Gillette Broadband Report

PREPARED FOR THE CITY OF GILLETTE, WYOMING

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VantagePoint

THE BROADBAND GROUP

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Appendices

CHAPTER ONE

1.0 Introduction & Engagement Update

1.1 Broadband Study, Goals, and Objectives

Vantage Point Solutions (VPS) and The Broadband Group (TBG) have been engaged by the City of Gillette to prepare a broadband study assessing the current state of broadband infrastructure and available services within the city. At its core, the main goals of this study are to assess:

- Current state of broadband infrastructure within the City.
- Level of satisfaction of businesses in reference to such facilities and available services.
- Financing and partnership options that may help secure improved broadband service.
- How to advance the City's economic development agenda with the enactment of such improvements.

In conducting this study, a key question that must be assessed and answered is: Does the City of Gillette have effective and efficient next generation broadband facilities to meet the communication, information, and telemetry needs for community anchor institutions, residents, and businesses for the foreseeable future? This study provides an initial engineering and facilities assessment and detailed market study to build the metrics and structure needed to answer this essential question.

As one reviews the City-issued request for proposals (RFP) that initiated the framework of this study (Project No. 14EE10), it is clear that broadband infrastructure improvements are needed; as such, this study and its contents address exactly that need while outlining of achievable options.

A key component of this report is the detailed market study, which evaluates the commercial satisfaction of currently available services and what future level of services might be needed (perhaps required) as information, access, and speed requirements inevitably increase. The initial findings of this report will come as no surprise to city leadership. No service provider has sufficiently invested in fiber-based broadband facilities in Gillette. Gillette must either incent and motivate new or improved investments from the private sector, or invest itself in municipal-

owned/controlled broadband facilities. Each of these options and alternatives bring elements of risk/reward that should be carefully assessed.

The balance of this report reviews options available to promote successful implementation of improved broadband facilities, while maintaining the personality of Gillette that has historically defined the community. The history and identity of Gillette need not be compromised simply to become a participant in the Information Age. Broadband innovation is the result of strategically deliberate action, with the community carefully defining its needs, while advancing the economic returns to potential partners interested in bringing next generation broadband investments to the city.

As clearly described in the RFP launching this initiative, this report can and should enable existing businesses to expand, generate avenues for added commerce, create new opportunities for employment, improve the efficiency of civic services, and enhance the diversity of the local economy. These laudable goals formed the basis for the work in drafting and submitting this report.

1.2 BROADBAND BACKGROUND

In 2010 the telecommunications industry was seemingly transformed when Google Fiber entered the market and illustrated both the desire for and benefits of advanced broadband infrastructure in underserved municipalities. Often referred to as the "Google Factor," Google's market entrance sparked an interest in cities and communities stepping up and articulating interest in and desire for next generation broadband facilities.[1] In doing so, these municipalities began the process of defining the economic, educational, healthcare-related, and IT needs of the region, and of evaluating how carefully-defined broadband strategies might advance these efforts.

There is now near unanimous acknowledgement that access to next generation broadband-enabled services will empower cities and their residents.[2] By commissioning this report, Gillette takes its place among cities that "get it." City leaders are beginning a conversation which will ultimately drive innovation and advance municipal commitment to update, rationalize, and improve city regulations that encourage and support new investments. To successfully meet its stated goals, the city must entice investment and competition - not attempt to simply mandate or regulate it - while also reviewing legacy regulations that may hinder such investment.

In 2014 the FTTH Council released a first-of-its-kind study quantifying the contribution of fiber-fed broadband to Gross Domestic Product (GDP) in U.S. communities.[3] In short, the study

[1] "Google is Forcing Big Broadband Providers to Boost Speeds," April 4, 2015. www.vox.com/2015/4/4/8341199/google-comcast-broadband-race.
[2] "Broadband Community Best Practices." http://broadbandadoptiontoolkit.com/download/p/fileId_31.
[3] "Full-fibre broadband communities have higher GDP, study finds," September 2014. www.uswitch.com/broadband/news/2014/09/full_fibre_broadband_communities_have_higher_gdp_study_finds.

demonstrated that access to advanced broadband infrastructure must be recognized as integral to any city's ability to remain relevant in today's global economy. For many years, access to broadband has been viewed as an amenity for homes and businesses that might provide peripheral benefits to a city and its citizens. As technology continues to play an increasingly role in our personal and professional lives, it is critical to understand how technology can also play an essential role in the life of a community.

Gillette is not alone in seeking to define and implement a strategic and financial plan centered on broadband technology. Throughout the U.S., there are now 136 municipal fiber networks, 11 of which are structured as public-private fiber networks.[4] Driven by the profound increase in Internet-connected devices, cities of all sizes are experiencing exponential growth in demand for, and a need to access, robust Internet speeds. Consumers rely on broadband-intensive applications for commerce, education, remote diagnostic telemedicine, interactive two-way video communications, entertainment, and personal productivity enhancements. Access to advanced broadband is enabling transformative solutions that frame the culture and identities of communities, cities, and those that populate them.

Cities should not sit passively and wait for (nor expect) incumbent service providers to independently elect to invest in infrastructure and develop broadband-enabled programs and applications. As an example, in many communities tele-health services are "stalled at the gate" until cities, broadband providers, and healthcare practitioners can develop the capacity needed to deliver those applications. The City of Gillette, working closely with its healthcare providers and enabled by broadband, can take the initial steps to "bring healthcare to the patient, as opposed to the patient traveling to healthcare."[5] As new bandwidth-intensive applications are developed for consumer, enterprise, and civic use, and more devices become Internet-enabled, access to high-quality and high-speed broadband facilities must march in a common line with a coordinated vision for implementation of these increasingly enabled technological efficiencies.

> *"We invented the internet. We can do audacious things if we set big goals, and I think our new threshold, frankly, should be 100 Mbps. I think anything short of that shortchanges our children, our future, and our new digital economy."*
>
> *- Jessica Rosenworcel*
> *FCC Commissioner*

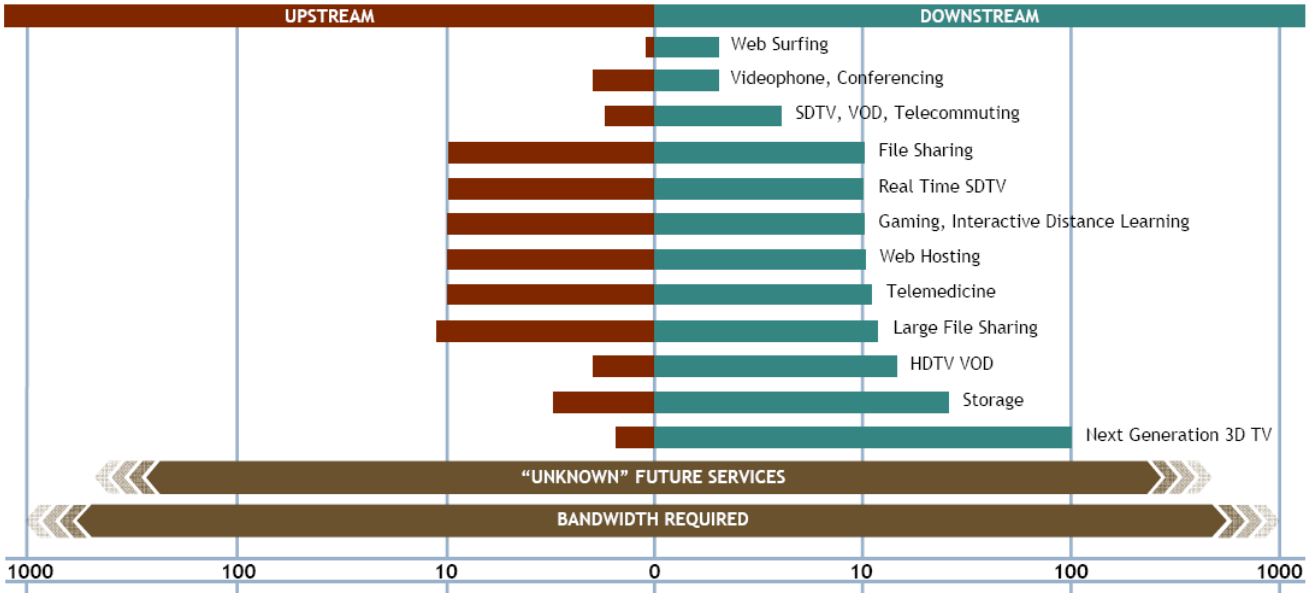
Less than ten years ago, a 56 Kbps modem was the most common method for accessing the Internet, and internet service providers (ISPs) built the base infrastructure to support such transmissions. Today, Internet-enabled services and applications have stimulated consumer demand for broadband speeds of 10 Mbps, 100 Mbps, and increasingly Gigabit speeds. Reflecting these market-driven consumer expectations, as part of its

[4] Broadband Communities Magazine. January 28, 2015.
[5] Dr. Jay Sanders, Founder American Telemedicine Association.

2015 Broadband Progress Report, the Federal Communications Commission voted to change the definition of broadband by raising the minimum download speeds required from 4 Mbps to 25 Mbps, and the minimum upload speed from 1 Mbps to 3 Mbps.[6]

Accordingly, it can be anticipated that Gillette citizens will seek 100 Mbps broadband speeds within the foreseeable future and that Gigabit speeds won't be far behind. In reality, speeds of 100 Mbps are already commonly available to many urban customers at "reasonable" costs. According to a February 2014 joint NTIA-FCC broadband data report, there were 99 Gigabit broadband networks operating in the U.S., and many more installations are anticipated over the next two years.

Customers' expectations are increasing and a wide variety of rich media applications are now a part of everyday culture. The demand for higher upstream and downstream broadband speeds is demonstrated in this graphic:[7]



Estimated Broadband Application Upstream and Downstream Rates (Mbps)

1.3 BROADBAND IN GILLETTE TODAY

Broadband in Gillette is a study of contrasts. On one hand, data from the National Broadband Map suggests that nearly every household within the city has access to 25 Mbps of download capacity, and almost 60% have a choice of three facilities-based broadband providers from which to choose. That level of competition exceeds what many cities across the country possess. There are indications, however, Gillette may not be well-positioned for the future. Available downloads

[6] "FCC Redfines Broadband," January 29, 2015. http://www.usnews.com/news/articles/2015/01/29/fcc-redefines-broadband-in-net-neutrality-prelude.
[7] Graphic from Calix, Inc.

speeds of 25 Mbps serve not only as a floor, but also as a ceiling for Gillette residences, as fewer than 2% of households have access to speeds 50 Mbps or faster. Nationwide, 83% of households have access to those speeds.[8]

A similar situation exists with upload speeds. Every home within the city limits of Gillette has access to upload speeds of at least 3 Mbps, which is considered "broadband" under the FCC's current definition. Only 12% of Gillette households have access to upload speeds faster than 6 Mbps, though. Nationwide, 64% of households have access to those speeds.[9]

Within Wyoming, a number of communities have faster speeds than Gillette. Download speeds of greater than 100 Mbps are available to 48% of the homes in Mountain View and to 28% of the homes in Evanston. Additionally, parts of the Cheyenne area (for example, sections of South Greeley and Fox Farm-College) have access to 100 Mbps.[10]

Chapter 3 describes each broadband provider and their coverage area in more detail, but one thing is clear. In order to seize the economic, healthcare, and educational opportunities of the future, Gillette must secure access to faster broadband service.

Access to 25 Mbps

Blue = Access to speeds of at least 25 Mbps
(per National Broadband Map)

Access to 50 Mbps

Blue = Access to speeds of 50 Mbps or more
(per National Broadband Map)

[8] Data accessible at www.broadbandmap.gov/.
[9] Ibid.
[10] Information from www.broadbandnow.com/Wyoming.

CHAPTER TWO

2.0 Field Findings

Vantage Point Solutions staff performed a site visit of construction corridors in Gillette to evaluate aspects relative to the possibility of future fiber construction. The focus of the site visit was to review the main business corridors of the community. The VPS team also met with City staff to specifically learn more about the community and the primary areas that might see new commercial/industrial growth.

The City has a substantial existing network of fiber, conduit, and fiber vaults (FVs) throughout many areas of the city. VPS visited areas to review the existing construction types, as well as areas where network expansion may be required. The following is a summary of the field findings. Additional information on the field findings is located in Appendix A.

2.1 Right Of Way (ROW) Considerations

ROW and easement considerations for the possible fiber construction would be an internal matter contained within the City of Gillette. This appears to eliminate the need for involvement with individual land owners for private easements.

2.2 Mainline Corridors

VPS staff drove the mainline business corridors in the city. The construction corridors are typical of a city the size of Gillette with a mix of buried and aerial construction. Aerial construction has been utilized in the dense, downtown-type areas with buried construction utilized in other areas. In most areas of potential future growth, VPS observed utility easements and ample right of way for buried fiber construction.

The majority of mainline buried fiber cable in Gillette will be normal for urban-type construction level of difficulty, and have normal urban construction costs. The following examples provide an overview of the mainline corridors in the area.

2.2.1 MAINLINE CORRIDOR EXHIBITS

2.3 Drop Corridors

VPS staff observed easements to service residential and business customers. The majority of drops in Gillette will be normal for level of difficulty to construction and have typical construction costs.

2.3.1 Drop Corridor Exhibits

2.4 GREENWAY AREAS

While on site, VPS identified several possible greenway areas suitable for possible equipment cabinets. These corridors were identified along key roads that would be ideal locations for the connecting with key fiber routes.

2.4.1 GREENWAY AREA EXHIBITS

CHAPTER THREE

3.0 Existing Infrastructure Evaluation

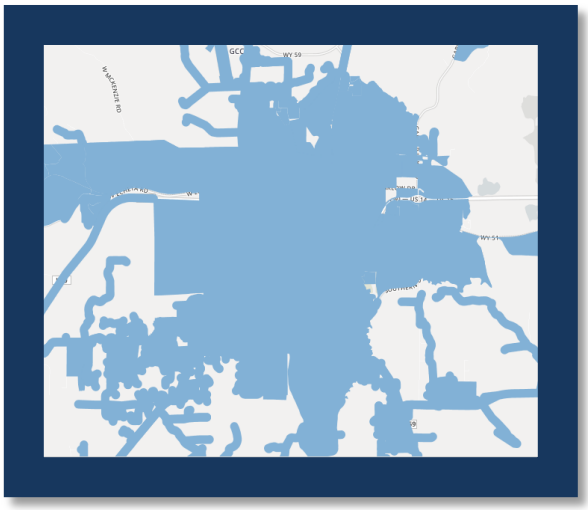
3.1 Types Of Technology Architectures (Wireline & Wireless)

3.1.1 Wireline Technologies (CenturyLink, Charter, Visionary)

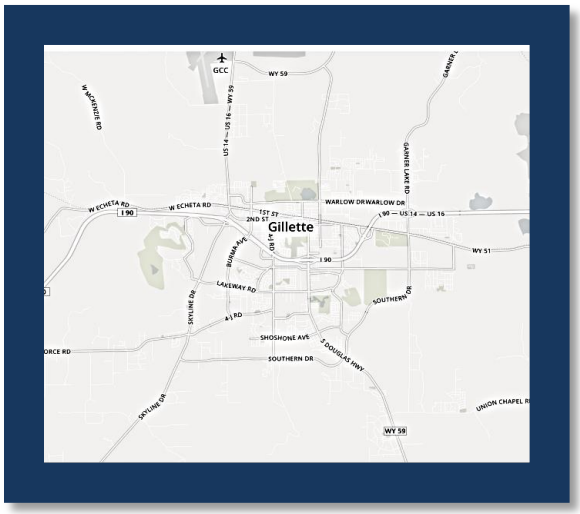
Wireline technologies rely on a physical cable for transmission of the communication signal. These cables usually transport an electrical signal on a copper cable or an optical signal on a fiber optic cable. The most common wireline technologies utilized today are:

a. Digital Subscriber Line (DSL) – CenturyLink and Visionary Communications offer DSL-based services in Gillette. This wireline technology overlays a broadband signal on existing twisted pair copper cables. Broadband speeds on DSL networks are dependent on the customer's distance from electronics, in remote terminals or central offices. DSL can typically provide 10 to 20 Mbps for customers fortunate enough to be close to the connection point. DSL is susceptible to electrical interference and typically has relatively high operational expenses. Its access speeds also diminish the further away a customer is from the serving CO, or central office. Of particular value is symmetrical DSL (SDSL) service, which provides upload speeds equal to its download speeds. Asymmetrical DSL (ADSL) is available at 97.4% of the locations in Gillette, but the more preferable SDSL is not currently available.[11]

Access to ADSL



Access to SDSL

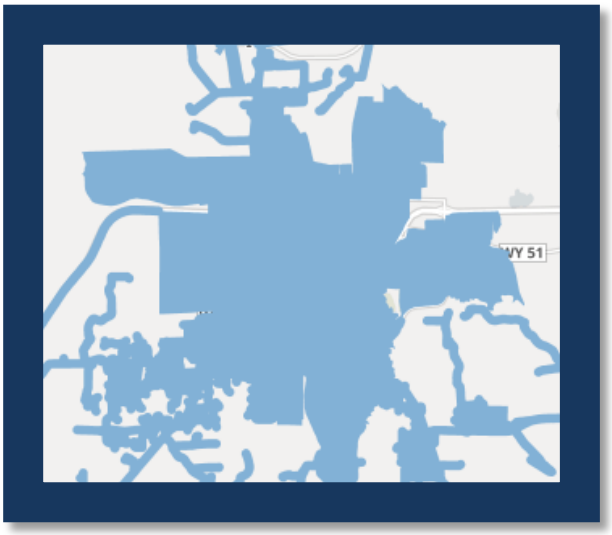


b. Coaxial Cable (DOCSIS) – Charter Communications utilizes a coaxial cable based plant to provide wireline broadband services. With the latest version of DOCSIS 3.0 Standards, speeds up to approximately 300 Mbps downstream and 120 Mbps upstream can be

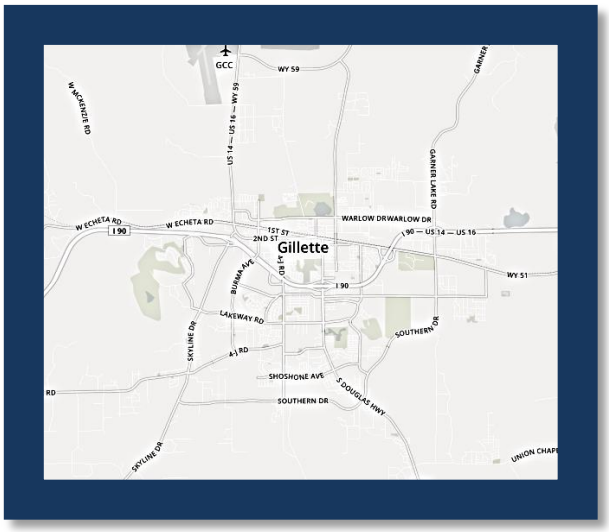
[11] Data accessible at www.broadbandmap.gov/.

shared by a large number of subscribers. Charter Communications has a coaxial cable based system in Gillette, but according to the National Broadband Map, has not yet deployed DOCSIS 3.0 within the city.

Access to Coax Network

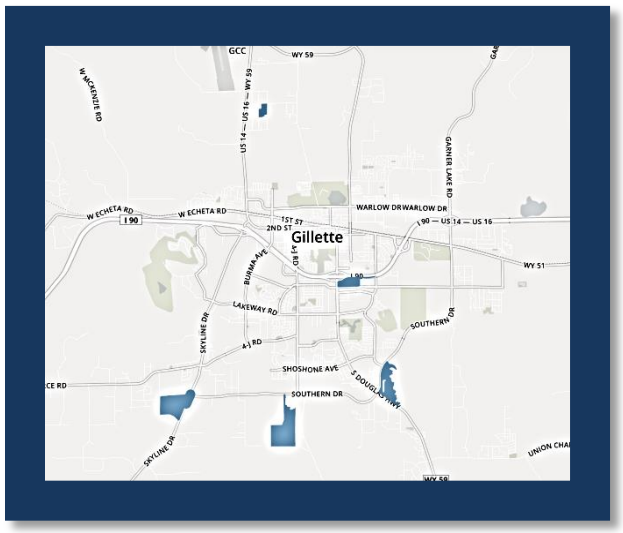


Access to DOCSIS 3.0



c. <u>Fiber to the Premises (FTTP)</u> – Some of Gillette's service providers also provide limited direct fiber connectivity to customers, but there is not a widespread fiber to the premises (FTTP) deployment in the City of Gillette. An FTTP network serves customers by a fiber optic cable. Most FTTP equipment allows between 70 Mbps and 1 Gbps of broadband to each customer and is capable of serving customers that are more than

Access to FTTP



twelve miles from the central office or electronic field terminal locations. When it comes to delivering broadband, nothing beats the performance and future potential of

fiber. Almost 11% of Wyoming residents have access to fiber-based service[12], and nationally, more than a quarter of homes are served by FTTP, but fiber-to-the-end-user is rare in Gillette. Less than 1% of households have access to FTTP.[13]

3.1.2 Wireless Technologies (Visionary, Collins Communications)

Wireless technologies transmit the communication signal "over the air" on a radio frequency (RF) carrier. Visionary Communications and Collins Communications offer fixed wireless services in the City of Gillette.

Today, nearly all terrestrial wireless providers have standardized to Long Term Evolution (LTE) as the Wireless Metropolitan Area Network (WMAN) broadband technology of the future. All major carriers in the U.S. are in the process of deploying or planning on deploying LTE. Practical implementations allow customers to burst up to 10 or 20 Mbps for short periods of time. However, this technology is not well-suited for large bandwidth needs.

Additionally, wireless Internet service providers (WISPs) primarily utilize unlicensed or "lightly licensed" spectra. In addition to utilization for broadband delivery, these unlicensed spectra must be shared with equipment being utilized for Wi-Fi, Bluetooth, agricultural GPS telemetry and control, cordless phones, garage door openers, baby monitors, microwave ovens, and many more applications.[14] Since operators in unlicensed spectra have no legal protection against interference – including from a competitor – interference can seriously degrade performance or even cause a complete network outage. Unlicensed wireless broadband is often used only as an adjunct service to fixed broadband.

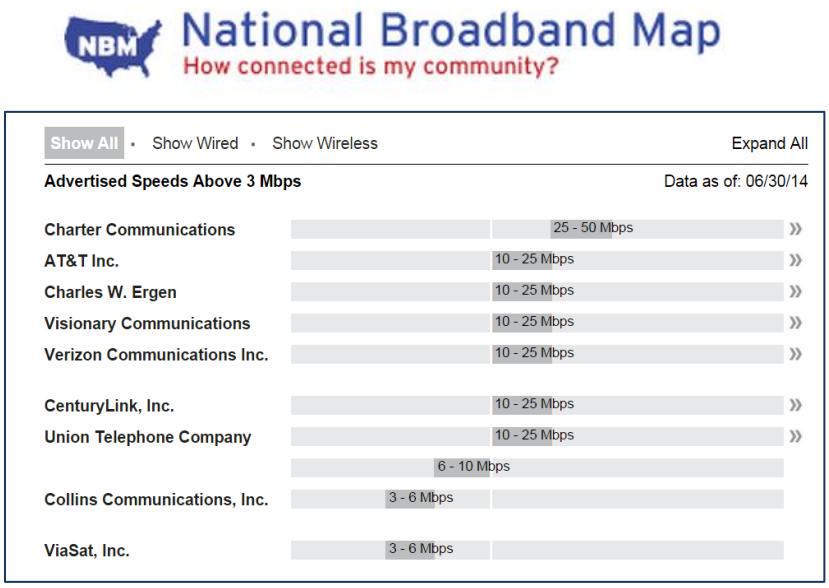
Satellite-based broadband is not considered a viable broadband alternative due to the high latency which makes it unsuitable for many applications and unable to provide reliable, high-quality voice connectivity.

Each of these types of broadband technologies is described in further detail in Appendix B.

3.2 Existing Providers: Service Offerings & Exhibits

The National Telecommunications & Information Administration (NTIA) National Broadband Map shows the following service providers in the City of Gillette that advertise speeds greater than 3 Mbps.

[12] Information at www.broadbandnow.com/Wyoming.
[13] Data accessible at www.broadbandmap.gov/.
[14] "Unlicensed Spectrum and the American Economy" at http://www.ce.org/CorporateSite/media/gla/CEAUnlicensedSpectrumWhitePaper-FINAL-052814.pdf.



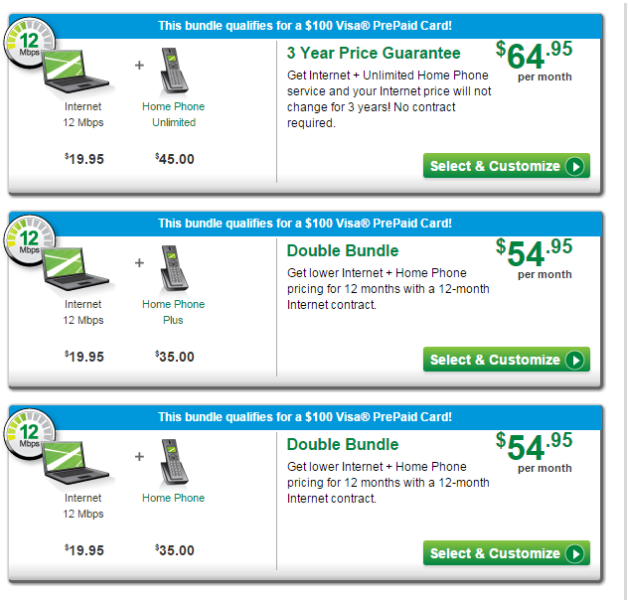
It is important to note two things related to the National Broadband Map. First, although the federal government has recently collected more detailed and up-to-date coverage information, the data currently utilized by the National Broadband Map is more than a year old. Second, the Map lists speeds generally available to customers, as reported by the providers. Providers can sometimes provide faster speeds to businesses via other business solutions (dedicated lines, for example). For those reasons, data from the National Broadband Map may not match current advertised speeds for all customers.

