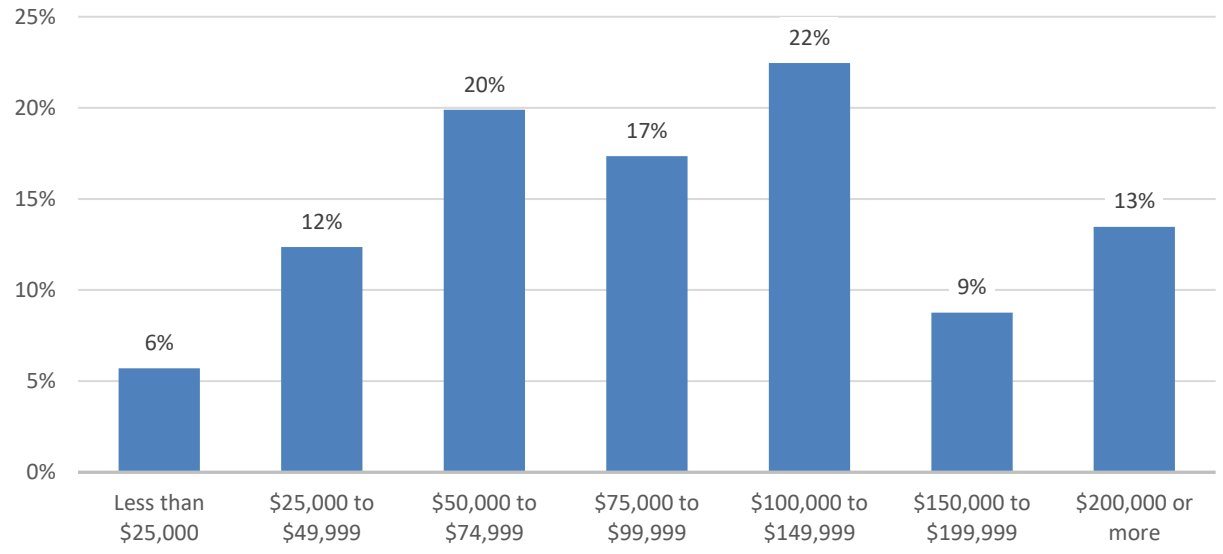
The respondents' highest level of education attained is summarized in Figure 122. More than seven in 10 respondents have either a four-year college degree or a graduate, professional, or doctorate degree.

Figure 122: Education of Respondent



More than four in 10 respondents have a household income of $100,000 or more. Another 18 percent of respondents have a household income under $50,000, as shown in Figure 123.

Figure 123: Annual Household Income



Most survey respondents (86 percent) are white, non-Hispanic, as illustrated in Figure 124.

Figure 124: Race/Ethnicity

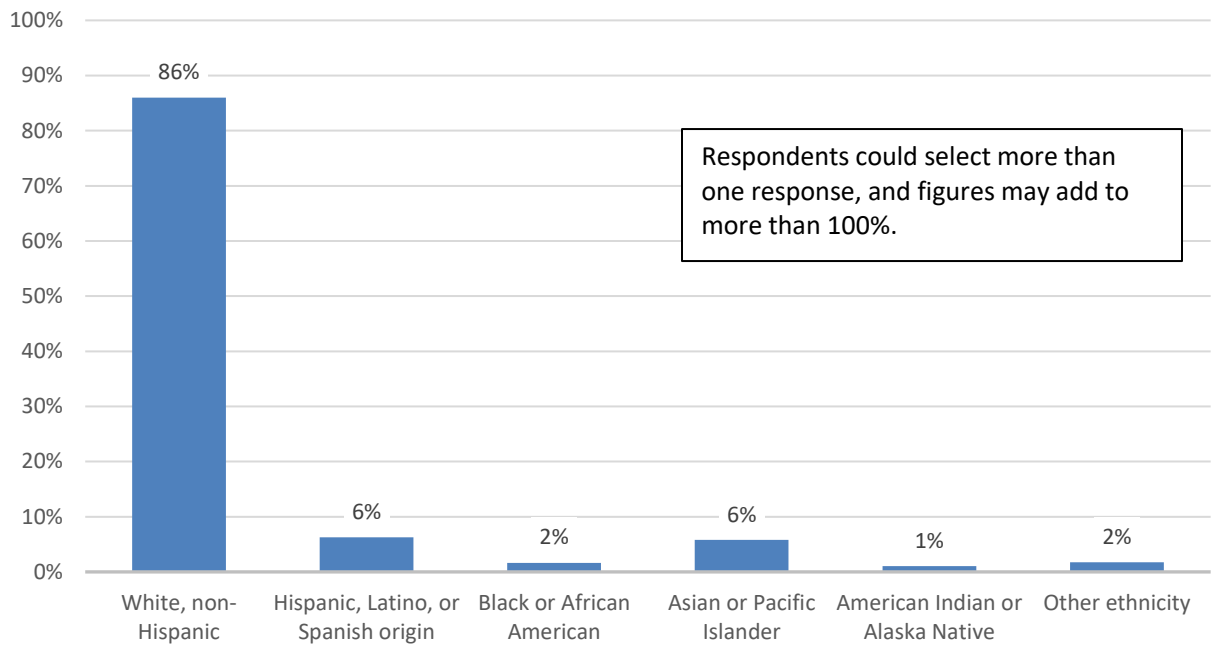
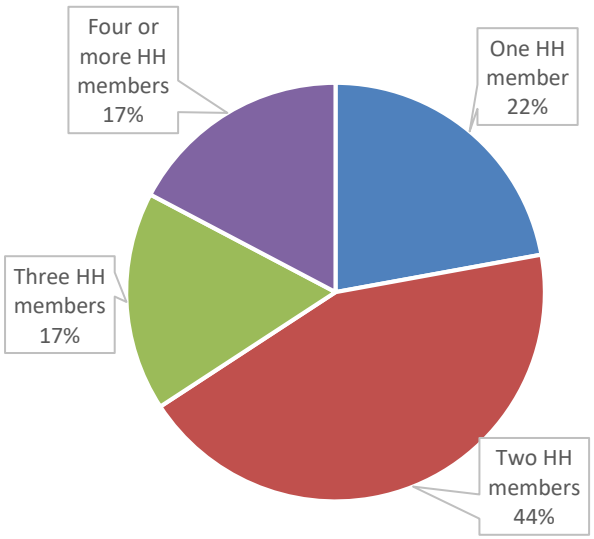


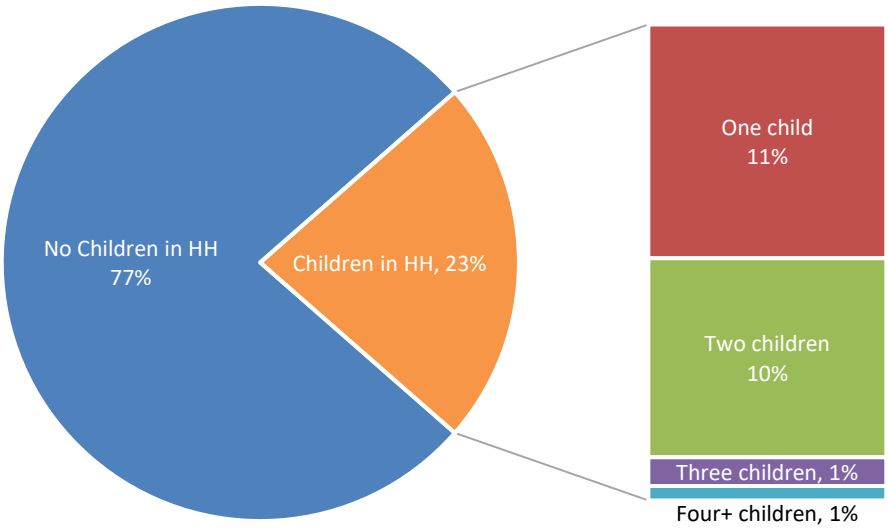
Figure 125: Total Household Size



Respondents were asked to indicate the number of adults and children in their household. More than one-fifth of respondents have just one person living in the household, and 44 percent have two household members (including both adults and children). Another 17 percent have three household members, and 17 percent have four or more household members (see Figure 125).

Nearly one-fourth of respondents have at least one child under age 18 living at home, as shown in Figure 126.

Figure 126: Number of Children in the Household



Most respondents own their home (see Figure 127). More than one-half of respondents have lived at their residence for five or more years, as shown in Figure 128.

Figure 127: Own or Rent Residence

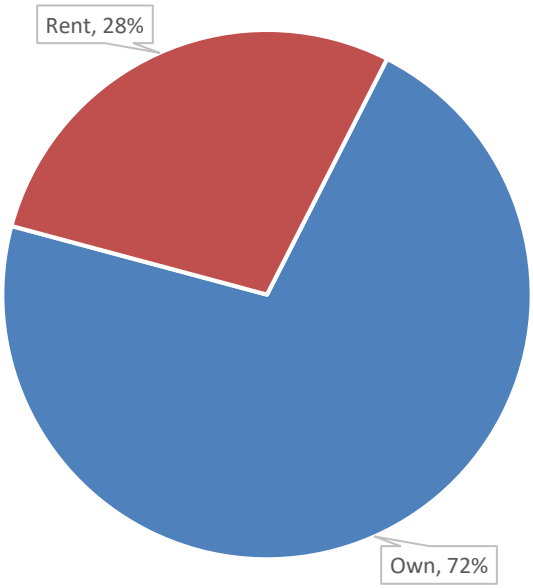
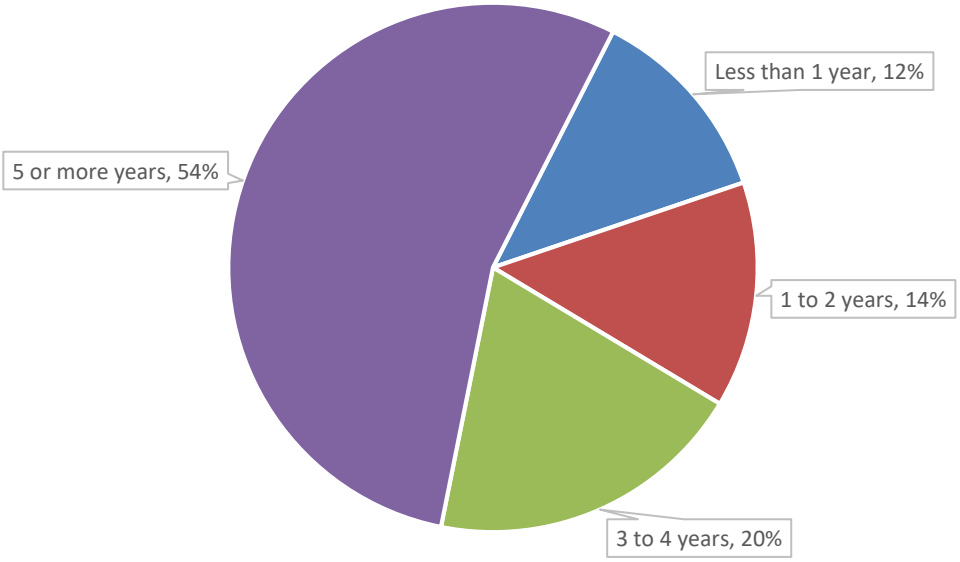


Figure 128: Length of Residence at Current Address



4 A Survey Found Businesses Are Highly Connected and Value Broadband

As part of this initiative, we also conducted an online survey of businesses in January and February 2020. The survey captured information about businesses' current communications services, satisfaction with those services, desire for improved services, willingness to pay for faster internet speeds, and opinions regarding the role of the Partner Agencies regarding internet access and service. A copy of the survey instrument is included in Appendix B.

A key focus of the survey was to assess businesses' use of internet services and whether businesses' needs are being met. Key findings include:

- Two-thirds of businesses have a cable modem connection (58 percent with business; 9 percent with residential). Fiber (15 percent) and DSL (6 percent) comprise smaller shares of the business market. Home-based businesses are more likely than others to have a residential account cable modem (43 percent).

- 44 percent of businesses provide internet access to customers over Wi-Fi hot spots, including 25 percent that said it is used regularly. Businesses reported that their website is very important for sharing information with customers and potential customers, and only moderately important for other functions.

- Respondents rated connection reliability as the most important business internet service aspect, with seven in 10 saying it is extremely important. Overall, respondents are moderately satisfied with their internet service. The largest gap between importance and satisfaction is for reliability, followed by price paid for service and overall customer service.

- The most important internet-based services and activities to businesses are cloud-based collaboration/file-sharing and large data/file transfers, etc., as well as VoIP, e-commerce, and providing online customer satisfaction.

- Business internet customers are moderately satisfied with their service provider. Six in 10 respondents would be very or extremely likely to switch providers if an alternative provider offered greater network bandwidth and greater speeds. One-half would be very or extremely likely to switch providers if an alternative provider were less expensive.

- Overall, there is support for ensuring access to competitively-priced broadband services. Three-fourths of respondents agreed or strongly agreed that the Partner Agencies should ensure access for all businesses.

- Respondents are only slightly to moderately willing to purchase high-speed internet service from another commercial provider for $300 per month, and willingness drops sharply at

higher price points. Willingness to purchase is higher for larger businesses with gross revenues of $5 million or more.

This report documents the survey process, discusses methodologies, presents results, and provides key findings that will help Multnomah County assess the current state and ongoing needs of businesses regarding high-speed communications services.

4.1 Survey Process

A total of 14,716 survey invitations were sent on January 28, 2020, with reminders approximately one week after the initial invitation. Final reminders were sent on February 13, 2020, and the survey closed on March 1, 2020.

A total of 450 completed surveys were received by the date of analysis, providing a gross response rate of 3.1 percent. Because 857 invitations were undeliverable, the net response rate was 3.2 percent.

The survey responses were exported into SPSS[23] software and the entries were coded and labeled. SPSS databases were formatted, cleaned, and verified prior to the data analysis. Address information was merged with the survey results using the unique identifiers included in each survey invitation. 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 following sections summarize the survey findings.

4.2 Survey Results

The results presented in this report are based on analysis of information provided by 450 businesses in Multnomah County. 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 differences by business types are noted where appropriate.

4.2.1 Business Information

Basic information was gathered from survey respondents to profile businesses in the survey. Key comparisons of survey responses by businesses characteristics are provided in this report. The following charts in this section highlight characteristics of businesses in the survey sample.

Three-fourths of businesses are the sole location, and one-half of businesses have fewer than five full-time employees. Nearly one-half (46 percent) of businesses are in a leased

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

office/retail/studio space, and 14 percent are in an owned office/retail/studio space. Two-thirds of survey respondents are the business owner.

A range of market areas are represented, with one-fourth of businesses having a market area within 500 miles of the location, one-fifth within Oregon only, and one-fifth within Multnomah County only. Another one-fifth of businesses operate throughout the United States, and 12 percent are international. Professional services (23 percent) is the leading industry represented in the sample, followed by nonprofits (12 percent).

Thirty-nine percent of businesses had a gross revenue of at least $1 million in 2019, including nine percent with $10 million or more. Another 17 percent of businesses had a gross revenue of less than $100,000, and 27 percent brought in $100,000 but less than $500,000.

One-fourth of businesses have an annual telecommunications expense of $5,000 or more, while 22 percent spend less than $1,000 per year. Additionally, 27 percent of businesses have zero annual expenses for mobile services, while 23 percent spend $500 to $999 and 24 percent spend $1,000 to $2,499 per year.

Almost all (98 percent) of businesses have personal computers, and 90 percent have smartphones. Specifically, 42 percent of businesses have one to four computers, and 51 percent have one to four smartphones. Just a small share of businesses has 20 or more devices.

Figure 129: Business Location Type

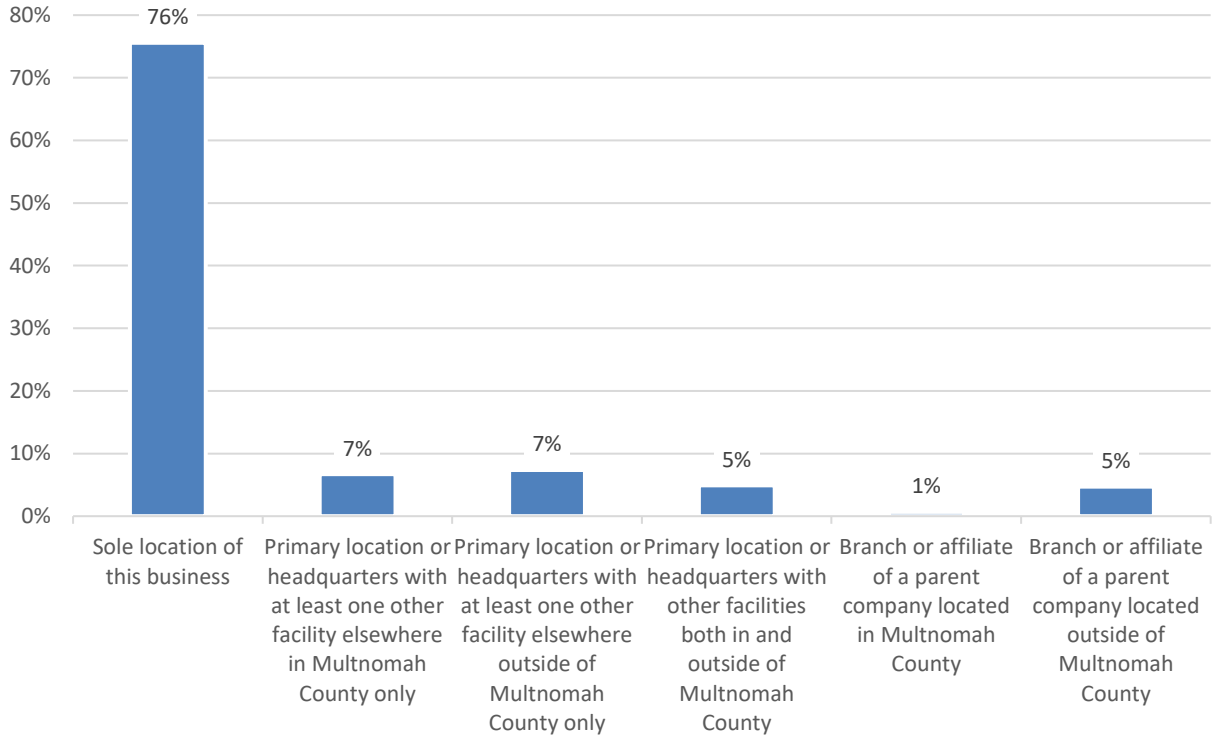


Figure 130: Number of Full-Time Employees

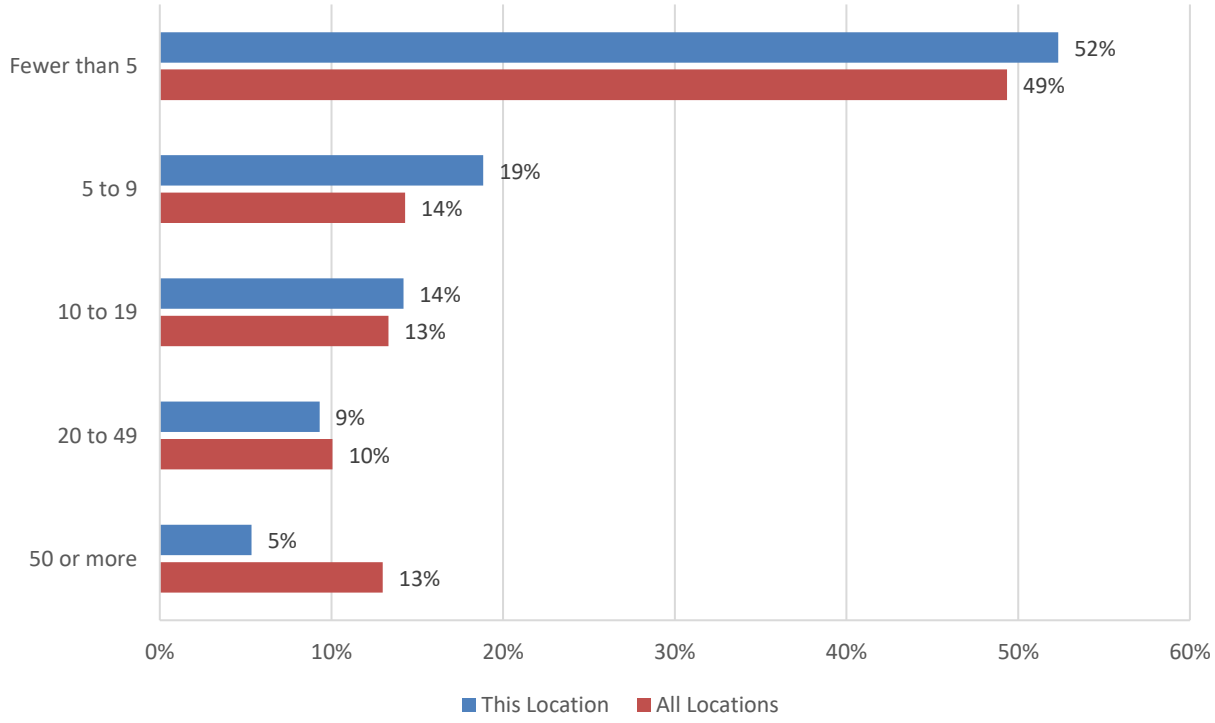


Figure 131: Type of Facility

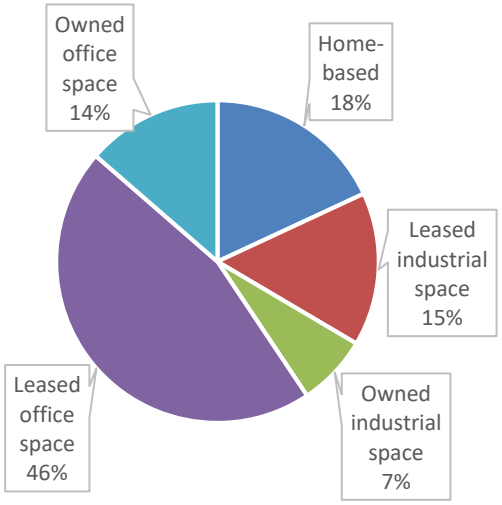


Figure 132: Market Area

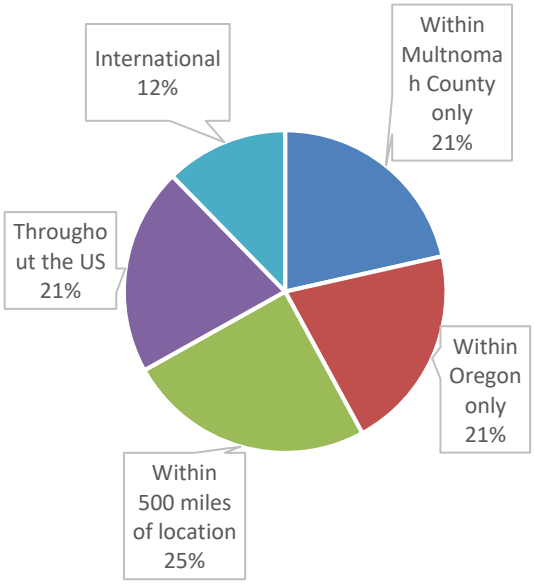


Figure 133: Industry

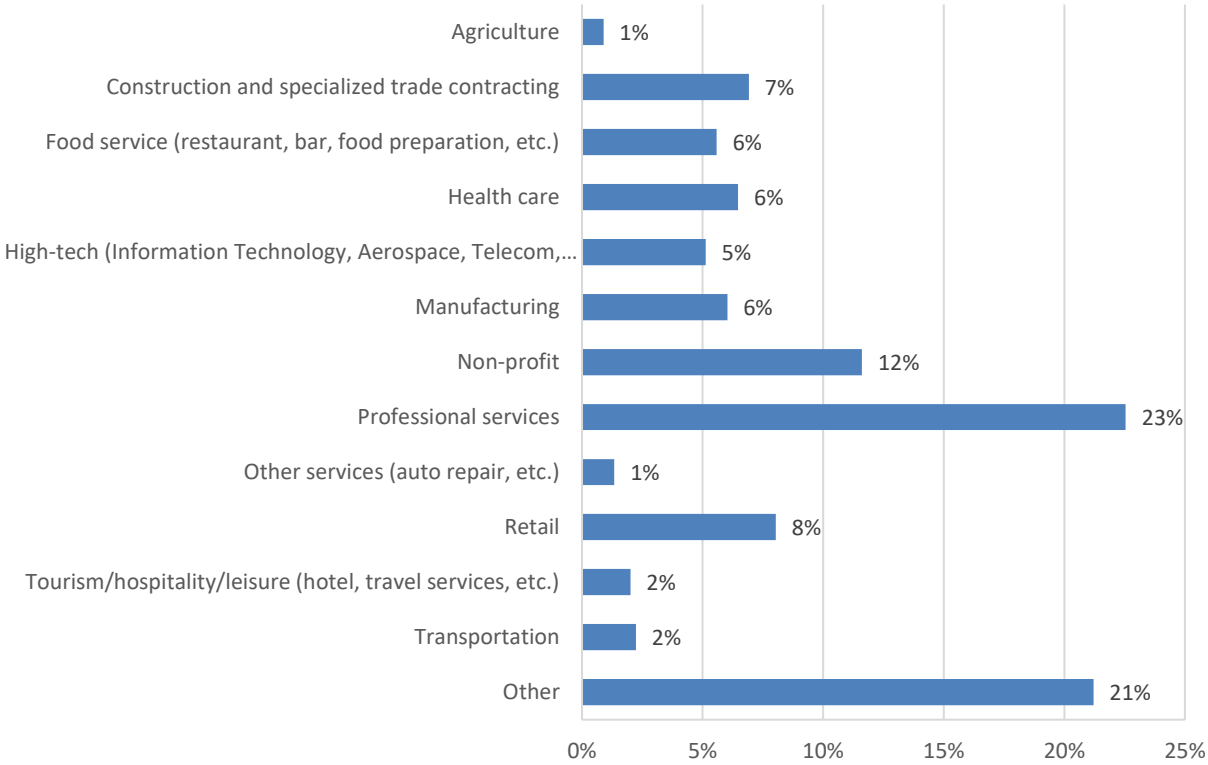


Figure 134: 2019 Gross Revenue

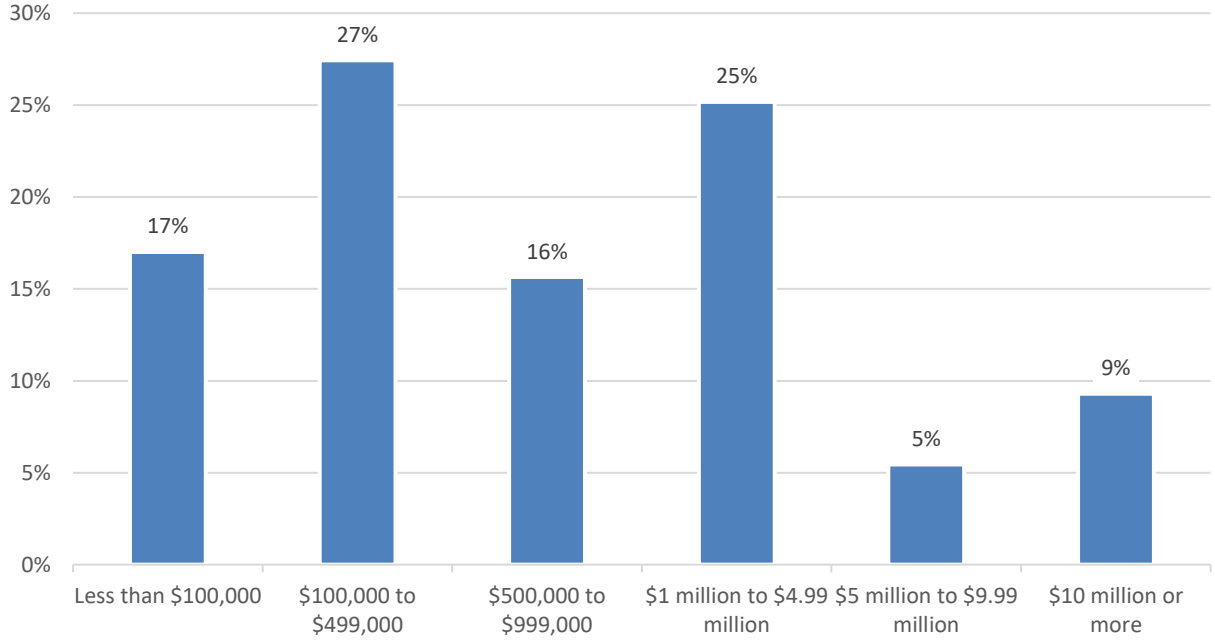


Figure 135: Telecommunications Expense

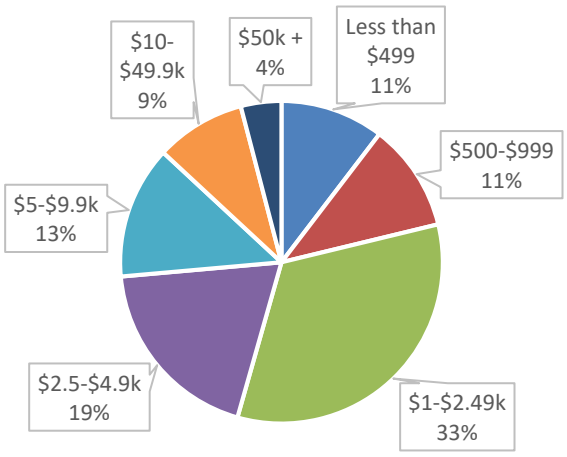


Figure 136: Mobile Service Expense

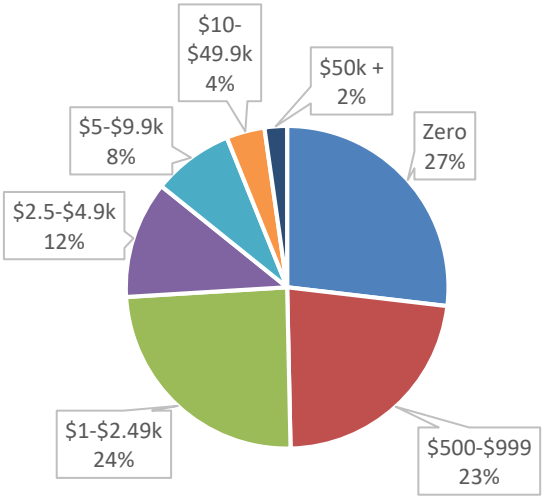


Figure 137: Number of Personal Computers

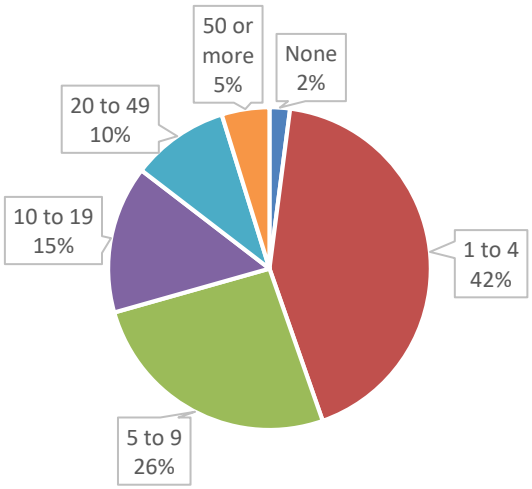


Figure 138: Number of Smartphones

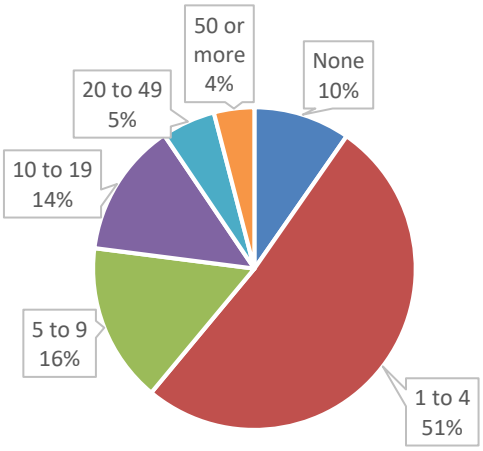


Figure 139: Role in Business

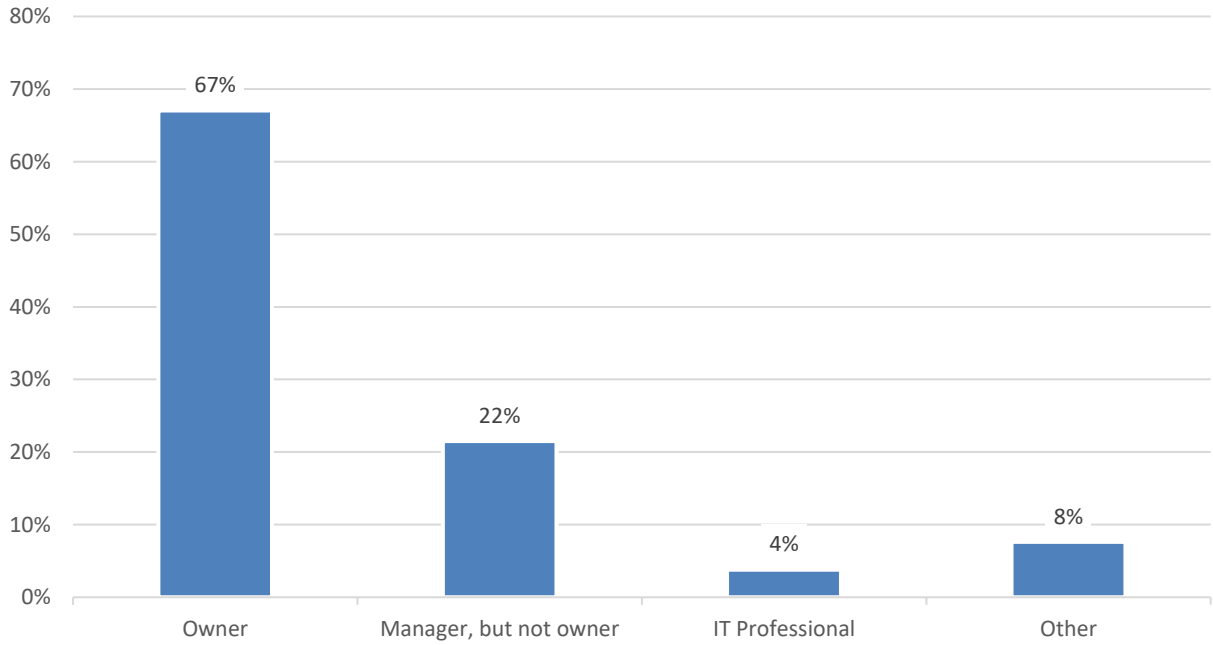


Table 16 and Table 17 show annual expenses for telecommunications and mobile services for key groups. Sole locations, those with fewer full-time employees, home-based businesses, and those with lower gross revenues spend less, as would be expected. These types of businesses also have fewer devices, as shown in Table 18 and Table 19.

Table 16: Annual Telecommunications Expense

		Less than $1,000	$1,000 to $2,499	$2,500 to $4,999	$5,000 or more	Total Count
Description of business at location	Sole location of business	24%	38%	21%	18%	*333*
	Other/multiple locations	13%	19%	15%	53%	*107*
Number of full-time employees at location	Fewer than 5	33%	42%	18%	7%	*224*
	5 to 9	15%	26%	26%	33%	*80*
	10 to 19	5%	25%	23%	47%	*60*
	20 or more	5%	13%	11%	70%	*61*
Type of facility	Home-based	45%	44%	5%	6%	*80*
	Leased	18%	32%	23%	27%	*271*
	Owned	10%	27%	19%	44%	*91*
Company's gross revenue	Less than $100k	53%	41%	1%	4%	*75*
	$100-$499k	28%	48%	19%	4%	*120*
	$500-$999k	18%	29%	37%	16%	*68*
	$1-$4.99 million	5%	30%	25%	40%	*109*
	$5 million or more	5%	6%	11%	78%	*65*

*Read across rows for the distribution of annual telecommunications expense for each group, e.g. 24% of those in a sole location spend less than $1,000, 38% spend $1,000 to $2,499, and so on. Read down columns to compare expenses for each group, e.g. 24% of those in a sole location spend less than $1,000, compared with 13% of those with multiple locations.

Table 17: Annual Mobile Service Expense

		Zero	$500 to $999	$1,000 to $2,499	$2,500 or more	Total Count
Description of business at location	Sole location of business	30%	25%	25%	20%	*332*
	Other/multiple locations	18%	17%	23%	43%	*108*
Number of full-time employees at location	Fewer than 5	30%	32%	26%	12%	*223*
	5 to 9	24%	21%	25%	30%	*80*
	10 to 19	32%	10%	18%	40%	*60*
	20 or more	16%	11%	15%	58%	*62*
Type of facility	Home-based	23%	37%	29%	10%	*78*
	Leased	29%	20%	23%	28%	*273*
	Owned	23%	20%	23%	34%	*91*
Company's gross revenue	Less than $100k	30%	38%	26%	7%	*74*
	$100-$499k	33%	26%	33%	8%	*119*
	$500-$999k	32%	26%	19%	23%	*69*
	$1-$4.99 million	24%	15%	24%	38%	*110*
	$5 million or more	14%	12%	14%	60%	*65*

*Read across rows for the distribution of annual mobile service expense for each group, e.g. 30% of those in a sole location spend $0, 25% spend $500 to $999, and so on. Read down columns to compare expenses for each group, e.g. 30% of those in a sole location have zero mobile service expenses, compared with 18% of those with multiple locations.

Table 18: Number of Personal Computers at Multnomah County Location(s)

		None	1 to 4	5 to 9	10 to 19	20 to 49	50 +	Total Count
Description of business at location	Sole location of business	3%	50%	26%	13%	6%	2%	*331*
	Other/multiple locations	0%	19%	25%	22%	22%	12%	*105*
Number of full-time employees at location	Fewer than 5	3%	71%	20%	4%	1%	0%	*220*
	5 to 9	1%	14%	58%	20%	6%	1%	*80*
	10 to 19	0%	13%	20%	42%	20%	5%	*60*
	20 or more	0%	3%	11%	21%	38%	26%	*61*
Type of facility	Home-based	4%	81%	10%	3%	3%	0%	*80*
	Leased	2%	38%	27%	19%	10%	5%	*269*
	Owned	1%	22%	38%	12%	17%	9%	*89*
Company's gross revenue	Less than $100k	5%	80%	9%	1%	4%	0%	*74*
	$100-$499k	3%	69%	24%	5%	0%	0%	*118*
	$500-$999k	3%	32%	46%	16%	3%	0%	*68*
	$1-$4.99 million	0%	14%	36%	33%	15%	3%	*110*
	$5 million+	0%	11%	11%	16%	33%	29%	*63*
Annual tele-communications expense	Less than $1,000	5%	66%	22%	8%	0%	0%	*93*
	$1,000 to $2,499	2%	57%	26%	13%	3%	0%	*144*
	$2,500 to $4,999	1%	38%	37%	15%	5%	4%	*84*
	$5,000 or more	0%	10%	22%	22%	30%	16%	*115*

*Read across rows for the distribution of number of personal computers for each group, e.g. 3% of those in a sole location of zero computers, 50% have 1 to 4 computers, and so on. Read down columns to compare number of computers for each group, e.g. 50% of those in a sole location have 1 to 4 computers, compared with 19% of those with multiple locations.

Table 19: Number of Smartphones at Multnomah County Location(s)

		None	1 to 4	5 to 9	10 to 19	20 to 49	50 +	Total Count
Description of business at location	Sole location of business	12%	57%	16%	11%	3%	1%	*334*
	Other/multiple locations	3%	34%	17%	22%	12%	12%	*107*
Number of full-time employees at location	Fewer than 5	12%	76%	9%	2%	1%	0%	*224*
	5 to 9	12%	33%	42%	10%	0%	2%	*81*
	10 to 19	3%	22%	10%	56%	7%	2%	*59*
	20 or more	5%	8%	16%	19%	29%	23%	*62*
Type of facility	Home-based	10%	86%	4%	0%	0%	0%	*80*
	Leased	10%	44%	18%	17%	6%	4%	*271*
	Owned	9%	43%	20%	14%	8%	7%	*92*
Company's gross revenue	Less than $100k	12%	81%	5%	0%	1%	0%	*75*
	$100-$499k	16%	70%	11%	3%	0%	0%	*120*
	$500-$999k	14%	51%	29%	3%	3%	0%	*69*
	$1-$4.99 million	4%	35%	25%	29%	7%	1%	*110*
	$5 million+	2%	9%	11%	31%	20%	27%	*64*
Annual tele-communications expense	Zero	29%	38%	12%	15%	3%	3%	*119*
	$500 to $999	3%	72%	19%	4%	1%	1%	*101*
	$1,000 to $2,499	3%	71%	11%	11%	4%	0%	*107*
	$2,500 or more	1%	28%	23%	23%	13%	12%	*114*

*Read across rows for the distribution of number of smartphones for each group, e.g. 12% of those in a sole location of zero smartphones, 57% have 1 to 4 smartphones, and so on. Read down columns to compare number of smartphones for each group, e.g. 57% of those in a sole location have 1 to 4 smartphones, compared with 34% of those with multiple locations.

4.2.2 Internet Services

Respondents were asked about their business internet connection, use of the internet for various activities, and satisfaction and importance of features related to internet service. This information provides valuable insight into businesses' need for various internet and related communications services.

4.2.2.1 Internet Service Connection

Respondents were asked what internet services are available at their business location, as well as what primary internet service connection they have. As illustrated in Figure 140 and Figure 141, seven in 10 respondents said cable modem connection is available, and two-thirds said this is their primary internet connection (including 58 percent with business cable modem connection). DSL and fiber comprise smaller shares of the business market.

Figure 140: Internet Services Available

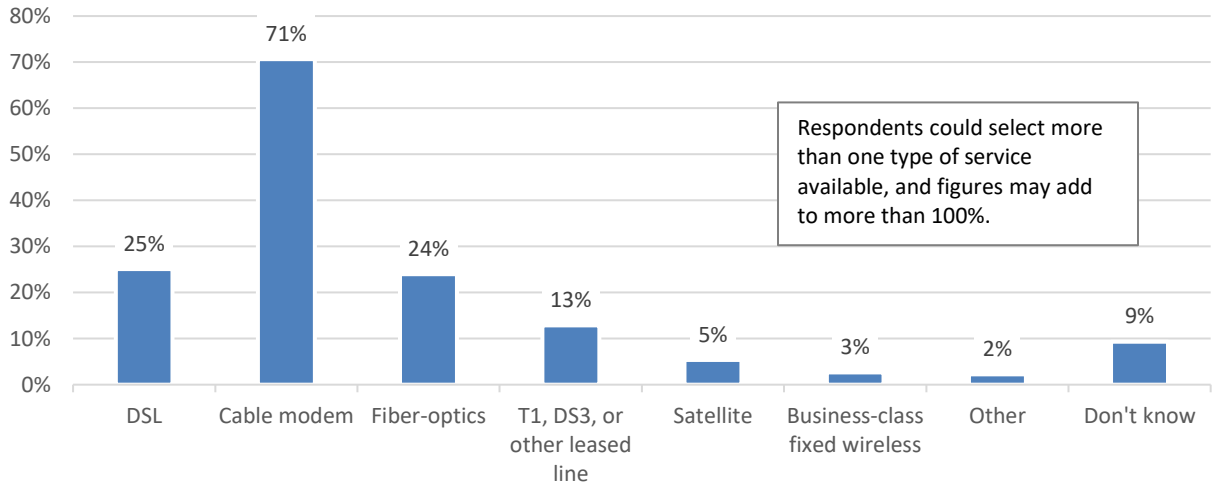
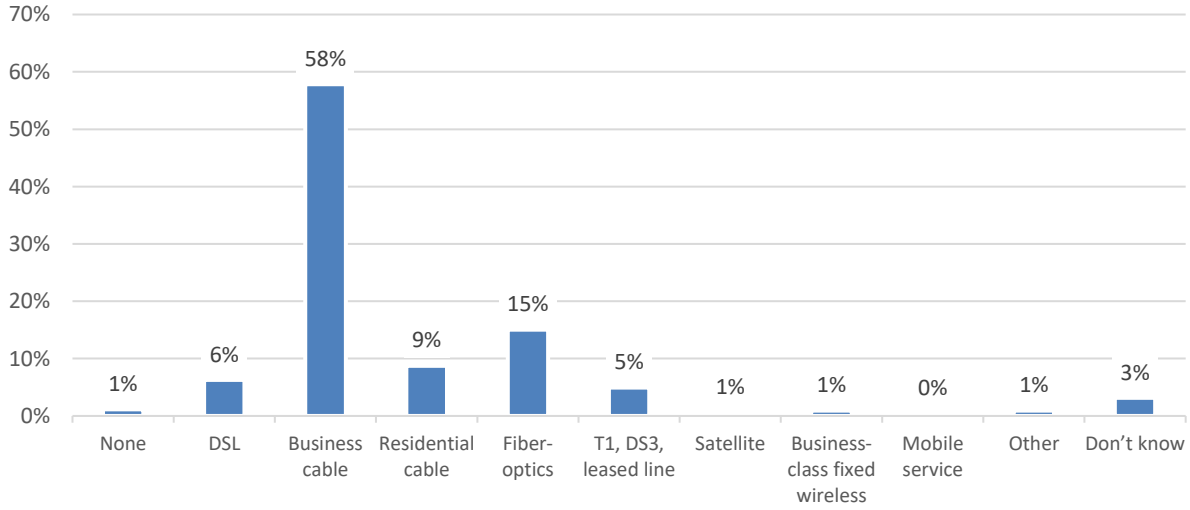
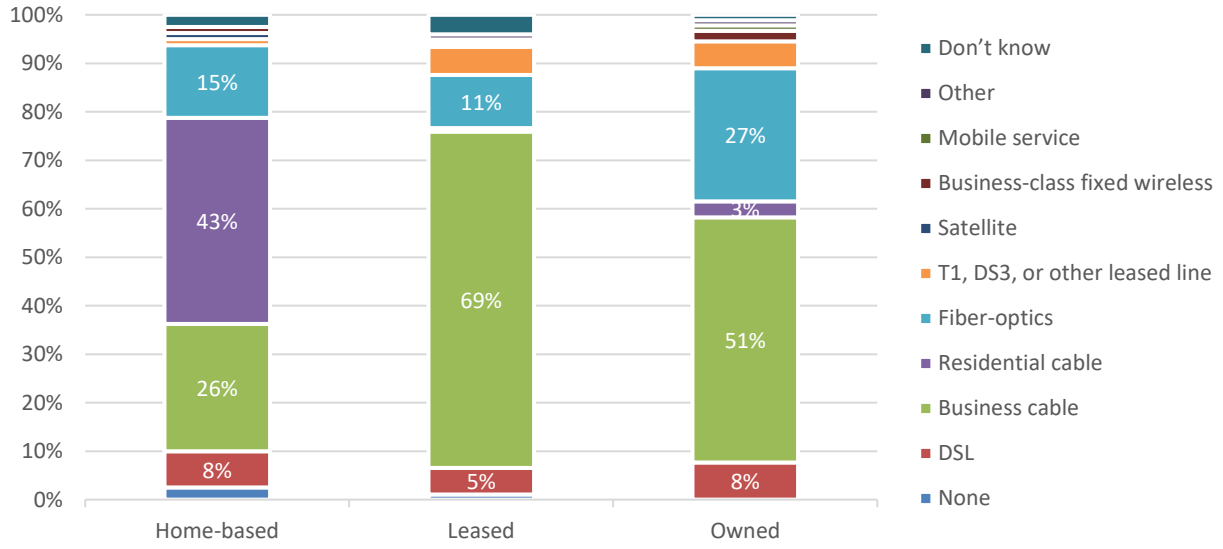


Figure 141: Internet Services Purchased



Home-based businesses are more likely than others to have a residential account cable modem (see Figure 142). Among all businesses with residential cable, the primary reasons cited are: no need for faster internet at this location (19 responses), residential speed internet meets our needs at this location (18 responses), and faster internet is too expensive (14 responses).

