MOFFAT COUNTY STRATEGIC BROADBAND PLAN

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Contents

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Introduction and Executive Summary

In the fall of 2016, Moffat County engaged NEO Connect (NEO) to prepare a strategic broadband plan. Moffat County communities including Craig, Dinosaur, and Maybell, along with local funding partners Tri-State Generation & Transmission, Colorado Northwestern Community College, The Memorial Hospital, Yampa Valley Electric Association (YVEA), and Danner Communications, have come together to study the current broadband services available in Moffat County and to study ways to improve broadband services. These entities are referred to within this report as the Committee. The intention of the study is to enhance and expand the work, the investments and the efforts that many of the communities have already done to improve broadband services.

The project was supported in part by an Energy and Mineral Impact Assistance Fund (EIAF) grant awarded through the Colorado Department of Local Affairs (DOLA).

The members of the Committee see the importance of having next generation broadband services to manage their respective operations, and perhaps more importantly, see the need for next generation broadband as a way to spur economic development. Other communities that have improved broadband services and have already seen the tremendous economic impact of building broadband infrastructure. These communities have fostered an environment of innovation, economic development and growth, collaboration, and creative activities. Because access to advanced broadband services is a priority for businesses and entrepreneurs, the communities that have built advanced broadband networks have already benefited economically by attracting businesses and industries, in areas like manufacturing and technology, to re-locate to their communities.

The shared goal of members of the Committee is to provide abundant, redundant and affordable Internet service to citizens, businesses and visitors. Next generation broadband services offer many advantages. Having access to affordable, abundant, high capacity Internet

is no longer a luxury. It is a necessity, like water and electricity. Having access to abundant broadband is critical for:

- creating more jobs,
- creating vibrant communities that are economically stable,
- providing for new opportunities,
- fostering an entrepreneurial environment
- improving technology advancement,
- providing better access to educational opportunities and online learning applications,
- providing for more affordable healthcare,
- improving public safety and emergency management services
- better access to e-government services,
- facilitating more telework and telecommuting,
- attracting the New Knowledge economy.

Advanced broadband networks are creating enormous shifts in local, state, national and global societies, as well as markets, business and in institutions around the world. Therefore, it is critical to have this infrastructure available to all citizens.

There are a number of options and strategies for improving broadband services throughout region. Some of these options may be considered in the short-term and others may best be part of a longer-term plan. For example, in the short-term, the Committee and its members may decide to collaborate with the service providers and regional partners to share in the costs of leased Internet transport, backhaul and access costs and install a wireless middle mile connecting various towers in the County. In the long-term, a strategy to construct fiber facilities between the communities may be implemented. Another short-term strategy may be to implement broadband policies and ordinances and to build to anchor institutions, while the long-term strategy of implementing a fiber to the premise network for last mile connectivity may be further developed. This plan will provide a road map of both short-term and longer-term strategies for consideration.

Current Environment, SWOT Analysis

NEO conducted an assessment of the current environment of the County in regards to broadband implementation. An analysis of the Strengths, Weaknesses, Opportunities and Threats (SWOT) was completed by NEO with the following results:

Strengths:

- Key anchor institutions and businesses have already come together, by forming a Committee to improve broadband services within the County. Often a project like this is led by the local government, either by the City or the County. The Committee is leading this effort and has been formed by concerned businesses and key anchor institutions within the community.
- Neighboring Counties, Rio Blanco and Routt County have already established plans to improve broadband services in the region. Much of the work and network infrastructure established by Moffat County's neighboring counties can be leveraged. Opportunities exist to collaborate on shared costs of potential builds and to share in potential operating efficiencies and costs to manage network infrastructure. Service providers within Rio Blanco and Routt County may benefit from further expansion into Moffat County.
- The Town of Dinosaur is considering applying for funding through the USDA Rural Service Administration to install natural gas to every home and business in the community. If awarded the grant and/or funding, this project could be further leveraged to install conduit within the open trench created by the installation of the natural gas utility. Once a trench is open, the costs for implementation of a fiber network are dramatically reduced. The RUS fund may also cover the costs of the conduit and construction for placement of the conduit. Deploying underground fiber may not be as cost effective as use of utility lines; however, this opportunity should be further explored.
- The service providers in the County have engaged in the planning process and have provided suggestions to improve broadband services and to collaborate with this effort.
- There is some fiber infrastructure in place that may be able to be leveraged.
- There are coordinated activities being conducted by various entities in the State for better broadband in rural areas. Additionally, there is discussion at a national level with the new administration that funding may be available for broadband infrastructure expansion. Having a plan in place provides the Committee with a shovel-ready project. With this, the Committee may have an opportunity to apply for federal funding if it becomes available.

Weaknesses:

- Implementing a broadband strategy in rural parts of the country are difficult. Capital costs to upgrade infrastructure are high and in less populated areas of the country, the business plan is difficult to make work for service providers. None of the service providers in the County have discussed plans to build a Gigabit-enabled network. There is a financially feasible approach that can be taken. This plan will provide detailed information in that regard.

Opportunities:

- There is an opportunity to drive down the cost for Internet services while dramatically increasing the bandwidth available to homes and businesses.
- In cities that are implementing a Gigabit of service to homes and businesses, the pricing standard is .07 - .09 per Mbps for residential service ($70 – 90/month for Gigabit Internet) and (.30 - .80 per Mbps for businesses or commercial service ($300 - $800 for businesses for Gigabit Internet).[1]
- Throughout this process, NEO and the Moffat County staff and members have engaged many key stakeholders and potential partners in improving broadband services throughout the region. There is an opportunity to work together to either share in the cost of leased circuits and/or leverage grant and funding opportunities and partnerships to build fiber connectivity between the communities and to more anchor institutions. Building a middle mile network between communities achieves a number of benefits. The primary benefits include better redundancy, lower leased access costs, true aggregation of demand of anchor institutions, potential shared services between government agencies, collaboration opportunities amongst all stakeholders, and reduced backhaul and transport costs for the anchor institutions. Additionally, access to this infrastructure provides better redundancy and lower access costs for the service providers.
- NEO and Moffat County issued a Request for Information for the service providers to provide input into helping improve last mile options within the region. Ten responses were received from service providers, consulting companies, and operational companies to potentially partner with the member communities on last mile broadband options.

Threats

- Perhaps the greatest threat and challenge for the broadband strategy is determining who should implement the plan. Although it is beneficial to have a Committee of committed partners, it may be difficult to determine who will provide funding, oversight, implementation and operations of the network. Much of this is primarily about appetite and commitment. Although NEO can provide information on the risks, the capital costs, the financial implications, potential partners, etc. NEO cannot influence appetite amongst the Committee members.

Why Expanding Broadband Service Matters

Our world is rapidly changing. Technology is impacting every part and parcel of our lives -- from where and how we conduct work, to whether or not we thrive economically and socially. The Internet has impacted the way we work and live including our entertainment, our culture, the way government services are provided and accessed, the way healthcare is being delivered,

[1] See http://www.newamerica.org/downloads/OTI_The_Cost_of_Connectivity_2014.pdf New America

and the way we educate our children and provide education to better improve our workforce. With the introduction and accelerated advancement of technologies, having access to affordable, redundant and abundant broadband is quickly becoming the most critical infrastructure of our time, just like electricity and transportation were in the early 1900's.

The importance of broadband was reflected in the recent Federal Communications Commission's (FCC) determination that broadband Internet access is a utility, as necessary to contemporary life as electricity, roads, and water systems. Advanced broadband infrastructure has the potential to create more jobs, increase the community's competitive ability globally, create new technologies, increase opportunities for the region's companies, enhance public safety, provide better and less expensive healthcare, and provide greater educational opportunities throughout our communities.

Advanced broadband networks are creating seismic changes in local, state, national and global societies, as well as markets, business and in institutions around the world. Access to social media and the Internet has shifted governments, threatened political boundaries and changed us culturally. Advanced broadband networks are fundamentally changing our world in ways that were not expected or anticipated. Much like electricity, advanced broadband networks are the enabling technology in which all things are impacted. Electricity was invented to turn on the lights, but empowered – literally, the transformation to an industrial society.

Just as it was impossible to predict the impact that electricity would have to power modern appliances, computers, health monitoring systems, manufacturing facilities, computers, radio and television, and financial markets; so too, is it impossible to predict the impact and reach of advanced broadband networks. We do not yet know the far-reaching impacts that the Internet will have on our lives and on generations to come. However, it is certain that NOT having access to advanced broadband networks would be equivalent to being in the dark without electricity.

Middle Mile Infrastructure

Bringing high-speed Internet and data communications capacity into and between communities and to an Internet hub is often referred to as "Middle Mile Infrastructure." Most of the existing middle mile infrastructure in Moffat County is provided by CenturyLink. Mammoth Networks, through Yampa Valley Medical Center and the Northern Colorado Broadband project, Strata Networks, and Tri-State have existing fiber located between communities in the region.

Broadband networks require access to an Internet "supply" – locations where there is an Internet hub, backhaul or transport point, located in population centers. These Internet hubs can either be accessed by building fiber directly to the location, utilizing a point-to-point digital microwave link or leasing existing infrastructure. The costs for leasing existing facilities or backhaul are often based upon mileage. In either of these options, the costs to build directly from the Internet "supply" to rural areas are extremely capital intensive and/or the monthly access charges for leasing infrastructure are too high.

In rural areas, incumbent providers – primarily CenturyLink in rural parts of Colorado - have infrastructure to link fiber back to these Internet hubs. The Internet hubs for this region are based in Albuquerque, Farmington, Denver, Salt Lake City or Grand Junction. However, CenturyLink to date has not allowed other entities or local governments to "tap into their fiber" to extend a network, as is common for new homes to tap into a main waterline. CenturyLink has recently allowed other ISPs to lease dark fiber for connectivity to the various communities, but their excess fiber is limited and they, in most cases, are the only company that has fiber in the region and therefore, the lack of competition still does not drive down backhaul costs.

These high monthly backhaul charges or capital costs to connect to Internet hubs are difficult to finance since most rural areas do not have the population to support an adequate return on investment for any providers to upgrade their networks. This issue was raised with other providers serving the area. Service providers discussed partnering with Moffat County on the connections between the communities to allow for improvement of services throughout the region and to provide redundancy through another route that is an alternative to using CenturyLink's network. These fiber optic connections between communities and to the Internet hub are often referred to as "middle mile." NEO has provided a comprehensive strategy for implementing connectivity between the communities in the County with wireless connections between various towers.

A longer-term approach may also be to partner with other entities to build fiber between the communities. NEO identified potential partnerships that could possibly be leveraged to reduce the capital costs of building new fiber along these routes. CDOT has fiber and is interested in building fiber along many of the state highways in support of reducing their operating expenses and allowing for better traffic management, reporting, vehicle locator services and other operating initiatives. Mammoth, and Strata Networks have fiber in the region between communities. Tri-State has empty conduit between Rifle and Craig which may be able to be used if the conduit is in good working condition.

Last Mile Options

Although building fiber between the communities may improve cost of backhaul and transport fees for the existing service providers and provide more bandwidth capability to the communities, this build will not completely solve the "last mile" issues that are prevalent within the region. "Last mile" refers to the broadband connection at homes and businesses.

Although the local service providers have invested in limited fiber optic infrastructure to key businesses and anchor tenants, the existing providers' networks are primarily based upon cable modem, Digital Subscriber Line (DSL), satellite and wireless technologies for the last mile. Below is a brief description of the various technologies:

DSL (Digital Subscriber Line) uses existing copper phone lines to deliver download and upload broadband speeds typically of 1.5 Mbps to 7 Mbps. DSL speeds diminishes as distance increases from the telephone company's central office. Homes or businesses located more than three miles from the central office will not receive as fast of speeds. There have been many improvements to DSL technologies to improve the speed available. In general, most forms of DSL service improvements support up to 10 Mbps. VDSL (Very High Bit Rate Digital Subscriber Line) can support up to 30 Mbps, but most Internet service providers do not support this type of service, including providers in the region.

Cable modem service uses coaxial cables already installed by the cable TV operators to provide broadband service. Most cable networks support speeds comparable to DSL. Cable operators are upgrading their cable networks by installing fiber optic cable closer to neighborhoods. These network improvements allow cable modem service to be able to support up to 30 Mbps. This connection type is a shared service, meaning, as more people are on the network within a neighborhood, the speed available to each customer diminishes.

Fiber optic technology converts electrical signals carrying data to light and sends the light through glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. Fiber is the best way to provide abundant broadband, but it often is the most capital-intensive to build. As fiber optic technology transmit pulses of light, more bandwidth can be delivered on a fiber optic network by adding various colors of light or additional spectrum. Fiber is unique because it can carry high bandwidth signals over long distances without signal or bandwidth degradation and it can provide that capacity in both directions – for both upload and downloading information.

Wireless broadband connects a home or business to the Internet using a radio link between the customer's location and the service provider's facility. Wireless technologies using longer-range directional equipment provide broadband service in remote or sparsely populated areas where

DSL or cable modem service would be costly to provide or fiber network installations may be too capital intensive.

Wireless broadband can be mobile or fixed. Wireless speeds are generally comparable to DSL and cable modem. Wireless services can be offered using both licensed spectrum and unlicensed devices. Wi-Fi networks typically use unlicensed spectrum. Wi-Fi networks use wireless technology from a fixed point and often require direct line-of-sight between the wireless transmitter and receiver. Wi-Fi networks can be designed for private access within a home or business, or be used for public Internet access at "hot spots" such as restaurants, coffee shops, hotels, airports, convention centers, and city parks. Using licensed spectrum, greater amounts of bandwidth can be delivered and often do not require direct line-of-sight.

In some communities, especially sparse, geographically diverse rural communities, small providers build out a wireless solution since wireless infrastructure is not as capital-intensive as building out a fiber optic infrastructure. While wireless technology does have its limitations, needing to be designed to get around “line of sight’ requirements as well as to support “shared” bandwidth on the network, smart engineering can deliver good connectivity.

Cellular 4G and LTE. Cellular service is often referred to as wireless service and it can be confused with Wi-Fi. Cellular and Wi-Fi are both wireless systems, meaning both use radio frequencies to transmit and receive data. But Wi-Fi has a radio transmitter and receiver that operates only at a range of 200 feet or so. The range of cellular is measured in miles. Wi-Fi's transmitter and receiver is called an access point. It is mounted in the corner of a room, or on a lamp post, or in a hotel lobby. A cellular transmitter and receiver is called a cell site, or a base station and can transmit for miles.

“4G” refers to the fourth and latest generation technology for data transmission over a cellular network. It can support greater data speeds than most public Wi-Fi networks and is used primarily when a customer is out of the range of a Wi-Fi network. LTE, which stands for “Long Term Evolution,” is the fastest, most consistent variety of 4G.

To date, the cellular companies have charged for data usage either by the amount of data used or with a flat fee for unlimited data use.

Wireless Local Area Networks (WLANs) provide wireless broadband access over shorter distances and are often used to extend the reach of a "last-mile" wireline or fixed wireless broadband connection within a home, building, or campus environment. An in-home Wi-Fi network is a WLAN – it does not use spectrum, rather it sends radio waves at a limited range. Mobile wireless broadband services are also becoming available from mobile telephone service providers. These services are generally appropriate for highly-mobile customers and require a

special wireless card with a built-in antenna that plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps.

Satellite broadband is another form of wireless broadband, and is also useful for serving remote or sparsely populated areas. Typically, a consumer can expect to receive (download) at a speed of about 500 Kbps and send (upload) at a speed of about 80 Kbps. These speeds are slower than DSL and cable modem, but they are about 10 times faster than the download speed with dial-up Internet access. Service can be disrupted in extreme weather conditions and are typically oversubscribed.

The "gold standard" in solving the last mile connectivity is in building more fiber out to homes and businesses. This is referred to in the industry as "Fiber to the Premise," or "Fiber to the Home," or "Fiber to the Business." This methodology is currently the only reliable way of providing Gigabit or 1,000 Mbps of broadband services to end users. There have been dramatic improvements in wireless technologies and although we are now seeing the ability for wireless to support Gigabit speeds, the wireless access points need to be fed with fiber and have a Gigabit reach of less than 500 feet. Gigabit players, Google Fiber and AT&T have announced plans to trial Gigabit wireless services in select markets in the U.S. for serving homes and businesses, but are not yet commercially available. Siklu is a company that is currently providing wireless equipment that supports Gigabit capacity; again, wireless access points need to be fed with fiber.

Methodologies and Activities Conducted During the Planning Process

There are a number of activities that were undertaken to put together a comprehensive plan for improving broadband services in the County. These activities included:

1. **Surveys.** Surveys were made available for citizens and businesses to provide feedback on current levels of broadband, how homeowners and businesses currently us the Internet, what currently being paid for services, current download and upload speeds are, and what is most important in regards to high speed Internet service.
2. **Stakeholder Meetings.** NEO's team met with key stakeholders in the community. These meetings included one-on-one discussions with staff members of the hospital, the community college, the municipalities, the County, the school district, the Chamber of Commerce, elected officials with City Council and the County Commissioners, YVEA, Tri-State and with businesses in the area. NEO also met with Rio Blanco County and discussed potential collaboration with Routt County.
3. **Research.** Independent research was conducted in regards to national mapping and availability reported though Broadband USA.
4. **Request for Information from the Service Providers.** A formal invitation to provide information and input into the plan was provided for the local service providers. Ten

responses were received from local and national providers and their input has been incorporated into the plan.

5. **Tower Inventory and Assessment.** NEO's team provided an on-site inventory and assessment of the existing wireless towers in the County and the surrounding area. The assessment included evaluation of the existing tower's structural capacity, available space, and providers currently using the towers. From there, a propagation study was conducted to identify gaps in both wireless broadband and cellular service coverage. This information was further confirmed by the formal Request for Information and the responses provided by the local service providers. A comprehensive wireless plan is included in this report to provide ways of improving wireless and cellular coverage throughout the County.
6. **Existing Assets.** NEO's team researched what existing fiber optic and conduit assets were available within the County. Maps of these existing assets have been provided to the Committee as a deliverable of this project.
7. **Community Anchor Institutions.** A list of community anchor institutions was assembled, identifying addresses, needs and current levels of services. Additionally, NEO obtained substation information and utility pole data from the local electric cooperatives, identifying possible strategies for placement of fiber on existing utility poles.
8. **Preliminary Design and Engineering.** Preliminary design and engineering was conducted to connect the communities with fiber and digital microwave services for a middle mile strategy. Preliminary design was also performed to connect anchor institutions with fiber optic cable as well as capital cost projections for a Fiber-to-the-Premise network for the communities within Moffat County. As mentioned earlier, design, engineering and capital cost estimates were also assembled for improving wireless capabilities.
9. **Financial Plan.** A detailed financial analysis was performed on various strategies for implementation. Financial models were created for a number of public-private partnership models and ownership/operating models. Financial plans and details were provided to the Committee as a deliverable of this project.
10. **Strategies and Plans.** And finally, this report was assembled to provide a path forward towards implementation of several strategies and plans to improve broadband and data connectivity for the County.

NEO's Recommendations

NEO recommends the following strategies for the Moffat County. These strategies will be addressed in detail in this report.

1. Hold an election to opt out of SB-152 for those communities that have not yet done so if the Colorado legislature does not overturn SB-152.

2. Implement broadband-friendly policies and ordinances in each of the cities, towns and counties to help reduce the cost of broadband expansion.
3. Work with Moon Lake Electric, YVEA and Tri-State to streamline the permitting process and gain access to their utility poles.
4. Follow up on discussion with the service providers for collaboration. Conversations regarding joint trenching and joint builds were initially discussed with the existing providers in the region. Additional collaboration may be in sharing very high-speed Internet access, transport and backhaul monthly fees. Many of the existing service providers would like access to more towers in the region and have discussed plans to upgrade their wireless equipment.
5. Partner with CDOT, Rio Blanco County, Northern Colorado Broadband, Tri-State, the existing service providers and YVEA to build key middle mile routes throughout the region.
6. Leverage grant funding – namely, the Department of Local Affairs (DOLA), the Rural Healthcare Grant, E-rate, the Economic Development Administration and USDA's Rural Utilities Services program to pay for a significant part of these builds. These grant programs will pay for 50-65% of the capital costs to connect government entities, schools and the medical establishments and may provide funding for placement of conduit and fiber to homes and businesses. Many of these grants will also pay for the middle mile portion of these builds to connect various government and quasi-government locations.
7. Establish a working group to spearhead and implement cooperation amongst all member communities in the region for shared services, shared data centers, buying and negotiating power for potential public private partnerships as well as other common member interests. The existing Committee may take on this role or another working group could be formed.
8. Build wireless facilities between towers in the County, accessing Rio Blanco's Rangely North tower that already has 10 Gbps Internet access in place. Share in the Internet access costs with Rio Blanco County.
9. Consider implementation of a fiber to the premise strategy for last mile infrastructure.

Laying the Foundation, Current Services, Existing Assets, Potential Partners

Section 1 - Current Market Assessment

NEO assessed the current market for broadband availability by conducting independent research on the existing technologies and speeds available in Moffat County. NEO also confirmed much of this information by conducting surveys for homeowners and businesses and through a formal Request for Information from the service providers. Here are the findings of the current market assessment.

Independent Research

According to Broadband Map USA[2], CenturyLink provides DSL broadband technologies to 84.55% of the population in Moffat County.

Technology	% of Population
DSL	84.55%
Fiber	5.85%
Cable	78.82%
Wireless	97.78%

5.85% of the population have fiber technology, 78.82% have cable modem technology and the bulk of the population have access to wireless technology.

[2] See http://www.broadbandmap.gov/

Moffat County, Wireline Broadband Availability		
Speed	% of Population with Available Download Speeds	% of Population with Available Upload Speeds
768 k	85.90%	85.59%
1.5 M	85.85%	82.61%
3 M	85.77%	82.61%
6 M	85.38%	81.37%
10 M	84.07%	81.37%
25 M	5.69%	5.69%
50 M	5.69%	5.69%
100 M	5.69%	5.69%
1 Gig	5.69%	5.69%

Most of the population does not have access to technology that meets the minimum definition of broadband: 25 Mbps in download and 3 Mbps in upload speed.

In fact, according to the Broadband Map website, only 5.69% of the population within Moffat County have WIRELINE availability meeting the definition of 25 Mbps in download speeds.

Moffat County, Wireless Broadband Availability		
Speed	% of Population with Available Download Speeds	% of Population with Available Upload Speeds
768 k	97.78%	96.89%
1.5 M	96.96%	96.89%
3 M	96.96%	96.79%
6 M	96.89%	90.53%
10 M	96.79%	88.46%
25 M	0.00%	0.00%
50 M	0.00%	0.00%
100 M	0.00%	0.00%
1 Gig	0.00%	0.00%

0% of the population in Moffat County have access to 25 Mbps in download WIRELESS speeds. The mapping data's last update was as of June, 2014. It is possible that the existing wireless providers have upgraded equipment in Moffat County in the past year. However, it is clear from the speed tests that were conducted throughout the planning process, and further confirmed by the mapping information available on Broadband Map USA, that much can be done to improved availability of better broadband services in the County.

Existing Service Providers and Pricing

Moffat County's existing incumbent service providers are CenturyLink for phone and broadband services and Charter for broadcast TV and broadband services. CenturyLink provides Internet service through DSL technology and Charter provides Internet services through cable modem technology.

ZIRKEL Wireless currently offers six standard plans that are offered to both residential and business subscribers. They include:

Zirkel Service Offering in Moffat County			
Plan	**Download Speed (Mbps)**	**Upload Speed (Mbps)**	**Price***
Economy	1.5	0.5	$29
Basic	3	1	$46
Premier	6	2	$59
Turbo	12	4	$79
Turbo Plus	18	6	$99
Turbo Extreme	30	10	$129

Additionally, Zirkel offers dedicated Internet plans with gigabit capacity. The pricing of the Gigabit service plans varies and are site specific.

Other homeowners and businesses in Moffat County use satellite based technology for Internet services offered through Hughes Net or Wild Blue.

Current Infrastructure Improvements in Moffat County

Zirkel is upgrading their wireless services available throughout the County by searching for new tower sites, specifically in the areas of Hamilton, Maybell, and Dinosaur. They are also upgrading their wireless equipment to offer faster speeds and are adding equipment to tower to increase their coverage area. Some of the towers within Moffat County are located on Bureau of Land Management (BLM) or on Forest Service land. Service providers who responded to the Request for Information indicated wanting to use these towers to expand their services. The application process to use towers on Forest Service land is often a 3- to 5-year process and therefore, is often seen as an obstacle in improving broadband services. Having the elected officials and County staff meet with local Forest Service representatives to streamline this process could help the existing providers expand their wireless reach. Many of the service providers stated they would upgrade their wireless equipment to accommodate higher broadband speeds.

CenturyLink was awarded $26 Million in annual grant funding per year for six years in Colorado through the federal high-cost program. The federal universal service high-cost program (also known as the Connect America Fund) is designed to ensure that consumers in rural, insular, and high-cost areas have access to modern communications networks capable of providing voice and broadband service, both fixed and mobile, at rates that are reasonably comparable to those in urban areas. The program fulfills this universal service goal by allowing eligible carriers who serve these areas to recover some of their costs from the federal Universal

Service Fund.[3]. Of the $26 Million annually, from the federal Connect America Fund II, $2.5 Million is allocated annually for six years for Moffat County.

CenturyLink CAF II Funding

County Name	Homes and Businesses Supported	County Carrier Total Support	6 years Support
Moffat, CO	949	$ 431,975	$ 2,591,848

The goal of the Connect America Funding is to make infrastructure improvements to bring unserved and underserved areas to 10 Mbps in download availability and 1 Mbps in upload availability. Although this program will help some areas within the county, this program is more of a stop-gap measure than a good long-term plan.

Surveys

NEO provided two surveys for engaging with the communities regarding current broadband services. One survey was designed for homeowners and residential customers and the second survey was designed for businesses and commercial users. These surveys generated 182 residential responses and 34 business responses.

In January of 2015, the FCC changed the definition of broadband by increasing upload and download speeds; raising the minimum download speeds from 4 to 25 Mbps and the upload speed from 1 to 3 Mbps. As part of the survey, respondents were asked to conduct a "speed test" noting actual residential Internet service speeds to determine whether or not citizens were meeting the new FCC definition of broadband service.

For the residential survey respondents, 72% of the download speed tests recorded in Moffat County were below the FCC's minimum broadband threshold.

Summary of Survey Results

Residential Results

Although the survey is a randomized sample, the survey results of 182 homes strongly suggest the following:

[3] See https://www.fcc.gov/general/universal-service-high-cost-areas-connect-america-fund

- Reliability is the most important factor for users, followed by speed/availability and then price.
- Most of the respondents indicated that upload and download speeds are acceptable; however, one out of three respondents (31.45%) are not satisfied with their current Internet speed. As most of the speed test results (72%) fell below the FCC's minimum standard for broadband, the fact that most respondents find the speeds "acceptable" is an interesting take-away.
- 42% of the residential respondents have at least one person telecommuting or working from home.
- Pricing for Internet services varies for residential subscribers with nearly half (49%) of respondents paying $56 - $100/month, and 1 out of 4 (27%) paying more than $100/month.
- Households mostly use the Internet for "basics" like email, browsing/research, etc.
- More and more, households are relying on streaming video over the Internet for in-home entertainment.
- Household members interact with local businesses (reservations, tickets, etc.) over the Internet and buys things online (Craigslist, eBay, etc.)
- Most respondents strongly agreed that their demands on Internet bandwidth and speed are consistently increasing.
- 30 of the respondents indicated that they would consider moving if the Internet service was inadequate.

Business Results

The business survey generated responses from thirty-four businesses and revealed important information about the local business community. As with residences, reliability is the most important factor for businesses, followed by speed and price.

- 57% of the businesses have employees that work from home at least one day per week. 14.29% responded that employees work five days a week from home. 17.86% responded that employees work three days a week from home.
- 21% of the businesses operate primarily from home.
- The strongest benefits for business respondents with faster Internet were that businesses would be more efficient, they would collaborate with customers and partners, they would provide and attend more webinars/online training and they would provide more products and services to their customers.
- 51.6% of surveyed businesses pay between $50-100/month for Internet service.
- The average speeds recorded were 33.89 Mbps download and 6.95 Mbps upload.
- 53% of all businesses identified Internet access as critical to their operations. And nearly half identified the need for increased broadband capacity in their businesses.
- When asked to rate the most critical components of Internet service, overwhelmingly, businesses are looking for reliability (70% indicated it was of the most importance), followed by and speed and then price.
- While most residential respondents rated their speeds as acceptable, in the business survey, most of the respondents indicated that their speeds were too slow. Only 27% of surveyed

businesses rate their download speeds as "excellent" or "good." While less than 12% rated their upload speeds as "excellent" or "good."

- Respondents agreed strongly that their business operations are heavily tied to the Internet and that their demands on Internet bandwidth and speed are consistently increasing.
- 87.88% of business owners think that Broadband is a utility.

Role of Government and Who Should Step in?

One of the primary study areas in the survey explored the respondents' thoughts regarding the role of government in solving broadband issues. The greatest number of respondents in the residential survey support either having the local government step in or to have the local government work with the private sector to provide adequate service. Businesses responded in favor of the government working with the private sector to provide service.

There are various public/private partnership models that can be explored to improve and enhance service delivery throughout Moffat County. These models leverage the private sector to share in the capital costs and to mitigate potential risks. A question was posed to respondents who should step in if the private sector did not provide adequate or affordable broadband. Respondents had a choice between the local municipality, the county, the electric company, or a consortium or "I am not sure." Most of the respondents responded with the last option – not sure who should fix it. This is often one of the most challenging areas of broadband planning – determining who is best received to step in and solve broadband challenges. Unfortunately, the survey responses do not give us the sure-thing solution on who should step in.

Detailed survey results are found in Appendix B of this report.

Section 2 – Identification of Existing Key Assets and Other Potential Partners

NEO identified and mapped assets in the region and identified gaps in services. This analysis included creation of a comprehensive broadband asset inventory list and infrastructure map. The map includes assets from existing service providers and from other potential partners. Information collected includes topological data, identification of current underground and overhead infrastructure, fiber lines, conduit, pole access, tower access and view-shed data. Maps of the existing assets were provided to Moffat County as a deliverable of this project.

In addition to meeting with the primary service providers within the region, NEO also reached out to other entities that might have assets in place today and/or may be potential partners for fiber expansion projects in the future. Key potential partners identified in this process are CDOT, Unite Fiber, Tri-State, Strata Networks, Mammoth Networks, YVEA, Northern Colorado Broadband (the non-profit organization in Routt County), and Rio Blanco County.

Unite Fiber

Unite has built a fiber network within Craig connecting all of the schools. Unite has been willing to discuss expansion or use of their fiber network to connect other anchor institutions within the community. A map of their network has been provided to the Committee as a deliverable of this project.

Strata Networks

Strata Networks has fiber in place from Craig to Salt Lake City. A map of this network has been provided to the Committee as a deliverable of this project.

Yampa Valley Medical Center (Routt County's Northern Colorado Broadband)

Yampa Valley Medical Center has built fiber from Steamboat Springs into Craig. There may be excess fiber available for this project through Northern Colorado Broadband. A map of this fiber has been provided to the Committee as a deliverable of this project.

CDOT's Initiatives

CDOT is investing in fiber optic facilities, per their website, to "facilitate the use of technology to quickly detect and verify traffic incidents, allowing CDOT to work with law enforcement and emergency responders to ensure fast, appropriate levels of response to incidents, thereby increasing the ability to save lives. Building out this technology will also allow the department to monitor and detect rapidly changing weather conditions and quickly relay this information to travelers." Investments in telecommunications backbone or fiber facilities are connected to the CDOT Transportation Management Center in Golden. This center is responsible for disseminating statewide traveler information, including weather, traffic congestion, and travel route information. Information is disseminated to travelers via message boards, phone apps, and other means. CDOT also uses information from the backbone to make operational decisions such as when and how to initiate road maintenance projects.

CDOT is also implementing infrastructure to support its "Connected Vehicles" applications. These applications include vehicle-to-vehicle and vehicle-to-infrastructure communications, which is part of a federal traffic management initiative that envisions facilitating communication between vehicles and infrastructure to increase safety and mobility and decrease the environmental impact of driving. Through communications interconnection, the

traffic management infrastructure will help vehicles to avoid crashes while reducing traffic congestion and associated fuel use. A reliable, high-speed communications network is required to implement Connected Vehicles technology.

CDOT also uses this infrastructure to connect its network to the Nationwide Public Safety Broadband Network, and create a platform to work with neighboring states to provide levels of transportation services that travelers expect.

CDOT has implemented these strategies through deployment of their RoadX project. Again, according to the CDOT website, "The RoadX program will employ a multi-pronged DO-IT (deployment, operations, innovation, technology) approach with the objective of being the most efficient, agile, and flexible system for bringing transportation technology to market. The RoadX program will implement several efforts along the DO-IT spectrum in 2016–18. CDOT plans to partner with private industry and others to deploy advanced technology to reduce the cost of transporting goods by 25%; to turn a rural state highway into a zero-death road; and to improve congestion on Colorado's critical corridors."[4]

Electric Companies as Potential Partners

Electric companies and cooperatives throughout the State of Colorado have deployed fiber between some of their substations and have been good partners to potentially help with middle mile infrastructure deployment. YVEA may be a good partner to develop middle mile strategies. YVEA may have a need to connect their substations throughout Moffat County. NEO's team put together a preliminary design and estimated capital costs for building fiber between YVEA's substations. Deploying fiber using existing utility lines and poles is sometimes a less expensive alternative than underground construction. Use of YVEA's utility lines and poles may be an attractive alternative to build fiber between communities in Moffat County.

Moon Lake Electric, who serves the Dinosaur area, may also be a good potential partner in use of their utility poles and in deploying fiber.

Tri-State has been a valuable partner in helping to bring better broadband services throughout the State and has also expressed interest in providing access to its fiber and/or conduit whenever possible. Tri-State has empty conduit in place between Rifle and Craig; an asset that may be leveraged for further middle-mile expansion.

One of the challenges with use of fiber deployed either by YVEA, Moon Lake Electric or with Tri-State, is the need to perfect easements for commercial use. Perfecting easements can be a

[4] See https://www.codot.gov/programs/roadx

time-consuming and uncertain endeavor, as not knowing how long it will take or how much it may cost can be concerning; however, there is much precedent that has been set across the state in gaining success throughout this process.

Other Regional Partners, Rio Blanco and NCB

Rio Blanco and Routt County are also identified as potential partners for the Moffat County's efforts. As part of the Northwest Colorado Regional Broadband Strategic Plan effort, Rio Blanco County identified that broadband service in the County was inadequate to sustain 21st century economic development. Rio Blanco County is deploying a wholesale Fiber to the Premise model. In 2014, Rio Blanco County voted to opt out of SB 152 and reclaimed their local telecommunications authority. Shortly after opting out, Rio Blanco received grant funding with the Colorado Department of Local Affairs (DOLA) to build out the network. The County and some of the local community anchor institutions are providing the match funding required by the grant. The County is building fiber infrastructure to the block in Rangely and Meeker and service providers will finish the build-out to each home or business. In the more rural parts of the county, subscribers will be served by wireless infrastructure and technologies.