3.3 WIRELINE PROVIDERS

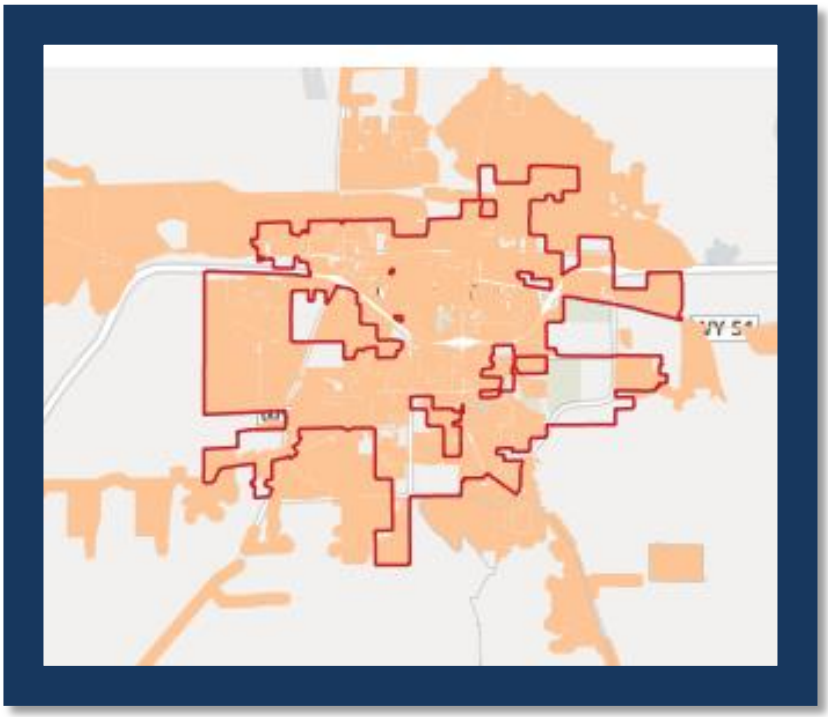
3.3.1 CENTURYLINK

CenturyLink is an incumbent telephone company, providing voice and data services primarily over twisted pair copper and fiber network. The National Broadband Map says that CenturyLink is capable of providing Internet access to all but about 2,000 of Gillette's residents, but the company says it is now able to provide some level of voice and Internet service to all housing units with city limits. For most residents, though, the speeds fall short of what the FCC defines as "broadband" (25 Mbps). The National Broadband Map indicates almost 94% of residents have access to speeds greater than 1.5 Mbps, 40% have access to 10 Mbps or faster, and 19% have access to 25 Mbps or faster. CenturyLink indicates that it offers fiber to the premises with Gigabit capability in a select number of subdivisions in Gillette. The graphics below display CenturyLink's service bundles and their Internet service territory in Gillette.[15]

[15] Residential bundles accessed from company website on August 1, 2015 for 201 E. Fifth Street in Gillette.

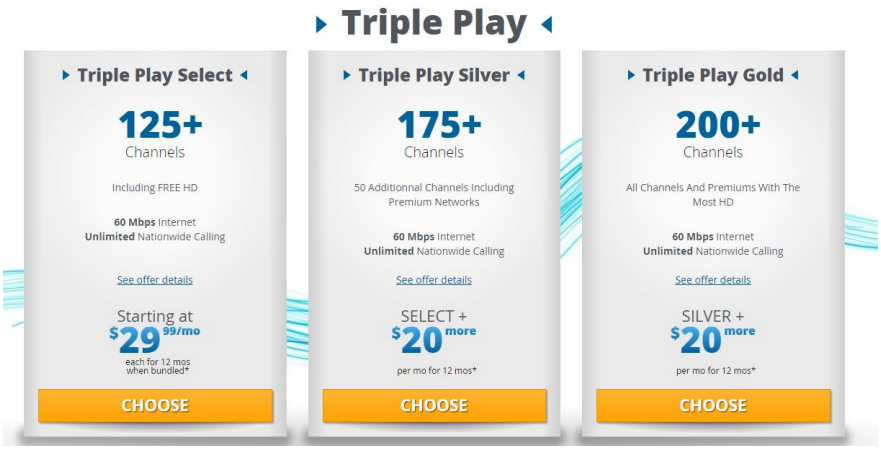


CenturyLink Service Territory

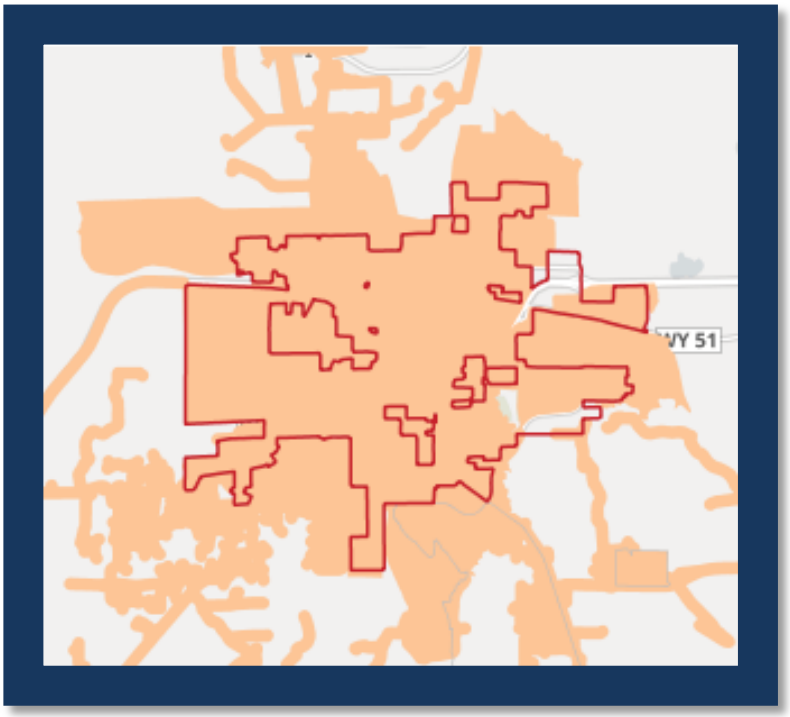


3.3.2 CHARTER COMMUNICATIONS

Charter Communications is a CATV company providing, voice, video, and data services over a hybrid fiber-coaxial cable network. Charter is able to provide Internet access to nearly all of the city's residents. Charter's top speeds on the National Broadband Map are listed at 25 Mbps. Charter today often advertises bundles with 60 Mbps, however. The graphics below display Charter's service bundles and their Internet service territory in Gillette.[16]



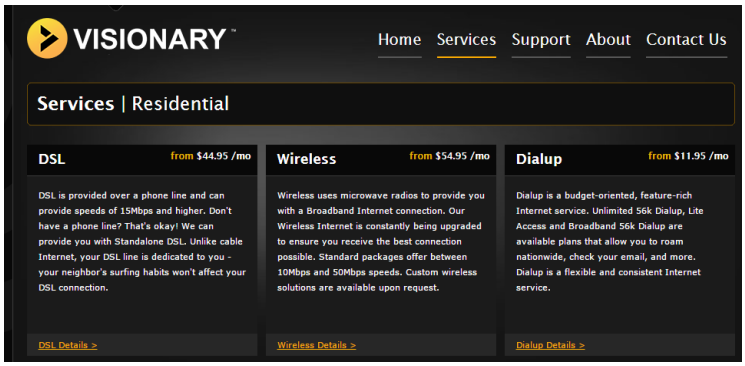
Charter Service Territory



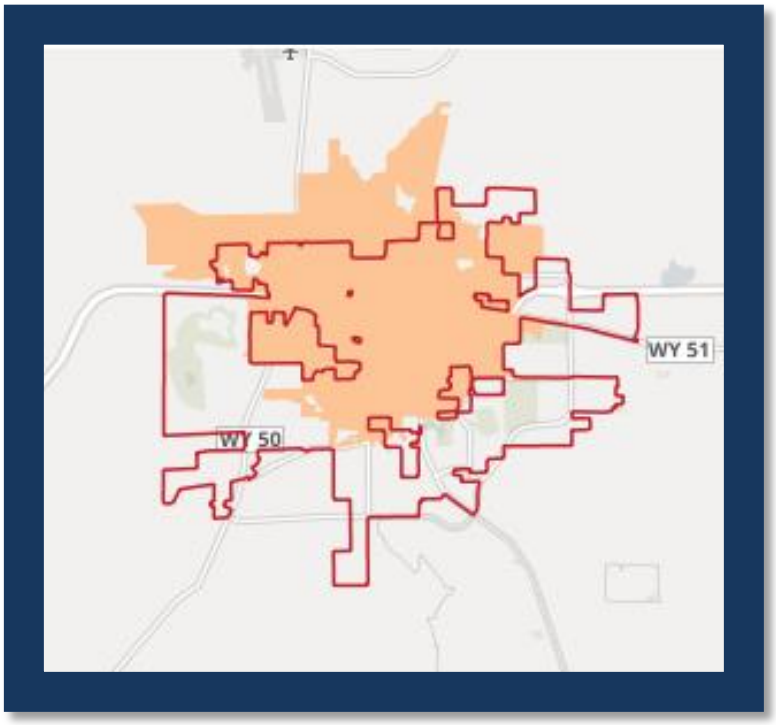
3.3.3 VISIONARY COMMUNICATIONS

[16] Residential bundles accessed from company website on August 1, 2015 for 201 E. Fifth Street in Gillette.

Visionary Communications provides data services over twisted pair copper and a limited amount of fiber facilities. Visionary is capable of offering service to 61% of the residents within the city, with speeds of 10 Mbps, which falls below the 25 Mbps standard the FCC has set for "broadband." According to the National Broadband Map, no Visionary customers are able to purchase a 25 Mbps plan within Gillette. Visionary does advertise packages with higher speeds utilizing fixed wireless service, however. The graphics below display Visionary's service bundles and their Internet service territory in Gillette.[17]

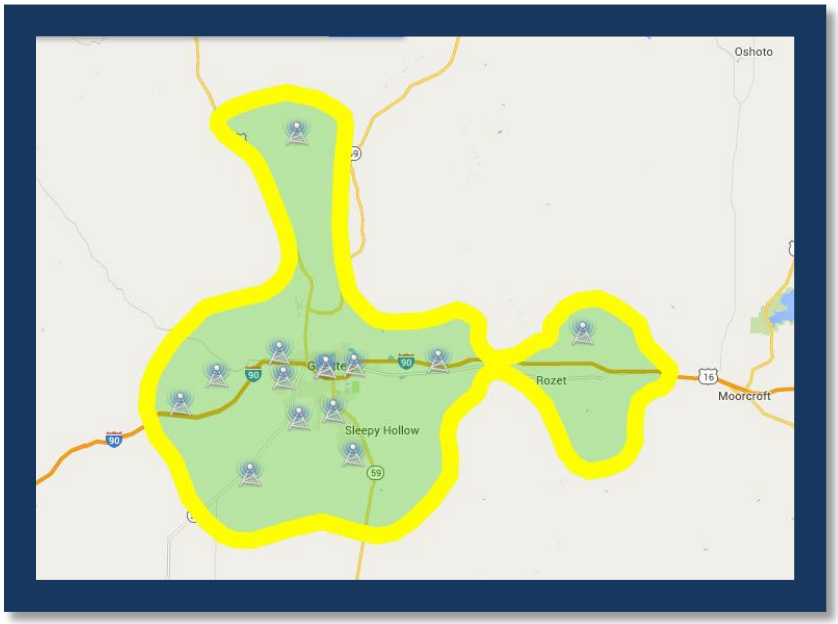


Visionary Service Territory



[17] Residential bundles accessed from company website on August 1, 2015 for 201 E. Fifth Street in Gillette.

The graphic above comes from the National Broadband Map.[18] Visionary has indicated that data does not properly reflect their coverage area and instead prefers the map below, which displays Visionary coverage areas served by either wireline or wireless facilities.



3.4 WIRELESS PROVIDERS

Additionally, the following wireless providers serve Gillette:

- Mobile Wireless
  - AT&T
  - Verizon
  - Union Telephone
- Fixed Wireless
  - Visionary Communications
  - Collins Communications
- Satellite
  - Charles W. Ergen
  - ViaSat

Wireless providers are an important part of the service landscape, but, as noted by the FCC, should be viewed as a compliment to, rather than a substitute for, wireline service.[19]

[18] Accessed on August 1, 2015.
[19] December 18, 2014 FCC Order at https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-190A1.pdf.

CHAPTER FOUR

4.0 Commercial Market Study

4.1 Survey Results – Currently Available Services & Business Acceptance Metrics

As part of this report, VPS and TBG completed a comprehensive commercial market study focused on broadband interest, levels of available service, and an overall ranking of such services from every available source. The complete market study is part of this report. Additionally, its highlights are listed here for an overall comprehensive view of both what services are available, as well as what local businesses perceive as necessary.

There appears to be a clear need for improvement of business Internet services in the region. Low satisfaction is shown by an extremely low Net Promoter Index score of -51% and by the fact that only 8% of businesses are "very satisfied."

Almost 60% of businesses in Gillette are dissatisfied with their current Internet service.

4.1.1 Commercial Internet Need In Gillette

- Businesses in Gillette are primarily small. Approximately 80% have fewer than 20 employees.
- Approximately 5% of businesses would qualify as larger commercial enterprise businesses and employers.
- There is a clear need for improvement of business Internet services in Gillette. As noted above, low satisfaction is shown by an extremely low Net Promoter Index score of -51% and the fact that only 8% of the businesses are very satisfied (9-10 rating). The majority, 59% are dissatisfied (1-6 rating).
- "Perceived" monthly downtime averages 4.4 hours per month - a very high number in comparison to other markets of similar size, scale, and invested network infrastructure.
- Stated needs and desires of businesses in Gillette include higher speed, more reliability, more choice, availability in all areas of town, and better value.

4.1.2 Barriers To Overcome

- Approximately 24% of the businesses surveyed deal with long-term contracts, and 27% of the local market businesses are tied to decisions made outside of the local Gillette area.
    - A subsequent phase activity following delivery of this study would be to conduct a study of "remaining term" contracts of businesses in Gillette.

- Approximately 25% of the businesses indicate they need more knowledge as to broadband alternatives, opportunities, and the availability of new services.

4.1.3 POTENTIAL OUTCOMES

- The Study findings indicate that take-rates could, over time, reach 39% or more. Initial take rates are estimated to start at 12% given sales barriers, resistance to potential utility providers, and overcoming long-term contracts.

FULL MARKET STUDY

Appendix C contains the 40-page in-depth market study conducted in March 2015.

CHAPTER FIVE

5.0 Service Models, Ownership, & Operations Analysis

5.1 Business Model Options

As financing, operational, and ownership models are considered, the City of Gillette must balance its desire for public control over newly-deployed broadband infrastructure with its investment risk appetite.

Achievable business models for municipally lead broadband initiatives range from low community involvement, limiting investment risks as well as potential financial returns, to full community ownership and operation of a broadband network. That approach features increasing investment risk and operational commitments, but also increasing potential for financial returns.

Option	Ease of Entry Considerations	Financial Considerations	Political Considerations	Risk/Reward	Capital Costs
LIT SERVICES					
MODEL ONE Municipality finances, constructs, operates, and markets broadband services. OWNER Municipality OPERATOR Municipality	Necessary to hire expertise in telecom planning, construction, operations, marketing, and billing. Some municipalities leverage the facilities, financing, operating, customer service, and legal expertise of a municipal electric utility.	100% financial commitment, total financial control. Opportunity to gain positive cash flow to support municipal government operations.	Where municipality has a positive service reputation, this can be a feasible approach. Quality private sector partner may reduce opposition from skeptics who believe technology is too sophisticated and/or dynamic for municipal control.	High/High Responsible for 100% of cost for construction and operation, but offers potential for capturing significant high margin revenues.	For Gillette, capital expenditures would vary based on the geographic scope of the deployment. A citywide overbuild could cost $50 million. A more modest deployment to additional large customers could cost closer to $5 million. The City's existing fiber drives costs down somewhat, but per location costs would still be greater than $5,000. Over time, those costs could be offset by operating revenues.
MODEL TWO Municipal utility providing fiber services to large customers only government entities, schools, hospitals, and large business. OWNER	Less complex to construct and operate than a network that serves all potential customers. Necessary to hire expertise in telecom planning, construction, operations,	Fiber network is often a good investment for connecting public sector buildings. Depending on available fiber and conduit assets, added cost may not be significant, especially with	This strategy provides operational savings to the public sector and potential for profits. Serves as an economic development strategy to attract/retain large	Med/Low Responsible for costs of construction and network operations. Focus on community anchor and large institutions reduces competitive risk of obtaining / retaining	For Gillette, capital expenditures for the first phase of a model two approach would likely run around $5 million. The City's existing fiber drives costs down somewhat, but per location costs would

Option	Ease of Entry Considerations	Financial Considerations	Political Considerations	Risk/Reward	Capital Costs
Municipality OPERATOR Municipality	marketing, and billing.	quality planning.	and/or tech-oriented corporations.	subscribers. Revenue potential reduced.	still be greater than $5,000. Over time, those costs could be offset by operating revenues.
MODEL THREE Municipality finances the network with a private sector entity serving as a wholesale provider to multiple retail service providers. OWNER Municipality OPERATOR Private Sector	Municipality sells bonds to construct network. Hires a wholesale operator who recruits service providers to serve end-customers (retail). Municipality role is generally limited to financing of network.	Must secure adequate revenues from retail service providers to service bond payments.	Multiple providers ensure choice in the market. Often referred to as an "open access" model.	Med/Med Responsible for network construction costs, but limited responsibility for network operations. Revenue share from multiple providers.	For Gillette, capital expenditures would vary based on the geographic scope of the deployment. A citywide overbuild could cost $50 million. A more modest deployment to additional large customers could cost closer to $5 million. The City's existing fiber drives costs down somewhat, but per location costs would still be greater than $5,000. Over time, those costs could be offset by operating revenues.
MODEL FOUR Municipality allows a private sector provider to enter the market. City may provide financing incentives, ease/remove barriers such as ROW fees or permitting, or serve as an anchor tenant (with other entities like schools, hospital, large businesses). OWNER Private Sector OPERATOR Private Sector	Must demonstrate sufficient return on investment for providers to have interest in constructing and operating the network.	Limited financial responsibility for capital expenditures or operations.	Reduced technology costs and risks to the municipality. New providers enhance the local competitive environment. The municipality lacks control of services offered, prices, etc.	Low/Low Municipality not responsible for cost of construction or operations. Creates new, if small, incremental revenue source with limited risks. .	Direct costs of a model four approach are usually models, but can include grant programs and city expenses for shared infrastructure

Option	Ease of Entry Considerations	Financial Considerations	Political Considerations	Risk/Reward	Capital Costs
Dark Fiber					
MODEL FIVE Municipality and large local public and private institutions build a dark fiber network that is then leased to any entity that wishes to use it. OWNER Municipality & Local Partners OPERATOR Private Sector	Necessary to hire expertise in telecom planning and construction. Municipality and large institutions/businesses finance the initial fiber build and point of presence. Dark fiber is leased to public and private entities.	Requires well capitalized institutions. Institutions that provide initial financing can realize large annual savings in total telecom budgets.	No ongoing public funding or liability. Municipality pays for their portion of the network often through right of ways and savings in annual telecom budget.	High/Low Responsible for 100% of cost for construction and operation. Revenue generally limited to cost recovery with low margin recurring revenues.	For Gillette, capital expenditures would vary based on the geographic scope of the deployment. A citywide overbuild could cost $50 million. A more modest deployment to additional large customers could cost closer to $5 million. The City's existing fiber drives costs down somewhat, but per location costs would still be greater than $5,000. Over time, those costs could be offset by lease revenues.
MODEL SIX Municipality builds infrastructure; private operator purchases electronics and operates the network for a number of years (often 15), providing all retail services. OWNER Municipality OPERRATOR Private Sector	Necessary to hire expertise in telecom planning and construction. Municipality finances the initial fiber build only. Some municipalities leverage the facilities, financing, and expertise of a municipal electric utility.	Municipality only needs to finance the fiber outside plant construction.	Municipality must renegotiate contract with network operator every X number of years.	Low/Med Responsible for reduced % of cost for construction. Low to medium revenue share possibility from provider.	For Gillette, capital expenditures would vary based on the geographic scope of the deployment. A citywide overbuild could cost $50 million. A more modest deployment to additional large customers could cost closer to $5 million. The City's existing fiber drives costs down somewhat, but per location costs would still be greater than $5,000. Over time, those costs could be offset by lease revenues.

Option	Ease of Entry Considerations	Financial Considerations	Political Considerations	Risk/Reward	Capital Costs
MODEL SEVEN Municipality builds fiber infrastructure for public sector uses including government and education; additional capacity may then be available for private sector use. Network can be built incrementally by connecting county buildings and linking with other public sector networks. OWNER Municipality OPERATOR Municipality & Private Sector	Necessary to hire expertise in telecom planning and construction. Municipality finances the initial fiber build and point of presence; available dark fiber is leased to public and private entities. Some municipalities leverage the facilities, financing, and expertise of a municipal electric utility.	Public funds are offset by existing private carrier costs to link participating municipalities and school districts. Counties are able to proceed based on county, municipal, and school district costs and service needs with possible future offsets secured from local business.	County or regional governments can build fiber networks to service public sector with a goal to achieve significant public sector cost savings. Policy decisions about opening this infrastructure to private sector users as an additional revenue stream can be a separate discussion.	Med/Med Responsible for 100% of cost for construction. However, cost can be staged as network is built incrementally. Benefits, in addition to cost recovery, include economic development.	For Gillette, capital expenditures would vary based on the geographic scope of the deployment. A citywide overbuild could cost $50 million. A more modest deployment to additional large customers could cost closer to $5 million. The City's existing fiber drives costs down somewhat, but per location costs would still be greater than $5,000. Over time, those costs could be offset by lease revenues.

5.2 Discussion

A few key factors unique to Gillette demand consideration when discussing the various ownership and operation models listed above:

- **Cost –** Many municipalities prefer the control that comes with constructing and operating the broadband network themselves. It is often the case, however, that the substantial cost of deployment causes them to pursue other options. Overbuilding the entire city of Gillette with fiber, as envisioned by model one, would likely cost in excess of $50 million. A targeted build out, as envisioned by model two, would cost considerably less. Based on how the project was designed and phased, a targeted build out could be done for less than $5 million of capital expenses. The City's existing fiber drives costs down somewhat, but per location costs would still be greater than $5,000.[20]

- **Competitive risk –** Gillette currently has three facilities-based Internet providers. Although none of those providers are currently offering the speeds desired by the City of Gillette, a multitude of competitors could make it more difficult for the City (or its partner) to earn significant market share, at least initially.

[20] Vantage Point Solutions has not conducted an engineering estimate for the City of Gillette.

- **Consumer relationship –** The City of Gillette currently offers electric service to its citizens. That existing customer relationship is a substantial benefit that could be utilized as part of a broadband service offering.

- **Limited telecommunications experience –** The city of Gillette does not have experience working as a telecommunications provider. Given the complexity of the industry, finding a strong private sector or hiring a talented and experienced telecommunications manager would be critical to success.

Gillette already utilizes a dark fiber approach by leasing its facilities to telecommunications providers. Although that arrangement has provided some benefits to citizens, it has not resulted in widespread availability of broadband, as defined by the FCC.[21] Models one through four, however, describe "lit fiber" solutions. Model one features the most municipal control over broadband deployment within Gillette and could result in substantial financial success for the City. It would likely cost more than $50 million to overbuild Gillette, however, and that investment would be subject to substantial market risk. Some government-owned broadband networks have faced financial challenges and can serve as a cautionary tale of the risks involved.[22] UTOPIA, a multi-city broadband effort in Utah, has struggled financially and has substantial liabilities. Last year Macquarie Capital, a worldwide capital investment group, stepped in to assist the UTOPIA consortium, which had not met its goals for deployment and adoption.[23]

There are certainly examples of successful "model one" municipal broadband systems. Cedar Falls, IA and Chattanooga, TN are two often-cited successful networks.[24] The former mayor of Chattanooga recently wrote that the City's network is "attracting businesses and industry to the area, helping to revitalize a community that once depended on pollution-heavy manufacturing."[25] The mixture of successful and failed municipal projects highlights the risk inherent with the model one approach, however. Unless the City has a substantial appetite for financial risk, model one may not be a good fit for Gillette.

Model three is, in essence, an "open access" approach. Managing a city-wide open access network features the same substantial upfront capital costs (and risks) as model one. The broadband system constructed by the City of Provo, for example, is viewed "by many . . . as a failure that cost taxpayers about $60 million."[26] After years of financial challenges, Provo sold

[21] "FCC Redfines Broadband," January 29, 2015. http://www.usnews.com/news/articles/2015/01/29/fcc-redefines-broadband-in-net-neutrality-prelude.
[22] "Why the FCC Should Stay Out of the Local Broadband Business," Governing (May 20, 2014). http://www.governing.com/gov-institute/voices/col-federal-communications-commission-local-government-broadband-business.html
[23] "Understanding the Debate over Government-Owned Broadband Networks," Advanced Communications Law & Policy Institute at New York Law School, p 76 (June 2014).
[24] "A Study of the Economic and Community Benefits of Cedar Falls, Iowa's Municipal Telecommunications Network," Iowa Association of Municipal Utilities (July 2004).
[25] "Chattanooga, Tenn., Is Proof Municipal Broadband Works," Governing (June 2, 2014).
[26] "Understanding the Debate over Government-Owned Broadband Networks," Advanced Communications Law & Policy Institute at New York Law School, p 83 (June 2014).

their network to Google for one dollar, although the city is still responsible for nearly $40 million in bonds.[27] Under a model three approach, the City could contract out the maintenance of the system if it preferred not to build internal capacity to do so.

Model four occurs when a community works to create a hospitable environment for private sector telecommunications investment. Model four is often a good approach for communities to adopt, as existing telecommunications providers are usually best positioned to improve broadband in a market, but there are times when pursuing different approaches is prudent. The City of Gillette has taken a number of "model four" steps and has attempted to engage the incumbent providers in conversations about increasing broadband speeds with the city. Thus far those efforts have been met with limited progress, but continuing with model four efforts is a prudent option for the City of Gillette. This study recommends the City of Gillette undertake additional due diligence on a model four approach, which is explored in greater depth in section 8.3.

Model two (targeted retail deployment) provides an intriguing possibility for the City of Gillette. Gillette, like Chattanooga and a number of other cities with successful municipal broadband projects, manages an existing electric utility system. The city also features an existing fiber backbone that could be utilized to provide service. If the City is looking to pursue an option with higher risk and higher reward, this study recommends Gillette undertake additional due diligence on a model two approach, which is explored in greater depth in section 8.3.

[27] "City of Provo actually has to pay for Google to take over its struggling fiber network," April 24, 2013, accessed at http://venturebeat.com/2013/04/24/iprovo-sad/.

CHAPTER SIX

6.0 Financing Options: Public & Private

6.1 Federal Loan Options

The USDA has two loan programs that can be utilized to provide funding for telephone and broadband service in rural areas. These include the Telecommunications Infrastructure Loan and the Farm Bill Broadband Loan Program. While the City of Gillette would qualify as an eligible entity for both programs, it appears from the definitional limits of "rural," the area covered by the City is not eligible. The eligibility requirements and rules of these programs change regularly, however, so it is helpful to have an understanding of the resources available.

6.1.1 USDA – Telecommunications Infrastructure Loan Program

For the Telecommunications Infrastructure Loan Program, towns must have a population less than 5,000. Also, the area must be without telecommunications service or the applicant must be the recognized telecommunications provider in the area. Therefore, this program may not be a fit for the City of Gillette, however, future and emerging loan programs might.

6.1.2 USDA – Rural broadband Access Loan Program

The 2014 Farm Bill continued the Rural broadband Access Loan Program, however, the regulations that govern the program have not yet been released. The Rural Utilities Services is not currently accepting applications. Also the current rules for the program limit the population of an eligible town area to 20,000 or fewer people.

