Broadband Strategic Plan

Waseca County, Minnesota

September 22, 2020

Finley Engineering
CCG Consulting

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EXECUTIVE SUMMARY

Finley Engineering and CCG Consulting submit this Broadband Feasibility Study that provides our findings and recommendations for bringing better broadband to the rural parts of Waseca County.

The first phase of the study was to look at the need for broadband in the county. We tackled that task in several ways. We talked to the existing service providers in the county to understand their long-term plans for broadband expansion. We mapped the coverage areas of existing ISPs. We investigated the current broadband products and prices available in the county today. Our analysis verified the county's belief that the rural parts of the county have slower and mostly inadequate broadband.

We then looked at what we call the broadband gaps in the rural parts of the county. This involved comparing broadband in the rural areas to broadband available in the cities in the county and elsewhere in the country. This report discusses the various broadband gaps we identified during our research and includes things like the urban/rural gap mentioned above. We discuss the homework gap where students without home broadband don't perform as well in school. We discuss the computer gap where homes without computers don't do as well as homes with them. We look at the broadband speeds available in the county today and compare them to other places. We discuss several ideas for overcoming the various identified broadband gaps.

In the next phase of the study, Finley Engineering quantified the cost of building a broadband network to serve the rural parts of the county. Finley studied two scenarios for bringing better broadband. The first scenario brings fiber to all rural parts of the county. The second scenario considers building a fiber network to serve rural wireless towers while serving fiber broadband to homes and businesses along the fiber routes. Finley Engineering undertook the engineering analysis in such a way that they could generate the cost for building to any portion of the county if an ISP wants to consider coming to Waseca County. We think this might be one of the most important parts of our product, since knowing the cost of building a network is generally the number one question asked by any ISP considering serving there.

Next, CCG Consulting created financial models that reflect the potential profitability for an ISP operating a broadband business in the rural parts of Waseca County. Just like with the Finley Engineering analysis, we could modify our work to fit some smaller footprint if an ISP is interested. These studies include assumptions that we think are representative for estimating the revenues and the costs from operating a broadband business.

We were not surprised to find out that sizable grants would be required to finance fiber construction in the rural parts of the county. That was fully expected, and we've never seen a rural area where customer revenues fully support the cost of fiber without some grant assistance. Our analysis shows that building fiber everywhere in the rural parts of the county would require at least $13.6 million in grants.

We conclude the report by providing a list of specific steps that Waseca County should consider after getting this report. The most obvious next step is to share this report with ISPs, and Finley engineering has already talked to a few ISPs that are the mostly likely interested in serving the county. This study will answer a lot of questions about serving in Waseca County and might also bring interest from an ISP that might not have otherwise considered coming to the county. There are other recommendations discussing how the county can address the various broadband gaps.

FINDINGS

Following are our primary finding:

Existing Providers and Market Rates. The county has a long list of ISPs operating somewhere in the county today. This includes incumbent telephone service provided by CenturyLink, Frontier, Consolidated Communications, Bevcomm, and Manchester Hartland. Two incumbent cable companies operate in the populated areas - Midcontinent Communications and Mediacom. Jaguar provides fiber to some locations in both cities and rural areas. There are several wireless providers in the county including LTD Broadband and Radio Link. Some rural homes get home broadband using the cellular broadband from AT&T, Verizon, and T-Mobile, which recently merged with Sprint. The county is also served with satellite broadband and cable TV. The study looks at the key products and prices currently offered by these existing ISPs.

The Study Areas. The County elected to look at a study that brings faster broadband to all parts of the county that are either unserved or underserved today using the Minnesota state definition of broadband. That defines anything slower than 25/3 Mbps as unserved and speeds between 25/3 Mbps and 100/20 Mbps as underserved. The towns of Waseca, New Richland, Janesville, and Waldorf are all considered as a served as well as customers along a few major highway routes. The study area is essentially all of the areas outside the cities, less some small pockets of fiber that will be built by the smaller telephone companies. A map of the study area is shown on Exhibit II.

The Study Scenarios. The broadband studies assume that the County will be seeking ISP partners to bring better broadband to the rural parts of the county, and our analysis was done from the perspective of the ISPs. The studies considered three scenarios:

- Bringing fiber to all of the rural parts of the county.
- Bringing better broadband with a network that builds fiber to seven wireless towers. This scenario would bring fiber broadband to about 129 homes and businesses and would bring wireless broadband with speeds of 50 Mbps to at least the rural parts of the study area, with many homes getting speeds as fast as 100 Mbps.

Broadband Gap Analysis. We undertook a broadband gap analysis by comparing the broadband products and speeds in the rural parts of the county to the cities and elsewhere. The most significant broadband gap in the rural parts of the county is broadband availability – the options for buying broadband in the rural areas are significantly fewer than in the cities.

The report also discusses the other typical broadband gaps that are present in every community. This includes the affordability gap where homes can't afford the cost of broadband. The computer gap describes the fact that many homes can't afford to buy and maintain a computer in the home. The broadband skills gap describes the fact that many residents don't have the digital skills needed to use computers and broadband. The homework gap describes the consequences for students that don't have computers and/or broadband in the home.

The report also discusses how broadband gaps are widening. Broadband speeds and capabilities have been increasing in cities while rural residents are left with the same poor broadband options. The gap between the cities and rural areas is widening rapidly with each passing year.

Fiber Network Design. Finley Engineering determined the cost of building the networks needed for each of the three study scenarios. The chosen network design uses Passive Optic Network (PON) technology on fiber to provide gigabit broadband capability on fiber. The network design also allows any large customers to be serviced using Active Ethernet technology that can deliver dedicated bandwidth up to 10 gigabits per second in speed. The hybrid scenario mixes fiber along with state-of-the-art wireless technology that can deliver download speeds up to 100 Mbps. In the majority of the rural area, except perhaps in pockets near the river, the cheapest construction method will be to bury fiber.

Passings. The telecom industry uses the term passing to mean any home or business that is near enough to a network to be considered as a potential customer. Finley Engineering primarily used the county's GIS database to count passings. Our engineers settled on the following as the count of potential passings for the study area.

Residential Customers	1,780
Business Customers	31
Total	1,811

Miles of Fiber Construction. The study contemplated building fiber to pass every home and business in the study area. Finley Engineering identified the following road miles of fiber required to bring fiber everywhere:

All Fiber Scenario	514.8 miles of fiber
Hybrid Scenario	60.6 miles of fiber

Asset Costs**.** Below is a summary of the cost of the assets needed to provide fiber to the study area. The all-fiber scenarios assumed a customer penetration rate of 65%, while the hybrid scenario assumed 60%. The needed assets change with fewer or greater numbers of customers.