Subscribers have the option to choose between two providers which are offering services on Rio Blanco's network. Local Access Internet (LAI) and Cimarron Telecommunications are offering symmetrical Gigabit Internet access (1,000 Mbps or 1 Gbps) for $70 per month.

In Routt County, Northwest Colorado Broadband (NCB) is working to improve broadband services and availability in Routt County and may prove to be a valuable partner for Moffat County. NCB is a Colorado non-profit formed in 2012. Its directors are appointed by Routt County, the City of Steamboat Springs, the Steamboat Springs School District, Yampa Valley Medical Center, YVEA and the Steamboat Springs Chamber Resort Association.

Since 2014, NCB has operated a carrier neutral location where broadband demand for four community anchor institutions is aggregated and served by bandwidth contracted by NCB from Mammoth Networks. This demand aggregation has resulted in 5-10x savings, greater capacity, and service redundancy for the anchor institutions served. In 2016, NCB director entities cooperated with Routt County to complete the Routt County Strategic Broadband Plan and successfully apply for Department of Local Affairs funding to construct the first phase of a fiber optic network that will connect additional community anchor locations to NCB service and be available through an open access model to private providers. The project is scheduled for completion in the summer of 2017. Routt County intends to convey the network asset to NCB for ongoing operations. Business planning to determine the details of network operation and

maintenance, including future public-private partnerships and pricing for third-party access, is scheduled for completion in the first quarter of 2017.[5]

NCB responded to the Request for Information. According to their response, "On a parallel track to NCB's efforts, in 2016 Yampa Valley Medical Center constructed fiber optic infrastructure in Craig, effectively creating a fiber loop around the southern edge of town. Given a change in their business plans, YVMC intends to convey this asset to NCB, to add to the assets that can be leveraged by NCB for community benefit in the region, either directly, or through public-private partnerships."

The response indicated that NCB is in the process of completing projected pricing information and planning and would like to engage with the Moffat County Broadband Planning Committee to explore how NCB might be a part of Moffat County's broadband improvement efforts.

Service Providers, Operating Partners

Additionally, many service providers responded to the RFI and stated that they too would like to participate in improving services for the County. Responses were received from Zirkel Wireless, Charter Communications, Allo, Cimarron Telecommunications, and Mammoth.

Companies that provide consulting, operations and implementation of networks also responded to the RFI. These include Colorado Fiber Community, who is currently providing operations and implementation of Rio Blanco's Fiber to the Premise network, Mammoth, who is providing these services for Routt County's NCB, Stratton, Entry Point and Foresight Group.

Section 3 –Senate Bill 05-152, Regulatory Analysis

One of the barriers for improving broadband services in the State of Colorado has been the regulatory environment, specifically, the passing of a law that prohibits local governments from providing services to homes and businesses and limits local governments' involvement in building telecommunications infrastructure.

In 2005, the State of Colorado passed a bill that limits municipalities from building telecommunications infrastructure for end users (§ 29-27-101 to 304, C.R.S., commonly referred to as "SB-152".) This legislation is a barrier for Colorado communities in improving broadband

[5] Taken directly from Northern Colorado Broadband's response to the Moffat County Request for Information.

capabilities and it limits the options for ownership and service delivery by municipalities, counties, and other local governments.

SB-152 generally requires an election before a local government may take various actions to provide Internet access service, cable television service, or telecommunications service to the public. The statute also requires "regulatory parity" between public and private providers of such services. Much of the statute concerns various exemptions from this requirement. For example, SB-152 provides that the law does not limit the authority of local governments to enter into agreements permitting private telecommunication service providers to lease space on government property for the placement of telecommunications equipment. Arrangements between municipalities and private telecommunication providers for placement of equipment such as cell phone antenna arrays are common. With this provision, no election is required in connection with such agreements. The statute also does not apply to government provision of various telecommunication service to citizens for governmental or intergovernmental purposes, including for use by persons "accessing government services." Governments commonly provide a variety of telecommunication services to citizens using its buildings and facilities; no election is required for this to continue. Furthermore, SB-152 makes clear that no election is required in order for governments to operate internal communications networks and to utilize such networks in cooperation with other governmental entities. Should local governments wish to sell insubstantial amounts of "excess capacity" on their networks, they may do so without an election, provided that the sale and use is made on an evenhanded, "competitively neutral" and "nondiscriminatory" basis.[6]

A local government can build any kind of a communications network, and can, without other authority, provide all of the services identified in this plan, but only to itself or other governmental/quasi-governmental entities. All of the services mentioned within this broadband blueprint would be considered advanced services if they are delivered at speeds in excess of 256 kbps. A government that has built a government network cannot expand and provide service directly to subscribers (as that term is defined in the statute), or enter into a public-private partnership without voter approval, unless it comes under one of the limited statutory exceptions.

Local governments can obtain exemption through a local ballot initiative to opt-out of SB-152. As of November 2016, approximately 90 municipalities, counties and school districts have held public elections to opt out of SB-152. All of the favorable opt outs have passed overwhelmingly. Some communities (Estes Park, Durango and Telluride) passed with over

[6] Geoff Wilson, Colorado Municipal League General Council brief of SB-152.

90% voting in favor of opting out of this restrictive bill, giving local governments the authority to solve broadband infrastructure gaps within their communities.

Moffat County and Craig have held successful opt out elections, but Dinosaur and Maybell would also need to opt out if their local governments participate in building out telecommunications infrastructure.

In January 2017 (as this report is being released) there is current discussion occurring in the State's legislature to overturn SB-0152 completely.

NEO's Recommendations

Section 4 – Establish Broadband Friendly Policies and Ordinances

NEO recommends putting in place broadband friendly policies and ordinances to encourage further broadband infrastructure deployment by helping to reduce the capital costs of fiber builds. These policies also encourage the following:

1. Reduce the cost of construction for broadband networks. 60-80% of a fiber optic network's capital costs are in opening a trench or in burying conduit that will house fiber optic cable. Policies that encourage placement of fiber in coordination with other government capital projects (sidewalks, trails, lighting, and road projects) and coordination with other utility projects by others - may all be opportunities to install conduit.

NEO recommends implementation of a ***Dig Once Policy*** that has the following components:

All public works or installation of other telecom, cable or utility infrastructure allows for conduit to be placed on behalf of the City and any other entities that want to participate. If there is an open trench, the policy provides for coordination of street cuts and excavations with utilities, public works, developers and other interested parties to maximize the opportunity for broadband conduit installation, and to minimize cost, disruption and damage.

Allows for a notice period informing other entities that an open trench will be available for placement of their conduit and/or fiber optic facilities.

Allows for shadow conduit to be placed for the Town, City or County. Installation of empty and/or space conduit by a public agency when excavations occur in the public right of way, with agency (Town, City or County) costs limited to incremental costs.

Additionally, NEO recommends that the various government agencies establish ***Joint Trench Agreements*** and ***Joint Build Agreement***s with other telecommunications, cable or utility providers. Cost for placement of conduit or fiber will be shared amongst all entities, allowing each entity to take advantage of trenches that have been opened through each other projects and allows for sharing of capital costs for any conduit and/or fiber builds. Standardization of these agreements across all potential owners of underground infrastructure can be established to ensure all parties are aware of the joint trenching opportunities as they become available.

NEO also recommends a ***Streamlined Permitting Process*** – placing responsibility for approval of broadband infrastructure projects solely in the public works department via encroachment permit processes. An ***Abandoned Fiber and Conduit Policy*** can be put in place if any abandoned fiber and/or conduit that are not claimed by the owner within a reasonable time period, the ownership of that conduit and/or fiber would revert to the local government agency.

2. Encourage standards for placement of conduit and/or fiber in new developments. Integrating broadband "utility" codes into land development policies and ordinances to ensure that new real estate developments incorporate a standard placement of conduit and/or fiber optic facilities. The land development codes could require new land developments, new real estate developments and/or newly built homes and office buildings to install fiber optic infrastructure. New building codes could describe specific compatible communications components and architectures into each new building, and could describe development and use of municipal/county right-of-way for communications connectivity, and could specify standardized specific wiring requirements for new buildings.

3. Set up funding mechanisms to allow for adoption of these policies. Conduit is not expensive. However, if the funding mechanism does not exist to place conduit, often opportunities to take advantage of open trenches or joint builds do not occur. A funding set-aside or budget process must be put in place to allow for adoption of these policies. The funding mechanism will allocate monies to build broadband infrastructure when opportunities arise and the fund would maintain a reserve or set-aside for unanticipated projects.

4. Keep a GIS database of all infrastructure, and provide for a process to submit plans. Any permit for work done within the right-of-way or for new developments would require as-built drawings to be submitted to routinely document conduit and other broadband asset data into a geographic information system. The policy could establish a requirement that plans and as-built drawings and other information be submitted by utilities, developers, contractors and others in an appropriate GIS format.

NEO provided sample policy and ordinance language that other communities have implemented for all of the above policy recommendations. NEO also provided information regarding compliance with the FCC Order on Mandatory Wireless Facilities Collocation.

Section 5: Wireless Tower Assessments and Plan

A Wireless Tower Assessment, Radio Frequency Analysis and Plan was conducted by NEO and its consultants. This plan ("Analysis") is intended to be used as a general planning tool for consideration for wireless broadband deployment in Moffat County. For purposes of this Analysis, a base station and tower are defined as follows:

Base Station - Equipment and non-tower supporting structure at a fixed location that enables wireless telecommunications between user equipment and a communications network. Examples include transmission equipment mounted on a rooftop, water tank, silo or other above ground structure other than a tower. The term does not encompass a tower as defined herein or any equipment associated with a tower. "Base Station" includes, but is not limited to:

- Any structure other than a tower that supports or houses radio transceivers, antennas, coaxial or fiber optic cable, regular and backup power supplies, and comparable equipment, regardless of technological configuration; and
- Equipment associated with wireless telecommunications services such as private, broadcast, and public safety services, as well as unlicensed wireless services and fixed wireless services such as microwave backhaul and broadband.

Tower- Any support structure built for the primary purpose of supporting any antennas and associated facilities for commercial, private, broadcast, microwave, broadband, public, public safety, licensed or unlicensed, and/or fixed or wireless services. A tower may be concealed or non-concealed. Non-concealed towers include:

- Guyed - A style of tower consisting of a single truss assembly composed of sections with bracing incorporated. The sections are attached to each other, and the assembly is attached to a foundation and supported by a series of wires that are connected to anchors placed in the ground or on a building.
- Lattice - A self-supporting tapered style of tower that consists of vertical and horizontal supports with multiple legs and cross bracing, and metal crossed strips or bars to support antennas.
- Monopole - A style of freestanding tower consisting of a single shaft usually composed of two (2) or more hollow sections that are in turn attached to a foundation. This type of tower is designed to support itself without the use of guy

wires or other stabilization devices. These facilities are mounted to a foundation that rests on or in the ground or on a building's roof. All feed lines shall be installed within the shaft of the structure.

This Analysis begins by identifying and assessing existing towers and base stations used for wireless communications including, but not limited to: public safety, microwave, personal wireless service facilities (PWSF), broadband and broadcast facilities. Visiting all known and accessible towers and base stations aids in data collection regarding ownership, equipment and use of the facility by owners and tenants. Theoretical coverage maps based on the assessment data are developed to identify gaps in wireless broadband coverage and solutions are provided to address the gaps in identified coverage.

This Analysis serves as an illustrative planning tool and guide for developing broadband deployment policies for future infrastructure and identifies county-owned and other public properties that can be part of network deployment solutions for providing wireless broadband. This Analysis can help establish policy for minimizing the future number of telecommunication facilities while maximizing network coverage objectives from as few new sites as possible.

Existing Wireless Facility Locations

NEO and its consultants assessed all known wireless communication facilities which consisted of existing tower and base station locations throughout the County to identify the following: 1) location of existing telecommunications facilities currently within and just outside the County; 2) existing tenants on the towers and base stations; and 3) availability of future potential collocations on the existing structures.

The wireless infrastructure assessment process identified twenty-two (22) existing wireless telecommunication sites with a total of thirty-nine (39) facilities within the County. Five (5) of the sites contain multiple towers which is why the number of facilities exceeds the total number of sites.

NEO and its consultants were unable to access nine (9) locations due to locked gates, private property restrictions or not knowing about the facilities until after the assessment process was completed and therefore some structures will not have site specific photos. Thirteen (13) of the facilities assessed have no identification of ownership or emergency contact information posted on the infrastructure making identification of ownership and tenants arduous. NEO recommends contacting the local Bureau of Land Management (BLM) office to inquire about these towers since most of the unidentified towers are on BLM properties.

Generally, most of the towers and base stations are located at higher topographical elevations within and around the more populous City of Craig, where the majority of the population resides within the County.

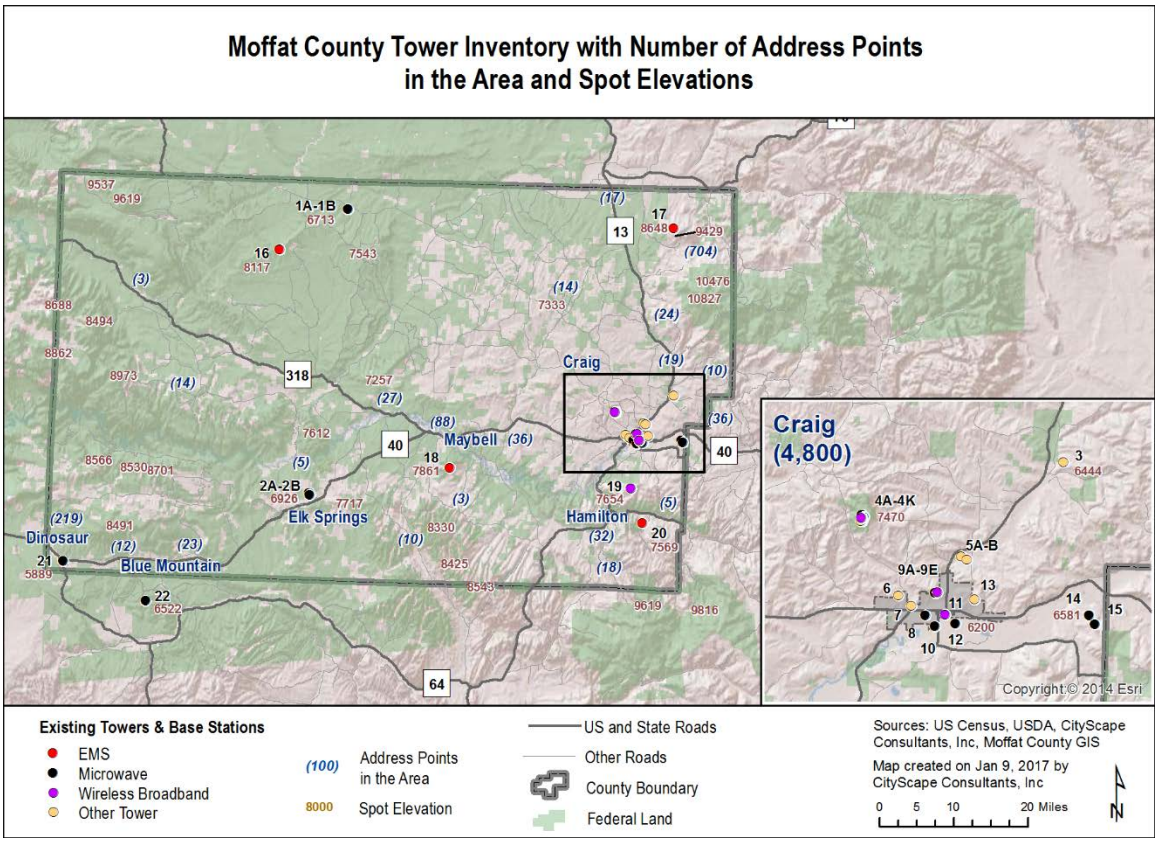


Figure 1: Map of Overall Existing Antenna Locations

Figure 1 identifies the location of the towers and base stations throughout the geographic study area as follows:

- Red dots depict emergency management facilities;
- Black dots depict facilities with microwave equipment;
- Purple dots depict wireless broadband facilities;
- Yellow dots depict other towers such as those used for PWSF and broadcast.

Additionally, in Figure 1:

- Federal lands are shaded in green;
- Towns and communities are identified in blue font;
- Address points are used as a quantifier of where people reside throughout the County. The number of address points is also provided in blue font;

- Spot elevations for some of the towers and taller mountains are provided in brown font.

Details collected from the assessment process and pre- and post-assessment research for each site number and/or letter are provided in the Data Table in Appendix A.

Theoretical Composite Frequency Maps

Wireless broadband is a type of Internet access where connections to service providers use radio signals rather than cables, either through Wireless Internet Service Providers (WISP) (typically called fixed wireless), Wi-Fi hot spots or cellular providers. Wireless service providers like Verizon, AT&T, and Union Wireless likely provide data to their subscriber base but not at the 25 Mbps broadband standard. Fifth Generation (5G) wireless networks are intending to meet the FCC broadband standards however deployment of 5G is not slated until years 2018 - 2020 in high-density urban areas while 5G to rural areas will be much later.

Illustrating the service area coverage based on propagation signal strength modeling is of value to determine gaps in network coverage. The composite map in Figure 2 depicts both low band PWFS frequency (700 - 990 megahertz (MHz)) in blue and high band PWSF frequency (1700 - 2300 MHz) in yellow. The highlighted areas represent where a generally reliable signal level should be available for indoor use for both low and high bands of service. Indoor usage is the service threshold utilized for composite modeling because it represents the lowest signal strength generally acceptable after considering the signal loss that occurs due to building penetration. Outdoor signal strength in the same area will usually be higher than indoor signal strength. Generally, the closer the subscriber is to the facility, the more reliable the service. A subscriber further from the facility will have less reliable service. As the subscriber gets closer to the edge of the yellow or blue area, the signal strength becomes more prone to degradation; particularly as usage in the area increases or environmental conditions worsen. The gray areas on the map indicate where the subscriber will experience weak, unpredictable levels of signal strength, or no service at all. Filling in these coverage gaps would require the installation of additional antenna and corresponding infrastructure.

Figure 2 illustrates current theoretical coverage for one service provider operating in the low or high band frequency from the fourteen (14) towers containing personal wireless service equipment. Three (3) of the fourteen (14) PWSF sites are located within several of the tower clusters and therefore fewer black dots are shown in Figure 2. With the exception of a small coverage area along Highway 40 west of Maybell, the only PWSF coverage in Moffat County is in and around the City of Craig, where according to 2015 United States Census data, approximately sixty-eight percent (68%) of the Moffat County population resides.

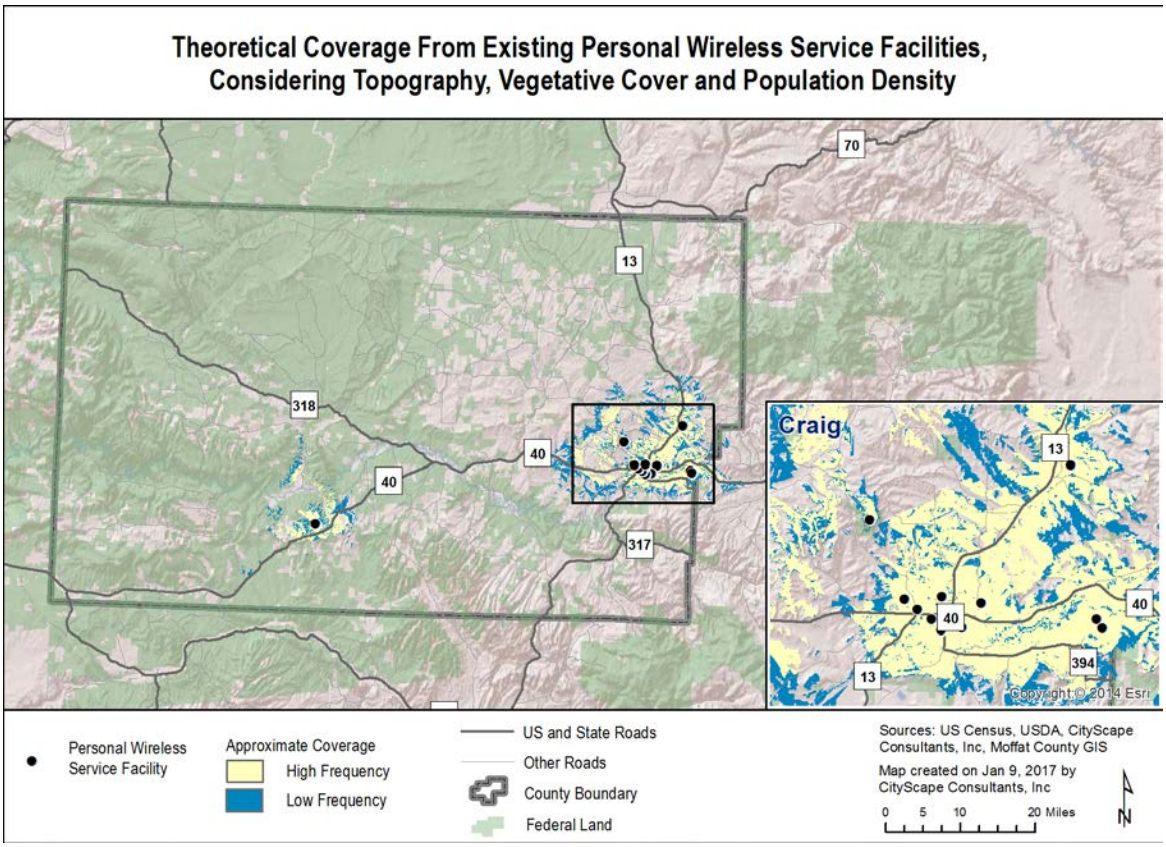


Figure 2: Theoretical Coverage from Identified 14 PWSF Locations Only

Four towers have been identified with equipment belonging to a local fixed wireless broadband service provider, Zirkel Wireless. These locations are identified in Figure 1 by a purple dot. Theoretical fixed broadband available for that network's subscriber base, from these four locations are shown in Figure 3 in blue. The geographic area with this service is the City of Craig because of the majority of population associated with the City.

The PWSF and fixed wireless broadband service is beneficial to the residents, businesses, local government and educational institutions in and around the City. Unfortunately, the rural and remote communities of Dinosaur, Blue Mountain, Maybell, Hamilton and other unincorporated areas of the county with population are underserved or not serviced by these providers.

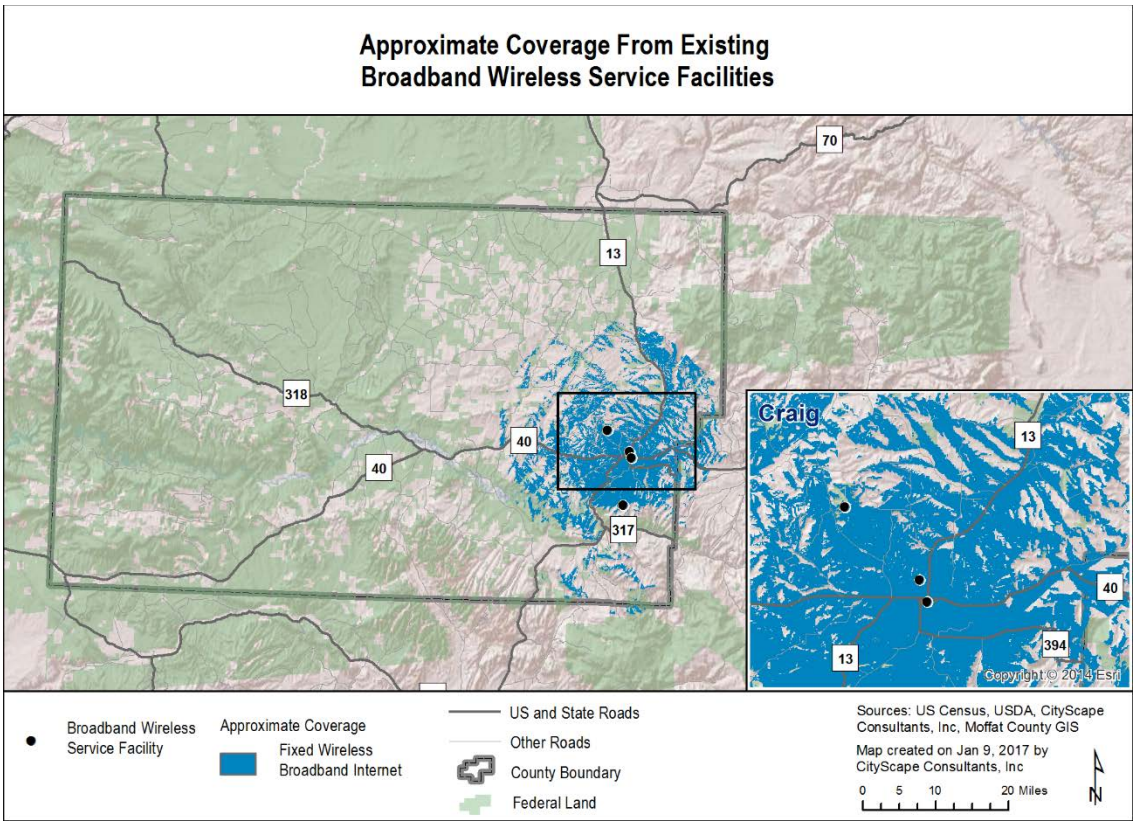


Figure 3: Fixed Wireless Broadband Theoretical Coverage from All 4 Identified Sites

Future Tower Site Projections for High Speed Internet and Broadband Through 2024

Modern and advancing technologies continue to transform how the wireless industry is electronically providing their services. Today Smartphones use the newer technologies known as fourth generation (4G) Long Term Evolution (LTE). This type of broadband application requires more information to be sent and received within the same radio envelope than was used in the previous deployment stages of personal wireless services. The more data contained within the radio frequency envelope makes it more important than ever to have as much signal density as possible. Increasing signal density requires more wireless facilities. Proximity of the infrastructure to the subscribers is becoming ever more relative to optimizing network services.

While there are some pockets of areas being tested with 5G technologies, the wide-area launch date is still undetermined although slated for 2018-2020 in some urban areas. Fifth generation will implement true high-speed data with download speeds well in excess of today's standard 25-megabit speeds.

Network Design Recommendations

To effectively and efficiently provide network coverage throughout the County over the next ten years, NEO and its consultants developed three options for high-speed wireless and broadband deployment. Each option factors in terrain, population, existing towers and wireless infrastructure for maximum collocation opportunities in an effort to reduce costs and the number of multiple new towers within the same geographic areas. These options also include new towers on possible anchor institution properties where tower or base stations do not exist, or where ground space or space on existing towers is unavailable.

Studying the maps in Figures 1 through 3, NEO and its consultants theorize a middle mile network coverage objective to serve the populations in Moffat County can be achieved by maximizing the use of an existing tower with fiber in Rio Blanco County and from a Network Operation Center (NOC) in downtown Craig as Points of Origin (POA). Please note of the three options developed for consideration, NEO and its consultants have no way to confirm if private tower owners are willing to negotiate tower leases and/or ground space leases for new equipment; nor can NEO assure existing towers are structurally capable to support new equipment. These variables will need to be researched at such time as the County determines to pursue a specific network deployment plan in more detail. All three middle mile options are theoretically possible based on information identified at this time.

The maps illustrating the middle mile line of sights use Figure 1 as the base map. A gold star icon represents locations where constructing a new tower at a location anchor institution could benefit the proposed network. The exact location of the anchor institutions is unknown and therefore the icon is randomly placed for illustration purposes only. Ideal line of sight scenarios are shown in gold; second line of sight considerations are shown with a blue line; third line of sight options are identified with purple lines and possible fourth line of sight options are dark orange lines.

Option A

NEO proposes three (3) options for consideration. The point of origin for Option A is at the tower located at Site 22 also known as Rangely North Tower. Fiber is present at this tower and it connects to a ten (10) Gbps pipe to the Internet. If one (1) Gbps can be dedicated solely to Moffat County with a burst capability of ten (10) Gbps, then this infrastructure can be a starting point of broadband for the County.

Option A utilizes seven (7) sites for the overall broadband plan. Of those seven (7) sites, five (5) will be used to distribute broadband to the community and two (2) are relay sites only. The five (5) broadband distribution sites will deliver consumer broadband starting at 20 Mbps for a reasonable price and up to 100 Mbps with added costs.

Under option A:

- Western Middle Mile would serve Dinosaur. As shown in Figure 4, the middle mile circuit would originate at Site 22 (Rangely North Tower), which is the point of origin, and transmit the middle mile circuit to an existing tower (Site 21) in Dinosaur that is on private property that could possibly be used for new middle mile transmission equipment. Otherwise a new tower will need to be constructed at an anchor institution in Dinosaur for the middle mile circuit and distribution equipment. The tower in Dinosaur would complete the Western Middle Mile circuit and distribute broadband to the community by Wireless Local Area Network (WLAN).

- Northern Middle Mile would serve Maybell, the City of Craig and a population cluster in the northeast corner of the County. As shown in Figure 5, the middle mile circuit would originate at Site 22 and transmit to one of the two existing private towers at Site 2 (A or B). Equipment on 2A or 2B would be a relay point only with no broadband distribution equipment. However, in the future should broadband distribution be needed that equipment could easily be added to this location. From Site 2 (A or B) the middle mile relay will transmit the broadband circuit to a new tower at an anchor institution in Maybell. This tower will serve two functions. One, as a distribution point of broadband by WLAN for the community of Maybell and the surrounding residents; and two, as a relay to the County-owned tower at Site 4F. The middle mile circuit will serve as a distribution point of WLAN to the City of Craig and surrounding population a middle mile circuit to Site 17, which is the County-owned public safety tower in the northeast corner of the County. Site 17 is the termination of the Northern Middle Mile circuit and will be a distribution point of broadband WLAN to the residents and businesses in that area of the County.

- Southern Middle Mile will serve the area of Hamilton as shown in Figure 6. The point of origin is Site 22 and the network follows the same circuit described for the Northern Middle Mile to Site 4F. From Site 4F the middle mile circuit will transmit south to either a new tower at an anchor institution in Hamilton or to Site 20, (the County-owned public safety tower) for broadband WLAN distribution for this geographic area. The new anchor institution tower or Site 20 will be the terminus for the Southern Middle Mile circuit.

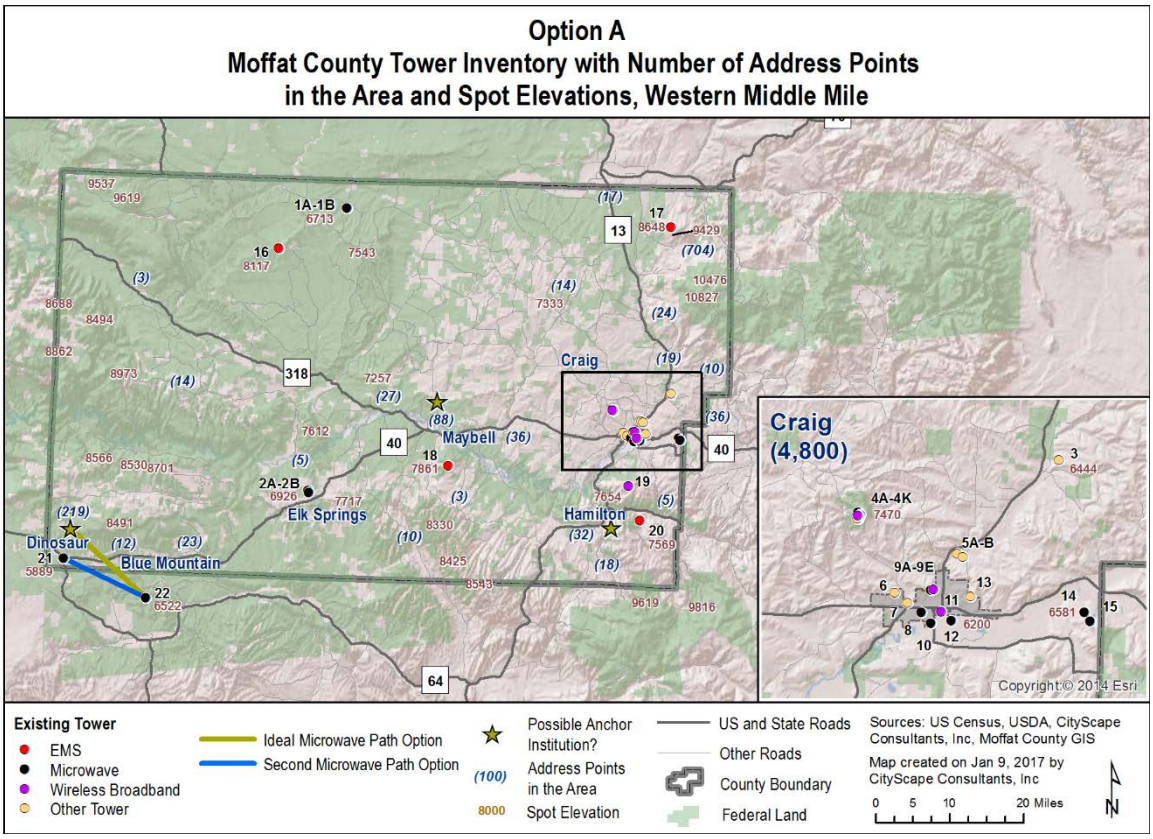


Figure 4: Option A Western Middle Mile

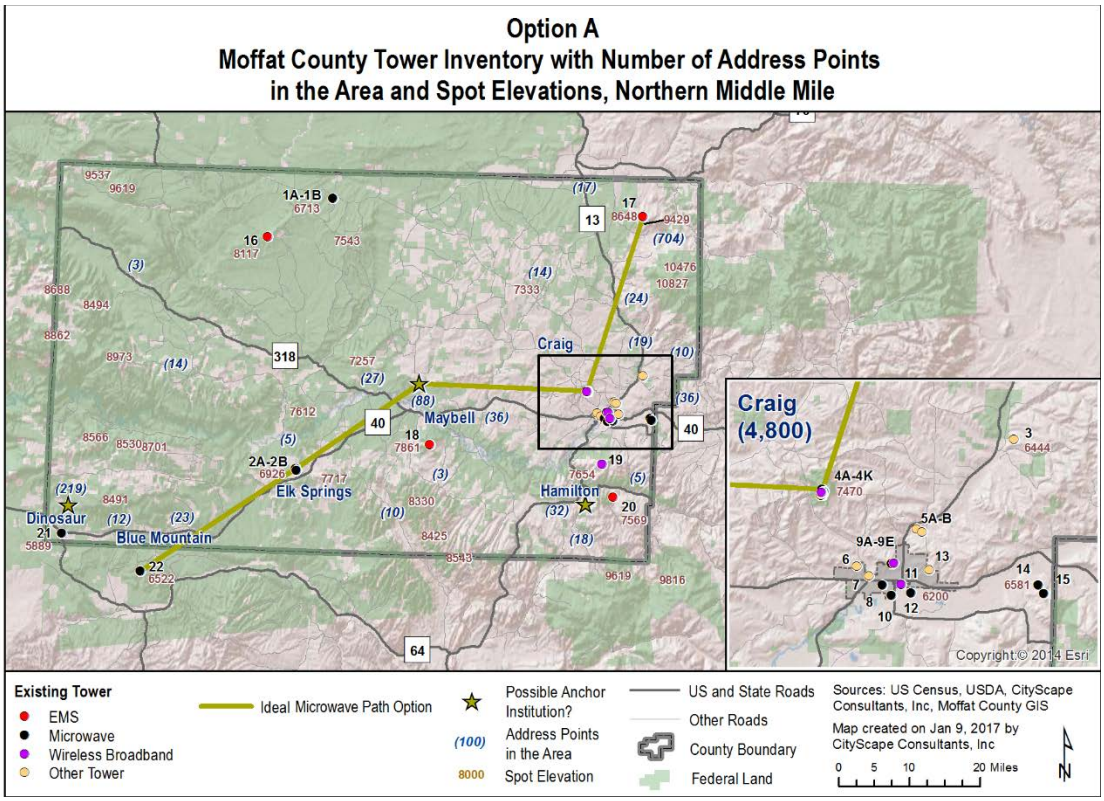


Figure 5: Option A Northern Middle Mile

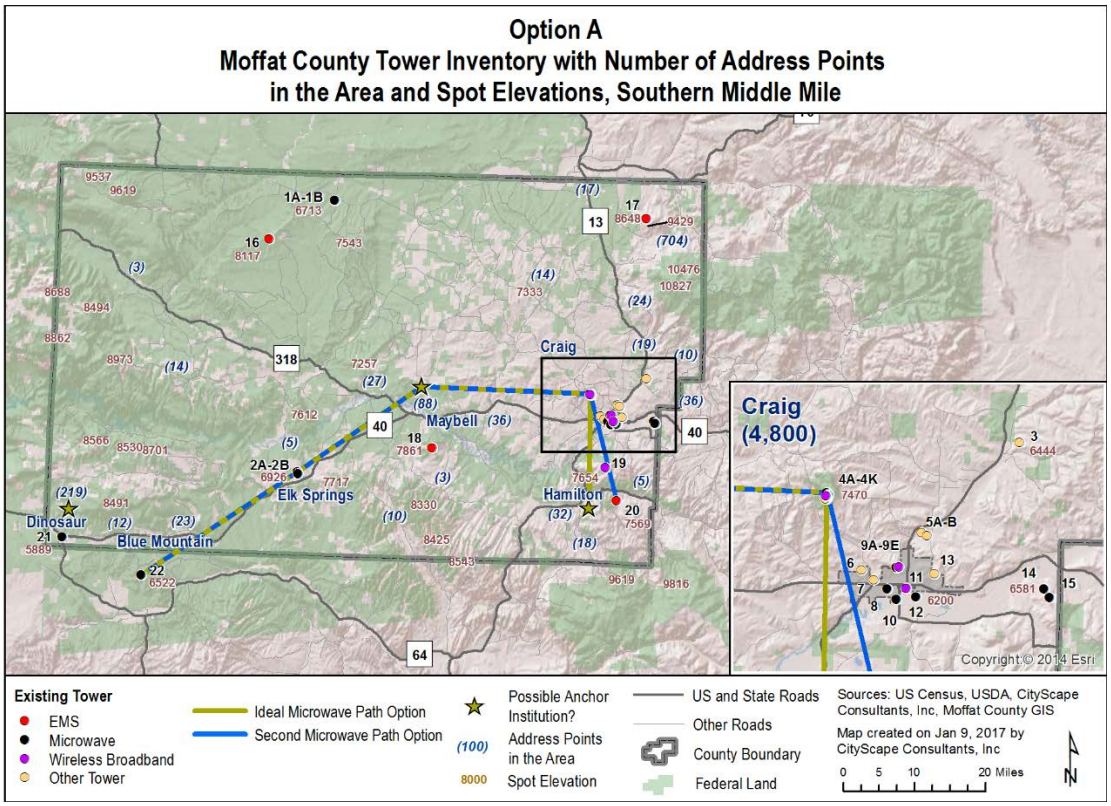


Figure 6: Option A Southern Middle Mile

Option B

The point of origin for Option B starts in downtown Craig at either a NOC, local exchange service provider or point of presence and is sent by microwave (or if possible fiber) to Site 4F. Site 4F becomes a hub for providing the Northern; Southern and Western middle mile circuits. Option B also utilizes seven (7) sites for the overall broadband plan. Of those seven (7) sites, five (5) will be used to distribute broadband to the community and two (2) are relay sites only. The five (5) broadband distribution sites will deliver consumer broadband starting at 20 Mbps for a reasonable price and up to 100 Mbps with added costs.