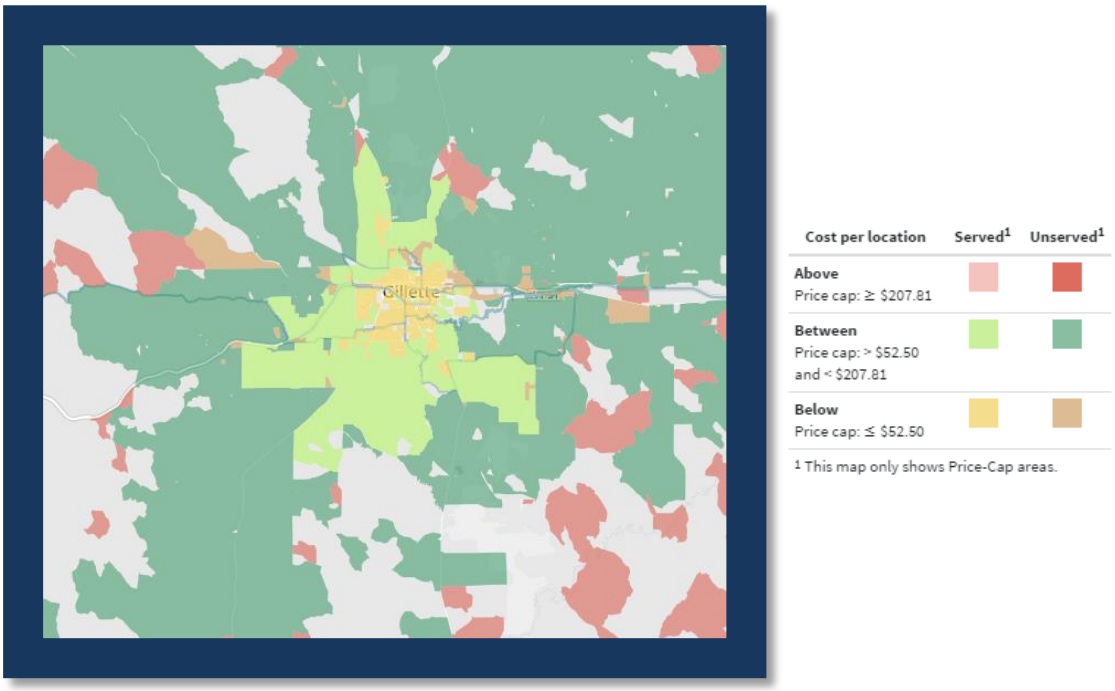
6.2 Federal Grant Options

6.2.1 USDA – Community Oriented Connectivity broadband Grant Program

The USDA has established a grant program to fund broadband deployment into rural communities. It is referred to as the Community-Oriented Connectivity Broadband Grant Program. This program is directed to areas where broadband service of 3 Mbps does not currently exist. Because there are providers within the city that offer this level of broadband, the City would again need to conduct research as to eligibility for this or related programs.

6.3 CONNECT AMERICA FUND (CAF) PHASE II

CAF II Areas Near Gillette



An additional potential source of funding for a City of Gillette project would be the Connect America Fund (CAF) Phase II. This program provides funding support for areas that are unserved by broadband. On April 30, 2015, the FCC released the census block list eligible for the programs $1.7B in available funds[28]. Incumbent price cap carriers (CenturyLink in Gillette) interested in accessing that funding have until August 27, 2015 to make a commitment to serve a significant amount of the eligible areas within the entire state.[29] If CenturyLink does not make this commitment for the state of Wyoming, the eligible census blocks would become available for a reverse auction process. The auction process will likely occur in 2016. Therefore, if the City were to move in the direction of becoming a municipal broadband service provider, there is a possibility that it could participate in the auction process for any eligible census blocks. The figure above shows preliminary eligible census blocks shaded in the darker shades of brown, green, and red. As currently shown, the eligible areas would be outside of city limits.

[28] http://www.fcc.gov/encyclopedia/price-cap-resources.

[29] FCC Public Notice at https://apps.fcc.gov/edocs_public/attachmatch/DA-15-509A1.pdf.

6.4 PUBLIC & PRIVATE FINANCING OPTIONS

6.4.1 GRANTS

Utilized to partially offset costs of a new deployment or network expansion (either public or private).

> Example: Chattanooga, TN and numerous stimulus Broadband Technology Opportunities Program (BTOP) awardees.
>
> The Department of Energy (DOE) granted to the EPB, $111M in stimulus funding to launch smart grid services; this is public record. This infrastructure was then used to build on, and expand, broadband services.
>
> *Source: Institute for Local Self-Reliance*

6.4.2 MUNICIPAL BONDS

A local government or utility issues bonds to private investors; often utilized for a city-wide deployment where there is a projected revenue from a city-owned and -operated model or with private parties interested in leasing access to the network for service delivery to commercial, and residential customers.

> Example: Lafayette, LA; Cedar Falls, IA; Longmont, CO
>
> In May 2013, Cedar Falls Utilities (CFU), a municipal utility that provides broadband communications, electricity, water and natural gas services in Cedar Falls, Iowa, launched Internet service at 1 Gbps. President Obama noted in a recent speech, Google named Cedar Falls the best city in Iowa for e-commerce due to its municipal fiber optic network.
>
> *Source: Institute for Local Self-Reliance*

6.4.3 PRIVATE FUNDING

Successfully securing outside private investment often requires a city to make available incentives or revenue enhancing pledges to demonstrate a sustainable business model with attractive ROI potential.

Example: Kansas City, MO; Austin, TX

Two new companies have recently entered the North American Market, UK based SiFi Networks and the Australian financial institution, Macquarie Infrastructure.

- http://sifinetworks.com/
- http://www.macquarie.com/mgl/com/mic

Each of these resources could provide build/finance options for the City.

Source: Institute for Local Self-Reliance

6.4.4 Cooperative Funding Model

When there is little to no private investment interests participating communities collectively have issued general obligations bonds.

Example: Sibley County, MN

The south central Minnesota-based initiative began in 2010 as a collaboration between a number of local county and municipal government entities in south central Minnesota. Local residents rallied behind the project, which was designed to connect both towns and surrounding farms. After numerous delays, the project is now designed to bring better connectivity options to approximately 6,200 customers as part of the RS Fiber Cooperative.

- http://www.rsfiber.coop

Participating communities will collectively issue $13.7 million in general obligation bonds. Local investors, bank loans, and other financing will provide the remaining $42 million. The project is scheduled for completion in 2018.

Source: Institute for Local Self-Reliance

6.4.5 Crowd Funding

Utilized for incremental, scalable projects with tangible benefits for civic investors (public Wi-Fi, Innovation Zones/Districts) or for exploratory costs in cases of widespread citizen demand and slow government action.

Example: Blacksburg, VA

In September 2013, the Town of Blacksburg, VA working with a local tech entrepreneur and Virginia Tech, announced a new broadband service in the downtown area consisting of a Wi-Fi offering connected to a Gigabit network.

The project is a result of the community successfully using crowd funding to raise funds for equipment and labor. The project has already enabled the development of next generation applications.

The service currently supports a local business incubator and adjacent restaurants, but plans are to expand to other high-traffic areas such as the library, schools and additional downtown restaurants, as well as other strategic locations in Blacksburg.

Source: Institute for Local Self-Reliance

6.4.6 Utility Fee

A relatively new approach, utilized for full-scale, ambitious, citywide deployment of a city owned and operated model or with private parties interested in leasing access to the network. To be successful, substantial political and public support is needed.

Example: Macquarie in Utah

Macquarie Infrastructure is requiring residents to pay a monthly utility fee (estimated at $18-20) regardless of whether or not they are network customers, to offset network build and operation costs.

This structure offers universal basic internet access, and the chance for everyone to purchase high speeds and premium services (voice and video) in a competitive market running on state-of-the-art infrastructure. The downside is the monthly utility fee, which is already proving contentious, as well as ceding control of the network to the private investor for 30 years.

Source: Institute for Local Self-Reliance

6.4.7 Infrastructure Financing Districts (IFDs) or Tax Incremental Financing (TIF) Districts

In states where such districts are set up or politically suggested and where projected future revenues / value from infrastructure projects are reliable.

Example: Wabash County, IN and California

Tax Increment Financing (TIF) is method of public financing that uses future gains in property or sales taxes within a defined area to subsidize a redevelopment or infrastructure project. A local jurisdiction can borrow money up front, build the project, and then use the increased tax receipts it generates to pay off the debt over a period of years. Whether or not TIF eventually proves to be a good tool for building high speed fiber optic networks in rural areas and small towns remains to be seen.

Source: Institute for Local Self-Reliance

CHAPTER SEVEN

7.0 FRANCHISE REFORM

7.1 BACKGROUND

This study encourages the City to streamline both the language, as well as the implementation guidelines of its city ordinance and franchise agreements related to:

- Cable television
- Crossing of rights of way of cable television service providers
- Requirements related to public, educational, and governmental (PEG) content
- Delivery, collection, and payment of franchise fees

Historically, the incumbent cable franchise holder has enjoyed "first mover advantage," thus limiting the potential for secondary franchise award grants. The emerging competitive market demands change, recognizing that even the City of Gillette might become a broadband service provider delivering linear video content. Effective competition has been achieved (service from cable companies, telcos, and direct-to-home satellite providers) and new entrants must be "pulled into the city" as they most likely will not be interested in "pushing their way into the city" without an easy to navigate franchise policy and program. This chapter highlights changes needed to create this environment.

A recent *Wired Magazine* article discussed the barriers to entry imposed by legacy franchise policies.

> *"Deploying broadband infrastructure isn't as simple as merely laying wires underground; that's the easy part. The hard part — and the reason it often doesn't happen — is the* pre-deployment barriers*, which local governments and public utilities often make difficult.*
>
> *Before building out new networks, Internet service providers (ISPs) (and or cable providers) must negotiate with local governments for access to publicly owned "rights of way" so they can place their wires above and below both public and private property. ISPs also need "pole attachment" contracts with public utilities so they can rent space on utility poles for above-ground wires, or in ducts and conduits for wires laid underground.*
>
> *The problem? Local governments and their public utilities charge ISPs far more than these things actually cost. For example, rights of way and pole attachments fees can double the cost of network construction.*
>
> *So the real bottleneck isn't incumbent providers of broadband, but incumbent providers of rights-of-way. These incumbents have the final say on whether an ISP can build a network. They determine what hoops an ISP must jump through to get approval."* [30]

[30] http://www.wired.com/2013/07/we-need-to-stop-focusing-on-just-cable-companies-and-blame-local-government-for-dismal-broadband-competition/

This section highlights changes needed to create an environment open to innovation, new competition, and next generation broadband investments.

- There is no attempt for this report to provide legal advice or drafting. The comments are operational and business terms that, if adopted, should be adopted with careful legal review.
- Comments are from the "Cable Television Franchise for the City Gillette, Wyoming," provided to the drafters of this report by City personnel.

7.2 COMMENTS, EDITS, & NOTATIONS

7.2.1 SECTION 1 – DEFINITIONS OF TERMS

Section 1.1e

Suggestion to Add: However, in no event shall the delivery of Cable Service, through a Cable System that is transported across City Easements or Rights of Way by either a common carrier or legally enabled common transport provider (such as a utility) require the issuance of a Cable Franchise to either the Cable Service provider or the Transport Provider, who may be governed as to its right of way crossing through non Franchise conditions. The only exception and remaining condition related to cable television Franchise requirements shall be the collection of and payment to the City of Franchise Fees as defined in the Cable Franchise of the City.

7.2.2 SECTION 2 – GRANT OF FRANCHISE

Section 2.4

Suggestion to Consider: The City, consistent with emerging Innovation District conditions as defined by the Brookings Institute and initiated by cities throughout the US, should agree to work closely and in cooperation with applicants, in areas such as reservation of rights and enforcement of local laws and regulations, so as to facilitate new investments.

Section 2.6a/b

Suggestion to Consider: While perhaps still relevant in a rapidly-changing telecommunications industry, the City might consider not engaging with the current "grantee" as defined herein. Such review should be independent from any existing grantee influence. Additionally, in that the current grantee has operated under effective exclusivity, the City may consider the necessary survival of "reasonably comparable to the extent required to provide all parties" language.

7.2.3 SECTION 3 – USE OF STREETS & PUBLIC GROUNDS

Section 3.1c

Suggestion to Consider: Every broadband service provider recognizes the advantages of first mover installation and investments. As such, perhaps the "intent" to grant public rights of way might facilitate early service provider investment and installation.

General Section Comments: Unless already in place, the City should adopt and enforce a "dig once" program ensuring orderly access to rights of way and the provisioning of "future use" conduit by authorized franchise holders.

In areas related to restoration of public ways, including mean time to repair, notice, and penalties, the City should consider itself a partner in enabling and encouraging investments in right of way improvements, and pass such rules and regulation with a renewed spirit of reasonableness yet retaining its rights in the event of egregious damage or lack of appropriate restoration.

7.2.4 SECTION 4 – SYSTEM MANAGEMENT & MAINTENANCE

Section 4.8a

Suggestion to Consider: With the achievement of effective competition as defined in this study, we recommend a complete deletion of this sub-section. This has been a historically validated burden and inhibitor to competitive new franchise applications and awards. While the City must ensure that franchise holders do not discriminate in terms of social, demographic, or ethnic boundaries, franchise holders should be afforded the opportunity to build where such construction is economically viable.

As such, Sections 4.8c would ideally not include a requirement to build simply upon potential subscriber requests. Sections 4.8d should be reviewed in terms of effective competition and non-citywide build requirements.

Section 4.9

Suggestion to Reconsider Requirements: PEG channels and access are a substntial barrier to entry. As such, section 4.9 should be considered for modification. Similar considerations apply to sections 4.10 and 4.11.

7.2.5 SECTION 5 – RATE REGULATION & CONSUMER PROTECTION

Sections 5.1a/b/c/d

Suggestion to Consider: While regulation, public policy, and federal standards most likely render these sections questionable in terms of enforcement, they often serve as barrier to new entry and in this franchise refer to unique build/rebuild conditions applicable to the current franchise holder.

Section 5.1e

Suggestion to Reconsider Requirements: With unique market variables and inconsistent competition in various such markets, this section is difficult to enforce and questionable to survive in such variable markets.

Section 5.5

Suggestion to Reconsider Requirements: With the scheduled retirement or sunset of traditional voice/TDM networks, this section may require modification or deletion.

7.2.6 SECTION 6 – FRANCHISE FEES

Section 6.1

Suggestion to Consider: The City may consider a 5% franchise fee cap to remain competitive with other markets. Franchise fees are a burden to subscribers more so than to providers.

7.2.7 SECTION 8 – MONITORING PERFORMANCE, EXERCISE OF REGULATORY AUTHORITY

Section 8.3d & Section 8.4/8.5

Suggestion to Reconsider Requirements: With the ease of access to records, the City may reconsider requirements related to "local office" records storage. The City may also reconsider requirements related to annual reports in the detail defined in the current franchise.

Section 8.11a/c

Suggestion to Reconsider Requirements: Refer to comments related to Section 4.9 in this study.

7.2.8 ATTACHMENT 1 – CUSTOMER SERVICE STANDARDS

Sections 1/2/3

Suggestion to Redraft Requirements: The City may consider updating these requirements to more adequately and accurately reflect currently available technology related to access and subscriber contact points.

CHAPTER EIGHT

8.0 Recommended Next Steps

The City of Gillette has requested a minimum of two recommendations for stimulating fiber deployment within the city. This section of the report provides a number of such recommendations.

8.1 General Recommendations

8.1.1 Broadband Information coordination

One of the easiest and most effective steps municipal governments can take to aid broadband deployment is to coordinate the gathering of broadband-related information that could be used by providers, citizens, and businesses. A few examples include:

- Centralize data, maps, and other information related to available fiber and conduit assets. Develop a Geographic Information Systems (GIS) based map that identifies current and future city-owned broadband infrastructure.
- Convene an annual meeting among all municipal agencies to better coordinate intra-departmental broadband planning and activities.
- More accurately quantify the city's broadband use and likely future demand to support a feasible business case to entice incumbents to upgrade infrastructure or to attract new market entrants.

8.1.2 Begin Community Conversation on Broadband

An important first step in beginning to use broadband resources differently is to think about how the community could utilize faster speeds. City leaders should challenge major community institutions, including schools, healthcare providers, the municipal electric department, and local governments to describe what applications they would implement by 2020 if they had Gigabit speeds available. For example:

- To what extent would schools utilize remote and authenticated student access to class content/materials?
- To what extent would healthcare providers implement advanced telemedicine applications?
- To what extent would the municipal electric department deploy energy information services and smart grid systems?
- To what extent would the city make better use of cloud-based applications for city business and utilize video conferencing/telepresence facilities and "meet-me" rooms throughout the city?

These conversations can ultimately manifest themselves in new broadband deployment and the implementation of exciting new technologies for citizens. An example from Cleveland, OH:

> *"Broadband and cable TV provider Cox Communications Inc. and the Cleveland Clinic Medical Center have announced a new venture to develop in-home healthcare services, stepping into a market that is poised to grow as medical care goes digital.*
>
> *The joint venture in Atlanta called Vivre Health is designed to help Cox expand its reach into healthcare beyond its current services, such as providing broadband for hospitals.*
>
> *The plan is to foster in-home monitoring and treatment, such as video consultation via broadband and home use of equipment to monitor and manage recovery from surgery, Cox executives said. That could cut down on costly in-person visits to doctors and hospitals.*
>
> *The Cleveland Clinic, a world-renowned academic medical center based in Ohio, will offer expertise to help create new services for patients.*
>
> *Cox also made an investment in HealthSpot, a company that provides walk-in kiosks where patients can interact with doctors through videoconferencing and take measurements with medical equipment such as blood pressure cuffs. The kiosks are being tested in several states at pharmacies and retailers. The amount of the investment was not disclosed.*
>
> *'Home health is an area that will see tremendous growth over time,' the Chief strategy officer for Cox Communications, said in an interview. 'It will require more and more broadband capability.'*
>
> *Cable TV providers, such as Cox, are seeking new revenue in areas such as healthcare and home security as their traditional business of selling TV services to residential clients matures."*

The City should also engage with other cities and organizations having similar conversations. Gillette may elect to follow the lead from communities engaged in creating what the Brookings Institute refers to as "Innovation Districts." Rather than seeking to duplicate the economic gains of major U.S. urban centers, Gillette has the capacity to functionally streamline its policies, procedures, and regulatory framework to advance the agenda for the recommendations included in this report. In terms of "Innovation District" thinking and planning, a new complementary urban model is now emerging.

These districts, by definition, are geographic areas where leading-edge community anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators. They are also physically compact, transit-accessible, and technically-wired and offer mixed-use housing, office, and retail. Innovation Districts are the manifestation of mega-trends altering the location preferences of people and firms and, in the process, re-conceiving the very link between economy shaping, place making, and social networking.[31]

[31] Brookings Institute, The Rise of Innovation Districts, 2014.

8.2 "MODEL FOUR" RECOMMENDATIONS

Chapter five of this study examined a number of different options for municipal involvement in broadband deployment. Model four envisions city government working to support and encourage a greater degree of private sector investment into broadband. This option brings a low risk profile and has successfully worked to deliver broadband speeds to most of America. One downside is that results can be uneven and may not occur as quickly as municipal leaders desire. This report recommends the City of Gillette increase its model four efforts.

8.2.1 BARRIER ELIMINATION

To ensure that the city's policies and practices are as conducive to private sector investment as is reasonable, the city should consider these steps that have proven effective in other communities:

1. **Infrastructure development –** Perform preparatory work on city poles for new telecommunication entrants. Also, in instances where providers are willing to commit to providing new brownfield broadband service, consider placing additional conduit in that area and providing reasonable access to that conduit.
2. **Revise franchise policies –** Review and implement updates to the city's current franchise policies. Section 7 contains a detailed assessment of this suggestion.
3. **Provider workgroup –** Regularly (perhaps annually) convene a work group of providers with the Gillette region to identify and amend regulatory roadblocks that might limit or delay private sector investment.
4. **Continue existing efforts –** Continue the City's efforts to improve its service level agreement (SLA) notifications and damage prevention program. That will increase provider confidence and comfort in leasing the City's fiber network.
5. **Do not require use of City fiber –** Do not require providers seeking franchise agreements or right-of-way use to utilize city-owned fiber.
6. **Reduce fiber lease rates –** Significantly reduce lease rates on city-owned fiber to make it less expensive for existing providers to expand service.

8.3 "MODEL TWO" RECOMMENDATIONS

Chapter five of this study examined a number of different options for municipal involvement in broadband deployment. Model two features public sector investment and municipal retail service offerings. This option features a higher risk profile than the model four approach recommended by this report, but if the City of Gillette desires a more direct role in expanding Internet speeds and availability, there are steps it can take to do so.

8.3.1 EXPLORE DIRECT MUNICIPAL INVOLVEMENT IN DEPLOYMENT

Direct municipal involvement in broadband deployment can be a challenging endeavor. Many municipal efforts have failed and most have struggled to meet their expected outcomes. The City of Gillette does feature a number of compelling advantages with regard to municipal deployment, however:

- **Backbone infrastructure –** The city has miles of existing fiber backbone in place. The existing fiber provides a jumping-off point for additional deployment.
- **Existing utility operations –** Citizens are used to getting a utility bill from the city. That existing customer relationship is a key asset.
- **Utility assets –** The already owns a large quantity of poles and a variety of associated maintenance assets that could be used in broadband deployment.
- **Community growth –** Gillette is a growing community. The prospect of more homes and business reduces the risk somewhat of broadband investment.
- **Strong marketing survey results** – Gillette's citizens are frustrated with their current options. That frustration may cause a higher-than-normal degree of enthusiasm and acceptance for municipal-led deployment.

8.3.2 What Type of Municipal Involvement?

After consideration of Gillette's position and unique advantages, it is possible the City of Gillette could have some success pursuing a variation of the model two approach, deploying fiber in a targeted way to serve large customers. Given the complexity of the telecommunications arena, if the City desires to adopt a model two approach, this report recommends the City of Gillette own and oversee an expanded fiber network, but that the City contract with an experienced telecommunications provider to help operate portions of the municipal system. This experienced provider (who may not currently provide service in the Gillette area) would remove many of the challenges that frustrate municipal deployments. An established provider would already have a switching solution, billing software or vendor, regulatory knowledge, and network experience. Combining those resources with the fiber network and customer relationships of the city gives Gillette the best of both worlds. Although the exact nature of the relationship and responsibilities would need to be determined through an RFP process and subsequent negotiation, this chart provides an overview of major responsibilities:

Responsibility	City of Gillette	Telecommunications Provider Partner
Strategic Oversight	✔	
Network Ownership	✔	
Funding Cap Ex	✔	
Construction	*	

Regulatory	*	
Switching		✔
Internet Service		✔
Video Service		✔ (optional)
Customer Billing	✔	
Carrier Access Billing		✔
Customer Support	✔	
System Maintenance	✔	
Marketing	*	

* = Most telecommunications providers contract one or more of these tasks out to professional experts (telecommunications engineers, telecommunications consultants, marketing firms, etc.).

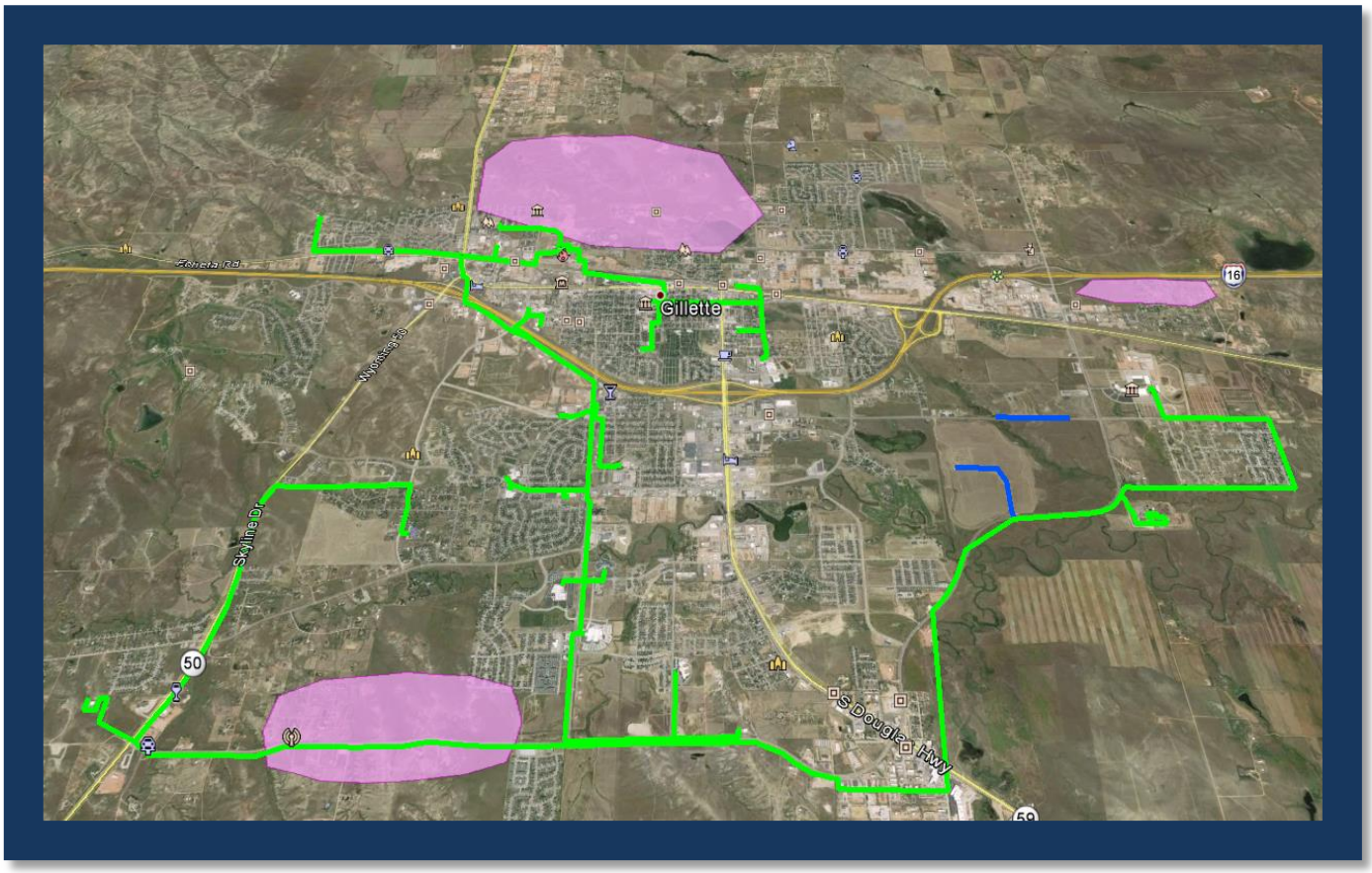
8.4.2 BROADBAND DEPLOYMENT STEPS

The City of Gillette has deployed an extensive backbone of fiber that connects public facilities, as well as commercial and industrial areas. In some cases, providers such as Visionary Communications lease dark fiber from a city in order to provide services. The city's existing fiber and conduit system could be utilized to provide the backbone for expansion of high-speed fiber based broadband services to more areas of the city.

If the city were to expand into providing broadband services, the city has potential warehouse and other buildings that could be utilized as primary locations for housing the electronics. As identified in the field site visit, there are also greenway areas within the city that could be utilized for electronics cabinet locations.

The City should view potential municipal broadband deployment as two major phases. Phase one would perform due diligence and possible construction and operation of a network close to the City's existing fiber backbone. By utilizing that backbone, phase one would feature lower upfront costs. Phase one, if successful, would connect more major customers proximate to the backbone each year for three years.