	All Fiber	Hybrid
Fiber	$12,972,108	$ 1,525,391
Fiber Drops	$ 1,158,371	$ 94,100
Electronics	$ 1,084,808	$ 1,503,569
Huts/Land	$ 223,000	$ 223,000
Operational Assets	$ 267,155	$ 176,690
Total	$15,705,442	$ 3,522,750
Cost per Passing	$ 8,672	$ 1,945
Cost per Customer	$13,342	$ 3,242

Our Approach to the Financial Analysis. We used the following approach in estimating the revenues and costs for operating a new fiber network for each scenario:

- A base model was created. We arbitrarily chose a 65% market penetration (the percentage of customers using the network) in the all-fiber scenario and 60% in the hybrid scenario. We don't know how many customers a new ISP network business might gain and chose these penetration rates as typical of other similar fiber markets.

- All financial models cover a 25-year period. All projections include projected financing costs for borrowing the money needed to build and launch the network.
- The studies include the engineering estimates of asset costs made by Finley Engineering. We've assumed that electronics wear out and need to be replaced periodically during the studied time frame.
- Products were priced at what we think is a reasonable market rate compared to existing prices in the county today. The Internet speeds offered on the fiber network would be significantly faster than other products available in the study area today.
- The estimates of operating expenses represent our best estimate of the actual cost of operating the fiber business. Most operating expenses are adjusted for inflation at 2.5% per year.

Key Financial Study Results. The assumptions used in creating the various business plans are included in Section III.B of the report. The results of the financial analysis are included in Section III.C of the report. A summary of the financial results is included in Exhibit V. Following are the key financial findings of our analysis.

- To bring fiber broadband to all the rural parts of Waseca County will require substantial grant funding. For example, at a 65% customer penetration rate we calculate that a grant of at least $13.6 million is required. Customer revenues alone cannot pay for a new fiber network.
- It looks like the hybrid scenario could be financed and constructed without grants.
- A fiber broadband business in rural Waseca County will be sensitive to a few key variables. One important variable is the customer penetration rate, and it would be essential before building fiber for an ISP to better understand the number of customers likely to buy broadband. Another key variable is broadband prices, and even shifting broadband prices by a few dollars has a big impact on the bottom line. The financial performance is also sensitive to loan term – the number of years to repay loans. The business models show less, but still significant sensitivity to the interest rates on debt and the cost of the network.

Funding Options. As mentioned above, any broadband expansion into the rural areas will require substantial grant funding. The most likely grant funding is going to come from various federal broadband grants and/or the Minnesota DEED grant program. There is currently a lot of talk in Washington DC about making more money available for rural broadband, so there is the chance of upcoming substantial broadband grants. Now that the county has this study in hand, especially the engineering cost estimates made by Finley Engineering, you are well-positioned to help ISPs consider any future grants.

RECOMMENDATIONS / NEXT STEPS

Following is a list of recommendations that come from our analysis of the broadband landscape in Waseca County.

Reach Out to Potential ISP Partners

We always recommend that the first step after undertaking this kind of study is to reach out to potential ISP partners. That begins by sharing the results of this study. ISPs will be interested in much of the research we've done. ISPs that have not undertaking any engineering analysis in Waseca County will be interested in the network cost estimates calculated by Finley Engineering. ISPs that haven't created financial business plans will be interested in the financial analysis that demonstrates how well they might perform in Waseca County. Finley Engineering has already communicated with the most likely ISP partners, but the County should pursue these arrangements directly.

It might be difficult to find an ISP willing to serve all of Waseca County. As can be seen by the engineering and financial analysis in this report, building fiber everywhere is an expensive undertaking. What we most normally see are ISPs that tackle some portion of a county first. If you don't find a solution for the whole rural area, then the County will have to keep working to find solutions for the remaining areas that are not served. It would not be surprising for it to take years to find a broadband solution for everybody in any rural county.

Sometimes the potential ISPs that are interested in a given county are obvious, and most broadband solutions come from local ISPs. However, we have been surprised at times when an ISP comes to a county that is not local, so Waseca County might want to consider a wider search for ISPs. There is a more thorough discussion of this process in Section IV.B. of this report.

Offer to Help Quantify Market Demand.

One of the most important ways that a community can help attract ISPs is to help them understand the potential for operating a successful broadband business in the area. The biggest concern that every ISP has about a new market is knowing if they can get enough customers to be successful. Rural areas differ widely in the willingness of people to subscribe to broadband. We've worked in rural communities in just the last few years where the demand for broadband varied between 60% and nearly 90% - and an ISP must understand where a community fall within that wide range.

We've seen local governments help ISPs to understand the market better. There are several techniques that communities have used to understand market demand:

> Statistically Valid Surveys. The goal for doing a residential survey is to be able to predict the most likely range of customer broadband penetration should somebody build a broadband network. We've found over the years that if a survey is conducted in a way to be statistically valid that the results provide a good prediction of the likely customer penetration rates.
>
> There are a few factors that are vital to get an accurate and believable survey. First, the questions asked must be unbiased and can't lead respondents into answering in a given way. It's also

important for a survey to be random if you want the results to represent the whole County. For example, since the goal is to predict broadband penetration rates, it's just as important to hear from those who don't want broadband as it is to hear from those who do.

It's also essential to have confidence in the survey results and this speaks to the accuracy of the answers obtained in the survey. Most business and political surveys are designed to provide an accuracy of 95% plus or minus 5%. That accuracy would mean that if you were to ask the same questions to 100% of the people in the area that the results should not vary by more than 5% from what was obtained in the survey. That is a high level of accuracy, but other levels of accuracy are possible by varying the number of completed surveys. For most communities, a survey with between 350 and 380 completed surveys will produce this desired accuracy.

Surveys have gotten a bad name due to political surveys. There are several reasons that a political survey can produce different results than what are seen in an election. The primary reason is that respondents might not truthfully answer all of the questions for many different reasons. We've found that we don't see this kind of bias in broadband surveys because the topic doesn't trigger emotional responses – folks generally tell the truth about the topic.

There are only two ways to conduct a statistically valid survey of a whole community – either by knocking on doors or by telephone. The effort required to knock on doors is massive, especially in a rural area, and especially during the pandemic.

It's far easier to administer the survey by telephone, but it makes no sense these days to do a telephone survey using the white pages and calling just landlines. We know that the households keeping landlines are older and more conservative and their responses on a survey probably don't represent all households in an area. A valid telephone survey needs a list of telephone numbers that includes cellphone numbers.