Under option B:

- Western Middle Mile would serve the areas of Maybell and Dinosaur. As shown in Figure 7, four options are possible; however, the ideal path is shown in gold. The middle mile circuit would originate at Site 4F and transmit middle mile broadband to a new tower at an anchor institution in or near Maybell. This tower will serve two functions. One, as a distribution point of broadband by WLAN to the residents in the area and as a relay to one of the two private towers at Site 2 (A or B). Equipment on 2A or 2B would be a relay point only with no broadband distribution equipment. However, in the future should broadband distribution be needed that equipment could easily be

added to this location. From Site 2 (A or B) the middle mile relay will transmit the broadband circuit to Site 21 or the new anchor institution site in Dinosaur. This would complete the Western Middle Mile circuit and distribute broadband to the community by Wireless Local Area Network (WLAN). The other scenarios provided are less costly because fewer repeater sites are used in the broadband network. However, transmitting the circuit longer distances in poor weather conditions will cause a decreased throughput and result is slower bandwidth speeds.

- Northern Middle Mile originates at Site 4F as shown in Figure 8. Site 4F is a middle mile circuit to Site 17, which is the County-owned public safety tower in the northeast corner of the County. Site 17 is the termination of the Northern Middle Mile circuit and will be a distribution point of broadband WLAN to the residents and businesses in that area of the County.

- Southern Middle Mile, as shown in Figure 9, will serve the geographic area of Hamilton. From Site 4F the middle mile circuit will transmit south to either a new tower at an anchor institution in Hamilton or to Site 20, (the County-owned public safety tower) for broadband WLAN distribution for this geographic area. The new anchor institution tower or Site 20 will be the terminus for the Southern Middle Mile circuit.

- The City of Craig and the surrounding geographic area will have broadband WLAN distribution from the hub at Site 4F.

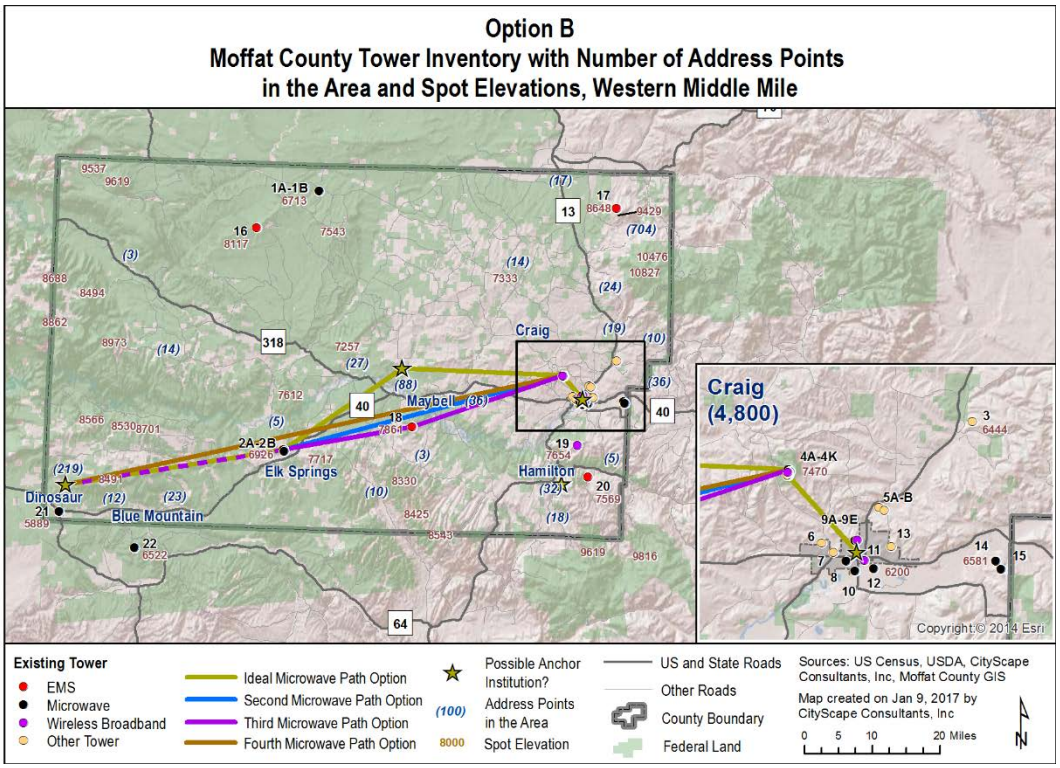


Figure 7: Option B Western Middle Mile

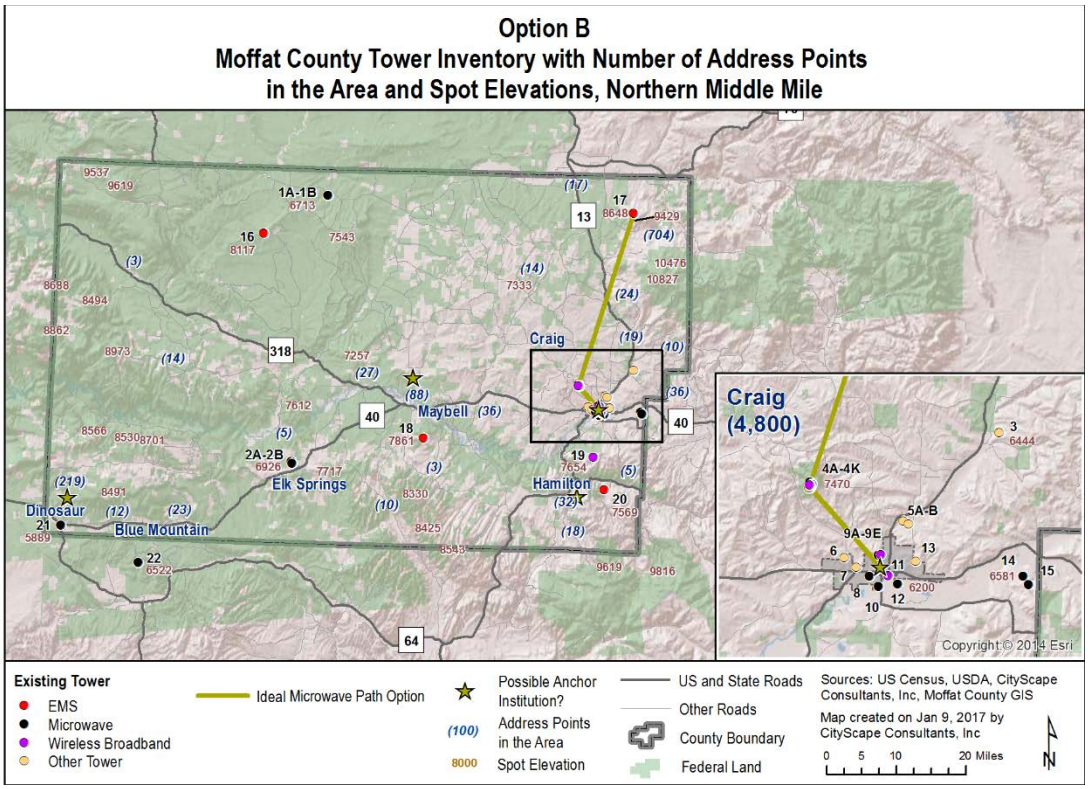


Figure 8: Option B Northern Middle Mile

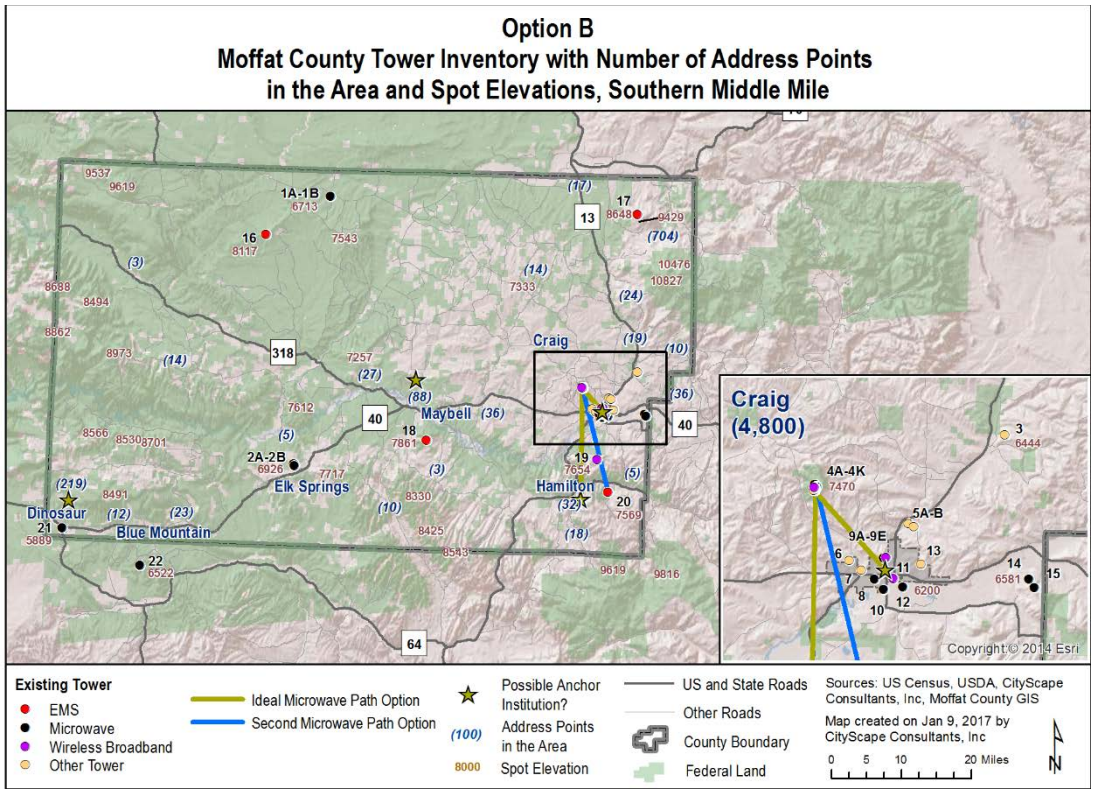


Figure 9: Option B Southern Middle Mile

Option C

Option C is the ideal middle mile plan because it includes two points of origin, Site 22 and the location in downtown Craig, which creates a more robust and reliable network. The overall system includes eight (8) sites of which five (5) will be used to distribute broadband to the community and three (3) relay sites only facilities. See Figure 10.

Option C Includes:

- Point of Origin from Site 22 will transmit middle mile circuit to an existing tower (Site 21) in Dinosaur that is on private property or to a new tower at an anchor institution in Dinosaur for the middle mile circuit and distribution equipment. The tower in Dinosaur would complete the Western Middle Mile circuit and distribute broadband to the community by Wireless Local Area Network (WLAN).

- Point of Origin from Site 22 will also transmit middle mile to one of the two existing private towers at Site 2 (A or B). Equipment on 2A or 2B would be a relay point only with no broadband distribution equipment. However, in the future should broadband distribution be needed that equipment could easily be added to this location. From Site

2 (A or B) the middle mile relay will transmit the broadband circuit to a new tower at an anchor institution in Maybell. This tower will serve two functions. One, as a distribution point of broadband by WLAN for the community of Maybell and the surrounding residents; and two, as a relay to the County-owned tower at Site 4F.

- Point of Origin from Craig to Site 4F would create a middle mile circuit to Site 17, which is the County-owned public safety tower in the northeast corner of the County. Site 17 is the termination of that middle mile circuit and will be a distribution point of broadband WLAN to the residents and businesses in that area of the County.
- Point of origin from Craig to Site 4F would also be the middle mile circuit to transmit south to either a new tower at an anchor institution in Hamilton or to Site 20, (the County-owned public safety tower) for broadband WLAN distribution for this geographic area. The new anchor institution tower or Site 20 will be the terminus for that middle mile circuit.
- Point of origin from Craig. Site 4F, would also provide broadband WLAN distribution the City of Craig and the surrounding geographic area.

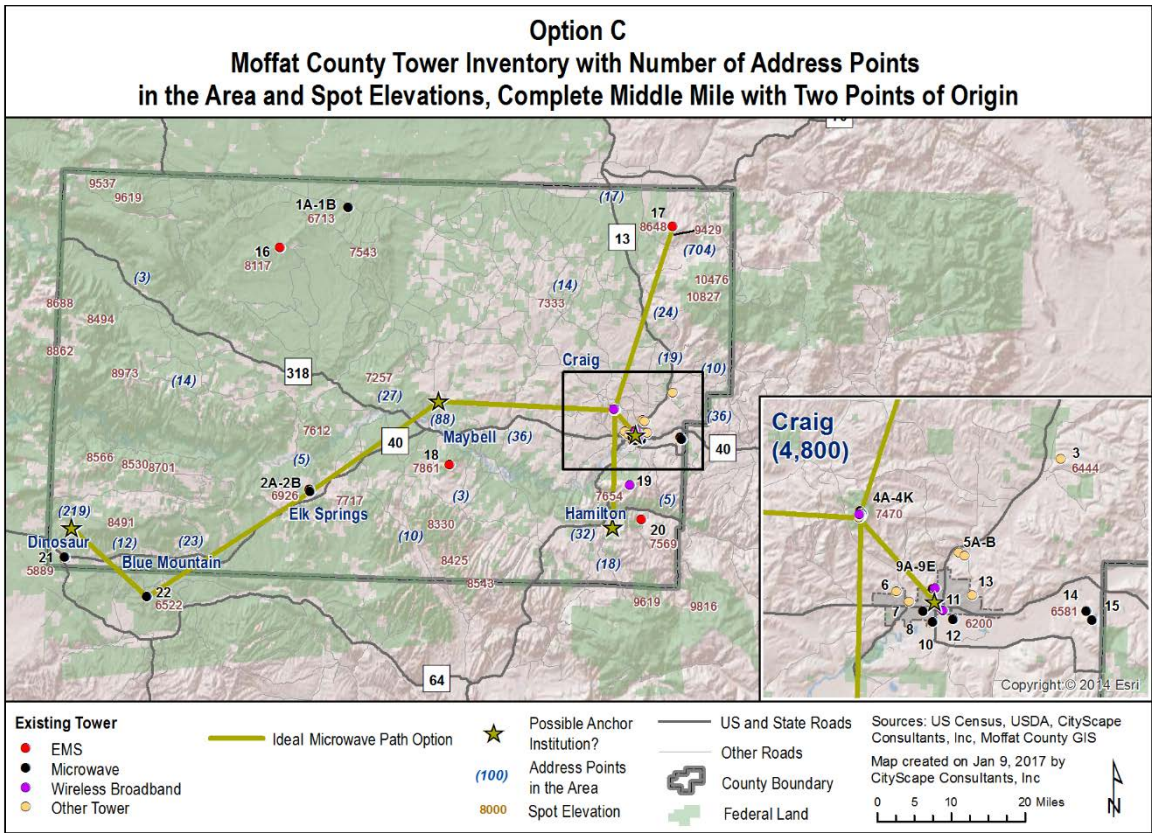


Figure 10: Option C Moffat County Middle Mile Option

Network Equipment Cost Estimates

Each circuit includes two sets of equipment including a microwave dish, a microwave transmitter receiver and miscellaneous appurtenance. Options A and B both use seven (7) sites but have six (6) circuits. Both options would include a total of twelve (12) microwave sets. The material cost is approximately $41,250.50. This figure includes fifteen (15) wireless access points at five (5) broadband distribution sites, each covering a 120-degree arc. The labor to install and configure would be approximately $32,860. The material is priced at manufacturer's suggested retail price (see attached). In Option C, links could be removed for a cost savings of approximately $3,250.00 to $6,500 but that would either eliminate the broadband distribution to some areas and/or decrease throughput due to the longer links between circuits.

Options A and B, Estimated Costs

	Estimated Costs
Total Job Hours:	364.5
Hourly Rate:	$ 78.25
Total Labor	**$ 32,860.50**
Material Price	**$ 47,870.00**
Tax	
Estimated S/H	
Total Material	**$ 47,870.00**
Total Project Cost	**$ 80,730.50**
2 Microwave dish's per install for middle mile	
Also needed: 3 Local radios per install assuming broadcast in a full radius at 120 degrees per radio	
Not Included: Bandwidth mangement, Firewall and Software license	

Option C uses eight (8) sites throughout the County. This option requires a total of thirteen (13) microwave sets. The material cost is approximately $50,370. This figure includes fifteen (15) wireless access points at five (5) broadband distribution sites, each covering a 120-degree arc. The labor to install and configure would be approximately $32,860.

Option C, Estimated Costs

	Estimated Costs
Total Job Hours	364.5
Hourly Rate	$ 78.25
Total Labor	**$ 32,860.50**
Material Price	**$ 50,370.00**
Tax	
Estimated S/H	
Total Material	**$ 50,370.00**
Total Project Cost	**$ 83,230.50**
2 Microwave dish's per install for middle mile	
3 Local radios are needed per install assuming broadcast in a full radius	

Equipment considered for the Middle Mile Wireless Network

- Cambium: Model PTP 820C. This model has a capacity of 1.66 Gbps. Specifications are provided as a part of this deliverable.

- Mimosa: Model B5. This model has a capacity of 1.0 Gbps; see the attached specification sheet. Mimosa operates in the unlicensed frequencies. See below comment from Mimosa regarding this model:

Higher order MIMO and advanced spectrum technology is at the heart of every product Mimosa offers, and our first radio is an excellent example of that focus. The B5 Backhaul is a 4x4:4 MIMO backhaul operates from 5150-5850 MHz and is capable of 1 Gbps throughput and the reliability of fiber. Mimosa highly engineers our products to, in essence, multiply spectrum, leveraging coordinated Massive MIMO technology to allow collocated radios to deliver an astonishing 16 MIMO streams, 4 Gbps throughput, all while sharing the same channel.

- The Ubiquity models have a diversity antenna and a very attractive price point; however, we recommend the Cambium and Mimosa models.

Consumer Premise Equipment

Consumer Premise Equipment (CPE) is a receiver dish, cable and grounding materials that will bring the WLAN broadband signal from the circuit into the consumers' residents, school building or office. Use of this type of CPE is strongly recommended over Wi-Fi receiver type antenna because the throughput will be much higher and allow the goal to provided broadband at a rate of 20 - 100 Mbps to be achieved. The cost for this equipment and installation will be approximately $300 per install.

Other Deliverables

A complete Wireless Facility Inventory Data Table and Catalogue of all of the Wireless Towers has been provided as a deliverable of this project.

Procedure

NEO and its consultants conducted an assessment of the existing antenna locations throughout Moffat County by driving to all accessible locations. Data for the assessments was obtained from a number of sources, including actual permits obtained from the County for wireless infrastructure, research of FCC registered site locations, direct information from existing wireless service providers and tower owners active in the County, County GIS, and through on-site visits to each accessible location.

Structural Evaluation

Based on a visual inspection of antenna arrays already on existing structures, NEO and its consultants made an evaluation as to whether each support structure is likely to physically accommodate more antennas. The number of estimated collocations is referenced as future antenna collocation possibilities. The suggested number of collocations is based on visual observations only. In this consideration, adding antennas equates to adding other wireless antenna platform(s) consisting of several antennas and associated coaxial cable. Prior to mounting new antennas and related equipment, the structure must be examined and analyzed by a structural engineer for its ability to support the proposed addition(s).

Site Photographs and Maps

Photographs of the exiting antenna are provided for most of the sites. The individual site map imagery is credited to "U. S. Department of Agriculture, Farm Service Agency" and the year of the photos is 2015.

Categorization

The criteria used to choose the sites is specific to the definitions as defined by the October 2014 Federal Communications Commission Report and Order on Improving Wireless Siting Policies. The definition of “tower” includes any structure built for the sole or primary purpose of supporting any Commission-licensed or authorized antennas and their associated facilities. Types of towers include monopoles, lattice and guy towers used for personal wireless service facilities such as Verizon, AT&T, etc. microwave, emergency services and/or broadcast. The definition of “base station” is the equipment and non-tower supporting structure at a fixed location that enables Commission-licensed or authorized wireless communications between user equipment and a communications network. For example, an antenna attached onto a rooftop or water tank is a base station.

Sites in the inventory are further categorized as personal wireless service facility (PWSF) meaning the antenna on the tower or base station is used by a wireless service provider to provide wireless telephone to a paid subscriber base.

Section 6 –Middle Mile Strategies, Connecting Anchor Institutions.

Providing Redundancy and Options for Service Providers, Middle Mile Transport Between Communities and to Internet "Supply"

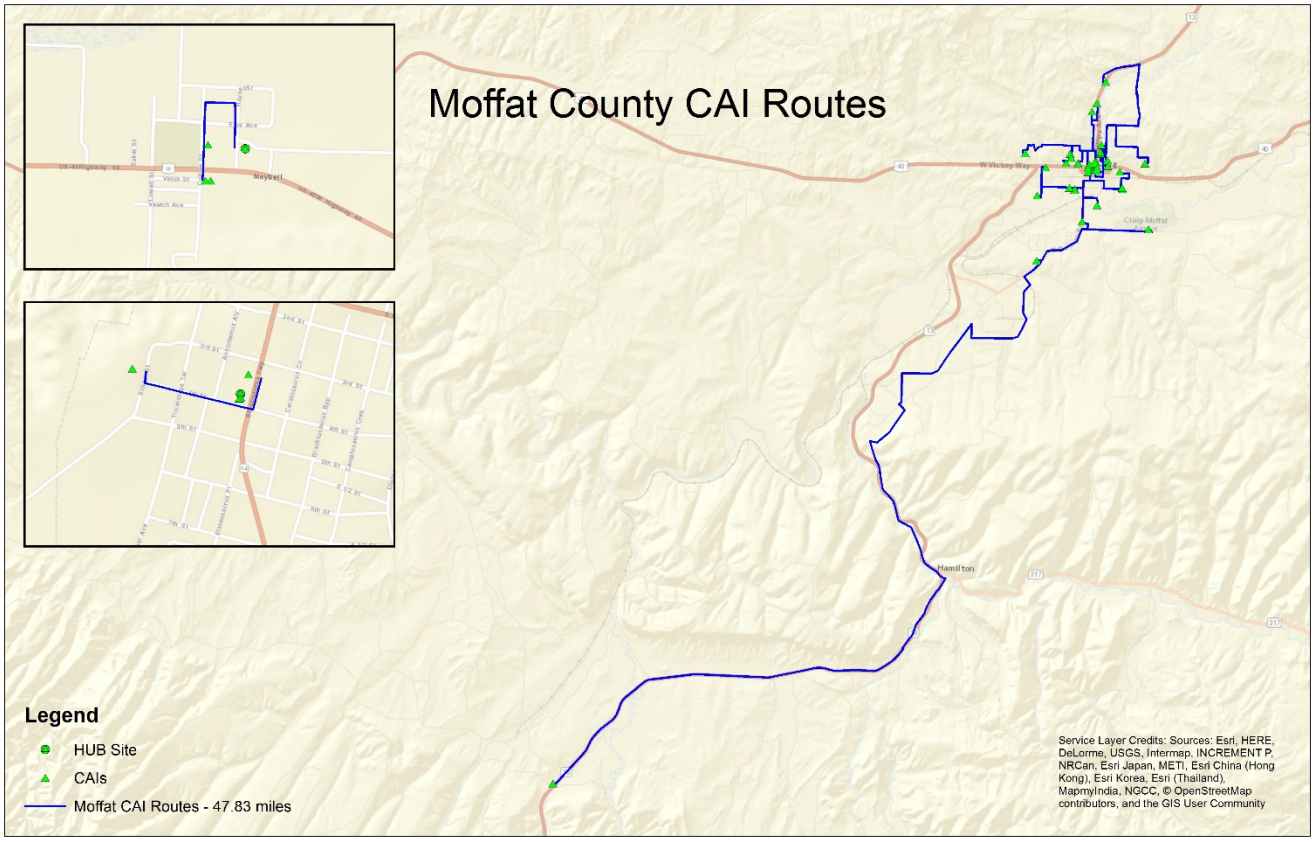
NEO put together a preliminary design and capital cost estimates for connecting the communities. Bringing fiber to the communities aggregates demand and reduces costs for broadband services, as the costs for the services are shared amongst all of the users. Also, once fiber is brought to a community, it is relatively inexpensive to expand this fiber within the community to other key locations and anchor institutions.

Connecting Anchor Institutions

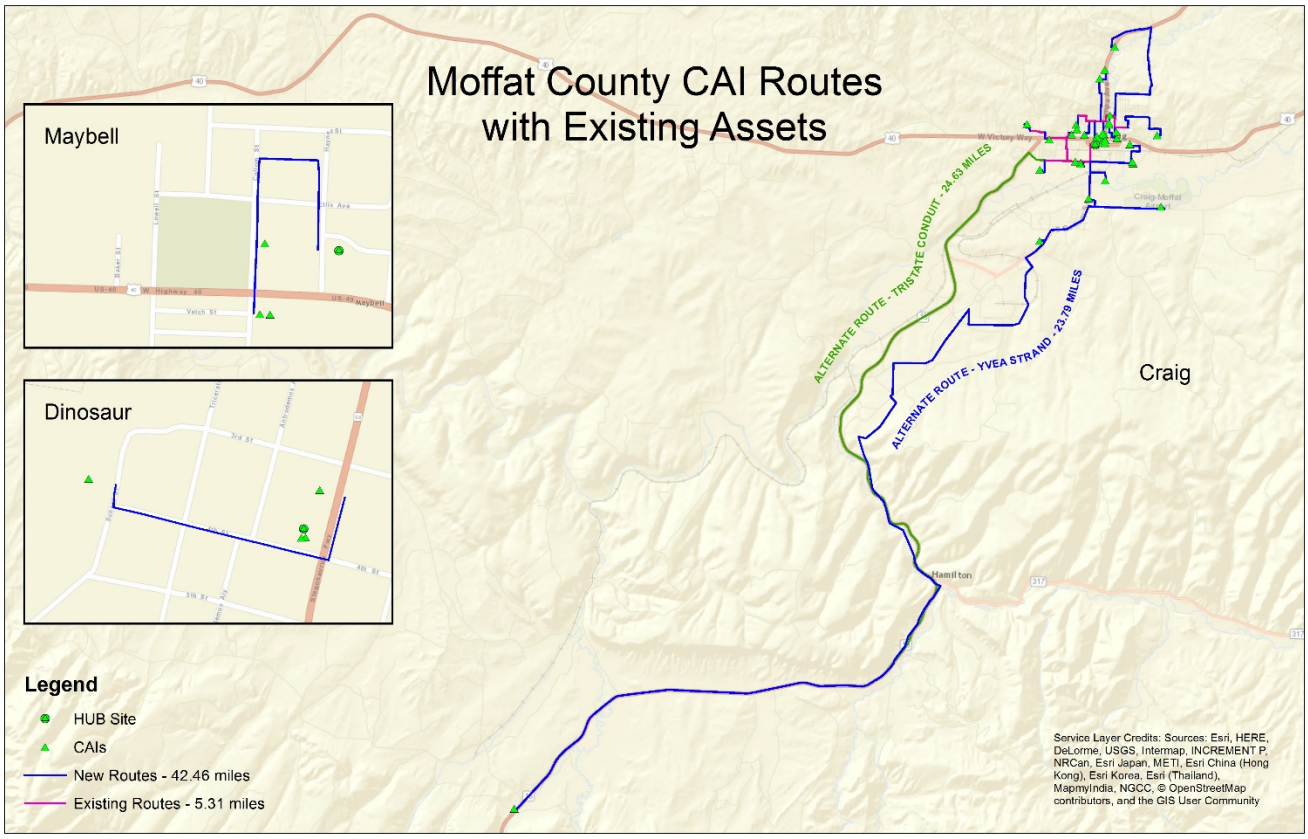
NEO updated the Community Anchor Institution list provided by the Colorado State OIT Department and verified this information with many of the key stakeholders on the Committee. This list includes schools, municipal and county locations, medical facilities and clinics, and libraries. We also included the substations for YVEA.

Capital costs were identified to build fiber between these communities to a Carrier Neutral Location (CNL) in each community. Separate estimates were put together connecting YVEA's substations. And finally, NEO estimated capital costs to build out to the anchor instutions identified throughout this process.

Below is an overview of the fiber design.


Moffat County CAI Routes
Legend
HUB Site
CAIs
Moffat CAI Routes - 47.83 miles
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

There are existing assets between Craig, Hamilton and Maybell. This route could potentially provide redundancy in and out of the communities within Moffat County, and it also provides connectivity for YVEA's substations.



Estimated capital costs are described in detail below.

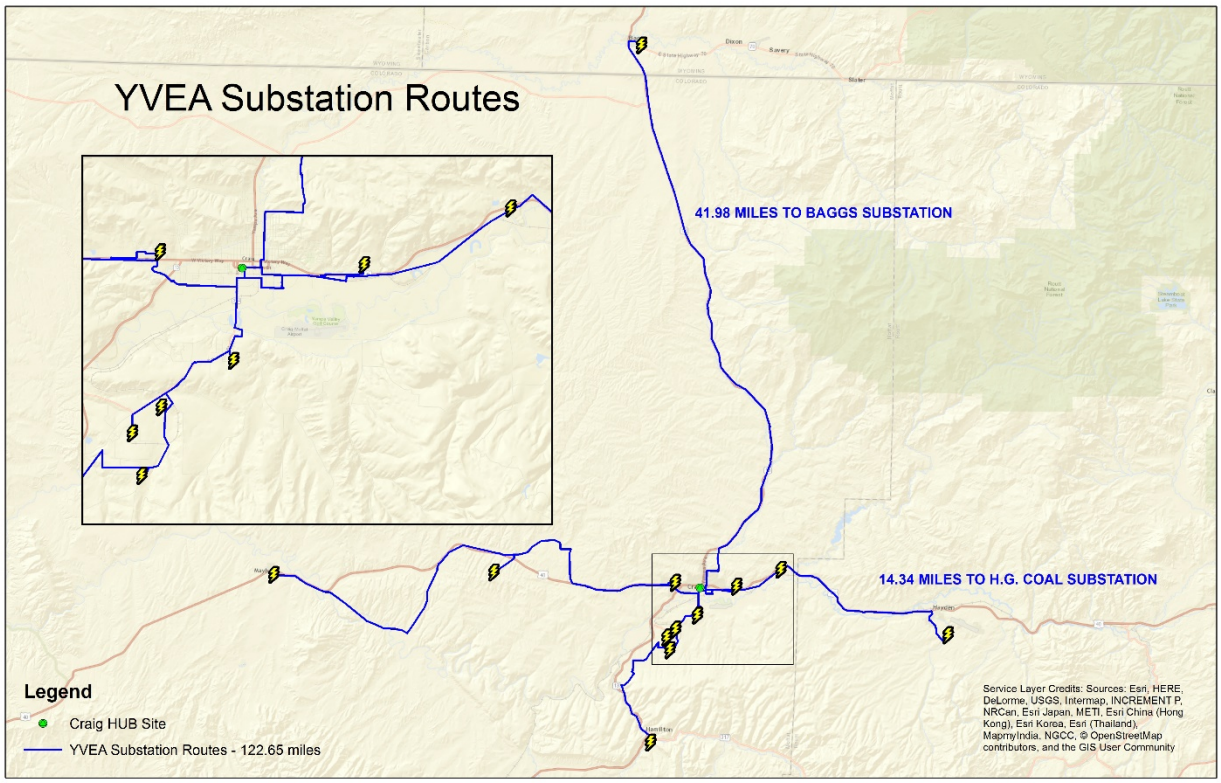
Capital Costs Identified

The capital costs to build fiber between the communities are shown below.