Figure 142: Primary Internet Service Connection by Type of Facility



Similarly, a higher share of businesses with lower gross revenue and lower telecommunications expenses (which are more likely to be home-based businesses) have a residential cable modem, as illustrated in Figure 143 and Figure 144. Higher earning/spending businesses are more likely than others to have a fiber-optic internet connection.

Figure 143: Primary Internet Service Connection by 2019 Gross Revenue

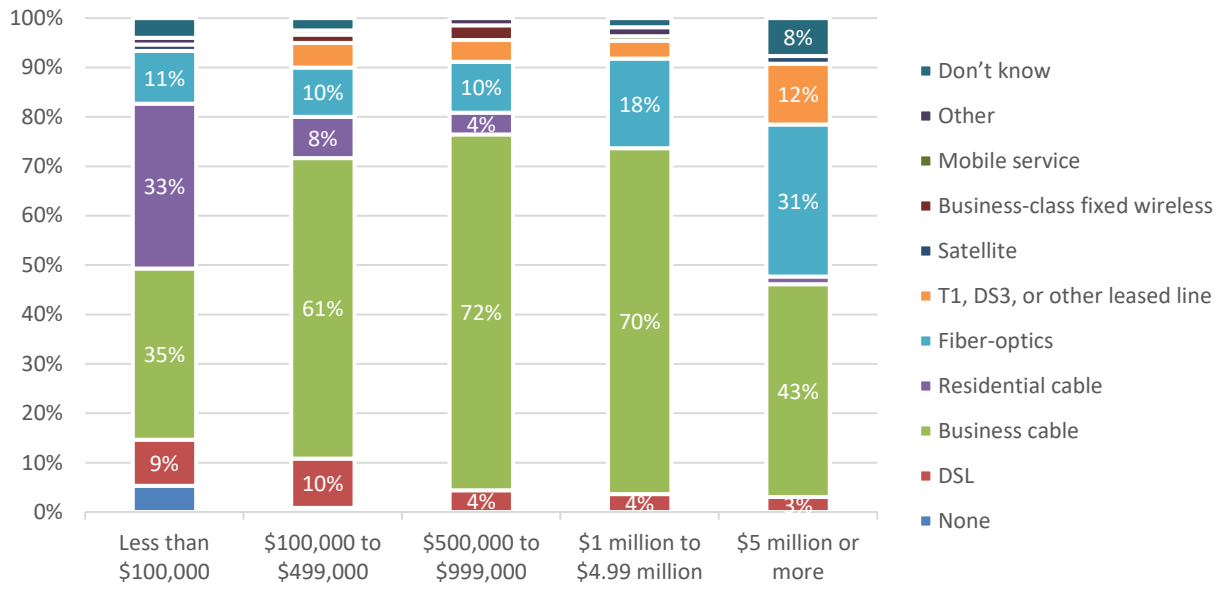
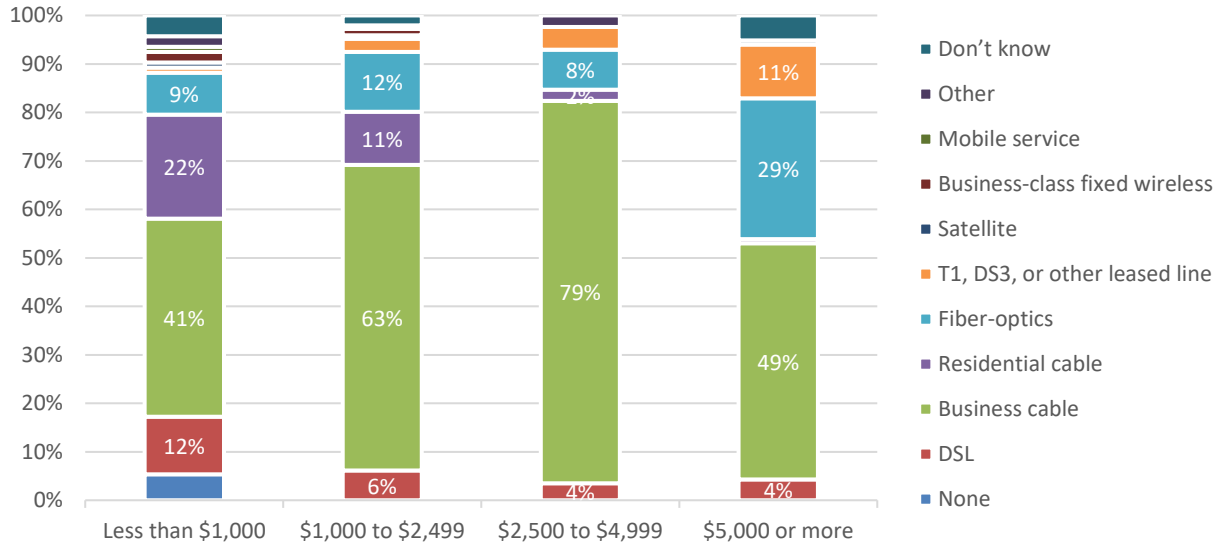
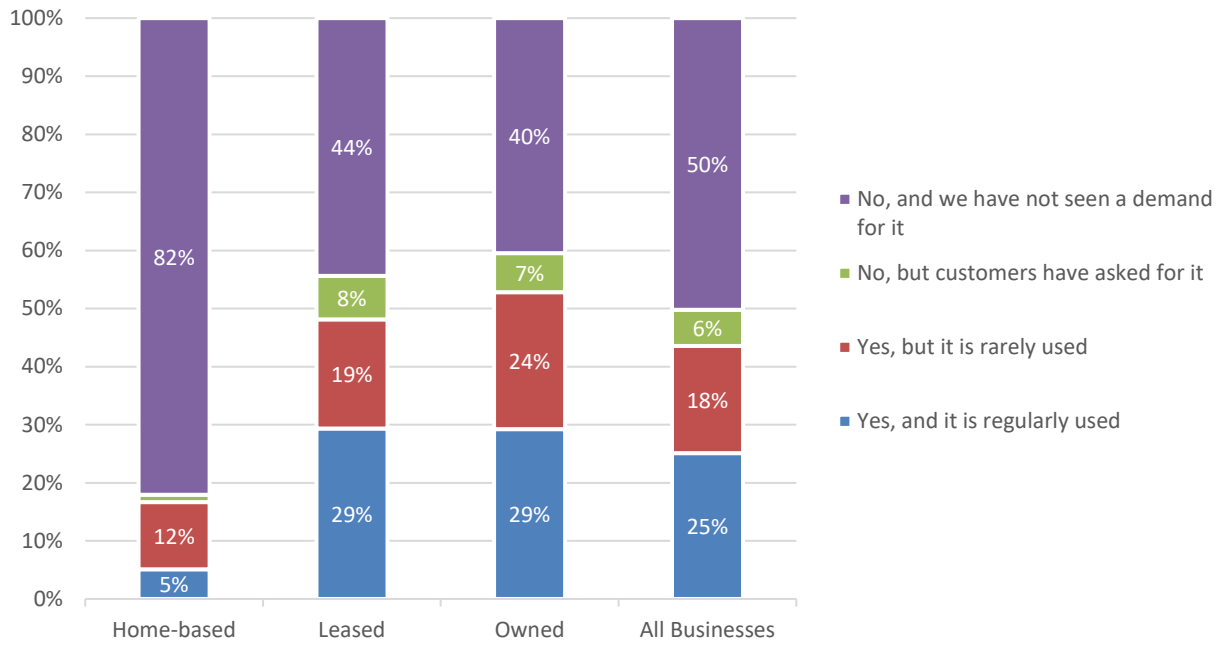


Figure 144: Primary Internet Service Connection by Annual Telecommunications Expense



Respondents were asked if their business provides internet access to customers over Wi-Fi hot spots. One-half of businesses do not provide internet and have not seen a demand for it, while 44 percent of do provide internet via hot spot. As may be expected, home-based businesses are less likely to offer Wi-Fi hot spots or to have seen a demand for it (see Figure 145).

Figure 145: Business Provides Internet Over Wi-Fi Hot Spots

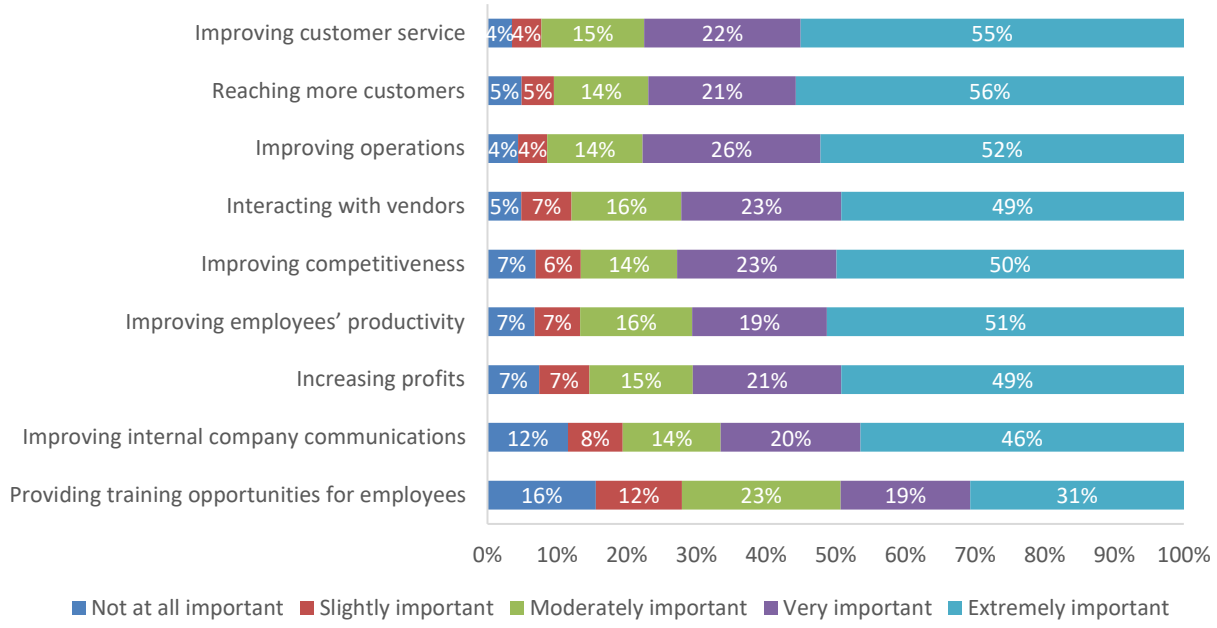


4.2.2.2 Importance of Internet Services

Respondents were asked to indicate the importance of various internet services to their business, using a scale where 1 =Not at all important and 5=Extremely important. The mean importance of various service aspects is illustrated in Figure 146, while detailed responses are illustrated in Figure 147.

Figure 146: Importance of Internet Service Aspects (Mean Ratings)

Figure 147: Importance of Internet Service Aspects



Businesses with a sole location, home-based businesses, and those with smaller revenue placed less importance on various internet services, as illustrated in Figure 148 and Figure 149.

Figure 148: Importance of Internet Services by Business Location Type

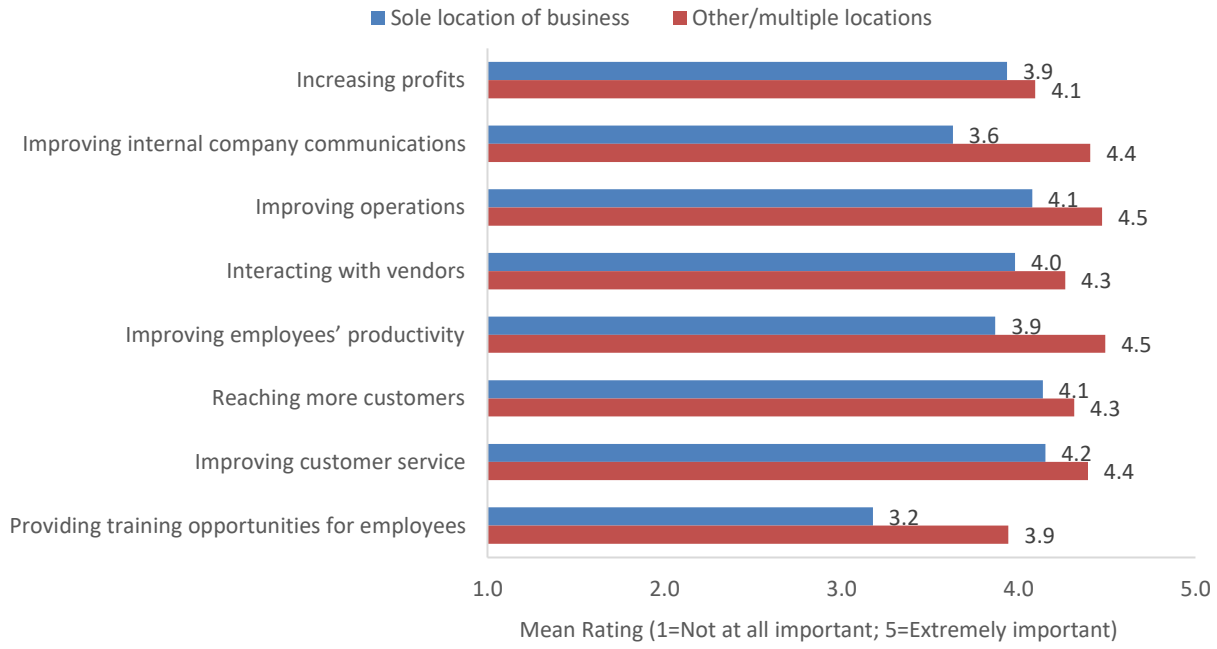
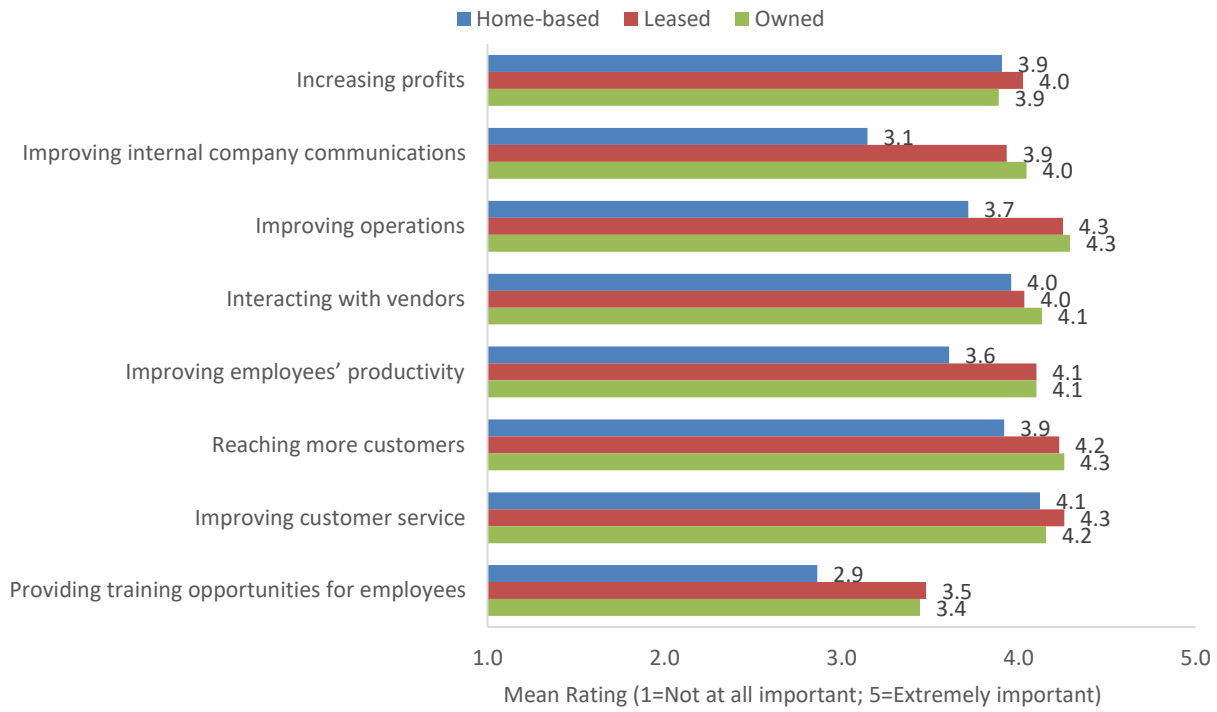


Figure 149: Importance of Internet Services by Type of Facility



4.2.2.3 Importance of Website

Respondents were asked to indicate the importance of their website for various functions, using a scale where 1 =Not at all important and 5=Extremely important. The mean importance of various website functions is illustrated in Figure 150, while detailed responses are illustrated in Figure 151. Businesses reported that their website is very important for sharing information with customers and potential customers, and only moderately important for other functions.

Figure 150: Importance of Website (Mean Ratings)

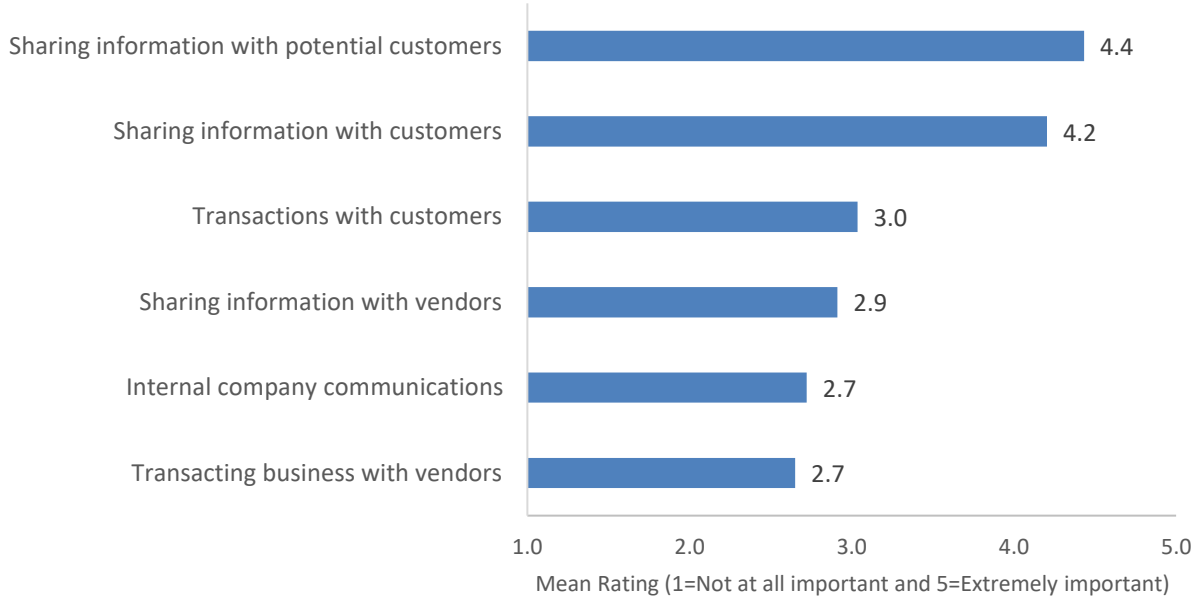
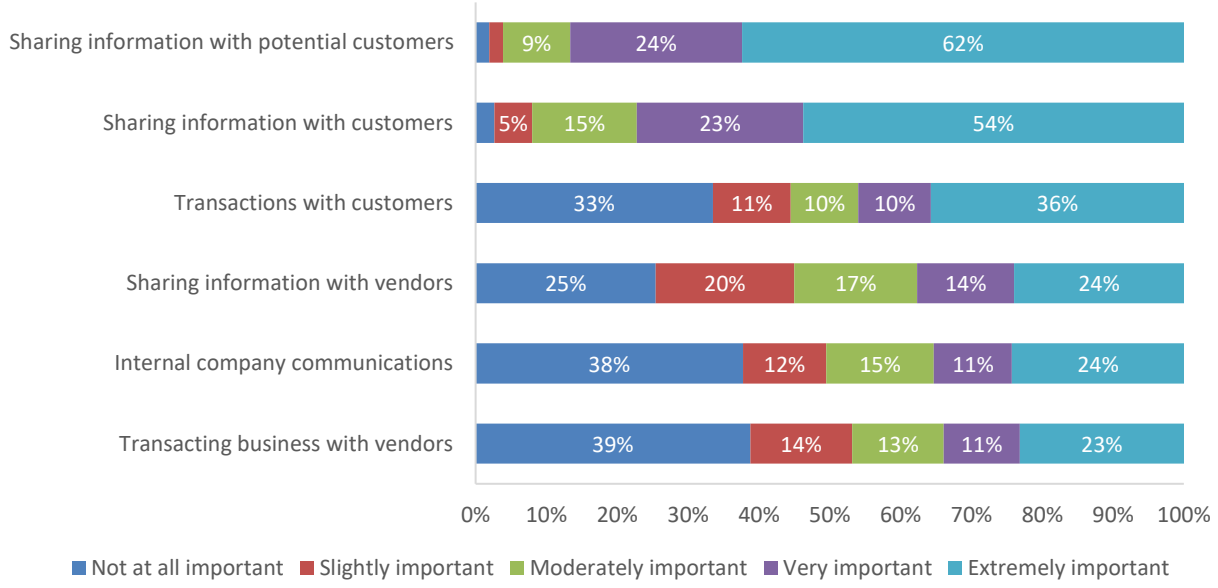


Figure 151: Importance of Website



4.2.2.4 Internet Service Aspects

Internet subscribers were asked to evaluate their satisfaction with various internet service aspects. This was compared with importance ratings given for these same aspects. The importance and satisfaction levels among internet users are compared in the following tables and graphs.

4.2.2.4.1 Importance

Respondents rated connection reliability as the most important business internet service aspect, with seven in 10 saying it is extremely important, as shown in Table 20. Other service aspects are very important to respondents as well, with approximately one-third saying they are extremely important and four in 10 saying they are very important.

Table 20: Importance of Internet Service Aspects

Service Aspect	Mean	Percentages
Total price paid for service	3.9	3% 27% 40% 27%
Download speed	4.1	3% 17% 43% 35%
Upload speed	4.0	5% 22% 38% 33%
Reliability	4.6	5% 23% 70%
Overall customer service	4.1	20% 42% 34%

Not at all important | Slightly important | Moderately important | Very important | Extremely important

4.2.2.4.2 Satisfaction

Overall, respondents are moderately satisfied with their internet service, as shown in Table 21. They are least satisfied with total price paid for service, which is typical of internet satisfaction surveys. The lower satisfaction levels could indicate a desire for improved service offerings or a willingness to switch internet service providers if needs are not being met.

Table 21: Satisfaction with Internet Service Aspects

Service Aspect	Mean	Percentages
Total price paid for service	2.6	18% 20% 45% 12% 5%
Download speed	3.2	6% 16% 42% 28% 8%
Upload speed	3.1	7% 18% 40% 27% 9%
Reliability	3.2	9% 15% 35% 29% 12%
Overall customer service	2.9	15% 19% 38% 21% 7%

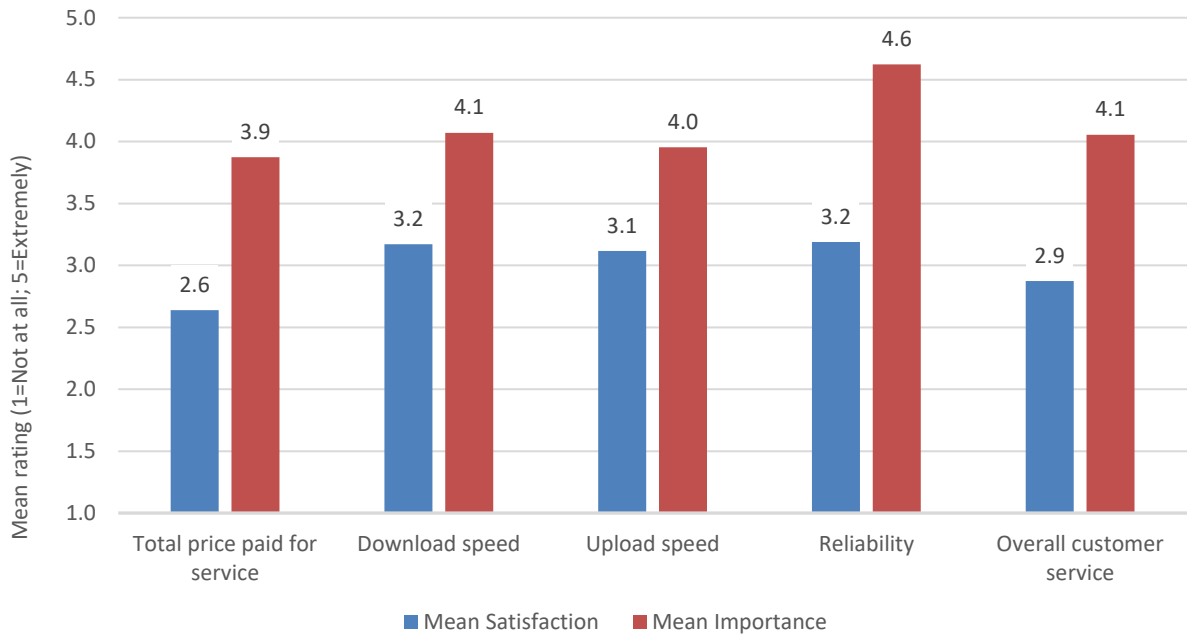
Not at all satisfied | Slightly satisfied | Moderately satisfied | Very satisfied | Extremely satisfied

4.2.2.4.3 Performance

Comparing respondents' stated importance and satisfaction of internet service aspects allows an evaluation of how well internet service providers are meeting the needs of customers (see Figure 152). Aspects that have higher stated importance than satisfaction can be considered areas in need of improvement. Aspects that have higher satisfaction than importance are areas where the market is meeting or exceeding customers' needs. However, it should be cautioned that the

extremely high level of importance placed on some aspects (such as reliability) may make it nearly impossible to attain satisfaction levels equal to importance levels.

Figure 152: Importance of and Satisfaction with Internet Service Aspects



The difference between importance and satisfaction of internet service aspects is also presented in the "gap" analysis table (see Table 22). The largest gap between importance and satisfaction is for reliability, followed by price paid for service and overall customer service.

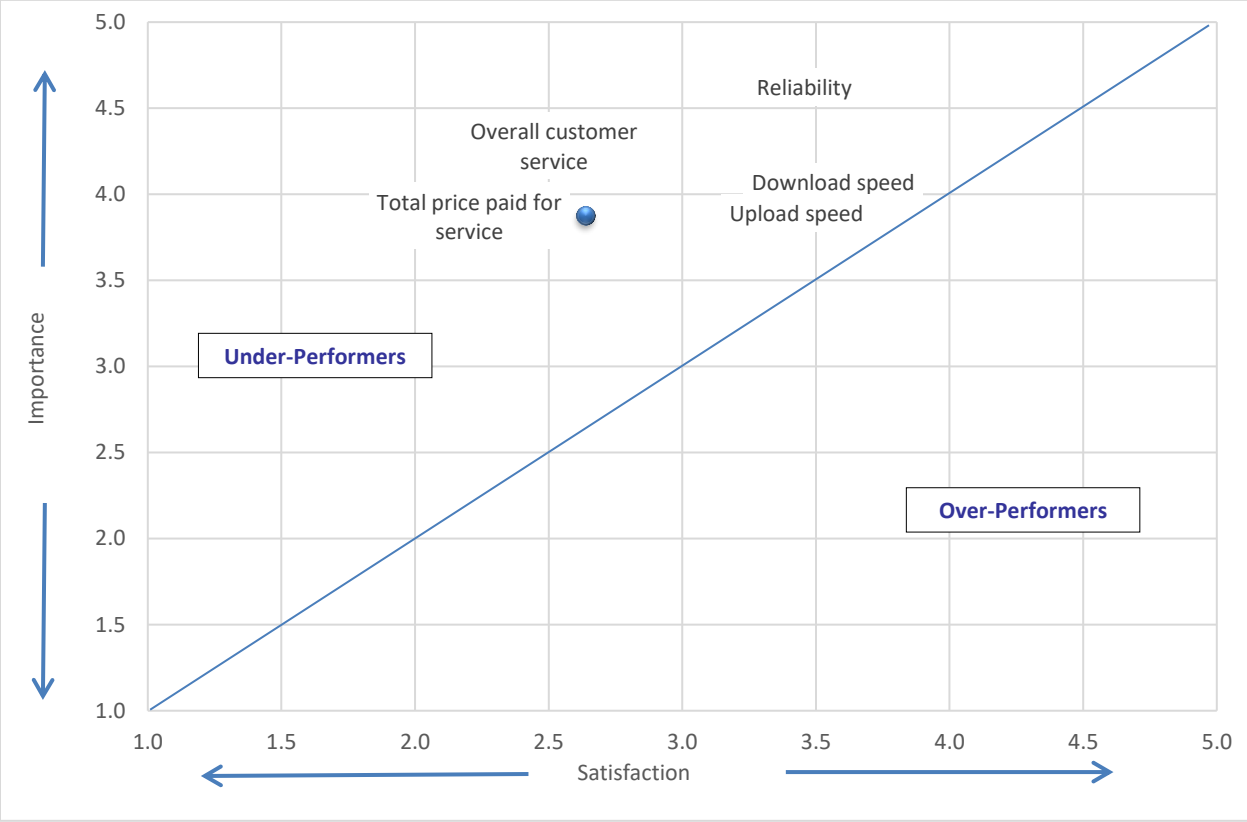
Table 22: Internet Service Aspect "Gap" Analysis

	Mean Satisfaction	Mean Importance	GAP < = >	Customer Expectations
Reliability	3.2	4.6	-1.4	Not Met
Total price paid for service	2.6	3.9	-1.2	Not Met
Overall customer service	2.9	4.1	-1.2	Not Met
Download speed	3.2	4.1	-0.9	Not Met
Upload speed	3.1	4.0	-0.8	Not Met

The importance scores and performance scores were plotted to help visually determine areas in which internet service providers are doing well and areas that might need improvement. Figure 153 compares the importance and satisfaction in a "quadrant" analysis. Those aspects for which importance is higher than satisfaction are above the equilibrium line and are defined as "underperformers." As is typical, the cost of internet service is well off the line, as satisfaction with costs is typically low. Reliability, upload and download speed, and customer service are

other under-performing service areas. The lower satisfaction levels could indicate a desire for improved service offerings or a willingness to switch internet service providers if needs are not being met.

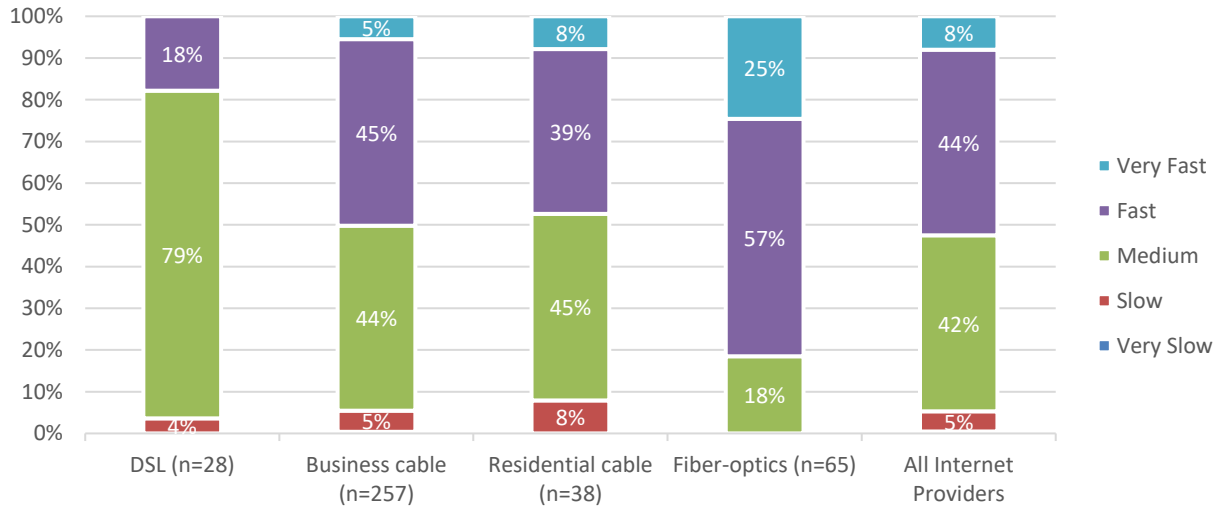
Figure 153: Internet Service Aspect "Quadrant" Analysis



4.2.2.5 Speed of Internet Service

Overall, most internet subscribers in the market area have "medium" or "fast" internet service, according to respondents. Fiber-optic subscribers were more likely than DSL and cable modem describers to describe their connection as "very fast," although counts are based on a small number of respondents (see Figure 154).

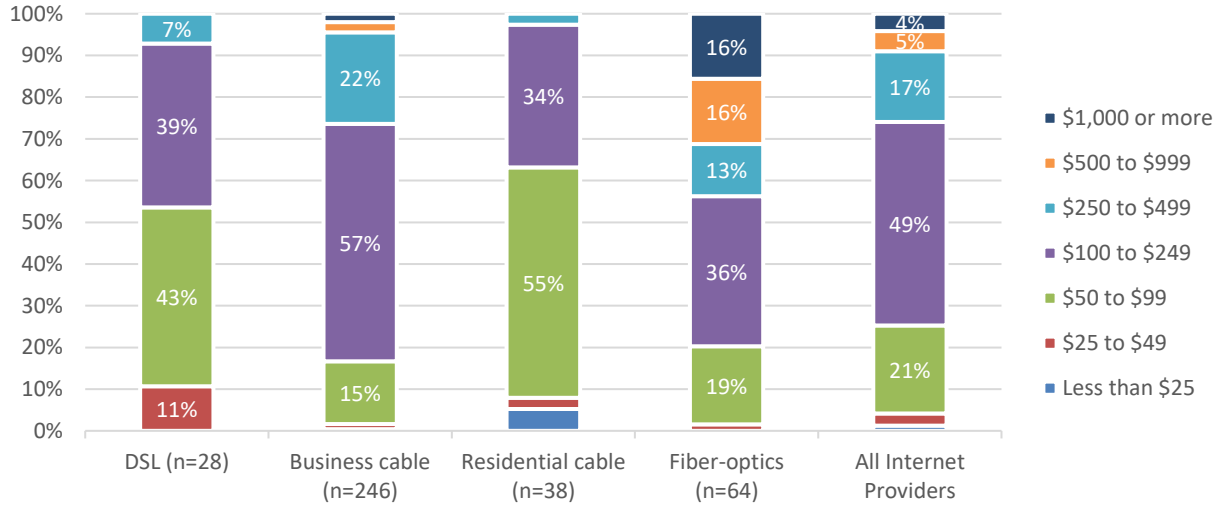
Figure 154: Internet Speed (Respondent Opinion) by Primary Internet Service



4.2.2.6 Cost of Internet Service

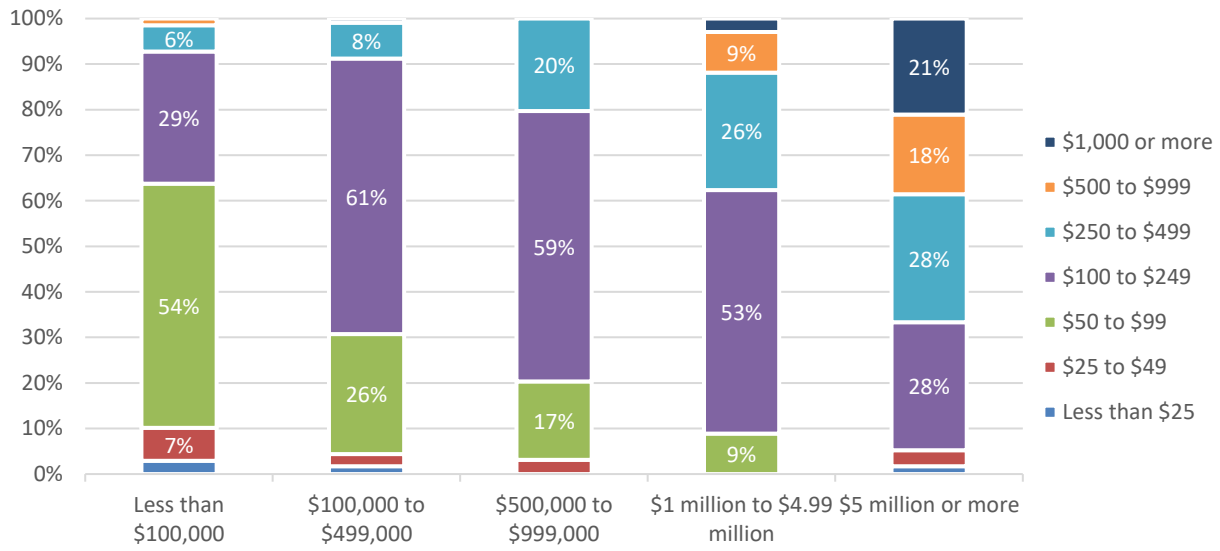
As Figure 155 illustrates, three-fourths of subscribers pay less than $250 per month for internet service. Approximately one-half pay $100 to $249 per month. Fiber-optic and business cable modem subscribers pay more per month on average compared with DSL and residential cable modem subscribers, although this is based on a small number of subscribers for some services.

Figure 155: Monthly Price for Internet Service



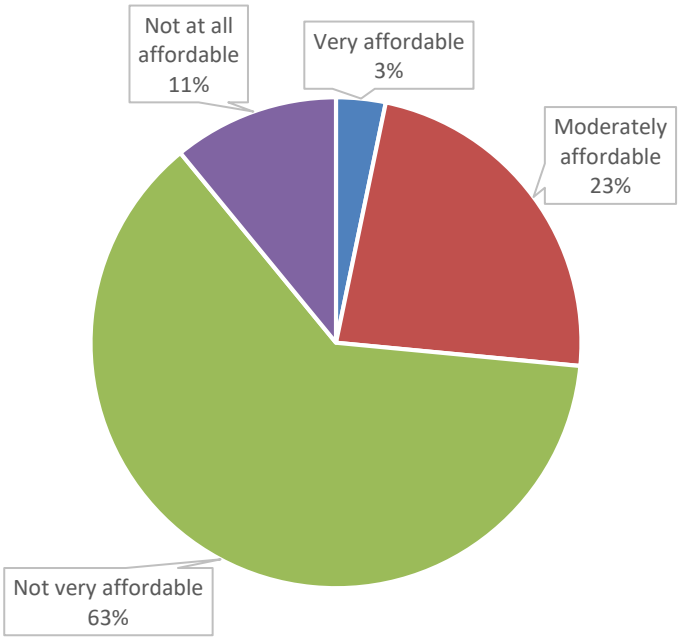
As may be expected, monthly cost of internet service is correlated with gross income (see Figure 156). Businesses with higher gross income spend more per month on internet service than do those with lower earnings.

Figure 156: Monthly Price for Internet Service by 2019 Gross Revenue



Most respondents said their internet service is not very affordable (63 percent) or not at all affordable (11 percent) (Figure 157). Just one-fourth of respondents said their internet service is at least moderately affordable. This does not vary significantly by provider type.

Figure 157: Affordability of Internet Service



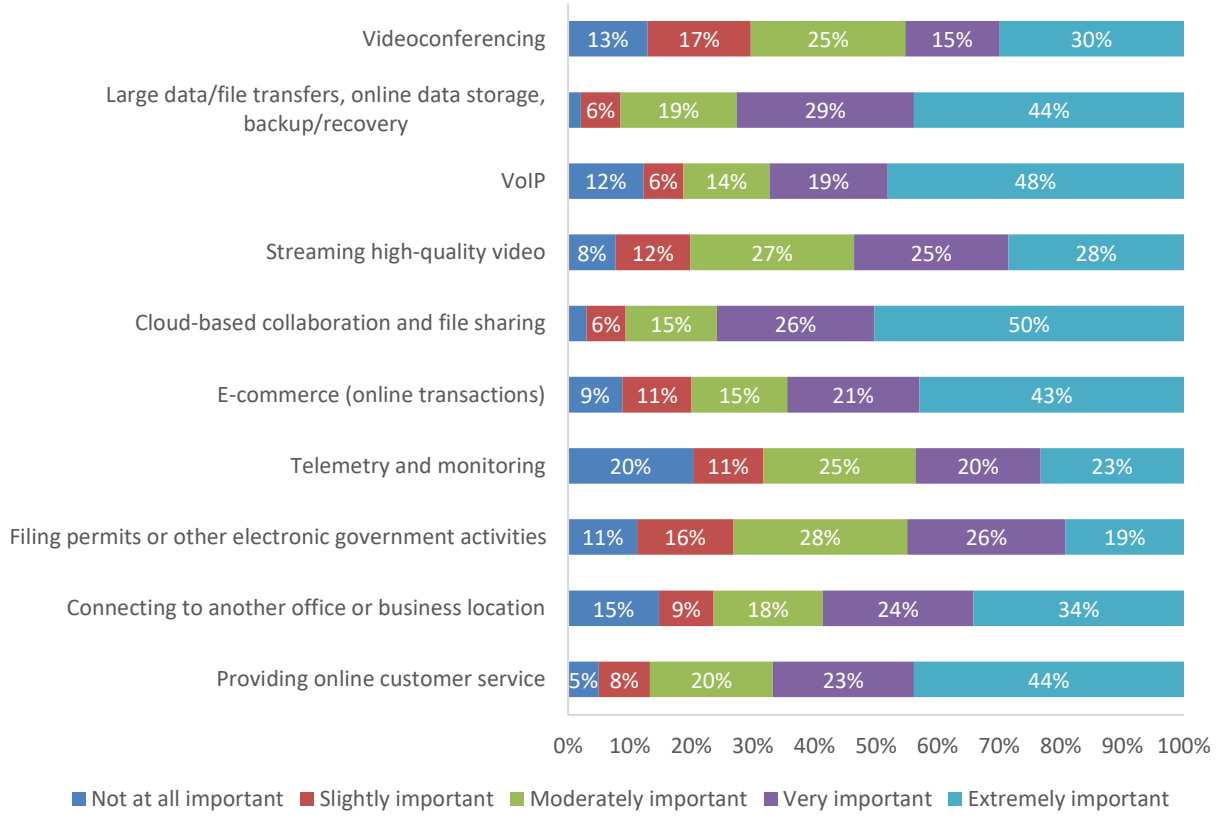
4.2.2.7 Internet-Based Services and Activities

Internet subscribers were asked to evaluate their satisfaction with their business's ability to perform various internet-based services and activities. This was compared with importance ratings given for these same aspects. Detailed responses given to importance and satisfaction are illustrated in Figure 158 and Figure 159. Mean ratings are compared in Figure 160.

4.2.2.7.1 Importance

The most important internet-based services and activities to businesses are cloud-based collaboration/file-sharing and large data/file transfers, etc., as well as VoIP, e-commerce, and providing online customer satisfaction.

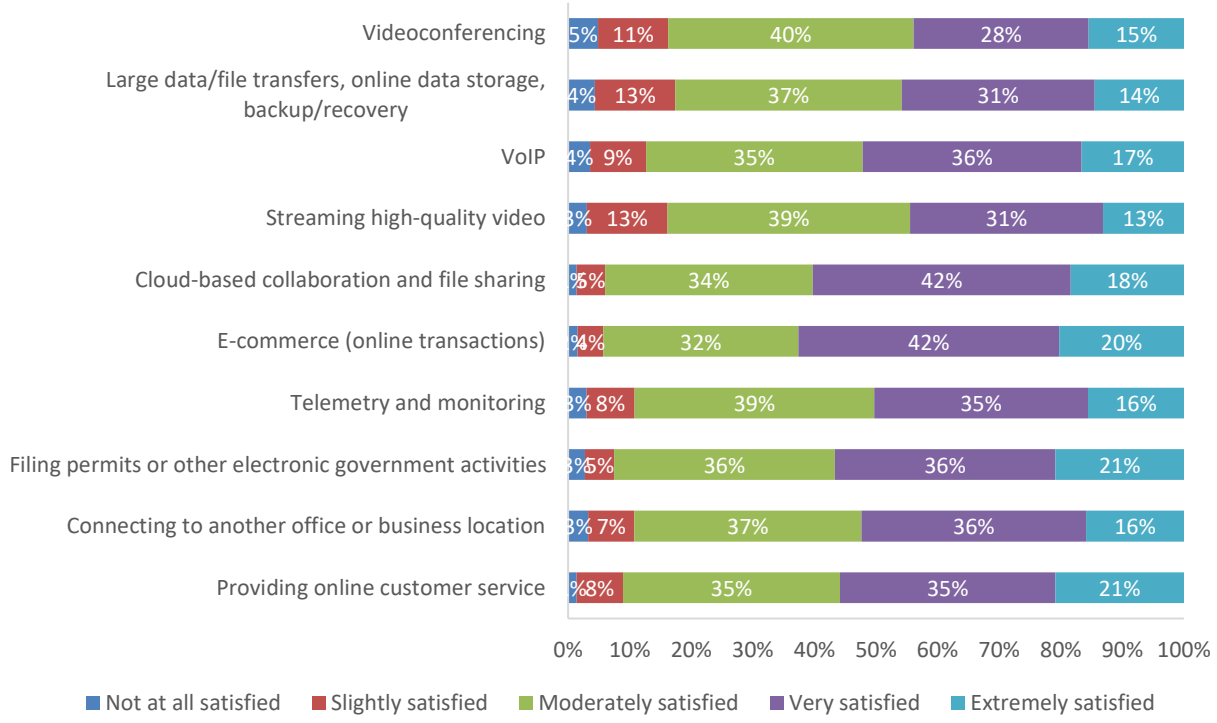
Figure 158: Importance of Internet-Based Services and Activities



4.2.2.7.2 Satisfaction

Respondents are most satisfied with e-commerce and cloud-based collaboration and file-sharing, followed by filing permits or other electronic government activities and providing online customer service.

Figure 159: Satisfaction with Internet-Based Services and Activities



4.2.2.7.3 Performance

A comparison of average importance and satisfaction scores for internet-based services and activities is shown in Figure 160. Aspects that have higher satisfaction than importance are areas where business needs are being met or exceeded. Aspects that have higher stated importance than satisfaction may be opportunities for improving service to business internet customers. The difference between importance and satisfaction of internet service aspects is also presented in the "gap" analysis table (see Table 23).

The largest gaps between importance and satisfaction is for large data/file transfers, online data storage, and backup/recovery, followed by cloud-based collaboration and file sharing, VoIP, providing online customer service, and streaming high-quality video. These are services of high importance. Business needs are being met or exceeded for other services and activities.