Canvass. If you can't get the needed list of phone numbers, the next best approach is to tackle a canvass. In a canvass, you try to reach everybody with the survey, and since a canvass isn't random, you need to gather considerably more completed responses. Ideally, you'd want to get at least one-third of homes to participate in a canvass – a big challenge.

Canvasses can be done in several ways. This can include online surveys, although this exclude homes with no broadband. You can mail surveys. You can engage groups like the PTA and other volunteer organizations to circulate canvasses.

Pledge-Card Drives. A more specific form of a canvass is asking the direct question if a household would buy broadband if a new network were built to them. A pledge card drive works best when you can cite specific products and prices. For instance, if an ISP was partnering with a county to come to a certain area, then naming that ISP and disclosing their products and prices provides a more believable response. We've seen communities do pledge card drives and then see more than 95% of homes that said they will buy broadband buy it when it became available.

Be Prepared to Support Grant Filings.

Most state or federal grant programs require a showing of local community support. Waseca County should be prepared to help an ISP partner by gathering government, resident, and business support for the grant applications. This means soliciting as many letters as possible to support a fiber grant. We've seen counties go even further – for example, we've seen counties that have undertaken a local pledge drive to gather large number of signatures supporting a fiber project.

Educate the Public

One important aspect of community engagement is to provide useful information to the public to help them better understand broadband issues. It also means providing basic information that explains broadband in ways the public can understand. We've seen communities tackle public education in some of the following ways.

- Publish This Feasibility Report. While not a lot of people will wade the whole way through a report of this size, it has been written for the layperson.
- Hold Public Meetings. Meetings can be held to explain the results of this study, or meetings could be more generic and be aimed at explaining the broadband issues. It's worthwhile to have elected officials at public meeting so they can directly hear the kinds of issues that households have due to lack of broadband. It's vital to advertise heavily to drive attendance at meetings. CCG and Finley Engineering have been to a community meeting where only one resident attended, and to other meetings that were standing room only in a large room.
- Broadband Web Site. Many communities that are looking for broadband solutions create a broadband web page. Such a page can be used to educate as well as inform. For example, a common educational feature is to have a lengthy section with responses to "Frequently Asked Questions." It's important that if you create a broadband web site that you keep it current. You want the public to think of this site as a resource.
- Gather List of Broadband Proponents. One important tool is to create a database of local broadband proponents – citizens who say they support fiber. Having list of emails, home addresses, and phone numbers can be useful when you want to ask for public support for specific tasks or want to notify people of upcoming meetings.
- Broadband Newsletter. Cities often create a newsletter dedicated to broadband. These newsletters are aimed at educating the public on topics related to broadband and also to keep the public informed on the progress of the effort to get better broadband.
- Outreach Meetings. One of the most successful ways to reach the public is what CCG calls outreach. This means sending a spokesperson to meetings of local organizations to talk about better broadband. This can be any sorts of groups – PTAs, church groups, service organizations, youth groups, etc. Most organizations will allow time for a short presentation. It's vital to have a prepared presentation to get across whatever message you want the public to know.

Lobby for Larger State Broadband Grant Funding.

While Minnesota has one of the more successful state broadband grant programs, funding rural broadband at $20 million per year might require a century to bring good broadband to all rural parts of the state.

Increasing broadband grant funding means lobbying state legislators to the problems caused by lack of broadband. Legislators are hearing a lot more about the need for broadband during the COVID-19 crisis, but the pressure needs to stay focused on the legislature to give rural broadband a higher priority and more funding. State legislators must hear loudly and often that the current level of funding is not enough if they want to pull the state up from the bottom in the country in broadband.

Push the Incumbents to do Better

This sounds like a bit of a lame suggestion, but we've seen cases where this has worked. For example, it might be possible to convince the cable companies to extend its network past the city boundaries to add unserved households. You never know until you ask, and one of the incumbents could become a great.

Consider Providing Some County Funding

The financial analysis shows that any broadband solution is going to require significant grant funding. Waseca County should consider contributing funding for the right partner and opportunity. Even a small amount of County-provided grant funding might impress other grant programs that you are serious about finding a broadband solution.

We've also seen relatively small local grants make a huge difference when ISPs are seeking large federal grants. For example, some federal grants award extra points for having local participation, and nothing demonstrates local desire for broadband more than the local government providing some funding for a project. The entities that award bigger grants, such as the Minnesota DEED grant program like to see that there is local dollar support for programs. It's worth noting that the county is competing with neighboring counties for ISP investments and other counties in the state have offered significant grants and loans to ISPs.

Consider Tackling the Other Broadband Gaps

This report looks at phenomena that are being described nationally as broadband gaps. The gaps discussed in the report include the affordability gap where homes can't afford the cost of broadband. The computer gap describes the fact that many homes can't afford to buy and maintain a computer in the home. The broadband skills gap describes the fact that many residents don't have the digital skills needed to use computers and broadband. The homework gap describes the consequences for students that don't have computers and/or broadband in the home. Each is these is a problem for at least some portion of every community and the County should consider quantifying the extent of each gap in the County and looking for solutions. The report discusses ways that other communities are tackling each of these gaps.

Be Persistent

It's the rare county where one ISP comes forward and provides a broadband solution for the whole county. That means that even if Waseca County finds a partial broadband solution that you're not done, and you'll need to continue with the above tasks until everybody in Waseca County has good broadband.

I. MARKET ANALYSIS

A. Providers, Products, and Price Research

The county has a long list of ISPs operating somewhere in the county today. This includes incumbent telephone service provided by CenturyLink, Frontier, Consolidated Communications, Bevcomm, and Manchester Hartland Telephone Company. Two incumbent cable companies operate in the populated areas – Midcontinent Communications and Mediacom. Jaguar provides fiber in a few of the cities and also to some rural customers. There is fixed wireless broadband provided by LTD Broadband and Radio Link. Most rural homes and businesses can buy satellite broadband from Viasat and HughesNet. Rural customers can also buy cable TV from DirecTV or Dish Networks. Some rural homes get broadband using cell phone data or cellular hotspots.

Following is an analysis of the prices being charged in Waseca County today. We know from experience that prices vary widely by customer for many ISPs. Over the years, customers have purchased bundles or participated in promotional pricing and might be charged differently than their neighbors. It seems almost counterintuitive, but the customers paying the most from most incumbents are often those that have been with them the longest. The wide variance in rates charged in the community means there is no longer anything that can be considered as a "standard" price in the market. Nevertheless, we wanted to understand the average prices being charged today for broadband and the other triple-play products.