City of Gillette Fiber Assets and Possible Phase Two Expansion Areas



Phase two would perform due diligence and possible construction and operation of a network requiring additional fiber backbone construction by the City. The following map shows the existing Gillette fiber system. The pink shaded areas are locations that were identified as possible phase two growth areas to be considered for the expansion of the fiber network.

A number of important tasks would need to be undertaken by the City before any municipal broadband service could be launched. Those include:

1. Engage key stakeholders Fall 2015

The City should begin by convening a meeting of large customers and community institutions close to the existing fiber network. Specific questions should be asked about their current broadband usage, projected broadband usage, and willingness to work with a municipal broadband provider. Although the market survey provides a good overview of customer sentiment, for phase one, specific commitments from specific customers is critical.

The City should also engage key political stakeholders. Before deciding to expand Gillette's municipally funded and managed network, the community needs to develop consensus-based answers to certain key questions, including:

- How will the network be financed?
- Why haven't incumbent providers met the city's needs?
- Is an expanded broadband network a prudent way to invest the city's resources, compared to other infrastructure needs?
- How will the community define success? Is Gillette seeking a stream of revenue, improved broadband speeds, high tech jobs, or other benefits from the network?
- What will be the size and scope of the municipal network?
- What type of provider partner would Gillette like to work with? What services would they provide?

2. Conduct preliminary engineering Spring 2016

If the community begins to coalesces around a vision for municipal broadband, then the City will need to develop a deeper grasp of the engineering and financial challenges before it. The information gathered in step one will allow an engineering plan, based on specific customer demands, to be developed. This plan would maximize the use of the existing fiber backbone and would initially (phase one) serve just a few large customers (increasing in number over three years). Working engineering FTTP layouts showing what areas would be built and how the existing fiber would be utilized, along with detailed cost estimates for project segment would be developed. Phase one and phase two components would be engineered separately.

With the migration of IP services in last few years, the city of Gillette is in an improved position regarding the path to becoming a service provider. Two obvious changes have occurred. One, the equipment costs have decreased along with the equipment becoming easier to manage. Second, the ability to partner with existing providers and "lease" their equipment and expertise remotely has become more common. The engineering plan would evaluate various possible partners that could provide telecom services such as switching and broadband services.

3. Issue a Request for Proposals Mid-2016

At the same time the City is working on preliminary engineering estimates, it should be developing a request for proposals (RFP) to identify a telecommunications provider who is capable of expertly performing the responsibilities outlined on page 49. An experienced telecommunications provider should be selected to operate the municipal system, at least for the first few years of operation. The customer relationship (including customer service and end-user billing) would remain with the City, but the telecommunications provider would handle key operational issues for the network. It will take a number of months to develop the RFP, wait for providers to develop responses, assess their responses, interview the finalists, and negotiate details with the successful respondent. The City should utilize a professional telecommunications consulting firm to help guide and manage this RFP process.

4. Develop detailed financial model Fall 2016

A financial model should be created, based on the RFP responses and the specific engineering plan for the city. The financial model would include a cap ex budget along with operating budget for the project. The marketing study findings, along with the commitments of key customers, would be utilized to project penetration. A number of municipal broadband projects have struggled because of overly optimistic assumptions about costs and take-rates, so an outside expert should be retained to develop a realistic financial model. Phase one and phase two components would have separate financial models. As a part of step three, the City should also determine what financing options are available to it, and which options are preferred.

5. Finalize deployment plans End of 2016

Once detailed engineering plans and financial models are developed, the City of Gillette will need to decide whether or not to proceed, and if so, to what extent. If the City proceeds, it will need to finalize details with its provider partner, develop an aggressive marketing, and work to foster community support for the project. Additionally, the City will need to work with the provider partner to construct a detailed operations plan for construction and customer turn-up. That plan will guide the daily and weekly progress for several months as the system works to come online. A consulting firm with expertise in helping providers deploying competitive broadband services should be retained to assist with each of these phases.

APPENDIX A

Figure 1 – S. Douglas Hwy and Patty Ave. Facing South (By FV 96)

This is an industrial, commercial and middle income housing area with high growth potential. Existing utilities are placed outside of the right of way (ROW) and there are also aerial cables on electrical poles.

Figure 2 – S. Douglas Hwy Looking North Lakeway Rd. (By FV 33)

This is a high traffic shopping area with hotels, restaurants, banking and retail businesses. The map indicates inactive fiber and two FV's going South past I-90.

Figure 3 – E. Lakeway St. and Jasper St.

This is a green location found in this crowded business area along FV 21 to FV 33.

Figure 4 – S. Douglas Hwy and E. 8th St. (By FV 74)

This is a green area in this vicinity.

Figure 5 – E. Lakeway Rd. and Hwy. 59 (By FV 33)

This is an undeveloped major commercial and industrial area. This green area has pedestals and existing utilities (see locate flags).

Figure 6 – E. 8th St. and S. Douglas Hwy.

Installation of a FV in a sidewalk. This shows an alternative location for FV's in restricted areas most often found in crowded downtown areas.

Figure 7 –S. Douglas Hwy., North of E. Boxelder Rd.

This is an utility easement running perpendicular to Hwy 59 near the Visitor's Center and Flying J Truck Stop. Future FV's are planned for this area.

Figure 8 – Campbell County Hospital and North Wyoming Community College

This area is accessible from existing FV's 45-46-47. There are also cell tower sites in area.

Figure 9 – Alleyway Facing First Interstate Bank (Downtown Area)

Telephone utilities are underground with peds placed around existing structures. County Courthouse, City Hall, and major banking facilities are in the vicinity.

Figure 10 – Existing Aerial Construction Example

These pictures show older areas of the city, utilizing alleyways with aerial telephone utilities. These areas are suitable for underground facilities.

Figure 11 – Chase Court and Gurley Ave.

FV's and conduit are in place around a new elementary school and housing subdivisions. These pictures show ample ROW space for all nodes and/or HH placement.

Figure 12 – Boxelder Rd. and Chara Ave. (Looking East to Cam-Plex Convention Center)

Existing FV and conduit are in place. There is ample ROW for node and hand hold placement to serve this commercial and retail area. Fiber access is from FV 38.

Figure 13 –S. 4-J Rd and Frontier Dr. (by FV 22)

Green areas found along bike pathways.

Figure 14 –Parallel to I-90 (by FV 34)

When major routes follow along Interstate highways, these green areas are found by adjacent streets.

Figure 15 –O-R Drive and S. 4-J Rd (near FV 23)

Right of way example in this area.

Figure 16 –S. 4-J Rd. (by FV 90)

Right of way example in this area.

Figure 17 –Area by FV 90 Looking West

Right of way example in this area.

Figure 18 –W. Walnut St., W. 4-J Rd. and Lakeway Rd. (by FV 21)

Utilities following a power pole easement to service residential and business customers.

Figure 19 – Along Butler Spaeth Rd. and Boxelder Rd.

Restricted ROW's along fence lines opening up to allow easier node and HH installation sites. Future FV's are planned for this area coming from FV38 and FV108.

APPENDIX B

APPENDIX B – ACCESS TECHNOLOGY OVERVIEW

WIRELINE TECHNOLOGY

Wireline networks are composed of a vast, interconnected mesh of cables and electronics – such as switches and routers – throughout the world. Today, there are two main wireline network cable types used by broadband providers: twisted pair copper cables, fiber optic cables, and coaxial cables.

When properly designed, copper and fiber networks are capable of providing both voice and data services. However, voice over twisted pair copper cable is susceptible to interference from power lines, crosstalk (signal interference between adjacent cables), and other types of electromagnetic interference. Fiber optic cable does not have these limitations. Both copper and fiber networks are capable of delivering data services. However, fiber optic cable has significantly more capability to provide higher quality voice and high-speed data services than copper cable.

TWISTED-PAIR COPPER (DSL OR DIGITAL SUBSCRIBER LINE)

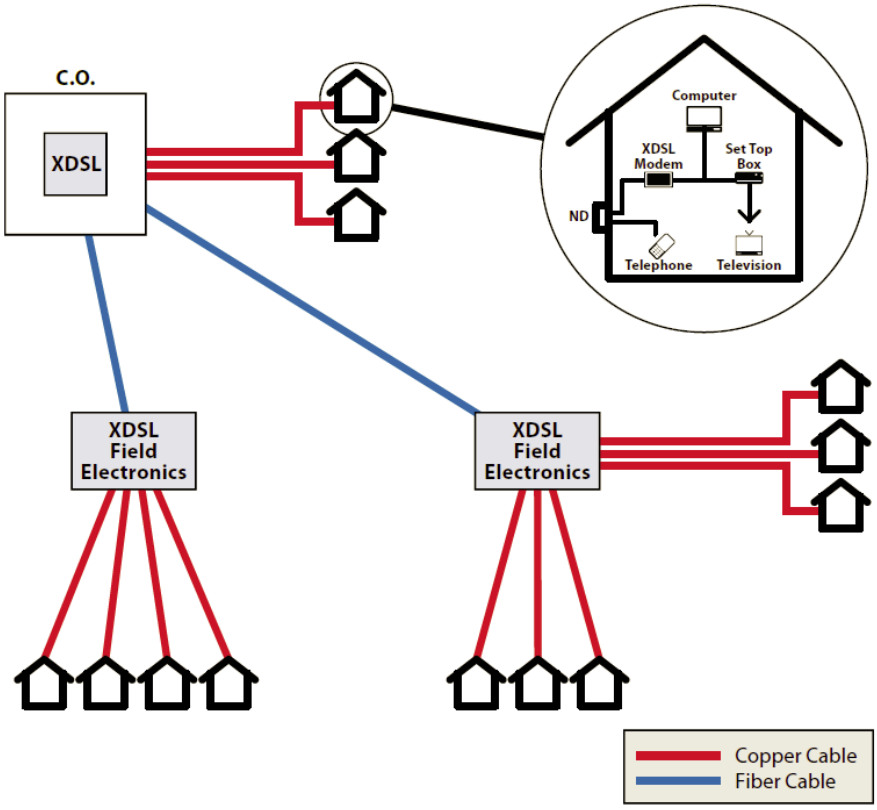
Telephone companies have historically provided voice service over twisted-pair copper cable. Consequently, millions of miles of twisted-pair copper cable have been deployed throughout the country. Voice services can be provided over twisted-pair copper cable to customers located many miles from the central office. However, for customers served by copper cable that exceeds 18,000 feet in length, the distortion caused by the capacitance of the cable renders the cable unsuitable for quality voice. Inductive loads, or load coils, can be added to the copper cable to cancel these distortions. Unfortunately, these load coils prohibit the transmission of any data or broadband services, such as Digital Subscriber Line (DSL) technologies. Even with unloaded copper cables, broadband speeds are heavily dependent upon cable length. This means that customers served by short copper cables (i.e., close to a central office or close to a remote terminal) can receive much higher broadband speeds than those served by longer copper cables. The Rural Utilities Service (RUS) recognized the importance of having a network that supports more than just voice services more than 20 years ago. Since that time, it has not funded the use of load coils on copper networks.

DSL technologies allow carriers to deliver broadband service to customers over these existing copper cables. Due to the physical characteristics of the copper cable, a network's capability is heavily dependent upon cable length. Customers who live close to central offices or remote terminals can receive much higher broadband speeds than those who live further away.

To increase broadband speeds, service providers have been moving electronics closer to the customer. These electronics are normally connected to the central office using fiber optic cable. The graphic below shows a typical DSL network with subscribers near the central office being served directly and the remaining subscribers being served from remote terminals. The size of the

DSL electronics serving area is dependent on the type of DSL technology being used and the bandwidth required by the customer.

The most common DSL technologies are Asymmetrical Digital Subscriber Line (ADSL) and Very-high-bit-rate Digital Subscriber Line (VDSL) with the latest variants of these technologies being ADSL2+ and VDSL2. When using DSL technologies, cable length is normally limited to 12,000 to 14,000 feet for 4/1 Mbps service.



DSL Network Topology

DSL has been used by telecommunications companies for nearly 20 years. However, most service providers have concluded that DSL is near the end of its useful life and will not be a long-term solution for broadband delivery. Therefore, they have been looking to fiber technology to meet the increasing customer demand.

As wireline service providers replace aging copper cable, it is common to replace all or a portion of their copper plant with fiber optic cable. Hybrid fiber/copper networks are normally called "fiber in the loop" or "fiber to the node" network structures, and consist of field electronics that are connected to the central office with a shared fiber cable and connected to the customer with dedicated copper cables. These electronics are normally located no more than 18,000 cable feet from the customers so that loading of the copper cable is not required and advanced services such as DSL can be provided to the customer. With a cable length of 18,000 feet, modern DSL

technologies can typically provide 1 Mbps to 2 Mbps download speeds, depending upon the quality and size of the copper cable. 3 to 4 Mbps could be provided over cable lengths of 12,000 to 14,000 feet, assuming good quality cable. Table 1 depicts a summary of twisted-pair performance.

Broadband Capability	• Typically 10 to 20 Mbps for customers close to the connection point (typically urban customers); could be 1 Mbps or lower for customers far from the connection point (typically rural customers). • Realistic maximum: 50 Mbps over very short loops (up to 3,000 feet).
Latency/Delay	• Low latency
Other Considerations	• Attainable data rates dependent on age and quality of plant • Mature technology; few further advancements expected • Can leverage existing twisted pair plant • Susceptible to electrical interference • Relatively high operational expenses
Overall Assessment	• Bandwidth capacity insufficient to meet long term customer

FIBER TO THE PREMISES (FTTP)

Fiber optic cable has been used by service providers for more than forty years to build high-speed broadband networks, primarily for long haul transport routes. Over the last ten to fifteen years, fiber has also been used to increase broadband speeds to the customer because no other technology can deliver as much broadband speed at such an economical cost. With FTTP[32], the broadband speed provided is not dependent upon cable length, but electronics. Each new generation of FTTP electronics allows service providers the ability to offer significantly higher broadband speeds over greater distances without having to make significant changes to their outside plant architecture. There is no foreseeable end to the amount of bandwidth that can be provided over fiber cables.

There are many reasons why fiber is the best technology to construct modern network or upgrade existing networks. Fiber is immune to electromagnetic interference, provides the most reliable services, and minimizes operational expenses. Therefore, it delivers the best voice and broadband services available for today and the foreseeable future. Deployment of fiber has significant economic and performance advantages over other technologies in rural areas in the short run, and these advantages will increase in the long run. As broadband demands continue to increase, FTTP will have an increased price advantage over other technologies. Over the last several years,

[32] Fiber-to-the-premises is sometimes referred to as fiber-to-the-home (FTTH).

increases in copper prices, advances in technology, and growth in broadband demand have all worked together to make FTTP an economical technology for providing broadband.

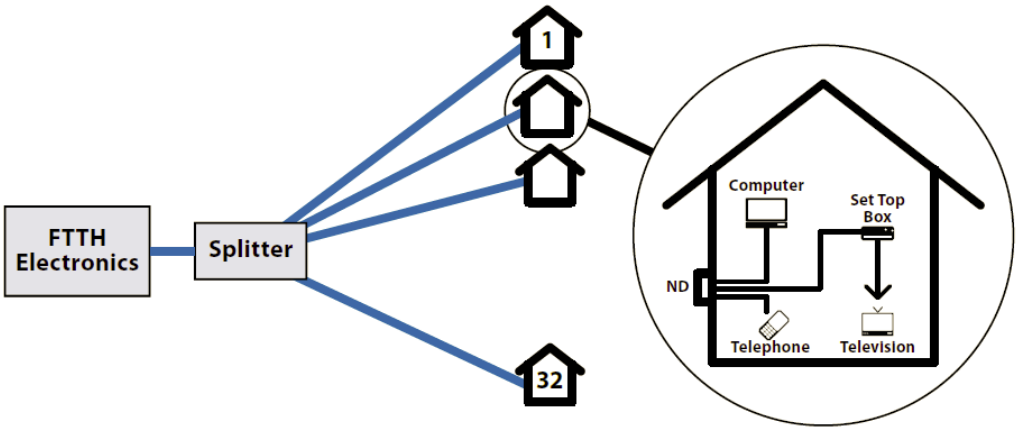
Not only is a fiber network less expensive to deploy, maintain, and upgrade, it has superior broadband capabilities, such as being able to offer telecommuting, telemedicine services, and telepresence. RUS has even shown preferential treatment for loan applications for a fiber network versus a copper network due to its short life expectancy and its limited ability to meet future customer broadband demands. Based upon requirements in the RUS loan design checklist, if new copper is being deployed, it is scrutinized by RUS and requires detailed cost analysis and design justification. Even retaining copper plant in new RUS loans requires a cost-benefit analysis. All of these factors make it clear that copper is a dying technology in the telecommunications industry. It would be unwise for companies to utilize copper in their network deployments going forward, except in certain very limited situations.

No other technology can deliver as much bandwidth to customers as economically as FTTP. Fiber optics have the ability to deliver greater bandwidth over a much larger distance and at a lower cost than other technologies. In addition, the bandwidth does not decrease as the cable length increases. Each new generation of FTTP electronics allows the service provider to offer significantly more bandwidth over greater distances.

Once fiber infrastructure is in place, service providers are able to increase the broadband speed by a factor of 100 or more by simply upgrading the electronics on the fiber cable, which represents a relatively small portion of the overall fiber network investment. Fiber technology will allow higher speeds to be delivered to customers over time with minimal incremental investment, making it the best technology for meeting future broadband service needs.

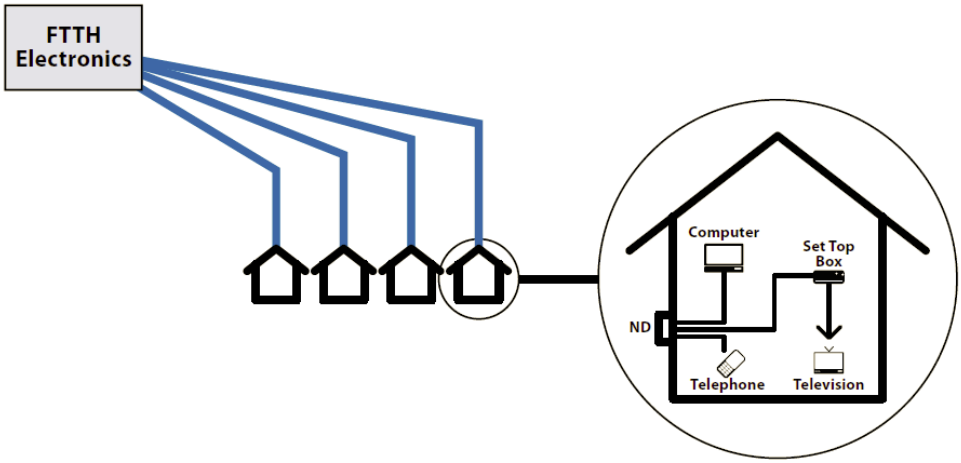
Today, there are two main competing FTTP technologies: Gigabit-capable Passive Optical Network (GPON) and Active Ethernet.

Most GPON implementations use optical splitters to serve up to 32 subscribers using a single fiber from the Central Office. GPON technology is defined by the International Telecommunications Union (ITU) Standards and currently allows for 2.4 Gbps downstream and 1.2 Gbps upstream. This bandwidth is shared by 16 or 32 customers. Under a “worst-case” scenario, where all customers are demanding their maximum broadband speed (which is unlikely), each customer would be limited to 75 Mbps downstream and 37.5 Mbps upstream. A future advancement of GPON, 10GPON, is expected to provide a four-fold increase in broadband speed. A typical PON system is shown below.



PON System

Active Ethernet systems use a dedicated fiber between the central office and the customer, so the broadband consumption of one customer does not affect the amount of broadband available to other customers. In addition, Active Ethernet systems are symmetrical, meaning they provide equal downstream and upstream rates. Today, most Active Ethernet systems can provide up to 1 Gbps to each subscriber, with some providing 10 Gbps per customer. Active Ethernet systems have not been as widely deployed as GPON systems in the United States. As subscriber broadband demand increases, Active Ethernet systems will continue to become more common.



Active Ethernet

Broadband Capability	• GPON: 75 Mbps per customer or more; 300 Mbps per customer planned • Active Ethernet: 1 Gbps to 10 Gbps symmetrical
Latency/Delay	• Low latency
Other Considerations	• Bandwidth is not limited by distance from Central Office. • Not susceptible to electrical interference. • Dramatic increases in bandwidth are possible by changing the relatively inexpensive electronics without any outside plant cable changes
Overall Assessment	• Provides more bandwidth than other technologies; significant bandwidth

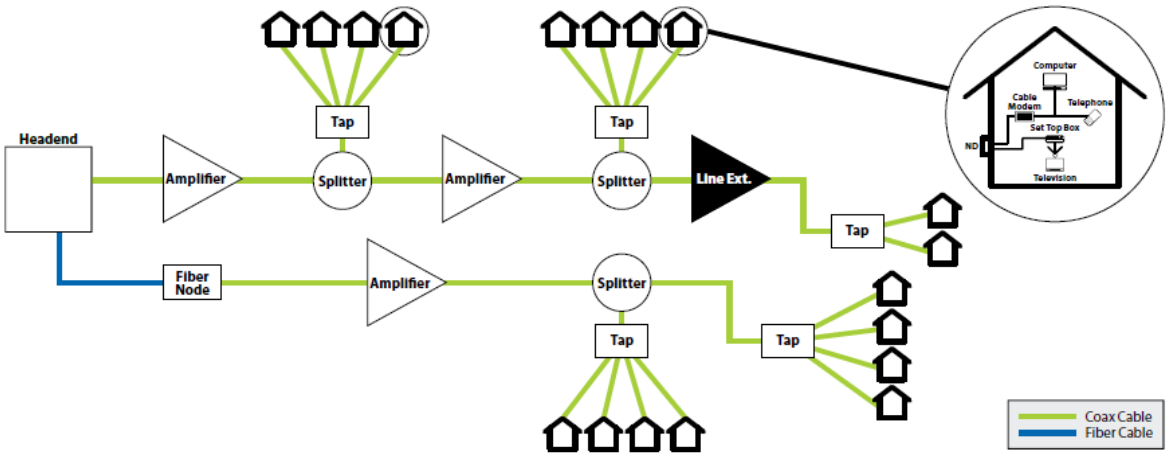
COAXIAL CABLE (DOCSIS)

Coaxial (coax) cable can also be used to provide wireline broadband services. Since most cable television (CATV) network rely on coax cables, we include a discussion of coax for completeness. The CATV industry has implemented standards called Data Over Cable Service Interface Specifications (DOCSIS), which defines how the coax network can be used to deliver broadband services to their customers. It is important to note that the CATV coax networks are shared – meaning a single cable leaving the CATV headend is split many times to serve many customers. Often, a single cable will provide broadband and/or video to hundreds of customers. This architecture worked well for broadcast video services, since it was a "one-to-many" service, but has limitations when delivering services such as broadband, where each customer requires their own unique connection.

DOCSIS provides the capability to give each customer their own "virtual" connection across the shared coax cable by putting data on the cable at frequencies that are normally used by video channels. There are three basic methods a CATV provider can use to increase bandwidth to their customers on a coax network:

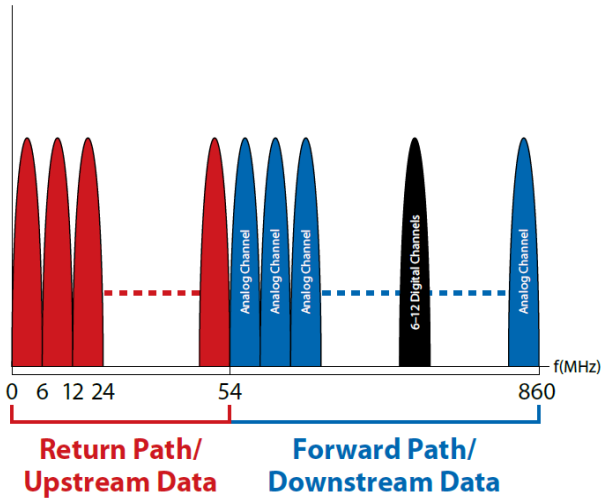
- Reduce the coax cable length to increase the available bandwidth.
- Reduce the number of customers sharing the bandwidth on each cable.
- Implement the bonding of multiple channels together.

The figure below shows a modern coaxial cable system that can deliver video, high-speed data and voice services. These systems are two-way capable (downstream and upstream), and utilize fiber nodes with coax distribution to the subscriber. When used for broadcast video deployment, a fiber node can serve hundreds or even thousands of customers. As broadband demands have increased additional fiber nodes must be deployed closer to the customer and often serve less than 200 customers each.



Coaxial Cable Access Network

The next figure is a depiction of a typical coaxial cable system channel usage. As shown, this signal on the coax cable is divided into 6 MHz segments. Analog video channels each take 6 MHz of bandwidth. As shown below, a number of digital video channels can also be placed within the same bandwidth as one analog channel. The bandwidth from 0 to 54 MHz is normally reserved upstream data (from the subscriber to the provider) and above 54 MHz is shared by video and downstream data (from the provider to the customer). It is also important to note that CATV networks share bandwidth amongst many customers in the access network and have significant limitations in their upstream bandwidth.



CATV Spectrum

In a DOCSIS configuration, several hundred users share the downstream and upstream data channels. The latest version of the DOCSIS specification is version 3.0. With DOCSIS 3.0, the 6 MHz channels can be bonded together (called a bonding group) to provide up to 160 Mbps downstream and 120 Mbps upstream per bonding group. Below is a summary of coaxial cable performance. This bandwidth is shared by all the subscribers that are assigned to that particular bonding group.

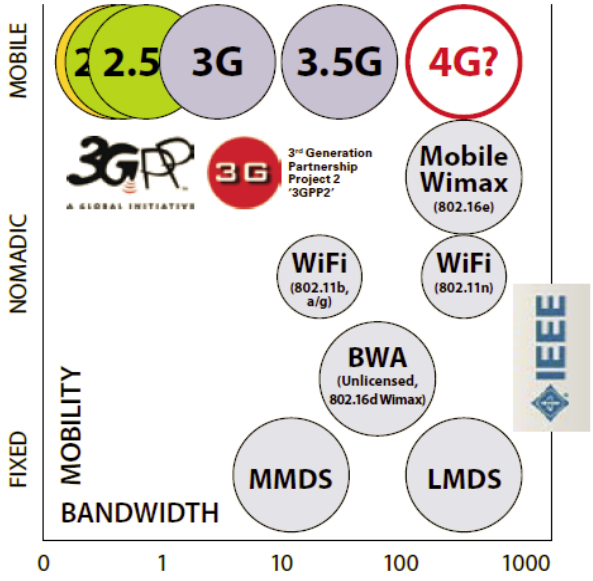
broadband Capability	• Up to 300 Mbps downstream (normally shared among a large number of subscribers) with DOCSIS 3.0 • Up to 120 Mbps upstream (shared among a large number of subscribers) with DOCSIS 3.0
Latency/Delay	• Low latency
Other Considerations	• Increasing bandwidth requires the deployment of many fiber-fed electronic nodes. • Older systems could require substantial upgrades to meet delivery requirements.
Overall Assessment	• Upstream bandwidth limitations will be significant as bandwidth demands become more symmetric. • broadband capacity shared, so speeds reduce as more customers are added to the network.