Figure 160: Importance of and Satisfaction with Internet-Based Services and Activities

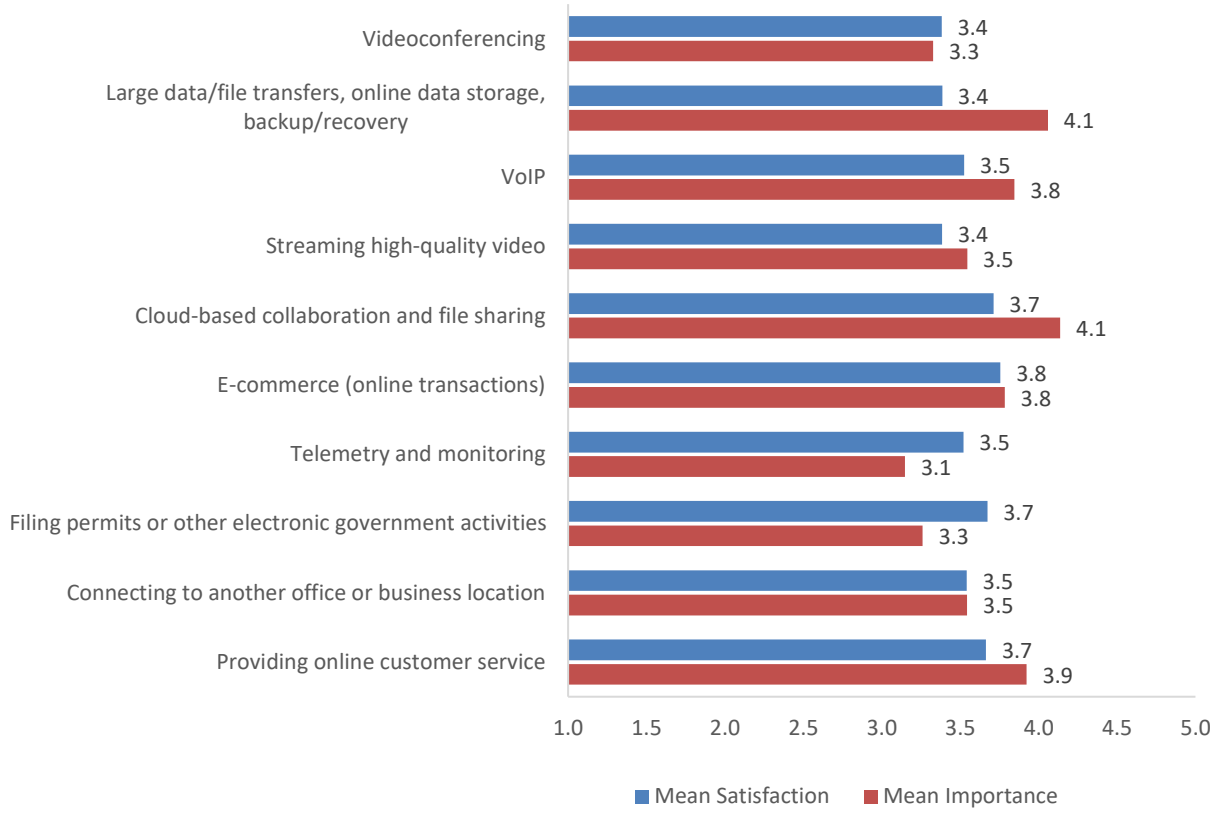


Table 23: Internet-Based Services and Activities "Gap" Analysis

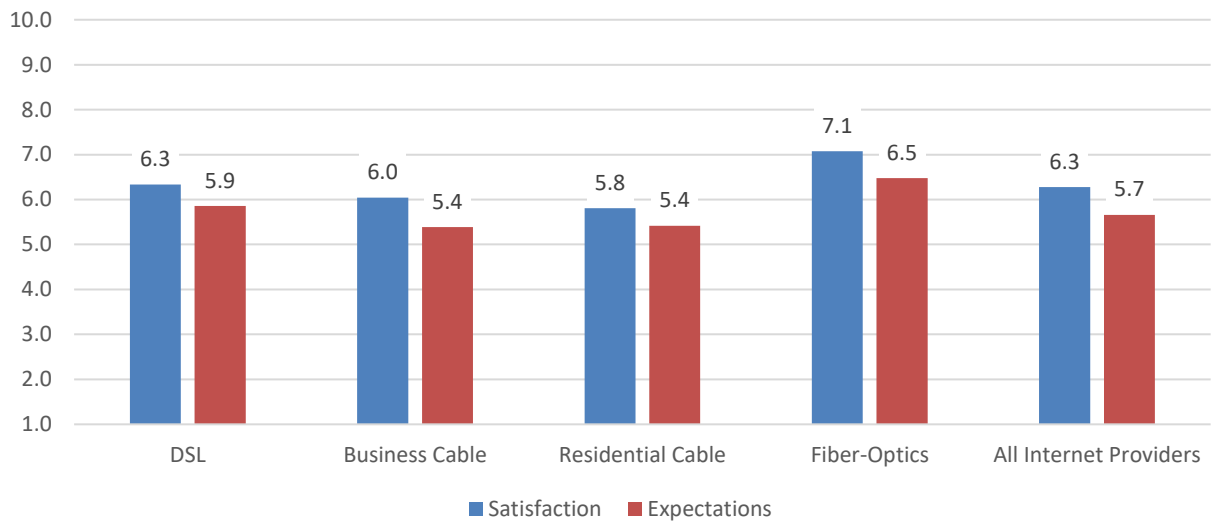
	Mean Satisfaction	Mean Importance	GAP < = >	Customer Expectations
Large data/file transfers, online data storage, backup/recovery	3.4	4.1	-0.7	Not Met
Cloud-based collaboration and file sharing	3.7	4.1	-0.4	Not Met
VoIP	3.5	3.8	-0.3	Not Met
Providing online customer service	3.7	3.9	-0.3	Not Met
Streaming high-quality video	3.4	3.5	-0.2	Not Met
E-commerce (online transactions)	3.8	3.8	0.0	Met
Connecting to another office or business location	3.5	3.5	0.0	Met
Videoconferencing	3.4	3.3	0.1	Met
Telemetry and monitoring	3.5	3.1	0.4	Exceeded
Filing permits or other electronic government activities	3.7	3.3	0.4	Exceeded

4.2.2.8 Customer Satisfaction and Loyalty

Respondents were asked a series of questions to help assess customer satisfaction and customer loyalty. As shown in Figure 161, business internet customers are moderately satisfied with their service provider (mean rating of 6.3, with a median of 7.0, on a scale where 1=Very dissatisfied and 10=Very satisfied).

Mean and median customer expectation scores (mean rating of 5.7, with a median of 6.0, on a scale where 1=Fallen short of expectations and 10=Exceeded expectations) suggest that internet service providers are meeting expectations (neither falling short of nor exceeding expectations).

Figure 161: Satisfaction and Expectations Scores by Connection Type (Mean Ratings)



Additionally, respondents were asked their likelihood of recommending their internet service provider, renewing their contract, and switching providers. The average likelihood scores are illustrated in Figure 162, while detailed responses are illustrated in Figure 163. Overall, customers are moderately loyal to their provider, with a mean loyalty score of 2.7 and a median of 2.8 (average score given to all four rating items on a scale of 1 to 5).[24]

Six in 10 respondents would be very or extremely likely to switch providers if an alternative provider offered greater network bandwidth and greater speeds. One-half would be very or extremely likely to switch providers if an alternative provider were less expensive.

Nearly one-half (46 percent) of respondents are very or extremely likely to renew their contract, but only 22 percent are very or extremely likely to recommend their provider.

[24] The loyalty scores were calculated by taking the average of all four aspects (recommend, renew, switch-cost, switch-bandwidth/speed). When calculating the score, the likelihood of switching scales were reversed so the higher score represents greater loyalty or less likelihood of switching.

Figure 162: Likelihood of Recommending, Renewing, or Switching Providers (Mean Ratings)

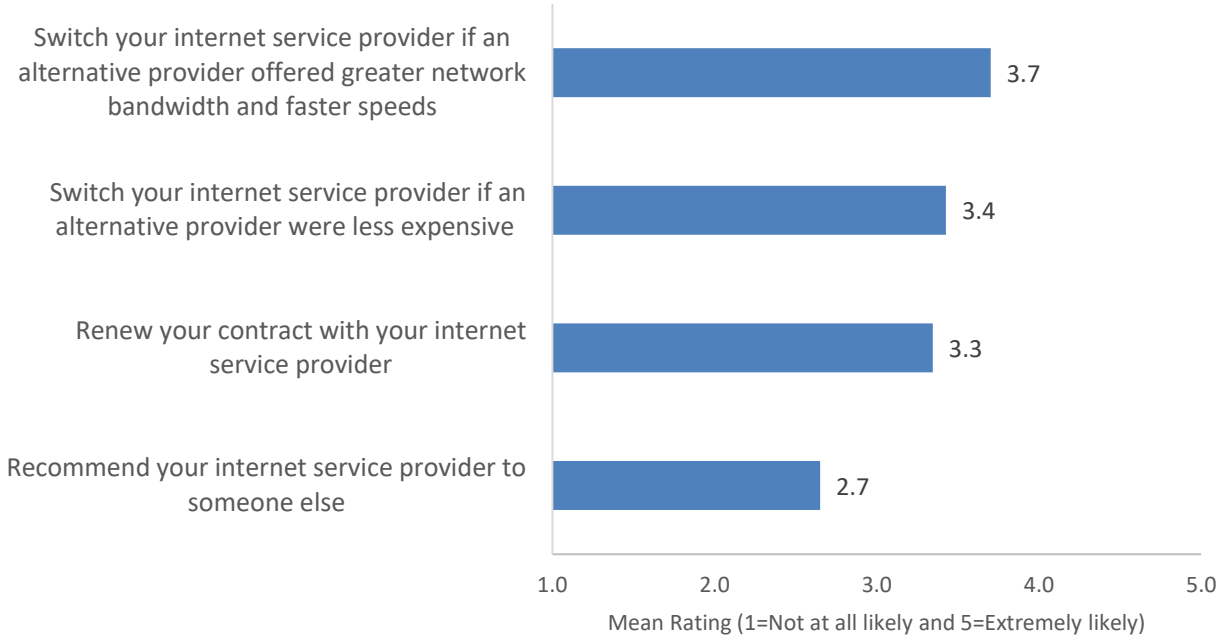
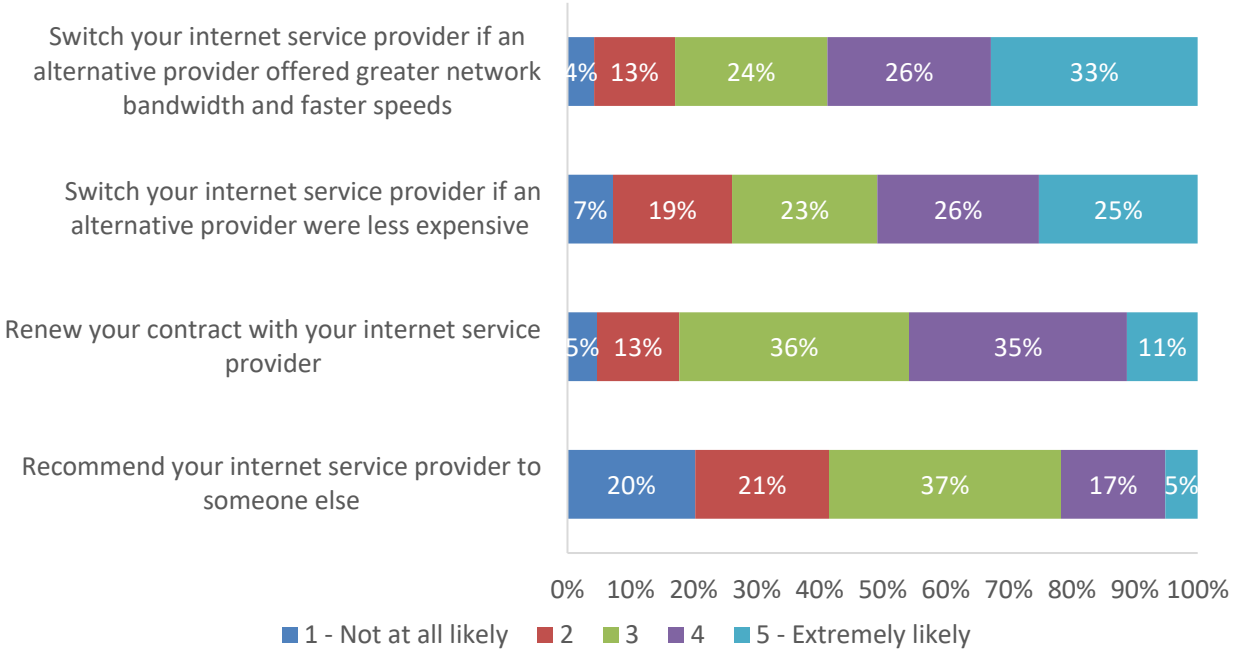


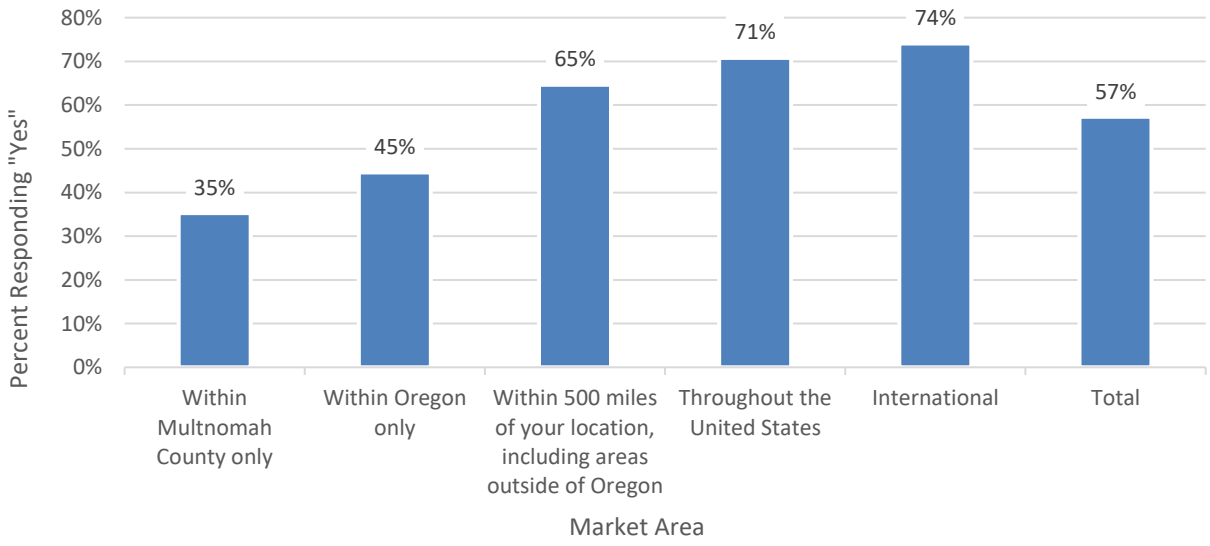
Figure 163: Likelihood of Recommending, Renewing, or Switching Providers



4.2.2.9 Telecommuting

As shown in Figure 164, 57 percent of respondents indicated that their business permits employees to telecommute. Businesses with market areas outside of Oregon are more likely to permit telecommuting and to have employees who telecommute and live outside of a metro area, compared with those within Oregon or Multnomah County only.

Figure 164: Business Permits Employees to Telecommute



Overall, 37 percent of businesses that allow telecommuting said at least some of their employees who telecommute live outside of a metro area (see Figure 165). Only three percent of businesses that do not permit telecommuting would do so if they had greater bandwidth and speed (see Figure 166).

Figure 165: Employees Who Telecommute Live Outside Metro Area

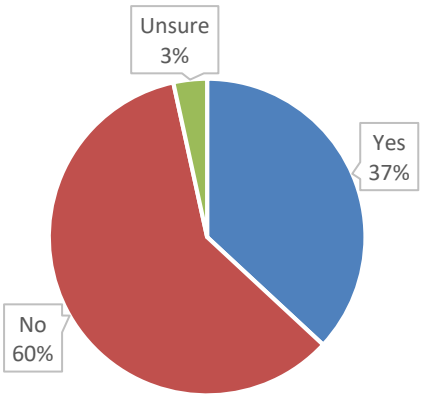
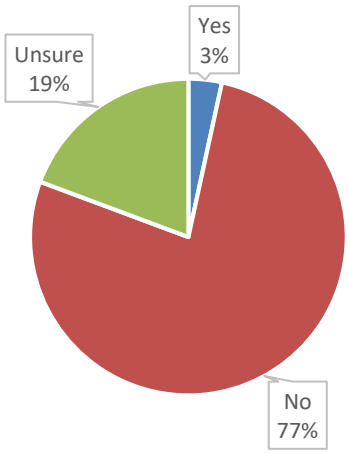


Figure 166: Would Implement Telecommuting



4.2.3 Respondent Opinions

Respondents were asked their opinions about the County's or Cities' role in providing or promoting broadband communications services within the area. Figure 167 illustrates the mean ratings, while Figure 168 provides detailed responses to each portion of the question.

Figure 167: Opinions About the Role(s) for Multnomah County and Cities (Mean Ratings)

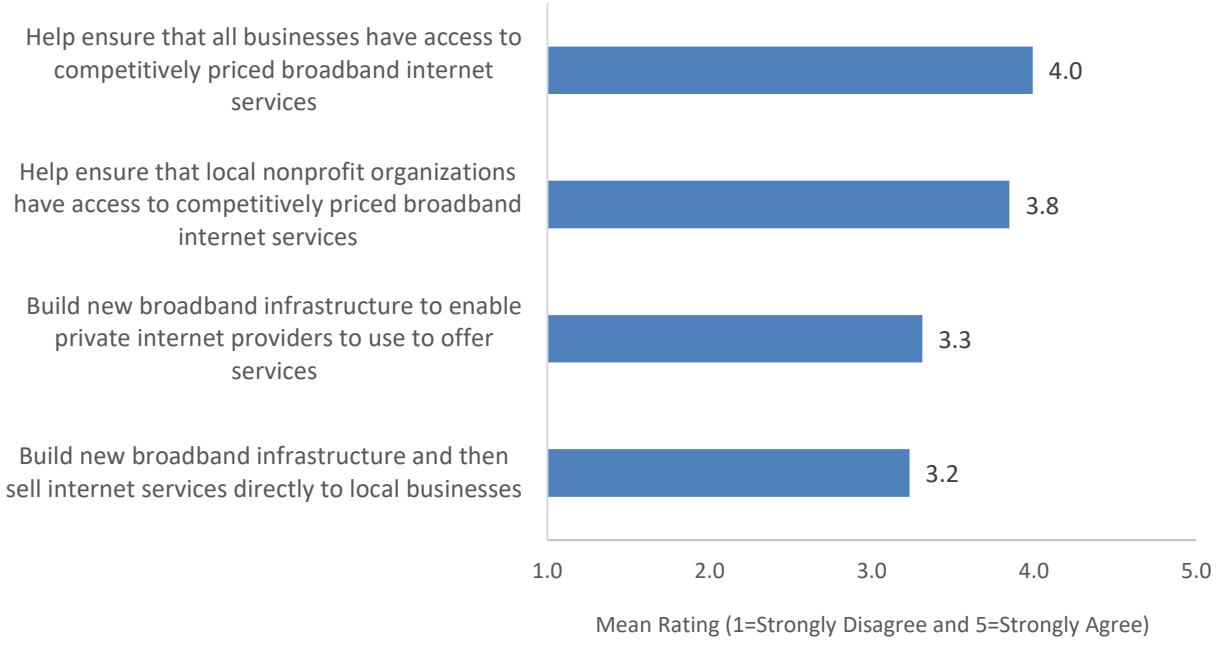
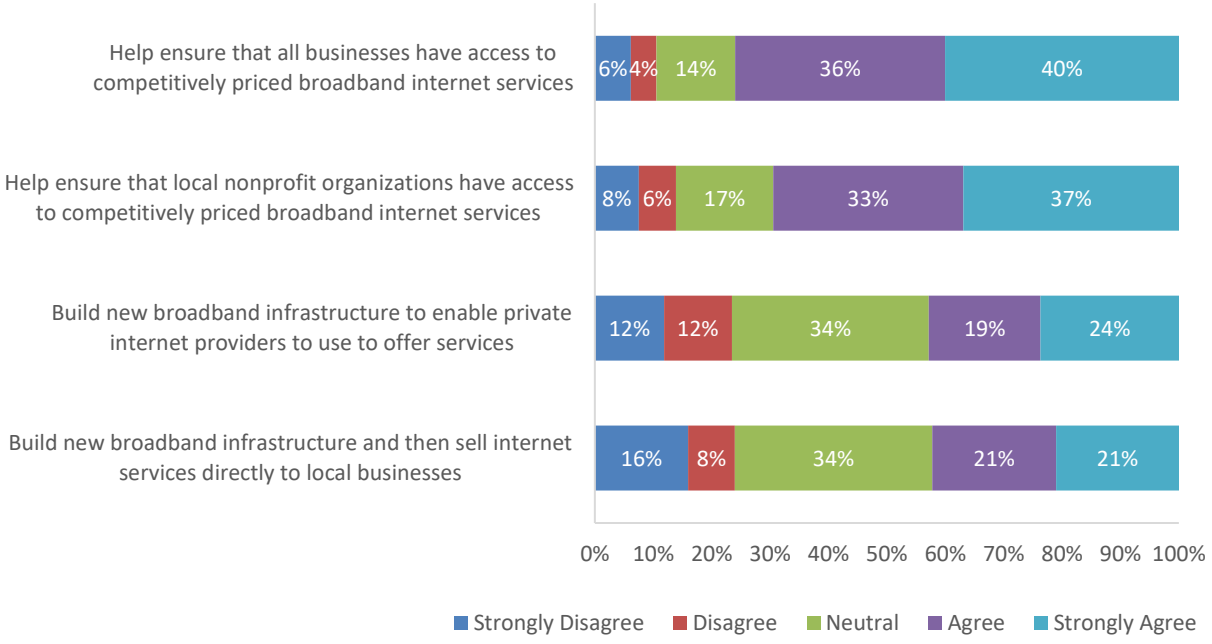


Figure 168: Opinions About the Role(s) for Multnomah County and Cities



Overall, there is support for ensuring access to competitively-priced broadband services. Three-fourths of respondents agreed or strongly agreed that the Partner Agencies should ensure access for all businesses, and seven in 10 agreed or strongly agreed that the Partner Agencies should ensure access for nonprofit organizations. Respondents were neutral or showed slight support for building a new broadband infrastructure. More than four in 10 agreed or strongly agreed, and one-third were neutral.

Respondents were also asked their opinion of the current broadband market. Overall, respondents moderately to strongly agreed with most statements. Agreement was somewhat lower for the availability of affordable, high-speed internet access being a factor in deciding where to locate or being critical to the provision of businesses' services. The average agreement with broadband availability statements are shown in Figure 169. Detailed responses to statements about broadband availability are illustrated in Figure 170.

Figure 169: Opinions About the Broadband Internet Market (Mean Ratings)

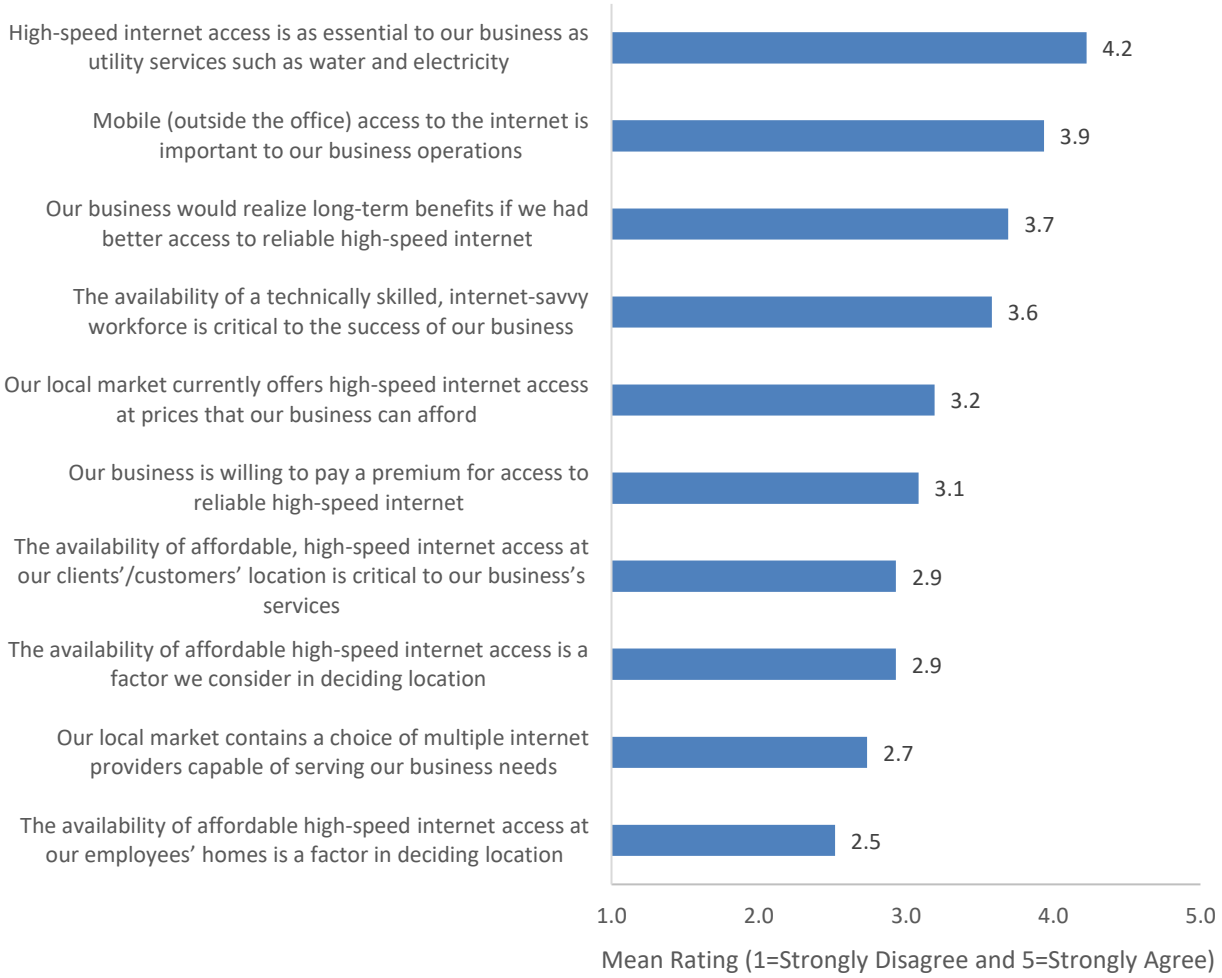
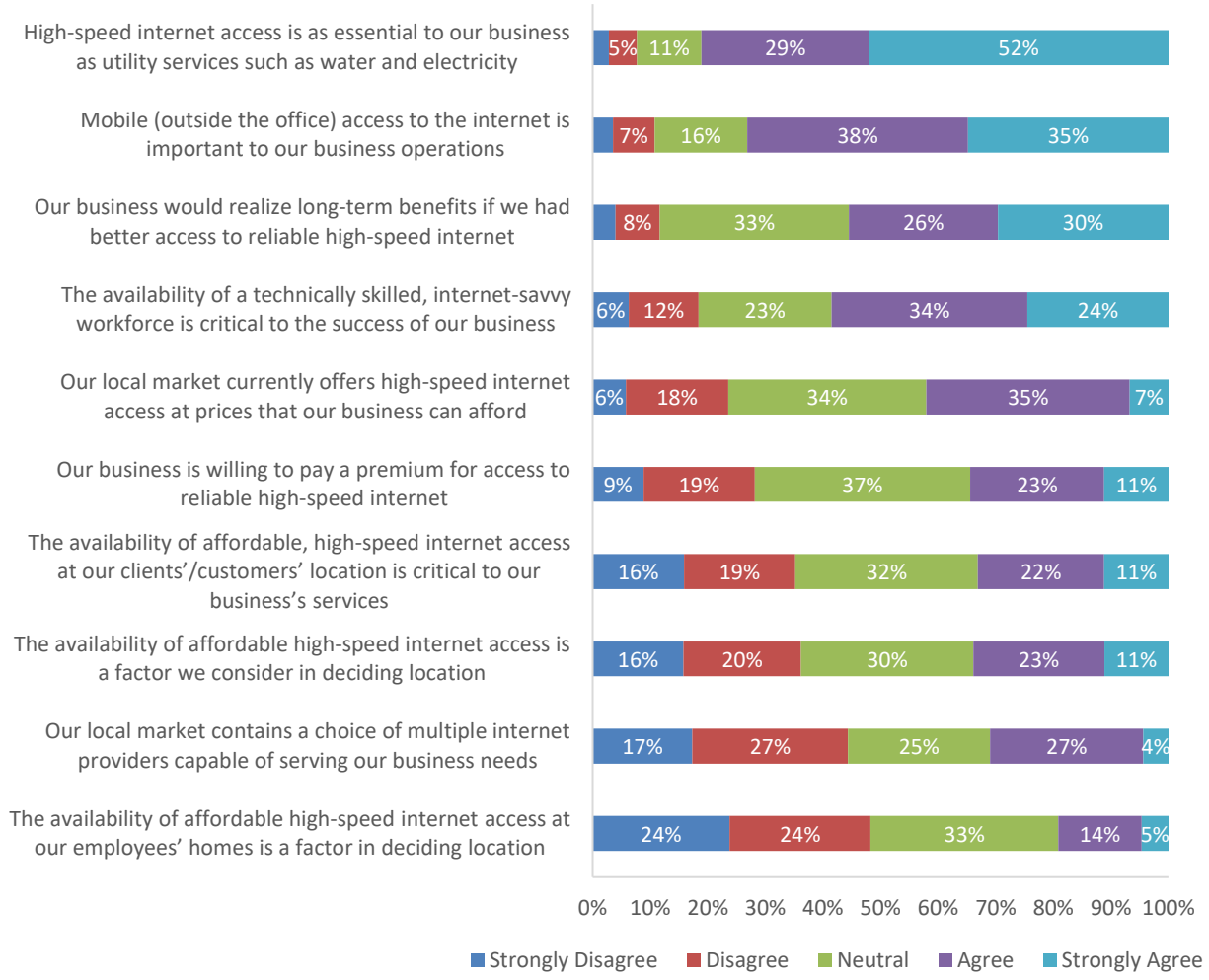


Figure 170: Opinions About the Broadband Internet Market

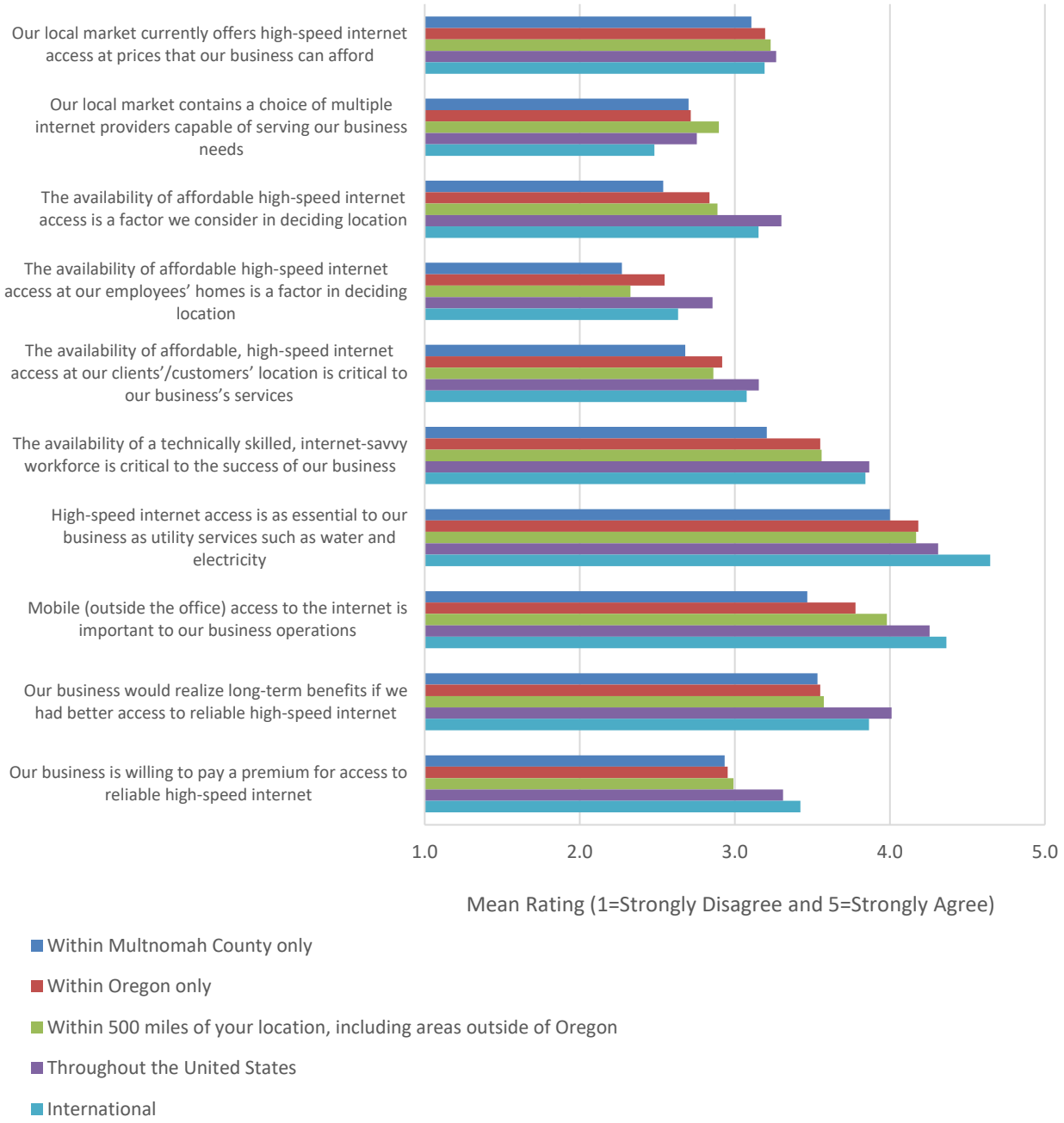


Among the factors listed, respondents were most likely to agree that high-speed internet is as essential to businesses as utility services (52 percent strongly agree, 29 percent agree). Most respondents also agree or strongly agree that mobile access to the internet is important to business operations (73 percent agree or strongly agree), their business would realize long-term benefits if they had better access to reliable high-speed internet (56 percent agree or strongly agree), and the availability of a technically skilled, internet-savvy workforce is critical to the success of their business (58 percent agree or strongly agree).

At the same time, only three in 10 agreed or strongly agreed that the local market contains a choice of multiple internet providers capable of serving their business needs. Just 43 percent are willing to pay a premium for access to high-speed internet.

National and international businesses were more likely to agree with statements about the availability of high-speed internet access and the importance of high-speed and mobile internet access, compared with businesses within Multnomah County or Oregon only (see Figure 171).

Figure 171: Opinions About the Broadband Internet Market by Market Area

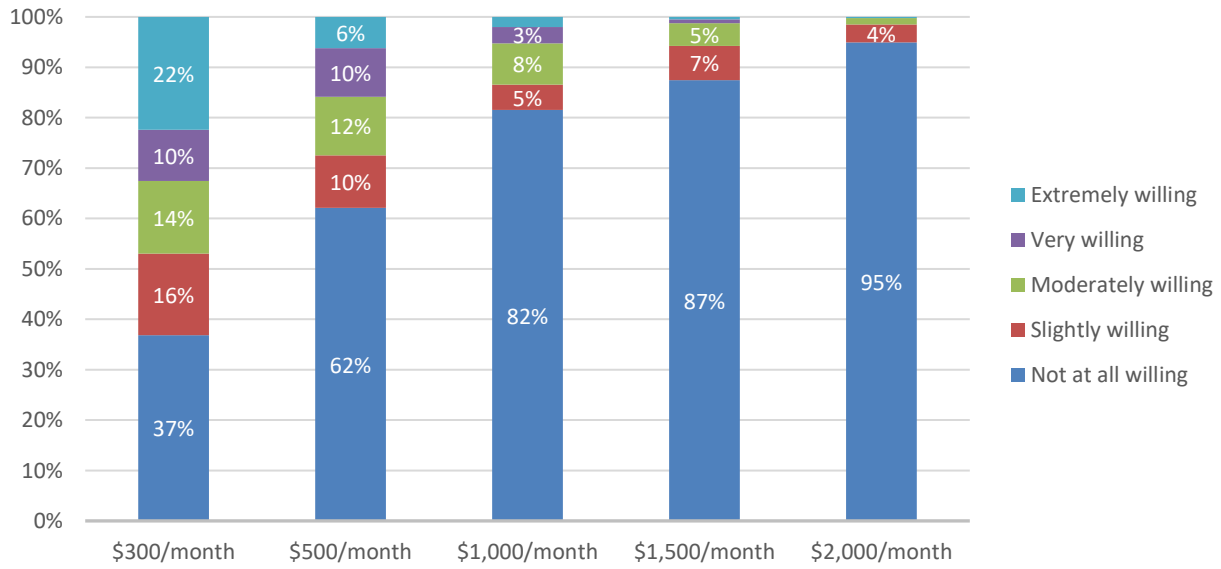


4.2.3.1 Willingness to Purchase High-Speed Internet Service

Respondents were asked if they would be willing to purchase 1 Gbps carrier-grade Ethernet transport and internet access service for various price levels from another commercial service provider. The mean willingness to purchase across this array of questions is illustrated in Figure 172, while detailed responses are illustrated in Figure 173.

Figure 172: Willingness to Purchase 1 Gbps Internet from Commercial Service Provider (Mean Ratings)

Figure 173: Willingness to Purchase 1 Gbps Internet from Commercial Service Provider



Respondents' willingness to purchase 1 Gbps internet service from another commercial provider is slight to moderate at $300 per month, and it drops considerably as the price increases. The mean rating falls to 1.9 at a price point of $500 per month and 1.4 at a price point of $1,000 per month (not at all to slightly willing). Most respondents are not at all willing to switch for $500 or more per month.

The willingness to purchase high-speed internet service from another commercial provider at various price points is higher for businesses with multiple locations, are not home-based, have 20 or more full-time employees at the location, have a gross revenue of $5 million or more, or have an annual telecommunications expense of $5,000 or more (see Figure 174 to Figure 178).

Figure 174: Willingness to Purchase 1 Gbps Internet by Business Location Type

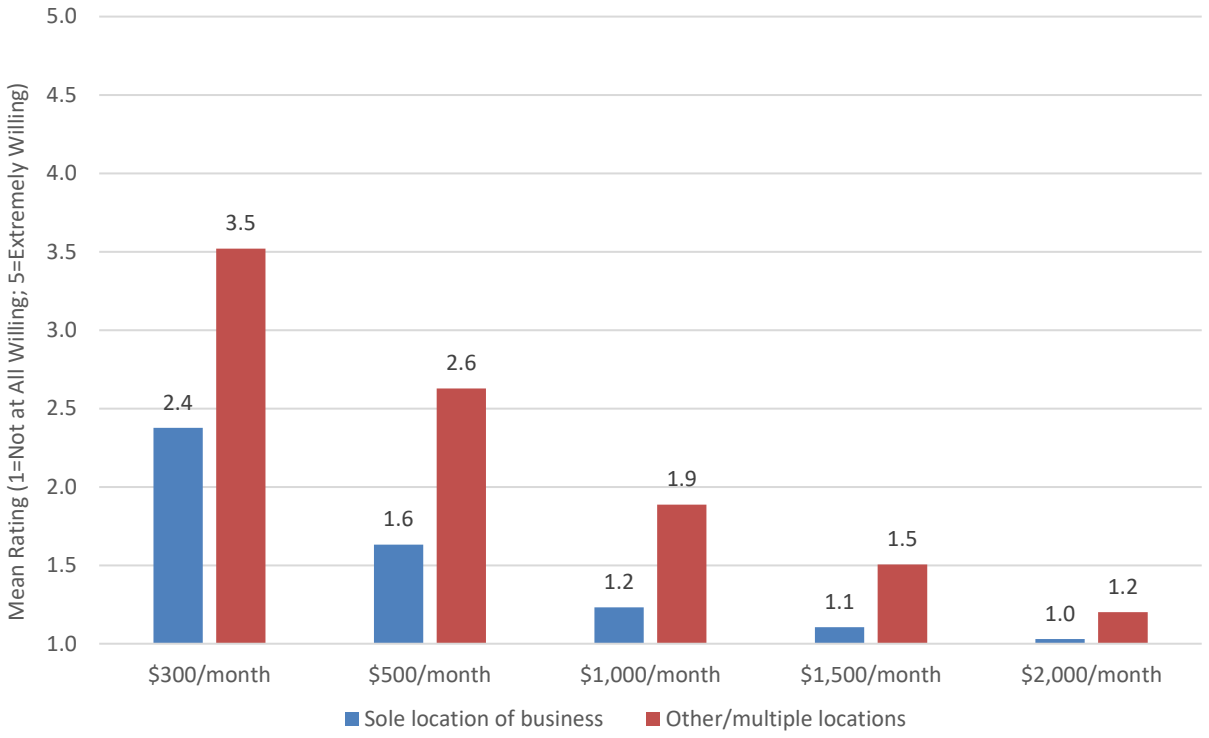


Figure 175: Willingness to Purchase 1 Gbps Internet Service by # of Full-Time Employees

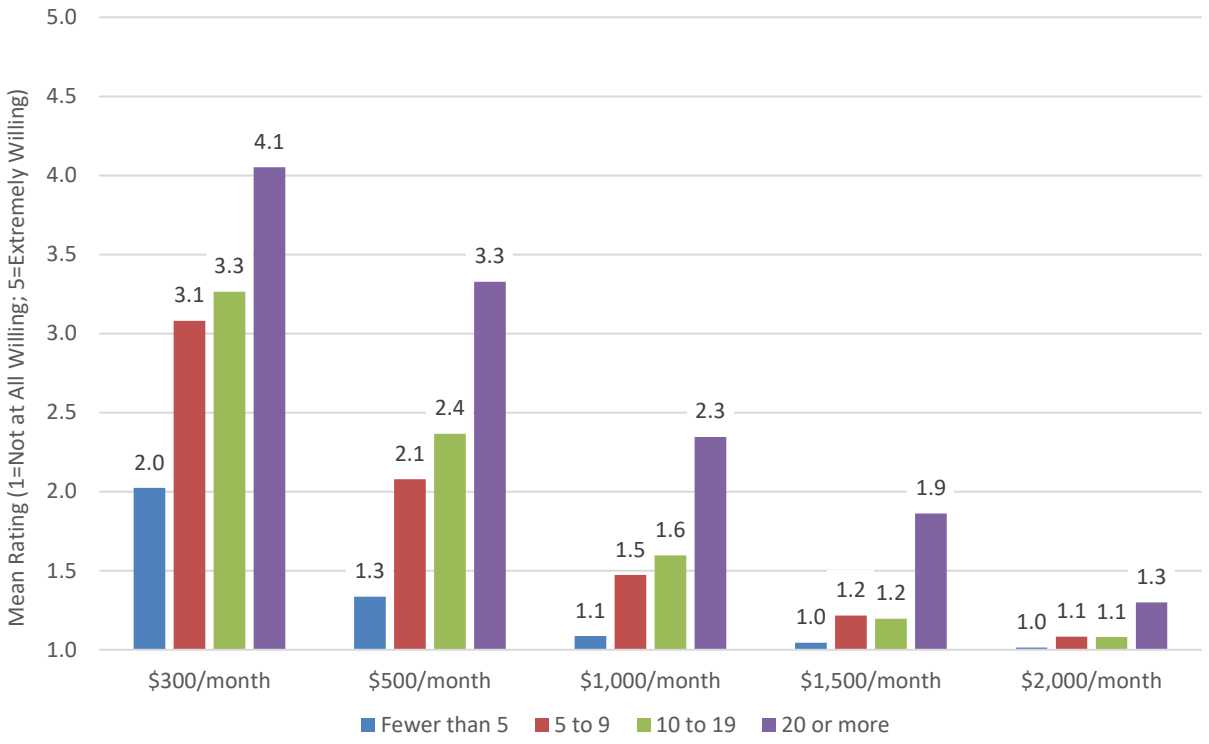


Figure 176: Willingness to Purchase 1 Gbps Internet Service by Type of Facility

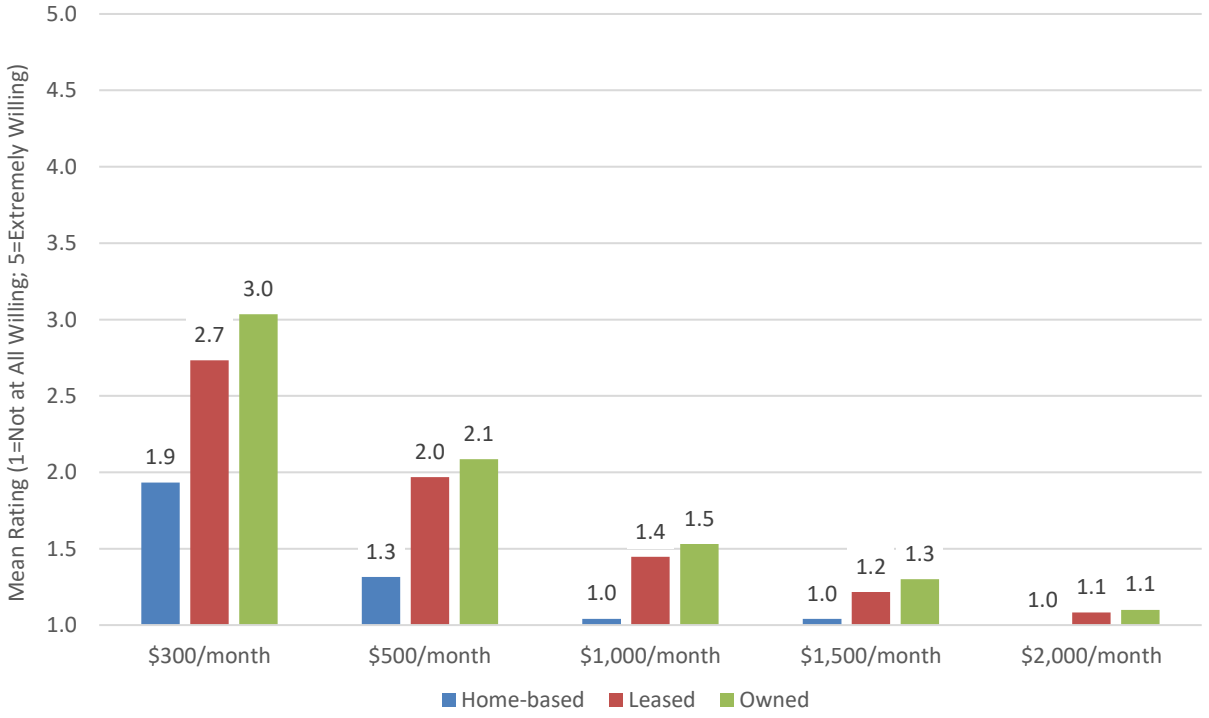


Figure 177: Willingness to Purchase 1 Gbps Internet Service by 2019 Gross Revenue

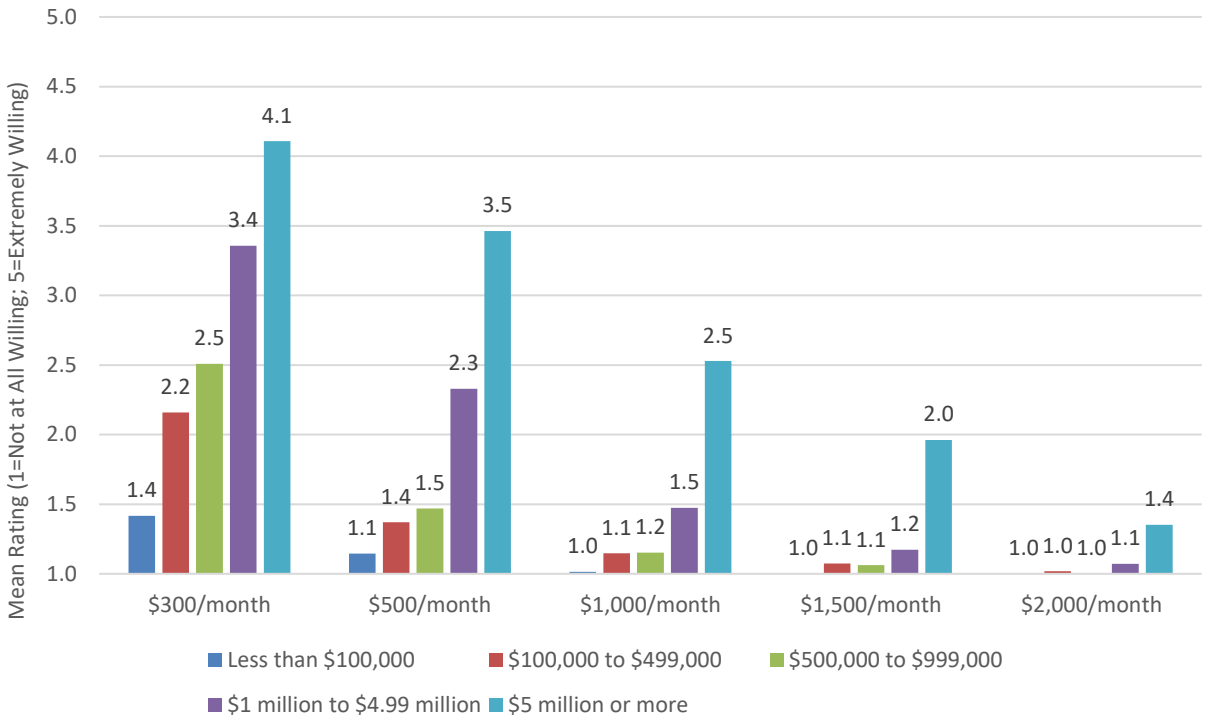
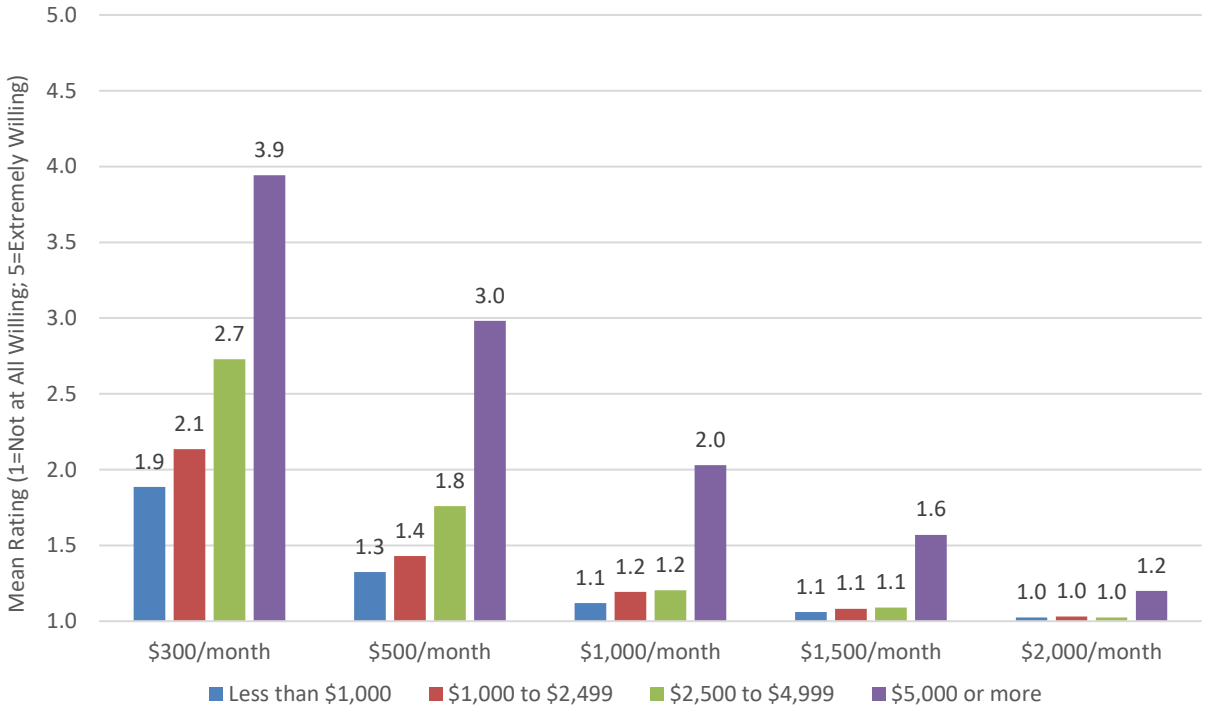


Figure 178: Willingness to Purchase 1 Gbps Internet Service by Telecommunications Expenses



5 A Countywide Fiber-to-the-Premises Network Would Cost $970 Million

CTC's engineers prepared a conceptual-level network design for the Partner Agencies' deployment of a gigabit-capable fiber-to-the-premises network to all homes and businesses in the County. Based on that design, we developed two cost estimates.