Incumbent Telephone Company

CenturyLink is the third-largest telephone company in the country with headquarters in Monroe, Louisiana. Several years ago, the company purchased Qwest, which was formerly Mountain Bell and US West, and was part of the Bell Telephone system. At the end of the first quarter of 2020, the company had 4,667,000 broadband customers. The company has a smaller number of cable TV customers but is phasing out that business line. For most markets, the company bundles with DirecTV. As we were writing this report, CenturyLink spun off sales to larger businesses to a newly formed company Lumen.

As the incumbent provider, CenturyLink is considered the "provider of last resort" in its service areas. This means that CenturyLink is required to serve all residential and business customers for basic local services, and it must provide facilities to all customers. The rules that govern the way that CenturyLink serves customers are embodied in their "General Customer Services Tariff," which is approved by the Minnesota Public Utilities Commission. This tariff contains all of the regulated products and prices, along with the terms and conditions under which CenturyLink will sell them to customers. The tariff sets forth rules for such customer service procedures as the manner and amount of customer deposits, the rules by which they will disconnect service for nonpayment, and the rules by which they will reconnect service.

In recent years CenturyLink invested significant capital in improving data speeds in metropolitan areas. For example, in 2016 and 2017 the company built fiber to pass 900,000 homes in major markets like Seattle, Phoenix, Denver, and the Twin Cities. Since then the company has merged with Level 3 Communications and last year the new CEO announced that the company would not be making any future investment in assets with "infrastructure returns".

After Jeff Storey said the company wouldn't be making new fiber investments, the stock took a hit since it turned out to be harder than hoped to infuse the Level 3 mindset into a 100-year-old telco. Starting in 2019 the company started talking about aggressively expanding its fiber network by adding large buildings to the network. The company recently said it had connected to over 18,000 buildings last year. It seems that those buildings were a combination of multi-tenant business buildings and apartment complexes. The company also said that it was building a lot of the new fiber in 2019 to reach small cell sites.

CenturyLink recently announced its fiber plans for 2020 and says it will be building to pass 400,000 homes and businesses with fiber this year as a follow-up to 2019 that saw the company add 300,000 passings. Like with all big telco announcements, a bit of looking behind the scenes is needed to understand what the company is doing. The company did not likely pass 300,000 homes last year with fiber. Many of the passings came from the 18,000 buildings that were added to the network. CenturyLink has also entered into a contract to operate the fiber network in Springfield, MO – a network that is funded, built, and owned by the City. The 85,000 or so passings from that project seem to be included in the fiber passings claimed for 2019 and planned for 2020.

What is still clear is that the company isn't investing in rural markets, even to keep the DSL copper networks working.

Telephone Rates

CenturyLink's telephone rates were as follows when last tariffed. This does not mean that these are the rates any longer and with a de-tariffed rate, CenturyLink is allowed to charge whatever they want, within reason. The following rates were the last listing of the flat rate option, meaning a telephone line using these rates can make unlimited local calls. There used to be options available for customers who wanted to be able to make and pay for fewer local calls.

	Monthly
Flat Rate Residential Phone Line	$18 - $22
Flat Rate Business Telephone Line	$42 - $45
Business PBX Trunk Lines	$45 - $51

These rates do not include the Subscriber Line Charge which is currently $6.50 for both a business and a residential line and would be added to the above rates. The rates also do not include the Access Recovery Fee (ARC), which is an FCC fee that is currently capped at $1 per month, and CenturyLink could be charging any amount up to and including the $1 rate.

CenturyLink telephone line prices don't include any features. These features are either sold a la carte or sold in bundles and packages. Some of the most commonly purchased features are call waiting, 3-way calling, voice mail, and caller ID. CenturyLink offers dozens of features and they range in price from $2.95 to $8.50 per feature for residential service. These products are also now de-tariffed, and CenturyLink can charge whatever it likes for these products.

CenturyLink DSL

CenturyLink sells high-speed Internet using DSL technology. They sell both a bundled DSL product, meaning that you purchase it along with a telephone line, and also a "Pure" product, meaning a customer can buy just DSL (most of the industry refers to this as naked DSL). As discussed above, CenturyLink offers a lot of specials, with special rates available on their web site for new customers. But as typical with most big ISPs, a subscriber's rates will revert to "normal" rates at the end of a special promotion. The following are base list prices for residential DSL. Note that the quoted speeds offered by CenturyLink DSL are "best effort" speeds, meaning they are not guaranteed. Rural customers typically get speeds significantly slower than the advertised speeds.

Residential DSL

Pure DSL is CenturyLink's name for a DSL line that is not bundled with telephone or DirecTV. There is one price for the first year, a higher price for the second year, and after that, the customer pays the list price:

	1st Year	2nd Year	List
1.5 Mbps download, 896 Kbps upload	$30.00	$40.00	$42.00
7 Mbps download, 896 Kbps upload	$35.00	$45.00	$47.00
12 Mbps download, 896 Kbps upload	$40.00	$50.00	$52.00
20 Mbps download, 896 Kbps upload	$50.00	$60.00	$62.00
40 Mbps download, 896 Kbps upload	$60.00	$70.00	$72.00

Pure DSL also requires a DSL modem. The charge for this seems to be negotiated and ranges from $1.95 to $6.95.

We don't expect that there is any DSL in Waseca County faster than 12 Mbps. Generally, faster speeds are available only in the metropolitan markets.

CenturyLink Business DSL

CenturyLink no longer publishes business DSL prices. There are no prices on the website and no prices listed in any of their sales literature or tariffs. CenturyLink will negotiate a price with a business customer based upon both how many other products they purchase as well as how long they are willing to sign a contract.

When CenturyLink last published rates their slowest business DSL ranged from $40.00 per month for a 3-year contract up to $62.50 for a month-to-month product and no contract commitment. But today each customer will negotiate with a salesperson and rates charged in the market are all over the board for the same product.

Frontier Communications is the fifth largest telephone company in the US. The company changed its name from Citizens Communications Company in 2008. Frontier Communications has grown through acquisitions. For instance, in 2015 they agreed to buy 2.2 million customers from Verizon in Florida, Texas, and California. The company spent $8.5 billion to buy a huge pile of customers from Verizon in

2009 and in 2013 bought the Connecticut operations of Verizon. As of the end of the first quarter of 2020 the company had 3.5 million broadband customers and 621,000 cable customers.