			With Use of Strata Networks		
MOFFAT COUNTY MIDDLE MILE (CONNECTIONS BETWEEN COMMUNITIES)	**Fiber Build**		**Fiber Build**	**IRU**	**Total**
Engineering and Construction Management	$ 1,363,318		$ 510,921		
Labor	$ 4,746,086	or	$ 1,788,645		
Materials	$ 1,485,072		$ 587,147		
TOTAL	$ 7,594,476		$ 2,886,712	$ 1,141,200	$ 4,027,912

Strata Networks has existing fiber along this route. The chart above shows the estimated costs to build fiber between these communities to be $7.594 Million. If an Indefeasible Right of Use (IRU) is negotiated with Strata Networks, the estimated costs to build fiber and use Strata's exisitng fiber is $4.927 Million.

YVEA may be a potential partner for the connections between the communities, levering a potential build to YVEA's substations.



Below are the projected capital costs for connecting YVEA's substations.

YVEA SUBSTATION NETWORK	Fiber Build		Without 2 Stations
Engineering and Construction Management	$ 1,670,606		$ 903,476
Labor	$ 5,857,922	or	$ 3,196,269
Materials	$ 1,948,154		$ 1,139,995
TOTAL	$ 9,476,681		$ 5,239,740

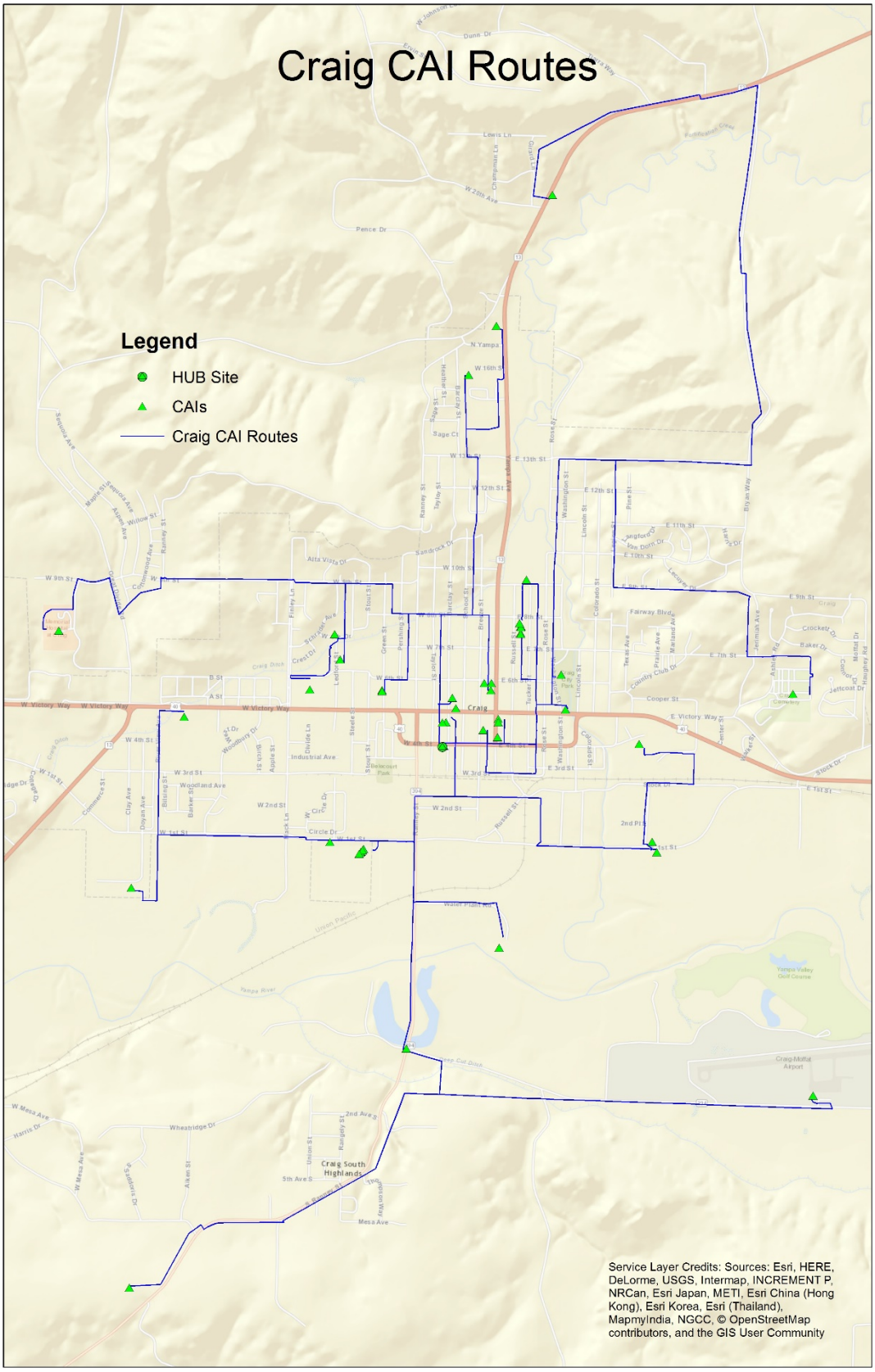
The estimated capital costs for connecting the substations within Moffat County are $9.476 Million. There are two outlier substation locations; the Baggs Substation and the HG Coal

Substation. If these two substations are not included in the build, the estimated capital costs are $5.329 Million.

NEO's team mapped the list of community anchor institutions and conducted a preliminary design to build fiber to each of the anchor institutions. Below are the maps of the preliminary design and the estimated capital costs for building fiber to each of the community anchor institutions.

Craig

NEO's team identified several entities that have existing fiber within the City of Craig. Strata, TriState, Unite Private Networks and Yampa Valley Medical Center/Northern Colorado Broadband have fiber already installed. Maps of these networks have been provided as a deliverable of this project.


Craig CAI Routes
Legend
HUB Site
CAIs
Craig CAI Routes
Craig
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

			With Use of Existing Networks		
CRAIG CAI NETWORK	**Fiber Build**		**Fiber Build**	**IRU**	**Total**
Engineering and Construction Management	$ 647,534		$ 574,472		
Labor	$ 2,968,384	or	$ 2,671,508		
Materials	$ 697,698		$ 631,069		
TOTAL	$ 4,313,616		$ 3,877,049	$ 79,800	$ 3,956,849

The projected capital costs for building fiber to the anchor institutions without the use of other existing fiber is projected at $4.313 Million. If the existing fiber can be used and the existing fiber is acquired through an IRU, the estimated capital costs wuld be reduced to $3.956 Million.

There is a long run to connect the northern part of the community; if this route is eliminated, the following capital costs would apply:

			With Use of Existing Networks, without Long CAI Run		
CRAIG CAI NETWORK	**Without Long CAI Run**		**Fiber Build**	**IRU**	**Total**
Engineering and Construction Management	$ 320,814		$ 247,752		
Labor	$ 1,641,280	or	$ 1,344,404		
Materials	$ 400,257		$ 333,628		
TOTAL	$ 2,362,352		$ 1,925,784	$ 79,800	$ 2,005,584

Maybell and Dinosaur

Below are the projected capital costs for connecting the anchor institutions within Maybell and Dinosaur.

MAYBELL CAI NETWORK	**Fiber Build**
Engineering and Construction Management	$ 4,120
Labor	$ 36,354
Materials	$ 23,842
TOTAL	$ 64,316

DINOSAUR CAI NETWORK	Fiber Build
TOTAL ENGINEERING & CONSTRUCTION MANAGEMENT	$ 4,257
TOTAL LABOR	$ 44,351
TOTAL MATERIALS	$ 25,921
TOTAL	$ 74,529

Why Connect Anchor Institutions?

Local governments and state agencies have been connecting their community anchor institutions with fiber optic networks for over twenty years. Community anchor institutions are state, county and local government offices and buildings, schools and libraries, hospitals, medical facilities and first responders. In fact, in the U.S., thousands of schools, libraries, community centers, and public health and safety providers obtain their broadband connectivity from local government and state non-profit networks, including state research and education networks.

Connecting these anchor institutions with fiber allows each location to receive very high-speed Internet and data connectivity while eliminating or drastically reducing the monthly lease or access costs paid to the private sector service providers. Anchor institutions often cannot afford to purchase high-capacity circuits from the private sector service providers and therefore, simply cap their bandwidth purchased. Capping their bandwidth requires the anchor institutions to choose which applications to deploy and limits their ability to use applications that require high bandwidth. Building a municipally-owned, or locally-owned fiber network to anchor institutions allows these critical key facilities to have the bandwidth they need to support all of their applications and once these networks are in place, additional bandwidth needs can easily be met without additional capital cost for construction.

Moffat County or the Committee could consider connecting their community anchor institutions with fiber to ensure that they have the highest-quality broadband connectivity. This could be done in collaboration with the other agencies to share in the cost of construction. Then, once these networks are built, the Committee could also consider leasing excess capacity of conduit or of fiber to the private sector for last mile build out and use. Once a network is built that serves schools, government offices, fire districts and the like, generally, this network reaches deep into neighborhoods and past business parks. These networks can then serve as an opportunity to allow the private sector to lease excess capacity and in turn serve homes and businesses with high-speed fiber. This trend is fast accelerating as hundreds of municipalities make available spare fiber optic capacity to private sector companies at rates designed to incentivize new private sector investment and opportunity.

Anchor Institutions may include Smart City Applications

An additional benefit of building a community anchor institution network for municipalities is it will be equipped to support "smart city" applications when the time comes for city service innovation. Smart city applications may include connecting traffic lights, traffic management, and smart journey planning. Smart journey planning systems use open city data in order to recommend how individuals can best navigate from one place to the next. The systems are becoming sophisticated enough to take into consideration personal preferences such as cost, safety concerns and CO2 footprint, as well as real-time traffic congestion and traffic patterns.

Other smart city applications may include connecting smart parking meters, automated meter reading and utilities management. Street lights are often connected with fiber and applications are emerging that allow active safety; increasing light levels in city centers when the light system detects individuals or motion, at bus stops or along walkways.

Another top smart city application is environmental monitoring, where a city that uses monitoring stations for pollution or weather conditions can now connect and use these systems for real time data collection and can pinpoint potential sources of pollution or weather issues and quickly react and efficiently deal with potential problems.

Other smart city applications are emerging around transport sharing, whether it is sharing bikes or cars or rideshare. Smart cars and electric cars will be a key enabler for wider adoption of city center car sharing, providing information to individuals about location and availability of shared cars and up-to-date information of pick up times for rideshare applications.

A robust fiber network connecting all of the anchor institutions within the community aggregates demand for all entities for Internet connectivity, but it also creates very high-speed connectivity for data services. This network can also be used as a platform for emerging smart city applications. Having very high speed data connectivity between the anchor institutions can support connections for the schools to a public safety network. It could support an outsourced service such as help desk, shared IT, shared software, or GIS functions by allowing the smaller communities to lean on the larger communities for this staffing. Smaller communities within the region can rely on the staffing, resources and expertise of some of the larger communities. For example, smaller towns might receive significant benefit from having access to best-in-class administrative and public safety applications. Services that would otherwise be out of reach economically, but that significantly increase efficiency and productivity, while reducing cost. Having very high-speed access between the various government agencies and communities would facilitate shared services.

As shared services and data connectivity between all anchor institutions is a concept that could be further explored within Moffat County, NEO recommends that a working group be

established to spearhead and implement cooperation amongst all member communities. This could continue to be supported by the Committee or a separate working group could be formed. This could include collaboration and cooperation for shared services, shared data centers, and/or buying and negotiating power for potential public private partnerships. This working group could be tasked with identifying common software applications amongst the communities and surrounding counties, shared applications and opportunities for cost reduction and greater efficiencies. Rio Blanco County is already providing a centralized data center for many of the anchor institutions within their county.

Paying for Capital Costs: Funding Opportunities

USAC has two sister programs – the E-rate and Rural Healthcare Grant Programs. These two programs can be leveraged to pay for many of the capital costs associated with building to schools and libraries (E-rate) and to medical facilities and hospitals (the Rural Healthcare Grant program). NEO worked with Colorado Telehealth Network (CTN) to identify anchor institutions (medical facilities and hospitals) that would be eligible for the Rural Healthcare grant program.

The Rural Healthcare Grant fund is available for the following eligible entities:

> (1) post-secondary educational institutions offering health care instruction, teaching hospitals, and medical schools;
>
> (2) community health centers or health centers providing health care to migrants;
>
> (3) local health departments or agencies;
>
> (4) community mental health centers;
>
> (5) not-for-profit hospitals;
>
> (6) rural health clinics; and
>
> (7) consortia of one or more of such entities.

The grant program would potentially fund 65% of the capital costs to connect these medical establishments, including the middle mile portions of the fiber build between the communities. Targeting this grant, and building to the medical establishments "first" would allow for much of the desired routes to be built.

In addition to this strategy, there are other grant and loan programs that are also available for broadband build-out. Certain financing and funding programs restrict who is eligible to apply

for and receive funding. A few of the state and federal grant and loan programs available for funding broadband construction are provided below.

The Colorado Department of Local Affairs (DOLA) in 2015 announced a $20 Million broadband implementation grant program for regional councils of governments and municipalities. In 2015, DOLA had three rounds of financing applications with deadlines for grant submission being April 1st, August 1st and December 1st. DOLA has not yet announced funding availability for 2016 or 2017 specifically for broadband implementation; however, applicants are encouraged to apply for funding through the Energy and Mineral Impact Fund.

The Rural Broadband Experiments and Connect America programs are available to unserved areas; the definition for eligibility is 3 Mbps combined upload and download. As the FCC in 2015 raised the definition of served to 25 Mbps download and 3 Mbps in upload speeds, there may be funds available through the Connect America to a wider group of communities. One caveat currently of the Connect America program is that it is available for Eligible Telecommunication Carriers.

The Telecommunications Infrastructure Loan Program available through the USDA "makes long-term direct and guaranteed loans to qualified organizations for the purpose of financing the improvement, expansion, construction, acquisition, and operation of telephone lines, facilities, or systems to furnish and improve Telecommunications service in rural areas. The definition for "rural area" is within the boundaries of any incorporated or unincorporated city, village, or borough having a population less than 5,000 inhabitants."

The Rural Broadband Loan Program, which is part of the Farm Bill, "is designed to provide loans for funding, on a technology neutral basis, for the costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural communities." Again, the definition of rural includes communities with a population less than 5,000 inhabitants.

There are grant programs that are available for Telemedicine and Distance Learning as well as program targeted specifically for Rural Health.

There are a number of other financing options some of which include; New Market tax credits, for which allocations would have to be secured; economic development retail sales tax funds, and bond financing through a number of different structures and types of bonds. Other sources of funding include internal loans, bonds, TIF, and revenue funds, economic development financing programs, and crowd sourcing.

A report written by NTIA referencing all federal programs available for broadband financing has been provided to the Committee as a deliverable of this project.

Tabor Laws

Financing of a broadband network, just like the financing of any other public project, is governed by state law, and primarily by the Constitutional Amendment known as the Taxpayer's Bill of Rights (TABOR). Colorado Constitution, Article X, Section 20. With respect to incurring debt, Section 20 (4)(b) of TABOR requires an election prior to "creation of any multiple-fiscal year direct or indirect district debt or other financial obligation whatsoever without adequate present cash reserves pledged irrevocably and held for payments in all future fiscal years." To the extent that the financing of a broadband network, or any components of a network would require the issuance of debt, the various municipalities and counties would be required by TABOR to seek a vote of the registered electors. To the extent that the municipalities or counties own or control existing network facilities that it wishes to use in a network, or has the financial resources to pay for new facilities, it may do so without an election.

Statutory municipalities are granted their authority in Title 31 of the Colorado Revised Statutes. Among the powers of statutory municipalities are the power to enter into contracts and the power to acquire, hold, lease, and dispose of both real and personal property. C.R.S. 31-15-1(b) and (c). The municipality also has the power to contract indebtedness (subject to TABOR) by borrowing money or issuing the bonds of the municipality "for *any public purpose* of the municipality, including *but not limited to* the following purposes: Supplying water, gas, heating and cooling, and electricity; purchasing land; and purchasing, constructing, extending, and improving public streets, buildings, facilities, and equipment…" C.R.S. 31-15-302(1)(d)(I). While this section of the statute does not specify telecommunications, the authority granted to the municipality is specifically not limited to the examples stated, and the broadband facilities the municipality is considered would, according to Denver-based attorney, Ken Fellman, be deemed a public purpose, and therefore permitted. That being said, the total amount of the municipality indebtedness for all authorized purposes may not exceed three percent of the actual value, as determined by the assessor, of the taxable property in the municipality. C.R.S. 31-15-302(1)(d)(II).

Section 7 – Last Mile Strategies, Potential Public-Private Partnerships

The most ambitious strategy to consider is the opportunity to connect all homes and businesses with fiber. More challenging geographies are sometimes forced to utilize wireless technologies to deliver service with a hybrid fiber/wireless network. Cities and/or electric cooperatives are building or facilitating Fiber to the Premise networks or "Gigabit-enabled" networks, allowing for Internet speeds of 1,000 Mbps or 1 Gbps in both upload and download speeds for all homes and businesses within a city's boundary.

There are a number of models to finance, design, construct and operate a Fiber to the Premise network. One of the models in the industry is when the municipality or electric cooperative designs, builds, owns and operates a network and becomes the Internet Service Provider to homes and businesses. This model is often referred to as a Retail Model and is discussed in detail below. Another model is one in which the entity builds and owns the fiber network and Internet services are provided directly by the private sector. This has often been referred to as a Wholesale Model, and again, is discussed in detail below.

Capital Costs for Fiber to the Premise

Before we dive into the Retail and Wholesale Models, we will first discuss the capital costs for building a Fiber to the Premise network for each of the communities.

Capital Costs vary widely based upon the take rate percentage. Take rate percentage essentially means market share, or the percentage of homes and businesses that sign up for services. There are a number of strategies to mitigate take rate percentage. One strategy is to build into a neighborhood when a minimum number of homeowners and businesses have signed up for the service prior to construction of the network within that neighborhood. Google Fiber and Longmont have used this strategy with great success.

NEO calculated the capital costs for Fiber to the Premise for each of the incorporated communities within Moffat County (Craig, Dinosaur and Maybell). NEO used the assumption of a 40% take rate percentage.

Craig, Fiber to the Premise

Estimate Dashboard					
Major Assumptions	**Values**				**Centralized Split**
# Parcels/Passings	4234		Overall	Project Cost	$6,697,773
Total Plant Miles	84.38			Cost per HHP	$1,581.90
# Poles	2568			Cost per HHS	$3,954.75
Est. Aerial Miles	82.69			Cost per MI	$79,376.31
Est. UG Miles	1.69				
Aerial %	98%		Engr. Labor	Project Cost	$517,311
UG %	2%				
Density HH/Mile	50.18		Aerial Labor	Project Cost	$2,238,869
Take Rate	40%				
Make Ready Cost per mile (all in labor only)	$ 14,243.58		UG Labor	Project Cost	$198,708
ADSS or Strand/Lash	Strand/Lash				
Missile Bore/Open Trench %	40%		Tech Services Labor	Project Cost	$400,685
Directional Bore %	60%				
Plow %	0%		Customer Premise Labor and Install Materials including	Project Cost	$1,777,573
LD Downtown %	0.0%				
HD Downtown %	0.0%				
Rock Adder %	15%				
Cut/Restore %	2%		OSP Materials	Project Cost	$1,423,414
Make Ready Construction	yes				
OLT Equipment	yes		Electronics	Project Cost	$141,212
ONT Equipment	yes				

Dinosaur, Fiber to the Premise

Estimate Dashboard					
Major Assumptions	**Values**				**Centralized Split**
# Parcels/Passings	250		Overall	Project Cost	$477,107
Total Plant Miles	6.21			Cost per HHP	$1,908.43
# Poles	189			Cost per HHS	$4,771.07
Est. Aerial Miles	6.09			Cost per MI	$76,828.81
Est. UG Miles	0.12				
Aerial %	98%		Engr. Labor	Project Cost	$33,787
UG %	2%				
Density HH/Mile	40.26		Aerial Labor	Project Cost	$164,812
Take Rate	40%				
Make Ready Cost per mile (all in labor only)	$ 14,243.58		UG Labor	Project Cost	$18,240
ADSS or Strand/Lash	Strand/Lash				
Missile Bore/Open Trench %	0%		Tech Services Labor	Project Cost	$23,650
Directional Bore %	100%				
Plow %	0%		Customer Premise Labor and Install Materials including	Project Cost	$104,739
LD Downtown %	0.0%				
HD Downtown %	0.0%				
Rock Adder %	20%				
Cut/Restore %	2%		OSP Materials	Project Cost	$97,242
Make Ready Construction	yes				
OLT Equipment	yes		Electronics	Project Cost	$34,636
ONT Equipment	yes				

As discussed previously, Dinosaur is planning to apply for funding through the RUS program to install a natural gas network to every home and business within the community. While the gas lines are being constructed, there is an opportunity to install conduit within the open trench. This reduces the costs dramatically for fiber construction. If this approach is implemented, the following capital costs would apply for the Town of Dinosaur.

Dinosaur, with the Natural Gas Project, Fiber to the Premise

Estimate Dashboard					
Major Assumptions	**Values**				**Centralized Split**
# Parcels/Passings	250		Overall	Project Cost	$762,568
Total Plant Miles	6.21			Cost per HHP	$3,050.27
# Poles	0			Cost per HHS	$7,625.68
Est. Aerial Miles	0.00			Cost per MI	$122,796.78
Est. UG Miles	6.21				
Aerial %	0%		Engr. Labor	Project Cost	$31,192
UG %	100%				
Density HH/Mile	40.26		Aerial Labor	Project Cost	$0
Take Rate	40%				
Make Ready Cost per mile (all in labor only)	$ -		UG Labor	Project Cost	$405,553
ADSS or Strand/Lash	Strand/Lash				
Missile Bore/Open Trench %	0%		Tech Services Labor	Project Cost	$23,650
Directional Bore %	100%				
Plow %	0%		Customer Premise Labor and Install Materials including	Project Cost	$113,127
LD Downtown %	0.0%				
HD Downtown %	0.0%				
Rock Adder %	20%				
Cut/Restore %	2%		OSP Materials	Project Cost	$154,409
Make Ready Construction	yes				
OLT Equipment	yes		Electronics	Project Cost	$34,636
ONT Equipment	yes				

Maybell, Fiber to the Premise

Estimate Dashboard					
Major Assumptions	**Values**				**Centralized Split**
# Parcels/Passings	75		Overall	Project Cost	$174,353
Total Plant Miles	1.83			Cost per HHP	$2,324.71
# Poles	56			Cost per HHS	$5,811.78
Est. Aerial Miles	1.79			Cost per MI	$95,275.05
Est. UG Miles	0.04				
Aerial %	98%		Engr. Labor	Project Cost	$10,049
UG %	2%				
Density HH/Mile	40.98		Aerial Labor	Project Cost	$48,761
Take Rate	40%				
Make Ready Cost per mile (all in labor only)	$ 14,243.58		UG Labor	Project Cost	$5,757
ADSS or Strand/Lash	Strand/Lash				
Missile Bore/Open Trench %	0%		Tech Services Labor	Project Cost	$8,180
Directional Bore %	100%				
Plow %	0%		Customer Premise Labor and Install Materials including	Project Cost	$32,078
LD Downtown %	0.0%				
HD Downtown %	0.0%				
Rock Adder %	20%				
Cut/Restore %	2%		OSP Materials	Project Cost	$36,834
Make Ready Construction	yes				
OLT Equipment	yes		Electronics	Project Cost	$32,694
ONT Equipment	yes				

The capital costs do not include potential costs to house a Carrier Neutral Location or a data center to house the optical equipment needed to light the fiber to the premise networks.

Additionally, there is existing fiber throughout Craig. Costs to deploy the fiber network may be reduced if access to the existing fiber can be negotiated. Projected capital costs do not include the assumption of use of the existing fiber; however, potential savings may be realized with successful negotiations.

Fiber to the Premise, Retail Model

In this model, the municipality and/or municipal utility designs, builds, owns and operates the network, and essentially becomes the Internet Service Provider. An increasingly prevalent case for investing in building municipal broadband is being made by advocates defining the Internet as a "utility" and thus a necessity for the public sector to provide when otherwise unavailable.

Most municipalities that have deployed a retail, Fiber to the Premise strategy have been providing electric services to their constituents. Municipal electric utilities have an easier implementation path because they already have the access to utility poles and other

infrastructure, billing processes in place, customer service centers operational, and business relationships with each and every homeowner and business.

The City of Longmont has deployed this approach and is nationally known as a model of success. Dubbed "NextLight," this Gigabit fiber network is owned and operated by the City and its power utility, Longmont Power & Communications (LPC). Longmont opted out of Colorado's SB 152 law in November of 2011 with 60% of the vote. Two years later, Longmont voters approved a $40.3 million bond issuance to cover the startup costs and network build.

Longmont followed Google Fiber's marketing strategy by launching a pre-build sign-up campaign. The neighborhood with the most market share or "take rate" would be the first area where Longmont would build. The first neighborhood received a 72% take rate prior to construction. Longmont's 38,000 homes and businesses now have symmetrical Gigabit service for $50 per month for those who signed up early. The $50 per month is guaranteed for the lifetime of the home as well as the owner/tenant of the home if he/she moves within the City limits. Longmont's business service includes symmetrical 100 Mbps for $230 per month and symmetrical 250 Mbps service for $500 per month.

Longmont is experiencing an average take rate percentage of 56%. The initial feasibility study conducted in 2013 predicted a 27% take rate. Late in 2016, the City voted to increase LPC's budget by $7 million, sourced from the Electric and Broadband Utility Fund balance, to hire staff needed to support take rates twice as high as initially predicted.

Meanwhile NextLight is helping businesses and fostering growth by providing connectivity that's enabling the community to successfully compete with its neighbor to the south, Boulder. Local businesses that were looking to expand outside the city elected to stay and grow in Longmont thanks to the Gigabit network. The network is also attracting regional work-from-home Coloradans looking for an ideal place to work and raise their family.

Financial Model, Fiber to the Premise, Retail Model

NEO Connect modeled this approach for Moffat County. It was assumed that debt financing would be obtained through revenue or general obligation bonds with interest rates of 4%.

NEO based the amortization schedule using this assumption, needing $7.350 Million in debt financing with the assumption of a 40% take rate. Building a fiber to the premise network of this size would most likely take two to three years. To mitigate financial risk and to have the most efficient use of capital, NEO recommends spending capital when neighborhoods have a predetermined take rate percentage of pre-sign ups. This ties capital outlay close to when the entity would receive revenue, mitigating debt coverage risk and creating an efficient use of capital.

Customer counts were based upon GIS data that was provided by Moffat County staff. We assumed 4,234 households in Craig, 250 in Dinosaur and 75 in Maybell represent the total market potential. If the model used the same assumptions for pricing as the Rio Blanco County, with $70 per month for Gigabit residential service, the following financial results are forecasted. NEO did not assume any revenue forecasts for TV or phone services, and did not assume a different price level for businesses.

Income Statement	Moffat County, Fiber to the Premise, Retail Model				
	2017	2018	2019	2020	2021
	Forecast Project Period				
	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues					
Service Revenues					
Craig	$ 889,100	$ 1,422,800	$ 1,422,800	$ 1,422,800	$ 1,422,800
Phase 1 Commercial	$ -	$ -	$ -	$ -	$ -
Dinosaur	$ -	$ 26,300	$ 55,100	$ 76,200	$ 84,000
Maybell	$ -	$ -	$ 8,000	$ 16,400	$ 22,800
Total Revenues	**$ 889,100**	**$ 1,449,100**	**$ 1,485,900**	**$ 1,515,400**	**$ 1,529,600**
Expenses					
Internet Access	$ 90,000	$ 90,000	$ 90,000	$ 90,000	$ 90,000
Annual Growth/Reduction of Internet Access	$ -	$ (9,000)	$ (9,000)	$ (9,000)	$ (9,000)
Software Maintenance	$ -	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Maintenance materials	$ 23,105	$ 23,105	$ 23,105	$ 23,105	$ 23,105
Salaries	$ 110,024	$ 110,024	$ 110,024	$ 110,024	$ 110,024
Payroll Taxes and Benefits	$ 42,029	$ 42,029	$ 42,029	$ 42,029	$ 42,029
Sales Churn, percent of Total Revenue	$ 17,782	$ 28,982	$ 29,718	$ 30,308	$ 30,592
Marketing and Sales Expense, percent of To	$ 44,455	$ 72,455	$ 74,295	$ 75,770	$ 76,480
Residential Customer Care, Operations	$ -	$ -	$ 19,620	$ 19,977	$ 20,060
Business Customer Care, Operations	$ -	$ -	$ -	$ -	$ -
Total Expenses	$ 344,274	$ 394,474	$ 416,669	$ 419,092	$ 420,168
EBITDA	$ 544,826	$ 1,054,626	$ 1,069,231	$ 1,096,308	$ 1,109,432
	2017	2018	2019	2020	2021
	Forecast Project Period				
	Year 1	Year 2	Year 3	Year 4	Year 5
Interest Expense	$ 291,644	$ 286,371	$ 280,882	$ 275,171	$ 269,226
Principal Payments	$ 129,436	$ 134,710	$ 140,198	$ 145,910	$ 140,198
Net Income	**$ 123,746**	**$ 633,546**	**$ 648,150**	**$ 675,228**	**$ 700,008**

Looking at Financial Feasibility Objectives

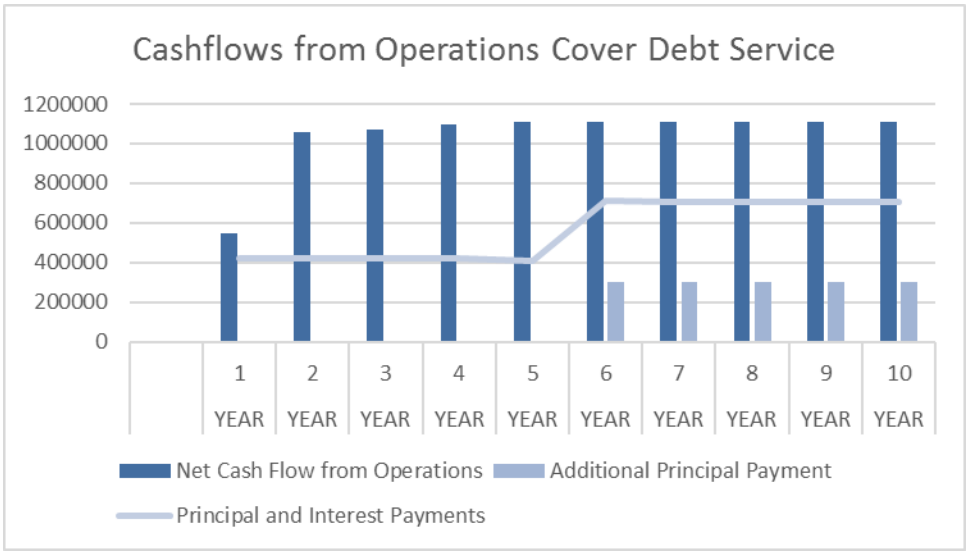
Covering debt is one of the most important financial risks that needs to be examined in detail before embarking upon a fiber to the premise strategy. NEO recommends examination of several financial feasibility objectives to mitigate debt coverage risks.

The first feasibility objective is the debt coverage ratio on funding. This ratio provides an indication of whether or not the project can be financed. NEO suggests a debt coverage ratio of over 200% after Year 5. The model achieves these objectives.

Debt service constant on outstanding debt; target over 200% after Year 5.							
	2017	2018	2019	2020	2021	2022	2023
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7
OPERATIONS							
Net Cash Flow from Operations	$ 544,826	$ 1,054,626	$ 1,069,231	$ 1,096,308	$ 1,109,432	$ 1,111,478	$ 1,111,478
Debt Service							
Total Interest Payments	**$ 291,644**	**$ 286,371**	**$ 280,882**	**$ 275,171**	**$ 269,226**	**$ 263,039**	**$ 256,600**
Total Principal Payments	**$ 129,436**	**$ 134,710**	**$ 140,198**	**$ 145,910**	**$ 140,198**	**$ 145,910**	**$ 151,854**
Additional Principal Payment			$ -	$ -	$ -	$ 300,000	$ 300,000
Net Cash Flow After Principal and Interest	$ 123,746	$ 633,546	$ 648,150	$ 675,228	$ 700,008	$ 402,529	$ 403,023
Cumulative Cash Flow After Principal and Interest	$ 123,746	$ 757,292	$ 1,405,443	$ 2,080,671	$ 2,780,679	$ 3,183,207	$ 3,586,231
Debt Service Constant on Outstanding Debt		260%	269%	281%	291%	312%	337%

Another good indication that this approach would be financially feasible is examining whether or not the cumulative cashflows from operations over ten years is greater than the outstanding debt in year ten. According to the model, additional principal payments of $300,000 can be made, starting in year 5 or 6.

Excess cashflows in early years could be earmarked for further expansion of the network and/or equipment refresh funds.

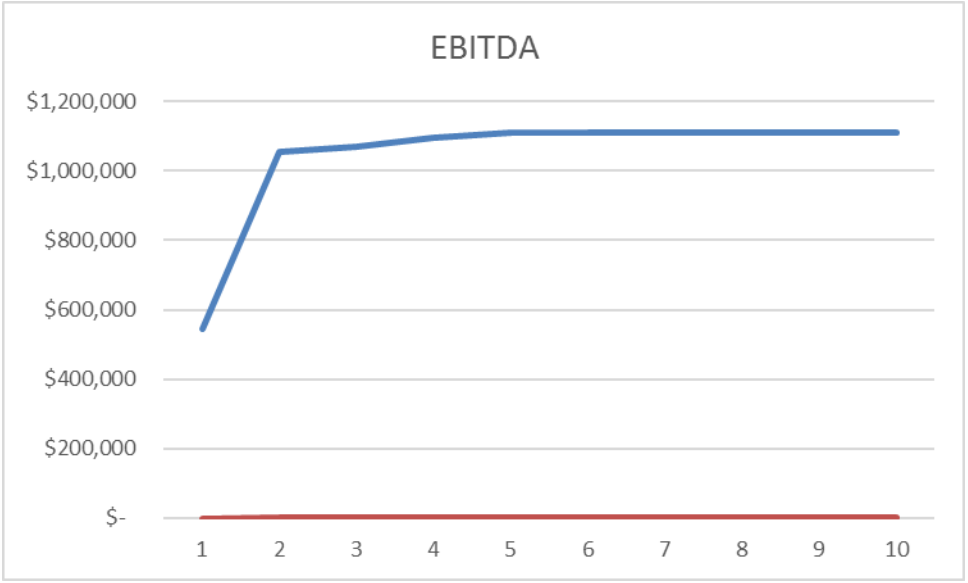


The forecast below show capital expenditures of $7.350 Million in year 1. The forecast shows the ability to make an additional $300,000 in principal payments starting in year 6.