The first estimate is the cost to deploy a fiber-to-the-premises infrastructure, all electronics, consumer drops, and customer premises equipment to every premises in the County. This estimate shows the *total capital costs*[25] to build a fiber-to-the-premises network to support a ubiquitously available gigabit data service. Assuming a take-rate (i.e., the percentage of residents and businesses that subscribe to the service) of 35 percent,[26] **the full fiber-to-the-premises network deployment would cost $970 million**. These costs might be borne by the Partner Agencies alone (i.e., if the Partner Agencies were to build and operate the network, and sell retail services to residents), by the Partner Agencies in partnership with one or more private partners, or by a private entity alone. (See Section 8 for an overview of potential partnership business models.)

The second cost estimate is to deploy fiber-to-the-premises infrastructure just in areas of the County that currently are not served by broadband providers (i.e., a network designed to pass only the County's unserved premises). The Partner Agencies would need to spend **$47 million to build an fiber-to-the-premises network to serve just the estimated 2,800 unserved homes and businesses**, assuming a 35 percent take-rate. (See Section 5.4 for more details.) As with the first estimate, these costs could be the responsibility of the Partner Agencies alone, the Partner Agencies and partners, or just a private entity.

These cost estimates provide data relevant to developing a business model for a potential construction effort by the Partner Agencies (including a retail approach or the full range of models for public–private partnerships) and to assessing the financial viability of network deployment. These estimates also enable financial modeling to understand the impact of the Partner Agencies' operational and business model choices—and, in the case of a municipal retail approach, to determine the approximate revenue levels necessary for the Partner Agencies to service any debt incurred in building the network. (See Section 8 for a complete financial analysis.)

[25] Capital costs are distinct from ongoing operations and maintenance costs the Partner Agencies or the Partner Agencies and partners would incur.

[26] This assumption is based on take-rates we have seen in other communities where a new provider constructs a network that competes against an existing internet service provider). This take-rate is not guaranteed.

5.1 Survey Methodology for Developing Design and Cost Estimates

The network design and cost estimates presented below are underpinned by data and insight gathered by CTC engineers through discussions with the Partner Agencies' stakeholders and an extensive survey of the County's physical environment using online maps and photography (i.e., a "desk survey").

To develop estimates of per-mile costs for aerial infrastructure (attached in the communications space on utility poles) and per-mile costs for underground infrastructure where poles are not available, CTC's outside plant engineers performed a survey of the County via Google Earth Street View. The engineers reviewed available green space, pole congestion (which requires make-ready work to free up space for a new fiber attachment), and the need for pole replacements where make-ready alone cannot create space for a new attachment—all of which have been factored into the design and cost estimates.

CTC's outside plant engineers noted that the quality of the poles and pole attachments in the County vary, as they do in many cities and counties—but that overall, most of the poles along the primary electrical distribution path would support an additional attachment. In neighborhoods with aerial utilities, the poles tend to be older and may need to be upgraded to support additional attachments.

Figure 179, Figure 180, and Figure 181 show examples of poles in various conditions throughout the County.[27]

[27] Source: Google Earth Street View

Figure 179: Utility Pole Line Where Tree Trimming Is Needed

Figure 180: Congested Pole Where Make-Ready Will Be Required

Figure 181: Example of Low-Make-Ready Pole Lines

Based on our desk survey, we determined that Portland will be the most expensive part of the County in which to build—at an estimated fiber construction cost of $200,000 per mile—due to the prevalence of underground utilities and crowded rights-of-way and utility poles.

We assume the remaining cities and unincorporated parts of the County will have lower construction costs—an estimated cost of $150,000 per mile—because more of these areas have aerial utilities and the poles and rights-of-way are less congested.

If the Partner Agencies were to construct fiber only in the unserved portions of the County, we assume construction costs would be even lower because there are fewer existing attachments on the utility poles in those areas. We estimate a cost of $125,000 per mile for constructing fiber in the County's unserved areas.

5.2 Fiber-to-the-Premises Network Design

We developed a conceptual, high-level fiber-to-the-premises design that reflects the Partner Agencies' goals and is open to a variety of architecture options. The design assumes a combination of aerial and underground construction (whichever is more cost-effective along a given route) based on the placement of existing utilities.

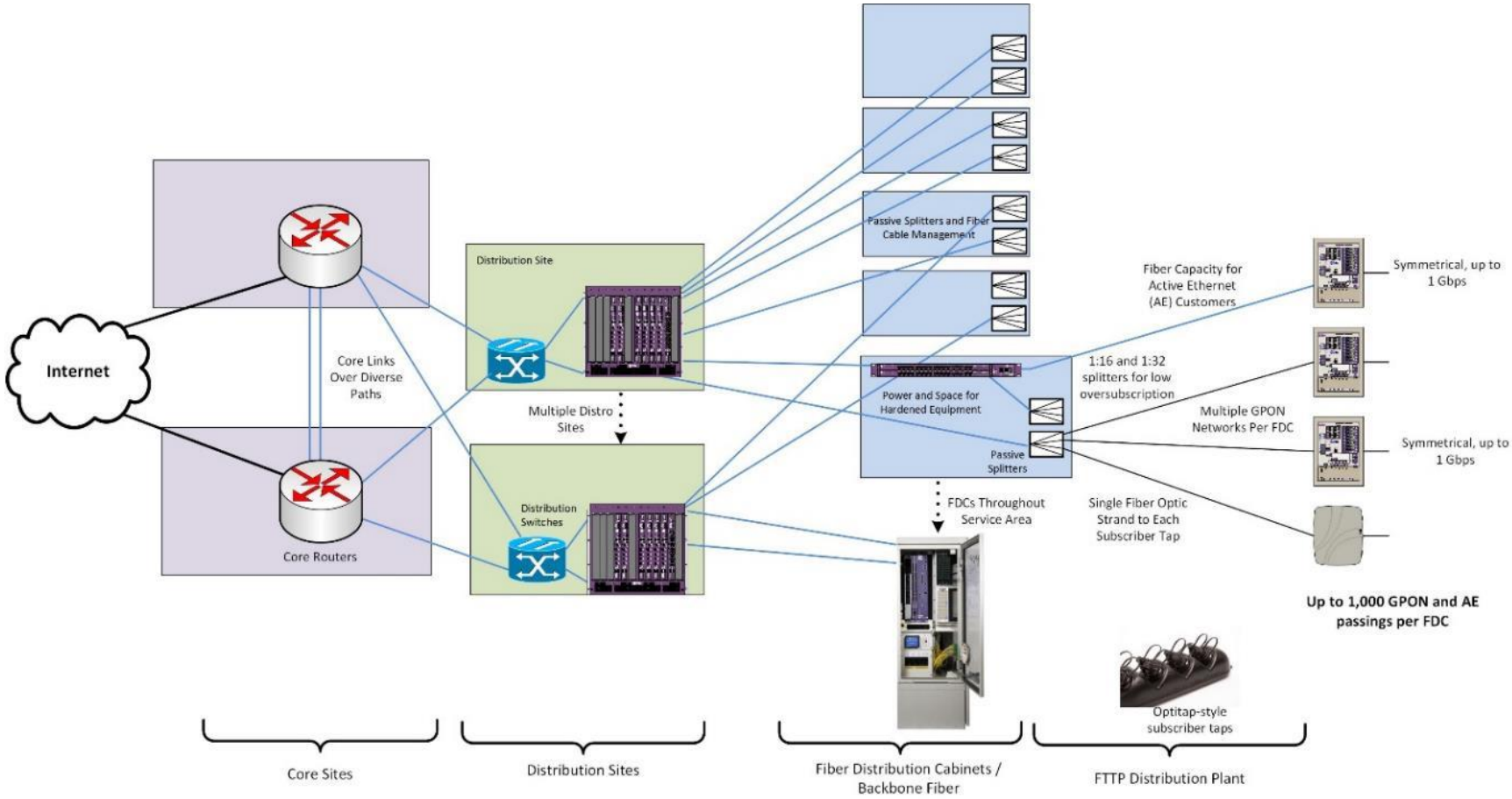
Figure 182, below, shows a logical representation of the high-level fiber-to-the-premises network architecture we recommend based on the conceptual design in this report. This design is open to a variety of architecture options.[28] The drawing illustrates the primary functional components in the fiber-to-the-premises 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 critical scalability and flexibility, both in terms of initial network deployment and its ability to accommodate the increased demands of future applications and technologies. The characteristics of this hierarchical fiber-to-the-premises data network are:

- **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
- **Resilient operation** – physical path diversity 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
- **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[29] 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)
- **Security** – controlled physical access to all equipment and facilities, plus network access control to devices

[28] 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.
[29] Open access networks allow multiple providers to offer services over the same network infrastructure.

Figure 182: High-Level Fiber-to-the-Premises Architecture



This architecture offers scalability to meet long-term needs. It is consistent with best practices for an open-access network model that may be required to support multiple network operators (depending on the Partner Agencies' business model), or at least multiple retail service providers requiring dedicated connections to certain customers. This design would support a combination of Gigabit Passive Optical Network (GPON) and direct Active Ethernet (AE) services (with the addition of electronics at the fiber distribution cabinets (FDC)), which would enable the network to scale by migrating to direct connections to each customer, or reducing splitter ratios, on an as-needed basis.

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 assumes the termination of standard lateral fiber connections within larger multi-tenant business locations and multi-dwelling units (MDU) such as apartment buildings.

5.2.1 Network Design Principles and Assumptions

The network design and cost estimates assume the Partner Agencies will:

- Use existing public land to locate two core hub facilities and up to 16 distribution hub facilities throughout the County. The cost estimate includes the facility itself, as well as the environmental and backup power systems needed to operate the network electronics and provide backhaul to the internet
- Construct a robust backbone network to connect to connect the core hub facilities to the distribution hubs—and the distribution hubs to new FDCs
- Construct fiber optics from FDCs to each residence and business that purchases service (i.e., from termination panels in the FDC to tap locations near the premises in the public right-of-way or on Partner Agencies' easements)
- Obtain easements or access rights to gated communities and private roads where public right-of-way do not exist
- Construct fiber laterals into large multi-tenant business facilities and MDUs

Multnomah County's population density varies from the denser central areas of the County to the low-density northeastern and western areas. It is important to construct a robust backbone that can serve the needs of the community in the future. The backbone should provide

redundancy where possible and extend to the outer edges of the County so that it will be near new subdivisions or other residential construction, which will enable service to be extended to these areas as they are built.

The backbone design could also be used to provide backhaul to wireless internet service providers that may be looking to deploy antenna sites where existing wireless service is inadequate or where fiber-to-the-premises services may not be cost-effective.

The fiber-to-the-premises network and service areas were defined based on the following criteria:

- Fiber will be installed in the communications space of utility poles where present, and in newly constructed conduit in underground areas
- The network will serve up to 288 passings per FDC in most areas, but 124 passings per FDC in the lower-density western part of the County
- The service area is the entire County
- Multiple FDCs will be installed per service area
- FDCs will be suitable to support hardened network electronics, backup power supplies, and an active heat exchange[30]
- The network design should avoid the need for distribution plant to cross major roadways and railways

Coupled with an appropriate network electronics configuration, this design would greatly increase the reliability of fiber services compared to services delivered by traditional cable and telephone networks. The backbone and hub design minimizes the average length of non-diverse distribution plant between the network electronics and each customer, thereby reducing the probability of service outages caused by a fiber break.

The access layer of the network, encompassing the fiber plant from the FDCs to the customers, dedicates a single fiber strand from the FDC to each passing; an optical splitter at the FDC combines the signals from 16 to 32 subscribers. This traditional fiber-to-the-premises design

[30] These hardened FDCs reflect an assumption that the County's operational and business model will require the installation of provider electronics in the FDCs 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 FDCs were replaced with passive FDCs (which would house only optical splitters) and the providers' electronics were housed only at the hub facility.

allows either network electronics or optical splitters in the FDCs, and offers scalability to meet long-term needs.

5.2.2 Network Core and Hub Site

The network core sites link the fiber-to-the-premises network to the public internet and deliver all services to end users. The proposed network design includes two core locations, based on the network's projected capacity requirements and the need for geographical redundancy (i.e., if one core site were to fail, the second core site would continue to operate the network).

The location of core network facilities also provides physical path diversity for subscribers and all upstream service and content providers. For the design and cost estimates, we assume the Partner Agencies' core sites will be housed in secure locations with diverse connectivity to the internet and the County's existing fiber optic network.

The core locations in this plan will house providers' operational support systems (OSS) such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for fiber-to-the-premises operations. The core locations are also where any business partner or content/service providers will gain access to the subscriber network with their own point-of-presence. (This may be via remote connection, but we recommend colocation.)

The core locations are typically run in a high-availability (HA) configuration, with fully meshed and redundant uplinks to the public internet and/or all other content and service providers. It is imperative that core network locations are physically secure and allow unencumbered access 24x7x365 to authorized engineering and operational staff.

The operational environment of the network core and hub locations is similar to that of a data center. This includes clean power sources, uninterruptible power source (UPS) batteries, and diesel power generation for survival through sustained commercial outages. The facility must provide strong physical security, limited/controlled access, environmental controls for humidity and temperature, and a fire suppression system.

Equipment is to be mounted securely in racks and cabinets, in compliance with national, state, and local codes. Equipment power requirements and specification may include 48 volt DC and/or 120/240 volt AC. All equipment is to be connected to conditioned/protected clean power with uninterrupted cutover to battery and generator power sources.

For the cost estimate, we assume the core facilities and distribution hubs will be located at existing Partner Agency facilities. Figure 183 is a photo of a sample hub facility.

Figure 183: Sample Hub Facility

5.2.3 Distribution and Access Network Design

The distribution network is the layer between the hubs and the FDCs. (The FDCs then provide the access links to the subscribers' taps.) The distribution network aggregates traffic from the FDCs to the core. Fiber cuts and equipment failures have progressively greater operational impact as they happen closer to the network core, so it is critical to build redundancies and physical path diversities in the distribution network, and to seamlessly re-route traffic when necessary.

The distribution and access network design proposed in this report is flexible and scalable enough to support two different architectures:

1. Housing both the distribution and access network electronics at the hub, and using only passive devices (optical splitters and patches) at the FDCs
2. Housing the distribution network electronics at the hub and pushing the access network electronics further into the network by housing them at the FDCs

By housing all electronics at the hub, the network will not require power at the FDCs. Choosing a network design that only supports this architecture may reduce costs by allowing smaller, passive FDCs in the field. However, this architecture will limit the redundancy capability from the FDCs to the hubs.

By pushing the network electronics further into the field, the network gains added redundancy by allowing the access electronics to diversely connect to the hub. In the event of a fiber outage on one link, the subscribers connected to the affected FDC would still have network access.

A design that supports both models would allow the Partner Agencies to accommodate many different service operators and their network designs. This design would also allow service providers to start with a small deployment (i.e., place electronics only at the hub site, and grow by pushing electronics closer to their subscribers).

5.2.3.1 Access Network Technologies

FDCs can sit on a curb (Figure 184), be mounted on a pole, or reside in a building. The model proposed here recommends installing sufficient FDCs to support higher-than-anticipated levels of subscriber penetration. This approach will accommodate future subscriber growth with minimal re-engineering. Passive optical splitters are modular and can be added to an existing FDC as required to support subscriber growth, or to accommodate unanticipated changes to the fiber distribution network with potential future technologies.

Figure 184: Sample Fiber Distribution Cabinet

The fiber-to-the-premises design also includes the placement of indoor FDCs and splitters to support MDUs. This would require obtaining the right to access the equipment for repairs and installation in whatever timeframe is required by the service agreements with the customers. Lack of access would potentially limit the ability to perform repairs after normal business hours, which could be problematic for both commercial and residential services.

In this model, we assume the use of GPON electronics for most subscribers and AE for a very small percentage of subscribers (typically high-end business customers) that request a premium service or require greater bandwidth. GPON is the most commonly provisioned fiber-to-the-

premises service—used, for example, by AT&T Fiber, Verizon (in its Fios systems), Google Fiber, and Chattanooga EPB.

Further, providers of gigabit services typically deliver these services on GPON platforms. Even though the GPON platform is limited to 1.2 Gigabits per second (Gbps) upstream and 2.4 Gbps downstream for the subscribers connected to a single PON segment, operators have found that the variations in actual subscriber usage generally means that all subscribers can obtain 1 Gbps on demand (without provisioned rate-limiting), even if the capacity is aggregated at the PON. Further, many GPON manufacturers have a development roadmap to 10 Gbps and faster speeds as user demand increases.

GPON supports high-speed broadband data and is easily leveraged by triple-play carriers for voice, video, and data services. The GPON optical line terminal (OLT) uses single-fiber (bi-directional) small form-factor pluggable (SFP) modules to support multiple (most commonly less than 32) subscribers.

GPON uses passive optical splitting, which is performed inside the FDC, to connect fiber from the OLTs to the customer premises. The FDCs house multiple optical splitters, each of which splits the fiber link to the OLT between 16 to 32 customers (in the case of GPON service).

AE provides a symmetrical (up/down) service that is commonly referred to as Symmetrical Gigabit Ethernet. AE can be provisioned to run at sub-gigabit speeds, and—like GPON—easily supports legacy voice, Voice over Internet Protocol (VoIP), and video. AE is typically deployed for customers who require specific service level agreements that are easier to manage and maintain on a dedicated service.

For subscribers receiving AE service, a single dedicated fiber goes directly to the subscriber premises with no splitting. Because AE requires dedicated fiber (also known as “home-run fiber”) from the OLT to the customer premises equipment, and because each subscriber uses a dedicated SFP on the OLT, there is a significant cost difference in provisioning an AE subscriber versus a GPON subscriber.

The fiber plant is designed to provide AE service or PON service to all passings. The network operator selects electronics based on the mix of services it plans to offer, and can modify or upgrade electronics to change the mix of services.

5.2.3.2 Expanding the Access Network Bandwidth

GPON is currently the most commonly provisioned fiber-to-the-premises technology, due to inherent economies when compared with technologies delivered over home-run fiber[31] such as AE. The cost differential between constructing an entire network using GPON and AE is 40 to 50 percent.[32] GPON is used to provide services up to 1 Gbps per subscriber and is part of an evolution path to higher-speed technologies that use higher-speed optics and wave-division multiplexing (WDM).

This model provides many options for scaling capacity, which can be done separately or in parallel:

1. Reducing the number of premises in a PON segment by modifying the splitter assignment and adding optics would increase capacity—for example, reducing the split from 16:1 to 4:1 would quadruple the per-user capacity in the access portion of the network.

2. Adding higher-speed PON protocols can be accomplished by adding electronics at the FDC or hub locations; since these use different frequencies than the GPON electronics, none of the other customer premises equipment would need to be replaced.

3. Adding WDM-PON electronics as they become widely available would enable each user to have the same capacity as an entire PON; again, these use different frequencies than GPON and are not expected to require replacement of legacy customer premises equipment.

4. Replacing a PON segment with a 1:1 connection to electronics would take Option 1 to the maximum,—an AE configuration.

These upgrades would all require complementary upgrades in the backbone and distribution Ethernet electronics, as well as in the upstream internet connections and peering—but they would not require increased fiber construction.

5.2.3.3 Customer Premises Equipment and Subscriber Services

In the final segment of the fiber-to-the-premises network, fiber runs from the FDC to customers' homes, apartments, and office buildings, where it terminates at the subscriber tap—a fiber optic housing located in the public right-of-way close to the premises. The service installer uses a pre-connectorized drop cable to connect the tap to the subscriber premises without the need for fiber optic splicing.

---

[31] Home-run fiber is a fiber optic architecture in which individual fiber strands are extended from the distribution sites to the premises. Home-run fiber does not use any intermediary aggregation points in the field.

[32] "Enhanced Communications in San Francisco: Phase II Feasibility Study," CTC report, October 2009, at p. 205.

The drop cable extends from the subscriber tap (either on the pole or underground) to the building, enters the building, and connects to customer premises equipment.

5.3 Countywide Fiber-to-the-Premises Cost Estimate

Assuming a take-rate (i.e., the percentage of residents and businesses that subscribe to the service) of 35 percent, the full fiber-to-the-premises network deployment would cost about $970 million, inclusive of outside plant construction labor, materials, engineering, permitting, network electronics, drop installation, customer premises equipment, and testing (Table 24).

Table 24: Estimated Countywide Fiber-to-the-Premises Cost

Cost Component	Total Estimated Cost (Rounded)
Outside Plant	$668 million
Central Network Electronics	$66 million
Fiber-to-the-Premises Service Drop and Lateral Installations	$164 million
Customer Premises Equipment	$68 million
Total Estimated Cost:	$966 million

Actual capital costs (both for the full fiber-to-the-premises network described here and the limited deployment to pass unserved premises, described below) may vary due to factors that cannot be precisely known until a detailed design is completed, or until construction commences. These factors include:

1. Costs of private easements;
2. Utility pole replacement and make-ready costs;
3. Variations in labor and material costs; and
4. Subsurface hard rock.

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

5.3.1 Cost per Passing

On a per-passing basis, the lit fiber-to-the-premises deployment will cost about $1,710—an average similar to costs in other communities with a high percentage of underground infrastructure and relatively high housing density.

As indicated above, the cost estimate assumes a 35 percent take-rate, which is within the range that may be feasible for a new entrant in a market like Multnomah County where both the cable and telephone companies already provide broadband service. The financial analysis in Section 8 discusses the impact of take-rate in additional detail.

The total cost of operations will also vary with the business model chosen and the amount and nature of existing infrastructure and other resources that can be leveraged by the Partner Agencies and any potential business partners.

5.3.2 Outside Plant Cost Estimation Methodology

As with any utility, the design and associated costs for fiber-to-the-premises 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 are further varied by soil conditions, such as the prevalence of subsurface hard 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.

To estimate costs, we extrapolated the costs for each City and the unincorporated areas of the County based on our outside plant desk survey. Table 25(below) outlines the cost by area, assuming a 35 percent take-rate.

The actual cost to construct fiber-to-the-premises to every premises in the County 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. Alternatively, if the Partner Agencies could partner with a local telecommunications provider and overlash to existing pole attachments, the cost of the build could be significantly lower. Further and more extensive analysis would be required to develop a more accurate cost estimate across the entire County.

Table 25: Fiber-to-the-Premises Costs by Jurisdiction

Jurisdiction	Street Miles	Passings	Passings per Mile	Outside Plant Cost	Outside Plant Cost per Passing	Core Equipment Cost	Distribution Electronics	Subscriber Costs	Total Cost
Fairview	42.3	2,176	51	$6,343,050	$2,915	$217,600	$152,320	$1,294,720	$8,290,570
Gresham	323.8	45,417	140	$48,565,350	$1,069	$4,541,700	$3,179,190	$27,023,115	$89,213,565
Portland	2,615.3	327,011	125	$523,067,800	$1,600	$32,701,100	$22,890,770	$194,571,545	$815,742,645
Troutdale	68.5	6,440	94	$10,279,200	$1,596	$644,000	$450,800	$3,831,800	$16,043,000
Wood Village	17.2	944	55	$2,583,300	$2,737	$94,400	$66,080	$561,680	$3,428,180
Unincorporated Served	220.8	5205	24	$33,119,400	$6,363	$520,500	$364,350	$3,096,975	$37,101,225
Unincorporated Unserved	355.0	2,800	8	$44,375,000	$15,848	$280,000	$196,000	$1,666,000	$46,517,000
Countywide	**3,643.0**	**389,993**	**107**	$668,333,100	**$1,710**	$38,999,300	$27,299,510	$232,045,835	$966,422,165

5.3.3 Outside Plant Costs

The estimated cost to construct the outside plant portion of the candidate fiber-to-the-premises network is approximately $668 million, or $1,710 per passing.[33] As discussed above, the model assumes a mixture of aerial and underground fiber construction, depending on the construction of existing utilities in the area as well as the state of any utility poles, existing infrastructure, and construction within the communications space on utility poles. Table 26 provides a breakdown of the estimated outside plant costs. (Note that the costs have been rounded.)

Table 26: Estimated Outside Plant Costs

Jurisdiction	Street Miles	Passings	Passings Per Mile	Outside Plant Cost	Outside Plant Cost per Passing
Fairview	42.3	2,176	51	$6,343,050	$2,915
Gresham	323.8	45,417	140	$48,565,350	$1,069
Portland	2,615.3	327,011	125	$523,067,800	$1,600
Troutdale	68.5	6,440	94	$10,279,200	$1,596
Wood Village	17.2	944	55	$2,583,300	$2,737
Unincorporated Served	220.8	5,205	24	$33,119,400	$6,363
Unincorporated Unserved	355.0	2,800	8	$44,375,000	$15,848
Countywide	**3,643.0**	**389,993**	**107**	**$668,333,100**	**$1,710**

5.3.3.1 Aerial and Underground Construction Approach

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 generally known, with the

[33] The passing count treats individual single-unit buildings and units in small multi-dwelling and multi-business buildings as single passings. It treats larger buildings as single passings.

exception of unknown economies of scale and inflation rates, and barring any sort of phenomenon restricting material availability and costs. The labor costs associated with the placement of fiber were estimated based on similar construction projects.

Aerial construction entails the attachment of fiber infrastructure to existing utility poles, which could offer significant savings compared to all-underground construction, but increases uncertainty around cost and timeline. Costs related to pole remediation and make-ready construction can make aerial construction cost-prohibitive in comparison to underground construction.

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

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 and the prevalence of subsurface hard rock—neither of which can be fully mitigated without physical excavation and/or testing.

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 consist 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.

5.3.3.2 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 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.

- ***Fiber-to-the-Premises Service Drop and Lateral Installations*** – consists of all costs related to fiber service drop installation, including outside plant construction on private property, building penetration, and inside plant construction to a typical backbone network service "demarcation" point; also includes all materials and labor related to the termination of fiber cables at the demarcation point. A take-rate of 35 percent was assumed for standard fiber service drops.

5.3.4 Central Network Electronics Costs

Central network electronics will cost an estimated $118 million, or $300 per passing, based on an assumed take-rate of 35 percent.[34] (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 central network electronics consist of the electronics to connect subscribers to the fiber-to-the-premises network at the core and cabinets. Electronics are subject to a seven- to 10-year replacement cycle, as compared to the 20- to 30-year lifespan of a fiber investment.

5.3.4.1 Core Electronics

The core electronics connect the distribution electronics and connect the network to the internet. The core electronics consist of high performance routers, which handle all the routing on the fiber-to-the-premises network and to the internet. The core routers should have modular

[34] The take-rate affects the electronics and drop costs, but also may affect other parts of the network, as the County may make different design choices based on the expected take-rate. A 35 percent take-rate is typical of environments where a new provider joins the telephone and cable provider in a County. In CTC's financial analysis, we will examine how the feasibility of the project depends on a range of take-rates.

chassis to provide high availability in terms of redundant components and the ability to "hot swap" line cards and modular routers in the event of an outage.[35] Modular routers also provide the ability to expand the routers as demand for additional bandwidth increases.

The cost estimate assumes running networking protocols, such as hot standby routing protocol (HSRP), to ensure redundancy in the event of a router failure. Additional connections can be added as network bandwidth on the network increases. The core sites would tie to the distribution electronics using 100 Gbps links. The links to the distribution electronics can 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 100 Gbps connections to ISPs that connect the fiber-to-the-premises network to the internet.

These costs do not include the service provider's OSS, such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for fiber-to-the-premises operations. The service providers may already have these systems in place.

5.3.4.2 Distribution Electronics

The distribution network electronics aggregate the traffic from the FDCs and send it to the core electronics to access the internet. The distribution electronics consist of high-performance aggregation switches, which consolidate the traffic from the access electronics and send it to the core for route processing. The distribution switches are typically modular switch chassis that can accommodate line cards for aggregation. The switches should also be modular to provide redundancy in the same manner as the core switches.

The cost estimate assumes that the aggregation switches connect to the access network electronics with 10 Gbps links to each distribution switch. The aggregation switches would then connect to the core switches over single or multiple 10 Gbps and 40 Gbps links as needed to meet the demand of the fiber-to-the-premises users in each service area.

5.3.4.3 Access Electronics

The access network electronics at the FDCs connect the subscribers' customer premises equipment to the fiber-to-the-premises network. We recommend deploying access network electronics that can support both GPON and AE subscribers to provide flexibility within the FDC service areas. 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

[35] 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.

reduce initial capital costs while the network is under construction or during the rollout of the network.

The access network electronics costs are based on a take-rate of 35 percent and include optical splitters at the FDCs for that take-rate.

5.3.5 Customer Premises Equipment and Service Drop Installation (Per Subscriber Costs)

Customer premises equipment is the subscriber's interface to the fiber-to-the-premises network. For this cost estimate, we selected customer premises equipment that provide only Ethernet data services (however, there are a wide variety of customer premises equipment offering other data, voice, and video services). Using the assumed take-rate of 35 percent, we estimated the cost for subscriber customer premises equipment will be approximately $68 million.

Each activated subscriber would also require a fiber drop cable installation and customer premises electronics, which would cost roughly $1,200 per subscriber, or $232 million total—again, assuming a 35 percent take-rate.

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. We estimate an average of $1,200 per drop installation.

The other per-subscriber expenses include the cost of the optical network terminal (ONT) at the premises, a portion of the OLT costs at the hub, the labor to install and configure the electronics, and the incidental materials needed to perform the installation. The numbers provided in Table 27, below, are averages and will vary depending on the type of premises and the internal wiring available at each premises.

Table 27: Per Subscriber Cost Estimates

Construction and Electronics Required to Activate a Subscriber	Estimated Average Cost
Drop Installation and Materials	$1,200
Subscriber Electronics (ONT)	$300
Electronics Installation	$100
Installation Materials	$100
Total	**$1,700**

5.4 Constructing Fiber-to-the-Premises Only to Unserved Areas of the County Would Cost $47 Million—or Six Times the Per-Passing Cost of a Countywide Network

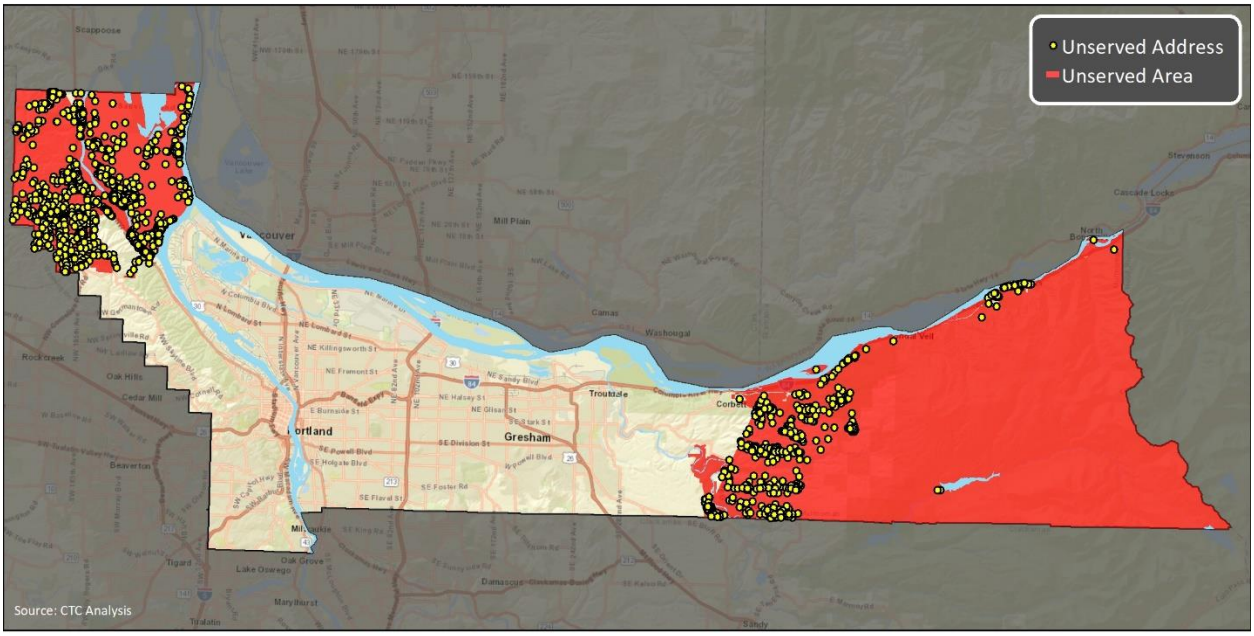
Taking a step back from the ubiquitous countywide fiber-to-the-premises network design, we analyzed the cost to serve only unserved areas of the County. In other words, we focused on the cost to deploy fiber where no wireline infrastructure capable of delivering services that meets the federal and state definitions of broadband passes[36] homes and businesses—meaning there is no cable or fiber plant in the right-of-way adjacent to the property.

We identified these unserved areas through a desk survey, in which a CTC outside plant engineer analyzed Google Earth Street View maps where available—searching images of miles of County roadways for the presence (or lack thereof) of broadband infrastructure such as cable attachments on poles (for aerial construction) and handholes and pedestals (for underground construction).

Our mapping and analysis identified approximately 2,800 homes and businesses unserved by wireline providers—geographically isolated in the County's far-northwest agricultural areas and forested eastern areas. Figure 185 shows the areas we determined to be unserved.

[36] 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.

Figure 185:Unserved Areas of Multnomah County



To serve its unserved homes and businesses, the Partner Agencies would need to spend $47 million to build a fiber-to-the-premises network, assuming a 35 percent take-rate. Table 28 outlines the costs below—including the almost-$16,000 per-passing cost, which is about six times the per-passing cost for the ubiquitous fiber-to-the-premises model.

Table 28: Unserved Areas Fiber-to-the-Premises Costs

Jurisdiction	Street Miles	Passings	Passings Per Mile	Outside Plant Cost	Outside Plant Cost per Passing	Equipment Cost	Subscriber Costs	Total Cost
Unserved	355.0	2,800	8	$44,375,000	$15,848	$476,000	$1,666,000	$46,517,000

6 Targeted Wireless Solutions Could Be an Effective Way to Deliver Broadband to Residents Who Cannot Afford Commercial Services

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 wireless approaches to meet the most critical broadband needs in the short term—in particular, providing basic connectivity to lower-income residents who may otherwise have no affordable options.

We examined two conceptual approaches for targeted broadband—Wi-Fi and fixed wireless—using wireless technologies that can be scaled to accommodate a wide budgetary range, can be deployed relatively quickly, are impactful at any funding level, and leverage existing infrastructure to expand reach and reduce deployment timeframes. These targeted broadband solutions cannot deliver ubiquitous coverage or fiber-like capacity, but they could provide a lifeline reaching across the digital divide to facilitate distance learning for students, job searches, access to government services, and access to healthcare professionals in the ongoing pandemic crisis.

6.1 Tactical Deployments of Wi-Fi Hotspots Could Meet the Most Basic Connectivity Needs Leveraging Existing Infrastructure

Strategically placed Wi-Fi hotspots throughout the County, particularly in low-income areas, is a least-cost solution with high impact, leveraging existing County and municipal fiber and facility assets to provide reliable internet access in close proximity to all residents.

Local governments nationwide use this approach to deliver public-amenity Wi-Fi, often in shopping districts and public gathering spots. For example, New York City delivers free Wi-Fi via its Link NYC kiosks and San Francisco offers free Wi-Fi in parks and other areas. The same technical approach would achieve a digital inclusion benefit if the County were to install hotspots in close proximity to residents' homes (assuming that County-owned fiber is accessible nearby). And it could be a partner, rather than the government, that makes free Wi-Fi available; In Seattle, during the Covid-19 pandemic, Comcast has opened its outdoor Wi-Fi hotspots for free public use.[37]

The County can install wireless access points at any or all of its over 600 government, schools, and library locations where members of the community can connect to the internet using their own mobile devices in a relatively safe environment from their vehicles or in outdoor spaces. In addition, the Partner Agencies could allow community sponsors who have an internet connection

[37] "Where to go for Free Access to Computers and the Internet," Seattle Information Technology, https://www.seattle.gov/tech/services/internet-access/free-access-to-computers-and-the-internet (accessed September 8, 2020).

to also host access points.[38] These community sponsors could be non-profit agencies, religious institutions, and community centers such as the Boys and Girls Club or the YMCA.

For our cost estimate we assumed that each location would require an average of two wireless access points mounted on the outside of each building with directional antennas to target the outdoor spaces and parking lots of the building. A power-over-Ethernet switch would provide power to each access point as well as tie into the building's existing internet connection. Residents would be able to use the outdoor spaces to access the internet, such as pulling up in a car or sitting in the outdoor space.

Figure 186: Public Wi-Fi at Community Locations

The model assumes that the County would manage and maintain the network at a best-effort level. The wireless access points would be managed by a central cloud management system that would allow the County to use a single Service Set Identifier (SSID), or Wi-Fi name, so that the service is easily identifiable by the community across locations, and would support access control through County-managed accounts (if desirable) and bandwidth limits per user and per site. The County would be able to manage wireless access policies remotely to keep the internet traffic separate from internal networks, enforce bandwidth limits per user and/or per site, and restrict certain applications, regardless of whether the access point is connected to the County's network or another internet connection.

[38] The sponsors would need to have connections that allow them to provide free Wi-Fi

The estimated cost per location is $4,700. This includes electronics, installation, configuration, and maintenance contracts that provide hardware replacements and cloud-based management services for three years. Table 29 breaks downs the costs per location.

Table 29: Wireless Access Point Costs per Location

Name	Description	Unit Cost	Units	Subtotal
Switch	8-port POE layer 2 switch such as the Meraki MS120-8 LP.	$700	1	$700
Wireless Access Point	802.11ac compatible using MU-MIMO antennas at 5 GHz and 2.4 GHz. POE-powered. Such as the Meraki MR-74.	$600	2	$1,200
Access Point Licensing	Licensing for each access point to be controlled by the centralized cloud management platform for three years.	$200	2	$400
Wireless Antennas	Directional antennas at 2.4 GHz and 5 GHz.	$100	4	$400
Wireless Installation	Includes Cat 6 wiring to the access point with cabling raceways. Access point mounting, configuration, and integration with the management system.	$1,000	2	$2,000
			Total	**$4,700**

The County can scale the program as budgets and need require. For example, if the County were to use its 600 government, schools, and library locations, the effort would cost $2.8 million and would support many thousands of concurrent users (limited primarily by the size of the physical spaces available). This assumes use of existing County and municipal fiber backhaul from each site and existing internet capacity. However, the County could target areas of greatest need and reduce the overall cost of the free public Wi-Fi system.

The County could also establish a program to allow community groups to apply to host the free public wireless system. The County could supply the equipment and install the electronics to allow approved community groups to provide free public Wi-Fi while still being managed be the County. The hosting organization would take on the role of providing space, internet, and power to support the network while the County would control the network policies allowed on the Wi-

Fi system. Approved organizations would need to have an internet connection with terms of service that allow the agency to provide free public Wi-Fi.

6.2 Fixed Wireless Could Serve About 25 Percent of Residents in the County's Low-Income Census Block Groups

The Partner Agencies could consider a fixed wireless network to deliver broadband services to targeted areas of the community that are most in need. The goal would be to provide an affordable or no-cost alternative even where service availability is not a barrier.

While fixed-wireless technologies continue to evolve, this approach has precedents. In rural Garrett County, Maryland, for example, the County Council approved a contract with a private partner to leverage county-owned fiber and additional public funding to support the deployment of a fixed-wireless network to bring service to as many as 3,000 then-unserved homes in the most remote parts of the county.[39]

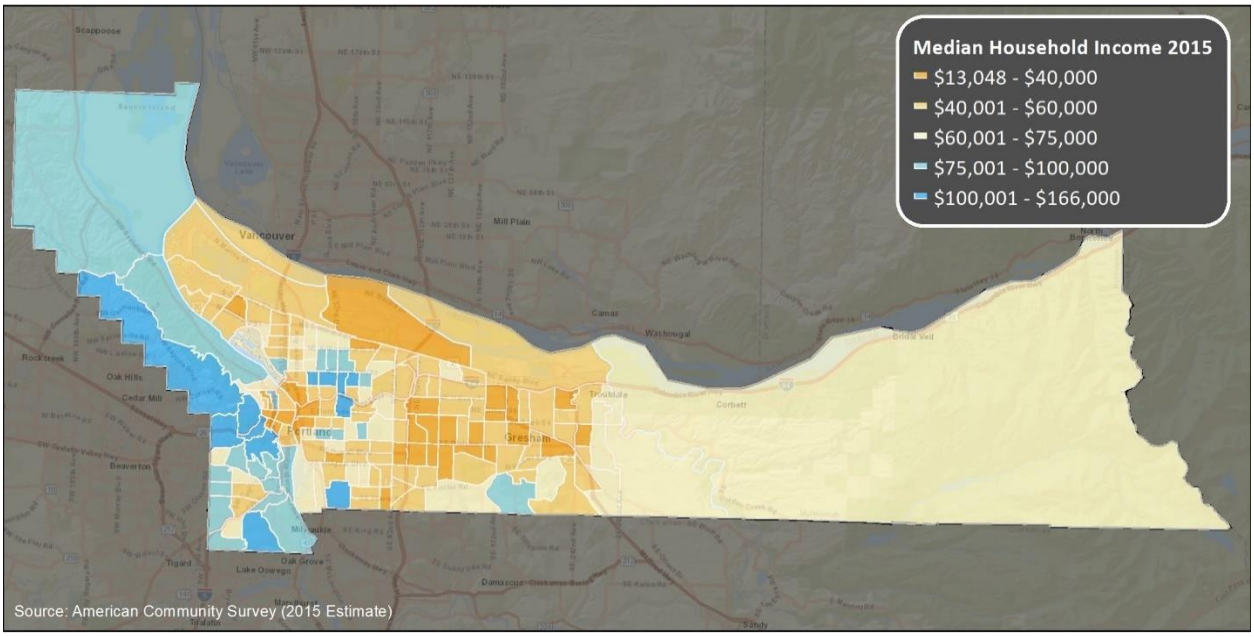
To evaluate this option for the Partner Agencies, CTC's engineers developed a fixed wireless network model to assess the viability of serving the County's lowest income areas using existing siting locations (towers or tall buildings) within the County.

Our analysis found that, although it would have clear technical limitations relative to a fiber optic network, a fixed wireless network may be able to provide service to approximately 25 percent of residents throughout the lower income areas of the County—a figure that takes into account the achievability of wireless coverage using non-commercial wireless spectrum and service eligibility criteria likely based on federal poverty level, eligibility under the National School Lunch Program (NSLP), similar criteria.

In total, we estimate this could encompass approximately 13,000 of the households in census block groups having the lowest average median income level in the range of $13,048 to $40,000 (Figure 187) for an estimated deployment cost of approximately $36 million, or approximately $2,700 per home.

[39] "Rural Broadband Expansion," Garrett County, Maryland, https://www.garrettcounty.org/broadband (accessed September 8, 2020).