Frontier filed for bankruptcy earlier this year. It's been obvious for a long time that Frontier is in trouble. Three years ago, the stock sat at over $51 per share. By January 2018 it had fallen to $8.26 per share, and to $2 per share a year ago. When this report was being written the stock sits at 10 cents per share. Frontier recently sold their properties in Washington, Oregon, and Idaho to raise cash.

Frontier is an incumbent telephone provider and is considered a provider of last resort, meaning they must try to reasonably provide telephone service to somebody within their defined service area. Frontier's telephone rates are still tariffed. However, the company is allowed to charge less than the tariffed rates with bundling with other products or promotional specials.

Frontier offers cable TV in rural areas through bundles with Dish Network.

Telephone Rates

Telephone rates in the county vary today by community. Here are the latest tariffed rates[1]:

	Residential	1-Party Business	Key Line	Trunk
Janesville	$13.56	$24.67	$26.08	$31.09

All of these products have an extra charge of $6.50 for a Subscriber Line Charge and up to $1 for an Access Recovery Charge (ARC).

The company also offers a residential phone line with unlimited long distance. This is not a tariffed product. The current web special has a price of $34.99. Over time this will increase to some higher number. We've seen bills of customers paying $40.99 for the product, plus the fees.

Frontier DSL.
Frontier offers broadband with DSL served on copper lines. The company has three DSL products available nationwide:

6/1 Mbps	Simply Broadband Core
12/1 Mbps	Simply Broadband Ultra
18/1.5 Mbps	Simply Broadband Plus

These are "up-to" speeds and we know that many rural customers get significantly slower speeds, with some reports barely faster than dial-up. As mentioned elsewhere in this report, the company has taken money from the FCC to supposedly upgrade some rural DSL customers in the county to speeds of at least 10/1 Mbps.

[1] The Frontier tariff can be found at http://carrier.frontiercorp.com/crtf/tariffs/index.cfm?fuseaction=local&stateID=MN&sctnID=6&companyID=103

New customers get promotional prices with the disclaimer that after two years the prices will revert to the "list price at that time." Frontier doesn't disclose the list price of these products. Web research shows that pricing after an introductory trial is at least $44.99 per month, with some customers paying an extra modem charge. All products also get assessed a $1.99 Internet Infrastructure Surcharge. This is not a tax and is part of the price of the product.

Consolidated Communications is a large incumbent telephone company headquartered in Mattoon, Illinois. At the end of the first quarter of 2020, the company had 786,000 broadband customers. In 2014, Consolidated purchased Enventis Corporation, which included the telephone properties known as Hickory Tech. That purchase included two local telcos that operate in the county that were previously known as Mankato Citizens Telephone and Mid-Communications.

Consolidated has grown rapidly through acquisitions and tripled the size of the company in 2017 with the purchase of FairPoint Communications in New England. The company now operates in 23 states. The company trades on NASDAQ under ticker symbol CNSL.

It's worth noting that Consolidated recently reached an agreement to partner with several cities in New Hampshire to build fiber. The partnership consists of the cities financing and building fiber and Consolidated operating the network. Customers pay an extra amount on their broadband bill each month until the cities have recovered the cost of building the network.

Prices for Consolidated broadband are as follows:

DSL Broadband	
Up to 10 Mbps	$62.95
Up to 20 Mbps	$72.95
Up to 80 Mbps	$77.95
WiFi Modem	$10.00
Kaspersky Internet Security	$2.99 to $4.99 per month

$1 fee for a paper bill
Also sells DirecTV Now, Fubo TV, HBO Now, and Philo – online cable programming

The broadband products have no data caps.

Broadband rates were increased by $2.25 per month in 2019. WiFi Modem price increased by $2 per month.

Residential Telephone		
Voice Plus	$24.99	60 minutes LD, Caller ID, Call Waiting
Voice Value	$29.99	60 minutes LD and many features
Voice Unlimited	$35.99	All features and unlimited LD

There is a $3.50/ month long-distance administration fee added to any phone line that can make long-distance calls. There are more than $6 of other fees also added to these rates that are revenue to the company (not taxes).

Cable TV. The company sells cable TV – this is available in Mankato but may not be available in the rural parts of the county.

Basic – 37 channels	$32.74
Standard – 101 channels	$35.95
Select – 174 Channels	$83.49
Expanded – 198 channels	$89.49

Rates were increased by $6 per month in 2019.

Home Security
The company sells and installs SimpliSafe home security systems.

Bevcomm, formerly known as the Eckles Telephone Company, is a fourth-generation family-owned telephone company that was founded by the Eckles family in 1895. The company has headquarters in Blue Earth, MN. The company serves the eastern and southeastern borders of the county in the Janesville, Minnesota Lake, and Delavan exchanges.

The company is in the process of building fiber everywhere. The following are Bevcomm broadband prices:

Residential Broadband Prices

DSL	
Low Income 4 Mbps	$9.95
4 Mbps	$49.95
8 Mbps	$59.95
15 Mbps	$69.95
25 Mbps	$79.95

Fiber	
30 Mbps	$ 49.94
60 Mbps	$ 59.95
90 Mbps	$ 69.95
1 Gbps	$149.95

WiFi	$7.95
Antivirus, etc.	$4.95
Wire Maintenance	$4.00

Telephone

Residential Phone	$30.37
Business Phone	$29.08
Residential Voice Mail	$ 3.50
Business Voice Mail	$ 5.00

These prices include fees and key features

Long Distance	10.9 to 12.9 cents per minute, bundles of minutes available

Cable TV

Basic TV	$50.95
Bevcomm TV	$99.95
Price includes 2 settop boxes	
DVR	$10.95
HDTV	$ 9.95

There are numerous bundles available.

Manchester Hartland Telephone Company is an independent telephone company that provides services in and around Manchester and Hartland, MN. The company provides service in a small corner of the southeastern part of the county. The company has built fiber to customers, and its service area was excluded from the study.

Residential Broadband
The company requires a customer to buy a telephone line in order to buy broadband.

25/25 Mbps	$ 34.95
50/50 Mbps	$ 55.00
100/100 Mbps	$ 85.00

Business Broadband
The company requires a customer to buy a telephone line in order to buy broadband.

25/25 Mbps	$ 55.00
50/50 Mbps	$ 75.00
100/100 Mbps	$100.00

Telephone Service

Resident Line	$ 30.10
Business Line	$ 33.70

The company will still lease a telephone to a customer for 50 cents per month.