WIRELESS TECHNOLOGY

Wireless broadband has become a requirement for many consumers. What began with simple text messaging has grown to include web browsing, file transfer, and video streaming. There are many ways that a wireless provider can deliver a broadband service to its customer. Each method comes with different costs and quality characteristics.

4TH GENERATION WIRELESS (4G)

Historically, there have been two distinct groups of wireless carriers those focused on serving the mobile user and those focused on serving the fixed (stationary) user. Normally, by sacrificing mobility, fixed wireless carriers can provide greater broadband speeds to their customers. As depicted, here both mobile and fixed wireless technologies are converging on what is referred to as a 4th Generation (4G) network, an all-IP network approaching the throughput of today's fixed/nomadic Wireless Local Area Networks (WLANs), along with the full mobility of cellular. There are currently two dominant 4G wireless technologies: Mobile-WiMAX and LTE.



Cellular and WLAN Converge on 4G

The ITU has tentatively defined 4G, which it calls "IMT-Advanced," as 1 Gbps capability for stationary users and 100 Mbps for mobile users, although a typical customer would realize only a small fraction of this throughput. The throughput achieved by wireless technologies is dependent upon many factors:

- **Customer Location** – As the customer's distance from the tower increases, the speed of the connection decreases.
- **Available Spectrum Bandwidth** – Higher spectrum bandwidth means higher connection speeds.
- **Frequency of Spectrum** – Generally, the higher the frequency, the shorter the propagation distance.
- **Presence of Obstacles** – Obstacles, such as trees, hills, buildings, can attenuate wireless signals and reduce or prohibit broadband.
- **Environmental Effects** – Some operating frequencies are highly susceptible to attenuation due to rain, fog, or snow, which can reduce broadband speed.
- **Order of Spatial Diversity** – The configuration of Multiple Input, Multiple Output (MIMO) antenna technology can affect the throughput.
- **Customer Premises Antennas** – The type and gain of the antennas can affect the achievable bandwidth.

Wireless carriers in the United States rely primarily on spectrum allocated by the FCC in the 700 MHz, 850 MHz (Cellular), 2 GHz (PCS and AWS) and 2.5 GHz (BRS/EBS) licensed bands. Many carriers have spectrum in several of these frequency bands.

Future 4G technology improvements will allow carriers to make spectrum from multiple bands function as a single broadband channel. Today's 4G technologies can achieve an average spectral efficiency of 1.5 bps of actual throughput per Hz of spectrum bandwidth. Thus, while some instantaneous peaks may be higher, a carrier with 10 MHz of spectrum could potentially deliver 15 Mbps to its customers on average. However, since wireless technologies share bandwidth among many customers, the total bandwidth is divided among the customers. For example, if 100 customers were to share 15 Mbps, each would effectively receive 150 Kbps on average, if all were using the system at the same time.

New technologies are becoming available that could increase the spectral efficiency by as much as a factor of two, but experts believe this is the limit of spectral efficiency. Here is a summary of 4G performance factors:

Broadband Capability	• Practical implementations of 4G technologies allow customers to burst up to 10 or 20 Mbps for short periods of time.
Latency/Delay	• Low latency
Other Considerations	• Since bandwidth is shared among subscribers, available bandwidth per subscriber decreases as density of subscribers increases. • Available bandwidth decreases as distance of subscriber from access point increases. • Not well suited for large bandwidth needs and often discouraged by carriers by only allowing a limited amount of data per month.
Overall Assessment	• Bandwidth is typically adequate for limited broadband access, some data, and small screen video

SATELLITE

Satellite broadband is normally delivered to customers using geostationary satellites. Geostationary satellites orbit the earth at the same speed as the Earth's rotation, so the satellites appear to be stationary above Earth. In order to do this, they are placed into orbit more than 22,000 miles above the equator. Since the signal must travel so far, satellite broadband services have very high latency and typically are not suitable for the delivery of interactive multimedia services.

To decrease the latency, there have been some efforts to deploy medium and low Earth orbiting satellites, where the satellites are only a couple hundred miles to a couple thousand miles above the Earth. At these altitudes, the satellites are orbiting the Earth rapidly and many satellites are required to ensure that a subscriber has a satellite in view at all times. When used for broadband delivery purposes, these satellite systems have historically proven to be very complex and expensive to deploy, and they are not an effective method of broadband delivery.

While advancements in satellite technology have increased the amount of bandwidth that can be delivered to customers, the bandwidth is often shared among hundreds or thousands of subscribers. Similar to other broadband delivery systems that have a shared access network, as the number of customers increases, the available bandwidth per customer decreases. Satellite broadband is normally considered acceptable for very remote subscribers who have no other broadband delivery options. The table below summarizes satellite performance.

Broadband Capability	• Shared bandwidth between many subscribers • Typical packages of 512kbps to 1.5Mbps for home subscribers
Latency/Delay	• High latency
Other Considerations	• Latency not suitable for interactive applications (such as voice and videoconferencing). • Can be susceptible to rain fade (outages). • Can provide data services to very remote areas that may not be feasible for wireline or other wireless technologies.
Overall Assessment	• Bandwidth capacity insufficient to meet long term needs of customers. • High latency limits broadband applications.

BROADBAND CHARACTERISTICS

A network's physical and technical characteristics determine its performance, capabilities, and limitations. As Gillette reviews current network assets, and seeks to encourage new broadband investments, it is important that City leadership has, at the very least, a cursory understanding of essential network elements to best determine what strategy should be pursued. The following performance criteria can be used when evaluating broadband networks: speed, latency, capacity, reliability and scalability. Some network limitations are technical in nature and cannot be overcome, whereas others can be mitigated with appropriate economic investments and network design.

SPEED

Broadband "speed" is the rate at which data can be delivered and is often measured in Megabits per second ("Mbps") or Gigabits per second ("Gbps"). Broadband speed can be thought of as how fast the data flows through the broadband "pipe," which is a physical cable for wireline broadband or the transmission "over the air" for wireless or satellite broadband. Cisco Systems, a major provider to the broadband service provider industry, projects that globally, the average fixed broadband connection speed will increase from 16 Mbps in 2013 to 42 Mbps by 2018.

In regard to broadband speed, FCC Chairman Wheeler has stated, "Today, a majority of American homes have access to 100 Mbps. And while it's laudable that a majority of American homes may

have access to 100 Mbps, it is not acceptable that more than 40% do not."[33] It is that type of bandwidth that the City should be pointing to as it moves further into the 21st century. Gillette is, realistically, one of those communities referenced where it is not available.

LATENCY

Latency refers to the delay that occurs from the time that a piece of data is sent to the time when it is received at the destination. Network latency is most commonly measured in milliseconds ("MS").

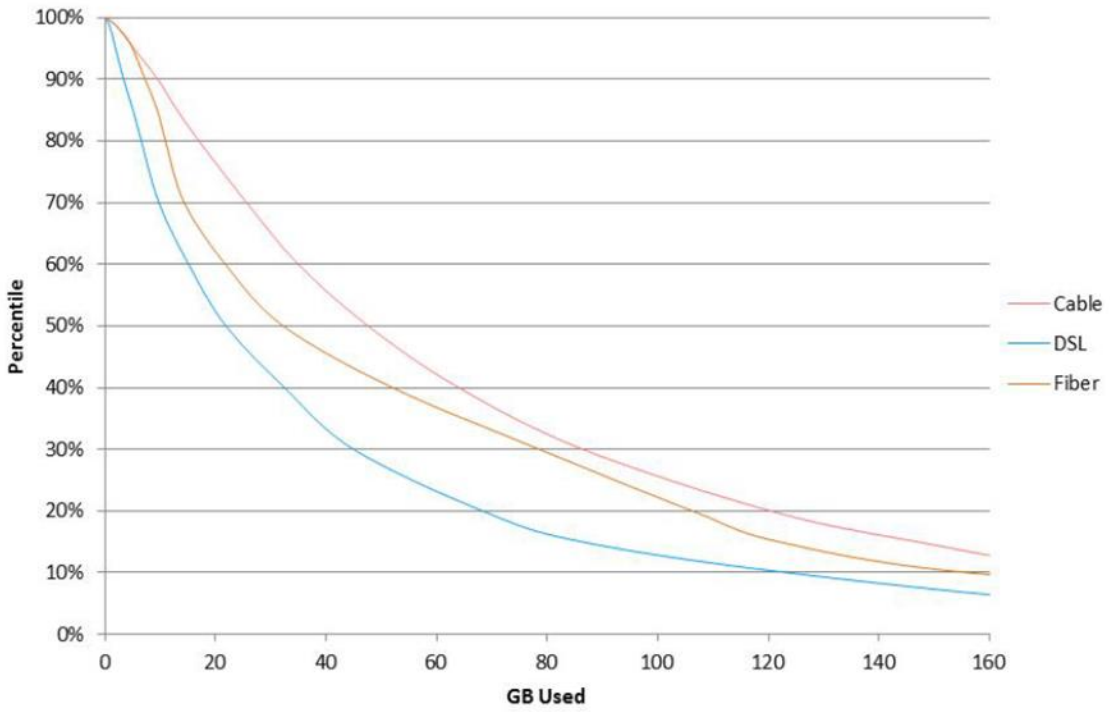
Many interactive broadband applications are adversely affected as latency increases. High latency can limit consumers' ability to use "real-time" applications, such as voice, video conferencing, Virtual Private Networking ("VPN"), remote learning, and telemedicine. With interactive two-way applications, round-trip latency is important since delays in delivering data can substantially degrade the quality of the application or make it unusable altogether.

CAPACITY

Network capacity is a physical limitation on the quantity or volume of data that can be delivered to a broadband user during a given time period. Capacity is often measured in megabytes ("MB") or gigabytes ("GB") per month.

Some networks have technical restrictions that limit customers' capacity. These technical restrictions can limit a customer's broadband capacity as more customers are added to the network. In networks where customers share the same communications channel, applications that demand continuous data delivery over long time periods (i.g., video) can quickly exhaust the network's capacity. To address this limitation, often networks are designed to permit customers to access data at high speeds, but for only short bursts of time. Customers on satellite networks and most wireless networks share the access portion of the network, while DSL and many types of fiber to the home ("FTTH") or fiber to the premises ("FTTP") networks have cable dedicated to a single customer in their access networks. Similar to consumers' increased demand for broadband speed, consumers' demand for capacity continues to grow. Figure 8 demonstrates customers' data consumption by technology based on September 2013 recorded data.34 The data shows that 20 to 25 percent of the customers served by coaxial and FTTP networks utilize more than 100 GB of capacity per month.

[33] "The Facts and Future of broadband Competition," Speech of Chairman Tom Wheeler, Federal Communications Commission, 1776 Headquarters, Washington, D.C., Sept. 4, 2014, p. 3.
[34] Accessed November 14, 2014. http://www.fcc.gov/reports/measuring-broadband-america-2014 , Chart 24, Page 51.

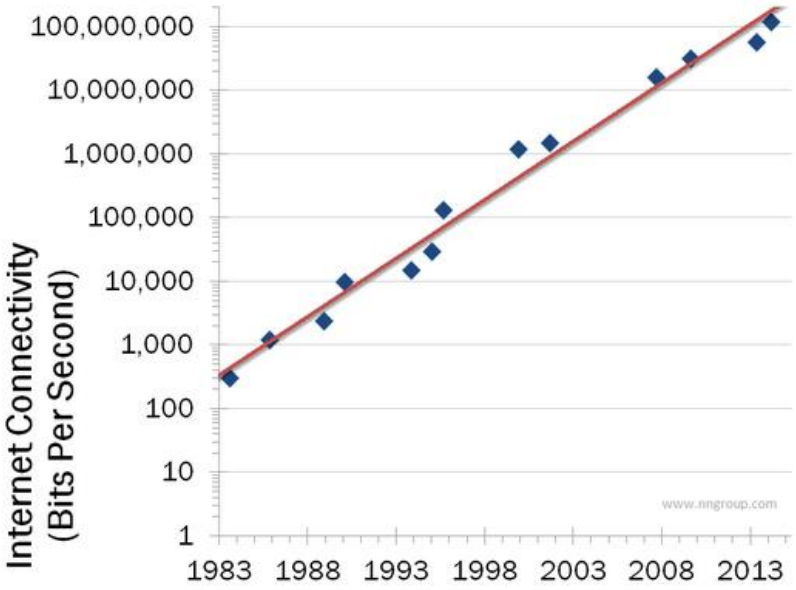


RELIABILITY

Reliability refers to a customer's ability to dependably use the network at different times and under various conditions. Customers are increasingly demanding a reliable broadband connection, because they depend on their broadband connection for e-commerce, entertainment, education, telemedicine, and the continuing market adoption of "always on" applications and devices. Some broadband networks reliability may be affected by environmental conditions, terrain, interference and the distance between the subscriber and the service provider's electronics. Technologies that are affected by environmental factors, weather and interference, are generally less reliable, as these factors are beyond the network provider's control.

SCALABILITY

Nielsen's law, theorized by Jakob Nielsen in 1998, states that broadband demand for high-end users grows at a rate of 50% a year:



This theory has proven largely correct and broadband speeds are expected to continue to rise at similar or greater rates.

An assessment of either a private or municipal broadband investment must consider not only existing broadband demands, but also the anticipated demands over the expected life of the facility. It would be short-sighted and cost prohibitive if a broadband network required significant upgrades, or had to be replaced prior to the exhaustion of its depreciation schedule or its operational acceptance. Consumers will soon demand, and broadband applications will require, minimum speeds in excess of 100 Mbps and capacities significantly greater than 100 GB per month. If networks do not easily scale to meet these increased points of demand, the network will inevitably become obsolete before capital would be available to re-invest. A network with a lower initial cost (the one often selected by today's Incumbent Service Providers), may not be the most economical, when considering the total cost of the network including upgrades over its scheduled economic life.

APPENDIX C

Survey of Gillette Businesses

Regarding Broadband Interest

◆ ◆ ◆ ◆

prepared for:

By

March 2015

Key Findings

Commercial Internet Need In Gillette

- Businesses in Gillette are primarily small. Approximately 80% have fewer than 20 employees. About 5 percent might be considered larger commercial enterprises.
- There is a clear need for improvement of business Internet services in Gillette. Low satisfaction is shown by an extremely low Net Promoter Index score of -51% and the fact that only 8% of the businesses are very satisfied (9-10 rating). The majority, 59%, are dissatisfied (1-6 rating).
- Perceived monthly downtime averages 4.4 hours per month which is quite high.
- Specific desires include higher speed, more reliability, more choice, availability in all areas of town, and better value.
- There does not appear to be a current fiber provider in Gillette.

Barriers To Overcome

- About 24% of the market currently deals with current long term contracts, and 27% with decisions made outside the area. Over time, these concerns could be mitigated.
- In addition, nearly one quarter of the market indicate they need more knowledge about broadband opportunities.

Potential Gigabit Messaging

- The market should be reminded of the increasing importance of broadband to business (perhaps including facts from this study), and of current market discontent.
- Product attributes to be promoted should of course include Gigabit speeds and symmetrical service, but also increased reliability and uptime.
- Increased choice involving a true and compelling alternative to current incumbent players is also an important message that should be well accepted
- The value of the broadband product in terms of cost per mbps and in terms of increased productivity should also be promoted.

Potential Outcomes

- It is currently estimated that take-rates could reach 39% or more, though it is certainly possible that final take-rates could be higher or lower. Initial take-rates could start at about 12% given sales barriers such as resistance to Utility provider, existing long term contracts etc..
- Potential financial project feasibility and revenue outcomes for Gillette fiber services will be presented in separate financial modeling .

Methodology

Methodology

Mail study review of 189 random businesses in Gillette. (+/- 6.1 % at 95% confidence.)

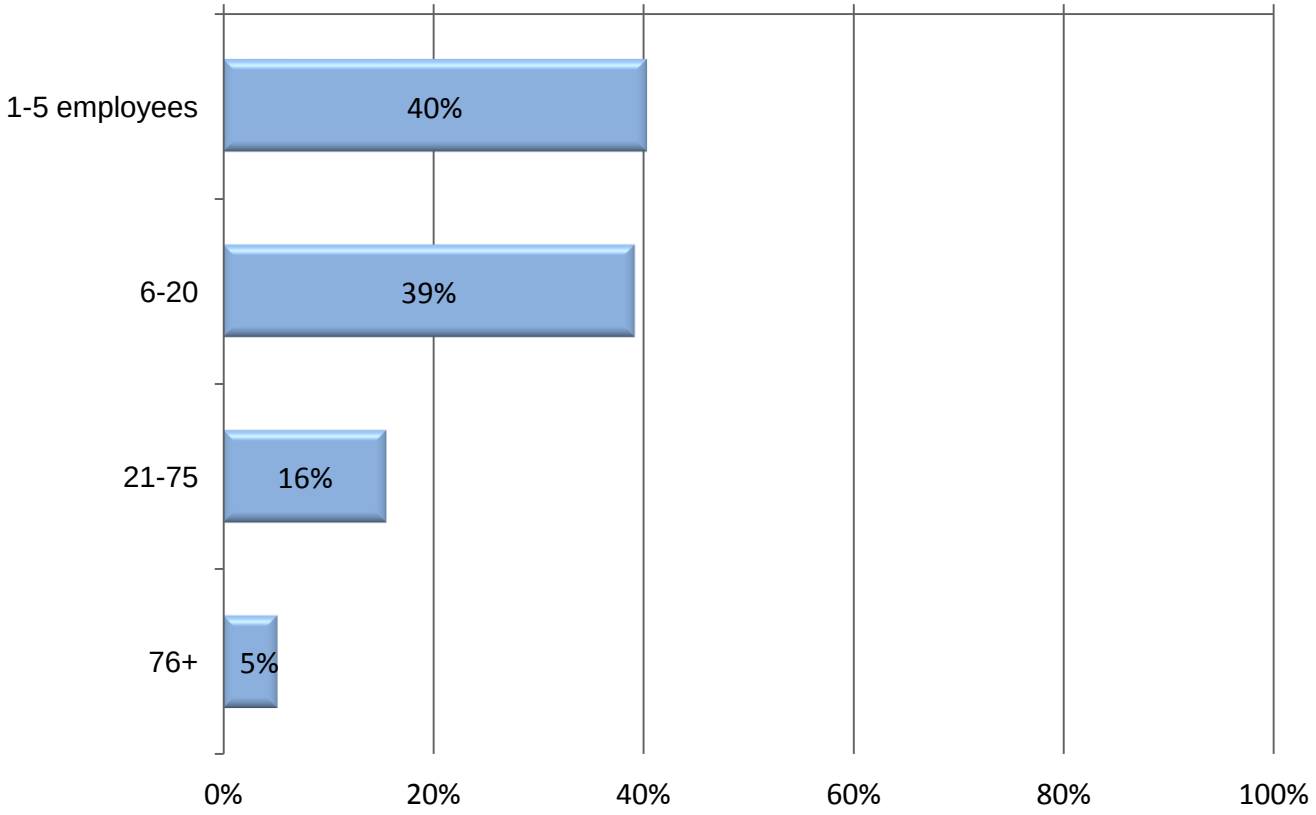
The mail study was fielded between February 8 and March 9, 2015.

Review Of Findings

Demographics Of Sample

The vast majority of commercial enterprises in Gillette represent small businesses.

Number Of Employees At Gillette Location

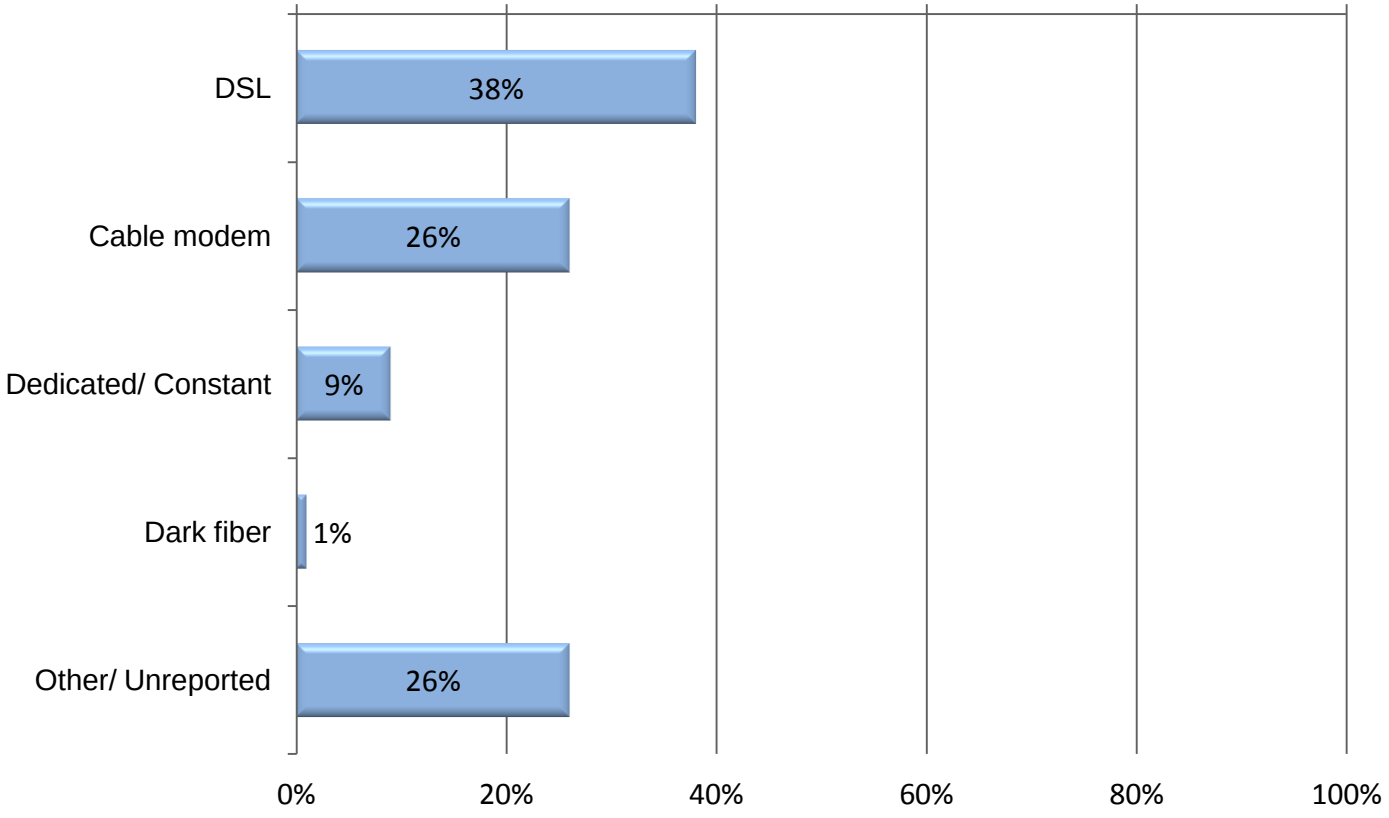


Communications Demographics

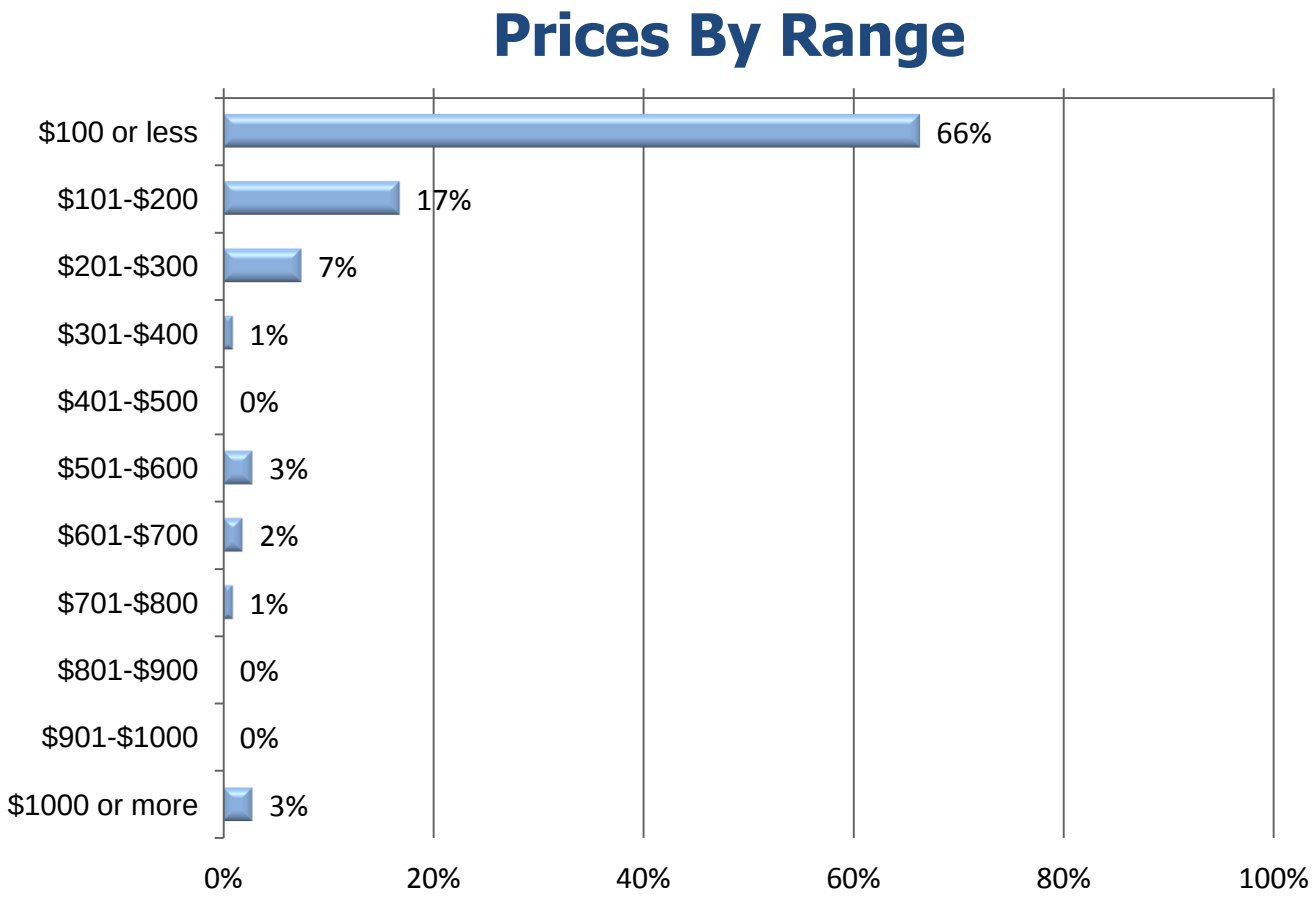
Currently, cable modem Internet is the most common form of broadband Internet utilized among businesses. A total of 9% say they have dedicated internet service – but there could be some confusion in this regard.