Figure 187: Median Household Income Map for Multnomah County



The network would leverage existing siting locations where available, and would require new construction of mounting structures (towers and/or utility poles) where needed. Our model assumes the requirement for approximately three towers per square mile to provide capacity and coverage of the neighborhoods. It would use point-to-point wireless connections for backhaul connections back to locations where the County has fiber to provide backhaul to the internet.

6.2.1 Overview of Fixed Wireless Analysis

We developed a fixed wireless network scenario for serving Multnomah's County's lowest average median income neighborhoods using existing towers and other elevated mounting assets, where available. Table 30 summarizes the cost of the network and conservatively assumes that new structures will be needed for all locations.

Table 30: Fixed Wireless Analysis Results

Number of Towers	Estimated Number of Homes Eligible for the Service and can Receive Coverage	Capital Cost	Average Distribution Network Cost per Connected Passing	Installation and Customer Premises Equipment Cost per Customer
36	13,000	$35.6 million	$940	$1,800

Although there are technological limitations relative to a fiber optic service (as well as higher operational costs and a shorter technology lifetime), 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; therefore these technologies are a better option now than they were in the recent past.

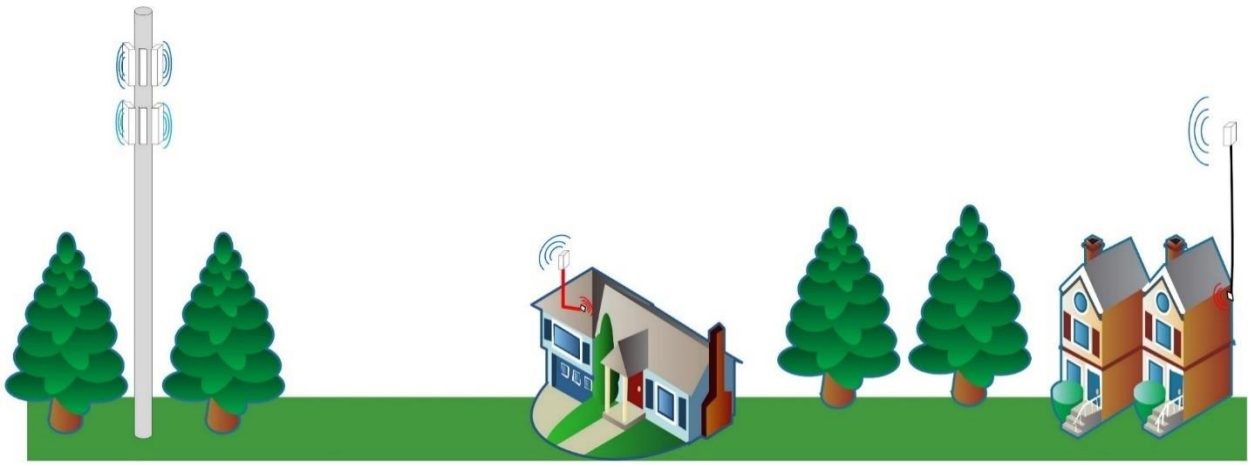
The following sections provide a high-level introduction to fixed wireless connectivity (including technologies, basic architecture, spectrum, and elements of costs) and describe the use of existing and new structures to deploy a fixed wireless solution for the County's residents who cannot afford traditional wireline internet services.

6.2.2 Introduction to Fixed Wireless Network Connectivity

Broadband speeds are more readily achievable using fixed wireless networks without the benefit of commercial wireless radio spectrum than in the past, owing to the recent introduction of the Citizens Broadband Radio Service (CBRS) spectrum into the market and new wireless technologies. However, foliage and other buildings are still a significant obstacle to service, and the variation in the line of sight in a service area corresponds to a wide variation in the quality of service to individual customers.

As opposed to an underground or aerial cable, wireless broadband is delivered via access point antennas mounted on towers or rooftops. Customers' antennas may be mounted on a customer's premises (e.g., the rooftop) to obtain line of sight back to the access point (Figure 188).

Figure 188: Sample Fixed Wireless Network



6.2.3 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 unlicensed technology have channel widths capable of delivering broadband speeds (25 Mbps downstream and 3 Mbps upstream)—so those are the two bands we considered for the model. Compared to TVWS, antenna heights are not limited by FCC rules, and CBRS provides the unique benefits of higher transmission power limits and lower likelihood of interference than unlicensed frequencies. [40]

TVWS 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 was not considered feasible. Also, because white space technology is still in an early stage of development, compatible equipment is far more expensive than other off-the-shelf wireless equipment. Finally, because Multnomah County has many existing broadcast television channels, the potential TVWS spectrum may be limited.

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. This can be a problem in areas with dense vegetation or multiple tall buildings. The County would need to lease space at or near the tops of towers; even then, some residents 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 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

[40] CBRS channels may be preempted by incumbent users, such as the U.S. military, at unpredictable times, temporarily reducing the spectrum availability. The impact of this preemption has not yet been document in detail in broadband networks and depends on movements of the Navy fleet and its use of radar. The impact would likely only be on parts of the spectrum and would slow, rather than shut off, CBRS services.

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 cost estimate in this document assume point-to-multipoint equipment, which is typical for a residential or small business connection.

6.2.4 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 uses 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 the County cannot get an adequate connection through point-to-point wireless technologies back to the County's existing fiber locations than additional fiber construction would be required
- **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 in the form of equipment and technology refresh.
- **Availability of unobstructed line of sight:** Most wireless networking equipment requires a clear, or nearly clear, line of sight between antennas for optimum performance; the County will need to lease space near the tops of radio towers, to cover the maximum number of premises with each base station

CTC determined that the lower income neighborhoods would need three siting locations per square mile, owing mostly to capacity needs in these relatively higher density areas of the County. Where existing commercial towers or building rooftops are not available to provide coverage and capacity, additional towers would be required. New towers typically cost around $150,000 each, not including any costs for purchasing land to site the tower. To create a conservative cost estimate, CTC assumed new towers would be constructed at each siting location. CTC also assumed each siting location would use both CBRS and 5 GHz fixed wireless frequency band options. We based our analysis on the following assumptions:

- Broadcast power would be at the maximum FCC limit
- Channel bandwidth would be 10 MHz for the CBRS band
- Subscriber equipment antennas would be placed at 4.57 meters (15 feet) above the ground
- All served addresses will require the installation of subscriber equipment
- Towers will be configured with four sectors for each frequency used
- Towers will be connected to backhaul using microwave links back to a location where the County can provide fiber connectivity
- Engineering and design costs include propagation studies, RF path analysis for point-to-point connections, structural analysis, construction plans, permits
- Site acquisition costs include 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
- Core network equipment to manage functions such as authentication, billing, security, and connection to the internet would cost $1.3 million (including the equipment and setup of a core)
- The costs outlined are capital costs only and do not include operational costs

6.2.5 High-Level Coverage and Cost Estimate

Based on the lowest median income level group of less than $40,000, we determined there are more than 54,000 homes and businesses in these census block groups, which cover an area of 12 square miles. Assuming the need for three towers per square mile, the fixed wireless network would need approximately 36 siting locations, which we assumed would be newly constructed towers (though they could also be existing towers or tall buildings).

Assuming that approximately 25 percent of homes are eligible for the service and can also receive coverage, the network could serve approximately 13,000 homes. Between the CBRS and 5 GHz radios, the network would serve approximately 50 homes per base station radio to achieve reasonable levels of oversubscription for delivery of broadband service at speeds of at least 25 Mbps. Where additional capacity is needed, additional radios could be added to a tower to increase capacity.

Table 31 and Table 32 illustrate the cost estimates.

Table 31: Capital Cost Estimate for Fixed Wireless Deployment

Item	Cost
Network Core	$1.3 million
Access Point Equipment	$1.1 million
Microwave Backhaul	$0.5 million
Installation, Engineering, and Design	$2.5 million
Site Acquisition (36 New Tower Locations)	$1.4 million
Tower Construction	$5.4 million
Total Distribution Network Costs	**$12.2 million**
Total Addresses	13,000
Cost per Unserved Address (Distribution Network Only)	**$940**

Table 32: Cost to Serve 25% of Households in Census Block Groups Below $40,000 Median Household Income (Fixed Wireless Model)

Item	Cost
Total Distribution Network Cost	$12.2 million
Total Incremental Customer Costs (13,000 @ $1,800 per Customer)	$23.4 million
Total	**$35.6 million**

7 Overview of Alternative Fiber Network Business Models

The fiber network cost estimates described above reflect the Partner Agencies' potential capital investment for a municipal retail business model (i.e., a scenario in which the Partner Agencies construct, own, and operate the network), but there exist other potential business models in which the Partner Agencies would build infrastructure for lease to one or more private lessees.

In this model, localities create hybrid arrangements where a locality and private partner find a creative way to share the capital, operating, and maintenance costs of a broadband network. Most commonly, a locality will finance, build, and maintain extensive fiber optics, reaching all or most of its residents and businesses, and then partner with a company that is willing to pay for access to that fiber and to those potential customers. The locality's risk is limited to the fiber—a long-term, future-proof asset—while the private company can enter the market quickly and without incurring the construction risk and capital expense of building the fiber network itself.

In these ways, an arrangement based on shared investment and risk plays to the strengths of both the public and private sector partners. Most localities consider fiber-to-the-premises deployment not as a moneymaker, but as a powerful tool for equity, education, and economic development. Thus, in a collaborative model, the risk is shared, but the community still receives 100 percent of the benefits it seeks—though at a potentially high cost (and recognizing that the benefits do not all appear on the project's financial statements). For the private partner, a shared investment means less upfront capital, with an opportunity for future revenues.

In this way, the collaboration model shares risk and responsibility between the public sector and a private partner. In most of these partnerships, the public entity funds, builds, and owns the basic infrastructure (typically dark fiber) and the private entity does the rest: it provides the electronics and service over the infrastructure and deals with the complexities of running a broadband business. The level of risk (and potential reward) can be calibrated under the partnership terms to suit local conditions and community goals.

The model leverages the best capabilities of the public and private sectors. Localities do what they've done for decades: finance and build basic infrastructure, manage rights-of-way, and maintain that infrastructure over time—ensuring that all residents benefit. Private entities do what they traditionally do well: run a business, engage in sales and marketing, handle customer service, and adapt to changing technologies and customer preferences.

The most common variation on this approach is the **dark fiber model**, wherein the public entity focuses only on building out a ubiquitous fiber network to all premises in the community. The locality's risk is limited to the fiber—a long-term, future-proof asset—while the private company can enter the market quickly and without incurring the construction risk and capital expense of

building the fiber network itself. In the dark fiber model, the locality is responsible for the physical fiber plant. This includes constructing the network, responding to and repairing fiber breaks, constructing and splicing new fiber, and performing ongoing maintenance tasks. Building and maintaining a dark fiber network also requires access to poles and/or conduit. The service provider lights the fiber and provides services, including the electronics at the customer premises (known as customer premises equipment or CPE). When a new subscriber takes service, infrastructure provider is typically also responsible for providing the "drop" from street to a network interface device at the premises.

The pioneering public networks in Westminster, Maryland, and Huntsville, Alabama, are examples of the dark fiber collaboration model.

In an **open conduit model,** the public infrastructure provider is responsible for the physical conduit plant. This typically includes constructing the conduit network, responding to and repairing any conduit breaks, maintaining network documentation, and providing access points for the service provider. The service provider does the rest, pulling fiber through the conduit, lighting the fiber, and providing services.

The most prominent example of the conduit model is in West Des Moines, Iowa, which early this month announced that Google Fiber will be the first lessee of its open access citywide conduit network.

7.1 Dark Fiber Model Case Study: Westminster, Maryland

The City of Westminster, Maryland, is a bedroom community of both Baltimore and Washington, D.C. where 60 percent of the working population leaves in the morning to work elsewhere.[41] The area has no major highways and thus, from an economic development perspective, has limited options for creating new jobs. Incumbents have also traditionally underserved the area with broadband.

The city began an initiative 12 years ago to bring better fiber connectivity to community anchor institutions through a middle-mile fiber network. In 2010, the State of Maryland received a large award from the federal government to deploy a regional fiber network called the Inter-County Broadband Network (ICBN) that included infrastructure in Westminster.[42]

[41] Case study is based in part on a presentation by Dr. Robert Wack, President, Westminster (Maryland) City Council, during a webinar hosted by the Fiber to the Home Council and facilitated by CTC Technology & Energy. *See*: http://goo.gl/x82Ro7 (password required). See also: Robert Wack, "The Westminster P3 Model," *Broadband Communities Magazine* (Nov./Dec. 2015), http://goo.gl/op1XpH.
[42] "The Project," Inter-County Broadband Network, http://goo.gl/GjBC26.

Westminster saw an opportunity to expand the last mile of the network to serve residents. At the time, though, it did not have any clear paths to accomplish this goal. City leaders looked around at other communities and quickly realized that they were going to have to do something unique. Unlike fiber-to-the-premises success stories such as Chattanooga, Tennessee, they did not have a municipal electric utility to tackle the challenge. They also did not have the resources, expertise, or political will to develop from scratch a municipal fiber service provider to compete with the incumbents. As a result, they needed to find a hybrid model.

As the community evaluated its options, it became clear that the fiber infrastructure itself was the city's most significant asset. All local governments spend money on durable assets with long lifespans, such as roads, water and sewer lines, and other infrastructure that is used for the public good. The leaders asked, "Why not think of fiber in the same way?" The challenge then was to determine what part of the network implementation and operations the private sector partner would handle and what part could be the city's responsibility.

The hybrid model that made the most sense required the city to build, own, and maintain dark fiber, and to look to partners that would light the fiber, deliver service, and handle the customer relationships with residents and businesses. The model would keep the city out of network operations, where a considerable amount of the risk lies in terms of managing technological and customer service aspects of the network.

The city solicited responses from potential private partners through a request for proposals (RFP). Its goal was to determine which potential partners were both interested in the project and shared the city's vision.

The city eventually selected Ting Internet, an upstart ISP with a strong track record of customer service as a mobile operator. Ting shared Westminster's vision of a true public–private partnership and of maintaining an open access network. Ting has committed that within two years it will open its operations up to competitors and make available wholesale services that other ISPs can then resell to consumers.

Under the terms of the partnership, the city is building and financing all of the fiber (including drops to customers' premises) through a bond offering. Ting is leasing fiber with a two-tiered lease payment. One monthly fee is based on the number of premises the fiber passes; the second fee is based on the number of subscribers Ting enrolls. Initially, this payment will be a flat fee—but in later years, when Ting's revenue hits certain thresholds, Ting will pay the city a small fraction of its revenue per user. That mechanism is designed to allow the city to share in some of the upside of the network's success. In other words, the city will receive a bit of entrepreneurial reward based on the entrepreneurial risk the city is taking.

Based on very preliminary information, given that this is a market in development as we write, we believe this is a highly replicable model.

What is so innovative about the Westminster model is how the risk profile is shared between the city and Ting. The city will bond and take on the risk around the outside plant infrastructure, but the payment mechanism negotiated is such that Ting is truly invested in the network's success.

Because Ting will pay Westminster a small monthly fee for every home and business passed, Ting is financially obligated to the city from day one, even if it has no customers. This structure gives the city confidence that Ting will not be a passive partner, because Ting is highly incented to sell services to cover its costs.

Perhaps most significantly, there is also a mechanism built into the contract that ensures that the two parties are truly sharing risk around the financing of the outside plant infrastructure. In any quarter in which Ting's financial obligations to the city are insufficient to meet the city's debt service, Ting will pay the city a portion of the shortfall. In subsequent quarters, if Ting's fees to the city exceed the debt service requirements, Ting will be reimbursed an equivalent amount. This element of the financial relationship made the deal much more attractive to the city because it is a clear demonstration of the fact that its private partner is invested with it.

7.2 Dark Fiber Model Case Study: Huntsville, Alabama

In February 2016, the city of Huntsville, Alabama, the state's northern technology hub, announced that its municipal electric utility will build a fiber network throughout its city limits (presumably, to pass all or most businesses and homes), and that Google Fiber will lease much of that fiber in order to provide gigabit services to residences and small businesses.

The arrangement between Huntsville and Google Fiber is a variation on the model pioneered in Westminster, though the payment terms are different and provide a key contrast. Google Fiber will lease fiber from Huntsville using a rate sheet that provides for various levels of pricing based on the amount of fiber leased. In contrast, Ting's obligations to Westminster are based in part on how much fiber it uses, in part on how many customers it secures, and in part on the revenues it generates. As a result, Westminster will have less predictability and certainty about its revenues from Ting but has the potential to share in the upside in the event that Ting is very successful in that market.

As in Westminster, the Huntsville model puts the city in the business of building infrastructure, a business it knows well after a century of building roads, bridges, and utilities. The model leaves to the private sector (in this case, Google Fiber and any other provider that chooses to lease Huntsville fiber) all aspects of network operations, equipment provisioning, and service delivery.

Interestingly, the Huntsville model holds the potential for competition among providers, as Google Fiber will not be the exclusive user of the fiber and other entities can also choose to lease fiber based on Huntsville Utilities' established rates. We anticipate that there will be other ISP users of the city's fiber, particularly to serve larger businesses and institutions, though we question whether the economics exist for another provider to compete against Google Fiber in the residential market, as least in the short-term. Over the long term, however, market demand and structures may change and new opportunities for competition may arise. By building and owning its own fiber assets, the city of Huntsville has ensured it will be able to react to those changes and maximize its benefits.

7.3 Open Conduit Model Case Study: West Des Moines, Iowa

The city council of the City of West Des Moines, Iowa, voted in early July to finance and build a ubiquitous underground conduit network throughout the city.[43] The conduit infrastructure will connect all homes, businesses, and institutions. The conduit network will be available on an open, non-discriminatory basis for any company wishing to provide competitive services to consumers and businesses in West Des Moines. The city views this infrastructure as a future-proof means of ensuring best-in-class, world-class communication services over many decades.

The city stated three clear goals for the effort: first, equity—that the network would reach all members of the community. Second, non-exclusivity—that it would be open to all ISPs for open and robust competition. Third, financial sustainability—that it would be a prudent and viable investment.

Competitive internet service provider Google Fiber has agreed to become the first lessee of space within the conduit system on a non-exclusive basis. Google Fiber will build fiber within the conduit and deliver services throughout the city. It will pay the city based on the number of connections made to potential customers. The company committed to a minimum amount over the first 20 years of operation such that the city has a predictable revenue stream.

This is the first new deployment by Google Fiber in a number of years and its first in the state of Iowa. Google Fiber's high profile is likely to drive interest in this public-private partnership strategy among both cities and internet service providers. Further, Google Fiber's expansion into this new way of partnering with cities suggests new expansion by Google Fiber itself and possibly more announcements of partnerships with cities.[44]

---

[43] Shelby Fleig, "West Des Moines set to become Iowa's first Google Fiber city," *Des Moines Register*, July 2, 2020, https://www.desmoinesregister.com/story/news/local/west-des-moines/2020/07/02/google-fiber-partner-west-des-moines-fiber-optic-internet-broadband-iowa-high-speed/3279256001/ (accessed July 2020).
[44] Google Fiber Blog, https://fiber.google.com/blog/2020/thank-you-west-des-moines/

8 Fiber-to-the-Premises Business Structure and Financial Analysis

This section of the report provides a financial model and examines the economics for the deployment and operations of a countywide fiber-to-the-premises network by the Partner Agencies.

8.1 Retail Model Overview

While a range of potential public-private partnership models exist, examining a traditional retail model of this type provides the most comprehensive picture of the overall financial viability for a new fiber-to-the-premises deployment. This analysis illuminates necessary take-rates and service pricing for the Partner Agencies to operate cash-positive annually.

The financial analysis assumes the Partner Agencies own, operate, and provide broadband data services to residents and businesses. This financial analysis is based on a number of assumptions, outlined below.

The model assumes that subscribership for data services will ramp up over years one through three, and then remain steady. The analysis does not include inflation and salary cost increases because we assume that these operating cost increases will be offset and passed on to subscribers in the form of increased prices. Models that add an inflation factor to both revenues and expenses typically greatly overstate future cash flow because net revenues are unlikely to increase as quickly as inflation. At best, the provider will be able to match expenses increases with a dollar-for-dollar rate increase, which is what the flat model represents.

The financial model is designed to be cash flow positive in year one; which is accomplished through startup funding and bond financing. Over time, given the cost to construct, maintain, and operate the fiber-to-the-premises network, the model indicates that a 36.5 percent take-rate of households and businesses passed will be required to maintain positive cash flow based on a four percent interest rate and broadband data services priced as follows:

- A 1 Gbps residential service at $80 per month
- A 1 Gbps small commercial service at $100 per month
- A 1 Gbps medium commercial service at $250 per month[45]

These prices are consistent with market dynamics and are in the same range as Google's and Ting Internet's 1 Gbps services, which are $70 and $89 per month, respectively.

[45] Medium commercial service receives a lower oversubscription rate, that is, less customers sharing the connection, decreasing the instances of network congestion reducing overall speeds.

We assume that 90 percent of businesses will subscribe to the small commercial service, and 10 percent of businesses will purchase medium commercial service.

We assume that all data subscribers will be charged a one-time $75 connection fee prior to receiving services.

A financial summary for this model is in Table 33.

Table 33: Retail Model Base Case Financial Summary

Income Statement	1	5	10	15	20
Total Revenues	$ 4,247,520	$ 147,213,830	$ 154,291,420	$ 161,369,000	$ 168,446,590
Total Cash Expenses	(5,056,610)	(35,980,670)	(39,763,360)	(43,528,180)	(47,684,850)
Depreciation	(18,932,000)	(64,726,460)	(61,865,150)	(60,258,010)	(60,258,010)
Interest Expense	(12,936,000)	(42,447,720)	(32,640,000)	(20,913,150)	(6,477,370)
Taxes	-	-	-	-	-
Net Income	$ (32,677,090)	$ 4,058,980	$ 20,022,910	$ 36,669,660	$ 54,026,360
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$ 377,610	$ 2,786,530	$ 15,541,270	$ 63,106,110	$ 129,288,400
Depreciation Reserve	-	67,947,850	126,675,575	115,736,715	169,727,215
Debt Service Reserve	16,170,000	57,365,000	57,365,000	57,365,000	57,365,000
Total Cash Balance	$ 16,547,610	$ 128,099,380	$ 199,581,845	$ 236,207,825	$ 356,380,615
Total Cash Balance (after investment payments)	$ 16,547,610	$ 128,099,380	$ 199,581,845	$ 236,207,825	$ 356,380,615

This base case will not generate a constant positive net income until year four, growing to a net income of approximately $ 54.0 million in year 20. However, the model will operate cash-positive, with the cumulative unrestricted cash balance growing to approximately $15.5 million at the end of year 10. By the end of year 20, this surplus will total nearly $ 130 million.

8.1.1 Municipal Retail Model Base Case Financing

The initial years of network deployment and operations will be capital-intensive, well beyond what initial subscriber revenues can support. This analysis projects the County covering these expenses by issuing a series of 20-year bonds, totaling $1,147,300 million. Our analysis assumes the bonds will be issued in the first four years of deployment, with a 1 percent issuance cost, and a 5 percent interest rate, with principal payments starting in the third year after issuance. We assume a debt service reserve of 5 percent is maintained, but that no interest reserve is necessary.

The model assumes a straight-line depreciation of assets, and that the outside plant will have a 20-year life span while the network equipment will need to be replaced after 10 years. Customer premises equipment and miscellaneous implementation costs will need to be replaced every five years. Network equipment, including last mile and customer premises equipment will be replaced or upgraded at 80 percent of original cost while miscellaneous implementation costs

(test equipment, vehicles, computers) will be at 100 percent. The model plans for a depreciation reserve account starting in year three to fund future electronics replacements and upgrades.

Table 34 shows the income statement for years one, five, 10, 15, and 20. Net income remains negative in years one through three, totaling nearly negative $32.7 million in year one and roughly negative $48.1 million in year three; by year 10, net income will equal over $20.0 million, growing to approximately $36.7 million in year 15 and almost $54.0 million in year 20.

Table 34: Municipal Retail Model Base Case Income Statement

	Year 1	Year 5	Year 10	Year 15	Year 20
Income Statement					
a. Revenues					
Video	$ -	$ -	$ -	$ -	$ -
Internet - Residential	3,832,320	132,838,120	139,224,570	145,611,010	151,997,460
Internet - Business	415,200	14,375,710	15,066,850	15,757,990	16,449,130
Total	$ 4,247,520	$ 147,213,830	$ 154,291,420	$ 161,369,000	$ 168,446,590
b. Content Fees					
Video	$ -	$ -	$ -	$ -	$ -
Internet	960,000	3,591,340	3,591,340	3,591,340	3,591,340
Voice	-	-	-	-	-
Total	$ 960,000	$ 3,591,340	$ 3,591,340	$ 3,591,340	$ 3,591,340
c. Operating Costs					
Operation Costs	$ 2,491,510	$ 19,968,420	$ 21,063,510	$ 22,270,170	$ 23,664,660
Labor Costs	1,605,100	12,420,910	14,399,250	16,692,680	19,351,390
Total	$ 4,096,610	$ 32,389,330	$ 35,462,760	$ 38,962,850	$ 43,016,050
d. EBITDA	$ (809,090)	$ 111,233,160	$ 115,237,320	$ 118,814,810	$ 121,839,200
e. Depreciation	18,932,000	64,726,460	61,865,150	60,258,010	60,258,010
f. Operating Income (EBITDA less Depreciation)	$ (19,741,090)	$ 46,506,700	$ 53,372,170	$ 58,556,800	$ 61,581,190
g. Non-Operating Income					
Interest Income	$ -	$ 313,280	$ 460,100	$ 432,750	$ 567,730
Interest Expense (Bond A)	-	-	-	-	-
Interest Expense (Bond B)	(12,936,000)	(42,761,000)	(33,100,100)	(21,345,900)	(7,045,100)
Interest Expense (Loan)	-	-	-	-	-
Total	$ (12,936,000)	$ (42,447,720)	$ (32,640,000)	$ (20,913,150)	$ (6,477,370)
h. Net Income (before taxes)	$ (32,677,090)	$ 4,058,980	$ 20,022,910	$ 36,669,660	$ 54,026,360
i. Taxes	$ -	$ -	$ -	$ -	$ -
j. Net Income	$ (32,677,090)	$ 4,058,980	$ 20,022,910	$ 36,669,660	$ 54,026,360

Table 35 shows the cash flow statement for years one, five, 10, 15, and 20. The cumulative unrestricted cash balance is nearly $378,000 at the end of year one and over $15.5 million by the end of year 10. By the end of year 15, the unrestricted cash balance is just over $63.1 million; it is approximately $129.3 million by the end of year 20.

Table 35: Retail Model Base Case Cash Flow Statement

	Year 1	Year 5	Year 10	Year 15	Year 20
Cash Flow Statement					
a. Net Income	$ (32,677,090)	$ 4,058,980	$ 20,022,910	$ 36,669,660	$ 54,026,360
b. Cash Outflows					
Debt Service Reserve	$ (16,170,000)	$ (5,000)	$ -	$ -	$ -
Depreciation Reserve	-	(24,078,240)	(23,013,840)	(22,415,980)	(22,415,980)
Financing	(3,234,000)	(1,000)	-	-	-
Capital Expenditures	(289,873,300)	(105,004)	(227,009)	(1,061,000)	-
Total	$ (309,277,300)	$ (24,189,244)	$ (23,240,849)	$ (23,476,980)	$ (22,415,980)
c. Cash Inflows					
Interest Reserve	$ -	$ -	$ -	$ -	$ -
Depreciation Reserve	-	4	227,009	1,061,000	-
20-Year Bond/Loan Proceeds	323,400,000	100,000	-	-	-
Total	$ 323,400,000	$ 100,004	$ 227,009	$ 1,061,000	$ -
d. Total Cash Outflows and Inflows	$ 14,122,700	$ (24,089,240)	$ (23,013,840)	$ (22,415,980)	$ (22,415,980)
e. Non-Cash Expenses - Depreciation	$ 18,932,000	$ 64,726,460	$ 61,865,150	$ 60,258,010	$ 60,258,010
f. Adjustments					
Proceeds from Additional Cash Flows (10 Year Bond)	$ -	$ -	$ -	$ -	$ -
Proceeds from Additional Cash Flows (20 Year Bond)	$ (323,400,000)	$ (100,000)	$ -	$ -	$ -
Proceeds from Additional Cash Flows (Loan)	$ -	$ -	$ -	$ -	$ -
g. Adjusted Available Net Revenue	$ (323,022,390)	$ 44,596,200	$ 58,874,220	$ 74,511,690	$ 91,868,390
h. Principal Payments on Debt					
10 Year Bond/Loan Principal	$ -	$ -	$ -	$ -	$ -
20 Year Bond/Loan Principal	-	44,589,200	54,253,700	63,469,200	77,220,000
Total	$ -	$ 44,589,200	$ 54,253,700	$ 63,469,200	$ 77,220,000
i. Net Cash	$ 377,610	$ 107,000	$ 4,620,520	$ 11,042,490	$ 14,648,390
j. Cash Balance					
Unrestricted Cash Balance	$ 377,610	$ 2,786,530	$ 15,541,270	$ 63,106,110	$ 129,288,400
Depreciation Reserve	-	67,947,850	126,675,575	115,736,715	169,727,215
Debt Service Reserve	16,170,000	57,365,000	57,365,000	57,365,000	57,365,000
Total Cash Balance	$ 16,547,610	$ 128,099,380	$ 199,581,845	$ 236,207,825	$ 356,380,615

8.1.2 Municipal Retail Model Base Case Capital Additions

Significant network expenses—known as capital additions—are incurred in the first few years during the construction phase of the network. These represent the equipment, material and construction labor associated with building, implementing, and lighting a fiber network. Table 36 shows the capital additions costs in years one through four, assuming a 36.5 percent take-rate, or just over 143,000 customers.

This analysis projects that capital additions in year one will total approximately $289.9 million. These costs will total just over $388.9 million in year two, over $195.1 million in year three, and roughly $192.9 million in year four.

Table 36: Retail Model Base Case Capital Additions

Capital Additions				
	1	2	3	4
Network Equipment				
Core & GPON Equipment	$ 80,356,700	$ -	$ -	$ -
Video (Resell Partner)	-	-	-	-
Voice (Facilities-Based CLEC)	-	-	-	-
Additional Annual Capital	-	-	-	-
Total	$ 80,356,700	$ -	$ -	$ -
Outside Plant and Facilities				
Total Backbone and FTTP	$ 201,157,500	$ 335,250,000	$ 134,100,000	$ -
Additional Annual Capital	-	-	-	-
Total	$ 201,157,500	$ 335,250,000	$ 134,100,000	$ -
Last Mile and Customer Premises Equipment				
CPE (residential and small commercial)	$ 2,131,500	$ 15,627,000	$ 17,758,000	$ 35,515,500
CPE (medium commercial)	15,000	110,000	125,500	250,500
CPE (enterprise)	-	-	-	-
Average Drop Cost	5,151,600	37,768,800	42,920,400	85,838,400
Additional Annual Replacement Capital	-	1	2	3
Total	$ 7,298,100	$ 53,505,801	$ 60,803,902	$ 121,604,403
Miscellaneous Implementation Costs				
OSS & Portal	$ 400,000	$ -	$ -	$ -
Vehicles	35,000	140,000	175,000	245,000
Service Equipment	100,000	-	-	-
Work Station, Computers, and Software	26,000	50,000	52,000	96,000
Fiber OTDR and Other Tools	100,000	-	-	-
Billing Software	250,000	-	-	-
Fiber Management Software	150,000	-	-	-
Additional Annual Capital	-	-	-	-
Total	$ 1,061,000	$ 190,000	$ 227,000	$ 341,000
Replacement Costs for Depreciation				
Network Equipment	$ -	$ -	$ -	$ -
Last Mile and Customer Premises Equipment	-	-	-	-
Miscellaneous Implementation Costs	-	-	-	-
Total	$ -	$ -	$ -	$ -
Total Capital Additions	$ 289,873,300	$ 388,945,801	$ 195,130,902	$ 121,945,403

8.1.3 Municipal Retail Model Base Case Operating and Maintenance Expenses

The cost to deploy a fiber-to-the-premises network goes far beyond fiber implementation. Network deployment requires additional staffing for sales and marketing, network operations, and other functions new to the Partner Agencies. The addition of new staff will require new office

space. Similarly, network inventory requirements will require warehousing space. The Partner Agencies will need to:

- Expand existing office facilities for management, technical, and clerical staff
- Open a retail storefront to facilitate customer contact and enhance their experience doing business with the fiber-to-the-premises enterprise[46]
- Provide warehousing for receipt and storage of cable and hardware for the installation and ongoing maintenance of the broadband infrastructure
- Establish a location to house servers, switches, routers, and other core network equipment

Training new and existing staff is important to fully realize the economies of starting the fiber-to-the-premises network. The training will be particularly important in the short-term as the new enterprise establishes itself as a unique entity providing services distinct from public services provided today. We estimate education and training at two percent of direct payroll expenses.

Marketing and sales costs will also be significant and staffing with skills in the following disciplines will be required:

- Sales/Promotion
- Internet and related technologies
- Staff Management
- Strategic Planning
- Finance
- Vendor Negotiations
- Networking (addressing, segmentation)
- Marketing

The expanded business and increased responsibilities will require the addition of new staff. The initial additional positions, staffing levels, and base salaries are shown in Table 37.

These numbers assume one and one-half shifts of both customer service representative support and customer technicians. Changing to full 24x7 staffing will increase costs. Similarly, reducing the support hours will decrease the required staffing. In the model, we added 40 percent overhead to the estimated base (year one) salaries.

[46] Due to the size of the enterprise, we assume the County will use existing facilities for office space and a "storefront," which will not require lease fees.

Table 37: Municipal Retail Model Base Case Labor Expenses

Service Position Total	Year 1	Year 2	Year 3	Year 4	Year 5+	Year 1 Salary
Integrity Manager	1.00	1.00	1.00	1.00	1.00	$ 153,500
Manager Communications and Community Outreach	-	-	-	-	-	$ 126,500
GIS Analyst	2.00	2.00	2.00	2.00	2.00	$ 94,000
Senior IT Specialist	1.00	1.00	1.00	1.00	1.00	$ 120,000
IT Specialist	1.00	1.00	2.00	2.00	2.00	$ 102,000
Customer Account Rep II	2.00	3.00	3.00	3.00	3.00	$ 68,000
Customer Account Rep I	2.00	13.00	26.00	52.00	52.00	$ 59,000
Field Services Technician	1.00	5.00	9.00	18.00	18.00	$ 101,000
Account Clerk II	1.00	1.00	1.00	1.00	1.00	$ 68,000
Customer Account Rep I	1.00	7.00	14.00	27.00	27.00	$ 59,000
Field Services Technician	1.00	4.00	5.00	5.00	5.00	$ 101,000
Total	13.00	38.00	64.00	112.00	112.00	

The Partner Agencies' total labor expenses will total just over $1.6 million in year one, $4.1 million in year two, $6.6 million in year three, and $11.1 million in year four on.

Additional key operating and maintenance assumptions include:

- Insurance
- Utilities
- Office expenses
- Underground utility locates and ticket processing for underground outside plant
- Legal fees
- Professional service fees
- Pole attachment expenses for aerial outside plant

Vendor maintenance contract fees are expected to start at $8.9 million in year two and remain steady from year two on (based upon 15 percent of accrued investment for network electronics). Annual variable operating expenses not including direct internet access include:

- Education and training are calculated as two percent of direct payroll expense
- Allowance for bad debts is computed as 0.5 percent of revenues
- Churn is anticipated to be six percent annually, which initiates a $175 per subscriber acquisition cost

The estimated cost of electronic billing for the new fiber-to-the-premises enterprise is $0.20 per bill.

Fiber and network maintenance costs are calculated at 0.4 percent of the total construction cost per year. This is estimated based on a typical rate of occurrence in the Multnomah County environment, and the cost of individual repairs. This is in addition to staffing costs to maintain the fiber.

Table 38 shows projected operating expenses for years one, five, 10, 15, and 20. Some expenses will remain constant while others will increase as the network expands and the customer base increases.

Table 38: Retail Model Base Case Operating Expenses and P&I Payments

	Year 1	Year 5	Year 10	Year 15	Year 20
Operating Expenses					
Insurance	-	432,000	476,960	526,600	581,410
Utilities	100,000	216,000	238,480	263,300	290,710
Office Expenses	25,000	54,000	59,620	65,830	72,690
Facility Lease	-	-	-	-	-
Locates & Ticket Processing	250,800	2,708,320	2,990,200	3,301,410	3,645,030
Contingency	100,000	216,000	238,480	263,300	290,710
Fiber & Network Maintenance	825,240	3,638,250	4,016,920	4,435,010	4,896,600
Vendor Maintenance Contracts	-	8,918,000	8,918,000	8,918,000	8,918,000
Legal	100,000	54,000	59,620	65,830	72,690
Consulting	150,000	81,000	89,430	98,740	109,010
Marketing	750,000	270,000	298,110	329,130	363,390
Education and Training	32,100	248,420	287,990	333,850	387,030
Customer Billing (Unit)	10,300	370,830	405,160	442,930	494,440
Allowance for Bad Debts	21,240	736,070	771,460	806,850	842,230
Churn (acquisition costs)	38,640	1,390,600	1,519,360	1,661,000	1,854,140
Pole Attachment Expense	88,190	634,930	693,720	758,390	846,580
Video	-	-	-	-	-
Internet	960,000	3,591,340	3,591,340	3,591,340	3,591,340
Voice	-	-	-	-	-
Sub-Total	$ 3,451,510	$ 23,559,760	$ 24,654,850	$ 25,861,510	$ 27,256,000
Labor Expenses	$ 1,605,100	$ 12,420,910	$ 14,399,250	$ 16,692,680	$ 19,351,390
Sub-Total	$ 1,605,100	$ 12,420,910	$ 14,399,250	$ 16,692,680	$ 19,351,390
Total Expenses	$ 5,056,610	$ 35,980,670	$ 39,054,100	$ 42,554,190	$ 46,607,390
Principal and Interest	$ 12,936,000	$ 87,036,920	$ 86,893,700	$ 84,382,350	$ 83,697,370
Taxes	-	-	-	-	-
Sub-Total	$ 12,936,000	$ 87,036,920	$ 86,893,700	$ 84,382,350	$ 83,697,370
Total Expenses, P&I, and Taxes	$ 17,992,610	$ 123,017,590	$ 125,947,800	$ 126,936,540	$ 130,304,760

8.2 Retail Model Sensitivity Scenarios

In this section, we demonstrate how fluctuations in certain key assumptions in the base case can affect the financial modeling (i.e., the take-rate required for positive cash flow).

Note that some of these scenarios may not be realistically attainable. They are meant to demonstrate the sensitivity of the financial projections to these assumptions. Some of our assumptions will dramatically impact the feasibility of the model.

In particular we examine fluctuations in the bond funding rate and the total estimated capital cost. The following tables illustrates how these fluctuations taken individually impact the required take-rate required for positive cash flow.

Table 39: Bond Rate Sensitivity Analysis Summary

Scenario	Bond Rate	Required Take-Rate
Base Case - 2.0 pp	2.0%	31.0%
Base Case	***4.0%***	***36.5%***
Base Case + 2.0 pp	6.0%	44.0%

Table 40: Capital Cost Sensitivity Analysis Summary

Scenario	Required Take-Rate
Base Case - 15% CapEx	30.5%
Base Case	***36.5%***
Base Case + 15% CapEx	44.5%

8.2.1 Retail Model Scenario 1: Base Case

As we previously noted, the base case shows that a 36.5 percent take-rate is required to maintain cash flow. Table 41 shows a financial summary for this scenario.

Table 41: Retail Model Base Case Financial Summary

Income Statement	1	5	10	15	20
Total Revenues	$ 4,247,520	$ 147,213,830	$ 154,291,420	$ 161,369,000	$ 168,446,590
Total Cash Expenses	(5,056,610)	(35,980,670)	(39,763,360)	(43,528,180)	(47,684,850)
Depreciation	(18,932,000)	(64,726,460)	(61,865,150)	(60,258,010)	(60,258,010)
Interest Expense	(12,936,000)	(42,447,720)	(32,640,000)	(20,913,150)	(6,477,370)
Taxes	-	-	-	-	-
Net Income	$ (32,677,090)	$ 4,058,980	$ 20,022,910	$ 36,669,660	$ 54,026,360
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$ 377,610	$ 2,786,530	$ 15,541,270	$ 63,106,110	$ 129,288,400
Depreciation Reserve	-	67,947,850	126,675,575	115,736,715	169,727,215
Debt Service Reserve	16,170,000	57,365,000	57,365,000	57,365,000	57,365,000
Total Cash Balance	$ 16,547,610	$ 128,099,380	$ 199,581,845	$ 236,207,825	$ 356,380,615
Total Cash Balance (after investment payments)	$ 16,547,610	$ 128,099,380	$ 199,581,845	$ 236,207,825	$ 356,380,615

8.2.2 Retail Model Scenario 2: Bond Funding Rate Increased 2 points to 6.0 Percent

Our second scenario looks at the implications of an increase in bond funding rates from our base case of 4.0 percent to 6.0 percent. All other assumptions remain the same as our base case.

The increased cost of borrowing in this scenario would necessitate an increased take-rate of 44.0 percent to remain cash positive, which we expect would be highly unlikely to attain and maintain in an environment with more than one existing broadband provider in many areas.

Table 42 shows a financial summary for this scenario.

Table 42: Retail Model Scenario 2 Financial Summary – Bonding Funding Rate Increased 2 Points to 6 Percent

Income Statement	1	5	10	15	20
Total Revenues	$ 5,119,920	$ 177,459,990	$ 185,991,720	$ 194,523,450	$ 203,055,180
Total Cash Expenses	(5,075,260)	(40,176,150)	(44,438,980)	(48,629,020)	(53,255,160)
Depreciation	(20,640,960)	(71,018,540)	(67,569,280)	(65,648,570)	(65,648,570)
Interest Expense	(20,964,000)	(70,348,800)	(56,289,780)	(37,732,740)	(12,684,160)
Taxes	-	-	-	-	-
Net Income	$ (41,560,300)	$ (4,083,500)	$ 17,693,680	$ 42,513,120	$ 71,467,290
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$ 465,560	$ 898,460	$ 13,377,240	$ 73,599,440	$ 161,181,130
Depreciation Reserve	-	74,088,290	132,097,425	106,793,495	158,906,645
Debt Service Reserve	17,470,000	62,390,000	62,390,000	62,390,000	62,390,000
Total Cash Balance	$ 17,935,560	$ 137,376,750	$ 207,864,665	$ 242,782,935	$ 382,477,775
Total Cash Balance (after investment payments)	$ 17,935,560	$ 137,376,750	$ 207,864,665	$ 242,782,935	$ 382,477,775

8.2.3 Retail Model Scenario 3: Bond Funding Rate Decreased 2 points to 2.0 Percent

Our second scenario looks at the implications of a decreased bond funding rate from our base case of 4.0 percent to 2.0 percent. All other assumptions remain the same as our base case.

The decreased cost of borrowing in this scenario would reduce to required take-rate to 31.0 percent to remain cash positive—still challenging, but an indication that low-cost borrowing clearly improves the business case. Table 43 provides a financial summary for this option.

Table 43: Retail Model Scenario 3 Financial Summary – Bonding Funding Rate Increased 2 Points to 6 Percent

Income Statement	1	5	10	15	20
Total Revenues	$ 3,609,360	$ 125,029,760	$ 131,040,800	$ 137,051,850	$ 143,062,890
Total Cash Expenses	(5,042,950)	(33,604,480)	(37,069,460)	(40,598,930)	(44,495,750)
Depreciation	(18,828,640)	(61,263,180)	(58,833,030)	(57,225,890)	(57,225,890)
Interest Expense	(6,324,000)	(19,592,600)	(14,308,580)	(8,663,850)	(2,266,970)
Taxes	-	-	-	-	-
Net Income	$ (26,586,230)	$ 10,569,500	$ 20,829,730	$ 30,563,180	$ 39,074,280
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$ 695,310	$ 2,599,620	$ 10,910,190	$ 43,558,890	$ 88,822,930
Depreciation Reserve	-	64,726,940	126,131,045	118,224,635	175,296,585
Patronage Reserve	-	-	-	-	-
Operating Reserve	-	-	-	-	-
Interest Reserve	-	-	-	-	-
Debt Service Reserve	15,810,000	54,235,000	54,235,000	54,235,000	54,235,000
Total Cash Balance	$ 16,505,310	$ 121,561,560	$ 191,276,235	$ 216,018,525	$ 318,354,515
Total Cash Balance (after investment payments)	$ 16,505,310	$ 121,561,560	$ 191,276,235	$ 216,018,525	$ 318,354,515

8.2.4 Retail Model Scenario 4: Capital Costs Increased by 15 Percent

Our fourth scenario looks at the implications of higher capital costs relative to the based case, with the estimated costs for each capital addition increased by 15 percent. All other assumptions remain the same as our base case.

The increased capital costs in this scenario would necessitate an increased take-rate of 44.5 percent to remain cash positive, which we expect would be highly unlikely to attain and maintain in an environment with more than one existing broadband provider in many areas.

Table 44 shows a financial summary for this scenario.

Table 44: Retail Model Scenario 4 Financial Summary – Capital Costs Increased by 15 Percent

Income Statement	1	5	10	15	20
Total Revenues	$ 5,179,320	$ 179,477,250	$ 188,105,960	$ 196,734,680	$ 205,363,390
Total Cash Expenses	(5,080,280)	(40,489,860)	(44,791,760)	(49,014,430)	(53,676,600)
Depreciation	(23,837,610)	(85,020,040)	(80,410,770)	(78,201,950)	(78,201,950)
Interest Expense	(15,736,000)	(52,520,050)	(40,457,500)	(26,054,000)	(8,287,620)
Taxes	-	-	-	-	-
Net Income	$ (39,474,570)	$ 1,447,300	$ 22,445,930	$ 43,464,300	$ 65,197,220
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$ 486,684	$ 3,766,748	$ 19,983,248	$ 81,491,748	$ 167,512,578
Depreciation Reserve	-	88,315,900	147,735,525	110,816,715	162,925,245
Patronage Reserve	-	-	-	-	-
Operating Reserve	-	-	-	-	-
Interest Reserve	-	-	-	-	-
Debt Service Reserve	19,670,000	70,865,000	70,865,000	70,865,000	70,865,000
Total Cash Balance	$ 20,156,684	$ 162,947,648	$ 238,583,773	$ 263,173,463	$ 401,302,823
Total Cash Balance (after investment payments)	$ 20,156,684	$ 162,947,648	$ 238,583,773	$ 263,173,463	$ 401,302,823

8.2.5 Retail Model Scenario 5: Capital Costs Decreased by 15 Percent

Our fifth scenario looks at the implications of a lower capital costs relative to the based case estimates, with each capital addition decreased by 15 percent. All other assumptions remain the same as our base case.

As with a reduced bond funding rate, the decrease in capital costs significantly reduces the required take-rate to remain cash positive to 30.5 percent.

Table 45 shows a financial summary for this scenario.