Cable TV
The company offers cable TV provided by Bevcomm

Cable TV Providers

Mediacom is the incumbent cable TV provider in St. Peter and Lafayette. The company is a large cable company with corporate headquarters in New York City. They are an interesting company that serves some large markets like parts of the New York City metropolitan area but mostly serves numerous small

rural markets. At the end of the first quarter of 2020, the company had 1.35 million broadband customers and 693,000 cable customers. They offer the triple-play products either standalone or in bundles.

Residential Broadband

60/5 Mbps	$ 69.99	400 GB cap
100/10 Mbps	$ 79.99	1 TB cap
200/20 Mbps	$ 99.99	2 TB cap
500/30 Mbps	$119.99	4 TB cap
1 Gb / 50 Mbps	$139.99	6 TB cap
Modem	$ 9.00	No WiFi
Model	$ 11.50	With WiFi
Internet Fee	$ 15.00	Added to standalone broadband

Telephone Rates. Mediacom offers a phone line with unlimited long-distance calling and 17 features.

Standalone Phone	$49.95
Bundled with one other product	$39.95
Bundled with TV and broadband	$29.95
Voicemail	$ 4.95

Offers long distance packages at $0.05 per minute

Cable TV

Basic	$29.95
Essential TV	$69.95
Variety TV	$84.99
Prime TV	$96.49
Local Surcharge	$16.57
Regional Sports Surcharge	$ 6.79

Note that all subscriptions are charged the Local Surcharge. Packages that include regional sports channels include the Regional Sports Surcharge.

Midcontinent Communications (Midco) is a regional cable company that offers the triple play over traditional cable network technology. The company is a joint venture between Comcast and Midcontinent Media. The company is headquartered in Sioux Falls, South Dakota, and has most of its customers in North and South Dakota, but with some in Minnesota and Wisconsin. The company has approximately 1.2 million customers and provides service in over 200 communities.

Midco was formed in 1999 when the customers from Midcontinent Media and AT&T (then called TCI for the cable business) merged their operations in North and South Dakota. The company then grew more by acquisition and purchased customers from the bankrupt Adelphia, from Charter Communications, and US Cable.

The company operates a regional sports network that carries college sports from North and South Dakota.

Midcontinent Communications serves New Richland and an area around Lake Elysian. The company was awarded funding in the FCC's Phase 2 Reverse Auction in CAF II in 2019 to provide fixed wireless broadband in parts of the county. The company has six years to fully deploy the fixed wireless.

Midcontinent also has a wide range of products across their system because they operate cable systems of widely differing capabilities. They have some systems that have cable modem speeds as fast as 100 Mbps and they have other systems with speeds of only a few Mbps, all according to the technical capability of the system.

It's worth noting that they have a philosophy with data products to increase speeds without a price increase as they upgrade their systems. There are many reviews from Midcontinent customers who talk about getting several speed upgrades over the last few years. The company accepted a Minnesota Border-to-Border DEED grant last year and is expected to increase speeds in the three communities in the county.

The company seems to have data prices in three ranges, which can best be described as slow, medium, and fastest. In each market, these prices are applied to whatever is available on the network. As networks are upgraded, people keep the prices they pay but increase in speeds. The low prices are around $35 to $40. The medium speeds are around $55 to $60, while there are fast speeds of 100 Mbps they seem to cost around $100.

Midcontinent also bundles prices like larger cable companies. Rather than just having a few bundles the company has hundreds of different combinations of products available.

Dish Network is a large satellite provider and has customers nationwide. The company had just over 9 million cable customers nationwide at the end of the first quarter of 2020. Dish Network now also offers an Internet-based cable product branded as Sling TV. This service offers an abbreviated channel line-up and costs less than traditional cable products.

Dish Network has the same pricing nationwide. The standalone price with no discounts is as follows:

190 Channels	$ 79.95
190 Channels +	$ 84.99
240 Channels +	$ 94.99
290 Channels +	$104.99

DirecTV is one of the largest cable providers in the US. The company is now owned by AT&T. The company had 15.1 million cable customers at the end of the first quarter of 2020, down almost 2.4 million customers during 2019. AT&T has decided to end all discount packages, resulting in significant rate increases for many customers who were getting various promotional discounts. DirecTV can be purchased in Waseca County directly and also as part of a bundle with CenturyLink.

DirecTV now offers an online version of its programming that was called DirecTV Now but which was recently renamed as AT&T TV.

Current prices after any promotional discounts are:

155 Channels – Select	$ 85.00

160 Channels – Entertainment	$ 97.00
185 Channels – Choice	$115.00
235 Channels – Xtra	$131.00
250 Channels – Ultimate	$142.00
330 Channels – Premier	$197.00

The above rates include increases effective January 2020 that range from $4 to $8 per month.

WISPs (Wireless ISPs)

WISPs (wireless ISPs) deploy a technology called fixed wireless where they mount a transmitter on a tower or other tall structure like a water tower. They beam broadband to a customer which is received through a dish receiver. The speed that a customer can receive is affected by the distance to the transmitting tower – the further from the tower, the lower the broadband speeds.

LTD Broadband is headquartered in Blooming Prairie, Minnesota. The company has over 1,500 tower sites and serves 40,000 square miles in southern Minnesota, Iowa, South Dakota, and Nebraska. The company's web site is at https://ltdbroadband.com/. Pricing is listed as "from" the following prices.

3/0.5 Mbps	$30.00
6/1 Mbps	$50.00 or more
10/2 Mbps	$70.00 or more
25/3 Mbps	$80.00 or more

RLI - Radio Link is a WISP with headquarters in Ellendale, Minnesota[2]. Their service map shows coverage in the eastern quarter of the county.

Their list prices for wireless broadband are:

3/2 Mbps	$30.00
5/3 Mbps	$45.00
15/5 Mbps	$55.00
22/7 Mbps	$65.00
30/10 Mbps	$85.00

Speeds up to 300 Mbps available in some areas.
There are no data caps.
Installation is $100.

Satellite Broadband.

There are two satellite broadband providers available to homes and businesses in Waseca County. Both Viasat and HughesNet utilize satellites that are parked at a stationary orbit over 20,000 miles above the earth.

[2] Their website is at https://www.radiolinkinternet.com/.

There are a few problems that customers consistently report with satellite broadband. Customers complain that satellite costs too much (Viasat claimed in their most recent financial report for June 2019 that the average residential broadband bill is $84.26). Customers also hate the high latency, which can be 10 to 15 times higher than terrestrial broadband. The latency is due to the time required for the signals to go to and from the satellites parked at over 22,000 miles above earth – that adds time to every round-trip connection to the web. Most real-time web connections, such as using voice-over-IP, or connecting to a school or corporate WAN work best with a latency of less than 100 ms (milliseconds). Satellite broadband has reported latency between 400 ms and 900 ms.