Current Primary Broadband Internet

By Type

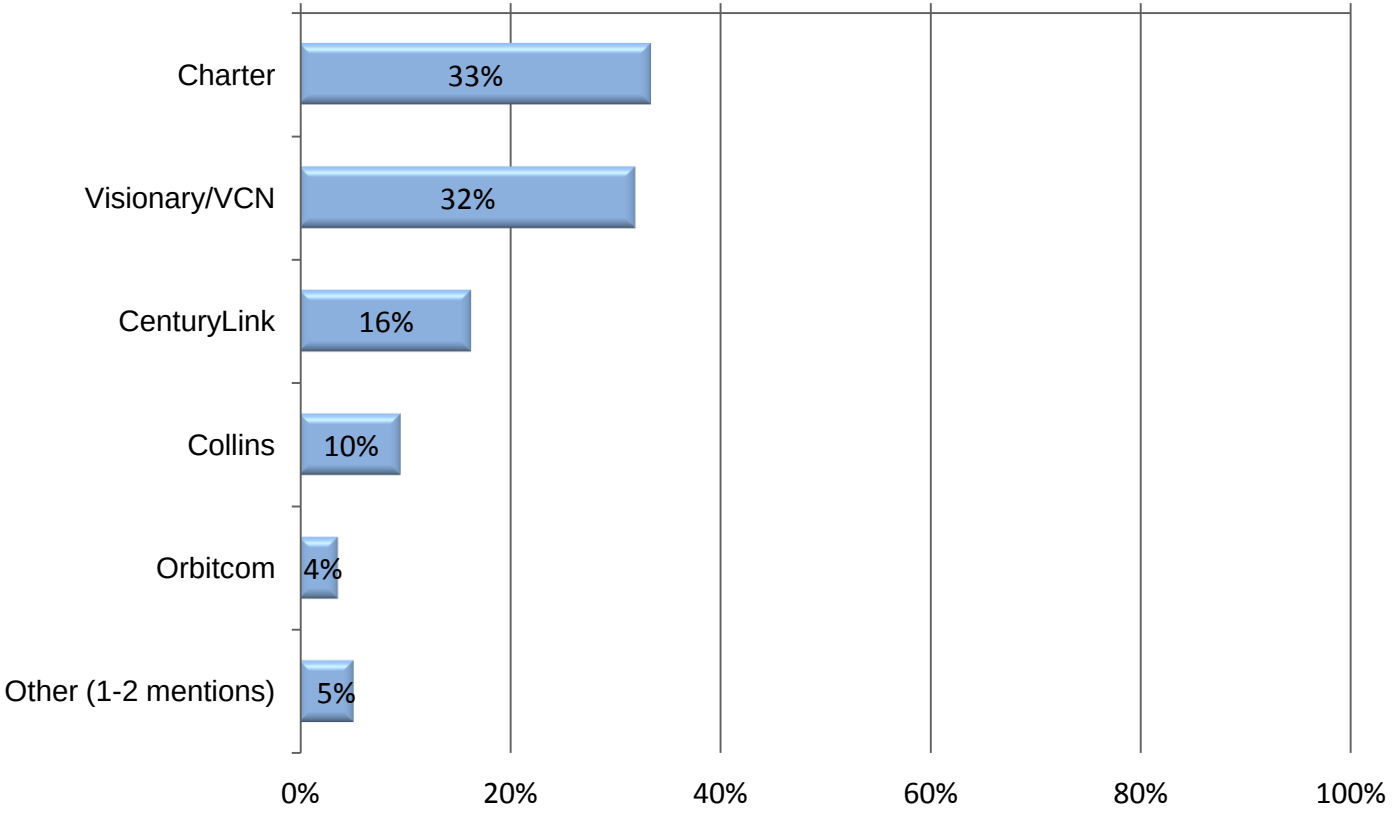


The vast majority of enterprises currently pay less than $200 for Internet services. Only three percent pay over $1000.

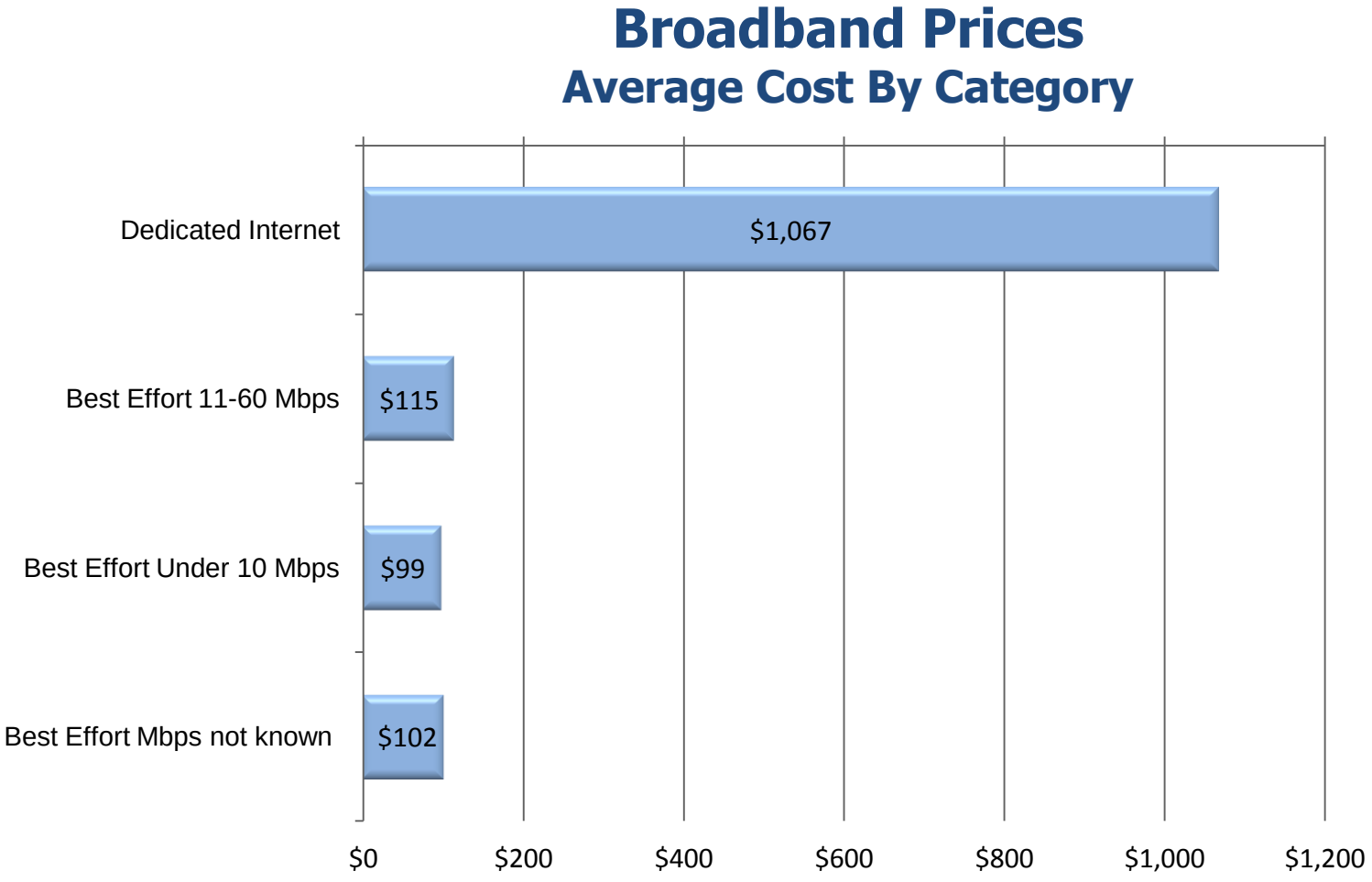


Charter and VCN account for approximately two-thirds of the commercial Internet connections in Gillette.

Current Brand Of Primary Broadband Internet

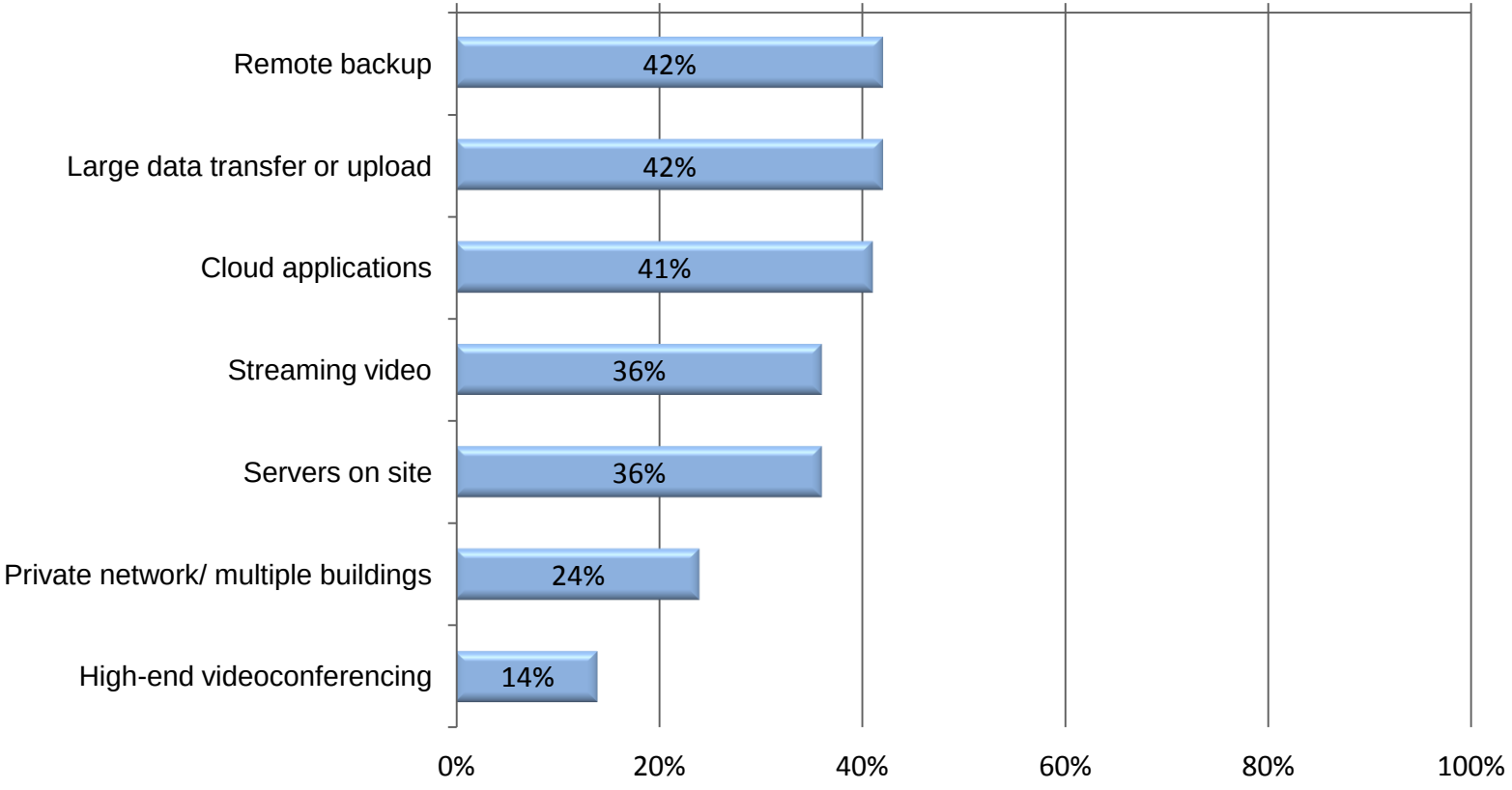


Average commercial pricing is high for the options available. Dedicated Internet averages over $1,000. (Though some report low prices.) Best effort Internet is over $100 for fairly slow speeds.



Businesses in Gillette report being most likely to use remote backup, data transfer, and cloud applications. Reported use of multiple building networks is also surprisingly high.

Business Bandwidth Intensive Applications Used

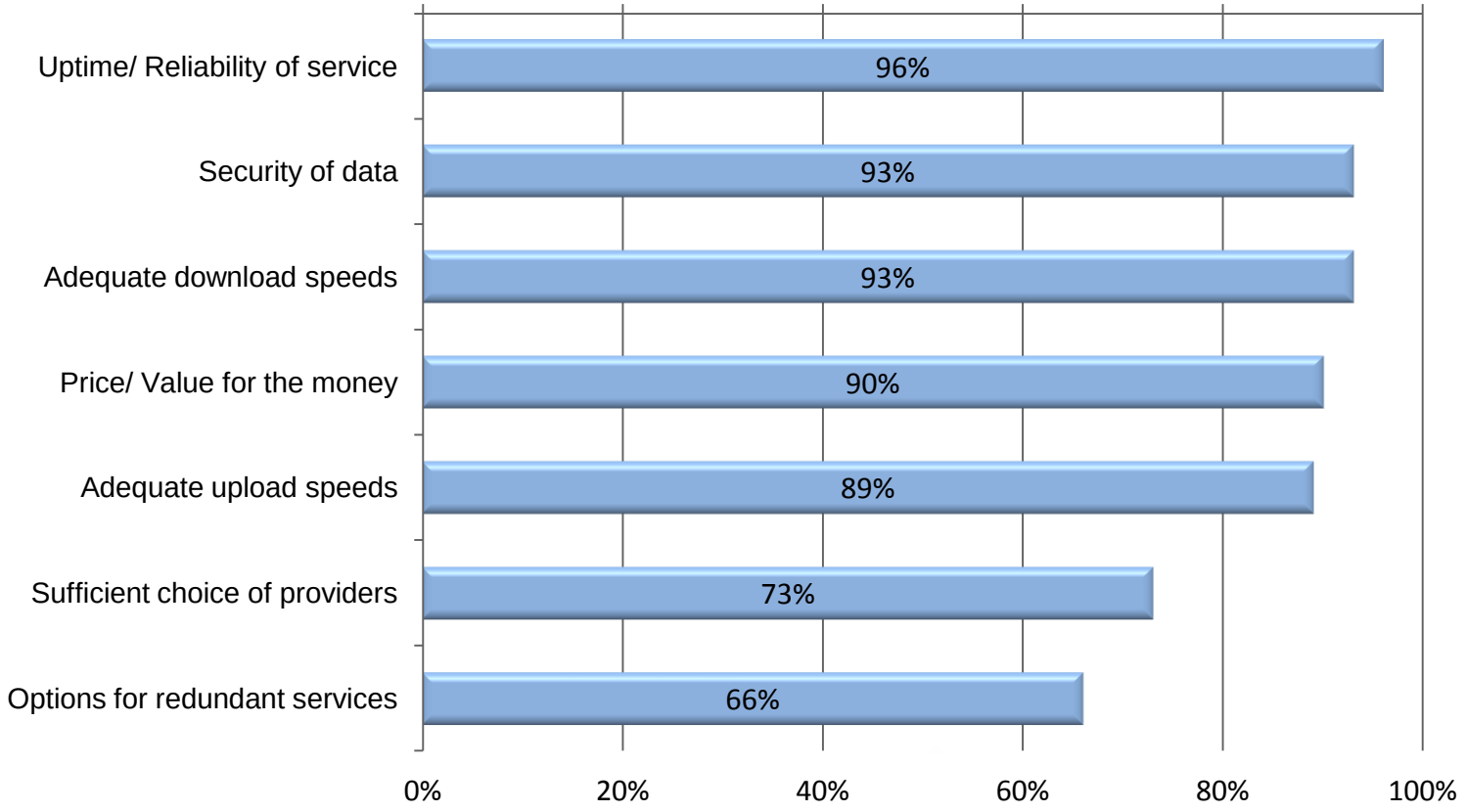


Importance Of Broadband

Most consider all broadband related aspects important – especially uptime, security, and speed.

Importance Of Area Commercial Broadband Service Aspects

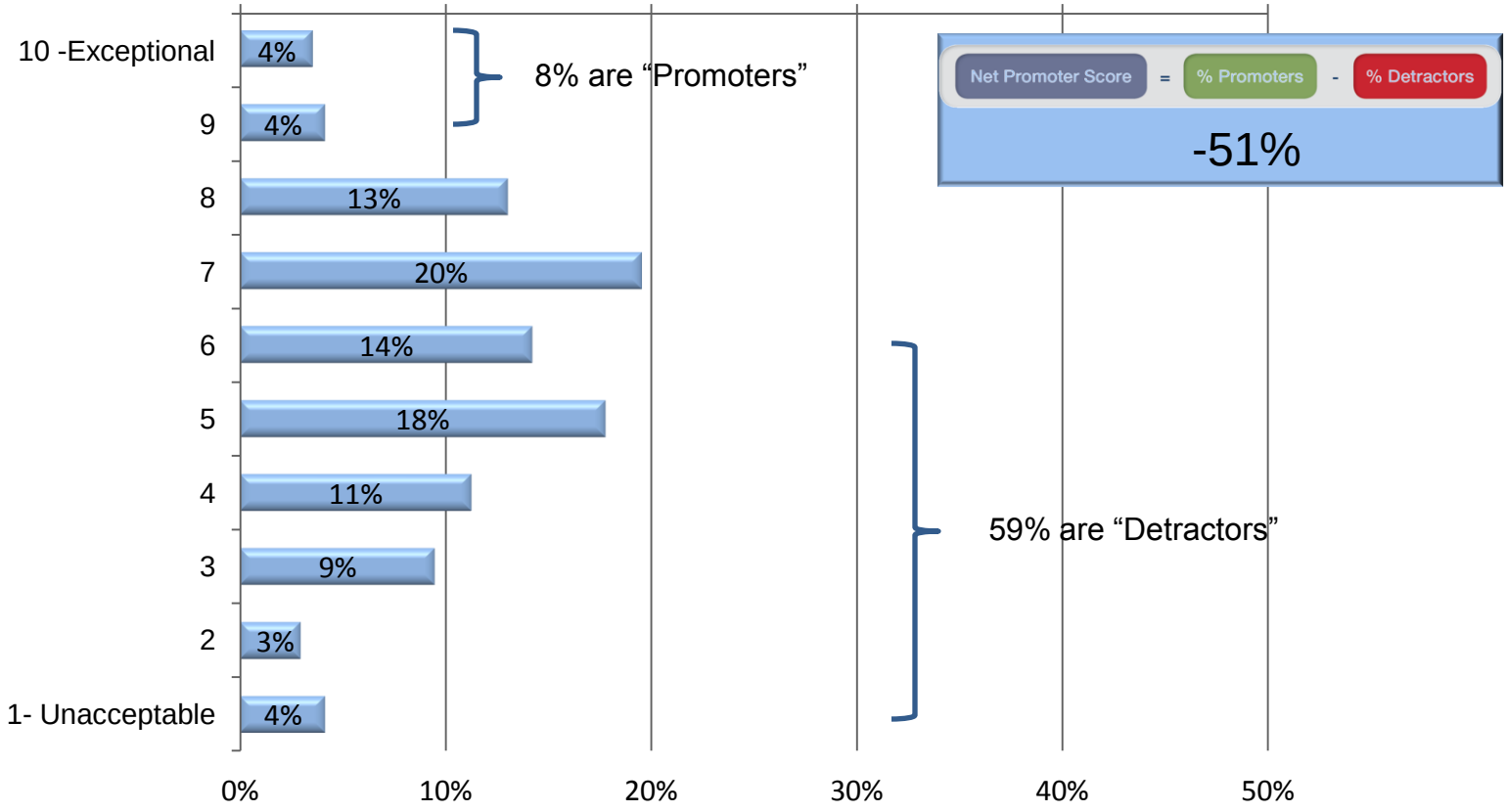
(Percent rating important or very important)



Broadband Performance And Satisfaction

Very few (8%) are actually “delighted” with Gillette commercial broadband. To the contrary, 59% can be described as detractors. The net promoter index (NPI) for Gillette commercial broadband (promoters minus detractors) is only -51%, which is an extremely low net promoter score.

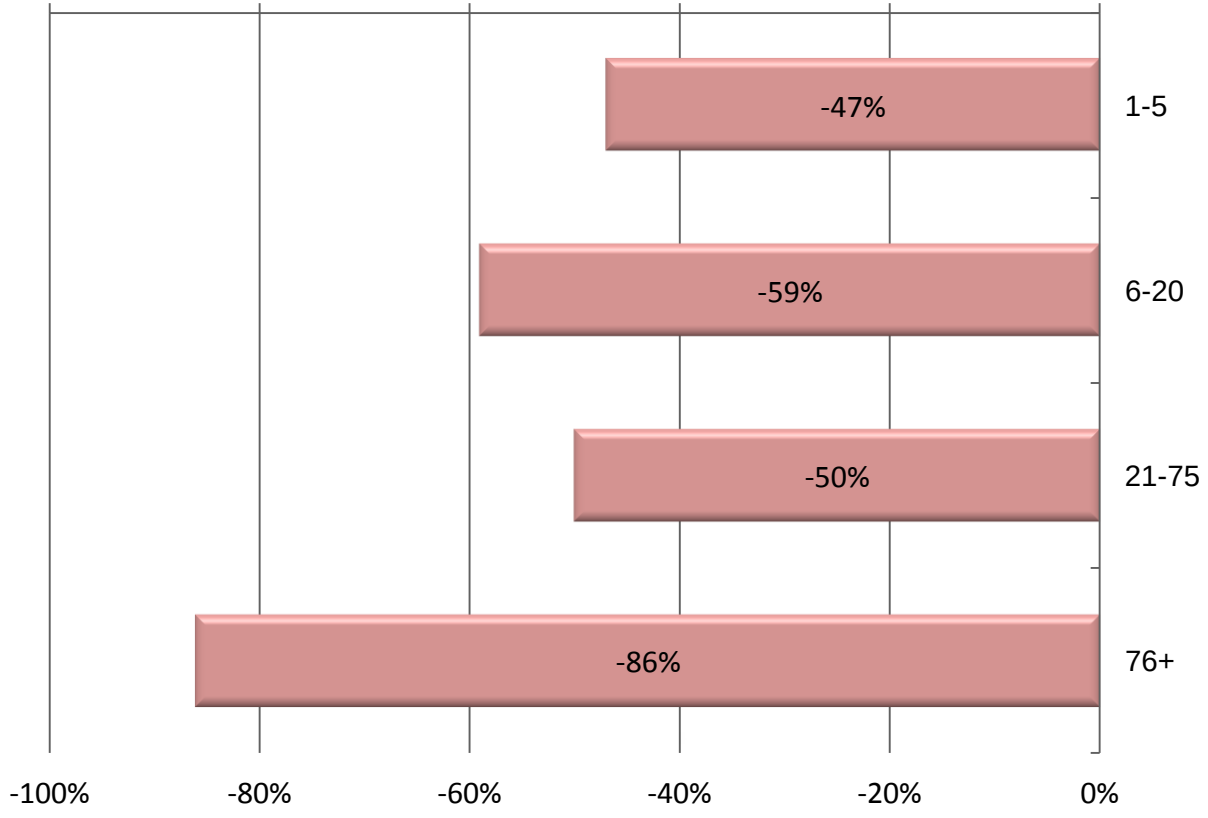
Overall Rating Of Commercial Broadband



The largest commercial enterprises in Gillette (ranging from 76-1200 employees) have the most negative impression of Gillette Broadband.

Overall Rating Of Commercial Broadband

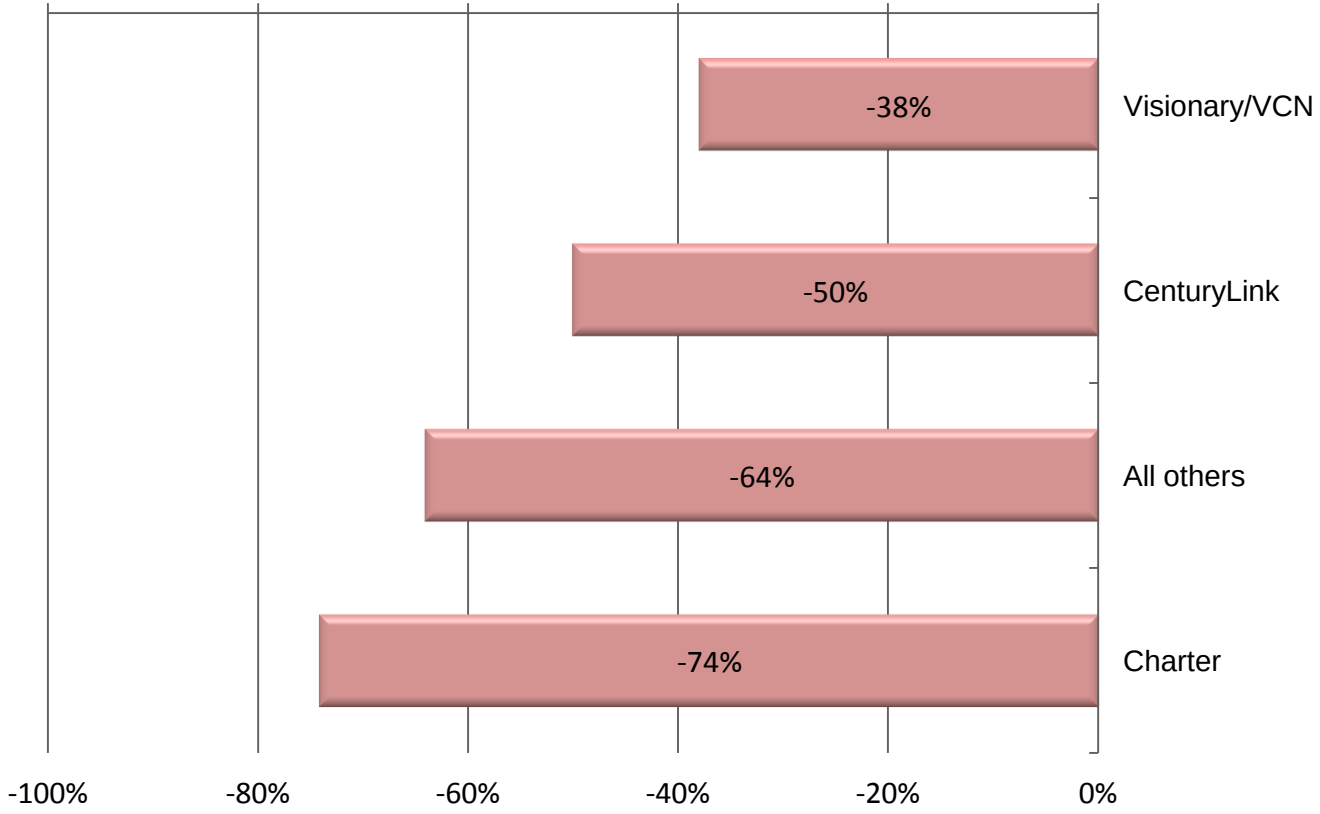
NPI Score By Size Of Company



Looking at the NPI score of larger suppliers, all are quite poor, but Charter has the lowest score.