Table 45: Retail Model Scenario 5 Financial Summary – Capital Costs Decreased by 15 Percent

Income Statement	1	5	10	15	20
Total Revenues	$ 3,549,960	$ 123,013,490	$ 128,927,600	$ 134,841,710	$ 140,755,820
Total Cash Expenses	(5,039,110)	(33,171,940)	(36,573,770)	(40,055,730)	(43,900,090)
Depreciation	(15,950,890)	(50,293,240)	(48,563,620)	(47,197,550)	(47,197,550)
Interest Expense	(10,976,000)	(34,611,540)	(26,565,070)	(16,952,180)	(5,116,810)
Taxes	-	-	-	-	-
Net Income	$ (28,416,040)	$ 4,936,770	$ 17,225,140	$ 30,636,250	$ 44,541,370
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$ 324,396	$ 1,958,430	$ 10,792,160	$ 46,723,160	$ 96,476,370
Depreciation Reserve	-	53,362,190	109,311,805	106,628,385	159,176,575
Patronage Reserve	-	-	-	-	-
Operating Reserve	-	-	-	-	-
Interest Reserve	-	-	-	-	-
Debt Service Reserve	13,720,000	46,860,000	46,860,000	46,860,000	46,860,000
Total Cash Balance	$ 14,044,396	$ 102,180,620	$ 166,963,965	$ 200,211,545	$ 302,512,945
Total Cash Balance (after investment payments)	$ 14,044,396	$ 102,180,620	$ 166,963,965	$ 200,211,545	$ 302,512,945

8.2.6 Retail Model Scenario 6: Residential Service Fee Reduced to $50 per month

Our sixth scenario looks at the implications of lower revenues at a given take-rate relative to the base case scenario by reducing the standard gigabit Internet service fee from $80 to $50—a price point our market research suggests would optimize potential take-rate. All other assumptions remain the same as our base case.

The significantly reduced revenue per subscriber requires a take-rate of 70.0 percent to remain cash positive, much higher that other scenarios.

Table 46 shows a financial summary for this scenario.

Table 46: Retail Model Scenario 6 Financial Summary – Residential Service Fee Reduced to $50 per Month

Income Statement	1	5	10	15	20
Total Revenues	$ 5,389,800	$ 186,788,780	$ 195,769,010	$ 204,749,240	$ 213,729,470
Total Cash Expenses	(5,438,860)	(52,125,000)	(57,947,100)	(63,330,210)	(69,273,590)
Depreciation	(22,703,760)	(88,966,240)	(83,478,800)	(81,244,530)	(81,244,530)
Interest Expense	(14,596,000)	(55,033,420)	(42,674,030)	(27,823,630)	(9,504,430)
Taxes	-	-	-	-	-
Net Income	$ (37,348,820)	$ (9,335,880)	$ 11,669,080	$ 32,350,870	$ 53,706,920
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$ 393,640	$ 39,275,690	$ 1,540,380	$ 5,782,750	$ 30,088,870
Depreciation Reserve	-	91,066,580	139,344,045	89,423,375	129,301,425
Debt Service Reserve	18,245,000	73,765,000	73,765,000	73,765,000	73,765,000
Total Cash Balance	$ 18,638,640	$ 204,107,270	$ 214,649,425	$ 168,971,125	$ 233,155,295
Total Cash Balance (after investment payments)	$ 18,638,640	$ 204,107,270	$ 214,649,425	$ 168,971,125	$ 233,155,295

Appendix A: Mailed Residential Survey Instrument

Multnomah County and the Cities of Fairview, Gresham, Portland, Troutdale, and Wood Village

Residential Internet Survey
February 2020

Even if you do not have home internet service, please complete the relevant portions of this survey form and return to us. Your opinions, experiences, and information are important to us.

Multnomah County and the cities of Fairview, Gresham, Portland, Troutdale, and Wood Village are sending you this survey as part of its research into how residents use internet services. *The information gathered will not be used to sell you anything.* It will not be used for any purpose other than to help the County and Cities understand how residents use internet services and to explore strategies to improve internet accessibility and affordability in Multnomah County.

Even if you do not have internet access at your home, please complete the relevant portions of this survey. We value your input.

How long will the survey take?
This survey should take approximately 10 minutes to complete.

What is the due date to complete the survey?
Please return your completed form in the enclosed postage-paid envelope by **February 28, 2020.**

What if I have questions about the survey?
If you have questions regarding this survey, please contact:

Jacob Farkas
Multnomah County, Department of County Assets, Information Technology Project Manager
503.988.7573
jacob.e.farkas@multco.us

Thank you in advance for your participation!

1. **Which of the following services do you currently purchase for your household or personal use?** *(✓ all that apply)*

   [1] Internet service in my home (excluding cellular/mobile)
   [2] Cellular/mobile service with internet (smartphone)
   [3] Cellular/mobile telephone service without internet (basic phone)
   [4] Fixed (land line) telephone service
   [5] Cable television or satellite television
   [6] Don't know
   [7] None of the above

2. **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) Fixed (land-line) telephone service	1	2	3	4	5
(e) Cellular/mobile telephone service	1	2	3	4	5

3. **What is your primary home internet service connection?** *(✓ only one)*

   [1] No home internet service **(Please skip to Question 17)**
   [2] Telephone line (dial-up)
   [3] Digital Subscriber Line (DSL) (from CenturyLink, Frontier, or other)
   [4] Cable modem internet (from Comcast)
   [5] Satellite internet (from HughesNet, ViaSat, VSAT, etc.)
   [6] Cellular/mobile internet (smartphone, mobile hotspot)
   [7] Fiber-optic connection (from CenturyLink, Wave G, Frontier, or other)
   [8] Fixed wireless service (from Stephouse, CoHo, or other -- not just wireless router in home)
   [9] Other (Please specify: _____)

4. **How *important* are the following aspects of your primary *home* internet service?** *(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) Speed of connection	1	2	3	4	5
(b) Reliability of connection	1	2	3	4	5
(c) Price of services	1	2	3	4	5
(d) Overall customer service	1	2	3	4	5
(e) Ability to "bundle" with TV and phone	1	2	3	4	5

5. **How *satisfied* are you with the following aspects of your current *home* internet service?** *(please circle your response for each aspect, where 1=Not at all satisfied, 2=Slightly satisfied, 3=Moderately satisfied, 4=Very satisfied, 5=Extremely satisfied)*

Aspect	*Not at all Satisfied*				*Extremely Satisfied*
(a) Speed of connection	1	2	3	4	5
(b) Reliability of connection	1	2	3	4	5
(c) Price of services	1	2	3	4	5
(d) Overall customer service	1	2	3	4	5
(e) Ability to "bundle" with TV and phone	1	2	3	4	5

6. **How many personal computing devices (desktop/laptop computers, tablets, smartphones) do you and members of your household have in your home?**

   1 1 to 3
   2 4 to 6
   3 7 or more
   4 I do not have any personal computing devices in my home

7. **How many other smart devices do you have in your home (internet-capable gaming consoles, smart TVs, etc.)?**

   1 1 or 2
   2 3 or 4
   3 5 or more
   4 I do not have any personal computing devices in my home

8. **Approximately how much does your household pay PER MONTH for your *home* internet service (not including television or phone service if you bundle services)?**

   1 Free
   2 $1 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

9. **Is the fee in Question 8 part of a bundled package (purchased together with cable TV or phone service)?**

   1 Yes
   2 No

10. **How would you describe the speed of your *home* internet connection?**

    1 Very Slow
    2 Slow
    3 Medium
    4 Fast
    5 Very Fast

11. **How likely is it that you would:** *(please circle your response for each aspect, where 1=Not at all likely, 2=Slightly likely, 3=Moderately likely, 4=Very likely, 5=Extremely likely)*

Factor	*Not at All Likely*				*Extremely Likely*
(a) Recommend your home internet service provider to someone else	1	2	3	4	5
(b) Renew your contract with your internet service provider	1	2	3	4	5
(c) Switch your primary home internet service provider if an alternative provider were the same price	1	2	3	4	5

12. How often does your family use your *home* internet connection (excluding cellular/mobile) for: *(please circle your response for each activity)*

Home Internet Activity	*Never*	*Occasionally*	*Frequently*
(a) Streaming music (music over the internet)	1	2	3
(b) Streaming video (movies or TV over the internet)	1	2	3
(c) Playing online games	1	2	3
(d) Connecting to a work network	1	2	3
(e) Using social media	1	2	3
(f) Shopping online	1	2	3
(g) Running business from home	1	2	3
(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, cameras, or other "smart home" devices	1	2	3
(m) Accessing cloud-based file storage and sharing	1	2	3

13. How often does your family use your *mobile/cellular* internet connection for: *(please circle your response for each activity)*

Home Internet Activity	*Never*	*Occasionally*	*Frequently*
(a) Streaming music (music over the internet)	1	2	3
(b) Streaming video (movies or TV over the internet)	1	2	3
(c) Playing online games	1	2	3
(d) Connecting to a work network	1	2	3
(e) Using social media	1	2	3
(f) Shopping online	1	2	3
(g) Running business from home	1	2	3
(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, cameras, or other "smart home" devices	1	2	3
(m) Accessing cloud-based file storage and sharing	1	2	3

Net neutrality *refers to the equal treatment by your internet service provider of data on the internet. A* ***net neutral*** *network is one on which your ISP provides you access to all content at the same speed and without preference or blocking of content.*

14. Is net neutrality something that you would consider in selecting your ISP?

1 Yes 2 No 3 Unsure

15. How willing would you be to switch your ISP to a net neutral ISP for $15 more than you are currently paying? *(please circle your response, where 1=Not at all willing, 2=Slightly willing, 3=Moderately willing, 4=Very willing, 5=Extremely willing)*

Not at all willing	*Slightly willing*	*Moderately willing*	*Very willing*	*Extremely willing*
1	2	3	4	5

16. How important to you are the following features in your *home* internet service? *(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)*

Feature	*Not at All Important*				*Extremely Important*
(a) I can choose from multiple internet service providers	1	2	3	4	5
(b) I can buy internet service with ***very high*** connection speeds	1	2	3	4	5
(c) I can buy internet service with ***symmetrical*** connection speeds	1	2	3	4	5
(d) I can be confident that my service provider does not sell data about me or my family	1	2	3	4	5
(e) I can be confident that my service provider treats all traffic in a "net neutral" way so that I choose what information or service I access on the internet	1	2	3	4	5
(f) I can "bundle" my internet with other other services such as cellular, video/cable, or telephone	1	2	3	4	5

TELEVISION AND TELEPHONE SERVICE

17. How do you receive video/television service at your home? *(✓all that apply)*

- [1] Cable (Comcast)
- [2] Satellite/Dish, Direct TV
- [3] Antenna (over-the-air)
- [4] Streaming over the internet
- [5] Don't watch video/television

Please answer Question 18

18. Approximately how much do you pay PER MONTH for cable or satellite television service (not including internet or phone)?

- [1] Free
- [2] $1 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

19. Please indicate which type(s) of telephone service you have: *(✓all that apply)*

- [1] Fixed (landline) from telephone provider (CenturyLink or Frontier)
- [2] Fixed from cable provider (Comcast)
- [3] Cellular/mobile wireless (AT&T, Verizon, Sprint, T-Mobile, etc.)
- [4] Internet-based phone service (Skype, Ooma, MagicJack, etc.)
- [5] Do not have any telephone service
- [6] Other phone service (please specify: _____)

INTERNET USE FOR JOBS/CAREERS

20. Does your job require you to have internet access at your home?

- [1] Yes
- [2] No

21. Are you or is any member of your household currently teleworking, or interested in telework opportunities?

- [1] Someone in my household currently does telework from home
- [2] Someone in my household would like to telework
- [3] No

22. 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

23. How important is a high-speed data or internet connection 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) Teleworking	1	2	3	4	5	9
(b) Planned/existing home-based business	1	2	3	4	5	9

INTERNET USE FOR HEALTHCARE

24. Does any member of your family use the internet to access healthcare services at your home?

1 Yes

2 No

25. How often does a member of your family use the internet to access the following healthcare services at your home: *(please circle your response for each activity)*

Home Internet Activity	*Never*	*Occasionally*	*Frequently*
(a) Video consultation with a medical professional (doctor or nurse)	1	2	3
(b) Video consultation with a pharmacy	1	2	3
(c) Checking online medical records	1	2	3
(d) Sending medical data to a medical professional over the internet	1	2	3
(e) Managing or applying for insurance or government healthcare benefits	1	2	3
(f) Remote monitoring of health and symptoms by a medical provider	1	2	3
(g) Emergency alert in event of health care emergency	1	2	3

26. How important is a high-speed internet connection for your healthcare needs?

1 Not at all important
2 Slightly important
3 Moderately important
4 Very important
5 Extremely important

INTERNET USE FOR EDUCATION

27. Does a member of your household use the internet connection 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 31)**

28. Does a member of your household use the internet connection for educational purposes related to homeschooling?

1 Yes
2 No

29. For what education level is your internet connection used?
(✓ all that apply)

1 Early Childhood (Preschool, 3K, 4K)
2 Primary (Grades 5k – 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 _____

30. How important is a high-speed internet connection for your educational needs?

1 Not at all important
2 Slightly important
3 Moderately important
4 Very important
5 Extremely important

ROLE OF THE COUNTY and CITIES

31. Please indicate to what extent you disagree or agree that the County and/or Cities 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) Ensure that all residents have access to competitively priced broadband internet services	1	2	3	4	5
(b) Ensure that all low-income residents have access to competitively priced broadband internet services	1	2	3	4	5
(c) Ensure that all students have access to competitively priced broadband internet in their homes	1	2	3	4	5
(d) Build a publicly financed network on which one or more private sector companies can offer competitive internet services	1	2	3	4	5
(e) Build a publicly financed network on which the County and/or Cities offer competitive internet services	1	2	3	4	5

32. 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 deciding 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

33. What do you think the MAIN role for the County and/or Cities should be with respect to broadband access? *(✓MAIN role)*

- [1] Build and operate a public state-of-the-art broadband network
- [2] Build a state-of-the-art network and lease it to one or more private companies to offer services to the public
- [3] Encourage a private company to build a high-speed network
- [4] Other role _____
- [5] No role
- [6] Don't know

34. Consider at what price level you would be interested in purchasing high speed internet service <u>from another commercial service provider</u>. How willing would you be to purchase 1 gigabit per second (very fast, fiber optic level of service) 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) $50 per month	1	2	3	4	5
(b) $70 per month	1	2	3	4	5
(c) $90 per month	1	2	3	4	5
(d) $110 per month	1	2	3	4	5
(e) $130 per month	1	2	3	4	5
(f) $150 per month	1	2	3	4	5

35. Consider at what price level you would be interested in purchasing high speed internet service <u>from the County and/or Cities</u>. How willing would you be to purchase 1 gigabit per second <u>from the County and/or Cities</u> 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) $50 per month	1	2	3	4	5
(b) $70 per month	1	2	3	4	5
(c) $90 per month	1	2	3	4	5
(d) $110 per month	1	2	3	4	5
(e) $130 per month	1	2	3	4	5
(f) $150 per month	1	2	3	4	5

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 Multnomah County.

36. 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

37. What is the highest level of education you have completed?

1 Some high school
2 Completed high school
3 Two-year college or technical degree
4 Four-year college degree
5 Graduate, professional, or doctorate degree

38. 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

39. What is your ethnicity? *(✓all that apply)*

1 White, non-Hispanic
2 Hispanic, Latino/a, or Spanish origin
3 Black or African American
4 Asian or Pacific Islander
5 American Indian or Alaska Native
6 Other: _____

40. How many people reside in your home (adults and children)?

Adults (including yourself)	Children age 18 and younger
1 1	1 None
2 2	2 1
3 3	3 2
4 4 or more	4 3
	5 4 or more

41. Do you own or rent your residence?

1 Own 2 Rent

42. 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

Thank you for completing this survey!

11

Appendix B: Online Business Survey Instrument

Multnomah County and the cities of Fairview, Gresham, Portland, Troutdale, and Wood Village are sending you this survey as part of their research into how businesses use internet services.

Your responses will be kept strictly confidential. *This information will not be used for any marketing or solicitation.* It will be used only to help the County and Cities understand how businesses use internet services and to explore strategies to improve internet accessibility and affordability.

This survey should be completed by the person who makes the purchasing decisions for your business's use of internet services. This survey should take **no more than 10 to 15 minutes** to complete. Please complete this survey by February 14, 2020.

Before answering the survey, please read the following instructions to ensure that we receive your important responses:

Maximize your computer screen for the best view of the survey. Always click the NEXT or arrow button at the bottom of each page after answering the question(s) on that page.

Click the SUBMIT button after you finish the survey. Please DO NOT click the X to close your browser tab until after you have submitted the survey or we may not receive your responses.

If you have any questions regarding this survey, please contact:

Jacob Farkas

Multnomah County, Department of County Assets, Information Technology Project Manager

503.988.7573

jacob.e.farkas@multco.us

Thank you in advance for completing this important survey!

ABOUT YOUR BUSINESS

1. **Which of the following best describes your business at this location?** *(✓only one)*

   - ☐ Sole location of this business
   - ☐ Primary location or headquarters with at least one other facility elsewhere in Multnomah County only
   - ☐ Primary location or headquarters with at least one other facility elsewhere outside of Multnomah County only
   - ☐ Primary location or headquarters with other facilities both in and outside of Multnomah County
   - ☐ Branch or affiliate of a parent company located in Multnomah County
   - ☐ Branch or affiliate of a parent company located outside of Multnomah County

2. **Approximately how many full-time employees does your business employ?**

At this location?	At all locations?
☐ Fewer than 5	☐ Fewer than 5
☐ 5 to 9	☐ 5 to 9
☐ 10 to 19	☐ 10 to 19
☐ 20 to 49	☐ 20 to 49
☐ 50 or more	☐ 50 or more

3. **In what kind of facility is your business located?** *(✓only one)*

   - ☐ Home-based
   - ☐ Leased industrial space
   - ☐ Owned industrial space
   - ☐ Leased office/retail/studio space
   - ☐ Owned office/retail/studio space

4. **Which of the following best describes the market area for the majority of your products or services?** *(✓only one)*

   - ☐ Within Multnomah County only
   - ☐ Within Oregon only
   - ☐ Within 500 miles of your location, including areas outside of Oregon
   - ☐ Throughout the United States
   - ☐ International

5. **Which industry best describes your organization?** *(✓only one)*

   - ☐ Agriculture
   - ☐ Construction and specialized trade contracting
   - ☐ Food service (restaurant, bar, food preparation, etc.)
   - ☐ Health care
   - ☐ High-tech (Information Technology, Aerospace, Telecom, etc.)
   - ☐ Manufacturing
   - ☐ Non-profit
   - ☐ Professional services
   - ☐ Other services (auto repair, etc.)

- ☐ Retail
- ☐ Tourism/hospitality/leisure (hotel, travel services, etc.)
- ☐ Transportation
- ☐ Other (please specify: _____)

6. Please estimate your company's gross revenue in 2018:

- ☐ Less than $100,000
- ☐ $100,000 to $499,000
- ☐ $500,000 to $999,000
- ☐ $1 million to $4.99 million
- ☐ $5 million to $9.99 million
- ☐ $10 million or more

7. What is the annual telecommunications expense (internet, phone, and video—but not including mobile service) for your business?

- ☐ Less than $499
- ☐ $500 to $999
- ☐ $1,000 to $2,499
- ☐ $2,500 to $4,999
- ☐ $5,000 to $9,999
- ☐ $10,000 to $49,999
- ☐ $50,000 or more

8. What is the annual mobile service expense (smart phone) for your business?

- ☐ Zero, the business does not pay for mobile service for employees
- ☐ $500 to $999
- ☐ $1,000 to $2,499
- ☐ $2,500 to $4,999
- ☐ $5,000 to $9,999
- ☐ $10,000 to $49,999
- ☐ $50,000 or more

9. How many personal computers (desktops, laptops, and other computer terminals) do you have at your Multnomah County location(s)?

- ☐ None
- ☐ 1 to 4
- ☐ 5 to 9
- ☐ 10 to 19
- ☐ 20 to 49
- ☐ 50 or more
- ☐ Don't know

10. How many smart phones (using mobile service) do employees at your Multnomah County location(s) use for work purposes (whether or not the business pays for the service)?

- ☐ None
- ☐ 1 to 4
- ☐ 5 to 9
- ☐ 10 to 19
- ☐ 20 to 49
- ☐ 50 or more
- ☐ Don't know

11. What is your role in the business?

- ☐ Owner
- ☐ Manager, but not owner
- ☐ IT Professional
- ☐ Other (please specify): _____

INTERNET SERVICES

12. What high-speed internet (broadband) services are available at this business location? *(✓all that are available)*

- ☐ Digital Subscriber Line (DSL) (from CenturyLink, Frontier, or other)
- ☐ Cable modem (from Comcast)
- ☐ Fiber-optics (from CenturyLink, Wave G, Frontier, or other)
- ☐ T1, DS3, or other leased line (from CenturyLink, Frontier, or other)
- ☐ Satellite (from HughesNet, ViaSat, VSAT, or other)
- ☐ Business-class fixed wireless (from Stephouse, CoHo, or other)
- ☐ Other: _____
- ☐ Don't know

13. What is the primary internet service connection at this location? *(✓only one)*

- ☐ No internet service (**Answer 13a and then SKIP TO Question 27)**
- ☐ Digital Subscriber Line (DSL) (from CenturyLink, Frontier, or other) [please also answer 13(b) below]
- ☐ Business account cable modem (from Comcast)
- ☐ Residential account cable modem (from Comcast) [please also answer 13(b) below]
- ☐ Fiber-optics (from CenturyLink, Wave G, Frontier, or other)
- ☐ T1, DS3, or other leased line (from CenturyLink, Frontier, or other)
- ☐ Satellite (from HughesNet, ViaSat, VSAT, or other)
- ☐ Business-class fixed wireless (from Stephouse, CoHo, or other)
- ☐ Mobile service (from Verizon Wireless, AT&T Wireless, T-Mobile, Sprint, or other)
- ☐ Other: _____
- ☐ Don't know

13a. Why do you not have internet service at this business location? (✓ all that apply)

- ☐ Not needed at this location
- ☐ Not available at this location
- ☐ Not necessary for my business
- ☐ Internet access is too expensive for this location
- ☐ Other:_____

13b. What is the main reason you have residential speed internet service rather than switching to a faster business internet connection? *(✓only one)*

- ☐ Faster business internet service is not available at this location
- ☐ Faster business internet is too expensive
- ☐ No need for faster internet at this location
- ☐ Can access fast internet at another location
- ☐ Residential speed internet meets our needs at this location
- ☐ None of the above
- ☐ Other: _____

14. On a scale of 1 to 5, how IMPORTANT is INTERNET service to the following aspects of your business? *(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)*

Business Aspect	*Not at All Important*				*Extremely Important*
(a) Increasing profits	1	2	3	4	5
(b) Improving competitiveness	1	2	3	4	5
(c) Improving internal company communications	1	2	3	4	5
(d) Improving operations	1	2	3	4	5
(e) Interacting with vendors	1	2	3	4	5
(f) Improving employees' productivity	1	2	3	4	5
(g) Reaching more customers	1	2	3	4	5
(h) Improving customer service	1	2	3	4	5
(i) Providing training opportunities for employees	1	2	3	4	5

15. If your business has a website, how IMPORTANT is the website for the following functions? (if your business does not have a website, please skip to Question 16)

Business Aspect	*Not at All Important*				*Extremely Important*
(a) Sharing information with customers	1	2	3	4	5
(b) Sharing information with potential customers	1	2	3	4	5
(c) Transactions with customers (online sales and accepting payments)	1	2	3	4	5
(d) Sharing information with vendors	1	2	3	4	5
(e) Transacting business with vendors (contracts, payments, etc.)	1	2	3	4	5
(f) Internal company communications (portal for remote work by employees, etc.)	1	2	3	4	5

16. Does your business provide internet access to customers over Wi-Fi hot spots?

- ☐ Yes, and it is regularly used
- ☐ Yes, but it is rarely used
- ☐ No, but customers have asked for it
- ☐ No, and we have not seen a demand for it

17. On a scale of 1 to 5, how SATISFIED are you with the following aspects of your INTERNET service? (please circle your response for each aspect, where 1=Not at all satisfied, 2=Slightly satisfied, 3=Moderately satisfied, 4=Very satisfied, 5=Extremely satisfied)

Aspect	*Not at All Satisfied*				*Extremely Satisfied*
(a) Total price paid for service	1	2	3	4	5
(b) Download speed (from the internet)	1	2	3	4	5
(c) Upload speed (to the internet)	1	2	3	4	5
(d) Reliability	1	2	3	4	5
(e) Overall customer service	1	2	3	4	5

18. On a scale of 1 to 5, how IMPORTANT are the following aspects of INTERNET service to your business? *(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) Total price paid for service	1	2	3	4	5
(b) Download speed (from the internet)	1	2	3	4	5
(c) Upload speed (to the internet)	1	2	3	4	5
(d) Reliability	1	2	3	4	5
(e) Overall customer service	1	2	3	4	5

19. How would you describe your internet connection speed? *(✓ only one)*

- ☐ Very Slow
- ☐ Slow
- ☐ Medium
- ☐ Fast
- ☐ Very Fast

20. Approximately how much does your business pay PER MONTH for internet service <u>at this location</u>?

- ☐ Less than $25
- ☐ $25 to $49
- ☐ $50 to $99
- ☐ $100 to $249
- ☐ $250 to $499
- ☐ $500 to $999
- ☐ $1,000 or more

☐ Don't know

21. How would you describe the price you pay for your internet service?

☐ Very affordable
☐ Moderately affordable
☐ Not very affordable
☐ Not at all affordable

22. On a scale of 1 to 5, how SATISFIED are you with your business's ability to perform the following internet-based services or activities? *(please circle your response for each aspect, where 1=Not at all satisfied, 2=Slightly satisfied, 3=Moderately satisfied, 4=Very satisfied, 5=Extremely satisfied)*

Activity	*Not at all Satisfied*				*Extremely Satisfied*	*Does Not Apply*
(a) Videoconferencing	1	2	3	4	5	9
(b) Large data/file transfers, online data storage, backup and recovery	1	2	3	4	5	9
(c) VoIP (Voice over Internet Protocol) telephone	1	2	3	4	5	9
(d) Streaming high-quality video (including security camera feeds)	1	2	3	4	5	9
(e) "Cloud-based" collaboration and file sharing (Google Docs, Dropbox, Microsoft 365, etc.)	1	2	3	4	5	9
(f) E-commerce (online transactions)	1	2	3	4	5	9
(g) Telemetry and monitoring (recording and transmitting data for monitoring remotely)	1	2	3	4	5	9
(h) Filing permits or other electronic government activities	1	2	3	4	5	9
(i) Connecting to another office or business location	1	2	3	4	5	9
(j) Providing online customer service	1	2	3	4	5	9

23. On a scale of 1 to 5, how IMPORTANT are the following internet-based services or activities to your business? *(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)*

Activity	*Not at All Important*				*Extremely Important*	*Does Not Apply*
(a) Videoconferencing	1	2	3	4	5	9

(b) Large data/file transfers, online data storage, backup and recovery	1	2	3	4	5	9
(c) VoIP (Voice over Internet Protocol) telephone	1	2	3	4	5	9
(d) Streaming high-quality video (including security camera feeds)	1	2	3	4	5	9
(e) "Cloud-based" collaboration and file sharing (Google Docs, Dropbox, Microsoft 365, etc.)	1	2	3	4	5	9
(f) E-commerce (online transactions)	1	2	3	4	5	9
(g) Telemetry and monitoring (recording and transmitting data for monitoring remotely)	1	2	3	4	5	9
(h) Filing permits or other electronic government activities	1	2	3	4	5	9
(i) Connecting to another office or business location	1	2	3	4	5	9
(j) Providing online customer service	1	2	3	4	5	9

24. Please consider all of your experiences to date with your business internet service provider. Using a 10-point scale on which "1" means very dissatisfied and "10" means "very satisfied," how satisfied are you with your provider overall? *(Please circle your response.)*

Very dissatisfied									Very satisfied
1	2	3	4	5	6	7	8	9	10

25. To what extent has your business internet service provider fallen short of your expectations or exceeded your expectations? Using a 10-point scale on which "1" now means "fallen short of expectations" and "10" means "exceeded your expectations", to what extent has your provider fallen short of or exceeded your expectations? *(Please circle your response.)*

Fallen short of expectations									Exceeded expectations
1	2	3	4	5	6	7	8	9	10

26. How likely is it that you would: *(please circle your response for each aspect, where 1=Not at all likely, 2=Slightly likely, 3=Moderately likely, 4=Very likely, 5=Extremely likely)*

Factor	*Not at All Likely*				*Extremely Likely*
(a) Recommend your internet service provider to someone else	1	2	3	4	5
(b) Renew your contract with your internet service provider	1	2	3	4	5
(c) Switch your internet service provider if an alternative provider were less expensive	1	2	3	4	5
(d) Switch your internet service provider if an alternative provider offered greater network bandwidth and faster speeds	1	2	3	4	5

27. Does your business permit employees to telecommute (work remotely)?

1 Yes → **(a) Do any of your employees who telecommute live outside of a metro area?**

- ☐ Yes
- ☐ No
- ☐ Unsure

2 No → **(b) Would your business implement telecommuting if you had greater network bandwidth and speed?**

- ☐ Yes
- ☐ No
- ☐ Unsure

ROLE OF THE COUNTY and CITIES

28. Please indicate to what degree you believe that Multnomah County and the Cities 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 local nonprofit organizations have access to competitively priced broadband internet services	1	2	3	4	5
(b) Help ensure that all businesses have access to competitively priced broadband internet services	1	2	3	4	5
(c) Build new broadband infrastructure to enable private internet providers to use to offer services	1	2	3	4	5
(d) Build new broadband infrastructure and then sell internet services directly to local businesses	1	2	3	4	5

29. On a scale of 1 to 5, how much do you AGREE or DISAGREE with each of the following statements? *(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) Our local market currently offers high-speed internet access at prices that our business can afford	1	2	3	4	5
(b) Our local market contains a choice of multiple internet providers capable of serving our business needs	1	2	3	4	5
(c) The availability of affordable high-speed internet access to our business location is a factor we consider in deciding where to locate our business	1	2	3	4	5
(d) The availability of affordable high-speed internet access at our employees' homes is a factor we consider in deciding where to locate our business	1	2	3	4	5
(e) The availability of affordable, high-speed internet access at our clients'/customers' homes and businesses is critical to the provision of our business's services	1	2	3	4	5
(f) The availability of a technically skilled, internet-savvy workforce is critical to the success of our business	1	2	3	4	5
(g) High-speed internet access is as essential to our business as utility services such as water and electricity	1	2	3	4	5
(h) Mobile (outside the office) access to the internet is important to our business operations	1	2	3	4	5

(i) Our business would realize long-term benefits if we had better access to reliable high-speed internet	1	2	3	4	5
(j) Our business is willing to pay a premium for access to reliable high-speed internet	1	2	3	4	5

30. Consider at what price level you would be interested in purchasing high speed internet service from another commercial provider. How willing would you be pay for access to 1 gigabit per second carrier-grade Ethernet transport and internet access service for the following monthly price? (A carrier-grade service guarantees reliability and performance.) *(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) $300 per month	1	2	3	4	5
(b) $500 per month	1	2	3	4	5
(c) $1,000 per month	1	2	3	4	5
(d) $1,500 per month	1	2	3	4	5
(e) $2,000 per month	1	2	3	4	5

Appendix C: Municipal Broadband PDX Report on Community Engagement

MUNICIPAL BROADBAND PDX

Report on Community Engagement

We represent Municipal Broadband PDX, an advocacy campaign supporting digital equity in the Portland metropolitan area. We are not affiliated with CTC Technology and Energy. We have been working with Multnomah County, Portland, Gresham, Troutdale, Fairview, and Wood Village since 2018 to improve internet access for all.

Background

In December 2019, we convened two town halls to better understand the needs of communities in Portland's inner east side and eastern Multnomah County as we consider making large investments in our digital future. Each town hall had this format:

1. An educational segment with presentations and status updates from Multnomah County and our campaign
2. A Q&A segment led by Bob Leek, Chief Information Officer, Multnomah County
3. A written survey we asked each individual present to fill out
4. A round-table discussion facilitated by an organizer from our campaign

We held one town hall in Inner Northeast Portland and the other in Gresham. They were approximately two weeks apart. We also asked our Twitter followers who were unable to attend one of our physical town halls to complete the same survey.

Raw survey response data, as well our methodology for producing the information in this report, are available in our GitHub repository*. The surveys include additional qualitative data not analyzed in this report. We always welcome any feedback or further insights.

* https://github.com/municipalbroadband/reports

1 of 13

Survey findings

We received a total of 168 survey responses, of which we excluded 6 from our analysis because their data were unusable (for example, some people answered no questions or contradicted themselves). We set out to have a rough understanding of the following:

- For our communities, do more tangible access problems, like price and customer service, outweigh abstract societal problems like lack of net neutrality?
- How do people feel about funding and governing a municipal ISP?

Demographics

Most of our respondents access the internet from home and/or work (FIGURE 1).

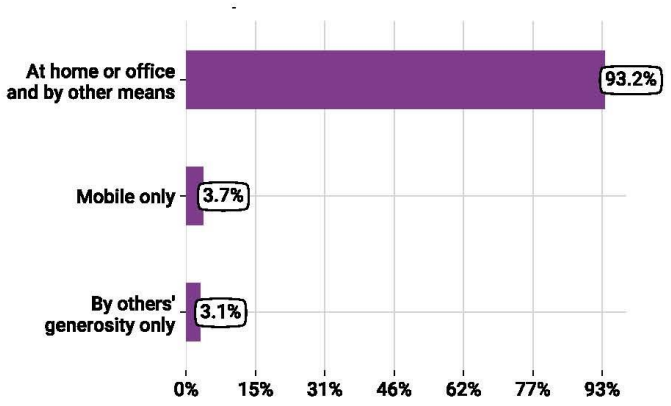


FIGURE 1: How respondents get on the internet

People frequently ask our campaign if wired internet access in urban areas is an outdated model to pursue given the proliferation of relatively inexpensive mobile data plans. We have yet to see evidence this is the case. In this survey, we asked respondents if they *only* access the internet using mobile data. Very few respondents do so.

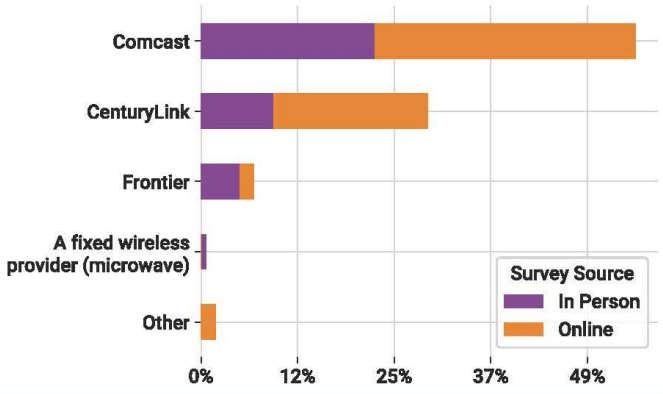


FIGURE 2: Respondents' ISPs by survey source

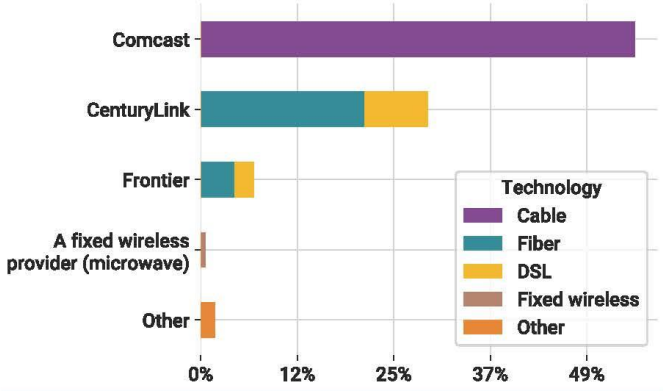


FIGURE 3: Respondents' ISPs by technology

Comcast is the most commonly used ISP among our respondents (FIGURE 2). Note the regional duopoly between Comcast and the local phone company (either CenturyLink or Frontier, depending on location). Very few respondents use a fixed wireless provider like Stephouse Networks or any other ISP. Looking more closely at the survey data by source, we also surmise that our online survey did not reach many people outside of Portland in eastern Multnomah County where Frontier is available.

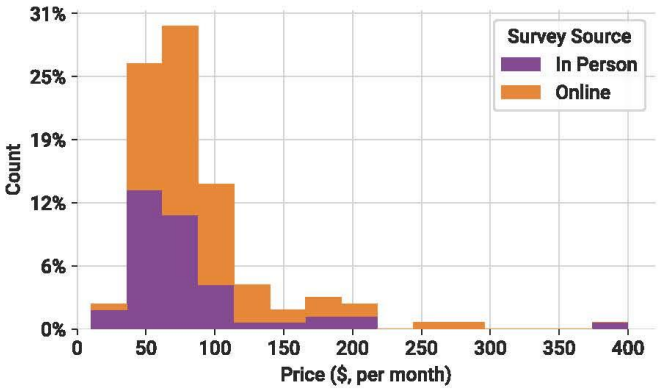


FIGURE 4: Respondents' monthly payments for internet plans

Broadly speaking, our online survey respondents paid more than in-person respondents for both internet and mobile plans (FIGURE 4). As noted above, this may be because our online survey biased to higher-income areas. We also guess that our online audience is more technical than the broader swath of community members who attended our town halls; online respondents may have the means and work requirements or personal reasons to select more expensive plans.

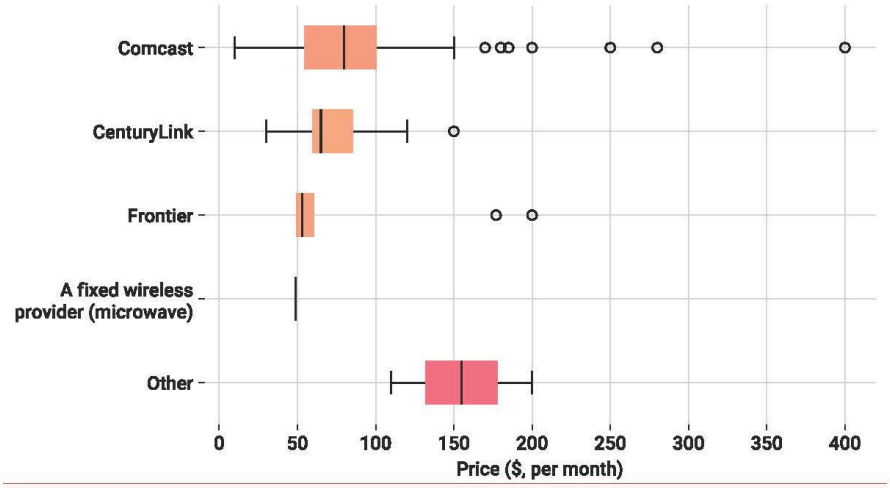


FIGURE 5: Monthly payments for internet plans by ISP

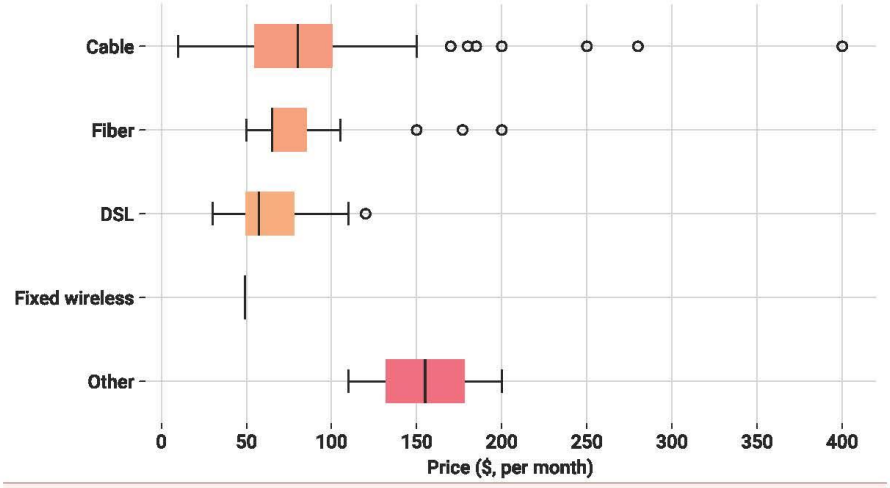


FIGURE 6: Monthly payments for internet plans by technology

Remember that more than 50% of our respondents use Comcast. The charts in FIGURES 5 and 6 give us a clue about price sensitivity. Comparable fiber connectivity through CenturyLink or Frontier is cheaper on average than Comcast, yet we don't see people switching away from Comcast readily. That said, Comcast's higher-speed cable offerings are available in more geographical areas than fiber, which may partially explain why they have so many subscribers.

Municipal broadband in society

The second part of our survey provides a qualitative look at how people feel about accessing the internet.

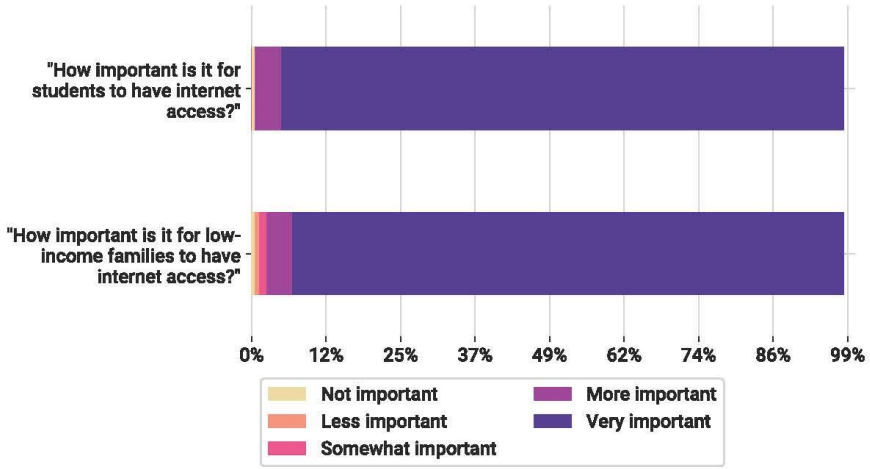


FIGURE 7: Importance of the internet in society

Without any consideration for price or how the service would be delivered, almost everyone agreed that it is important for both students and low-income families to have internet access (FIGURE 7).

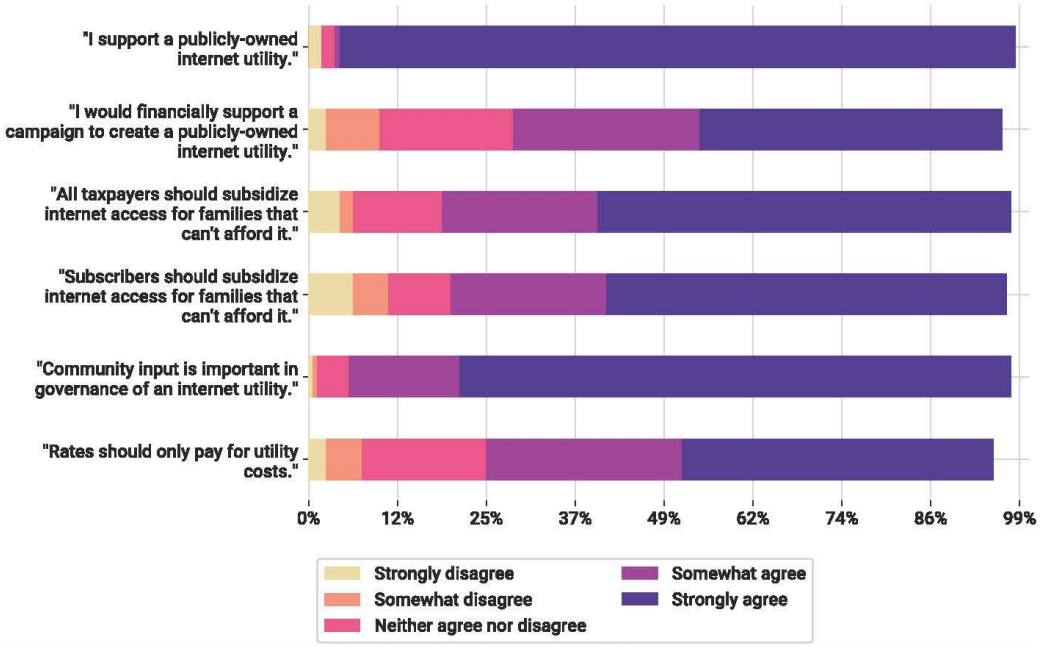


FIGURE 8: Respondents' agreement with public utility proposals

We asked a series of questions about funding and oversight of a municipal ISP (FIGURE 8). We established a baseline by asking each individual whether they supported such an ISP. Unsurprisingly, our respondents almost universally strongly agreed in their support of municipal broadband. Then we wanted to understand:

1. **How do we subsidize access for those unable to afford internet access?** We thought there might be a preference for subscribers to the ISP subsidizing access instead of offloading the burden to all taxpayers, but did not find that to be the case. Over 75% of respondents agreed that all taxpayers should subsidize internet access as needed. Some respondents were in fact more emphatic about this, indicating disagreement for subscriber-paid subsidies only.
2. **Should a municipal ISP be able to use its funding for initiatives other than operating the network?** We wondered whether people would accommodate a municipal ISP spending some of its income on, for example, community education or access to new technology in schools, so we asked whether rates should only pay for utility costs. Although we again found about 75% of respondents in agreement with the premise, this question proved more controversial with only about 50% of people strongly agreeing.
3. **Do subscribers want to help run their ISP?** An overwhelming number of respondents, around 90%, agreed that community input is an important aspect of the governance of any internet utility. With Federal Communications Commission (FCC) rulings about net neutrality and National Security Agency (NSA) surveillance making news cycles relatively frequently over the past few years, it isn't surprising to see a desire for more transparency and direct democracy in a government-run ISP.

To get a better sense of our communities' needs for internet access, we asked respondents to enumerate their dislikes of their current service, allowing them to select many answers (FIGURE 9). We anticipated more practical dislikes (price, reliability, speed, etc.) because these problems prevent people from effectively using the internet on a day-to-day basis. Of those, only price made it into the top tier of responses. Instead, respondents indicated that societal issues like lack of net neutrality guarantees, lack of choice in providers, and lack of privacy guarantees were problematic for them.

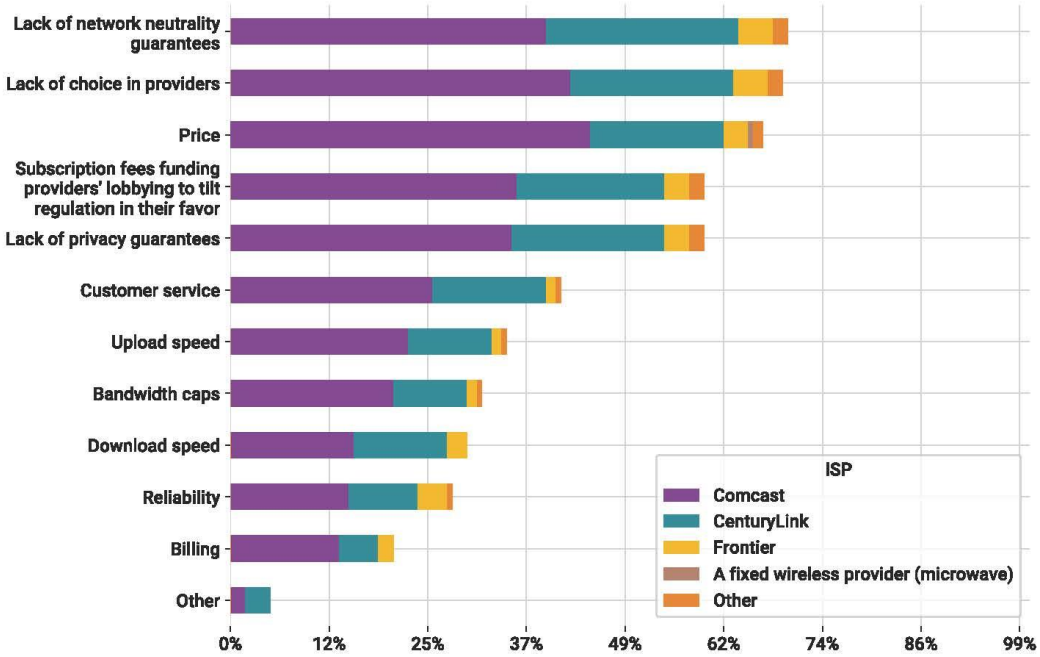


FIGURE 9: Respondents' dislikes of current internet service

Notably, for Comcast customers, price was indeed the most common dislike, outweighing the top two choices for our respondents as a whole.