After ten years, the cumulative cash flows are forecasted at over $10.4 Million; while the outstanding debt in year ten is $4.3 Million.

Cumulative cash flows over 10 years greater than the debt service										
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	YEAR	YEAR	YEAR	YEAR	YEAR	YEAR	YEAR	YEAR	YEAR	YEAR
	1	2	3	4	5	6	7	8	9	10
OPERATIONS										
Net Cash Flow from Operations	$ 544,826	$ 1,054,626	$ 1,069,231	$ 1,096,308	$ 1,109,432	$ 1,111,478	$ 1,111,478	$ 1,111,478	$ 1,111,478	$ 1,111,478
Cumulative Cash Flow from Operations	$ 544,826	$ 1,599,453	$ 2,668,684	$ 3,764,992	$ 4,874,424	$ 5,985,901	$ 7,097,379	$ 8,208,857	$ 9,320,335	$ 10,431,812
CAPITAL EXPENDITURES										
Capital Expenditures	$ 7,350,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
EQUITY 0%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service										
Required Draws	$ 7,350,000	$ -	$ -	$ -	$ -	$ (300,000)	$ (300,000)	$ (300,000)	$ (300,000)	$ (300,000)
Principal Payments	$ 129,436	$ 134,710	$ 140,198	$ 145,910	$ 140,198	$ 145,910	$ 151,854	$ 158,041	$ 164,480	$ 171,181
Total Outstanding Debt	$ 7,220,564	$ 7,085,854	$ 6,945,656	$ 6,799,747	$ 6,659,549	$ 6,213,639	$ 5,761,785	$ 5,303,743	$ 4,839,263	$ 4,368,082
Interest	$ 291,644	$ 286,371	$ 280,882	$ 275,171	$ 269,226	$ 263,039	$ 256,600	$ 249,899	$ 242,925	$ 235,667

EBITDA (Earnings before Interest, Taxes, Depreciation and Amortization) is forecasted to be $1 to 1.1 Million after the network is built.



There is sufficient cashflow to cover principal and interest payments.

Positive EBITDA?	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
EBITDA	$ 544,826	$ 1,054,626	$ 1,069,231	$ 1,096,308	$ 1,109,432	$ 1,111,478	$ 1,111,478	$ 1,111,478	$ 1,111,478	$ 1,111,478
Less Interest Expense	$ 291,644	$ 286,371	$ 280,882	$ 275,171	$ 269,226	$ 263,039	$ 256,600	$ 249,899	$ 242,925	$ 235,667
Less Principal Payment	$ 129,436	$ 134,710	$ 140,198	$ 145,910	$ 140,198	$ 145,910	$ 151,854	$ 158,041	$ 164,480	$ 171,181
Earnings after Interest and Principal Payments	$ 123,746	$ 633,546	$ 648,150	$ 675,228	$ 700,008	$ 702,529	$ 703,023	$ 703,537	$ 704,073	$ 704,630

Understanding the financial model is important for the Committee, not only from the viewpoint of whether the City or the County or an electric cooperative pursued a strategy to own and operate the network, but also, to understand what the implications may be for a potential public-private partnership.

The primary take-away from this is that building a fiber to the premise network in Moffat County is feasible, whether the City, the County or another entity does it.

Fiber to the Premise – Wholesale Model

Municipalities or Counties, or in this case, the Committee can take one of two approaches with the wholesale model, owning the fiber only or owning the fiber and the equipment it takes for it to run or be "lit." For ease, we are going to use "county" to describe this model; although, it is understood that the county, or the municipality or any other entity has not yet stepped up to owning infrastructure. Fiber optic cable that does not have equipment on the ends of it is referred to as "dark" fiber. Fiber optic cable that has equipment in place is referred to as "lit" fiber.

Whether the county provides dark or lit fiber, the wholesale model assumes at least one and possibly multiple service providers are available to provide Internet services. The county owns the network, and in some cases, the equipment to light the network, and the service provider(s) pay a lease fee to the county in the form of a monthly payment or in the form of a revenue share, a percentage of the gross revenues generated by service fees on the network.

This ownership by a local government, run by a private entity approach is nothing new; it has been prevalent for decades with toll roads that are managed privately. What is a new and emerging trend, is communities funding a network and turning it over to a traditional carrier to manage and operate the network, such as in Rio Blanco County.

Financial Model, Wholesale Services

If the Committee wanted to pursue a wholesale model, the estimated capital costs could be the costs of the fiber network *only* (engineering labor, aerial labor, underground labor and outside plant (OSP) materials.) This is a negotiable point with the service providers. In some cases, the

service providers would pay for the electronics and customer premise equipment. For the model, NEO assumed that the county would pay for all of the capital costs of the network.

A revenue share would be negotiated with the service providers. We assumed a revenue share of $30 per month.

One advantage with the wholesale model over the retail model is that the infrastructure owner would not be responsible for customer care. These costs were taken out of the wholesale model as the service provider would be responsible for customer service, billing, and trouble resolution. Also, the costs for Internet backhaul or Internet access would most likely be the responsibility of the service provider(s).

NEO modeled this approach and finds that it is not feasible. The reason why this works in Rio Blanco County is that there is little debt in their model, as most of their network was funded through grants. Nevertheless, here are the results.

Income Statement	Moffat County, Fiber to the Premise, Wholesale Model				
	2017	2018	2019	2020	2021
	Forecast Project Period				
	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues					
Service Revenues					
Craig	$ 381,000	$ 609,600	$ 609,600	$ 609,600	$ 609,600
Phase 1 Commercial	$ -	$ -	$ -	$ -	$ -
Dinosaur	$ -	$ 11,300	$ 23,700	$ 32,600	$ 36,000
Maybell	$ -	$ -	$ 3,400	$ 7,100	$ 9,800
Total Revenues	**$ 381,000**	**$ 620,900**	**$ 636,700**	**$ 649,300**	**$ 655,400**
Expenses					
Internet Access	$ -	$ -	$ -	$ -	$ -
Annual Growth/Reduction of Internet Access	$ -	$ -	$ -	$ -	$ -
Software Maintenance	$ -	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Maintenance materials	$ 23,105	$ 23,105	$ 23,105	$ 23,105	$ 23,105
Salaries	$ 110,024	$ 110,024	$ 110,024	$ 110,024	$ 110,024
Payroll Taxes and Benefits	$ 42,029	$ 42,029	$ 42,029	$ 42,029	$ 42,029
Sales Churn, percent of Total Revenue	$ 7,620	$ 12,418	$ 12,734	$ 12,986	$ 13,108
Marketing and Sales Expense, percent of To	$ 19,050	$ 31,045	$ 31,835	$ 32,465	$ 32,770
Residential Customer Care, Operations	$ -	$ -	$ -	$ -	$ -
Business Customer Care, Operations	$ -	$ -	$ -	$ -	$ -
Total Expenses	$ 218,707	$ 255,500	$ 256,606	$ 257,488	$ 257,915
EBITDA	$ 162,293	$ 365,400	$ 380,094	$ 391,812	$ 397,485
	2017	2018	2019	2020	2021
	Forecast Project Period				
	Year 1	Year 2	Year 3	Year 4	Year 5
Interest Expense	$ 291,644	$ 286,371	$ 280,882	$ 275,171	$ 269,226
Principal Payments	$ 129,436	$ 134,710	$ 140,198	$ 145,910	$ 140,198
Net Income	**$ (258,787)**	**$ (55,680)**	**$ (40,986)**	**$ (29,268)**	**$ (11,938)**

There is positive EBITDA, but the entity would not be able to meet its principal and interest payments.

Looking at Financial Feasibility Objectives

Again, the first feasibility objective is the debt coverage ratio. The objective is not met of 200% coverage ratio. In fact, debt payments would not be met with this wholesale approach.

Debt service constant on outstanding debt; target over 200% after Year 5.										
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
	YEAR 1	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**YEAR 6**	**YEAR 7**	**YEAR 8**	**YEAR 9**	**YEAR 10**
OPERATIONS										
Net Cash Flow from Operations	$ 162,293	$ 365,400	$ 380,094	$ 391,812	$ 397,485	$ 398,508	$ 398,508	$ 398,508	$ 398,508	$ 398,508
Debt Service										
Total Interest Payments	**$ 291,644**	**$ 286,371**	**$ 280,882**	**$ 275,171**	**$ 269,226**	**$ 263,039**	**$ 256,600**	**$ 249,899**	**$ 242,925**	**$ 235,667**
Total Principal Payments	**$ 129,436**	**$ 134,710**	**$ 140,198**	**$ 145,910**	**$ 140,198**	**$ 145,910**	**$ 151,854**	**$ 158,041**	**$ 164,480**	**$ 171,181**
Additional Principal Payment			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flow After Principal and Interest	$ (258,787)	$ (55,680)	$ (40,986)	$ (29,268)	$ (11,938)	$ (10,441)	$ (9,946)	$ (9,432)	$ (8,897)	$ (8,339)
Cumulative Cash Flow After Principal and Interest	$ (258,787)	$ (314,467)	$ (355,453)	$ (384,721)	$ (396,659)	$ (407,100)	$ (417,046)	$ (426,478)	$ (435,374)	$ (443,714)
Debt Service Constant on Outstanding Debt		90%	96%	101%	104%	107%	109%			

The cumulative cash flows for ten years are greater than cash flows from operations. The cumulative cash flows for ten years are forecasted at over $3.68 Million; while the outstanding debt in year ten is $5.86 Million.

Cumulative cash flows over 10 years greater than the debt service										
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
OPERATIONS										
Net Cash Flow from Operations	$ 162,293	$ 365,400	$ 380,094	$ 391,812	$ 397,485	$ 398,508	$ 398,508	$ 398,508	$ 398,508	$ 398,508
Cumulative Cash Flow from Operations	$ 162,293	$ 527,694	$ 907,788	$ 1,299,600	$ 1,697,086	$ 2,095,594	$ 2,494,103	$ 2,892,611	$ 3,291,119	$ 3,689,628
CAPITAL EXPENDITURES										
Capital Expenditures	$ 7,350,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
EQUITY 0%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service										
Required Draws	$ 7,350,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Payments	$ 129,436	$ 134,710	$ 140,198	$ 145,910	$ 140,198	$ 145,910	$ 151,854	$ 158,041	$ 164,480	$ 171,181
Total Outstanding Debt	$ 7,220,564	$ 7,085,854	$ 6,945,656	$ 6,799,747	$ 6,659,549	$ 6,513,639	$ 6,361,785	$ 6,203,743	$ 6,039,263	$ 5,868,082
Interest	$ 291,644	$ 286,371	$ 280,882	$ 275,171	$ 269,226	$ 263,039	$ 256,600	$ 249,899	$ 242,925	$ 235,667

In addition to the retail and wholesale Fiber to the Premise models, there are a number of emerging public-private partnership models that are just being introduced in the industry. A description of typical funding mechanisms for municipalities or counties will be discussed below as well as a description of the emerging public-private partnership models.

Public-Private Partnerships

The following models are provided to the Committee to help understand other possible approaches. These various approaches may or may not work in Moffat County.

When evaluating public-private partnerships, local governments need to balance the tension between control, risk and reward against the goals for the project. Control, in this context, refers to ownership of the network or how much capital the municipality is willing to invest. A local government must consider how much control or capital is needed to be invested to minimize risks and maximize rewards. Risks are associated primarily with financial risks such as debt and debt coverage, as well as implementation, execution and operational risks. Reward is often associated with where and how fast a network is constructed, coupled with what type of services will be offered and at what price. There may be other benefits that are classified under "reward" such as fiber built for the city's benefit at no cost or construction and operational efficiencies gained from the potential partnership.

Partners can include private for-profit companies, local non-profits, other anchor institutions and even local residents. In some instances, the local government may have a very limited role in a partnership and may only provide access to rights of way or other city infrastructure such as conduit, excess fiber, water or public safety towers, licensed spectrum, light poles or local government buildings. In other cases, a local government may agree to become an anchor tenant and pay for service on the network for a contracted term, providing a guaranteed revenue source for the network project partner to justify the business plan to build out further in the community. In more extensive partnerships, the local government can play a larger role, such as providing capital for part or all of the network construction. In some public partnership models, the private sector provides financing, while the local government shares in some of the risk. In other models, the local government pays for a substantial portion or all of the network build and contracts the operation of the network to the project partner. Sharing in the financial and operational risks and in the associated benefits of a project can allow communities to pursue broadband endeavors that may otherwise be unattainable.

Below are examples of three public partnership models that have been implemented by communities in the recent years.

Google Fiber, No Capital Outlay from the Municipality (and no Control)

Perhaps the most coveted example of a public-private partnership is the Google Fiber project in the Kansas City area. Google chose Kansas City, KS and Kansas City, MO as the community to embark upon its first foray into building fiber infrastructure. Kansas City, KS committed to facilitate access to local infrastructure and conduit that it owned and provided access to its rights of way. Kansas City, MO committed to waive local permitting fees and provided Google with unfettered access to dedicated city staff to support the project.

In return, Google has agreed to build and operate a fiber to the premise network and provide Internet access service with 1 Gbps speeds to homes at $70 per month and to businesses at $300 per month. Google Fiber did not commit to ubiquitous coverage in Kansas City, but agreed to build out fiber in neighborhoods (called "fiberhoods") that met a predetermined take rate percentage prior to construction.

Google Fiber used this same approach in Austin, TX and in Provo, Utah. Although in the past three years Google has announced plans to replicate this model in 35 other cities, Google has recently announced that it is pulling back its fiber to the premise strategy and is experimenting with Gigabit wireless technologies. Currently Gigabit wireless technology is limited to 500 feet; meaning, fiber optic cable still needs to be installed very close to homes and businesses for the wireless technology to deliver Gigabit bandwidth. Nevertheless, Google's pull back has caused some trepidation in the industry. Google is evaluating other models for partnership with cities and their pause in fiber to the premise implementation should not be taken as an indication of their appetite for collaboration with cities.

In the Google Fiber KS model, the local governments do not commit capital to build the network. This limits the cities' financial risk substantially, but it also curbs the control they have over how and where the network is built. The municipalities in the Google Fiber projects have no say over prices charged to the customers, how the network is built or how fast. Google makes all of the decisions regarding current and future operations, and whether or not they pull out of a market. Given their most recent announcements of pulling back their plans, this has proven to be a substantial risk to the communities. Critics of Google's fiberhood approach claim that Google has "cherry-picked" more affluent neighborhoods to build its fiber and has left economically challenged neighborhoods off its build list.

Ting, Municipality Builds the Fiber Network, Ting pays for Equipment and Operates the Network

Canada's Ting has recently made a name for itself as a private carrier that will deliver fiber to the premises services over a city-owned network. Already underway in Westminster, MD, Santa Cruz, CA, and Huntsville, AL, Ting is now partnering with Centennial, CO to bring Gigabit fiber Internet access to Centennial's 107,000 residents and its local businesses.

In this model the municipality provides the capital to build, own and maintain the "dark" fiber throughout the community and to every home and business. Ting "lights" the fiber by providing capital for the equipment. Ting provides Gigabit services to homes for $89 per month and to businesses for $139 per month. In order for the city to pay down its debt associated with building the fiber network, Ting pays the city a fee for homes and businesses that are fiber-ready or have been passed with fiber and another fee when homes and businesses start subscribing to Internet services.

While the fiber network is the property of the city and eventually an "open network," meaning several service providers can use it to offer services to homes and businesses, Ting partnerships typically feature an "exclusive right to operate network" for a minimum amount of time. While the build is the responsibility of the respective cities, Ting will lease and light the fiber and provide all equipment and Internet access. Cities partnering with Ting are mitigating risk and staying out of the challenging ISP business, but have more control over where, how and how fast the network is built. The cities also have control over pricing and services offered and can require that the network is available for others to use after an initial period of time.

Other companies are now replicating this model. Companies in Colorado that have stated they would enter into public-private partnerships similar to Ting's model include Cedar Networks, Allo, FastTrack and Forethought. In Rio Blanco County, Cimarron Telecommunications and Local Access Internet are providing services in a similar model. Others may also offer a similar model if asked to respond to a formal Request for Information or Proposal.

Long-term Lease, Shared Take Rate Risks or Utility Fee

Private firms including SiFi and Symmetrical Networks will fund a network build, and will oversee design, engineering, construction and operation of the network with a 20-year exclusive lease agreement. These firms are forecasting that the subscription rates they receive will provide healthy returns on their investment. And for extra measure, they ensure a sufficient return by requiring cities to guarantee take rates, or pay the difference. The good news is that these potential city paybacks have a long ramp-up time before ever going into effect. Additionally, the guaranteed take rate is typically more than achievable at somewhere between

30-38%, depending on the negotiated terms. At the end of the negotiated years, the city owns the network free and clear but can continue to lease the fiber to their established partner(s).

Macquarie Capital will also work with communities to establish a fiber network using a similar model to that described above or with a utility fee structure model. This utility fee structure model was recently used to rescue Utah's Utopia network from its financial woes. In the Utopia project, Macquarie charges a flat utility fee for every home and business that the network passes, whether the home or business signs up for services or not. Terms of the deal were reported to be $22.60 per month for five cities. In terms of revenue sharing, each city is able to keep 75% of wholesale revenue after the first $2M per year. This arrangement is expected to wipe out Utopia's debt by 2021 if the network sees a 24% take rate for premium services

Macquarie Capital is also providing financing, design, engineering, construction and operations for an anchor institutions network for the State of Kentucky. This "concessionaire model" provides a long-term agreement of 30 years where Macquarie is the lead vendor coordinating all financing and implementation for the project and the State of Kentucky, in turn, shares in the risks and rewards of the project.

How is the Network Implemented and Operated?

As discussed, there are a myriad of ways that a public-private partnership can be funded. In the same vein, implementation and operation models vary. In many instances, the municipality has staff and resources that are already providing utilities to their constituents, or are already maintaining roads and right of ways. With this being said, designing, building and operating a fiber network is not always in a municipality's wheelhouse. Often a municipality will outsource the design, engineering, permitting, construction of the network and physical turn-up of services. In some cases, the municipality may also contract for operations of the network and in other instances, the municipality may source these functions in-house.

Private entities Macquarie, SiFi, Symmetrical Networks and Fujitsu, that are providing financing for these networks to be built under a public-private partnership model, are also looking for opportunities to work with municipalities who wish to outsource either part or the entire above list. Other municipalities are choosing to partner with these firms for the financing and operations, by keep the design, engineering and construction services under their control, using standard procurement processes for these functions.

As discussed in the funding section of this paper, each entity has a different model to recoup its investment and meet their business case for success. Usually these arrangements, fees, and exclusive rights contracts are complex and should be reviewed by a firm with extensive experience in multiple cities with a wide variety of business models and contingencies.

Software Defined Network, with an "Opt-In" Twist

Named the community broadband project of the year by the National Association of Telecommunications Officers and Advisors (NATOA), the City of Ammon, Idaho's open access network is obviously making many communities take notice. Ammon's fiber network is a "software defined network," allowing "fiber apps" to be setup and hosted on the network. One such application, is an innovative public safety application that uses the fiber network to coordinate immediate, real-time responses to school shootings. This has led to the City partnering with the University of Utah in a $600,000 initiative to research and develop a series of next-generation networking technologies supporting public safety, including broadband public emergency alerts.

Ammon has created Local Improvement Districts (LIDs) where residents can "opt in" or "opt out" of receiving service from the fiber to the premise network. For those who opt-in, they are charged a monthly fee, where those who are not interested are not charged. The city council's logic is that those who opt-in are investing in an opportunity to increase their property value.

Within a specific LID, improvement bonds are used to cover the expense. Bonds are paid off by an assessment of each participating property. It's estimated that this will result in a $15 to $20 monthly charge for opting-in households.

The open-access network has an accessible online dashboard where Ammon's residents can change providers if they're not happy with their current provider. They can also set up private, high speed "rooms" online, with a few clicks. Virtual connections can be set up between all of the schools, or with the school and the hospital – on the fly, again, with a few clicks. Ammon's open access model offers very high speed Internet with a number options for providers, but more importantly, it also supports a number of growing data applications, allowing collaboration with anyone on the network at any time

Appendix A: Benefits of Advanced Broadband Networks and Why This Matters

The following section is taken from a white paper written by NEO Connect. The information is relative to this project in understanding the applications and trends in broadband services. This section discusses the community benefits of advanced broadband networks and provides the context of why building Gigabit-enabled networks are important.

Stimulate Economic Growth. **Many municipalities across the country are deploying next-generation, high-bandwidth telecommunications networks as a means of stimulating economic growth and development.**

Our world is changing; and it is doing so rapidly. Technology is impacting every part and parcel of our lives -- from where and how we conduct work, to whether or not we thrive economically and socially. It has impacted the way we live, our entertainment, our culture, the way government services are provided and accessed, the way healthcare is being delivered, and the way we educate our children and provide education to better improve our workforce. With the introduction and accelerated advancement of technologies, having access to affordable, redundant and abundant broadband is quickly becoming the most critical infrastructure of our time, just like electricity and transportation were in the early 1900's. Advanced broadband infrastructure has the potential to create more jobs, increase the community's competitive ability globally, create new technologies, increase opportunities for the region's companies, enhance public safety, provide better and less expensive healthcare, and provide greater educational opportunities throughout our community. In a recent meeting/webinar and report produced by Brookings in May of this year, fiber was added as a critical infrastructure.[7]

Advanced broadband networks are creating seismic changes in local, state, national and global societies, as well as markets, business and in institutions around the world. Access to social media and the Internet has shifted governments, threatened national and local boundaries, inspired revolutions, and has changed us culturally. The Internet and its associated technologies have impacted wealth, work, education, government, health, public safety, and education. Having equal access to advanced broadband networks bridges the digital divide and helps creates economic and educational equality.

Like the introduction of electricity, advanced broadband networks are fundamentally changing our world in ways that were not expected or anticipated. Much like electricity, advanced broadband networks are the enabling technology in which all things are impacted. Electricity was invented to turn on the lights, but empowered – literally, the transformation to an industrial society. Advanced broadband networks are now the enabling technology to transform us yet again, to a global technology and information society; the new Knowledge Economy. (See *Captive Audience* by Susan Crawford).

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[7] Joseph Kane and Robert Puentes, "Beyond Shovel Ready: The Extent and Impact of U.S. Infrastructure Jobs," Brookings Institution, (May, 2014) available at http://www.brookings.edu/research/interactives/2014/infrastructure-jobs#/M10420

Just as it was impossible to know in advance the impact that electrification would provide the critical infrastructure to power all of our modern appliances, computers, health monitoring systems, manufacturing facilities, radio and television, and financial markets; so too, is it impossible to predict the impact and reach of advanced broadband networks. We do not yet know the far-reaching impacts that the Internet will have on our lives and on generations to come. However, it is certain that not having access to advanced broadband networks would be equivalent to being in the dark without electricity!

The incumbent providers of phone service, Internet, and cable TV services are not building best-in-class broadband networks fast enough. The model by which these services are being provided needs to shift dramatically to enable faster deployment of advanced services, affordable broadband and abundant capacity to support our current and future needs for bandwidth.

Speed Matters. **Global network traffic has quadrupled from 2009 to 2014. Both commercial and residential Internet bandwidth consumption are doubling every year.**

Bandwidth refers to the capacity, or speed of the networks to carry traffic. The question is often presented, "How fast is fast enough?" and "What should be the definition of broadband?"

In the early days of the Internet, text messaging, email and web sites were not data-rich or bandwidth intensive and the average consumer did not need more than 7 Mbps of bandwidth. When YouTube burst upon the scene in 2005, this dramatically changed things. One video download was the equivalent of downloading 30,000 web pages. Since that time, videos and picture-rich content have been downloaded and uploaded on a regular basis by the masses. The applications we use on the Internet are becoming much more feature-rich and bandwidth intensive and our existing networks cannot keep up with the demand for networks that support these applications.

The Fiber to the Home Council stated its position clearly in a brief to the FCC. "Even today, with most users still operating on last-generation broadband technologies, the capabilities of advanced video, cloud-based services, and other bandwidth-intensive applications are growing at a pace beyond what our existing networks are capable. Cisco and other scientific companies talk about

the network in terms of "terabytes" of capacity in the network center, or "core."[8] According to the Cisco 2012 Zettabyte Report, businesses today routinely require symmetrical gigabit service between their locations."[9]

Also, referenced in the Cisco 2012 Zettabyte Report, global Internet traffic grew 45 percent during 2009 alone and has doubled every year since then. Both commercial and residential Internet bandwidth consumption are doubling every year, as video, cloud computing, advanced storage solutions, telemedicine, telecommuting, video conferencing, etc., are becoming more prevalent from end users. Applications are becoming more bandwidth intensive and as more devices – tablets, Smartphones, computers, appliances – are being used both in the home and for business applications. Research conducted by Cisco states by 2016, there will be nearly three Internet Protocol or IP-connected devices per person. Internet-connected televisions, radios, set-top boxes, Blu-ray players, Netflix, cameras and picture frames now receive or deliver movies, TV and photos through the Internet.

According to FTTH Council's brief to the FCC referenced above, "the average monthly traffic in 2014 on the Internet has been equivalent to 32 million people streaming Avatar in 3D, continuously for the entire month." In 2014, video downloads and uploads comprised 50 percent of all Internet traffic. In the coming years, the sum of all forms of Internet Protocol (IP) video (Internet video, video on demand, video files exchanged through file sharing, video-streamed gaming, and videoconferencing) will reach 86 percent of the total Internet traffic. Applications supported by cloud-based services through multiple devices have created the need for always-on connectivity and advanced broadband network bandwidth.

While Internet bandwidth use is doubling, cellular networks are also greatly overextended.

In addition to explosive growth in Internet consumption from homes, businesses, and mobile Internet use has also advanced dramatically. Smartphone applications are spurring higher consumption of multimedia services. With tablets and smartphones having easy access to games, e-books, TV programs, email, shopping, banking and social media sites, wireless service providers have been scrambling to upgrade their networks.

[8] Fiber to the Home Council, "America's Petition to the Federal Communications Commission for Rulemaking to Establish a Gigabit Communities Race-to-the-Top Program," July 23, 2013.
[9] Cisco, "*The Zettabyte Era*" (May 30, 2012).

The need for advanced broadband connectivity must include both a consideration for fiber, connecting our businesses and homes; as well as wireless and cellular, allowing for mobile and portable access as we travel, move about and commute.

Community Outreach and Support. **All-Fiber networks are imperative, critical and necessary to stimulate economic development and growth. Municipalities, communities and regions that want to impact economic development must build 21st Century infrastructure.**

Municipalities, communities and regions that have deployed all-fiber networks have already seen the tremendous economic impact of building symmetrical gigabit networks. These communities have fostered an environment of innovation, economic development and growth, collaboration, and creative activities. As having access to advanced broadband services is the number one priority for large businesses as they are looking for commercial real estate, the communities that have built gigabit-enabled fiber networks have already benefited economically by attracting businesses and industries to re-locate to their communities.

After Chattanooga deployed their Gigabit network, the city attracted numerous high-tech firms, and entrepreneurs to relocate their company facilities, including Amazon, Alstom, and Volkswagen amongst others. Several venture capital firms were established in Chattanooga after their Fiber to the Home network was built because this fostered a business climate that was perfect for innovation and creativity. When surveyed, 42 percent of economic development professionals claimed that 1 Gigabit of service actually attracts new businesses to an area (see Table 3). Since building its gigabit network, Chattanooga has created over 7,000 new jobs and attracted billions of dollars in capital investment in a city once referred to as the "dirtiest city in America."[10]

In 2012, the Chattanooga Electric Power Board (EPB) established Gig Tank, an application-incubation facility. The goal of Gig Tank is to build applications to utilize the capabilities of gigabit networks. According to its website, "Gig Tank is a startup accelerator connected to a living, metro-wide fiber optic network. Hosted by the Company Lab, this annual program attracts entrepreneurs from across the globe to Chattanooga, the home of America's first widely-available gigabit Internet service. With Internet speeds that run 100x faster than the national

[10] Chattanooga's "Gig Tank" website, available at http://www.thegigcity.com/gigtank/

average, Chattanooga offers entrepreneurs the opportunity to innovate on the broadband platform of the future." This year, Gig Tank is focusing on three start-up tracks accelerating seed stage startups in the additive manufacturing (3D printing), smart grid and healthcare industries by connecting these new companies with the tools, capital and connections to go to market.

Chattanooga itself has experienced great success with its smart grid system that is running on the city's all-fiber network. The smart-grid system promotes energy efficiency throughout the city, remotely monitoring the system's power consumption, load balancing and power substations. It allows the electric system to re-route around failures and downed power lines in storms and outages, restoring services within minutes. Prior to the smart-grid system implementation, typical outages may have lasted four to five hours and many neighborhoods may not have had services restored until residents notified Chattanooga's EPB of the outage. Today, with the new smart-grid system in place over the all-fiber network, EPB can restore service in minutes. Savings realized by better management of the city's power system and improved operations has paid for the cost of deploying the Fiber to the entire community system.[11]

Similar to Chattanooga's Gig Tank program, entrepreneurs have developed gigabit-ready applications through the US Ignite Partnership.[12] US Ignite is a non-profit, public-private organization that is supported by the White House Office of Science and Technology and the National Science Foundation. US Ignite is focusing on creating applications in the following disciplines of national priority:

- Education and Workforce
- Energy
- Health
- Public Safety
- Transportation
- Advanced Manufacturing

In addition to creating transformative applications, US Ignite connects people and resources, coordinates test beds, provides efforts towards scalability and providing these applications to the masses, informs the public and takes these applications to market. One cutting-edge application being developed by researchers at the University of Massachusetts, and supported by US Ignite, is the Collaborative Adaptive Sensing of the Atmosphere (CASA) program. CASA uses

[11] Mike Smalley, "Broadband and the Smart Grid," (2008) available at http://www.carinatek.com/PDFs/BBP_AugSep08_SmartGrid.pdf

[12] US Ignite, available at https://us-ignite.org/about/what-is-us-ignite/

predictive storm-tracking technology and "data 5 to 10 times more detailed than current radar systems" to provide citizens with advanced notification of severe weather events. These applications, as well as all of the other applications developed by US Ignite, are only possible with having access to a minimum of 100 Mbps of bandwidth. US Ignite is participating with municipalities and communities that have built out fiber networks and are offering this type of bandwidth to their constituents.

Kansas City offers another example. When Google issued a Request for Proposal for the "Think Big with a Gig" program to host gigabit test-beds and have Google build within their city, over one thousand communities across the country submitted applications.[13] Google selected the bi-state Kansas City metropolitan region. Kansas City has already seen an uptake in new high-tech start-ups due mostly to Google's FTTH efforts. Through Homes for Hackers and the Kansas City Startup Village, entrepreneurs have built a community of innovators enticed by the possibilities presented by the Google Fiber network.[14] A prominent venture capitalist has even purchased a home in a Kansas City "fiberhood" to allow entrepreneurs to live for free in Kansas City and build gigabit-ready applications. High-tech companies recognize the benefits of these networks and are willing to relocate just to have access to them.

Since Google's roll-out of gigabit services in Kansas City, it has made plans to build Fiber to the Home in Austin and has recently purchased an existing system in Provo, Utah. Google last year announced plans to build FTTH in 34 municipalities across the country upon cooperation and attainment of a checklist put out by Google.

Other communities that have built fiber networks have shown economic growth by attracting manufacturing, high-tech and technology companies in large part because of their investment in all-fiber networks.

Telecommuting Opportunities

The number of people working from home or telecommuting has increased enormously in the past few years and will increase exponentially in the future. According to a study conducted by the Global Workplace Analytics[15], telework grew nearly 80% from 2005 to 2012. In 2010, based

[13] Topeka, Kansas, even changed their name to Google in hopes of being selected as the test-bed.
[14] Kansas City Startup Village, available at http://www.kcstartupvillage.org; and Homes for Hackers, available at http://homesforhackers.com.
[15] Global Workplace Analytics Recent Statistics on Telecommuting available at http://www.globalworkplaceanalytics.com/telecommuting-statistics

on its own limited survey, *WorldatWork* estimated that 16 million employees worked at home at least one day a month, a number that increased almost 62% between 2005 and 2010. Extrapolating from 2010 to 2014 would put the current number of those who telecommute at least one day a month at approximately 25 million.

There are significant economic benefits from telecommuting and working from home. According to the Global Workplace Analytics website, "If those with compatible jobs and a desire to work from home did so just half the time (roughly the national average for those who do so regularly) the national savings would total over $700 Billion a year." Other data points from the website are:

- A typical business would save $11,000 per person per year
- The telecommuters would save between $2,000 and $7,000 a year
- The oil savings would equate to over 37% of our Persian Gulf imports
- The greenhouse gas reduction would be the equivalent of taking the entire New York State workforce permanently off the road.
- The Congressional Budget Office's estimate of the entire five-year cost of implementing telework throughout government ($30 million) is less than a third of the cost of lost productivity from a single day shut-down of federal offices in Washington DC due to snow ($100 million).

According to the Aspen Institute's Communications and Society Program's publication, "The Future of Work", (2011) work is no longer confined to a specific time and place. Open systems, open platforms, shared folders and databases, crowdsourcing, and collaboration between employees, contractors, vendors and suppliers happens in the cloud facilitating the ability to work anywhere there is a high-speed Internet connection, at any time.[16]

Providing the ability for people to work from home or from Internet meeting rooms – i.e. the local coffee shops, libraries, community centers, co-working spaces, incubator locations or virtual offices -- requires access to advanced broadband services. The benefits and cost savings of telecommuting can only be realized when workers have access to abundant broadband. If work is portable, people will choose communities that are rich in culture, art, entertainment, recreation, educational opportunities for kids and adults and are affordable. Work is no longer tied to place. Communities need to change to attract and maintain this new *portable* workforce.

[16] David Bollier, *"The Future of Work, What it Means for Individuals, Markets, and Governments,"* Aspen Institute's Communications and Society Publication, (2011).

Every "Thing" will be Connected to the Internet: Medical Devices, Health Monitoring Systems, Our Cars, Our Clothes, Household Systems, Appliances, Energy Controls – the "Internet of Things."

Every good thing out there is connected to the Internet; the new "Internet of Things." These things include household systems that monitor security systems, locks, energy use, temperature, and water control. It includes appliances that call automatically for maintenance; make shopping lists, schedule events, order parts, and schedule repair -- all without the need for human intervention or oversight.