Overall Rating Of Commercial Broadband

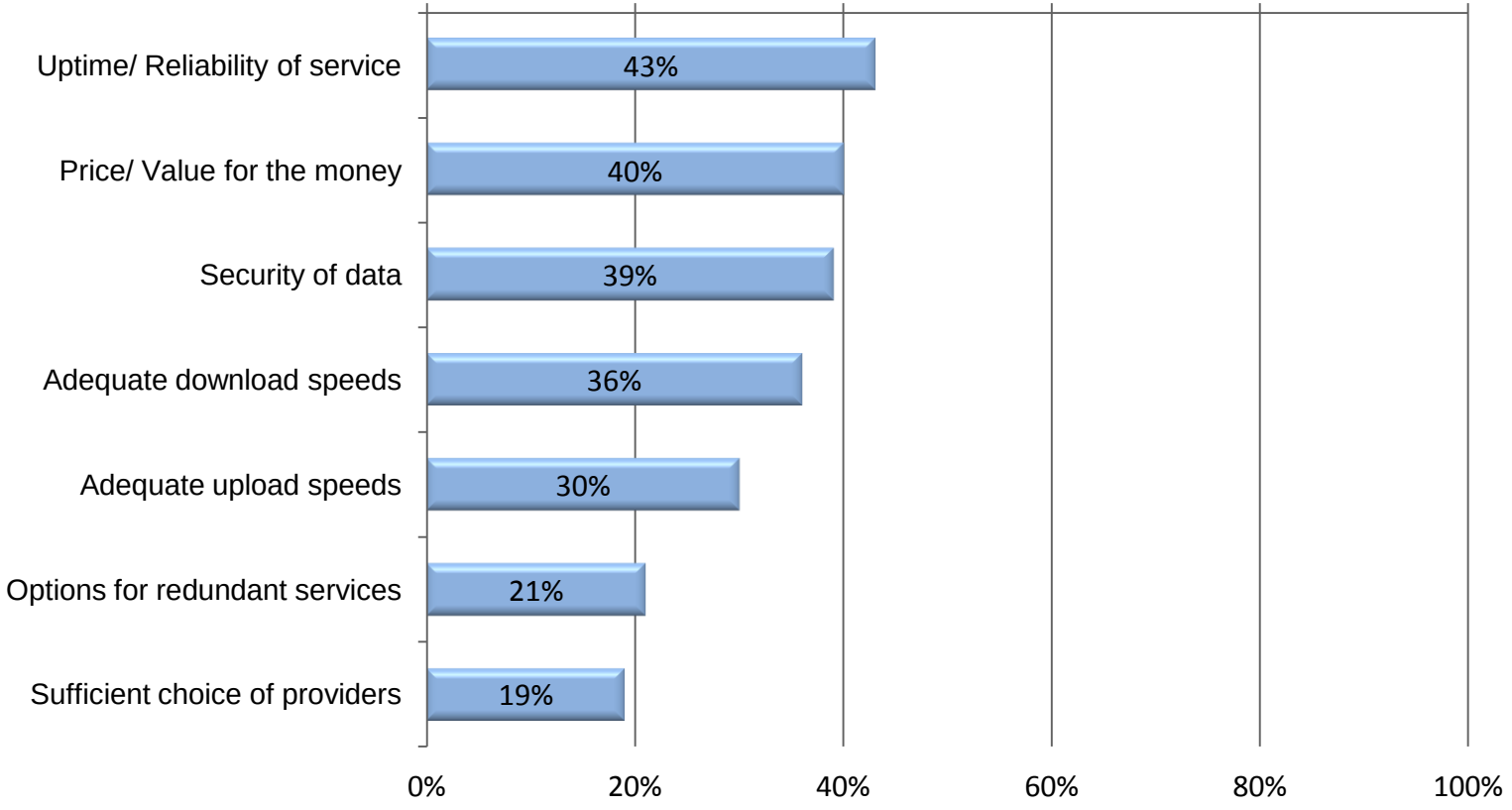
NPI Score By Current Supplier



In terms of impressions of current broadband aspects in the area, all ratings are considerably lower than importance – but especially price, options for redundancy, and sufficient choice.

Rating Of Current Area Broadband Service Aspects

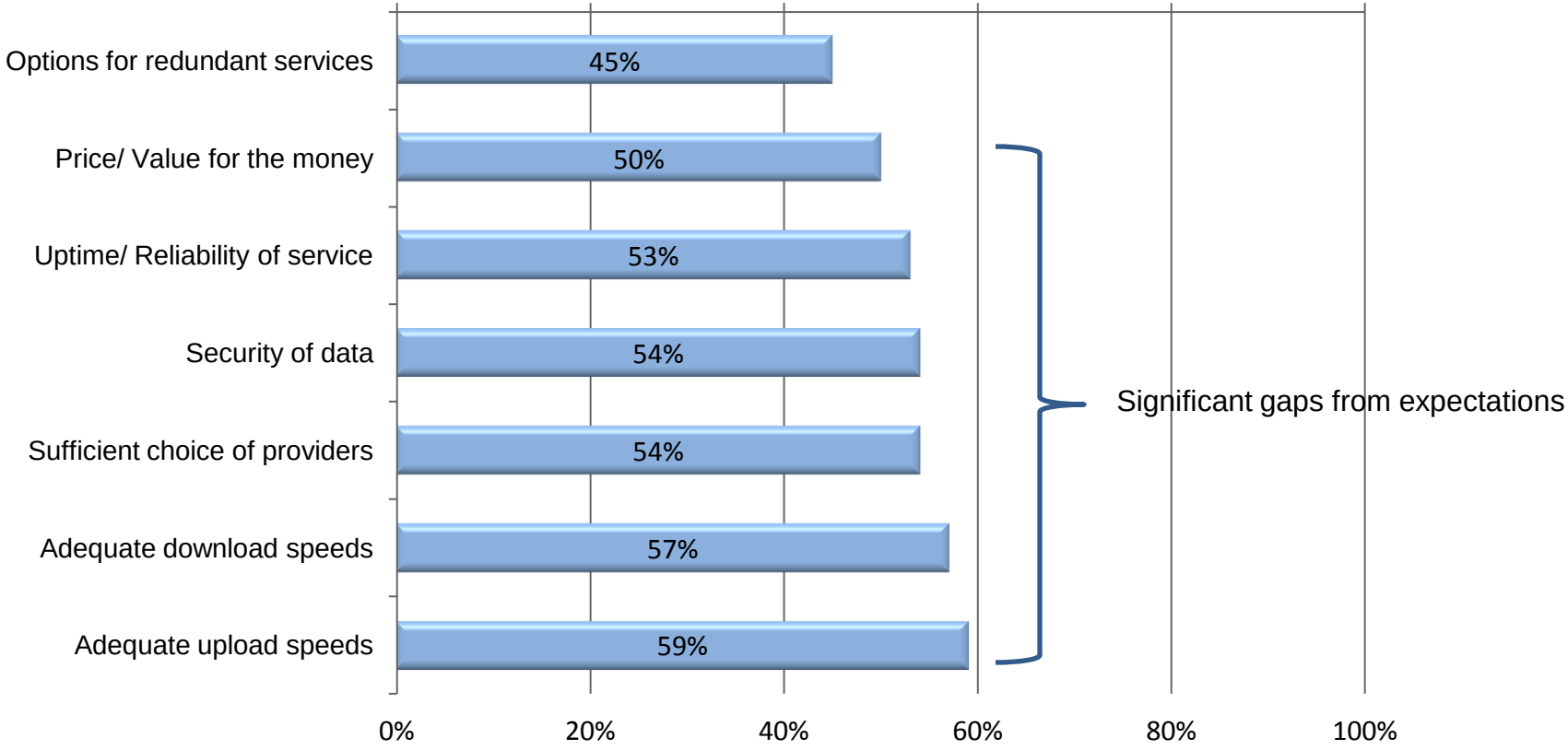
(Percent rating good or very good)



Reviewing the gap between importance and current service ratings, the largest gaps are for speeds, followed closely by other aspects.

Area Broadband Importance Vs. Service Rating

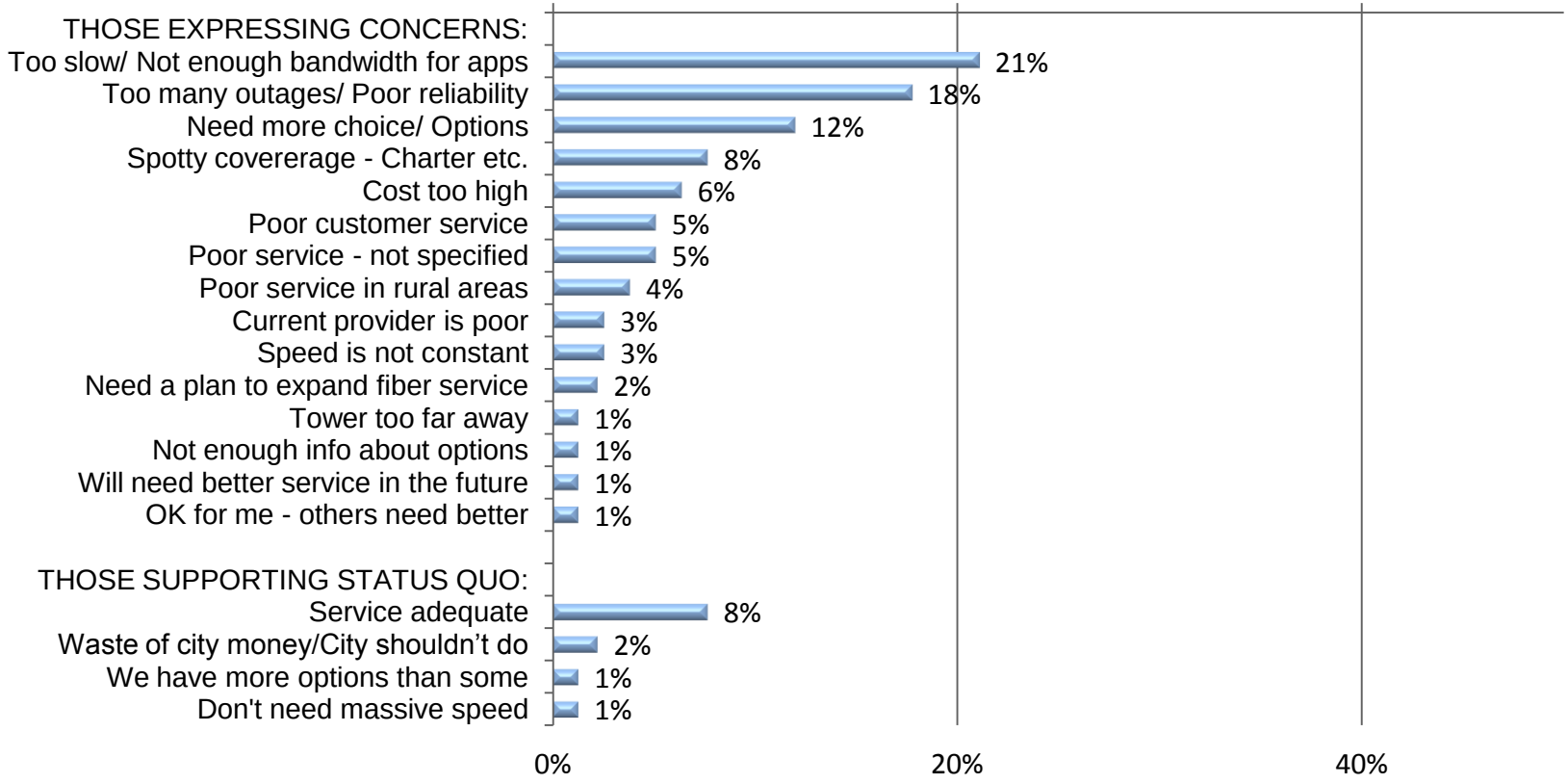
Gap Analysis



Most open comments about Gillette broadband were negative – especially related to speed, reliability, choice, coverage, and price.

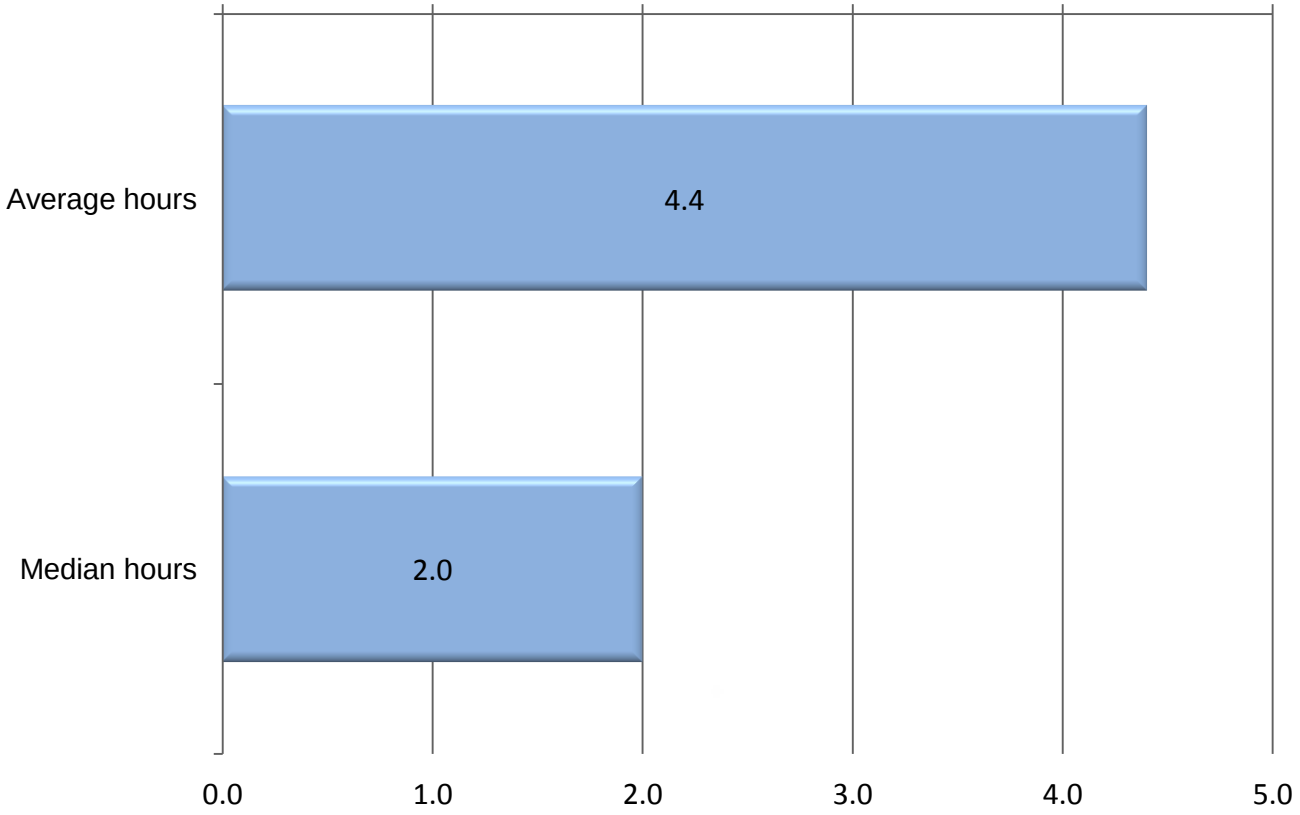
Comments About Gillette Broadband Internet

Open End Comments



On average, businesses report an average downtime of about 4 hours per month.

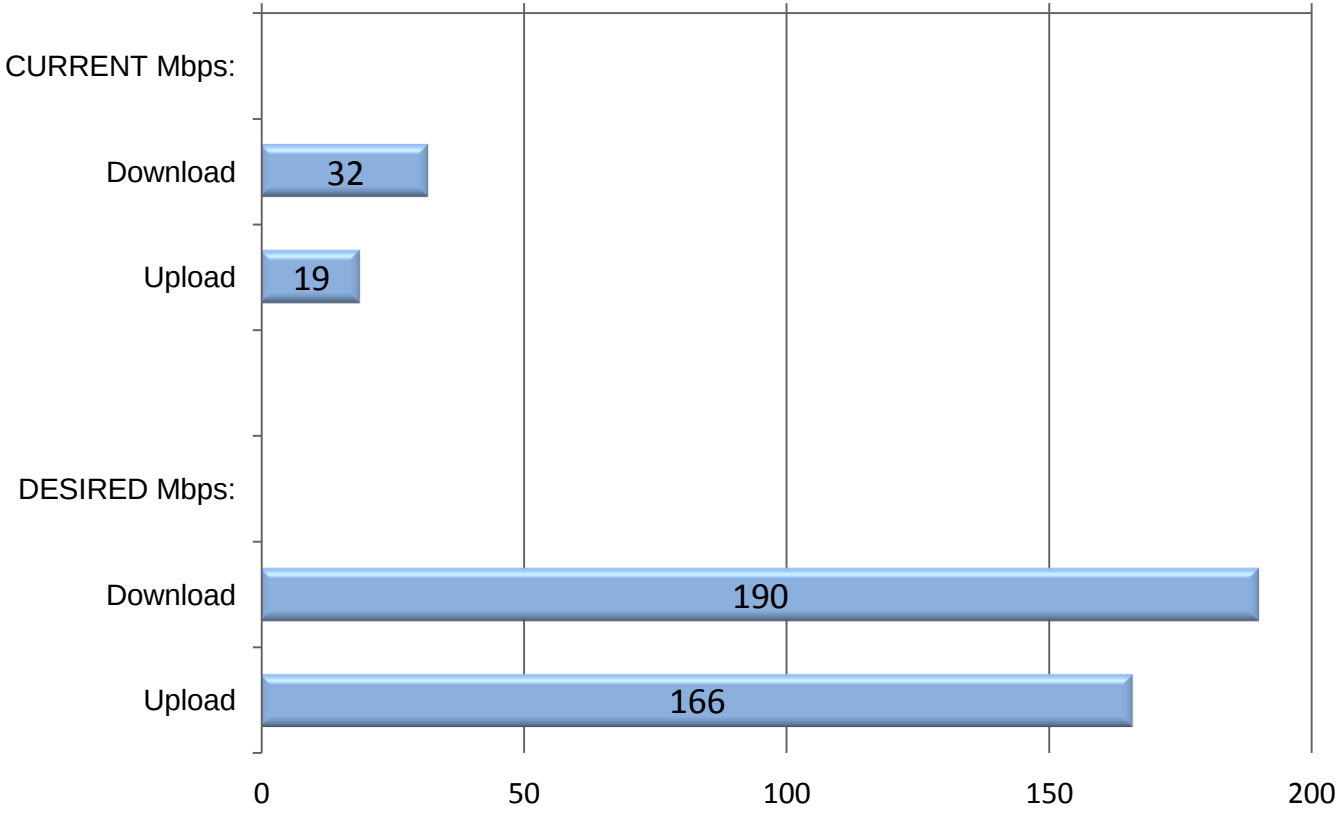
Broadband Downtime Experienced Monthly



Interest In Switching

Desired download speeds at a reasonable price are currently 6 times higher than current advertised speeds now received.

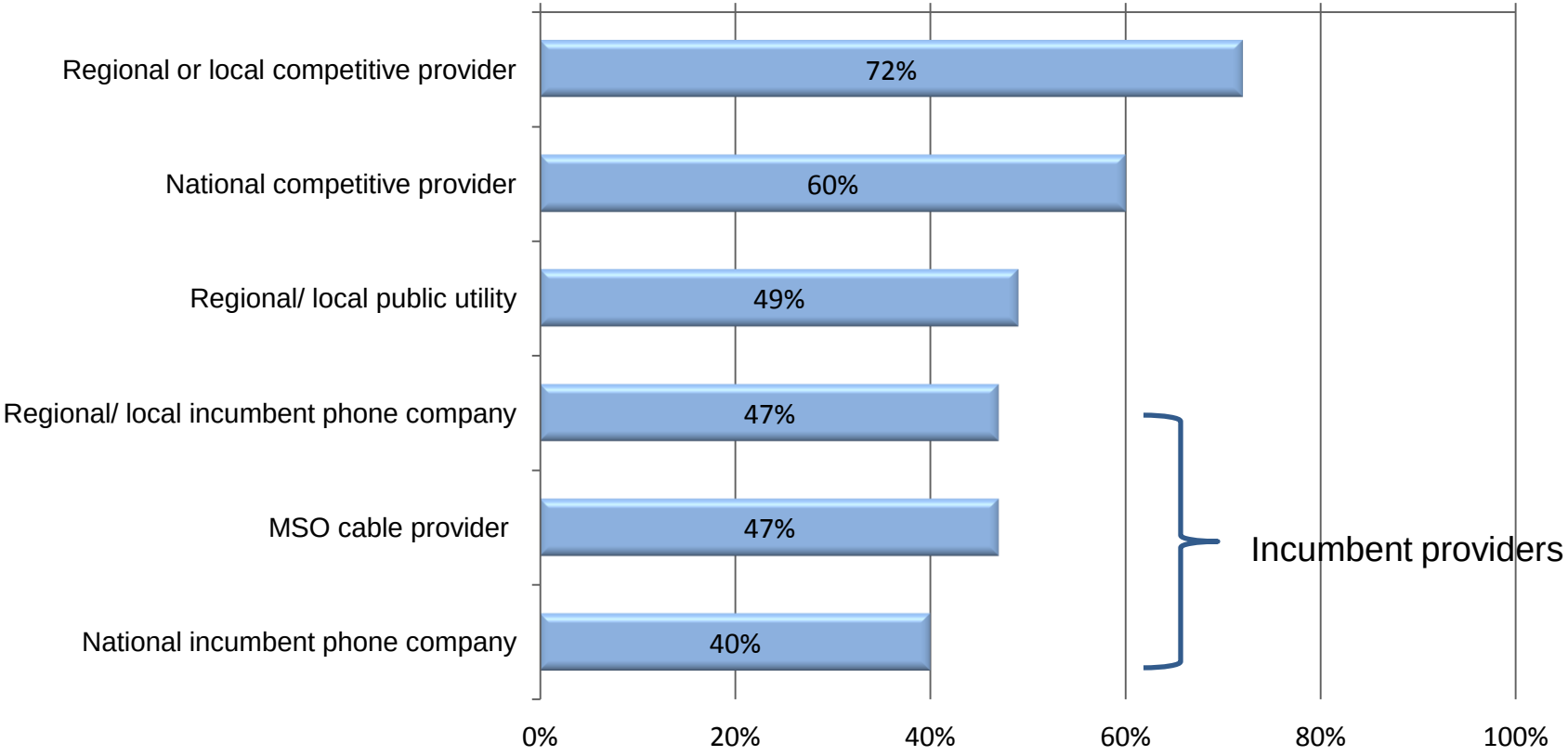
Internet Speeds: Current Versus Desired



Perhaps as a measure of their frustration with current providers, businesses in Gillette are especially interested in fiber based commercial broadband from new providers – private competitive providers and public utilities. They are less interested in new fiber services from incumbent providers.

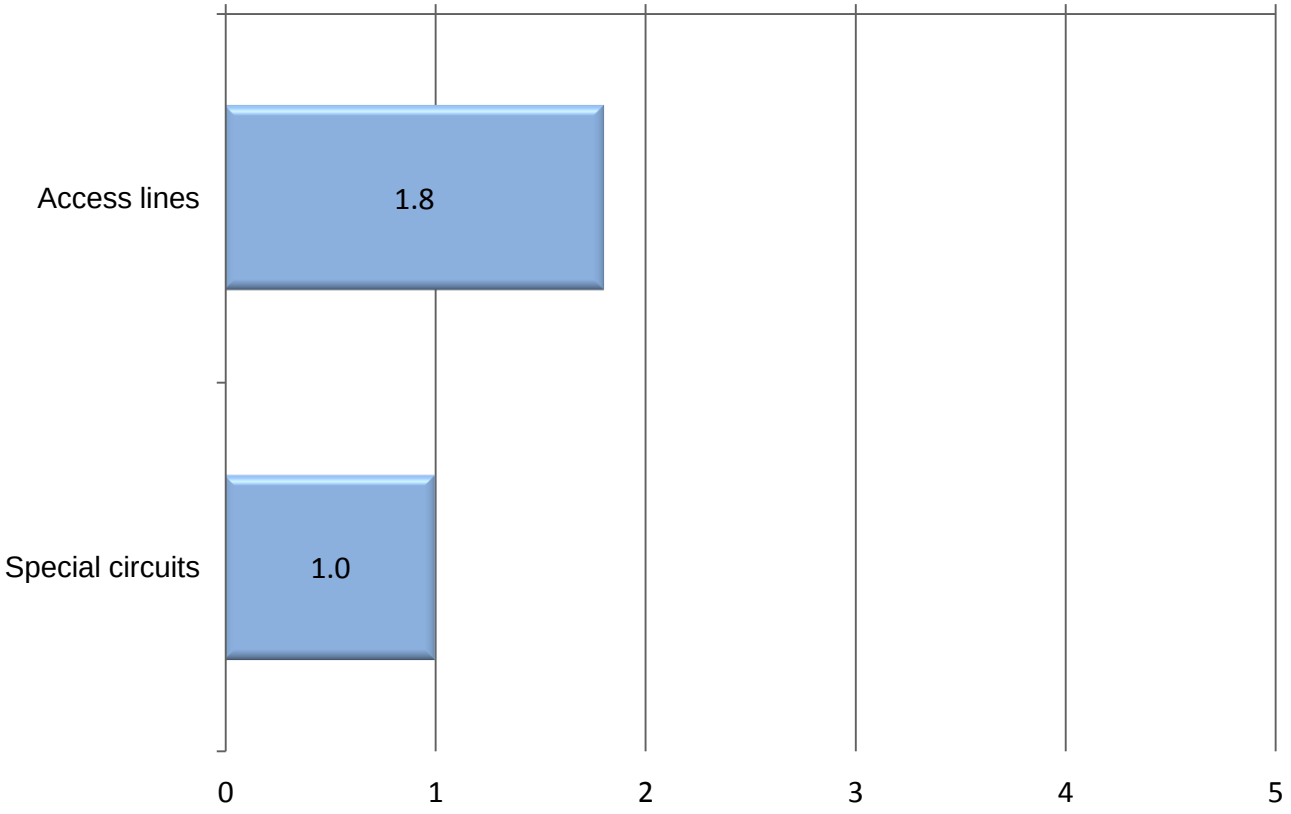
Interest In Provider Types For New Commercial Broadband

(Percent rating interested or very interested)



On average, businesses need approximately two access lines. Many did not answer the question about special circuits – but the answer of “one” was mentioned on average among those answering.