	Slope	r^2
Price	0.002804	0.055002
Reliability	-0.000443	0.001311
Customer service	0.000906	0.004686
Billing	0.000050	0.000020
Lack of choice in providers	0.001062	0.008826
Download speed	0.000940	0.005697
Upload speed	0.001197	0.008563
Bandwidth caps	0.002319	0.033223
Lack of network neutrality guarantees	0.001467	0.017220
Lack of privacy guarantees	0.001793	0.020261
Subscription fees funding providers' lobbying to tilt regulation in their favor	0.000651	0.002730

TABLE 1: Correlations between respondents' payments for internet plans and dislikes

With that in mind, and considering that Comcast customers pay more on average than our other respondents, we anticipated a positive relationship between household internet service costs and disliking price of service. Our data show a very loose correlation (TABLE 1); furthermore, we did not observe any correlation between internet price and any other dislike.

Round table discussions

We dedicated the final hour of each town hall to round table discussions facilitated by organizers from the Municipal Broadband PDX campaign. We aimed to have tables of about eight people, including the facilitator, and each facilitator had the same set of topics to focus on. At a high level, these were:

- Concerns about broadband access in our market
- Possible models for municipal broadband (open access, integrated public offering, etc.)
- Price sensitivity
- Phased deployment
- Concerns and ideas for public ownership

In some cases, we deviated from those specific topics because everyone at the table was engaged in a different but relevant conversation. We highlight a few of these discussions as well.

Concerns about broadband access in our market

For this topic, we aimed to understand what concerns a municipal ISP might need to address that we didn't capture in our survey. Several participants were opposed to the idea of having any price tiering based on income, contending that putting the burden of proof on low-income families in fact prevents them from getting service. Participants also noted that billing transparency (for example, clearly enumerating any fees for equipment rental) is as important as low prices.

Possible models for municipal broadband

Participants seemed to prefer whichever operating model conferred the most transparency and choice to them. Concerns like pricing, technical support, etc. did not come up frequently in these discussions. For example, one participant wants the county to collect metrics about connection fairness to guarantee net neutrality.

In our second town hall, Bob Leek, Multnomah County's CIO, mentioned the potential for a partnership with Comcast to provide (as an example) Telehealth services, calling it a "win-win-win." Virtually all participants in the subsequent discussion expressed at least some concern with this idea, worrying about a slippery slope to broader incumbent control or whether money that would otherwise stay within our communities would be diverted to out-of-state corporations. Participants indicated they would likely only tolerate public-private partnerships if the network is truly open access.

Price sensitivity

In concert with our survey findings, our qualitative discussion about price sensitivity revealed a sincere willingness to pay more for internet access that aligned with participants' technical needs or ethics. Specifically, people wanted higher upload speeds and a renewed focus on content creation, expressed a lack of trust in incumbent providers to keep prices low (even if they initially undercut a municipal offering), and indicated a desire to increase competition between ISPs. Some participants, especially at our eastern Multnomah County town hall, were frustrated both by the amount they pay for internet access and by the seeming inaction of any regulatory body to keep service prices reasonable.

Phased deployment

Participants mostly agreed that they were comfortable waiting longer for the chance to connect to a municipal network if it reduced the overall risk of the deployment. However, some wanted to see a complete plan first; others were concerned about delays in initial roll-outs. We also discussed a potential opportunity to require new construction to fund fiber connectivity, offsetting deployment costs in underserved communities.

Participants agreed that the county should prioritize a deployment strategy that targets areas of highest need as quickly as possible.

Concerns and ideas for public ownership

Participants' concerns about public ownership aligned with their preferences for the operating model, worrying mainly about lack of transparency in network operations. Although we briefly addressed topics like illegal spying, participants agreed that private for-profit ISPs were as likely, if not more likely, to be engaged in those activities.

Participants were in favor of contracting out the physical work to build the network, and saw a boon to the local economy by opting to use union labor for construction.

Paying for deployment

Several participants wanted to discuss how to pay for the network, so we spent some time discussing different types of bonds, how local improvement districts work, and how other communities have paid for their publicly-owned infrastructure. Generally, people felt impatient about what we interpret as the general approach municipal governments use to fund projects. This led to a variety of creative suggestions emphasizing a rapid start to construction. One individual proposed a novel idea: to perform studies of building foundations in the course of laying underground fiber and to sell those studies to insurance companies. Feasibility of this particular idea aside, we do wonder if there exist secondary markets, tangential to fiber deployment or network operations, that the county could readily take advantage of.

Municipal broadband and COVID-19

Since our town halls took place, society has changed dramatically with the onset of the COVID-19 pandemic. For the first time in history, we are forced to understand the internet's role in everyone's lives, and we see the disproportionate negative impact on those who don't have internet access. School systems nationwide scrambled to get their students connected for virtual classes while those applying for unemployment without internet access waited in hours-long phone queues.

> ❝ Now, more than ever, the need for access to quality high speed internet access is clearly evident. As we continue to move through a world in lock-down due to a health crisis the only way most of us can survive, connect, work, and learn is hinged upon an available connection to the internet. This crisis has only amplified the well known divide between the connected (haves) and the disconnected (have nots). Our students, impoverished families, homeless, and so many others are left behind without this access in a digital world. It is past time for a solution that can be flexible and robust enough to meet the needs of an ever changing landscape. It is clear that a municipal broadband offering is the only solution that will serve the needs of our community, to provide connectivity as a utility as we do with water, electricity, and plumbing. We need this resource in the greater Portland area as a means to grow, learn, and serve all of the people who live and work here!
>
> — Don Wolff, Chief Technology Officer, Portland Public Schools

Conclusion

At a high level, this report provides an informal yet informative glimpse at the way the people in Multnomah County want to use the internet. As we've come to expect from our communities, we care about far more than a low price and a reliable connection (although those are important too!).

First, we know we need an operating model that focuses on transparency, democracy, and equity. Net neutrality and privacy need to be core tenets of the network, and they need to be auditable. The network must have an organizational structure that provides for community engagement and governance. Openness, accountability, and a board that includes members of the public are key. And we *must* prioritize access for those who need it most, treating internet service no different than other vital utilities like clean water, sewers, and electricity.

Second, we find that if our municipal network takes care of our societal needs, those who are able to afford internet access will happily pay a higher rate for service than what existing ISPs offer. Like the renewed focus on environmentalism has shown us in the realm of physical products, when ethics are on the line, prices are not necessarily a race to the bottom.

Finally, we want to emphasize the opportunities our residents and businesses see in municipal broadband. The energized and enthusiastic atmosphere of our town halls made it so incredibly evident that the participants understand how attractive municipal broadband networks are. They see the potential for business investment. They see the benefit to workers in keeping money in our local economy and using union labor. They know the long-term impact on society when every child has access to the vast educational material available on the internet. And they've demonstrated that they're willing to work with us, and with their government, to come up with creative solutions to make municipal broadband a reality.

We'd like to thank our wonderful communities for participating in our events and for their support as we try to build an amazing digital future for everyone. We look forward to continuing to work with Multnomah County on this project!

This report is provided as an addendum to the Multnomah County Municipal Broadband Feasibility Study on June 16, 2020, by Noah Fontes[†], Founding Organizer, Municipal Broadband PDX, with many thanks to the Municipal Broadband PDX team.

† noah@municipalbroadbandpdx.org

Appendix D: Federal Funding Options

We evaluated the full range of federal broadband funding programs and determined that the County is not eligible for any program whose criteria include an applicant's levels of rurality or poverty.

However, the Commerce Department's Economic Development Agency announced on May 7, 2020, that almost $1.5 billion in CARES Act funding has been added to its existing economic development grant program. The program, called Public Works and Economic Adjustment Assistance, provides a number of vehicles to support infrastructure and planning targeted towards economically distressed communities. The new funding, however, is open to all communities that want to fund projects that strengthen economic resilience, diversification of economy and workforce, or recovery in the face of Covid-19. Technical planning and assistance towards that effort, as well as the actual construction of such infrastructure resiliency, can apply to broadband projects as well. State and local governments as well as other public bodies, and non-profits are eligible applicants. The funds are on a first-come-first-serve basis until funds run out, so submission of project requests sooner rather than later is highly recommended.

The sections below summarize a number of ongoing federal broadband funding programs that could help fund broadband deployment. (We also recommend the County subscribe to alerts of upcoming funding deadlines through www.grants.gov.) The nature of support varies widely, with some programs providing low-interest loans and others providing grants or tax credits. In some instances, support has declined significantly in recent years as the federal budget has tightened. Some programs are narrowly tailored to specific types of investments (e.g., educational or health care), while other programs have broad mandates that can be used to support virtually any broadband improvements.

Department of Commerce

Economic Development Administration, Public Works and Economic Adjustment Assistance Program

This program is a rebrand of the previous Economic Development Administration (EDA) Program and is designed to address needs in economically distressed areas. While the agency does not receive many broadband programs, this can actually be a strategic advantage for communities that can show broadband is needed as an element of their economic development plan. While it focuses on distressed communities, especially those that have experienced plant or base closures, an addendum was added on May 7, 2020, to announce additional funding through the CARES act to support recovery of communities adversely affected by Covid-19. Funding requests that target recovery from Covid-19 distress are intended to be flexible and spent quickly and not subject to the regular economic distress requirements.

Entities Funded: Eligible entities 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.

Funding availability: In 2019 around $200 million were awarded in public works, economic adjustment grants and planning grants. $1.467 billion was added in Covid-19-related funding.

Nature of Award: Grants and cooperative agreements

Typical Grant Award: Grant awards vary with a minimum of $100,000, and a maximum of $30 million.

Match: Grant covers up to 50 percent of project costs; maximum allowable investment rate can increase if other economic factors are met. Funds from other federal financial assistance awards may be considered matching only if authorized by statute.

Requirements: Community Economic Development Strategy (CEDS) must be in place for the intended project area & must discuss the need for broadband. The applicant must demonstrate support of the project by the business community.*

Restrictions: 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: (i) 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; (ii) 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 (iii) a "Special Need," as determined by EDA."*

Application deadline and process: Rolling applications. Requires engaging an EDA Regional representative at start of process.

*Note that the EDA has determined that the economic impact of the coronavirus pandemic constitutes a "special need," and has extended eligibility to all communities. Applicants must still explain in their applications how their project would "prevent, prepare for, and respond to" to coronavirus, or respond to "economic injury as a result of the coronavirus."

Key Links:

- Program Fact Sheet: https://www.eda.gov/pdf/about/Economic-Adjustment-Assistance-Program-1-Pager.pdf

- Notice of Funding Opportunity, including CARES Act allocation: https://www.grants.gov/web/grants/view-opportunity.html?oppId=321695
- Frequently Asked Questions: https://www.eda.gov/coronavirus/faq/index.htm

Agency Contact: Find the Economic Development Representative for your community here: https://www.eda.gov/contact/

Department of Agriculture

Rural Broadband Program (Through the Farm Bill)

The Rural Broadband Program, previously called the Rural Broadband Access Loan and Loan Guarantee Program, has historically been the RUS program with the greatest promise for competitive broadband. The application process is not onerous and there is some flexibility in what loans can cover.

Entities Funded: Entities eligible to receive loans include corporations, limited liability companies, cooperative or mutual organizations, Indian tribes, and state or local government. Individuals or partnerships are not eligible.

Nature of Award: Awards are in the form of Treasury-rate loans, four-percent loans, and loan guarantees. Loans are for the term of the life of the facility (thus, 18-20 years for standard-wire broadband). Money is dispersed as construction is completed, with monthly advances against the following month's contract. Once awarded, funding covers capital costs and can retroactively cover pre-application expenses (e.g., project design); however, applicants must take a "leap of faith" in preparing these details during the application process.

FY 2020 Resources: $11.2 million has been allocated for the program in FY 2020.

Typical Grant Award: Congress approves an annual appropriation (loan subsidy) and a specific loan level (lending authority) for the program. Minimum and maximum award amounts will be published in the Federal Register, but have historically been $100,000 (minimum) to $100 million (maximum).

Cost-Share Requirement: N/A (loan)

Applicable Deadlines:

Program Mission: The Rural Broadband Loan Program has a broad mission. It is designed "[t]o provide loans for funding, on a technology neutral basis, for the costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural communities."

Projects Funded: The program funds costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural areas. Thus, loans are not limited by anticipated end uses.

Restrictions: Loans are limited to eligible rural communities (i.e., an area with less than 20,000 inhabitants and not adjacent to an urbanized area with more than 50,000 inhabitants). An eligible service area must be completely contained within a rural area, at least 15 percent of the households in the area must be underserved (unless the current borrower applies to upgrade existing facilities in an existing service area, in which case they are exempt from this requirement), no part of the service area can have more than three incumbent service providers (note that an area may have two competing broadband service providers), and no part of the funded service area can overlap with the service area of current RUS borrowers and grantees or be included in a pending application before RUS. It is likely that portions of a service territory would qualify, although the service territory may not qualify in its entirety. Incumbent service providers are broadband providers that RUS identifies as directly providing broadband service to at least five percent of the households within a service area.

Other Requirements: Applicants must complete build-out within three years, demonstrate ability to provide the service at the Agency's "broadband lending speed" (5Mbps up and down), and demonstrate an equity position of at least 10 percent of the loan amount. (76 Fed Reg 13779) Note that awards are only partially based on project design, but pay particular attention to the business plan and pro forma. Thus, applicants must invest resources preparing these supporting documents. Loans are given to those projects that demonstrate the greatest likelihood of repayment (as demonstrated by the business plan). RUS will give greatest priority to applicants that propose to offer broadband to the greatest proportion of households that have no incumbent service provider.

Key Links:

- Fact Sheet: https://www.rd.usda.gov/sites/default/files/fact-sheet/508_RD_FS_RUS_FarmBillBroadbandLoans.pdf
- Application Guide: https://www.rd.usda.gov/files/FB_AppGuide_Revised_18_19.pdf
- Federal Register Notice: https://www.govinfo.gov/content/pkg/FR-2020-03-12/pdf/2020-04086.pdf

ReConnect Program

Entities Funded: Awards can be given to both public and private entities. Eligible applicants for broadband grants include incorporated organizations, Indian tribes or tribal organizations, state

or local units of government, or cooperatives, private corporations, and limited-liability companies organized on a for profit or not-for-profit basis. Individuals or partnerships are not eligible.

Nature of Award: There are three types of opportunities offered through this program: 100 percent grant, 50/50 grant/loan, and 100 percent loan.

FY 2020 Resources: Round one of the program has awarded over $621 million. Round two closed on April 15, 2020, and will distribute $550 million plus an additional $100 million from the stimulus act. The details of a third round are unknown, but it is generally anticipated that there will be more rounds in the future.

Typical Award Size: Awards range considerably in size. One hundred percent grants are limited to $25 million, and 50/50 awards are limited to $25 million for each the grant and the loan. One hundred percent loans are limited to $50 million.

Cost-Share Requirement: Applicants receiving a 100 percent grant must provide a match equal to 25 percent of the overall project cost.

Applicable Deadlines: The application deadline for the second round of program funding was April 15, 2020. Updates on application deadlines are available through USDA Rural Development Updates at https://public.govdelivery.com/accounts/USDARD/subscriber/new?email=&commit=Sign+Up.

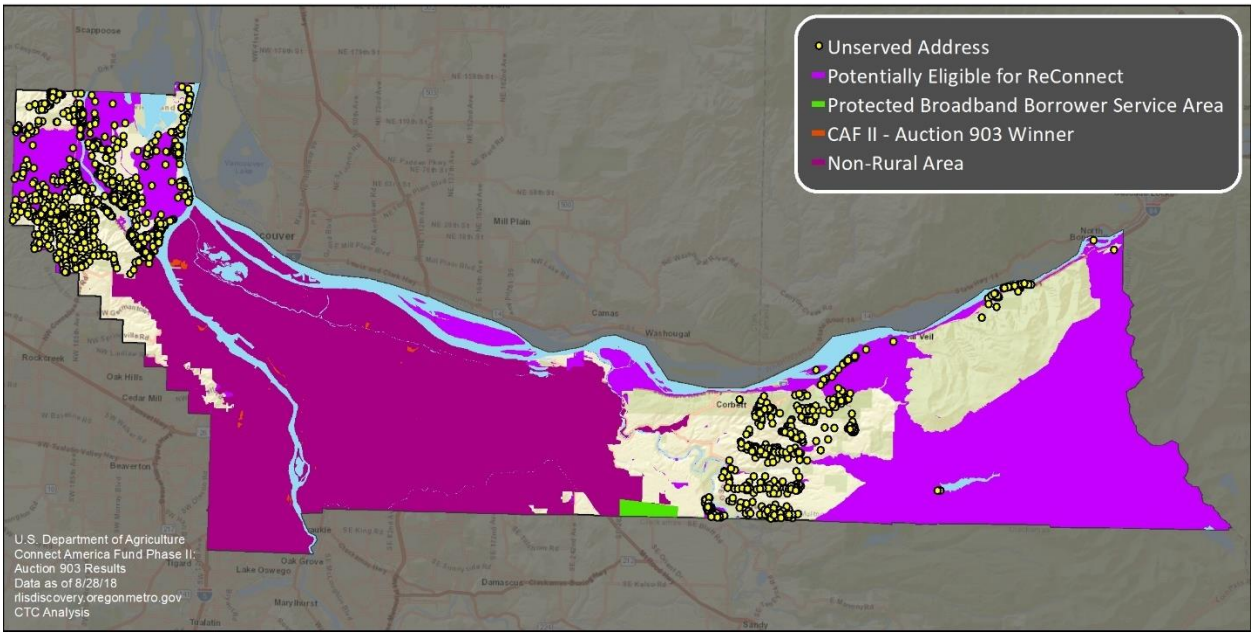
Program Mission: The ReConnect program offers financing to facilitate broadband deployment in rural areas of the country that lack access to at least 10/1 Mbps.

Projects Funded: Eligible projects must propose to provide at least 25/3 Mbps broadband service to all premises in the proposed service area that do not have sufficient access to broadband, and must demonstrate that they can be completely built out within five years of funding being made available. Award funds can be used to fund the construction or improvement of broadband facilities, the acquisition of an existing system (up to 40 percent of the total requested award), and reasonable pre-application expenses (up to five percent of the total requested award). Operating costs are not eligible costs.

Restrictions: To be eligible for ReConnect, service areas must be rural, and 90 percent of households must lack access to fixed, terrestrial service of at least 10/1 Mbps. RUS will not fund a project proposing to serve an area that has already received financial assistance for broadband service from RUS broadband loans, the Community Connect program, CAF II Auction 903, state-funded areas, or previous rounds of ReConnect.

Eligible Areas in Multnomah County: Figure 189 illustrates the areas and addresses that are eligible for ReConnect funding under the governing statute and rules.

Figure 189: Areas and Addresses Eligible for ReConnect Funding



Key Links:

- Program overview: https://www.usda.gov/reconnect/program-overview
- Second funding round Funding Opportunity Announcement: https://www.govinfo.gov/content/pkg/FR-2019-12-12/pdf/2019-26522.pdf

Community-Oriented Connectivity Broadband Grant Program ("Community Connect")

Priority for Community Connect grants is given to areas demonstrating "economic necessity." The application process is rigorous and competitive (with awards given to only 10 percent of applicants) and once awarded, program requirements are demanding (e.g., requiring last-mile service for all households in the service area). Awards are fairly modest.

Entities Funded: Awards can be given to both public and private entities. Eligible applicants for broadband grants include incorporated organizations, Indian tribes or tribal organizations, state or local units of government, or cooperatives, private corporations, and limited-liability companies organized on a for profit or not-for-profit basis. Individuals or partnerships are not eligible.

Nature of Award: Grant with modest (15 percent) match requirement.

FY 2020 Resources: For FY 2020, $35 million was available for Community Connect Grants. Funding is provided through annual appropriations in the Distance Learning and Telemedicine account within the Department of Agriculture appropriations bill.

Typical Grant Award: Awards range considerably in size, from $100,000 to $3 million.

Cost-Share Requirement: Applicants must make a matching contribution of at least 15 percent of the total award. This match can be made with "in kind" contributions, but cannot be made with federal funds.

Applicable Deadlines: Applications for the Community Connect program are typically opened around March or April, and conversations with program staff confirm that there is a about a 45 to 60-day application window with awards given in September. As of May 2020, a Funding Opportunity Announcement had not yet been announced for this year. Updates on application deadlines are available through www.grants.gov.

Program Mission: Community Connect has a broad program mission of helping "rural residents tap into the enormous potential of the Internet."

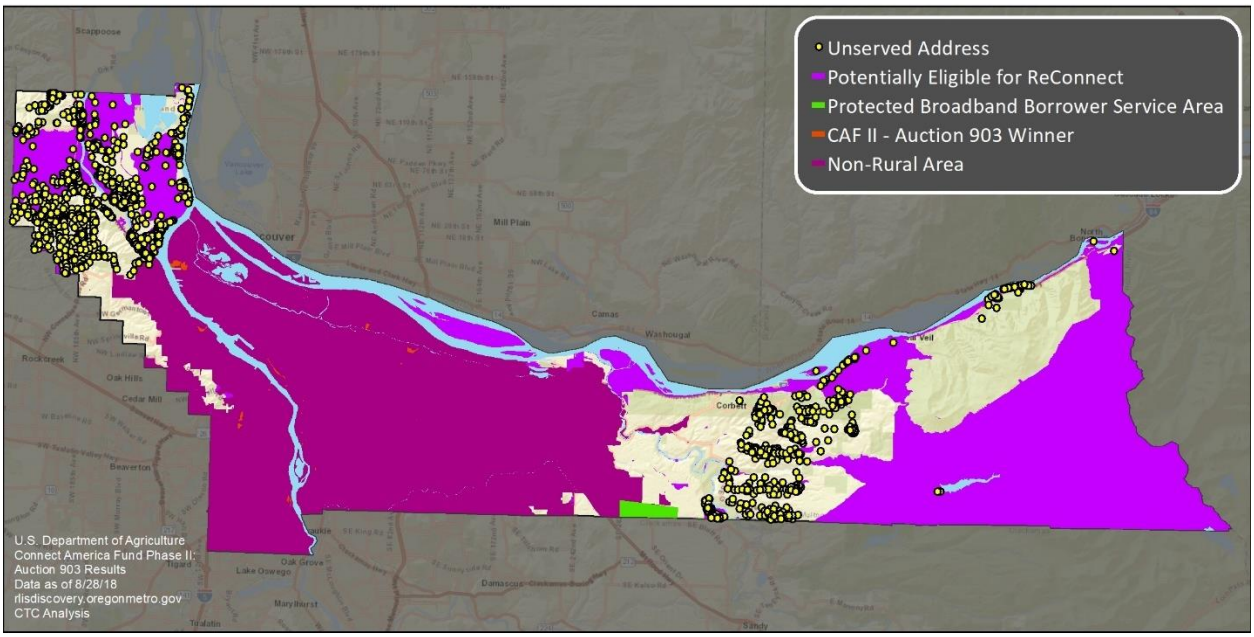
Projects Funded: Community Connect funds approximately 15 projects annually (from an application pool of 150). Eligible projects must offer basic broadband transmission service to both residential and business customers within the proposed service area. Examples of eligible projects include deploying broadband transmission service to critical community facilities, rural residents, and rural businesses; constructing, acquiring or expanding a community center (but only five percent of grant or $100,000 can be used for this purpose); or building broadband infrastructure and establishing a community center with at least 10 computer access points, which offer free public access to broadband for two years.

Restrictions: While Community Connect has a fairly broad mission, funding is geographically limited to a contiguous area with a population less than 20,000 that does not currently have Broadband Transmission Service (defined as 3 Mbps up and down, as reflected in the FCC National Broadband Map). Grants cannot duplicate any existing broadband services, nor can applicants charge for services to any critical community facilities for at least two years from the grant award. Priority is given to areas that demonstrate "economic necessity." The grant process is very selective, with awards given to only 10 percent of applicants.

Other Requirements: Grant requirements are fairly onerous, as recipients must agree to provide last-mile services throughout the entire service area (i.e., "basic transmission service to residential and business customers").

Eligible Areas in Multnomah County: While the eligibility criteria are not identical for Community Connect and ReConnect, our analysis is that ReConnect areas will be favored by USDA for Community Connect funding given the narrow criteria. In Multnomah County, those areas are illustrated in the following map:

Figure 190: Areas and Addresses Eligible for ReConnect and Likely to be Competitive for Community Connect Funding



Key Links:

- Basic background: http://www.rurdev.usda.gov/utp_commconnect.html
- Application Guide: https://www.rd.usda.gov/files/CC_Application_Guide_FY2019_final.pdf
- 2019 Funding Opportunity Announcement: https://www.rd.usda.gov/files/2019_CC_FOAfinal.pdf

Distance Learning and Telemedicine (DLT)

Grants for this program are given for equipment, rather than broadband service; however, this may provide a good way for a utility to leverage a new broadband network (e.g., by helping finance video conferencing systems and home medical units). As such, this could be a good

supplement to other funding options. Applicants have a fairly high likelihood (70 percent) of receiving an award.

Entities Funded: Funds can be awarded to both public and private entities (including corporations or partnerships, tribes, state or local units of government, consortia, and private for-profit or not-for-profit corporations), assuming they provide the requisite services. Individuals are not eligible. Grantees must provide education and medical care via telecommunications. Eligible entities must either directly operate a rural community facility or deliver distance learning or telemedicine services to entities that operate a rural community facility or to residents of rural areas.

Nature of Award: Grant

FY 2020 Resources: The second funding round will distribute $47 million, in addition to any leftover funds from the first round window and a special Covid-19 addition of $25 million.

Typical Grant Award: Grant awards range from $50,000 (minimum) to $1 million (maximum). Roughly 70 percent of applicants are awarded grants.

Cost-Share Requirement: The grant program requires a 15 percent match. Such matches may be made through "in kind" contributions, but cannot be made with federal funds. Applications that provide a greater contribution may be scored more favorably.

Applicable Deadlines: The deadline for the second funding round is July 13.

Program Mission: Grants are available for projects that "meet the educational and health care needs of rural America."

Projects Funded: Grants can be used for equipment, but not broadband service. Eligible projects vary and can include capital assets (e.g., interactive video equipment, data terminal equipment, inside wiring, etc.), instructional programming that is a capital asset, technical assistance and instruction. Grants can provide operating costs for the first two years of a program, and are made for projects where the benefit is primarily delivered to end users that are not at the same location as the source of the education or health-care service.

Restrictions: RUS borrowers are not eligible for DLT loans. Demonstration projects are not eligible for DLT funds. Projects must be in a rural area as defined by 7 CFR 1703.126(a)(2). Eligible projects must receive at least 20 (of 45) points using these criteria.

Key Links:

- Program page: https://www.rd.usda.gov/programs-services/distance-learning-telemedicine-grants

- Funding Opportunity Announcement: https://www.rd.usda.gov/sites/default/files/USDARUS2020_DLT_FOAR2CARESActFunding_04142020.pdf
- Application Guide: https://www.rd.usda.gov/sites/default/files/FY2020_DLT_App_Guide_Final.pdf

Telecommunications Infrastructure Loans

USDA provides loans to support broadband in rural communities. Loans are limited to telephone companies serving rural areas within cities of fewer than 5,000 inhabitants. Other, more generous grants and subsidies may be available.

Entities Funded: The Department of Agriculture provides Telecommunications Infrastructure Loans to entities providing telephone service in rural areas; public bodies providing telephone service in rural areas as of 1949; cooperative, nonprofit, limited dividend or mutual associations. All borrowers must be incorporated or a limited liability company.

Nature of Award: All awards are in the form of low-interest loans and include: cost-of-money loans (3.15 percent for a 20-year term beginning June 2014), guaranteed loans (interest rates are Treasury rate plus 1/8 percent; historically between .15 and 4.2 percent), and hardship loans (5 percent interest).

FY 2020 Resources: $690 million is budgeted for FY 2020.

Typical Award: $50,000 is the minimum loan award. The maximum is unclear, though as of June 2011, Triangle Telecom has received $136 million over the course of a decade.

Cost-Share Requirement: N/A (loan)

Applicable Deadlines: Applications can be submitted year-round.

Program Mission: The Telecommunications Infrastructure program makes "long-term direct and guaranteed loans to … finance[e] the improvement, expansion, construction, acquisition, and operation of telephone lines, facilities, or systems to furnish and improve Telecommunications service in rural areas." The loans are intended to provide advanced telecommunications networks for rural areas, especially broadband networks designed to accommodate distance learning, telework and telemedicine.

Projects Funded: Loans can be used to finance telecommunications in rural areas for improvements, expansions, construction, acquisitions and refinancing.

Restrictions: Loans are limited to rural areas, narrowly defined as areas within a city of fewer than 5,000 inhabitants.

Key Links:

- General information: http://www.rurdev.usda.gov/utp_infrastructure.html
- Brochure: http://www.rurdev.usda.gov/supportdocuments/telecomloansflyerfactsheet.pdf
- Regulations: http://www.rurdev.usda.gov/supportdocuments/7_cfr_part_1735.pdf

Federal Emergency Management Agency (FEMA)

Homeland Security Grant Program (HSGP)

The Homeland Security Grant Program supports three interconnected grants (totaling $1.12 billion for FY2020) that are intended to enhance national preparedness capabilities: the State Homeland Security Program, the Urban Areas Security Initiative (UASI), and Operation Stonegarden (OPSG). Of these, the State Homeland Security Program (SHSP) holds the greatest promise, though it is not likely to be a substantial funding source.

For 2020, the funding priorities of the three programs are:

1) Enhancing cybersecurity (including election security);
2) Enhancing the protection of soft targets/crowded places (including election security);
3) Enhancing information and intelligence sharing and cooperation with federal agencies, including DHS; and
4) Addressing emerging threats (e.g., transnational criminal organizations, weapons of mass destruction [WMDs], unmanned aerial systems [UASs], etc.).

State Homeland Security Program (SHSP)

Entities Funded: The SHSP provides funding to all 50 states. States typically solicit project proposals from State, County and local government agencies and prioritize projects they want to submit for funding. Funding amounts to states and awards are based on risk, and effectiveness of overall state proposal which pools local projects.

Nature of Award: Grant.

FY 2020 Resources: While funding remains substantial, it has declined considerably in recent years. Funding in fiscal year 2011 ($526,874,100) was 50 percent of funding the previous year—and has been reduced still further. In 2020, $415,000,000 was made available.

Typical Grant Award: Grant awards vary significantly and their sizes are largely at the discretion of the individual state who will decide what projects to support at what levels to meet the state allocated budget.

Cost-Share Requirement: None

Applicable Deadlines: The deadline for FY 2020 applications was April 30, 2020.

Program Mission: SHSP assists state, local, tribal, and territorial efforts to build, sustain, and deliver the capabilities necessary to prevent, prepare for, protect against, and respond to acts of terrorism.

Projects Funded: Projects submitted by the State should align with the funding priorities.

Restrictions: In addition to the program priorities, at least one project must address election security, and states are required to prioritize projects focused on intelligence sharing and fusion centers.

Key Links:

- Summary of all HSGP programs: http://www.fema.gov/fy-2014-homeland-security-grant-program-hsgp
- Frequently Asked Questions addressing all HSGP programs: http://www.fema.gov/media-library-data/1395150571234-0b433243a3e4c6cd0a5346e807a591c0/FY_2014_HSGP_FAQs_Final.pdf
- HSGP fact sheet: http://www.fema.gov/media-library-data/1395150379152-78b9ca072f888d611d122ec8ea9fd079/FY_2014_HSGP_Fact_Sheet_Final.pdf
- FY 2020 Funding Opportunity Announcement: https://www.fema.gov/media-library-data/1583442273016-07cbcf9445f9fda3cdc5bf8439ec72c9/FY_2020_HSGP_NOFO_FINAL_508ML4.pdf

Urban Area Security Initiative (UASI) and Operation Stonegarden

Entities Funded: The only entity eligible to submit applications is the State Administrative Agency, which can submit on behalf of eligible UASI areas or selected applicants. For FY2020, OPSG,

Entities eligible for funding are the state, local, and tribal law enforcement agencies that are located along the border of the United States.

Nature of Award: Grant

FY 2020 Resources: $615,000,000; $90,000,000

Typical Award Size: Target allocations are set for each state and territory.

Cost-Share Requirement: None

Applicable Deadlines: April 30, 2020

Program Mission: To enhance the ability of governments and nonprofits to prevent, protect against, and respond to and recover from terrorist attacks.

Projects Funded: Projects can support core capacities, the continuity of operations, cybersecurity, law enforcement, and terrorism prevention, as well as the development of community partnerships. Funds can be used for planning, organization, personnel, equipment, networks, training, and exercises. Funding will be awarded based on risk and the anticipated effectiveness of the proposed use of grant funds.

Key Links:

- Notice of Funding Opportunity: https://www.fema.gov/media-library-data/1583442273016-07cbcf9445f9fda3cdc5bf8439ec72c9/FY_2020_HSGP_NOFO_FINAL_508ML4.pdf
- FEMA Preparedness Grants Manual: https://www.fema.gov/media-library-data/1581623378002-f8280c8c1ab2e38f650fe67289764826/FEMA_PreparednessGrantsManual_21320_1605_508c.pdf

Emergency Management Performance Grants (EMPG)

Emergency Management Performance Grants appear to extend to broadband deployment. Because allocations are population-based, this is unlikely to be a substantial funding source for some counties. Nonetheless, this may be an option worth exploring with the state Emergency Management Agency.

Entities Funded: FEMA awards Emergency Management Performance Grants (EMPG) directly to all 50 states. A single state application is accepted from the State Administrative Agency (SAA) or

the State's Emergency Management Agency (EMA) on behalf of state and local emergency management agencies.

Nature of Award: Grant.

FY 2020 Resources: $355.1 million was initially made available for FY 2020, and $100 million was added to the program for Covid-19 supplemental support.

Typical Grant Award: Grants are distributed based on population.

Cost-Share Requirement: The EMPG Program has a 50-percent federal and 50-percent state cost-match requirement. The state match can be made with in-kind contributions, but cannot be met with other federal funds.

Applicable Deadlines: FY 2020 applications were due April 15, 2020.

Program Mission: Emergency Management Performance Grants are given to intra- and inter-state emergency management systems that encourage partnerships across all levels of government and with non-governmental organizations. Grants are given "for the purpose of providing a system of emergency preparedness for the protection of life and property in the United States from all hazards and to vest responsibility for emergency preparedness jointly in the federal government and the states and their political subdivisions."

Projects Funded: Broadband is identified as an eligible project: "Emergency communications activities include the purchase of interoperable communications equipment and technologies such as voice-over-Internet protocol bridging or gateway devices or equipment to support the build out of wireless broadband networks."

Restrictions: Grants must be expended during a 24-month period of performance.

Key Links:

- Fact sheet: http://www.fema.gov/pdf/government/grant/empg.pdf
- Guidance and application kit: http://www.fema.gov/pdf/government/grant/2011/fy11_empg_kit.pdf
- FY 2020 Notice of Funding Opportunity: https://www.fema.gov/media-library-data/1581717192496-3736b5626f11012c3750de5efb6a4d37/FY_2020_EMPG_NOFO_FINAL_508SA2.pdf

Federal Communications Commission

Rural Digital Opportunity Fund (RDOF)

Entities Funded: Open to those with an Eligible Telecommunications Carrier designation (or who will get one).

Nature of Award: Reverse auction subsidy

FY 2020 Resources: The total RDOF program budget is $20.4 billion over ten years; the Phase I auction has a budget of $16 billion and Phase II will distribute the remainder (at least $4.4 billion).

Typical Award: Awards are given via a reverse auction, in which applicants bid to serve an area with a certain amount of money from the FCC. Bidders who propose to provide service with the smallest subsidy (after applying other evaluation weights) will be awarded the bid.

Cost-Share Requirement: None

Applicable Deadlines: The Phase I auction is scheduled to begin October 22, 2020. Short form applications are likely due in July.

Program Mission: RDOF is a two-phase reverse auction program that will target funds to rural America for the buildout of broadband infrastructure.

Projects Funded: The Phase I auction will target census blocks that are entirely unserved by 25/3 Mbps broadband. Phase II will include census blocks that are partially served, as well as locations that aren't funded in Phase I. Eligibility is determined using Form 477 data and the Connect America Cost Model (CAM). Areas lacking 10/1 Mbps and Tribal areas are given priority. The minimum performance tier is 25/3 Mbps and the baseline performance tier is 50/5 Mbps. Additional performance tiers exist for 100/20 Mbps and 1 Gbps/500 Mbps service.

Restrictions: Must provide both voice and broadband service. Recipients are also required to offer standalone voice service, and to ensure that voice and broadband services are offered at costs comparable to rates in urban areas.

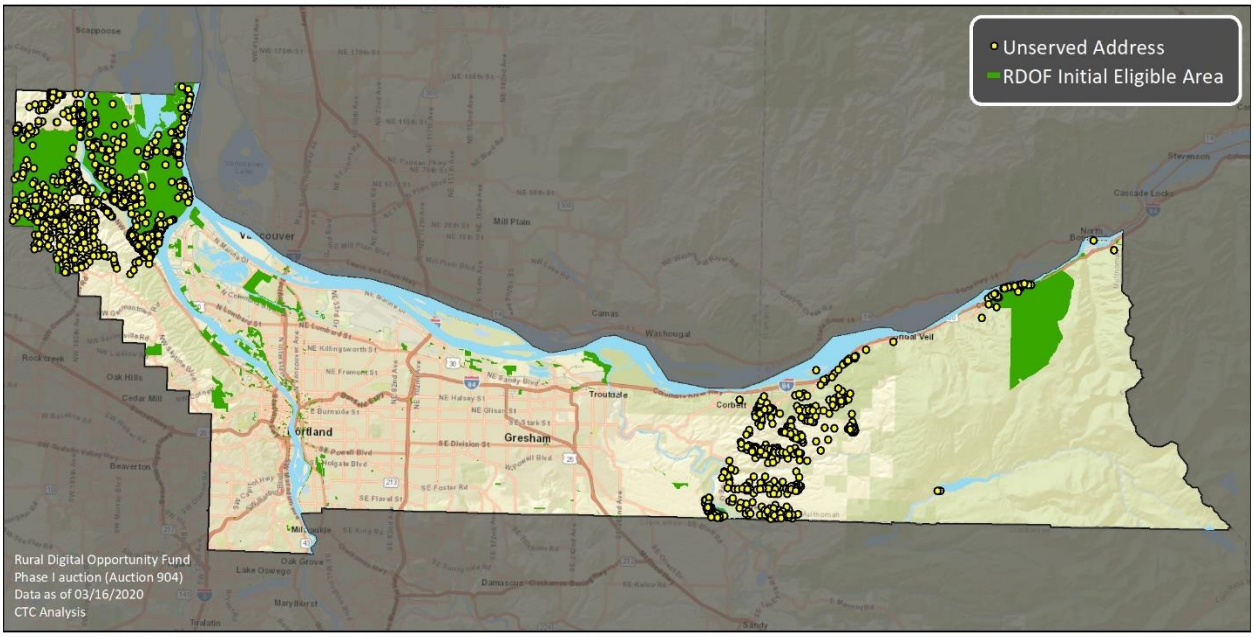
Key Links:

- General information: https://www.fcc.gov/implementing-rural-digital-opportunity-fund-rdof-auction
- Report and Order: https://docs.fcc.gov/public/attachments/FCC-20-5A1.pdf

Geographic Eligibility in Multnomah County:

Figure 191 illustrates the census block groups the FCC has determined are eligible for the reverse auction in 2020 in Multnomah County.

Figure 191: Census Blocks and Addresses Eligible for Rural Digital Opportunity Fund



Connected Care Pilot Program

Entities Funded: Eligible nonprofit and public healthcare providers

Nature of Award: Grant

FY 2020 Resources: $100 million will be made available over three years

Typical Award: There is no floor or ceiling for the requested grant amount. Awards are given for a three-year duration, plus up to six months for project set-up and six months for project close-out.

Cost-Share Requirement: A 15 percent match is required from awardees. The match can be from participating patients, healthcare providers, or government or non-profit grants, but cannot be from vendors. Awardees cannot also receive grants for broadband from the Healthcare Connect program for the same purpose.

Applicable Deadlines: Application hasn't been released yet.

Program Mission: This program is intended as a three-year pilot to help understand the future of Universal Service Fund use and how the fund can support connected care and telehealth over

the long term. The program defrays costs for healthcare providers to provide connected care services, especially for low-income and veteran patients.

Projects Funded: Pilot projects that provide broadband connectivity, network equipment, and information services One goal of the program is to use funded projects as data sets to understand impacts, so the program will likely favor projects that target a sufficiently large amount of patients to be able to analyze and aggregate data.

Restrictions: The program does not provide support for health care providers' administrative costs associated with participating in the pilot program, doctor or staff time spent on the pilot program, or other miscellaneous costs.

Key Links:

- Report and Order: https://docs.fcc.gov/public/attachments/FCC-20-44A1.pdf

Rural Health Care Program

The Rural Health Care Program (RHC) provides funding to eligible health care providers (HCPs) for telecommunications and broadband services necessary for the provision of health care. RHC is comprised of three programs: the Healthcare Connect Fund, the Telecommunications Program, and the Rural Health Care Pilot Program. Of these, the Healthcare Connect Fund (HCF) seems most promising. While none of these programs support comprehensive broadband deployment, they may provide useful resources to support eligible health care providers. Although the Rural Health Care Program has an annual cap for funding, the program has never reached the cap, and often has millions of dollars that go uncommitted. Applicants who submit their funding requests early have a high likelihood of obtaining the maximum financial benefit. In the Telecommunications Program, funding is calculated based on the urban-rural differential for the cost of service. In the Healthcare Connect Fund Program, funding is provided at a flat 65 percent rate for all eligible services.

The Healthcare Connect Fund (HCF) provides support for high-capacity broadband connectivity to eligible health care providers (HCPs) and encourages the formation of state and regional broadband HCP networks. Through the HCF Program, eligible HCPs can obtain a discount on eligible expenses, including broadband connectivity and equipment necessary to make the broadband functional. For HCPs that apply as consortia, the HCF Program will also provide support for upfront charges associated with service provider deployment of new or upgraded facilities to provide requested services, dark or lit fiber leases or IRUs, and self-construction where demonstrated to be the most cost-effective option.

Entities Funded: HCF applies to eligible rural healthcare providers, and those non-rural providers that are members of a consortium consisting of majority rural (more than 50 percent) HCP sites. To receive discounts in any of the rural health care programs, health care providers must be public and not-for-profit. "Health care provider" is defined by statute as hospitals, rural health clinics, local health departments, community health centers or health centers providing health care to migrant workers and post-secondary educational institutions offering heath care instruction, teaching hospitals, and medical schools. Ineligible HCP sites (i.e., those that are not public and not-for-profit) may still participate in a consortium and take advantage of bulk-buying, but must pay their fair share (they will not get a discount from USAC). Individual providers can determine whether they are located in a rural area through a look-up tool on USAC's website (http://www.usac.org/rhc/telecommunications/tools/Rural/search/search.asp).

Nature of Award: There are two principal sub-programs in the Rural Health Care Program—the Healthcare Connect Fund and the Telecommunications Program—and the award amount depends on which program the applicant chooses to participate in. The HCF program provides a subsidy (65 percent) to eligible institutions for telecommunications and Internet services. For HCF consortia applicants, this subsidy extends to fiber and expenses related to network design, engineering, operations, installation, and construction of the network. In the Telecommunications program, the subsidy is based on the urban-rural differential cost of services.

FY 2020 Resources: Funding is stable as resources are not subject to appropriations. The Rural Health Care Program was authorized in the 1996 Telecommunications Act and FCC and is funded through the Universal Service Fund. As of FY 2017, annual funding is capped at $571 million, adjusted each year for inflation.

Typical Grant Award: In the HCF Program, all eligible HCP facilities receive a discount of 65 percent on eligible expenses. The Telecommunications Program funds the urban rural rate differential for telecommunications services.

Cost-Share Requirement: In the Healthcare Connect Fund Program, eligible providers can receive a 65 percent discount from the fund on all eligible expenses and are required to contribute the remaining 35 percent to participate. In the Telecommunications Program, eligible providers are required to pay the remaining costs after the subsidy (calculated by the urban-rural differential) has been credited.

Applicable Deadlines: The Rural Health Care Program funding year runs from July 1 through June 30 of the following year. Although funding requests may be submitted through the last day of the funding year, applicants are encouraged to submit funding requests during the initial funding

request filing period, which runs from March 1 through May 30. All funding requests filed within the initial "filing period" will be treated as though simultaneously filed. Funding requests filed after the initial filing period will be treated on a rolling, first-come, first-served basis, and may be filed until the end of the funding year. Prior to submitting a funding request, applicants are required to allow 28 days for competitive bidding before selecting a service provider.

Program Mission: The Rural Health Care Program is intended to reduce the disparity in cost between rural and urban telecommunications and Internet services used for the provision of health care at eligible facilities. The Healthcare Connect Fund expands provider access to broadband services, particularly in rural areas, and encourages the formation of state and regional broadband networks linking health care providers.

Projects Funded: HCF supports any advanced telecommunications or information service that enables HCPs to post their own data, interact with stored data, generate new data, or communicate, by providing connectivity over private dedicated networks or the public Internet for the provision of health information technology. Coverage extends to cloud-based connectivity services; last-mile, middle-mile and backbone services; fiber (and maintenance costs); Internet2 and connections to research and education networks; network equipment; and network design, engineering, operations, installation, and construction of the network.

Restrictions: To receive funding through the Telecommunications Program, facilities must be located in a rural area. Non-rural HCP facilities may receive funding through the Healthcare Connect Fund Program if they participate in a majority rural consortium. To determine if the HCP facility is located in a rural area, see the Eligible Rural Areas search tool on the Rural Health Care Program website: http://www.usac.org/rhc/telecommunications/tools/Rural/search/search.asp

Key Links:

- General background: http://www.usac.org/rhc/
- Fact Sheet Comparing the Telecommunications Program and the Healthcare Connect Fund Program: http://www.usac.org/_res/documents/rhc/pdf/handouts/RHC-Program-Comparison.pdf
- Fact Sheet for the Healthcare Connect Fund Program: https://apps.fcc.gov/edocs_public/attachmatch/DOC-319092A1.pdf
- Fact Sheet: https://apps.fcc.gov/edocs_public/attachmatch/DOC-319092A1.pdf
- Frequently Asked Questions about HCF: http://www.usac.org/_res/documents/rhc/pdf/fcc/FCC-HCF-FAQs.pdf

- FCC Order on HCF: http://usac.org/_res/documents/rhc/pdf/fcc/13.02.25_Linked_Order.pdf#page=3

Rural Health Care Pilot Program (now transitioning to Healthcare Connect Fund)

The Rural Health Care Pilot program was funded by the FCC at a not-to-exceed cap of $417 million. This program provided 85 percent of the costs for eligible construction, equipment, leased services, etc. of new regional or statewide networks to serve public and non-profit health care providers in areas of the country where broadband is unavailable or insufficient. As of June 2014, the Pilot Program has successfully distributed over $238 million to 50 projects with an affiliated 3,800 health care providers. The Pilot Program is limited to consortia that were selected in the Rural Health Care Pilot Program Selection Order, so opportunities to participate may be limited.