The Internet of Things includes medical devices that monitor our health, detect and alarm us when medical issues are present, clothes that detect glucose levels or heart conditions, and hats that monitor our brain activity. Cars are now connected to the Internet, monitoring the car's status and performance, notifying drivers of traffic delays, alternative routes, hazardous conditions, and mechanical issues. Soon cars will drive themselves. Internet-connected cars will provide anti-collision technology, automatically braking and steering clear of accidents or potential accidents. Our coming and going, our location, customer information and applications will all be collected, stored and monitored. Some of this sounds a bit uncomfortable; however, the reality of all of this is here. Devices are all Internet-enabled. Although we as individuals will need to determine how far and how much data we want to have shared and collected, it is clear that the Internet of Things is only enabled with advanced broadband capacity.

Affordable Healthcare: The growing Baby Boomer population and the implementation of the Patient Protection & Affordable Care Act will create new challenges for our healthcare system.

The baby boomers are getting older; the largest portion of our population is aging. Concerns of increased healthcare costs with an aging society will need to be curbed by providing better, smarter, more cost-effective healthcare. Implementation of the Patient Protection and Affordable Care Act is placing new demands on the medical industry to become more efficient, cost effective and nimble, demanding that physicians interact with more patients.

Telemedicine is the use of information technology including the telephone, the Internet and personal computers, for diagnosing, treating and monitoring patients. Telemedicine is adding a

new dimension to modern health care. These advances are not only making care more accessible and convenient, they are lowering the costs of medical care, while not sacrificing the quality of care, and in many studies, improving the quality of care. Physicians can consult with more patients, and patients can meet with their physicians in a shorter time period. Less time is spent checking the patient in and leading the patient to the exam room. In terms of economic advantages, telemedicine can save a great deal of time for patients who otherwise would have to travel to medical facilities. Telemedicine can also eliminate many ER visits, which are often the costliest means of providing healthcare services.

According to the Wellness Councils of America (WELCOA), as many as 70 percent of primary care visits, and 40 percent of emergency room visits to treat acute medical conditions could have been diagnosed and prescribed medication all over the phone.[17] The methodology of providing care has not changed; however, the medium for providing care has. The physician can perform diagnostic testing, interview the patient, check vital signs, etc. remotely using videoconferencing and remote monitoring equipment, and the telephone or Internet; instead of providing these services in person.

The American Telemedicine Association highlights various reports on the efficacy, cost savings, improved healthcare and patient benefits of telemedicine.[18] One report highlights the experience of UPMC Health Plan, an integrated delivery and financing system headquartered in Pittsburgh, Pennsylvania, in its efforts to support primary care practices as they converted to patient-centered medical homes. From 2008 through 2010, sites participating in the UPMC pilot achieved lower medical and pharmacy costs; more efficient service delivery, such as lower hospital admissions and readmissions and less use of hospital emergency departments; and a 160 percent return on the plan's investment when compared with nonparticipating sites.

Presbyterian Healthcare Services based in Albuquerque, New Mexico, adapted the Hospital at Home® model developed by the Johns Hopkins University Schools of Medicine and Public Health to provide acute hospital–level care within patients' homes. In this program, patients show comparable or better clinical outcomes compared with similar inpatients, and they show higher satisfaction levels. Available to Medicare Advantage and Medicaid patients with common acute care diagnoses, this program achieved savings of 19 percent over costs for similar

[17] Wellness Council of America, "Collecting Data to Drive Health Efforts," available at https://www.welcoa.org/resources/collecting-data-drive-health-efforts-classic-edition/

[18] American Telemedicine Association, numerous case studies available at http://www.americantelemed.org/about-telemedicine/telemedicine-case-studies

inpatients. These savings were predominantly derived from lower average length-of-stay and use of fewer lab and diagnostic tests compared with similar patients in hospital acute care.

Additionally, patients that are participating in a home health program or telemedicine program experience higher satisfaction as they receive more personal one-on-one care, without taking time from work to travel to a medical clinic and wait for their appointment with the doctor. The source of satisfaction for most patients is the ability to see a specialist trained in the area most closely related to the patient's condition, the feeling of getting personalized care from a provider who has the patient's interest in mind, and the ability to communicate with the provider in a very personal and intimate manner over the telecommunications technologies.

With the Internet of Things for Medical Devices, it is now possible to remotely monitor a patient's health with the use sensors, detectors, actuators and the Internet. Medical remote monitoring devices are connected to the Internet where a patient's vital statistics get transmitted via a gateway onto secure cloud-based platforms where the data is collected, stored, monitored and analyzed. These devices can monitor and alert physicians or loved ones if a patient's vitals fall outside a healthy range. Scanners can monitor inventory levels for pharmaceuticals before a medication runs out and order supplies and inventory ensuring that hospitals and clinics have the needed supplies.

Other medical applications enabled with advanced broadband include medical training and consultation with other physicians and providers, electronic health records, and the ability to log-in and read patient charts, MRIs and X-rays.

Education and Distance Learning: **Our workforce must continue to evolve through workforce training and education. The manner in which we provide education to our kids and to adults is changing, requiring us to access information and education through distance learning and reverse classroom experiences.**

The concept of working for a single company or within a single industry for thirty years until retirement is no longer an economic reality. Workers will change careers an average of seven times during their lifetime. Workers cannot expect to enjoy a "steady job" with a lifelong employer, nor expect that employer to provide the training and skills needed as the work

changes. Workers require on-going training, education and mentorship. Many of these resources for further education and mentoring are now mostly available on-line and virtual. Educational institutions, workforce training, universities, and corporations must provide education when people can use it, rather than at a specific place and time, working around lifestyle, schedules and work/home priorities and pressures.

Homework assignments, testing and accessing educational videos are rapidly moving online. Schools are beginning to provide a reverse classroom, or flip education; a concept that includes providing a video of the lesson online. Students download the lesson remotely while at home, watch the lecture, can pause, reflect, rewind and watch again. The classroom time is then used for more in-depth study, homework, questions and interaction between the students and teachers.

Public Safety: Our first responders need reliable, ubiquitous coverage, higher standards than what our commercial networks currently have, interoperability between networks and priority access to information and databases.

Emergency response teams have unique needs and higher standards for broadband and communications. Our first responders need networks that are reliable, always on, secure, provide ubiquitous coverage, interoperability between network and priority access to information and databases. Their devices need to be small, lightweight, versatile and autonomous, wearable and portable. The devices need to be capable of sensing the environment, of tracing and tracking resources and able to convey a wealth of information to other responders, civil protection authorities and to crisis management centers. Sensor-nets can provide for situational awareness for disasters, fires, emergencies, car wrecks and other events, but these sensors require access to high bandwidth and the current wireless networks do not currently support these applications adequately.

Police officers are ready to trade in their handheld radios for use of their iPhones, iPads, and Android devices while on the job. Until recently, this has created a problem for law enforcement agencies as smartphones and tablets haven't been able to connect to conventional Land-Mobile Radio (LMR) networks. U.S. public safety agencies will soon be able to use the FirstNet network that provides priority access for law enforcement, first responder and public safety agencies. This

is critical during disasters when cell phone networks can become congested, as FirstNet is a network that will have spectrum dedicated exclusively for public safety entities.

Additionally, most devices for law enforcement include video applications – camera-equipped police and camera-equipped cars, cameras on traffic stops and enforcement of speed sensors and speeding tickets, and live ambulance video-links to hospitals. The existing wireless networks cannot support the applications that are in use today. The 911 system cannot process videos from citizens, but as we are finding during emergencies, the public is often the "eyes and ears" during these crises as citizens are videotaping events as they happen. Having the public be able to record events and send the information to first responders allows for better transparency, honesty and less mistakes.

Digital Inclusion and Civic Engagement: The Great Equalizer?

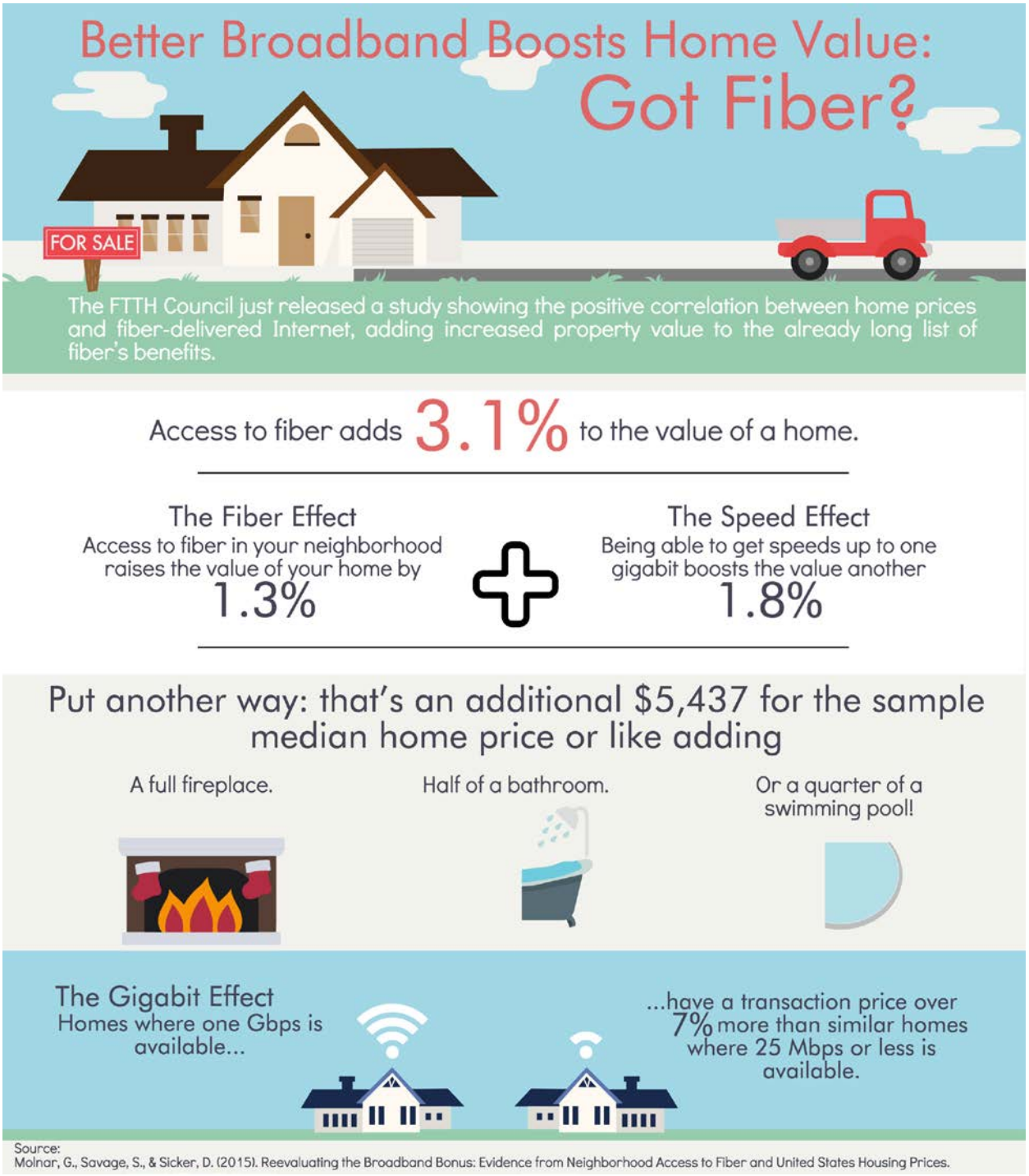
Broadband must be ubiquitous or it will further create a digital divide. When broadband is ubiquitous it can be the great equalizer between different economic classes. In 2014, the International Economic Development Council asked economic development professionals if broadband service could "encourage individual entrepreneurship among under-served constituents," and 35 percent said that it is quite likely and 14 percent said that they had seen it firsthand. Ubiquitous broadband access can help create social and economic equality. However, not having advanced broadband access available to everyone can create further inequalities of wealth, education access, social institutions, and government resources. Broadband must be abundant, redundant and available to everyone.

Civic Engagement, Transparency, Access to Government Resources.

Advanced Broadband Networks can transform civic engagement, access to government resources and transparency of government. Government documents, including GIS data, applications, information on initiatives, information on financial contributions etc. can now be available online. Documents must be able to be in a standardized format, searchable and available where data can be edited and used by other programs. Providing citizens access to this data provides further transparency, community engagement, public input, and public impact on government.

Higher Home Values

Finally, statistics from the FTTH Council state that real estate developments communities that have deployed FTTH networks have instantly improved home sales values. According to the FTTH Council, access to fiber adds 3.1% to the value of a home and having a Gigabit available increases home values by 7% over homes that have access to 25 Mbps or less.

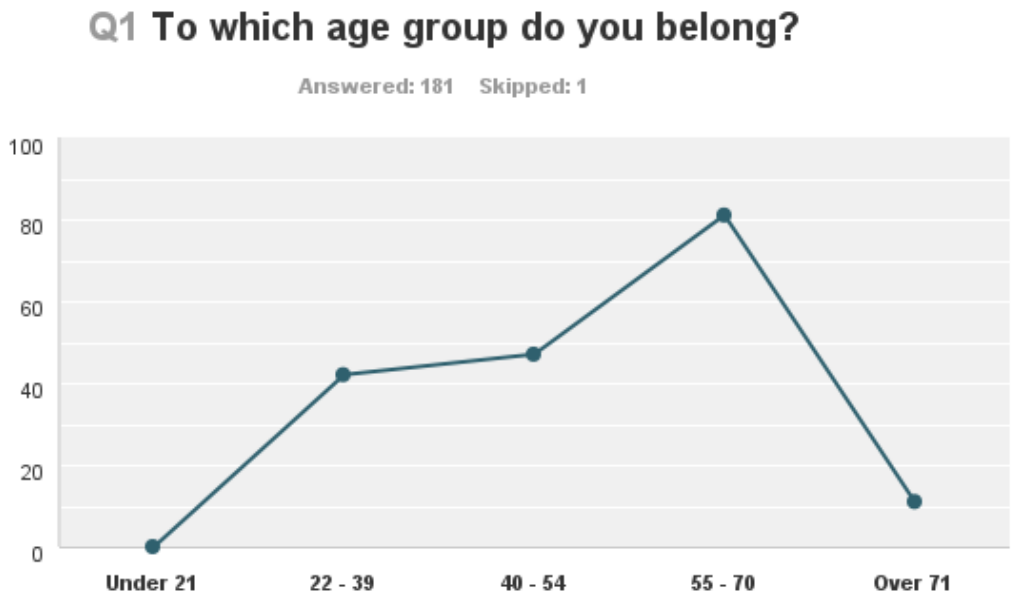

Better Broadband Boosts Home Value:
Got Fiber?
FOR SALE
The FTTH Council just released a study showing the positive correlation between home prices and fiber-delivered Internet, adding increased property value to the already long list of fiber's benefits.
Access to fiber adds 3.1% to the value of a home.
The Fiber Effect
Access to fiber in your neighborhood raises the value of your home by
1.3%
The Speed Effect
Being able to get speeds up to one gigabit boosts the value another
1.8%
Put another way: that's an additional $5,437 for the sample median home price or like adding
A full fireplace.
Half of a bathroom.
Or a quarter of a swimming pool!
The Gigabit Effect
Homes where one Gbps is available...
...have a transaction price over 7% more than similar homes where 25 Mbps or less is available.
Source:
Molnar, G., Savage, S., & Sicker, D. (2015). Reevaluating the Broadband Bonus: Evidence from Neighborhood Access to Fiber and United States Housing Prices.

Appendix B: Survey Results Detail

Residential Survey Results Detail

Demographics

Age. 45% of respondents (80 out of 181 responses) are between the ages of 55 and 70 followed by respondents falling in the age range of 22-54 (23.2%).



39% of the survey's respondents have school-aged children at home. Many homework assignments are now web-based and often require robust connectivity to support bandwidth intense applications. Additional bandwidth demands at home are the result of at-home-workers.

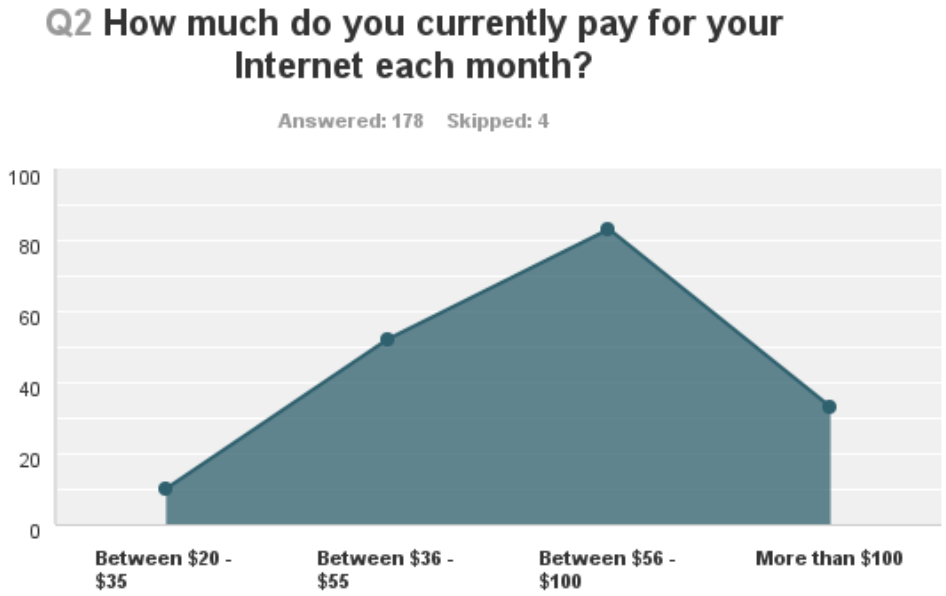
Telecommuting

Craig and Moffat county respondents report 42% of households have at least one person who works from home. 34% have one person working from home and another 7% have two people working from home.

Answer Choices	Responses	
Yes, 1 person does	**34.07%**	62
Yes, 2 people do	**7.14%**	13
Yes, more than 2 people do	**0.55%**	1
No	**58.24%**	106
Total		**182**

Current Service

Current Pricing. Nearly half (47%) of respondents are paying between $56 - $100/month for their Internet service. One out of five households pay more than $100/month to obtain adequate service.



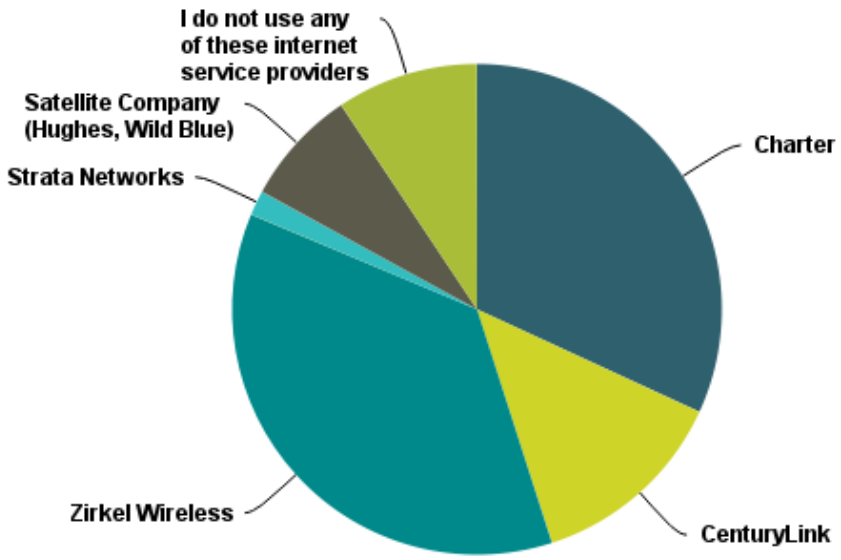
Bundling. To determine if the Internet costs were standalone or part of a service package, respondents were asked what else was included in the monthly price. 27% included some other service (TV, telephone, cell phone) while 73% just included Internet service.

Answer Choices	Responses	
Yes, it includes my telephone service.	**21.23%**	38
Yes, it includes my TV service	**15.64%**	28
Yes, it includes my cell phone service	**2.79%**	5
No, the costs just include my Internet service.	**72.63%**	130
Total Respondents: 179		

Bundling many services under one invoice was important in the past as it was typically seen by consumers as a cost saving tool. However, the importance of a single invoice and bundling of services today is not important, with 67% of residents saying it's not a deciding factor for them.

Current Providers

Carriers. Zirkel Wireless and Charter Communications were the dominant service providers, supporting a combined subscriber base of nearly 70% of all respondents.



Answer Choices	Responses	
Charter	**31.87%**	58
CenturyLink	**13.19%**	24
Zirkel Wireless	**36.26%**	66
Unite Fiber Networks	**0.00%**	0
Strata Networks	**1.65%**	3
Mammoth	**0.00%**	0
Level 3	**0.00%**	0
Satellite Company (Hughes, Wild Blue)	**7.69%**	14
I do not use any of these internet service providers	**9.34%**	17
Total		**182**

Connectivity. 36% of users are connected to the Internet via Wireless, followed by 27% using cable.

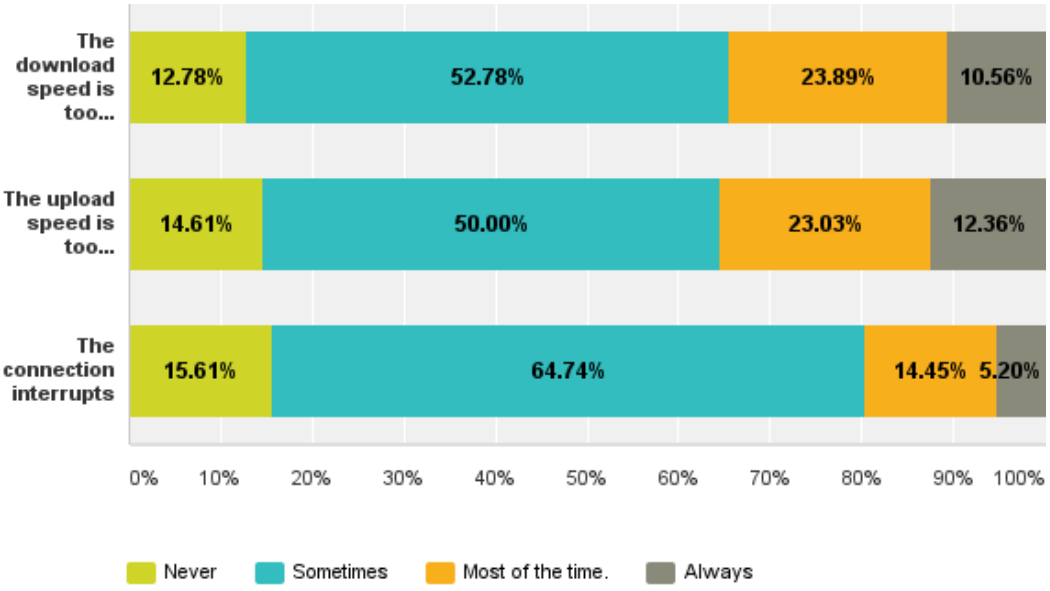
Answer Choices	Responses	
Wireless (usually provided by an independent service provider using an antenna on the roof pointed to another ground antenna.)	**35.71%**	65
Cable (usually provided as part of your cable TV package)	**26.92%**	49
DSL (usually provided by the phone company)	**15.93%**	29
Satellite (usually provided as part of your Satellite TV package)	**12.09%**	22
Mobile Phone Wireless, Cellular (typically is part of your cell phone plan)	**3.85%**	7
I don't have Internet service at my home.	**3.30%**	6
Dial-up (requires you to use a modem and your regular phone line)	**1.65%**	3
I do not know what type of connection I have at my home.	**0.55%**	1
T-1 Service (a special kind of service often available from the phone company rated at a fixed 1.5 Mbps)	**0.00%**	0
Fiber connection (uses fiber optics to provide the signal. May be provided by the phone company or other providers. Typically used for higher speeds)	**0.00%**	0
Total		**182**

Speed Test Results, Reliability, Perceptions

Speed Test Results –The survey provided instructions to respondents to take an actual speed test. 158 of the 182 respondents took the speed test and recorded the results.

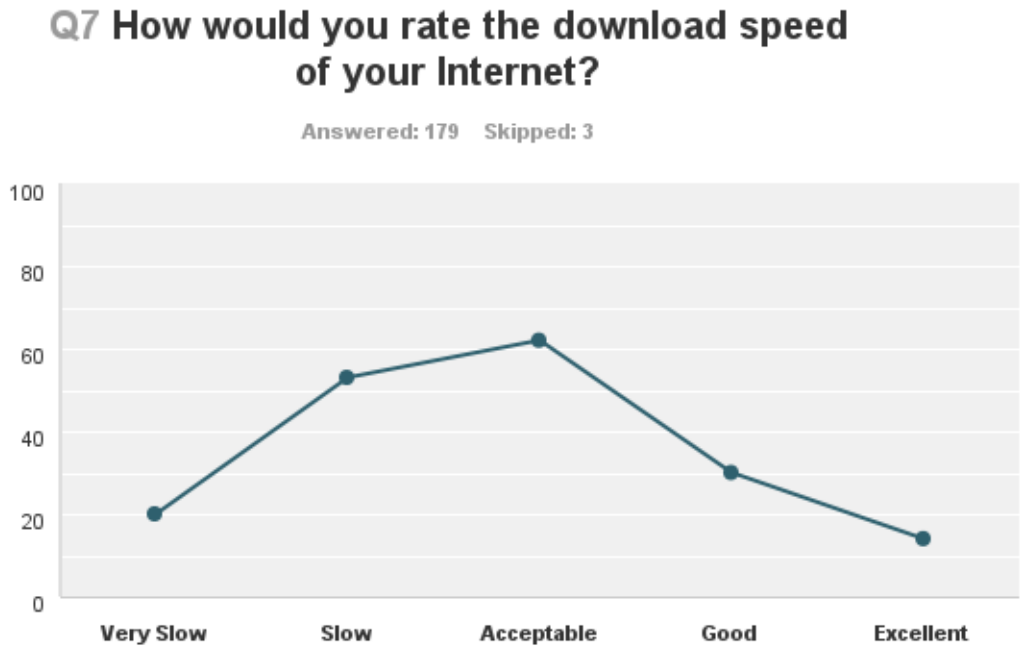
- The average speeds recorded were 19.5 Mbps download and 4.25 Mbps upload.
- The lowest speeds recorded were .26 Mbps download and 0.04 Mbps upload.
- The highest speeds recorded were 68 Mbps download and 26.67 Mbps upload.
- 72% of the speed tests recorded were below the FCC's 25 Mbps download threshold.
- 39% of the speed tests recorded were below the FCC's 3 Mbps upload threshold.

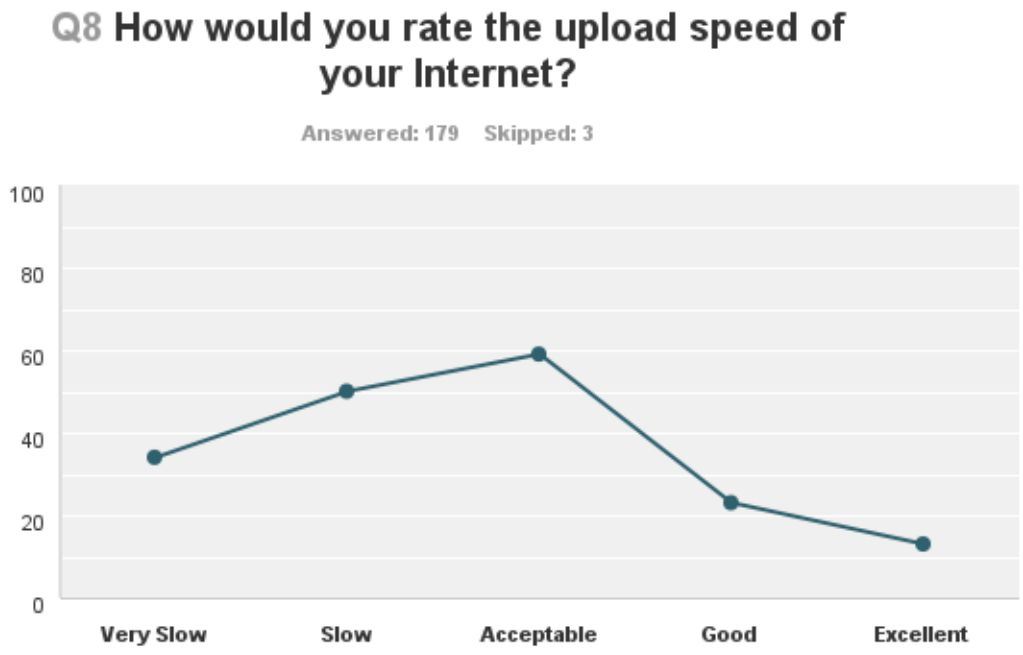
Perceived Reliability. If fast Internet and no interruptions are the goal, only 13-15% of respondents say their carrier is delivering. Roughly 35% say their connection is too slow either all, or most of the time, and nearly 20% said they have frequent service interruptions.



Perception of Speed. Only 1 out of 4 respondents (24%) are happy with their Internet speed in terms of rating it "excellent" or "good."

Most of the respondents indicated that both the upload and download speeds are acceptable, but 41% see their speed as "slow" or "very slow."





Devices. Internet connected streaming TV devices, game consoles, smart TVs, DVRs, smart phones and more are all placing ever-increasing demands on bandwidth needs.

	None	1	2	3	more than 3	Total
Tablet	11.24% 19	43.20% 73	25.44% 43	11.24% 19	8.88% 15	169
Desktop computer	34.57% 56	48.77% 79	11.73% 19	3.09% 5	1.85% 3	162
Laptop computer	9.77% 17	41.95% 73	28.74% 50	10.34% 18	9.20% 16	174
Smart phone	4.00% 7	20.00% 35	46.86% 82	16.00% 28	13.14% 23	175
Smart TV	46.15% 72	33.97% 53	12.82% 20	3.21% 5	3.85% 6	156
DVD/DVR or Blue Ray Player	13.25% 22	55.42% 92	19.88% 33	7.83% 13	3.61% 6	166
Game Console	47.37% 72	34.21% 52	10.53% 16	4.61% 7	3.29% 5	152
Streaming TV (Apple TV, Google Chromecast, Amazon Fire, etc.)	51.85% 84	27.78% 45	11.11% 18	5.56% 9	3.70% 6	162

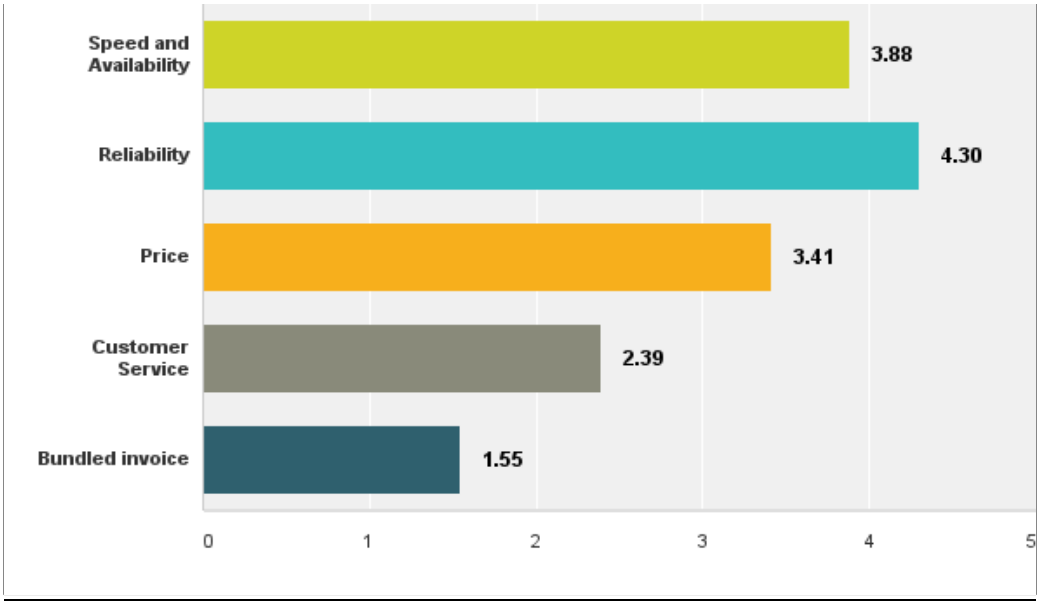
Expected Level of Service

Of respondents that did not have a definitive speed requirement, nearly half want faster speeds and greater capacity. A third desire greater download capability and 21% percent want faster upload speeds.

Answer Choices	Responses
I don't know how fast I need, but I would like it MUCH faster than what I have.	49.06% 78
I don't know how fast I need, but I know that I need more DOWNLOAD speed than what I have.	31.45% 50
I don't know how fast I need, it seems to be working fine with what I have now.	24.53% 39
I don't know how fast I need, but I know that I need more UPLOAD speed than what I have.	20.75% 33
Total Respondents: 159	

What is Important?

When asked to rate the most critical components of Internet service, residents are primarily focused on reliability and speed, with price coming in as a close third.



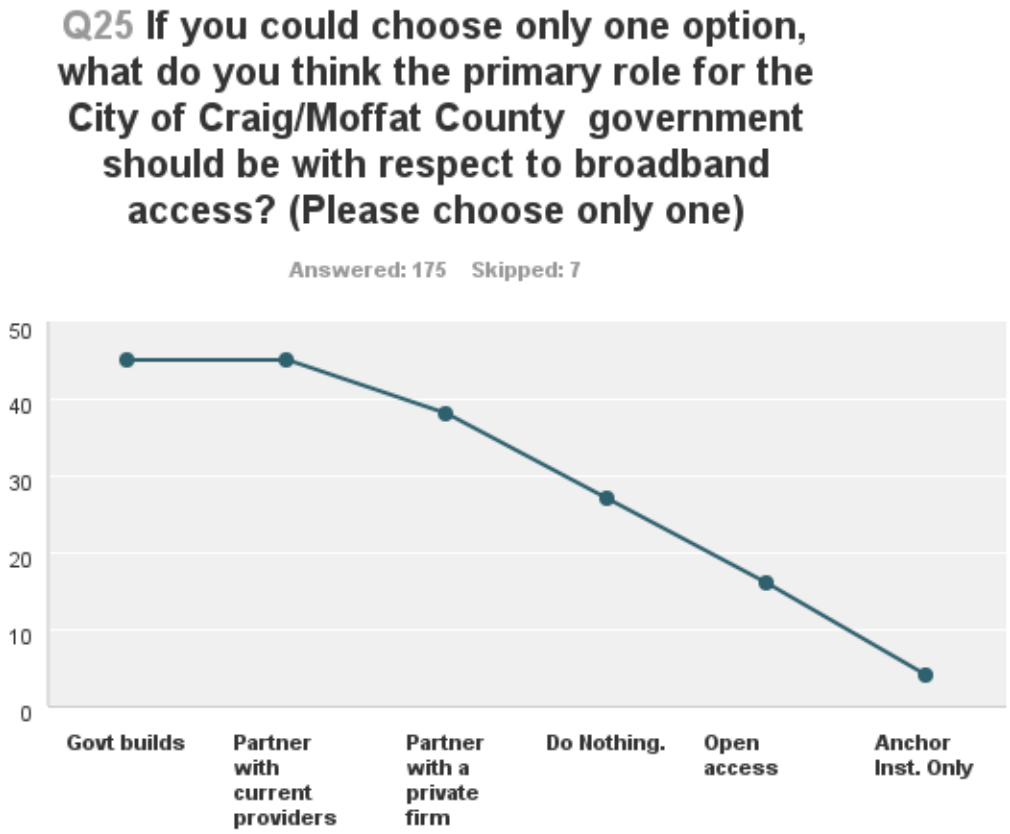
The Role of Government.