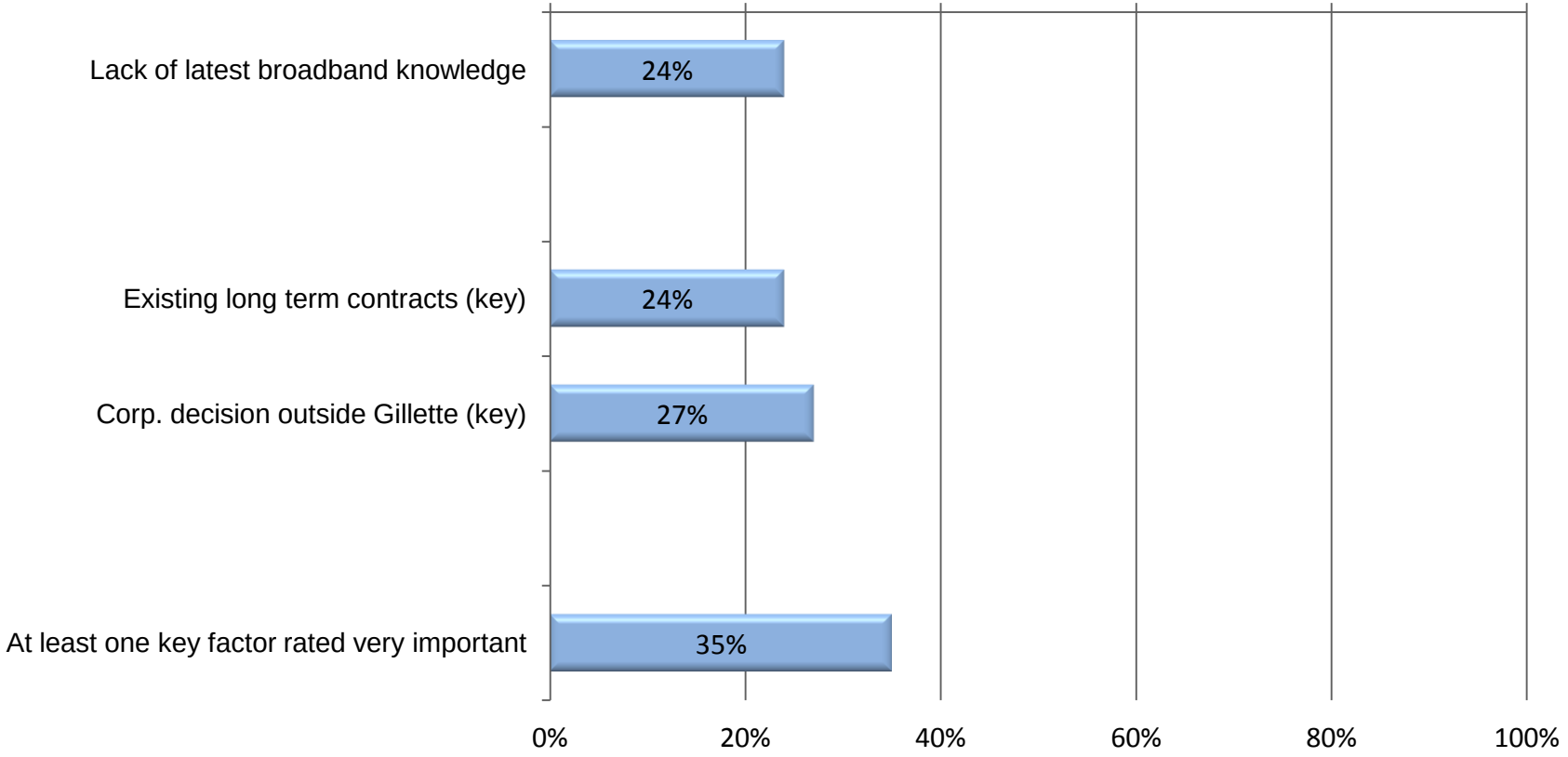
Services Desired



Businesses rate lack of broadband knowledge and existing long term contracts as potential factors delaying a change in broadband services.

Potential Delay Factors For Changing Broadband Services

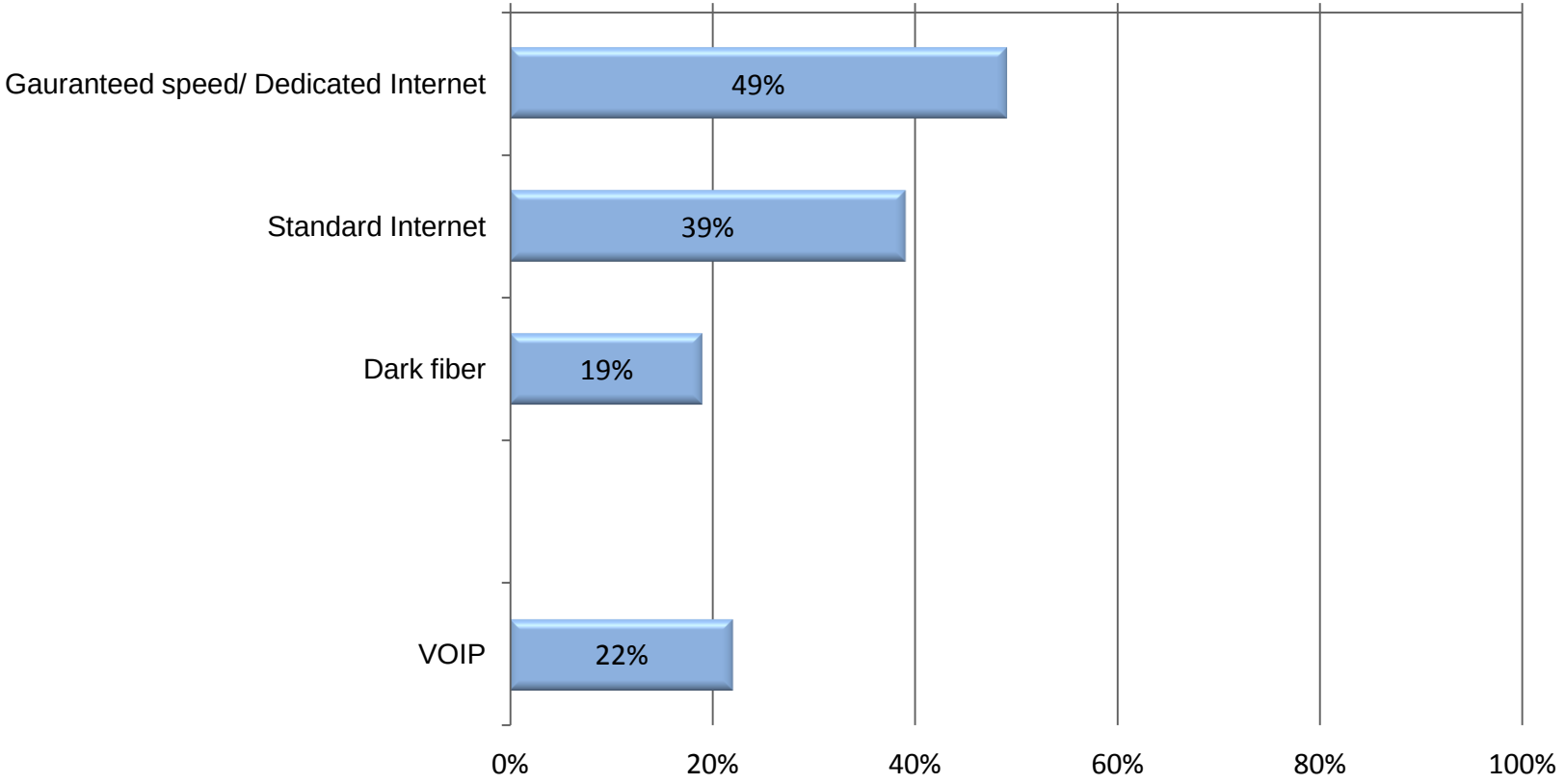
(Percent rating factor very important)



There appears to be some pent up demand for dedicated Internet/ guaranteed speeds in Gillette. (Much of this probably relates to concerns about current speeds. It is likely that much of this interest could be met in a high quality best effort product – i.e. Gigabit, etc.)

Interest In New Broadband For Reasonable Price

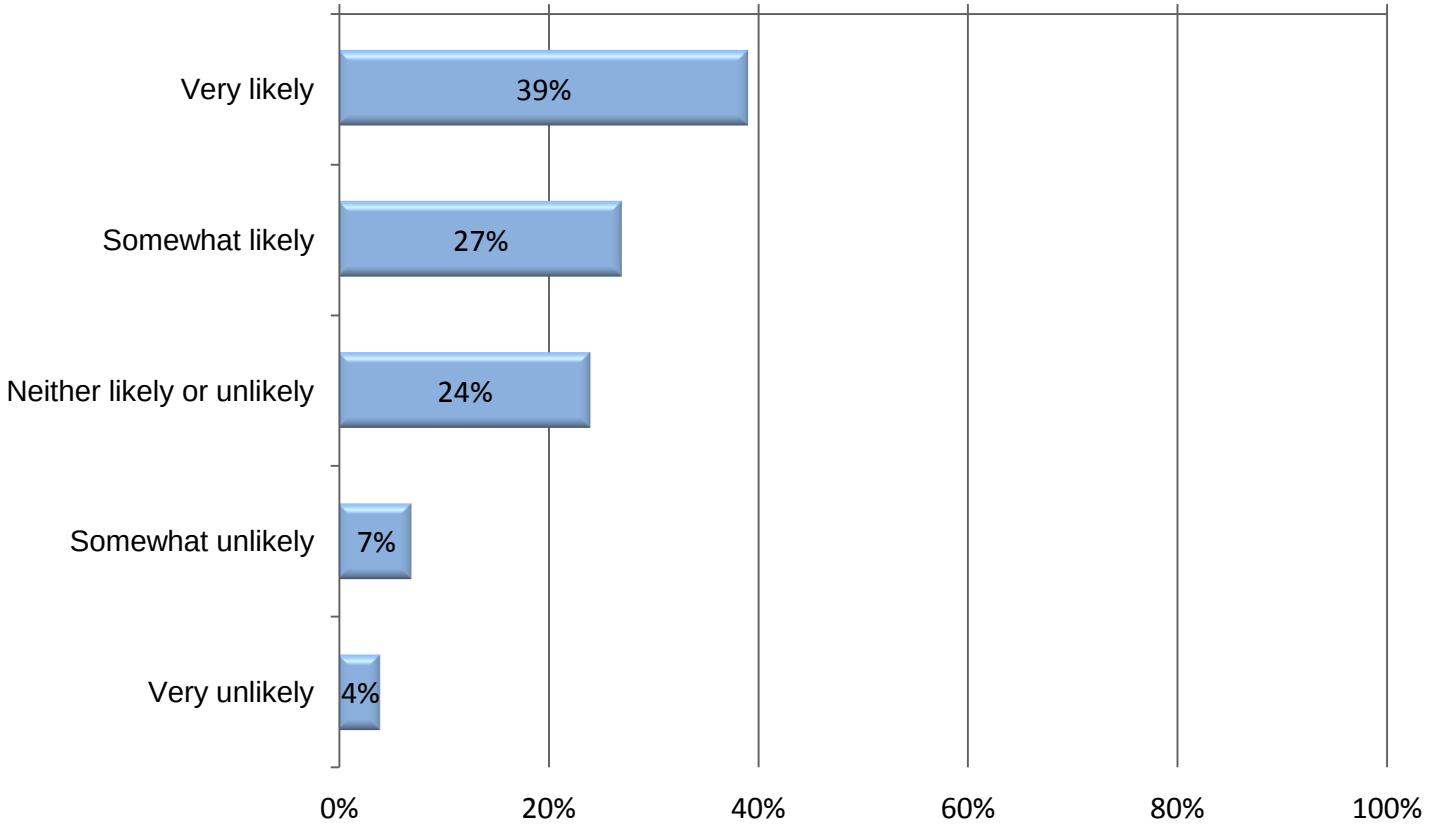
(Percent rating very interested)



Interest in Gigabit service in Gillette is high, with 39% saying they are very likely to switch to this service and 66% at least somewhat likely to switch.

Likelihood Of Switching To Gigabit Service

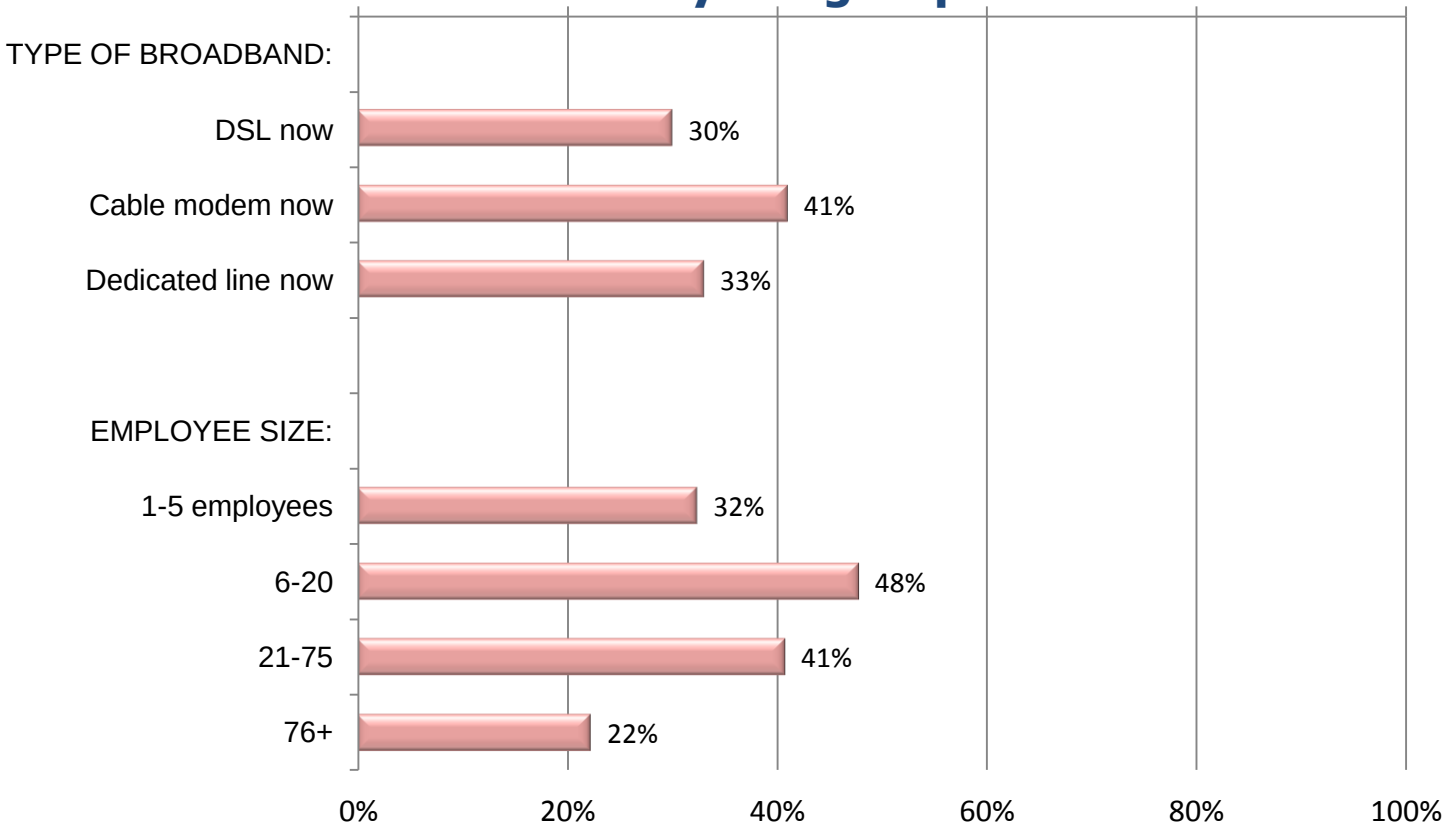
Assuming Reasonable Price



Although large companies are not satisfied, they are not as likely to say they will switch to Gigabit (best effort) service. It is likely they would prefer a higher bandwidth dedicated service.

Very Likely To Switch To Gigabit Service

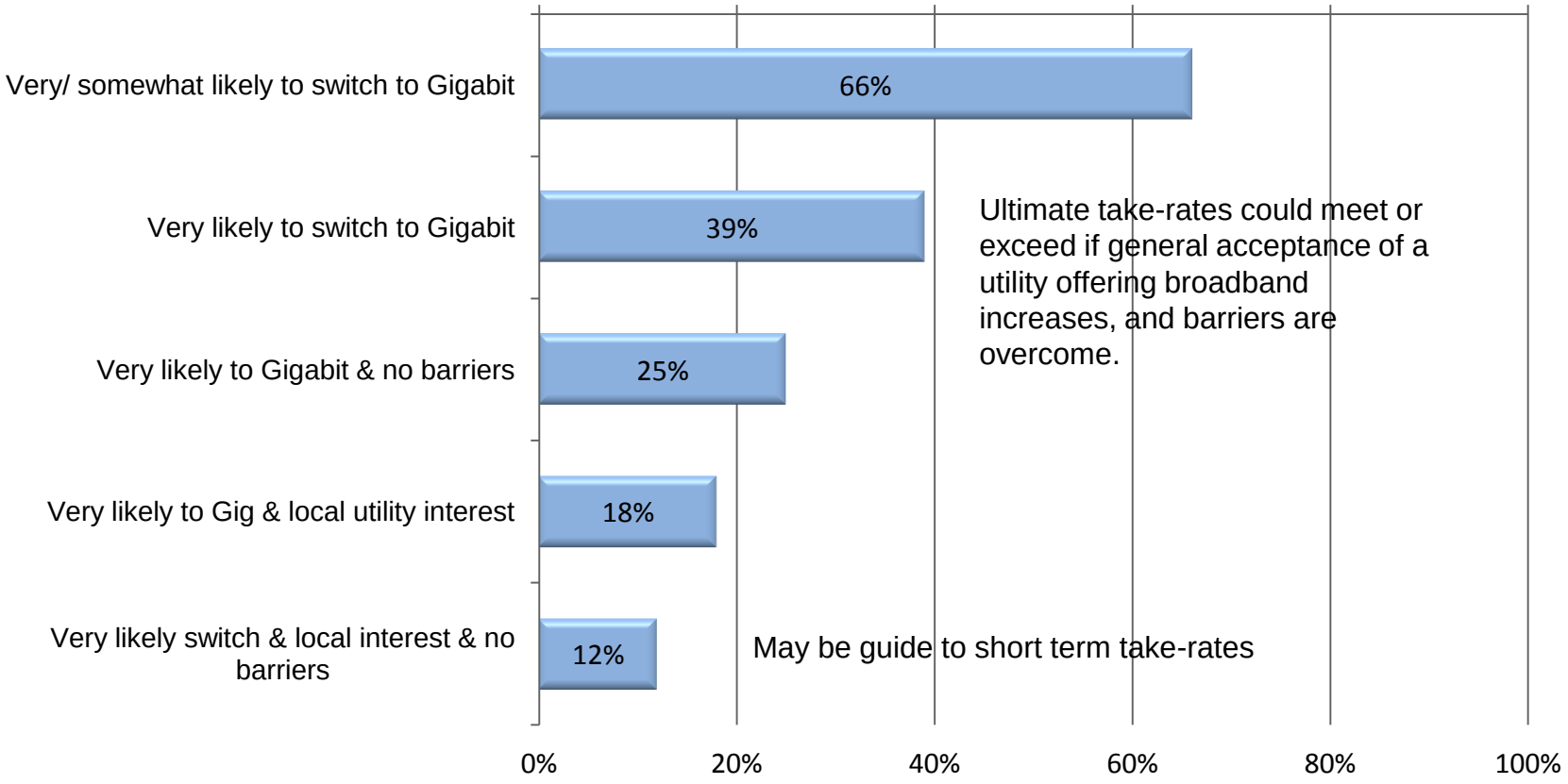
By Subgroups



Key Modeling Metrics

Based on these reviews, survey results point to a take-rate that could reach 40% or beyond. Initial take-rates may hit 12%. It is possible, given the high dissatisfaction with current Internet service, that a new service with good word of mouth could quickly accept a public utility as the provider, and move quickly to higher take-rates.

Potential Take-Rates – Survey Review



Based on the results of this study, and assuming good project implementation and marketing and reasonably attractive pricing, RVA currently estimates the ultimate commercial take-rate in Gillette to be approximately 39%. Changing economic, internal, and competitive factors would, of course, alter this estimate. Near term take-rates could be closer to 20%.

Estimated Ultimate Take Rates

Factors that could increase take rates

Exceptional marketing effort

Little reaction from current incumbents in terms of lower prices, promotions, marketing efforts, etc.

Factors that could decrease take rates

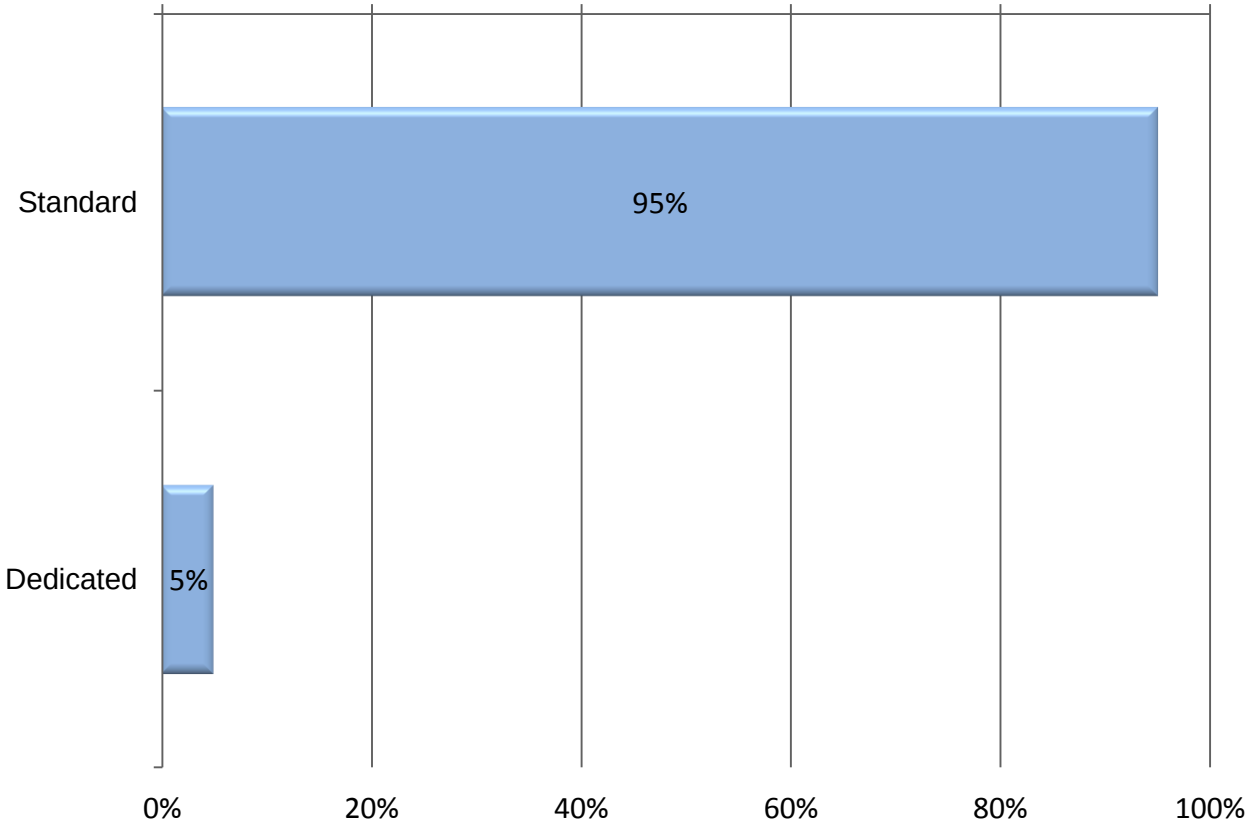
Insufficient marketing effort

Significant reaction from current incumbents in terms of lower prices, promotions, marketing efforts, etc.

Other competition in the area.

Based on the fact that only 5% of businesses have over 75 employees and only 3% currently pay more than $1,000, it is estimated that about 5% will take a higher priced dedicated service.

Estimated Product Mix For New Internet Service



Appendix

City of Gillette, WY Commercial Broadband Services

1. How would you rate the current broadband Internet services that are available to your business?

Unacceptable — Exceptional

1 2 3 4 5 6 7 8 9 10

2. How would you rate the following specifics about broadband Internet services in the area?

		Importance (Not Important - - - - - Very Important)					Rating of Current Services (Very Poor - - - - - Very Good)				
a.	Adequate Download Speeds.....	1	2	3	4	5	1	2	3	4	5
b.	Adequate Upload Speeds.....	1	2	3	4	5	1	2	3	4	5
c.	Security of Data.....	1	2	3	4	5	1	2	3	4	5
d.	Uptime/Reliability of Service.....	1	2	3	4	5	1	2	3	4	5
e.	Price/Value for the Money.....	1	2	3	4	5	1	2	3	4	5
f.	Options for Redundant Services....	1	2	3	4	5	1	2	3	4	5
g.	Sufficient Choice of Providers.....	1	2	3	4	5	1	2	3	4	5

3. Do you employ any bandwidth intensive applications at your business? *(Check all that apply)*

☐ Cloud Applications ☐ Remote Backup ☐ Large Data Transfer or Upload ☐ Servers on Site ☐ Streaming Video
☐ High-end Videoconferencing System ☐ Private Network/Multiple Buildings ☐ Other: _____

4. If you experience broadband Internet provider interruptions, what would you say is the cumulative time per month your primary Internet source is down? _____ Total Hours/Month *and/or* _____ Total Minutes/Month

5. If new services were offered at a reasonable price, how likely would you be to seek information on each?

		Not at all Likely - - - - - Very Likely				
a.	Standard Internet Service (Best Effort Speeds).....	1	2	3	4	5
b.	Dedicated Internet Services (Guaranteed Speeds).....	1	2	3	4	5
c.	Dark Fiber (Your Company Lights the Fiber).....	1	2	3	4	5
d.	Voice over IP (VOIP) Telephone Service via Fiber.....	1	2	3	4	5

6. What type of primary broadband Internet service do you currently have?

Type: ☐ DSL ☐ Cable Modem ☐ Dedicated Line/Constant ☐ Dark Fiber (Self Lit) ☐ Speed: Mbps Down ___ Mbps Up ___

Provider of Current Primary Internet Service: _____ Approx. Cost Per Month: $_____

How many access lines and special circuits do you currently have? Access Lines: _____ Special Circuits: _____

7. If you could have your choice of speeds at an acceptable price, what upload and download speed would you prefer for your primary business service? Download Mbps:_____ Upload Mbps: _____

How many access lines and special circuits would you prefer? Access Lines: _____ Special Circuits: _____

8. Which kinds of companies would you be most interested in for fiber-based commercial broadband services?

		Not at all Interested - - - - - Very Interested				
a.	A National Incumbent Telephone Company.....	1	2	3	4	5
b.	A Regional or Local Incumbent Telephone Company.....	1	2	3	4	5
c.	An MSO Cable Provider.....	1	2	3	4	5
d.	A Regional or Local Public Utility.....	1	2	3	4	5
e.	A National Competitive Provider.....	1	2	3	4	5
f.	A Regional or Local Competitive Provider.....	1	2	3	4	5

9. Which of the following would prevent you from making changes regarding your broadband Internet service?

		Not at Factor - - - - - Important Factor				
a.	Lack of Enough Knowledge about the Latest Broadband Services.....	1	2	3	4	5
b.	Existing Long Term Contracts.....	1	2	3	4	5
c.	Broadband Decisions Made from Outside Gillette, WY.....	1	2	3	4	5

10. Please share your comments related to broadband Internet services available in the Gillette area.

_____

_____

11. About how many employees are currently at your location in the Gillette area? _____ Employees

12. If one or more providers in Gillette introduced very high bandwidth service (Gigabit) at a reasonable price, how likely would you be to switch to this service?

		Not at all Likely - - - - - Very Likely				
a.	Likelihood of Switching from Current Service.....	1	2	3	4	5

Survey of Gillette Businesses

Regarding Broadband Interest

◆ ◆ ◆ ◆

prepared for:

CITY OF Gillette Wyoming

Service with Productivity Responsibility Integrity Dedication Enthusiasm

By

RVA LLC

Market Research & Consulting

THE BROADBAND GROUP

March 2015