Entities Funded: The Rural Health Care Pilot Program has funded 50 projects around the country with an affiliated 3,800 health care providers. This includes construction, leased services, IRUs and equipment. The Pilot Program is limited to consortia that were selected in the Rural Health Care Pilot Program Selection Order. However, eligible health care providers not represented in the selected consortia applications may pursue ways to be included in their networks which are eligible for Pilot Program funding, if funding in a project is still available. Potential recipients under the Healthcare Connect Fund include acute-care facilities that provide services traditionally provided at hospitals, and renal dialysis centers and facilities and administrative offices and data centers that do not share the same building as the clinical offices of a health care provider but that perform support functions critical for the provision of health care.

Nature of Award: Subsidy to reduce the cost of service in rural areas.

FY 2020 Resources: Funding is through the Universal Service Fund (i.e., surcharges on telephone bills), rather than Congressional appropriations. In June of 2018, the FCC issued an order that increased the annual RHC Program funding cap to $571 million, to annually adjust the cap for inflation, and to establish a process to carry-forward unused funds from past years for use in future years. For FY 2020, the program cap was $604,759,306.

Typical Grant Award: The Healthcare Connect fund provides a flat 65 percent subsidy for all eligible services. This includes monthly recurring costs for access to broadband services, construction, equipment etc. These funds are distinct from—and unaffected by—the new Connect America Fund.

Cost-Share Requirement: The Healthcare Connect fund provides a flat 65 percent subsidy for all eligible services. Health care providers are responsible for the additional 35 percent.

Applicable Deadlines: Applications for Funding Year 2020 for the HCF Program are being accepted. More information can be found here.

Projects Funded: The Pilot Program covered both traditional telecommunications and broadband. The Rural Healthcare Program provides for ATM, Centrex, DSL, e-mail, Ethernet, fiber, fractional T1, frame relay, Internet access charges, ISDN, mileage-related charges, monthly Internet access charges, MPLS, NRS, OC-1 or OC-3, redundant circuit, satellite service, telephone service, T1, T3 or DS3. The program would provide support for the construction of state or regional broadband health care networks that can, for example, connect rural and urban health-care providers; facilitate the transmission of real-time video, pictures, and graphics; bridge the silos that presently isolate relevant patient data; and make communications resources more robust and resilient. Broadband infrastructure projects could include either new facilities or upgrades to existing facilities. In addition, funding could be used to support up to 85 percent of the cost of connecting health-care networks to Internet2 or National LambdaRail (NLR), both of which are non-profit, nationwide backbone providers.

Restrictions: Providers receiving resources from the current Telecommunications Program (to subsidize rates paid by rural health care providers for telecommunications services to eliminate the rural/urban price difference for such services within each state) would not be eligible to receive support under this program for the same service. Health care providers that did not receive funding under the current Rural Health Care Pilot Program could apply, assuming that they met the general eligibility criteria for the program. Funding is limited to rural areas for individual applicants. Consortia can have non-rural participants as part of their network.

Key Links:

- General background: www.usac.org/rhc

E-Rate Program – USF Schools and Libraries Program ("E-Rate")

The E-rate program provides support to schools and libraries by partially funding the cost of broadband services (and, in some cases, the cost of construction of fiber laterals), representing an important revenue source for communications providers such as utilities.

Entities Funded: Funding is provided to eligible schools, school districts and libraries (either individually or as part of a consortium). Funds are distributed to both public and private schools, as long as they provide primary or secondary education, operate as a non-profit business, and do not have an endowment exceeding $50 million. Eligible libraries must be eligible for assistance from a state library administrative agency under the 1996 Library Services and Technology Act. Generally, libraries are eligible if their budget is separate from a school and they do not operate as a for-profit business. Applicants can determine whether a school or library has filed a Form

470 to initiate the application process by searching the website (submitted forms can be searched by year and zip code at:

http://www.slforms.universalservice.org/Form470Expert/Search_FundYear_Select.aspx).

Nature of Award: Funding is provided through the Universal Service Fund in the form of a subsidy on the eligible facility's telecommunications expenses. The size of the subsidy varies, as elaborated below and may cover both Internet service and infrastructure.

FY 2020 Resources: Funding is stable as resources are not subject to appropriations. E-rate program funding is based on demand up to an annual cap of about $4.15 billion (modified annually to account for inflation). Note that the E-rate program is a distinct program from the Connect America Fund; as such, resources are unaffected by the CAF. Resources for any given school or library are determined based on levels of rurality and poverty in the relevant district.

Typical Grant Award: E-Rate provides a discount on eligible services, with the size of the discount (ranging from 20 to 90 percent) dependent on the level of poverty and the urban/rural status of the population served. The funding level can be determined from the matrix available on the E-rate website (http://www.usac.org/_res/documents/sl/pdf/samples/Discount-Matrix.pdf). The primary measure for determining Schools and Libraries support discounts is the percentage of students eligible for free and reduced lunches under the National School Lunch Program (NSLP), calculated by individual school. For instance, if 70 percent of the students at the relevant school are eligible for NSLP, E-rate will reimburse 80 percent of the costs for eligible services.

Cost-Share Requirement: E-rate discounts range from 20 to 90 percent, with higher discounts for higher poverty and more rural schools and libraries. Schools and libraries are always responsible for paying at least some part of the cost of service.

Applicable Deadlines: The application process typically begins in July (Form 470) and continues throughout the year. A flowchart depicting the general process (without dates) is available online (http://www.usac.org/_res/documents/sl/pdf/handouts/Applicant-Process.pdf).

Program Mission: The program is intended to reduce the disparity between rural and urban broadband services. The program is intended to ensure that schools and libraries have access to affordable telecommunications and information services.

Projects Funded: The Schools and Libraries Program is designed to support connectivity - the conduit or pipeline for communications using telecommunications services and/or the Internet. Funding is requested from providers under four categories of service: telecommunications services, Internet access, internal connections, and basic maintenance of internal connections. Eligible services include both equipment (fiber) and access. (USAC maintains a complete

description of eligible services (available online: http://www.usac.org/_res/documents/sl/pdf/ESL_archive/EligibleServicesList-2014.pdf). The E-rate helpline notes that eligible applicants are virtually assured funding to assist with Priority 1 projects (i.e., telecommunications, telecommunications services and Internet access services).

Restrictions: Facilities need not be located in rural areas, though funding levels will increase based on poverty and rural status.

Key Links:

- To submit questions about the program: http://www.usac.org/about/tools/contact-us.aspx
- General background: http://www.usac.org/sl/
- Eligible service list (a comprehensive document with descriptions of all qualifying services): http://www.usac.org/_res/documents/sl/pdf/ESL_archive/EligibleServicesList-2014.pdf
- Training sessions are provided to potential applications in the fall (http://www.usac.org/sl/about/outreach/default.aspx for schedule and links)

U.S. Treasury

New Markets Tax Credit

The New Markets Tax Credit (NMTC) may provide a source of revenue for broadband investments; however, to qualify, the applicant must identify a Community Development Entity that has an available NMTC allocation and is willing to invest in the project. Moreover, projects must be located in low-income communities (defined below). Even if the applicant can identify a qualifying CDE and a low-income community, the credits are very competitive. Recipients of NMTC financing typically receive favorable terms and conditions on a loan from a CDE (e.g., allowing them to offset up to 39 percent of the cost of the project investment over seven years). Notably, while broadband is consistent with the program mission, only one broadband project appears to have received NMTC funding. The government has expressed an interest in shifting the focus away from real estate, however, which may make broadband projects more desirable going forward.

Entities Funded: The NMTC program permits individual and corporate taxpayers to receive a credit against federal income taxes for making Qualified Equity Investments (QEIs) in Community Development Entities (CDEs), which serve as investment intermediaries. CDEs then use the proceeds that they raise from QEIs to make Qualified Low-Income Community Investments into businesses in qualified communities. CDEs are typically nonprofits, government entities, and

others who provide subsidized financing, whose primary mission is to benefit low-income households. Thus, a utility could receive the credit as a CDE, raise cash representing the value of the credit from investors, and then pass the investment to a developer who would receive a loan with below-market terms and conditions to deploy broadband in a low-income community. The CDE must first apply to the Community Development Financial Institutions Fund within the Department of Treasury for allocation awards. Efforts are made to support rural communities, with nearly 20 percent of NMTC investments going to rural communities through the course of the program.

Nature of Award: The program provides an NMTC allocation to qualifying CDEs. Once a CDE receives an allocation, it can secure investors to make Qualified Equity Investments (QEIs) in exchange for the credit. The investors claim a 39 percent tax credit over seven years, 5 percent annually for the first three years and 6 percent in years four to seven. Having secured this investment, CDEs can then offer preferential rates and terms to developers in low-income communities.

FY 2020 Resources: $5 billion in credits is allocated for CY 2020.

Typical Grant Award: Under IRC §45D(a)(2), NMTC investors claim a 39 percent tax credit over seven years, five percent annually for the first three years and six percent in years four to seven. Thus, if a CDE receives a $2 million NMTC allocation, an investor can claim a NMTC equal to 39 percent of $2 million (or $780,000). In essence, an investor in the NMTC program gets 39 cents in tax credits during the seven-year credit period for every dollar invested and designated as a QEI. These benefits, in turn, are transferred to developers who receive loans with below market-rate terms and conditions for their activities. Through 2013, there have been 11 NMTC allocation rounds.

As of August 2019, the CDFI Fund had made a total of 1,178 NMTC allocation awards totaling $57.5 billion in allocation authority, reflecting a 30 percent applicant award rate since the program's inception.

Cost-Share Requirement: There is not technically a cost-share, though the tax credit merely offsets expenses (so recipients are still responsible for 61 percent of project costs).

Applicable Deadlines: The funding window for new applicants is initiated with a Notice of Allocation Authority in the Federal Register and collected for several months. The credit then applies for a seven-year cycle, which begins on the date the Qualifying Equity Investment is initially made. The 2019 application cycle opened in September and closed in October; while the 2020 program announcement has not yet been made, it is anticipated to be released in the summer of this year.

Program Mission: The NMTC provides tax incentives to induce private sector, market-driven investments in businesses and real-estate developments in economically distressed communities.

Projects Funded: While "substantially all" (85 percent or more) of a CDE's investments must be targeted to the low-income service area identified by the CDE, there is significant flexibility in the types of businesses and development activities that NMTC investments support—including community facilities such as child care or health care facilities and charter schools, manufacturing facilities, for-profit and nonprofit businesses, and home-ownership projects. In 2011, an NMTC award was used to support a broadband project in rural Alaska.

Restrictions: The NMTC is only given to projects that benefit "a low-income community" (LIC), defined as any population census tract where the poverty rate for such tract is at least 20 percent or in the case of a tract not located within a metropolitan area, median family income for such tract does not exceed 80 percent of statewide median family income, or in the case of a tract located within a metropolitan area, the median family income for such tract does not exceed 80 percent of the greater of statewide median family income or the metropolitan area median family income. At least 85 percent of the investment must be made in a low-income community.

Key Links:

- Background information (from IRS): http://www.irs.gov/pub/irs-utl/atgnmtc.pdf
- Introduction to the New Markets Tax Credit Program: https://www.cdfifund.gov/Documents/2019%20Introduction%20to%20the%20NMTC%20Program-Final.pdf
- Program Fact Sheet: https://www.cdfifund.gov/Documents/NMTC%20Fact%20Sheet_Jan2018.pdf
- Program Page: https://www.cdfifund.gov/programs-training/Programs/new-markets-tax-credit/Pages/default.aspx

Department of Health and Human Services

Telehealth Network Grant Program

Entities Funded: Eligible applicants include public and private non-profit entities, including faith-based and community organizations, as well as federally-recognized Indian tribal governments and organizations.

Nature of Award: Grant

FY 2020 Resources: $8.7 million

Typical Award Size: Awards are limited to $300,000 per applicant, subject to the availability of appropriated funds.

Cost-Share Requirement: None

Applicable Deadlines: Applications are due June 15, 2020

Program Mission: The program is designed to promote tele-emergency services with an emphasis on tele-stroke, tele-behavioral health, and tele-emergency services (tele-EMS).

Projects Funded: Proposed projects should enhance telehealth networks to deliver 24-hour Emergency Department consultation services via telehealth to rural providers without emergency care specialists. Composition of the telehealth network must include at least one community-based healthcare provider. Services must be provided to rural areas, though applicant can be located in an urban area.

Restrictions: Grant funds cannot be used for construction or to buy property or equipment. If indirect costs are included in the budget, an indirect cost agreement will be required.

Key Links:

- Notice of Funding Opportunity: https://grants.hrsa.gov/2010/Web2External/Interface/Common/EHBDisplayAttachment.aspx?dm_rtc=16&dm_attid=f6d93ca0-413f-4edf-a2fb-3870c81526a3

Appendix E: Project Scope of Work

Per the County's contract with CTC, the appendix comprises the project scope of work (including deliverables).

MULTNOMAH COUNTY SERVICES CONTRACT

Contract Number 44000003956

EXHIBIT 1
Statement of Work #2

This STATEMENT OF WORK #2 is attached and incorporated into the Multnomah County Contract ("Contract") bearing the Contract number listed above and entered into by the parties effective on the Effective Date set forth therein, and sets forth the deliverables and other professional, technical, creative, and/or other services that Contractor will provide to County under the Contract. Capitalized terms used but not defined in this SOW shall have the meanings given to them in the Contract.

BACKGROUND:
Multnomah County has entered into an Inter-Governmental Agreement with the Cities of; Fairview, Gresham, Portland, Troutdale, and Wood Village (each individually a "Member Agency" and collectively "Partner Agencies"), to assess the feasibility of a high-speed fiber-to-the-premises (FTTP) network ("Municipal Broadband") for residential and business use, in the geographic area encompassing Multnomah County, Oregon ("Geographic Area").

SUMMARY:
County desires to engage Contractor for additional Work under the Agreement. Contractor will provide Consultation Services to County in conducting a feasibility assessment for a Municipal Broadband network ("Project"). The Project's deliverable is a comprehensive, investment-grade feasibility analysis and plan for the deployment of Municipal Broadband in the Geographic Area described herein, including business modeling that evaluates both public sector operations and public-private partnerships. The deliverable will be contained in a report that sets forth Contractor's analysis and plan for the Municipal Broadband network (the "Project Report"), and contains as an attachment the SOW describing Contractor's recommended Project scope and deliverables for said deployment.

PROJECT SCOPE:
The Project Report should include, but need not necessarily be limited to, the following:

a. *Assess and evaluate each Member Agency's current network capabilities and the Partner Agencies' combined infrastructure landscape.*
   This task begins with an engineering assessment of existing fiber and other broadband-enabling infrastructure (owned and leased) and should result in an inventory of each Member Agency's existing, relevant assets and facilities (e.g., towers, wireless facilities, fiber, conduit) and coverage.

Infrastructure Analysis

To the extent feasible given publicly available information and details provided by the Partner Agencies, we will assess the Partner Agencies' existing broadband infrastructure assets (owned and leased).

We will conduct this assessment through desk surveys. We will also facilitate technical discussions with Partner Agencies' engineers about related issues, such as:

- Poles (number per mile, suitability for additional attachment, etc.)
- Underground passageways (availability of conduit, suitability for additional fiber, etc.)
- Existing fiber optics, including any existing connectivity (building entry, etc.)

We will review relevant maps, studies, documents, or data that the Partner Agencies can share with us. A CTC outside plant engineer will then conduct an extensive desk survey using GIS maps, Google Earth imagery, and other relevant sources.

Network Capabilities Analysis

In parallel with our infrastructure analysis, we will seek to evaluate the Partner Agencies' existing internal network infrastructure—both the parts the Agencies own and operate, and the part they lease. We will evaluate how to maximize the Partner Agencies' internal operations and capabilities over time for government communications, as well as for the provision of public-facing broadband service.

Drawing on maps, as-builts, budgets, financial statements, and other relevant inputs that the Partner Agencies provide, we will analyze the Partner Agencies' current technical capacities (including sites served, current and likely future capabilities, expansion plans, and so on) and the networks' financial implications (including not just costs incurred, but the expenses that the networks enable the Partner Agencies to avoid).

b. Assess the broadband service options in the Partner Agencies' market(s).

This task is a survey and analysis of the existing and emerging high-speed Internet service offerings in the Geographic Area. The result should be a profile that details the types of services, pricing, availability, and limitations of the existing network for the collective telecommunications environment of the Partner Agencies across the Geographic Area as well as individual profiles broken out per Member Agency where applicable.

We will analyze the current competitive environment for residential broadband services in the Geographic Area, with an emphasis on understanding service availability and identifying service gaps in the unincorporated areas.

In this task, we will seek to document what providers are active, what services are available, and what residents pay for varying levels of service. We propose here an innovative, multi-faceted, approach to assessing the competitive landscape based on publicly available information.

We propose to look at a wide range of datasets in part because so much of the existing broadband availability data, particularly that gathered by the federal government, is inaccurate and grossly overstates availability. As the U.S. Government Accountability Office has pointed out, the FCC's data overestimates broadband availability because it is insufficiently granular and is self-reported by carriers.

For this reason, we are proposing to evaluate, test, and incorporate a wide range of different sources of data—understanding that each is likely to have different importance and usefulness for this project—and with the intent of building a comprehensive picture based on a larger set of sources. We will:

- **Develop a list of current broadband providers**, including their costs for services, based on publicly available information. The geographic presence of individual broadband providers will be evaluated at a relatively high geographic level using a spot-check methodology based on jurisdictional boundaries.
- **Evaluate available FCC Form 477 data** about broadband services available in the Geographic Area. There is tendency for internet service providers (ISP) 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 black meets the FCC's requirement. In the case of this analysis, that overstatement may be to our advantage; if we find census blocks within the Geographic Area that are shown as being unserved, then we can be certain that the residents there truly are unserved.
- **Evaluate Connect America Fund (CAF II) funding areas**. Evaluating the FCC's maps and data related to CAF II funding in the County will provide useful data on areas deemed unserved or underserved by that program. Given the 10-year buildout window for entities receiving CAF II funding, we note that unserved areas that are subject to an award may still be unserved for many years.
- **Evaluate the USDA Rural Utilities Service's map of served and unserved areas**, which is based on a range of different datasets. In our view the map is under-inclusive of the unserved portions of the country but provides another set of insights to add to our broader analysis.
- **Identify and analyze relevant Member Agency datasets.** In our experience local governments have access to datasets that can give them considerable insight into where communications infrastructure exists in their communities. However, using those data to understand the big picture requires innovative analysis. We specialize in understanding how otherwise underutilized datasets can provide insight about broadband availability. We will work with the Partner Agencies to identify and develop

the most useful data—potentially including permitting, public works, and public safety communications datasets.

- **Identify and analyze relevant commercial datasets**. There exist a range of commercial datasets of different levels of usefulness that provide insight into broadband infrastructure and availability. For example, FiberLocator is a commercial service to which we subscribe that aggregates data about known backbone fiber routes in the United States. In addition, some companies, like Zayo, publish maps of their enterprise fiber in order to communicate where they can provide enterprise-level service. We will incorporate these important datasets into our full analysis.
- **Review existing cable franchise agreements throughout Multnomah County**, which will tell us where the cable companies are obligated to build and where lower population density has resulted in them not having an obligation. To complement this review, we will analyze the Partner Agencies' GIS-based population density data to identify areas where cable infrastructure is required. (Some of the areas where we expect to see underserved residents are the pockets of lower-density housing development in the County's incorporated areas.)
- **Conduct an extensive desk survey** using the Partner Agencies' GIS maps, Google Earth imagery, and other relevant sources. We will use the desk survey to spot check and verify the other datasets in order to develop the most accurate and comprehensive overview of service availability.
- **Conduct outreach to local private providers** to gather input on their service areas, their perceptions of service gaps, and their plans for expansion.
- **Review other relevant maps, studies, documents, or data** that the Partner Agencies can share with us.
- **Review broadband speed data collected by Measurement Lab (M-Lab)**, a consortium led by academic and public interest entities that was founded by our close collaborators at New America's Open Technology Institute. The M-Lab broadband speed dataset is considered the most comprehensive and authoritative in the country and has no commercial elements, thus ensuring the independence of the data. M-Lab was co-founded by our colleague and proposed collaborator on this project, Dr. Sascha Meinrath, the Palmer Chair in Telecommunications at Penn State University.
- **Estimate demand based on the results of our survey work in other communities, Pew research, and other reputable data sources**. We have performed broadband demand surveys for more than 20 years. We will assess these datasets to identify demographic patterns that may align with the Geographic Area.

Based on all these different inputs, we will build an estimate of where there is broadband and where there is not within the unincorporated parts of the County. Ideally, we will be able to use this multi-step analysis to develop a map that visually approximates what kind of services are available in each part of the County—to supplement and confirm the results of our other data gathering tasks.

c. *Assess the Partner Agencies' current and foreseeable MUNICIPAL BROADBAND network needs, including "middle mile" and "last mile" service.*
This task includes an analysis of how and whether the Partner Agencies' existing Internet service offerings meet community needs and a projection, based on input from the Partner Agencies, regarding how existing need may change based on a change in demand, services, and (network) technology. This assessment, will target the needs of; (a) the collective Partner Agencies across the Geographic Area, (b) each Member Agency's internal needs (i.e., its various departments and agencies), (c) other public agencies in the Geographic Area, (d) business partners in the Geographic Area, (e) and commercial users in the Geographic Area. This task should include recommendations for long-term provision to maintain high-speed MUNICIPAL BROADBAND network access and quality in the Geographic Area.

The stakeholders for this engagement include the public sector (including the Partner Agencies and the individual Member Agencies, other regional government agencies, federal agencies, and educational institutions), business customers, institutional stakeholders (representing healthcare providers and other entities), and broadband service providers. Each of these stakeholder groups has different current broadband needs, and will have unique future demands.

In this task, which we will conduct in parallel to the stakeholder outreach efforts (see Task 4, below), we will conduct meetings and teleconferences with representatives of the range of key stakeholders. We will prepare an appropriate list of questions for each interview subject with a goal of understanding their fiber needs, as well as constraints and challenges. We will take detailed notes on the discussions, and will use the insights we develop to inform subsequent project tasks.

We will rely on the Partner Agencies and other agencies and partners to communicate their fiber needs to us. We will work with them to expand and develop it as necessary—but we trust, given the number of agencies and entities with which we will meet, that they will share with us their long-term needs.

d. *Conduct stakeholder outreach.*
This task is a series of workshops and discussions with local (within Multnomah County) and regional stakeholders on issues surrounding high-speed Internet. These events should result in a list of stakeholder issues that inform policy and SOW development.

We believe, through our experience conducting needs assessments for local governments nationwide, that group interviews and one-on-one discussions with stakeholders will produce important insights for the Partner Agencies' analysis of broadband needs. While this approach is qualitative rather than quantitative, it allows for follow-up questions, in-depth discussion, and an exploration of nuanced needs and concerns related to the broadband market.

We will conduct up to 20 on-site interview meetings and teleconferences with representatives of the Partner Agencies' range of key local and regional stakeholders. We will develop the list of stakeholders with the Partner Agencies' guidance.

We will prepare questions for each interview and outreach session with a goal of understanding the stakeholders' broadband needs, constraints, and challenges. We will use the insights we develop to understand the Partner Agencies' broadband priorities and opportunities, and to inform subsequent project tasks.

Our outreach to Partner Agencies' staff will have a specific focus: We will seek to identify their fiber broadband needs, and to develop an anecdotal inventory of opportunities and functions that fiber connectivity might support. This outreach will include, to the extent feasible, an attempt to identify the leased circuit costs that the Partner Agencies' could reduce or eliminate through expanded Partner Agency-owned fiber.

We anticipate conducting the in-person sessions over a period of several days in the County in conjunction with our project kick-off meeting. We suggest holding discussion groups in the afternoon and the evening. We will facilitate up to five discussion groups over three days in the County and several more by teleconference if necessary.

For all of these meetings, we request the assistance of the Partner Agencies in identifying the participants; determining who should be invited for a discussion group and who should be contacted for individual interviews; scheduling and confirming the meetings; and arranging a suitable location for the discussions.

e. *Conduct customer market research.*
   This task involves compiling recent and relevant, or preparing and distributing new, residential and business surveys that solicit(ed) feedback on:
   a. satisfaction with existing telecommunications, high-speed Internet service and providers;
   b. proposed characteristics of a FTTP network drawn from stakeholder input and policy direction received from the Partner Agencies;
   c. anticipated current and future needs of customers and the community's desire for MUNICIPAL BROADBAND network and services;
   d. community willingness to support and patronize a MUNICIPAL BROADBAND network and services provided by municipal government agencies over commercial providers;
   e. user willingness to pay for alternative service (as provided by municipal government agencies); and
   f. overall interest in obtaining services from one or more new providers.

Using a variety of industry-accepted evaluation methods, we will seek to identify current broadband use and needs among residential and business customers. We propose below a market research approach that we believe, through our experience conducting needs assessments for local governments nationwide, will produce the insights and data that the Partner Agencies request.

In addition to the research we conduct in the County, we will also selectively apply reputable national survey data (e.g., Pew) as well as market research data that CTC has previously collected

through statistically significant surveys conducted in other communities nationwide, to develop a demand estimate for the local market.

Conduct statistically valid residential market survey

We will prepare and distribute a residential market survey on the current and potential future use of broadband by residents in the community. Our market research will be designed to estimate demand for next-generation broadband services, and to gather insight on issues that will impact the Partner Agencies' future plans by:

- Providing statistically valid market data to assist in identifying the potential market for broadband—as well as the risk that the market is not sufficiently large
- Providing market data to encourage private sector involvement in the project
- Establishing residents' needs and concerns
- Understanding residents' views on the role of Partner Agency involvement in providing service
- Identifying residents' price sensitivities and willingness to pay for broadband
- identifying differences among residents based on income level, education level, and other factors
- Understanding customer satisfaction as well as perceptions of current prices and service attributes offered by the existing providers
- Understanding the overall market demand for communications services
- Quantifying the use of high-speed connectivity in the Partner Agencies' jurisdictions
- Determining the number of residents subscribing to a service where it is available
- Gauging demand for alternative broadband services

Recognizing the differences in broadband options between residents of rural areas and residents of urban/suburban areas—and that, statistically speaking, a survey of the County as a whole would be dominated by results from Portland—we will design the survey around three geographic areas:

1. Portland
2. Fairview, Gresham, Troutdale, and Wood Village
3. All other portions of the County (mostly unincorporated)

We will purchase a mailing list and mail a written survey to randomly selected samples of residents from each of the three geographic areas. Based on the sample sizes for each of the geographic areas, we would anticipate receiving approximately 400 responses from each area—which would provide results within a confidence interval of ±5.0 percent for each of the three areas at the 95 percent probability level. That is, 19 times out of 20, the results from the respondents would be within those boundaries as compared to the responses from the entire population.

The survey will require an estimated 12 to 15 minutes to complete. To encourage participation, the survey will be printed as a booklet (which enhances readability) and mailed in a non-standard sized envelope (which increases the likelihood that it will be noticed and opened by the recipients). We will manage all aspects of survey distribution, return mailing, processing, and data analysis.

The residential survey will be designed to collect the following specific responses:

- Basic demographics of the respondent
- Respondent's income
- Number and ages of household residents
- Computer availability and usage rates
- Customer loyalty to existing services
- Satisfaction with current connectivity services and prices
- Interest in next-generation high-speed Internet
- Internet/email use, service, cost, and time since connected
- Use of telephone services
- Use of IP-based video and voice services
- Desired new services
- Motivation to switch communications service providers
- Perceived value of new voice, video, and data services
- Relationship of price vs. willingness to switch providers

In addition to traditional survey questions, we will include:

1. Questions on importance of service attributes versus satisfaction with services. Most surveys only ask for respondents' satisfaction level. Asking questions to determine the importance of aspects of their service allows for an evaluation of whether and where the private provider market is meeting or failing to meet consumers' needs.
2. Questions directed to what the respondents believe the Partner Agencies' role should be in promoting internet access. If a large majority of residents are skeptical of municipal involvement in this area, for example, that is an important piece of data for elected decision-makers.
3. Questions regarding respondents' willingness to switch services for a range of alternative pricing and service scenarios. We believe that the answers to these questions assist in predicting price points and market share.

The Partner Agencies will have an opportunity to review and edit the printed residential survey instrument prior to mailing.

Survey responses will be entered into a database format and analyzed. The raw data will be reviewed and processed following our standard data-cleaning protocol. This might include coding missing responses, establishing new response categories, verifying skip logic, and other steps necessary to ensure a clean and valid dataset.

The residential survey data will be weighted by the age of the respondent to minimize any age bias in the survey results. Because younger residents are much less likely to respond to surveys, "weighting" the survey responses based on the actual (Census) distribution of adult population by age cohort is necessary to minimize response bias. This is especially true for surveys regarding internet technologies and uses that may be more widely adopted by younger residents than by older residents.

Data analysis will include, at minimum, development of frequency tables for all responses and selected cross-tabulations and/or comparisons of mean ratings by geographic area and key demographics. Examples of key cross-tabulations that may be evaluated include:

- Internet connection type by age of respondent
- Internet connection type by geography (urban/suburban/rural or congressional district)
- Internet uses by business type (industry classification)
- Internet connection type by business size
- Satisfaction with vs. importance of internet service characteristics
- Use of telecommuting or distance learning by home internet connection type

Additionally, we will seek to identify key target segments by examining demographic, income, or other relevant drivers. The level of analysis completed will depend on the number of responses and the characteristics of the data collected.

For example, cluster analysis and/or classification trees can be used to segment and profile residents according to their needs or perceptions, and a gap analysis can help us evaluate whether and where the broadband Internet marketplace is meeting or failing to meet expectations for attributes that are important to respondents. That is, including questions about the level of importance respondents assign to various aspects of their service, along with the level of satisfaction with those service aspects, enables us to identify in what areas providers are meeting or failing to meet customers' expectations. An example of this analysis is shown in the following table.

Sample Gap Analysis

	Mean Importance	Mean Satisfaction	GAP <—>	Significance?
Price (n=345)	7.9	7.2	-0.7	Expectations not met
Local office (n=322)	5.0	6.4	1.4	Expectations exceeded

	Mean Importance	Mean Satisfaction	GAP <—>	Significance?
Connection speed (n=343)	8.3	7.6	-0.7	Expectations not met
Connection reliability (n=308)	9.0	8.6	-0.4	Not significant

Prepare Spanish-language survey instrument (optional task, priced separately)
To encourage participation from the Spanish-speaking community, we will produce a two-sided questionnaire booklet in place of the English-only booklet envisioned in the task above. The booklet will have one side in English and the other side in Spanish (with alternate-language instructions on both sides to flip over for the other language). This approach will allow all survey recipients to choose between English and Spanish and maintain confidentiality.

Because the Spanish-language surveys will have the same question numbering and numerical response options, there will be no need for reverse translation; respondents will be able to mail the survey back to CTC (as with English-language survey responses) for analysis.

Support non-English-language survey distribution (optional task, priced separately)
For surveys in non-English languages that are not spoken as extensively as Spanish, we recommend that the Partner Agencies select a limited number of languages that are most widely spoken by potential survey recipients or are otherwise deemed most important to this project. We will print a version of the following notice in up to three languages on the cover of the English or English/Spanish survey instrument: "If you would like to receive this survey in [language], please call [telephone number]." Survey recipients who call will then be able to request a copy of the survey in the language of their choice.

For cost-effectiveness, and to capitalize on the Partner Agencies' local resources, we will ask the Partner Agencies to identify a staff member(s) to field these phone calls, provide the phone number, prepare the survey translations, and mail the survey instruments as requested.

Because the translated surveys will have the same question numbering and numerical response options, there will be no need for reverse translation; respondents will be able to mail the survey back to CTC (as with English-language survey responses) for analysis.

We would anticipate few requests for non-English-language surveys, in which case those respondents would not represent a statistically significant sample. While this methodology may incur additional costs for the Partner Agencies as compared to offering translated surveys online, we recommend offering a written survey instrument—as with the primary survey methodology—

because limiting non-English-language surveys to an online platform may exclude some residents who do not have access to broadband service.

Survey and analyze data about the general business community (online survey)

Across the market research industry, reports indicate that response rates for surveys of businesses have fallen in recent years. As business owners and individuals are bombarded with requests for feedback, there is a sense that being over-surveyed has reduced recipients' willingness to respond even to "important" surveys. Accordingly, we do not believe that the expense of a written business survey will deliver a return on the Partner Agencies' investment.

To seek to develop insight into business' broadband needs and issues—while limiting the Partner Agencies' costs—we will 1) analyze data about businesses in the same three geographic areas identified for the residential survey, and 2) invite businesses to participate in an online survey.

We will purchase a dataset on all local business entities reporting email addresses [47] in Multnomah County from our supplier, InfoUSA. Key data points will likely include the number of employees, the size and location of the facility, annual sales, annual telecommunications expenditures, annual technology spending, and email contact information (for some portion of the businesses in the dataset).

Using the three-part geographic framework established for the residential survey, we will analyze these data based on differentiating factors (e.g., type of business, number of employees, annual telecommunications spending) to determine potential demand patterns. We can make initial estimates of what types of communications services the businesses might be interested in purchasing based on these factors, our experience conducting similar analyses around the country, and insights gained in the previous task.

Next, using email addresses from the dataset we purchase from InfoUSA (which, we note, will be neither complete nor entirely accurate—as is the nature of email lists) and business email lists that are provided to us by the Partner Agencies, we will email an invitation to local businesses to participate in an online survey.

The business survey will include questions such as:

- What types of broadband services do the businesses currently use?
- What limitations do these businesses see with the available services?

[47] Approximately 16,200 records (approximately 15,000 in Portland and 1,200 other regions of the County.)

- What are the businesses' expectations for current and future broadband needs, and how well do current providers meet these needs?
- How aware are businesses of their available broadband options?
- How likely would the businesses be to purchase services from a new provider?

We will administer the survey through an online portal, track survey responses, and remove any duplicates. The raw data will be reviewed and processed following our standard data-cleaning protocol. Survey responses will be entered into a database format and analyzed. Data analysis will include, at minimum, development of frequency tables for responses.

As a caveat for the online business survey results, we note that the level of analysis completed will depend on the number of responses and the characteristics of the data collected. The response rate for the online business survey will typically be much lower than a mail survey response rate—both because of the lack of a comprehensive email list, and because online survey response rates for businesses are typically low.

f. Assess potential for regional coordination and cooperation.
This task involves meeting with other potential regional partners and service providers and assessing their interest in working with the Partner Agencies on a MUNICIPAL BROADBAND network.

Building on our analysis in previous tasks and our knowledge of regional broadband issues, we will assess the Partner Agencies' opportunities for pursuing regional coordination and cooperation to deploy a municipal broadband network. We will explore this over the course of a single group meeting with potential regional partners (which will be coordinated and planned by the County). Based on the information provided by the partners at that meeting, we will evaluate the current regional elements of the Partner Agencies' fiber networks, including, to the extent such features exist, fiber connections to other local governments, co-location/peering sites, and interconnection with regional networks. With that baseline, we will consider opportunities (technical, operational, and otherwise) for achieving the Partner Agencies' goals in concert with regional cooperation, investment, and planning.

g. Engage with potential providers.
Identify and engage potential network provider-partners to:
g. identify entities that can be service providers to end-users;
h. engage providers early to understand network infrastructure and operations; and
i. determine what financial resources and investment providers can bring to the Project.

Discussions with broadband service providers are an opportunity not only to assess total community demand, but also to explore potential partnerships and joint opportunities—and the shared benefit that might result from creative planning. While service providers are typically reluctant to discuss competitive details about their business (e.g., customer demand, take-rates,

future buildout plans), in our experience many providers are interested in partnering with the public sector under a variety of models.

With that approach as our framework, we will seek to have constructive conversations (in person or via telephone) with local middle-mile and last-mile service providers, including incumbent and competitive service providers in the enterprise markets. Our request to discuss broadband planning with local providers will reflect the Partner Agencies' openness to collaborating with these entities to mutual benefit. We will seek to determine what financial resources and investments the service providers might bring to a municipal broadband project. We anticipate engagement with approximately a dozen companies.

h. Provide assessment of benefits/risks, gap analysis, and project map.
This task involves developing cost estimates for the various proposed MUNICIPAL BROADBAND network options, evaluating their cost-based benefits and risks and then considering differences in service levels. Specifically, assessing community benefits and risks through improved and more efficient MUNICIPAL BROADBAND network services (enhancing citizen opportunities for learning, health care, leisure, emergency services, law enforcement and community connections); evaluating the current environment against current and future needs of each Member Agency and collectively of the Partner Agencies, including all identified stakeholders; identifying key issues limiting enhanced MUNICIPAL BROADBAND network expansion; and creating a comprehensive map that provides analysis of the Geographic Area's broadband environment, including clear identification of the areas with the most underserved population.

CTC's engineers will prepare a system-level design and cost estimate for a fiber network to meet the Partner Agencies' stated goals and identified needs. Our design will enable either Partner Agencies' or third-party operations, and multi-phase buildout.

To be clear, we will not be providing a blueprint-level network design or cost estimate. Rather, we will be providing an analysis of existing infrastructure, a conceptual design, high-level maps, and a system-level overview of the potential infrastructure—which in turn will become a roadmap for financial analysis and business modeling, and for future decisions (potentially including detailed engineering and contracting with private sector service providers).

Network Design

As an initial step, we will review Partner Agencies-provided GIS data and any other relevant maps, studies, documents, or data that the Partner Agencies can share with us. With access to relevant data provided by the Partner Agencies, we will evaluate potential opportunities for the Partner Agencies to expand its infrastructure in conjunction with planned construction such as public works projects, traffic signal upgrades, and projects for which permits have been issued for underground construction.

A CTC outside plant engineer will then conduct a desk survey using the Partner Agencies' GIS maps, Google Earth imagery, and other relevant sources.

We will include in our engineering analysis any existing infrastructure (including utility poles, fiber and conduit, but also rights-of-way access and locations for network hubs and other necessary infrastructure) that we believe the Partner Agencies can use to support deployment.

Cost Estimate

CTC will prepare cost estimates and supporting documentation for fiber deployment, inclusive of anticipated construction labor, materials, engineering, permitting, pole attachment licensing, quality control, and testing.

Supporting documentation will include summary tables of key project metrics generated for cost estimation purposes, including estimated fiber plant mileage; number of homes and businesses; and anticipated percentages of aerial versus underground construction. Additionally, CTC will provide a narrative to explain key construction characteristics that impact the cost estimates.

Our intent is that the cost estimates will allow the Partner Agencies to inform future cost estimates for detailed engineering of specific phases, as well as to properly scope construction phases according to particular budgetary constraints.

As is typical in this phase of a fiber construction project, the cost estimates will not be based on a detailed design, environmental assessment, or geotechnical analysis of soil composition. As a result, actual costs may vary due to unknown factors, including: 1) costs of private easements, 2) utility pole replacement and make-ready costs, and 3) subsurface hard rock. We will, of course, incorporate suitable assumptions to address these items based on our experience.

i. Report findings and analysis to Partner Agencies to seek input and guidance on next steps

Following our extensive data collection tasks, we will facilitate an on-site, interactive workshop to report to the Partner Agencies' steering committee and key stakeholders on our findings and analysis. We will cover topics including project status, broadband challenges, service gaps, and other issues identified, researched, and analyzed to this point in the engagement.

Beyond the important aspects of providing a mid-point status update, our primary goal will be to have an interactive discussion of potential solutions given what we will know at this point in the project about the County's challenges. We anticipate emerging from this session with a clear vision for subsequent phases of the project, particularly in regard to aligning potential solutions with identified problems.

To that end, the workshop will be an opportunity for the steering committee to provide direction on what types of solutions to explore, and to work with CTC to calibrate the next steps of the project.

The stakeholders and CTC will work together collaboratively to determine which strategies will be addressed in the following tasks. We will together narrow the options to no more than three strategic options for detailed engineering, business, and financial analysis.

We note, too, that with the exception of the statistically valid market research, for which geographic granularity is described in the statement of work above, all analysis will be based on a countywide strategy and vision rather than the geographic boundaries of the Partner Agencies. Stated otherwise, we understand this project to be focused on the broader needs of the County as a whole, rather than on the individual needs of the Partner Agencies. While we may recommend strategies with geographic concentration based on both gaps and viable opportunities identified through this project, the project as a whole represents a collective effort rather than a series of individual Partner Agency efforts.

j. Recommendation for MUNICIPAL BROADBAND network strategies, business models.

This task involves describing enhanced MUNICIPAL BROADBAND network options and then identifying those models that are recommended approaches. Recommendations should be based on the Contractor's analysis and feedback from the Partner Agencies, stakeholders, and residents and include modeling the option and developing a conceptual network design. Business model strategies must be based on sound and reasonable business cases that can be demonstrated quantitatively through development of a comprehensive financial model that presents the potential benefits and risks of each model. At least one business case should consider options and alternatives for addressing the most underserved areas of the study first.

Business models must also identify at a minimum but not limited to the following:

j. ownership of network, such as:
   i. a network built and operated by the Partner Agencies;
   ii. a network built and operated by the Partner Agencies but with related services provided by another party;
   iii. a network built and services offered by another party or in partnership with another party.
k. management and operation of network;
l. capital investment required (i.e., amount, timeframe, responsible party);
m. assets required (alignment with inventory of assets and inventory); and
n. potential services and partners.

Business model strategies to be considered should include at a minimum:

o. municipal retail – residential only;
p. municipal retail – residential and commercial;
q. municipal retail – commercial only;
r. open access provider;
s. municipal broadband partnership;
t. infrastructure;
u. public services; and
v. public policy only.

This should include Contractor's recommended approach to implementation of preferred business model strategies.

We will bring to this engagement our experience in identifying the challenges of municipal network expansion—and our realistic approach to assessing project risks. We will be very frank about the trade-offs among risk, benefits, and network control in various partnership approaches.

We will assess and provide guidance on the full range of business models described above and will discuss them in a way that evaluates how they can support the Partner Agencies' next steps and inform an implementation roadmap. We will consider the strategies we believe are relevant to the Partner Agencies' desired role and their risk tolerance.

We will evaluate options including:

Partner Agencies-owned and facilitated solutions
As we have done for such communities as Seattle and San Francisco, we will consider the prospects of a Partner Agencies-owned and operated infrastructure to serve unserved and underserved residents. This model frequently entails considerable cost and risk but is important to consider as part of a full evaluation of feasible solutions.

Developing one or more public-private partnership strategies
As a means of developing lower-risk models to meet broadband goals, CTC has designed most of the significant broadband public-private partnerships in the United States and literally wrote the book on broadband public-private partnerships—"The Emerging World of Broadband Public-Private Partnerships: A Business Strategy and Legal Guide," published by the Benton Foundation.

We will look at a range of collaboration strategies, many of which would involve extensive involvement by the Partner Agencies. Specifically, we will evaluate:

- **Public facilitation of private investment ("public policy" model).** This model focuses not on a public sector investment, but on modest measures the public sector can take to enable or encourage greater private sector investment. We specialize in understanding ISP needs and developing strategies to make underserved areas more attractive to ISPs seeking to expand their networks.
- **Public funding and private execution (municipal "concessionaire" model).** This model, which involves a substantial amount of public investment, offers private execution in return for public support and risk. The model enables an arrangement in which a private "concessionaire" undertakes turnkey financing, construction, and operations of a publicly-supported or publicly-guaranteed broadband project.
- **Shared investment and risk.** In this model, localities and private partners find creative ways to share the costs and risks of building and operating a broadband network. These shared-risk models include fiber-based shared-risk strategies throughout the country and such rural public-private partnerships as that in the Appalachia portion of Maryland, where we developed a collaboration between Garrett County, Maryland, and

Declaration Networks Group—a network that has been recognized and applauded by Microsoft's Airband rural broadband project.

k. *Evaluate financing and funding availability.*
This task includes evaluating the potential or confirmed availability of Project financing, including:
w. from contributions by potential additional partners, and/or stakeholders;
x. via one or more public-private partnerships;
y. from grants funds; and
z. from capital, revenue bond and municipal self-funding sources (e.g., advertising).

Develop Financial Model

We will analyze business models and develop a business case and financial analysis for a municipal broadband network deployment. As we have done for public sector broadband networks nationwide, we will develop a financial model (pro forma data) for the Partner Agencies' broadband network operations based on the recommended system-level design and related cost estimates.

These financial projections will also include a risk assessment. We will identify buildout requirements (financial, staffing, business and technical expertise needed) and evaluate factors that would be affected by the selected model.

Based on our consideration of potential partnership approaches, we will next develop a business case and financial analysis model for the deployment. The high-level financial model for the Partner Agencies' proposed fiber construction will consider a range of likely costs, including:

- Capital investment and additional assets required
- Financing
- Operations, maintenance, and repair

We will outline operational attributes and processes including policies, staffing levels, maintenance agreements, and other considerations. Particular attention will be paid to financing and funding sources and approaches, as well as operating requirements and working capital projections. We will discuss a strategy for fiber maintenance and management based on best practices.

The model will include an overall analysis of viable potential services and will provide:

- Sensitivities of key assumptions including, but not limited to:
  - Customer segmentation
  - Market penetration
  - Pricing
  - Operating costs
  - System construction
  - Staffing levels
    - Base, best, and worst-case analysis

The pro forma will follow accounting standards and will provide schedules that detail:

- Operating income and cash flow
- Net present value analysis
- Subscriber revenue by service/customer class
- Debt service analysis and reserve fund requirements
- Uses and sources of funds
- Operating expenses and savings
- Depreciation summary
- Projected construction costs for network, hardware, buildings, and other equipment
- Return on investment (ROI)

Our assumptions and price sensitivities will be clearly stated and justified. This financial model will provide the Partner Agencies with an order-of-magnitude estimate of the overall project cost, and will support a phased implementation roadmap by providing inputs for potential business models, financing options, and partnering opportunities.

As our references can attest, our financial analyses are based on reasonable, conservative assumptions regarding potential costs (capital and operating) and revenue, and are extremely detailed in terms of taking into consideration the financial implications of staffing, maintenance contracts, and so on.

In addition to our narrative report, we will provide the Partner Agencies with a detailed Excel workbook that includes underlying data and assumptions, and can be manipulated to illustrate the impact of changing costs or revenue on the network's potential income statement.

Evaluate Financing and Funding Options

Public sector broadband network deployments reflect both an ambitious vision and, often, a public commitment to financing broadband access for all citizens. Many local governments have pursued grans or loans, taken out bonds, or otherwise sought funding for construction of publicly owned fiber networks.

We will help the Partner Agencies develop realistic options for funding (e.g., federal or state grants) and financing (e.g., general obligation bonds, revenue bonds).

We will draw on our hands-on knowledge of broadband funding opportunities and our research capabilities in this area to conduct a high-level evaluation of existing state and federal grant programs that the Partner Agencies might consider. Our goal in this task is to help the Partner Agencies determine whether they have a path toward at least partial funding for broadband deployment.

l. *Address lifecycle issues for infrastructure and technologies.*
This task requires an evaluation of the likely operational life of network assets and technologies; costs associated with replacement, decommissioning, and disposal; and models for building into network architecture flexibility to accommodate technology advances to improve network performance and reduce costs.

Our financial analysis (Task 10) will include long-term cost projections related to operations, equipment replacement (including decommissioning and disposal), and equipment upgrades for improved performance and reduced costs.

DELIVERABLES AND ACCEPTANCE CRITERIA:

Our final deliverable will be a comprehensive feasibility study (the "Project Report") that recommends for the Partner Agencies' consideration a strategic approach for the potential deployment of a Municipal Broadband network. The report will include the data, insights, and recommendations developed in the engagement—including an investment-grade financial analysis and business modeling for both public sector operations and a public-private partnership.

We will provide the Partner Agencies with an electronic draft of our report, which will include a concise narrative supported by tables, graphics, and maps as appropriate. We will incorporate feedback from reviewers and deliver an electronic version of the final report.