The majority of respondents either support having the local government build a state of the art network or support a partnership between local governments and the private sector to provide adequate service to the public, including homes and businesses. Roughly 15% of respondents said that government should do nothing and let the private sector decide on service offerings.

Specific Actions. Respondents were presented with six (6) options for actions that could be taken by the community. Having the City of Craig and Moffat County partner with current providers to improve speed and reliability scored the highest of the six options.

Answer Choices	Responses	
Install state-of-the-art network and offer services to the public, including homes and businesses, and government offices	25.71%	45
Partner with current providers to improve the speed and reliability of their services.	25.71%	45
Partner with a private firm to build a state-of-the-art network.	21.71%	38
Do Nothing. Let private providers decide what services they are willing to provide.	15.43%	27
Install state-of-the-art services and enter into agreements with private companies to offer services to the public.	9.14%	16
Install state-of-the-art network for businesses, schools, government offices and the medical community only.	2.29%	4
Total		175

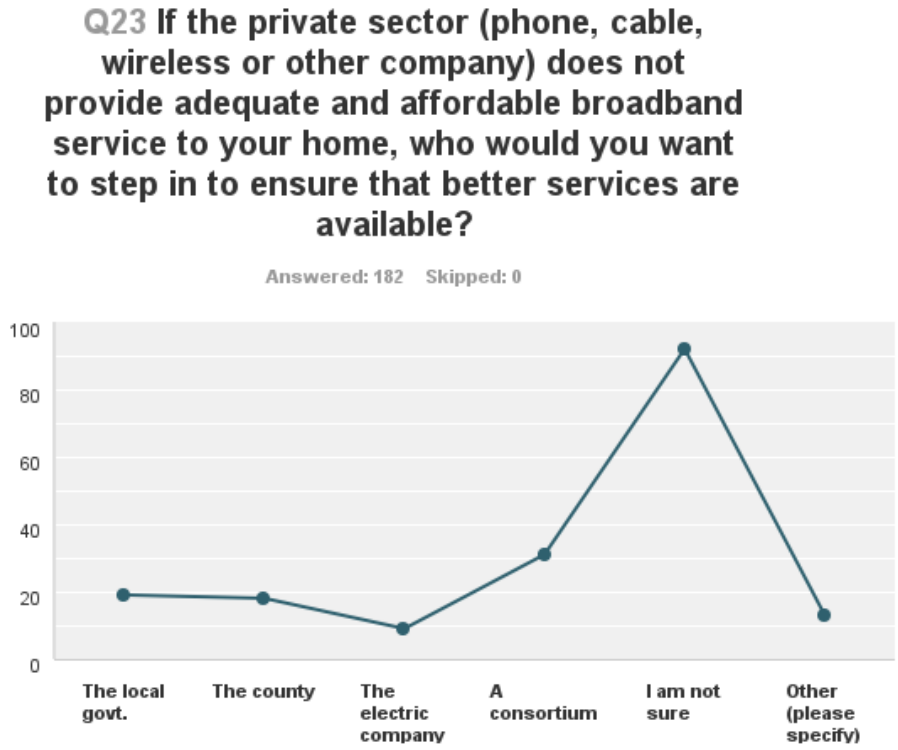
When asked to select only one option in regards to the role of government, responses to have the government build the network or partner with the current providers received the highest results.



Who Should Fix this if there is a Problem?

A question was posed to the respondents regarding who should step in if the private sector does not provide adequate or affordable service. It should be understood that this effort is being led by a committee of stakeholders. The stakeholders are made up of local government (the City of Craig), Moffat County, YVEA, Tri-State, the hospital, the school district and the community college.

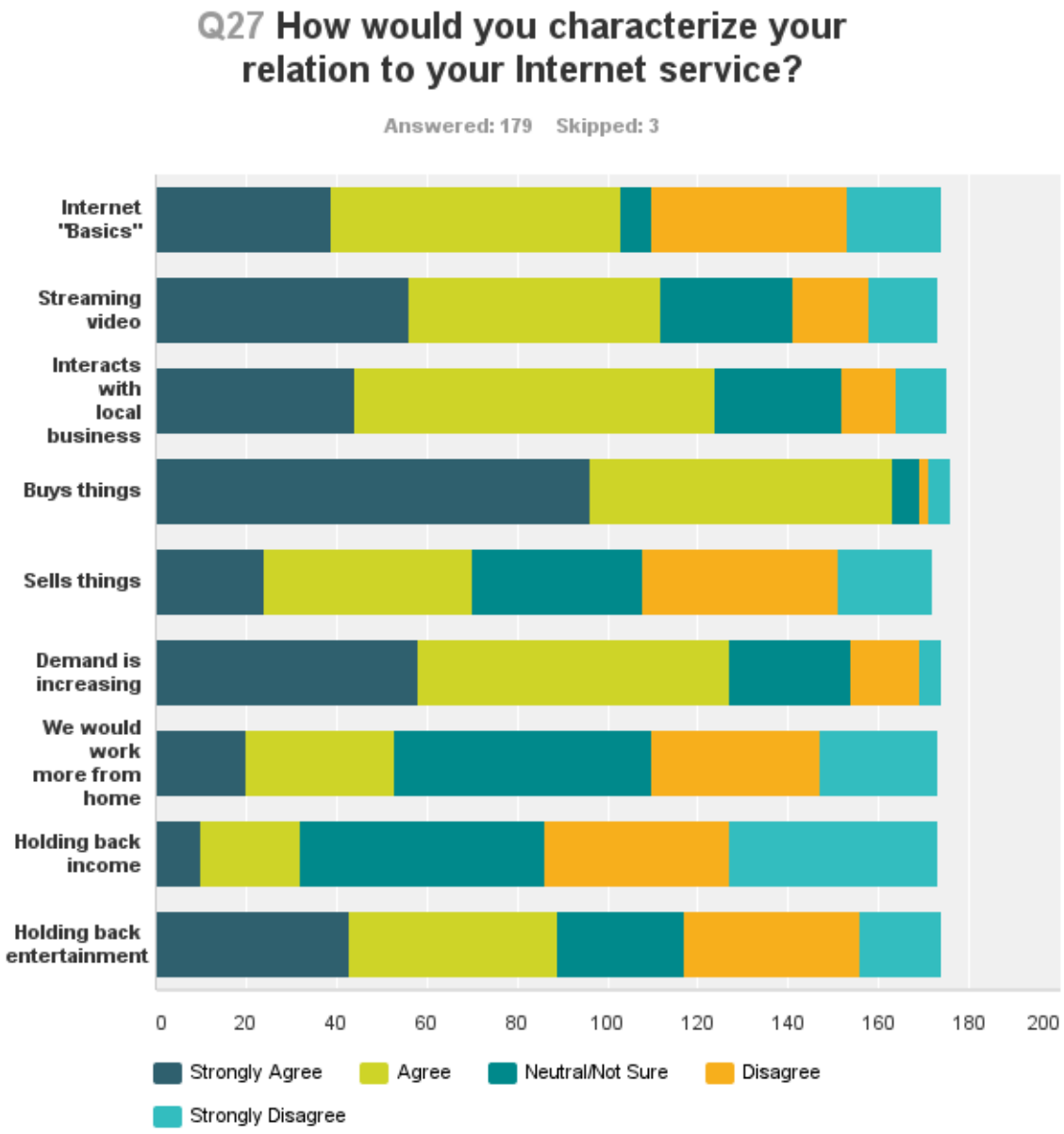
Most of the responses stated that that they did not know who should step in and facilitate a solution.



Households' Relationship to the Internet

There were several questions posed to respondents regarding how strongly they agree with various statements regarding their household's relationship to the Internet. The questions included the following:

- Our household mostly just uses the Internet for "basics" like email, browsing/research, etc.
- More and more, our household is relying on streaming video over the Internet for in-home entertainment
- Household members interact with local businesses (reservations, tickets, etc.) over the Internet
- Our household buys things online (Craig's list, eBay, etc.)
- Our household sells things online (Craig's list, eBay, etc.)
- Our household's demands on Internet bandwidth and speed is consistently increasing
- If we had better home Internet service, one or more of us would work from home more often
- The current Internet speed available is holding back our household's income potential
- The current Internet speed available is holding back our household's entertainment options



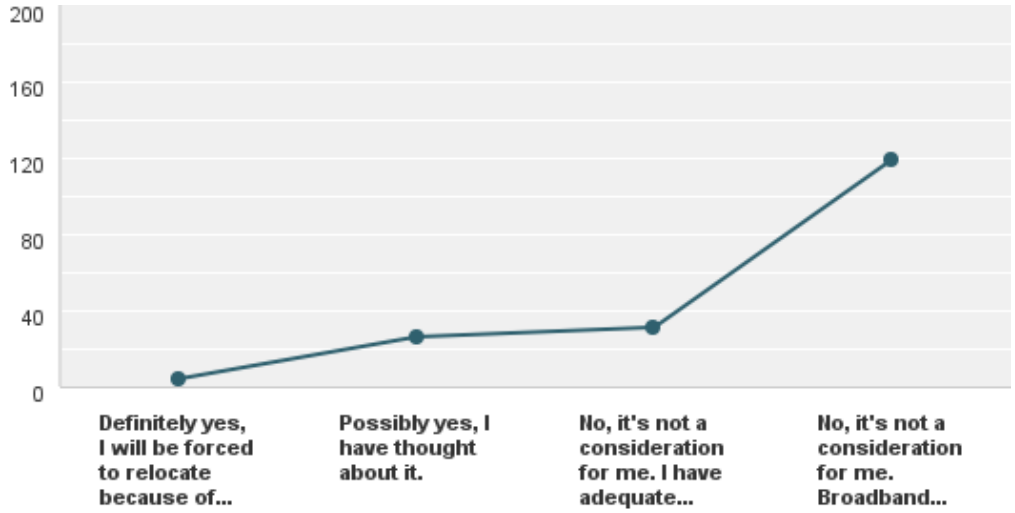
Results where we see "Strongly Agree" in dark blue and "Agree" in green, show responses that are the most prominent. Areas with the most agreement are:

- Our household mostly just uses the Internet for "basics" like email, browsing/research, etc.
- More and more, our household is relying on streaming video over the Internet for in-home entertainment
- Household members interact with local businesses (reservations, tickets, etc.) over the Internet
- Our household buys things online (Craig's list, eBay, etc.)

- Our household's demands on Internet bandwidth and speed is consistently increasing

Would Residents Move Because of the Internet?

Would residents move away from Craig and Moffat County if adequate broadband is not available? 17% said they would either move or consider moving.



Answer Choices	Responses
Definitely yes, I will be forced to relocate because of inadequate broadband service.	2.22% 4
Possibly yes, I have thought about it.	14.44% 26
No, it's not a consideration for me. I have adequate broadband service.	17.22% 31
No, it's not a consideration for me. Broadband services need to be better here, but I am not planning to move.	66.11% 119
Total	**180**

Open Ended Responses, Residential Survey

The survey asked for any other comments regarding current Internet service or thoughts in regards to a community broadband service. Here is a sampling of the comments.

- Broadband needs to be developed in an expedited manner to maintain the economic health of the community.
- butt out and let free trade take the reins. this town is headed for a Clinton melt down. we don't need to spend any more money on trivial toys

- Century Link frequently reduces our speed by 50% and tells us we are lucky to get that.
- Century Link told me 18 months ago, that upgrade work in our neighborhood would begin in June 2016. To my knowledge, nothing has been done.
- Charter's Internet reliability needs to be better. Many businesses have switched to them because they have the best speed, but when they have an outage it severely affects those businesses. Sometimes to the point that they have to close their doors until the Internet comes back up. We're there any service level agreements put in the franchise contract? If not, there should be and there should be SLA's for any new broadband going forward.
- Competition among the private sector will provide much better service than that provided through the government.
- Disappointing.
- Get the government out of the broadband business. Don't do it
- Good Luck :)
- Govt I have one message for you- GET OUT OF MY LIFE AND LET AMERICA WORK. WE DON'T NEED YOUR DAMN HELP BECK!
- having such limited options, we get screwed over one way or another
- I guess I don't have actual broadband Internet... I use a, jet pack from Verizon.
- I HAD ZIRKEL BUT GOT RID OF THEM BECAUSE OF HOW OFTEN IT DIDNT WORK
- I have no options for broadband service here in Shadow Mountain other than my phone and that is spotty with Verizon
- I have to pay for a 12m line to sustain a 1meg download speed for programs. It's very expensive.
- I live in the county and Internet options are very limited and expensive
- I moved here from Greeley Colorado in June and the speed of Internet is considerably slower
- I think with the current shortfall on the Craig budget that this is a total waste of money that could have been spent improving things in our community the Craig city council should not be spending money they don't have let us pick our own Internet provider
- I would be nice to have another option in the county other than satellite. More and better cell coverage is needed even in Craig.
- I would like it to stay at one price instead of going up every year. It is getting to the point where people cannot afford it.
- I would like to expand our broadband speed, but the economy and our jobs do not allow it for now.
- If we could access Cedar Mountain we would be using Zirkel and have much better service.

If you have any other comments regarding your current Internet service or a community broadband service, please tell us below:

- Improving broadband service would help our community attract businesses to diversify our economy.
- In today's world, Internet is a part of life no matter where you are, and having broadband provided as a utility seems to be, to me, the direction we should be heading.
- It goes in and out like cell phone service does.
- It would help with the education places quite a bit.
- keep what we have

- Local service is the only option so they know it's there way or no way. No competition, so you have to pay it or go somewhere else.
- Make broadband happen - we do not want to continue to live in the electronics stone age.
- My wife and I both work from home and our Internet has been sufficient but improving the speed and reliability would help us to be more effective with our jobs. As technology changes, our bandwidth will become more of a priority.
- Our Internet is Wildblue which charges a fee every month but we have limited data.
- Re: question # 28, I chose definitely yes but feel it should be worded "I would be forced to relocate because of inadequate broadband service" because I feel Charter provides adequate download speed most of the time. We are able to stream multiple shows and browse on multiple devices at the same time with the speeds we have now. But if that service was not available that would be a problem for me.
- Service is slow and often interrupted...we have been told many times it's our router only to replace it and have the same results. How many times can you replace the router...come on!
- Survey seems biased to try and get a locally ran high speed network. While I support a local initiative to speed up our Internet, I don't know if our town has the personnel required to install such a network.
- Thank you for the Inter net. Have nice day.
- Thanks
- The faster speed the better! Reasonable cost for Senior Citizens on fixed income is very important to me. Our Charter service is OK but it was better when we had Optimum! Charter is too large a company to properly deal with our small community.
- The needs of those living in rural areas must be included if broadband becomes available - especially if tax dollars are involved in any partnership agreement.
- This is a tax-oriented survey that is looking for an entity to pay for increased service. I disagree that the "big guy" ought to pay the lion's share. If broadband is a utility, then Everybody pays a little, and those that use it the most, pay more.
- Ultra-high speed broadband could be the cornerstone of a grand strategy that can diversify our economy, bring in businesses we didn't think we could have previously attracted, and indemnify our economy against the challenges growing in the energy sector. Not doing this could be the greatest mistake Craig has ever made.
- We do not have Internet at home because there are not adequate services available where we live. It would be nice to have a reliable option that was not prohibitively priced. With the school district forcing the students to have tablets and an increasing amount of homework on these devices, it would be nice for students to be able to do their work from home, and not have to find a hot spot.
- We had NGL Connections for about 10 years, and this month (October 2016) they informed us that they were dropping Craig from their service. We were told to contact Zirkel Wireless to arrange connecting to their service but when the installer arrived he took a look around (we live north of Craig in a low spot between hills) and told us we don't have 'line of sight' of their towers and therefore cannot make use of their service. I have also contacted Century Link, Dish Net, Accede, and Charter to no avail. Looks like we are SOL unless we are willing to try Verizon's MiFi device which uses cell tower connections and costs accordingly. My son in Denver told us it's time to move away from Craig.
- We have Charter. I'd give them a 7 out of 10. We had Zirkel on Thomson Hill and I'd give them a 7 out of 10. We started with CenturyLink and I'd give them a 2 out of 10.

- We have moved past the days of commercial/private Internet connections. This is a functional utility for everyone, just like water and sewer. All of the community together can fund more than competing companies can, and we all have better services for it.
- We must be competitive in our Internet services/utilities to bring businesses to Moffat County! I'm confident that many businesses have chosen to locate elsewhere because our county cannot support their needs. We cannot serve the needs of our businesses that are here. It's time to step up!
- We strongly support the City of Craig and Moffat County opting out of SB05-152 to allow the citizens a choice in what their local government can provide with regard to broadband Internet.
- We would always "love" bigger, badder, faster but it is not a "need". Our broadband service is adequate at this time for us.
- Zirkel provides both my home and business with excellent service.

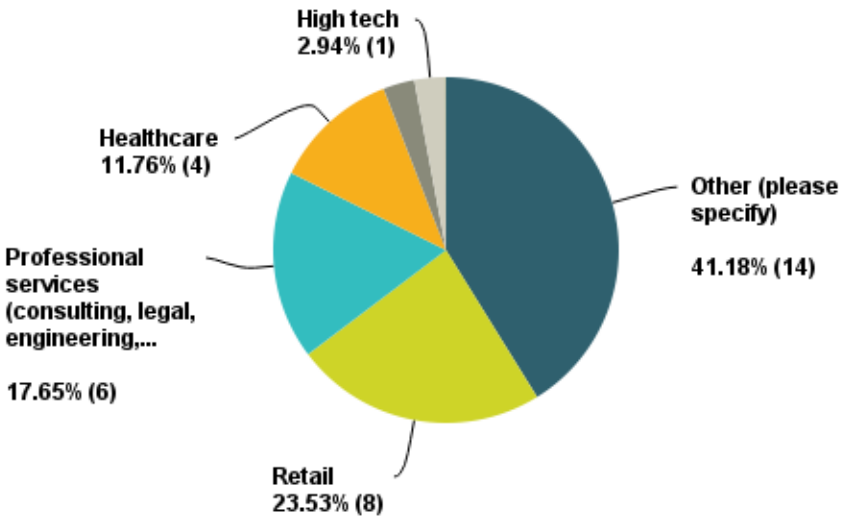
Business Survey Results Detail

Demographics

Business type. 41% participate in Retail and Professional services, while an additional 41% fall under the "Other" category, which includes Agriculture, Aviation, Boarding Kennel, Church, Generating Electricity, Government, Hospitality, Hotel, Media, Mining, Motel, Nonprofit, Tourism/Marketing and Wholesale.

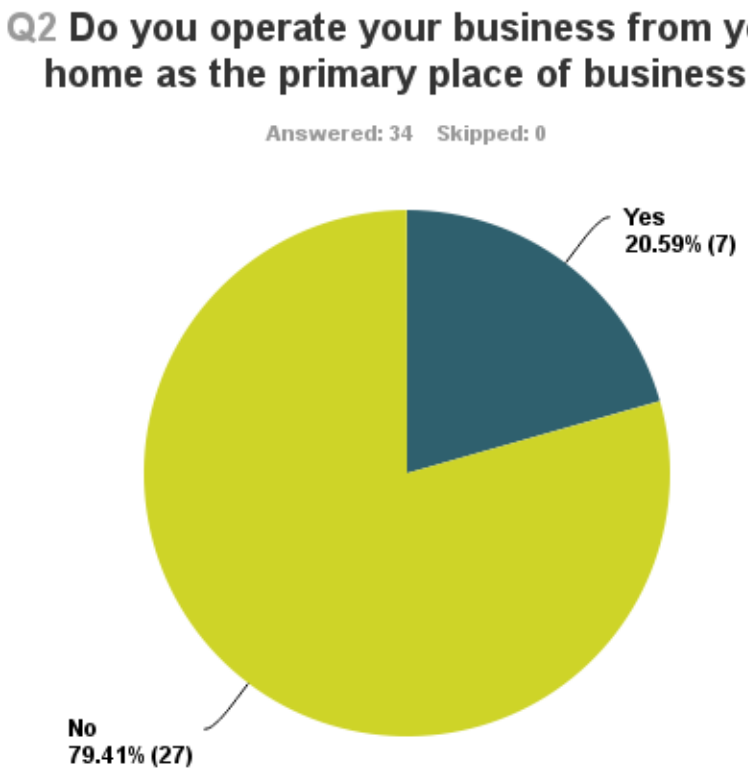
Q1 What type of business are you in?

Answered: 34 Skipped: 0



Answer Choices	Responses	
Other (please specify) Responses	41.18%	14
Retail	23.53%	8
Professional services (consulting, legal, engineering, accounting, banking, etc.)	17.65%	6
Healthcare	11.76%	4
Manufacturing	2.94%	1
High tech	2.94%	1
Restaurant, Food	0.00%	0
Education	0.00%	0
Total		34

Operate a Business Primarily from Home. 20.6% of the respondents operate a business primarily from home.

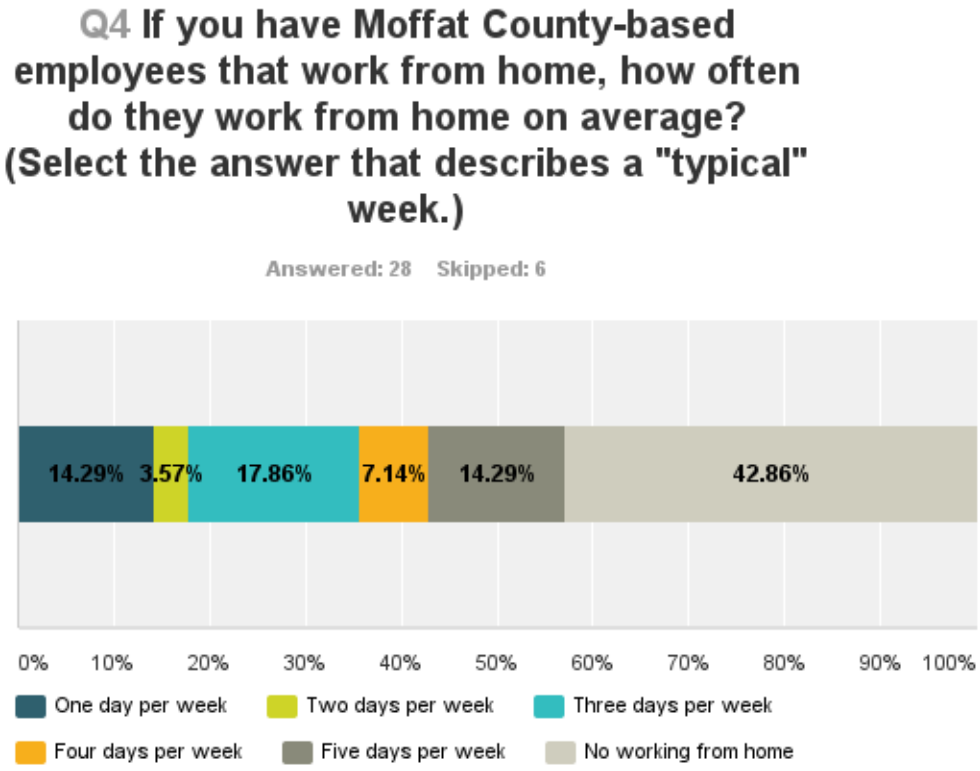


Business size. Businesses responding to the survey were primarily firms with three or fewer employees.

	Less than 3	3 to 6	6 to 10	10 to 20	20 to 50	More than 50	Total
How many employees?	64.29% 9	0.00% 0	14.29% 2	7.14% 1	0.00% 0	14.29% 2	14
How many employees are located in Moffat County?	9.52% 2	38.10% 8	9.52% 2	9.52% 2	14.29% 3	19.05% 4	21
How many Moffat County employees primarily from home?	85.71% 18	9.52% 2	0.00% 0	4.76% 1	0.00% 0	0.00% 0	21

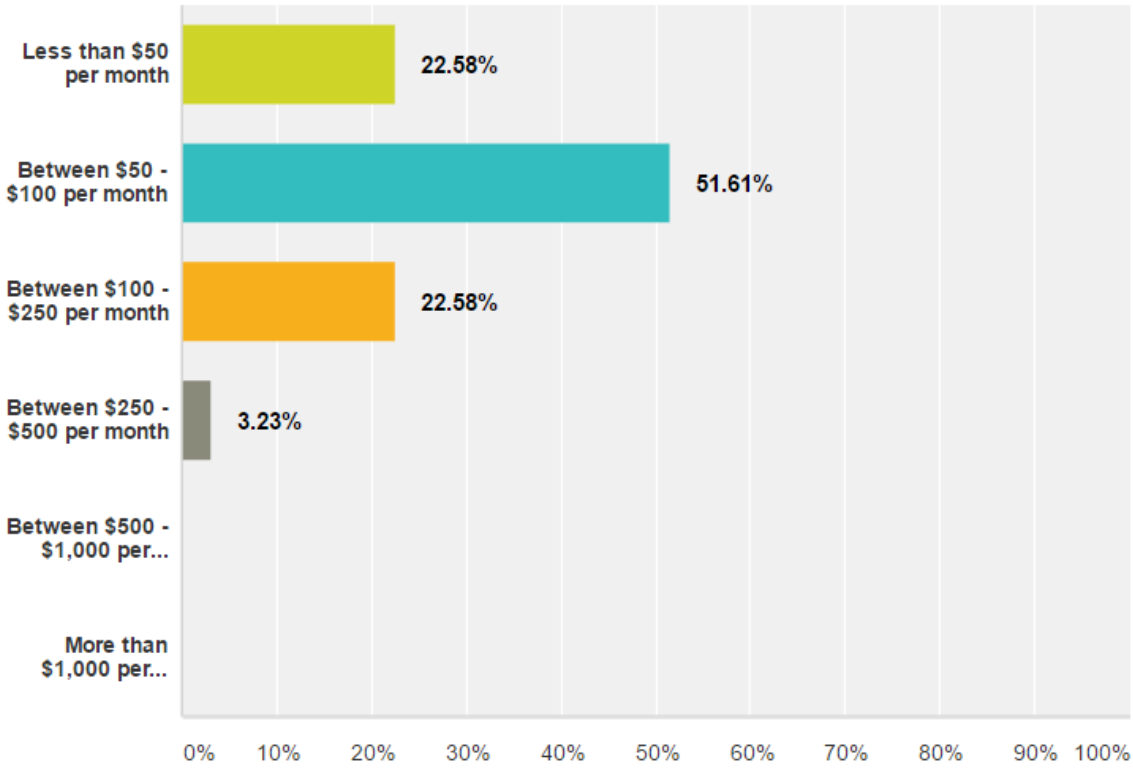
Teleworking. Of the 28 businesses that responded, 57% have employees that work from home at least one day in a typical work week.

- 14.29% responded that employees work five days a week from home.
- 17.86% responded that employees work three days a week from home.



Current Service

Nearly a quarter of surveyed businesses pay between $100 & $250/month for Internet service.

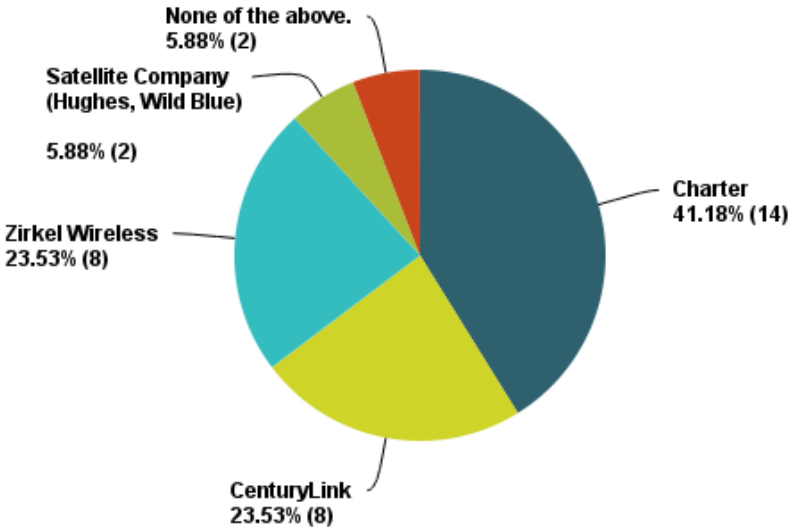


Current Providers

Charter (41%) and CenturyLink (24%) subscribers dominated the business survey sample as the primary Craig/Moffat County ISPs.

Q5 Which of the following Internet Service Providers do you use at your business? If you have more than one Internet Service Provider, please select your primary provider at your business.

Answered: 34 Skipped: 0



Answer Choices	Responses	
Charter	41.18%	14
CenturyLink	23.53%	8
Zirkel Wireless	23.53%	8
Unite Fiber Networks	0.00%	0
Strata Networks	0.00%	0
Mammoth	0.00%	0
Level 3	0.00%	0
Satellite Company (Hughes, Wild Blue)	5.88%	2
I do not use any of these internet service providers	5.88%	2
Total		34

Connectivity. 39% of Craig/Moffat County residents are connected to the Internet with cable and 24% are connected with DSL. No businesses in Moffat County are currently connected by fiber.

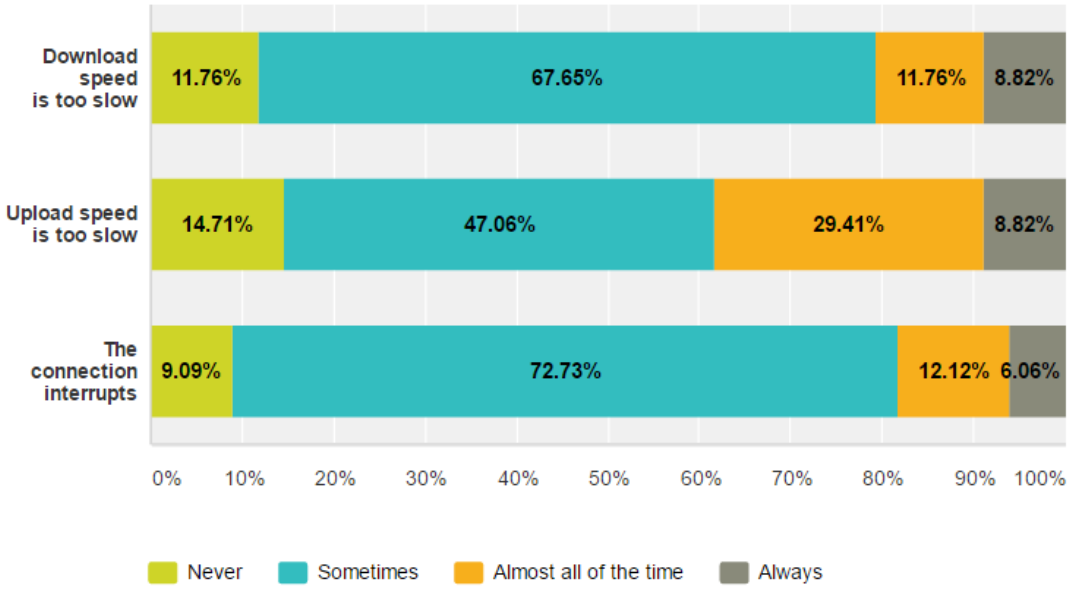
Answer Choices	Responses	
Cable (usually provided as part of your cable TV package)	39.39%	13
DSL (usually provided by the phone company)	24.24%	8
Wireless (usually provided by an independent service provider using an antenna on the roof pointed to another ground antenna.)	12.12%	4
I don't have Internet service at my home.	12.12%	4
Mobile Phone Wireless, Cellular (typically is part of your cell phone plan)	6.06%	2
Satellite (usually provided as part of your Satellite TV package)	3.03%	1
I do not know what type of connection I have at my home.	3.03%	1
Dial-up (requires you to use a modem and your regular phone line)	0.00%	0
T-1 Service (a special kind of service often available from the phone company rated at a fixed 1.5 Mbps)	0.00%	0
Fiber connection (uses fiber optics to provide the signal. May be provided by the phone company or other providers. Typically used for higher speeds)	0.00%	0
Total		33

Speed Test Results, Reliability, Perceptions

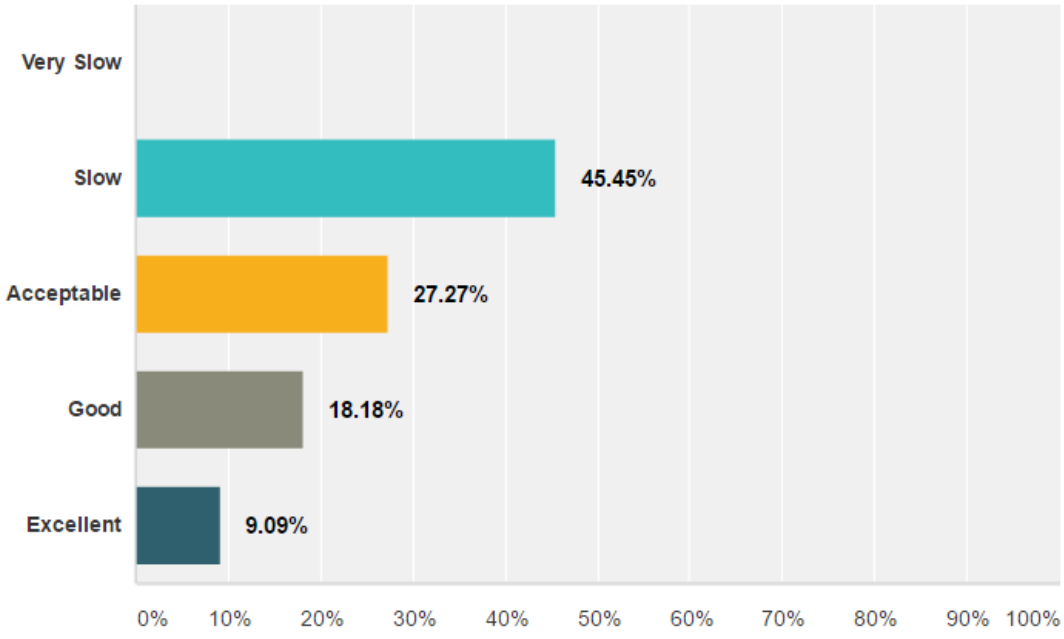
Speed Test Results. The survey provided instructions to respondents to take an actual speed test. 33 of the 40 respondents took the speed test and recorded the results.