The other customer complaint about satellite broadband is the tiny monthly data caps. As can be seen by the pricing below, monthly data caps range from 10 gigabytes to 150 gigabytes. To put those data caps into perspective, OpenVault recently announced that in the first quarter of 2020 that the average US home used 402 gigabytes of data per month, up from 344 gigabytes in 2019, and 275 gigabytes in 2018. They also reported that the average cord-cutting home used 520 gigabytes per month in 2019. The small data caps on satellite broadband make it impractical to use for a household with school students or for a household that wants to use broadband to work from home.

Viasat (was formerly marketed as Exede or Wildblue) offers broadband from one older and one newer satellite. Following are the products from Viasat:

	Price	Speed	Data Cap
Liberty 12	$30	12 Mbps	12 GB
Liberty 25	$50	12 Mbps	25 GB
Liberty 50	$75	12 Mbps	75 GB
Unlimited Bronze 12	$50	12 Mbps	35 GB
Unlimited Silver 12	$100	12 Mbps	45 GB
Unlimited Gold 12	$150	12 Mbps	60 GB
Unlimited Silver 25	$70	25 Mbps	60 GB
Unlimited Gold 50	$100	50 Mbps	100 GB
Unlimited Platinum 100	$150	100 Mbps	150 GB

Online reviews say that speeds can be throttled as slow as 1 Mbps once a customer reaches the monthly data cap.

HughesNet is the oldest satellite provider. They have recently upgraded their satellites and now offer speeds advertised as 25 Mbps download and 3 Mbps upload for all customers. Prices vary according to the size of the monthly data cap. Their packages are as follows:

10 GB Plan	$ 59.99
20 GB Plan	$ 69.99
30 GB Plan	$ 99.99
50 GB Plan	$149.99

These packages are severely throttled after meeting the data caps.

Cellular Data

There are three primary cellular companies in the country—AT&T, Verizon, and T-Mobile. Earlier this year T-Mobile merged with Sprint and the Sprint brand name has disappeared from the market. Part of the merger conditions was that Sprint would provide some of the spectrum that would allow Dish Networks to become the fourth cellular nationwide carrier.

The following are the nationwide average 4G data speeds for the four carriers, shown for 2017 and 2019. Speeds are improving over time. However, these are nationwide averages and rural customers likely get slower speeds than these averages.

	2017	2019
AT&T	12.9 Mbps	17.8 Mbps
Sprint	9.8 Mbps	13.9 Mbps
T-Mobile	17.5 Mbps	21.1 Mbps
Verizon	14.9 Mbps	20.9 Mbps

All three carriers now offer "unlimited" data plans. The plans are not unlimited, and AT&T and Verizon have monthly data caps in the range of 20 – 25 gigabytes per month of data. T-Mobile claims to offer unlimited data but begins throttling customers after 50 GB of data usage in a month.

We have found customers in almost every rural community who use cellular broadband in the home. However, there have been reports of Verizon disconnecting rural customers who use too much data on these plans.

There are two different cellular data standards in use: 3G and 4G. There are likely to still be some 3G cellular towers in rural parts of the county. The amount of usage on 3G networks is still significant. GSMA reported that at the end of 2018 that as many as 17% of all US cellular customers still made 3G connections which accounted for as much as 19% of all cellular connections. Opensignal measures actual speed performance for millions of cellular connections and reported the following statistics for the average 3G and 4G download speeds as of July 2019:

	4G 2019	3G 2019
AT&T	22.5 Mbps	3.3 Mbps
Sprint	19.2 Mbps	1.3 Mbps
T-Mobile	23.6 Mbps	4.2 Mbps
Verizon	22.9 Mbps	0.9 Mbps

Fixed LTE Products. The cellular companies have cellular broadband products aimed at rural home broadband customers. These data plans use the cellular network but are priced differently than data for cellphones.

> Verizon. Verizon's hotspot product has four available pricing tiers based upon the monthly data allowance. The 10 GB plan is $60, the 20 GB plan is $90, the 30 GB plan is $120, and the 40 GB plan is $150. The real price killer is that Verizon bills each additional gigabit over the data cap at $10 each.

Verizon says that broadband speeds average from 5 – 12 Mbps download and 2 – 5 Mbps upload. If a customer refuses to pay the overage charges and doesn't buy additional broadband, Verizon throttles broadband to a crawl once the start of the next monthly cycle.

T-Mobile. T-Mobile has six hotspot pricing plans based upon the monthly data usage. The 2 GB plan is $10. The 6 GB plan is $25, the 10 GB plan is $40, the 14 GB plan is $55, the 18 GB plan is $70, and the 22 GB plan is $85. Each plan offers a $5 discount for customers who authorize autopay. The killer with this plan is that speeds revert to 3G speeds when the cap has been met. The plans also include unlimited texting.

It's worth noting that T-Mobile will offer a plan that provides 100 GB of monthly data to qualified students for the next 5 years as one of the promises made to merge with Sprint. We don't yet know the definition of eligible households, but the company estimated that it would eventually reach 10 million students.

AT&T**.** AT&T has three hotspot plans. That includes 3 GB of data for $25, 10 GB of data for $50, and 18 GB of data for $75. The overage data prices range from $10 for 1 GB with the $25 dollar plan to $10 for 2 extra GB with the 18 GB plan.

These hotspots are some of the most expensive broadband in the world. You have to look at third world countries to see similarly high data prices.

- Verizon plans range from $3.75 to $6.00 per gigabyte. Additional gigabytes are $10 each.
- T-Mobile data prices range from $3.86 to $5 per gigabyte. After hitting the data cap, the company throttles customers rather than provide more expensive data.
- AT&T hotspots are the most expensive and range between $4.16 and $8.22 per gigabyte. Extra gigabytes on AT&T range between $5 and $10 per gigabyte.

B. Broadband GAP Analysis

A broadband gap is a situation where there some customers with an advantage compared to others for using the Internet. This report will look at the different kinds of broadband gaps as described below.