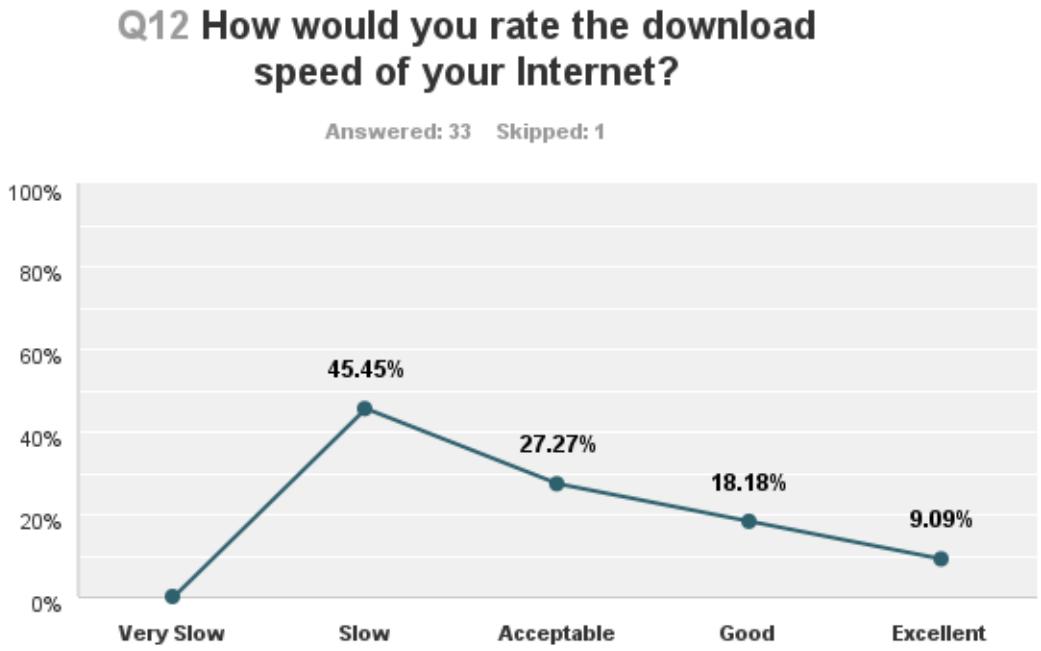
- The average speeds recorded were 33.89 Mbps download and 6.95 Mbps upload.
- The lowest speeds recorded were 4.29 Mbps download and .15 Mbps upload.
- The highest speeds recorded were 66.42 Mbps download and 9.04 Mbps upload.
- 48% of the speed tests recorded were below the FCC's 25 Mbps broadband threshold.
- 28% of the speed tests recorded were below the FCC's 3 Mbps broadband threshold.

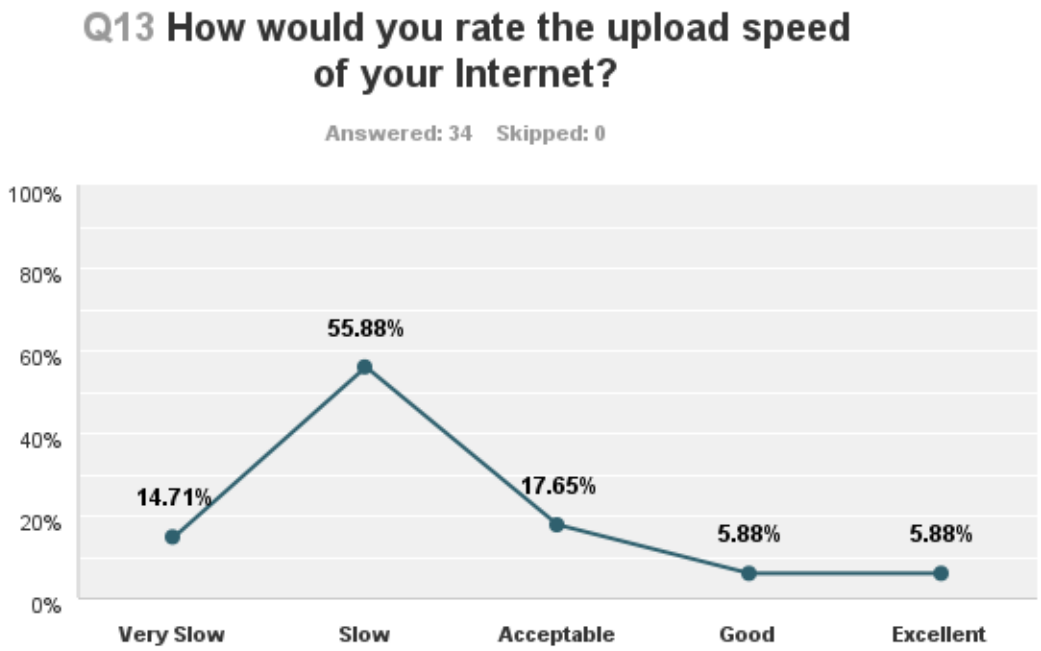
Reliability. 21% of respondents say their business' download speed is either always or almost always too slow, while 38% say the same about their upload speed. Nearly a quarter (18%) said they have frequent service interruptions.



Perception of Speed. Only 28% of surveyed businesses rate their Internet as "excellent" or "good." 45% see their speed as "slow".





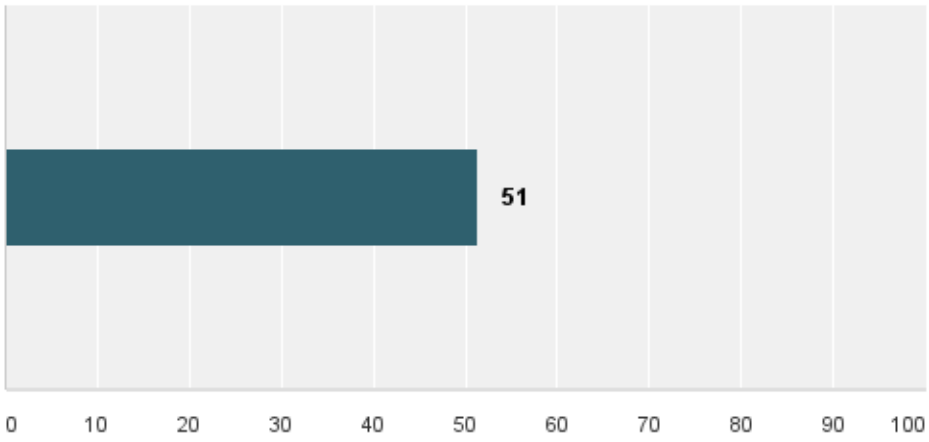


Expected Level of Service

When asked how fast the Internet should be, business respondents on average wanted 51 Mbps.

Q18 How fast do you think your Internet service should be at your place of business? What service level do you expect or need?

Answered: 25 Skipped: 9



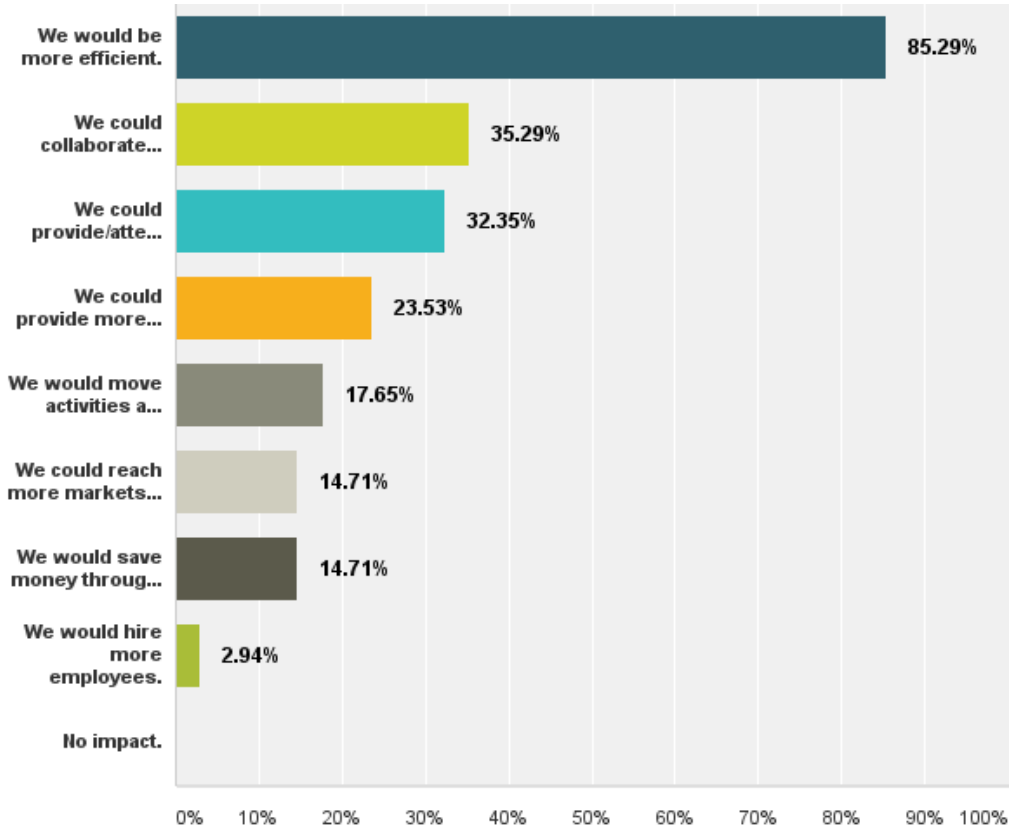
As it is difficult to understand how fast the Internet should be, most stated they did not know how fast the Internet should be, but that it should be MUCH faster. Correlating closely with the residential survey data, respondents wanted faster service than what they have today.

Answer Choices	Responses	
I don't know how fast I need, but I would like it MUCH faster than what I have.	41.94%	13
I don't know how fast I need, but I know that I need more UPLOAD speed than what I have.	25.81%	8
I don't know how fast I need, but I know that I need more DOWNLOAD speed than what I have.	22.58%	7
I don't know how fast I need, it seems to be working fine with what I have now.	22.58%	7
Total Respondents: 31		

How would the Business Benefit with Faster Internet?

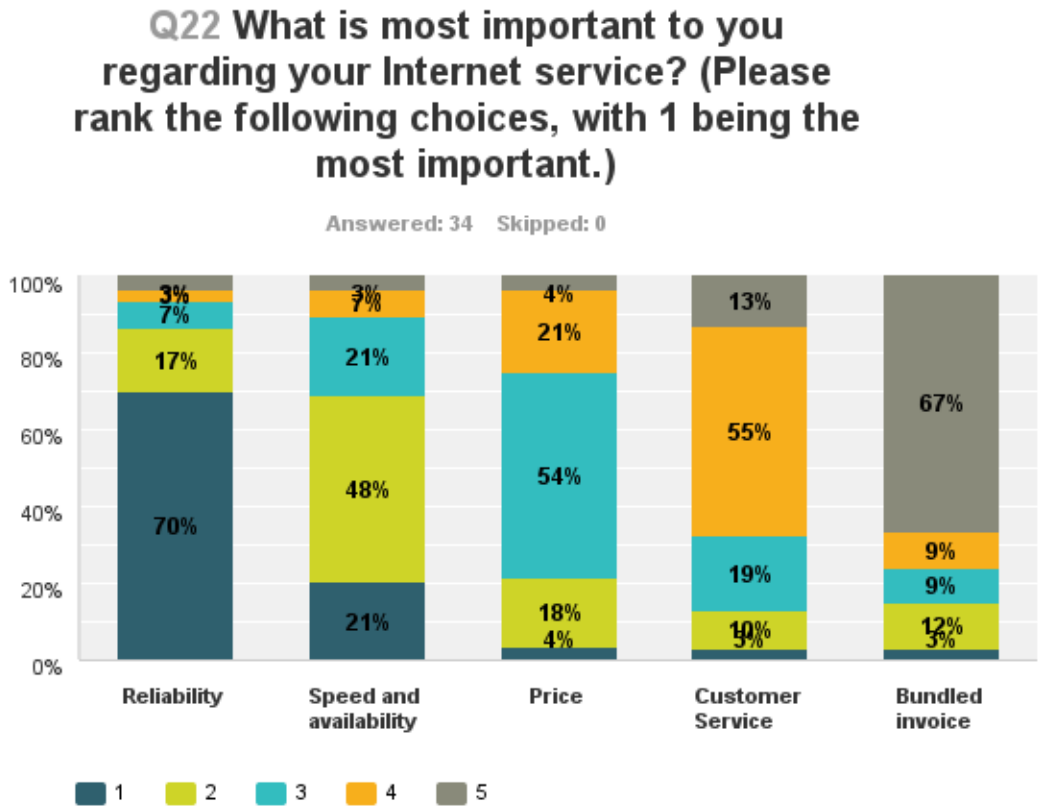
The strongest benefits regarding faster Internet were that businesses would be more efficient, they would collaborate with customers and partners, they would provide and attend more webinars and online training and they would provide more products and services to their customers.

Answer Choices	Responses	
We would be more efficient.	**85.29%**	29
We could collaborate with customers and partners we currently have difficulty connecting with now.	**35.29%**	12
We could provide/attend more webinars and online training.	**32.35%**	11
We could provide more products and services to our customers.	**23.53%**	8
We would move activities and more business functions/applications to the cloud.	**17.65%**	6
We could reach more markets, more territories, more locations.	**14.71%**	5
We would save money through Internet applications	**14.71%**	5
We would hire more employees.	**2.94%**	1
No impact.	**0.00%**	0
Total Respondents: 34		



What is Important?

When asked to rate the most critical components of Internet service, overwhelmingly, businesses are looking for reliability (70% indicated it was of the most importance), followed by and speed and then price.



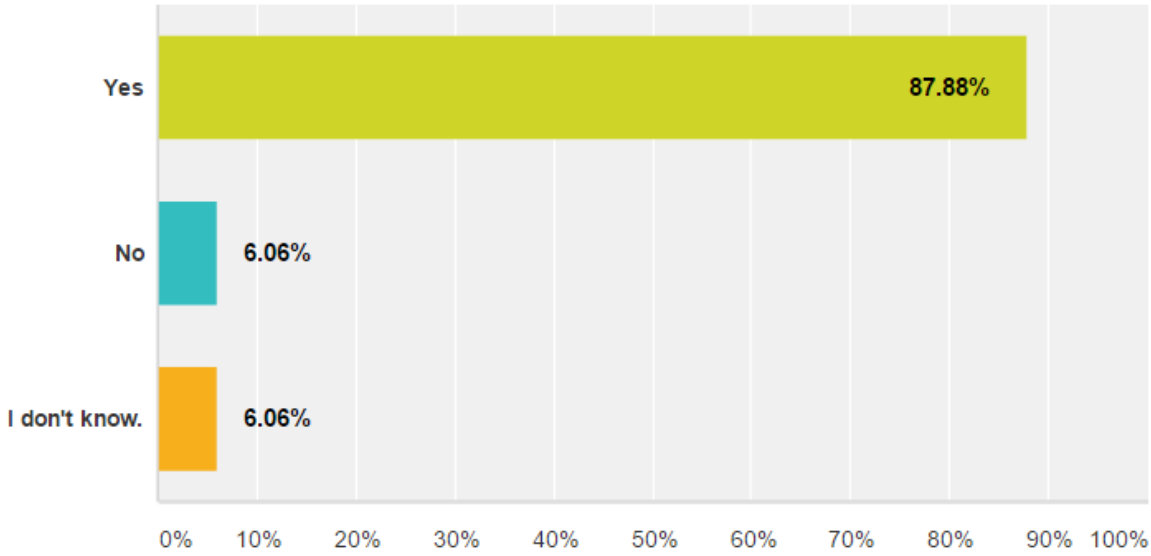
Relationship of Broadband to Operations & Broadband as a Utility

When asked how to characterize their business in relation to their Internet service, most businesses report that they are heavily tied to the Internet and their demands for it are increasing.

	Strongly Agree	Agree	Neutral/Not Sure	Disagree	Strongly Disagree	Total	Weighted Average
Our business operations are heavily tied to the Internet.	53.13% 17	28.13% 9	6.25% 2	9.38% 3	3.13% 1	32	4.19
Our demands on Internet bandwidth and speed is consistently increasing.	46.88% 15	40.63% 13	3.13% 1	9.38% 3	0.00% 0	32	4.25
We rely on the Internet to drive leads and revenues.	31.25% 10	46.88% 15	9.38% 3	6.25% 2	6.25% 2	32	3.91
The Internet is important to my business, mostly for "basics" like email, research, etc.	18.18% 6	27.27% 9	6.06% 2	24.24% 8	24.24% 8	33	2.91
We currently sell our products and services online.	18.18% 6	39.39% 13	18.18% 6	15.15% 5	9.09% 3	33	3.42
The current Internet speed available will eventually prevent us from our growth potential.	18.75% 6	43.75% 14	21.88% 7	15.63% 5	0.00% 0	32	3.66
The current Internet speed available is holding back our growth potential today.	15.63% 5	28.13% 9	43.75% 14	6.25% 2	6.25% 2	32	3.41

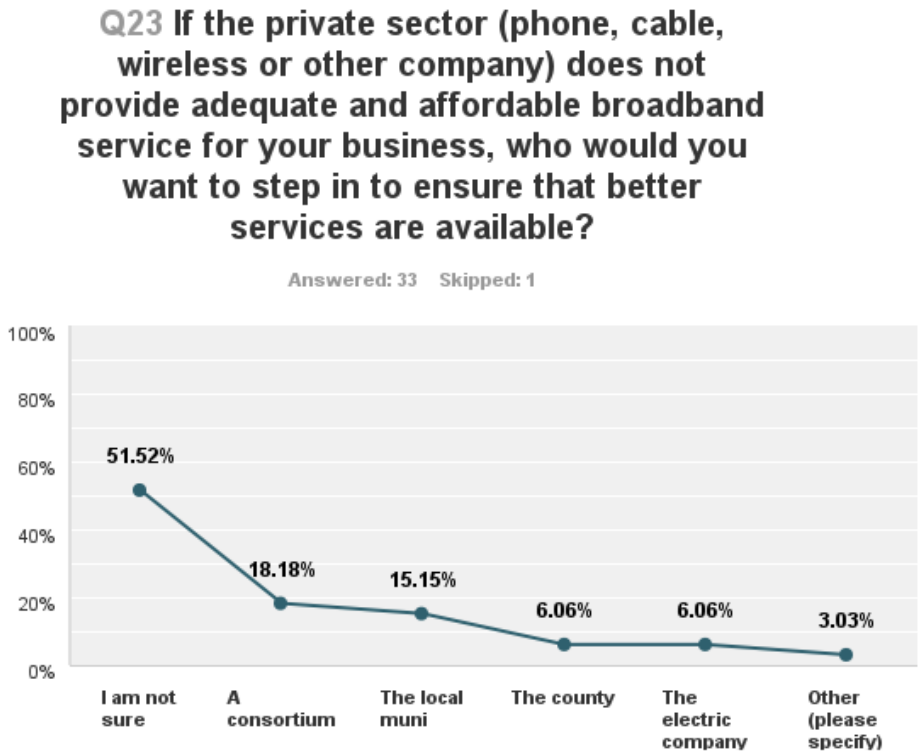
Broadband as a Utility.

Nearly 90% of businesses surveyed believe that Broadband is a utility.



The Role of Government

Respondents were asked, who should step in to provide adequate and affordable broadband services to business where the private sector is not currently doing so. Over half of all respondents were unsure about who should close the gap.



When asked what the role of government (i.e. the local municipality or the county) should be in terms of solving broadband issues within a community if adequate or affordable service was not being offered from the private sector, unlike the residential survey, most respondents were in favor of the local government working with the private sector or having the private sector build the network.

More specifically, business respondents were presented with six (6) options for action that could be taken by the community, including "do nothing" as one of the options. Most popular were options that included partnership with the private sector, either current Internet Service Providers (ISPs) or other private firms.

Answer Choices	Responses	
Partner with current providers to improve the speed and reliability of their services.	31.25%	10
Partner with a private firm to build a state-of-the-art network.	25.00%	8
Install state-of-the-art network and offer services to the public, including homes and businesses, and government offices	18.75%	6
Install state-of-the-art services and enter into agreements with private companies to offer services to the public.	12.50%	4
Do Nothing. Let private providers decide what services they are willing to provide.	9.38%	3
Install state-of-the-art network for businesses, schools, government offices and the medical community only.	3.13%	1
Total		32

Businesses Relationship to the Internet

There were several questions posed to respondents regarding how strongly they agree with various statements regarding their business's relationship to the Internet. The questions included the following and resulted in the following order of importance.

- Our business operations are heavily tied to the Internet.
- Our demands on Internet bandwidth and speed is consistently increasing.
- We rely on the Internet to drive leads and revenues.
- The Internet is important to my business, mostly for "basics" like email, research, etc.
- We currently sell our products and services online.
- The current Internet speed available will eventually prevent us from our growth potential.
- The current Internet speed available is holding back out growth potential today.
- If Internet service doesn't improve, we may have to move all or part of our operations to another community.

	Strongly Agree	Agree	Neutral/Not Sure	Disagree	Strongly Disagree	Total	Weighted Average
Our business operations are heavily tied to the Internet.	**53%** 17	**28%** 9	**6%** 2	**9%** 3	**3%** 1	32	4.19
Our demands on Internet bandwidth and speed is consistently increasing.	**47%** 15	**41%** 13	**3%** 1	**9%** 3	**0%** 0	32	4.25
We rely on the Internet to drive leads and revenues.	**31%** 10	**47%** 15	**9%** 3	**6%** 2	**6%** 2	32	3.91
The Internet is important to my business, mostly for "basics" like email, research, etc.	**18%** 6	**27%** 9	**6%** 2	**24%** 8	**24%** 8	33	2.91
We currently sell our products and services online.	**18%** 6	**39%** 13	**18%** 6	**15%** 5	**9%** 3	33	3.42
The current Internet speed available will eventually prevent us from our growth potential.	**19%** 6	**44%** 14	**22%** 7	**16%** 5	**0%** 0	32	3.66
The current Internet speed available is holding back our growth potential today.	**16%** 5	**28%** 9	**44%** 14	**6%** 2	**6%** 2	32	3.41
If Internet service doesn't improve, we may have to move all or part of our operations to another community.	**3%** 1	**6%** 2	**23%** 7	**29%** 9	**39%** 12	31	2.06

Open Ended Responses, Business Survey

The survey asked for any other comments in regards to current services or thoughts regarding a community broadband network. Here are all responses to the open-ended comment question.

- If our community members and professional partners want us to be able to stay current in technologies and be able to communicate outside of our little microcosm we need to invest in infrastructure.
- It would be nice if Moffat County would do something about Internet and cell service. Too often are their areas with no cell service, no network service, etc... Our company would be more efficient with our jobs as well as serving our customers if we didn't lose Internet as often as we do or also speed up the Internet so it is not such a delay when trying to assist teammates and customers. I hope this county does do something to assist with these problems.
- Let the free market thrive and focus on a small, limited government as opposed to an overreaching government that will require unproportionate increased revenues in order to provide slightly faster Internet speeds. Stop trying to make Craig like Steamboat Springs or Denver. If we wanted to live there, we would be there.
- Let's do this!!!!

- We cannot accept mediocracy!

- We have seen some attempts in the past to improve our Internet but nothing has been totally followed thru.
- We need to focus efforts on redundancy to avoid outages, then worry about speed, at least in the beginning.
- What benefit does the City of Craig provide to the public for the franchise fees associated with each bill? Where does the money go? Who is the responsible person in city government who is supposed to address service issues? What was their job performance rating on this issue at their annual review/evaluation?

Appendix C: Glossary of Broadband Terms

Provided by The Institute of Local Self Reliance, https://muninetworks.org/glossary.

asymmetrical

Internet connections have two components - a downstream and upstream. When the two speeds are not comparable, the connection is termed asymmetric. Typically, phone and cable companies offer much slower upload speeds than download, in part because the Internet tended to be a download-centric system in the 90's and early 00's. However, users increasingly need faster upstream connections to take full advantage of modern applications.

backhaul

A general term for the segment of a network between the core and the edge. An example: the connection from a community network hub in a small town to a carrier hotel where it connects to the Internet backbone.

bandwidth

The rate at which the network can transmit information across it. Generally, higher bandwidth is desirable. The amount of bandwidth available to you can determine whether you download a photo in 2 seconds or 2 minutes.

bit

The base unit of information in computing. For our purposes, also the base unit of measuring network speeds. 1 bit is a single piece of information. Network speeds tend to be measured by bits per second - using kilo (1,000), mega (1,000,000), and giga (1,000,000,000). A bit is a part of byte, they are not synonyms. Bit is generally abbreviated with a lower-case b.

BTOP

Broadband Technology Opportunities Program - established by the 2009 stimulus legislation, a program to disburse $4.7 billion to improve broadband access and literacy throughout the country.

byte

The base unit for file storage. Comprised of 8 bits (just to confuse you - if you don't like powers of 2, stay away from computer science). A 1MB (megabyte) file is made of 8 million bits. Bytes generally refer to the size of storage whereas bits are used frequently when discussing how rapidly files may be moved. Byte is generally abbreviated with a capital B.

cable modem system

Cable television companies have offered Internet access via their cable system for more than a decade. The network architecture uses a loop that connects each subscriber in a given neighborhood, meaning they all share one big connection to the Internet. Over time, needs have increased faster than capacity on these networks. Because the cable network shares the last mile connection among hundreds of subscribers, a few bandwidth hogs can slow everyone's experience.

cloud

Some refer to the entire Internet as a cloud - the idea being that all the information is just out there and it does not matter where. More commonly now, cloud computing refers to services such as Amazon's S3 where users pay a fee to store information on Amazon's servers without ever really knowing the physical location. As we gain access to faster Internet connections (particularly on the upstream) cloud services may offer cheaper means of accomplishing tasks and more reliable backups.

conduit

A reinforced tube through which cabling runs. Conduit is useful both to protect fiber-optic cables in the ground and because one can place the conduit underground when convenient and later "blow" or "pull" the fiber cabling through the conduit.

CPE

Customer Premises Equipment - typically describes the box on the side of a house that receives and sends the signal from the network, connecting the subscriber.

DOCSIS 3

This is a technical specification that allows modern cable networks to offer considerably faster speeds than those used by earlier DOCSIS specifications. Comcast rolled out DOCSIS 3 in Minneapolis/St. Paul in early 2008, offering an “up to"50 downstream/5 upstream connection for $150/month. Note the slow upstream connection and the high price. The greatest flaw with

DOCSIS 3 remains the shared nature of the last mile, meaning a few bandwidth hogs can slow everyone's connection on that loop.

DOLA

The Colorado Department of Local Affairs (DOLA).

downstream

Internet connections have two components - a downstream and upstream. Downstream refers to the rate at which the user's computer can receive data from the Internet.

Synonyms: download

DSL

Digital Subscriber Line - or Internet access offered over the phone lines. DSL allows users to use the Internet at speeds greater than dial-up while also using the phone line for telephone conversations. DSL uses frequencies not used by human voices. Unfortunately, these frequencies degrade quickly over distance, meaning customers must live within a mile of the central office to get the fastest speeds.

duopoly

A situation in which two companies own all or nearly all of the market for a given type of product or service.

fiber-optic

A system that uses glass (or plastic) to carry light which is used to transmit information. Typically, each side of the fiber is attached to a laser that send the light signals. When the connection reaches capacity, the lasers may be upgraded to send much more information along the same strand of fiber. This technology has been used for decades and will remain the dominant method of transmitting information for the foreseeable future.

FiOS

Verizon is the only large carrier building a FTTP network. This network is called FiOS. Though FiOS is similar technologically to community fiber networks, we believe communities should have a strong voice in how the network is run and Verizon does not offer this.

franchise

A cable company wishing to provide television services in a community historically signed a franchise agreement with the municipal government. The agreement would specify what the community would receive from the cable company in return for access to rights of way (such as telephone poles). However, this arrangement has changed in many states recently, where states have preempted local control. Cities now are not permitted to offer exclusive franchises.

FTTH

Fiber-to-the-home. As most telecommunications networks use fiber in some part of it, FTTH is used to specify those that use fiber to connect the subscriber. Some claim they have a fiber-optic network because they use fiber to the node even when they use phone lines or a cable network over the last mile. FTTH may be more expensive to install currently, but offers significant savings in terms of maintenance when compared to copper alternatives.

FTTU

Fiber-to-the-User is used somewhat interchangeably with FTTH to describe full fiber networks.

Gbps

Gigabits per second - or one billion bits per second. 8 Gbps means that 8 billion bits are transferred each second. Using an 8 Gbps connection, it would take 1 second to transfer a 1 GB (Gigabyte) file - a compressed 90 min movie, for instance. 1 Kbps (Kilobits)<1 Mbps (Megabits)<1 Gbps

greenfield

A plot of land that will soon become a residential development. Building a broadband network is cheap in Greenfields because roads, sidewalks, lawns, and buildings are not yet impediments to running the necessary wires.

HFC

Hybrid Fiber-Coax - a network that combines some fiber-optic elements (typically from the head end to a node in the field) and coaxial cable (typically the loop that connects the node to subscribers).

I-Net

Short for Institutional Network. This is the network a municipal government requires to carry out its duties. I-Net frequently refers specifically to a network built for city uses (connecting

schools, for instance) by the cable company as part of the franchise agreement with the city. Cities are increasingly seeing the value of owning their own network.

Synonyms: Institutional Network

Kbps

Kilobits per second - a measure of speed. 8 Kbps means that 8 thousand bits are transferred each second. Using an 8 Kbps connection, it would take 1 second to transfer a 1 KB (Kilobyte) file - a text file, for instance. Don't get lost in the details - when it comes to Kbps, more is faster - but anyone on the modern internet better measure their connection in Mbps. 1 Kbps<1 Mbps (Megabits)<1 Gbps (Gigabits)

last mile

Describes the final leg of a connection between a service provider and the customer. In DSL and cable systems, this is the most frequent bottleneck and the most expensive to resolve. The service provider may run a faster fiber-optic network into the neighborhood but deliver the last mile (which could be considerably less than a mile -"last “is the operative term) with a phone lines that cannot sustain fast speeds.

Synonyms: first mile

latency

The amount of time it takes for a bit to get from point A to point B. In the words of Dr. Stuart Cheshire: "If you want to transfer a large file over your modem it might take several seconds, or even minutes. The less data you send, the less time it takes, but there's a limit. No matter how small the amount of data, for any particular network device there's always a minimum time that you can never beat. That's called the latency of the device."

Mbps

Megabits per second - a measure of speed. 8 Mbps means that 8 million bits are transferred each second. Using an 8 Mbps connection, it would take 1 second to transfer a 1 MB (Megabyte) file - a photo, for instance. Don't get lost in the details - when it comes to Mbps, more is faster. 1 Kbps (Kilobits)<1 Mbps<1 Gbps (Gigabits)

MDU

Multiple dwelling unit - most frequently apartment buildings. MDUs can offer a challenge when building a FTTP network due to the need to negotiate with building owners and rewiring that may be necessary to bring fast speeds to each unit.

middle mile

Middle mile is a term most often referring to the network connection between the last mile and greater Internet. For instance, in a rural area, the middle mile would likely connect the town's network to a larger metropolitan area where it interconnects with major carriers.

NATOA

National Association of Telecommunications Officers and Advisers. NATOA is comprised of local government officials and employees that work on cable and broadband issues - from public access television to managing the community's rights-of-way.

NTIA

National Telecommunications and Information Administration - a division of the Department of Commerce in Washington, DC.

open access

An arrangement in which the network is open to independent service providers to offer services. In many cases, the network owner only sells wholesale access to the service providers who offer all retail services (i.e.: triple play of internet, phone, TV). Open access provides much more competition from which potential subscribers can choose.

overbuild

To create a network that goes into competition with an incumbent provider.

passed

Residences or businesses that have access to the network. As a FTTP network is constructed, it will generally be built through a neighborhood before individual houses or businesses are connected via a drop cable (which is also a fiber-optic cable). When a house or businesses is"passed,"it means they are eligible to sign up for services (which may require a technician to hook up the drop cable).

peer-to-peer

This is a type of network that allows computers to connect directly to each other rather than organizing them via hierarchical connections. This term is most often used to describe a type of file sharing that has greatly increased bandwidth usage and allow faster downloading of the same file from multiple computers. Peer to peer technologies, such as Bit Torrent, can greatly reduce the cost of distributing content to a large audience but also have been used to exchange copyrighted materials without permission. P2P connections generate a lot of traffic and are often throttled or denied access by broadband providers.

Synonyms: p2p

PEG

PEG is an acronym for Public Access, Educational, and Government video programs. These are common programming options made available to the community by the cable company in return for access to the community's rights of way.

quadruple play

Triple-play with cell phone service. Only a few companies are starting to offer this - combining the now standard triple-play (television, phone, and Internet access) with a cell phone plan.

RUS

Rural Utilities Service - a branch of the US Department of Agriculture. RUS offers loans to entities deploying broadband in rural areas.

symmetrical

Internet connections have two components - a downstream and upstream. When the two speeds are comparable, the connection is termed symmetric. Fiber-optic networks more readily offer symmetrical connections than DSL and cable, which are inherently asymmetrical. Ultimately, purely symmetrical connections are less important than connections which offer robust connections in both ways. However, modern asymmetrical connections via DSL and cable networks offer upload speeds that are too slow to take advantage of modern applications.

T1

A data circuit that transmits at 1.544 Mbps.

Synonyms: T-1, T.1

take rate

The number of subscribers to a service - typically expressed in a percentage of those taking the service divided by the total number of people who could take the service. If a community fiber network passes 10,000 people and 6,000 people subscribe, it has a take rate of 60%. When planning the network, it will be built to be profitable at or above a certain take rate as defined in the business plan. Generally, networks require a few years to achieve take rates due to the long time it takes to connect each customer.

telco

Telephone company - a provider of telecommunications services such as voice (telephony) and data services. Also, called common carriers or LECs (Local Exchange Carriers); ILECs are incumbent providers, often AT&T or Verizon.

telepresence

This term refers to a variety of attempts to use modern technology to make it seem like a person in a remote location is in the room. The more bandwidth available, the more realistic the remote person will appear. Modern telepresence applications are impressive, using sophisticated algorithms with multiple video cameras and microphones to go far beyond video-telephone systems.

triple-play

The three main services offered over these networks - television, phone services, and Internet access. Turns out that many people like to get all three from the same service provider on the same bill. Service providers frequently offer deals that will lower the cost on these packages. Typically, television breaks even or loses money whereas the service provider makes the most profits from phone and Internet access.

upstream

Internet connections have two components - a downstream and upstream. Upstream refers to the rate at which the user's computer can send data to the Internet. DSL and cable networks frequently offer upload speeds at only 1/10 of the downstream speeds. This is one of the main reasons DSL and cable networks are insufficient for the modern Internet.

Synonyms: upload

USF

Universal Service Fund - a federal program with four programs: high cost (subsidizes the high cost of services in rural areas), low income (includes Lifeline and Link Up discounts to those in poverty), rural health care (reduced rates to rural health care providers to ensure they have access to similar services as urban counterparts), and schools and libraries (E-Rate subsidizes telecommunication services to schools and libraries).

Wi-Fi

This is a suite of protocols that allow wireless devices to exchange information using unlicensed frequencies. Equipment carrying the Wi-Fi brand is interoperable. Recently, a number of cities and some private companies attempted to blanket their cities with Wi-Fi but the technology is not well suited to such large-scale efforts. Wi-Fi has proved tremendously successful in homes and businesses on small cities.