- The Gap in Broadband Speeds. Broadband speeds vary widely throughout Waseca County.
- The Gap in Broadband Availability. There are homes with no landline broadband available.
- The Gap in Broadband Affordability. In every community, there are households that don't subscribe to broadband because of the cost.
- The Gap in Computer Ownership. There are households that don't subscribe to broadband because they can't afford a computer.
- The Gap in Broadband Skills. There are citizens who don't buy broadband because they lack the skills needed to operate in the digital age.
- Future Broadband Gaps. Even where there is adequate broadband today, the amount of broadband used by homes continues to grow at a torrid pace, and the slower broadband technologies will become obsolete over time. This will create new broadband gaps that might not exist today.

After describing the different broadband gaps, this report will look at the consequence of the broadband gaps and will ask the question if there are any practical solutions to the broadband gaps that the county could facilitate.

The Gap in Broadband Speeds

Is Waseca County Unserved or Underserved?

The topic of the quality of broadband in a given area often starts with the question of whether an area is unserved or underserved with broadband. There is no firm answer to that question because the FCC doesn't maintain an official definition of unserved and underserved. Instead, these two terms have been used over the years in relation to federal grant programs.

The two terms were first used in 2009 as part of the grant program created by the American Recovery & Reinvestment Act of 2009. The language defining that grant was created by Congress and used the two terms. In that grant program, unserved meant any home or business that has a broadband speed under 10/1 Mbps. Underserved was defined as homes having speeds above 10/1 Mbps but slower than 25/3 Mbps.

These terms were not officially defined outside of that grant program, but the terms began to be widely used in the industry when talking about broadband availability. The terms also began to show up in other grant programs after 2009. For example, the FCC's CAF II grant program in 2015 gave money to the largest telephone companies in the country and funded 'unserved' locations that had speeds less than 10/1 Mbps.

The same definition was used in the ReConnect grants created by Congress in 2018 and 2019. Those grants made money available to bring better broadband to areas that had to be at least 90% unserved, using the 10/1 Mbps definition.

The biggest FCC grant program of 2020 has redefined "unserved." This $20.4 billion Rural Digital Opportunity Fund (RDOF) grant program is being made eligible to Census blocks that are "entirely unserved by voice and with broadband speeds of at least 25/3 Mbps." That seemingly has redefined unserved to now mean 25/3 Mbps or slower broadband – at least for this federal grant program.

Minnesota has a different and official definition of broadband that sets the definition a lot higher than the FCC:

> *An unserved area is an area of Minnesota in which households or businesses lack access to wire-line broadband service at speeds that meet the FCC threshold of 25 megabits per second download and 3 megabits per second upload. An underserved area is an area of Minnesota in which households or businesses do receive service at or above the FCC threshold but lack access to wire-line broadband service at speeds 100 megabits per second download and 20 megabits per second upload.*

FCC Definition of Broadband

In 2015, the FCC established the definition of broadband as 25/3 Mbps (that's 25 Mbps download and 3 Mbps upload). Prior to 2015 the definition of broadband was 4/1 Mbps, set a decade earlier. The FCC defines broadband to meet a legal requirement. Congress established a requirement for the FCC in Section 706 of the FCC governing rules that the agency must annually evaluate broadband availability in the country. Further, the FCC is required to act if broadband is not being deployed in a timely manner. The FCC reports the state of broadband to Congress every year.[3] In these reports, the FCC compiles data about broadband speeds and availability and offers an opinion on the state of broadband in the country. In every report to date, the FCC has acknowledged that there are broadband gaps of various kinds, but the FCC has never determined that the problems are so bad that they need to take extraordinary measures to close any broadband gaps. Most recent FCC reports have acknowledged that there are broadband gaps but claim that the broadband situation is improving due to actions taken by the FCC.

The FCC didn't use empirical evidence like speed tests in setting the definition of broadband in 2015. They instead conducted what is best described as a thought experiment. They listed the sorts of functions that a "typical" family of four was likely to engage in and then determined that a 25/3 Mbps broadband connection was fast enough to satisfy the broadband needs of a typical family of four.

The FCC asked the question again in 2018 if 25/3 Mbps was still an adequate definition of broadband. They took no action and decided that 25/3 Mbps was still a reasonable definition of broadband. There were comments filed by numerous parties in that docket that thought that the definition of broadband should be increased. The FCC recently suggested in the Notice of Inquiry for the 2021 broadband report that 25/3 should remain the definition of broadband.

The FCC Measures Broadband Speeds

Since the FCC is required by law to state an opinion about the state of broadband deployment, they collect data from ISPs about broadband that is deployed and sold to customers in the US. The FCC collects ISP data using a process called the Form 477 process. The FCC collects data from every landline broadband ISP in the country (they don't require this data from dial-up providers, satellite providers, or cellular companies). The FCC collects the following data twice per year from every ISP (even though we know there are small ISPs that don't participate).

- ISPs report broadband customer counts by Census Block. Those are finite geographic areas defined by the US Census bureau that typically cover between 60 and 100 homes. In a city, a Census block might be a city block and in a rural area, it might cover a large portion of a county.
- For each Census Block, the ISP reports the fastest speed available to customers.

After the FCC gathers this data from ISPs, they make it available in the form of databases showing the speeds reported by each ISP in every Census Block. The FCC also maps the broadband data in various ways. The most common maps produced by the FCC show areas that don't have broadband that meets the 25/3 definition of broadband, areas that meet the 25/3 speed, areas that achieve speeds of at least 100/10 Mbps, and areas that have gigabit broadband capability. Many other variations of these maps are also possible.

[3] The FCC report to Congress for 2019 can be found at https://docs.fcc.gov/public/attachments/FCC-19-44A1.pdf.

Unfortunately, the FCC database rules report the fastest speed available from an ISP in each Census block. If only one customer gets a fast broadband speed, it's assumed that this is true for the whole Census Block

To make matters worse, ISPs are supposed to report actual speeds to the FCC, but there is no penalty for reporting any speed number they want. Many ISPs, particularly rural telcos, have been accused of reporting marketing speeds instead of actual speeds. As an example, an ISP might advertise DSL as a speed of "up to 30 Mbps" and then report the 30 Mbps speed to the FCC. In actual practice, the DSL speeds might be significantly slower than the advertised speed. Those two factors – reporting by Census Block and reporting by advertised speeds means that the FCC's reported broadband speeds are significantly overstated, particularly in rural America.

One place where coverage is often overstated is rural areas adjacent to towns and cities that have decent broadband speeds. Homes in the surrounding area are often shown as having the same broadband capabilities as the town even though homes might have no broadband available. This can also happen in rural areas. For example, a big telco might place a DSL cabinet at the opening to a subdivision and provide a decent DSL service there. The FCC mapping will show the entire Census Block as having good DSL, even though it is only available inside the subdivision.

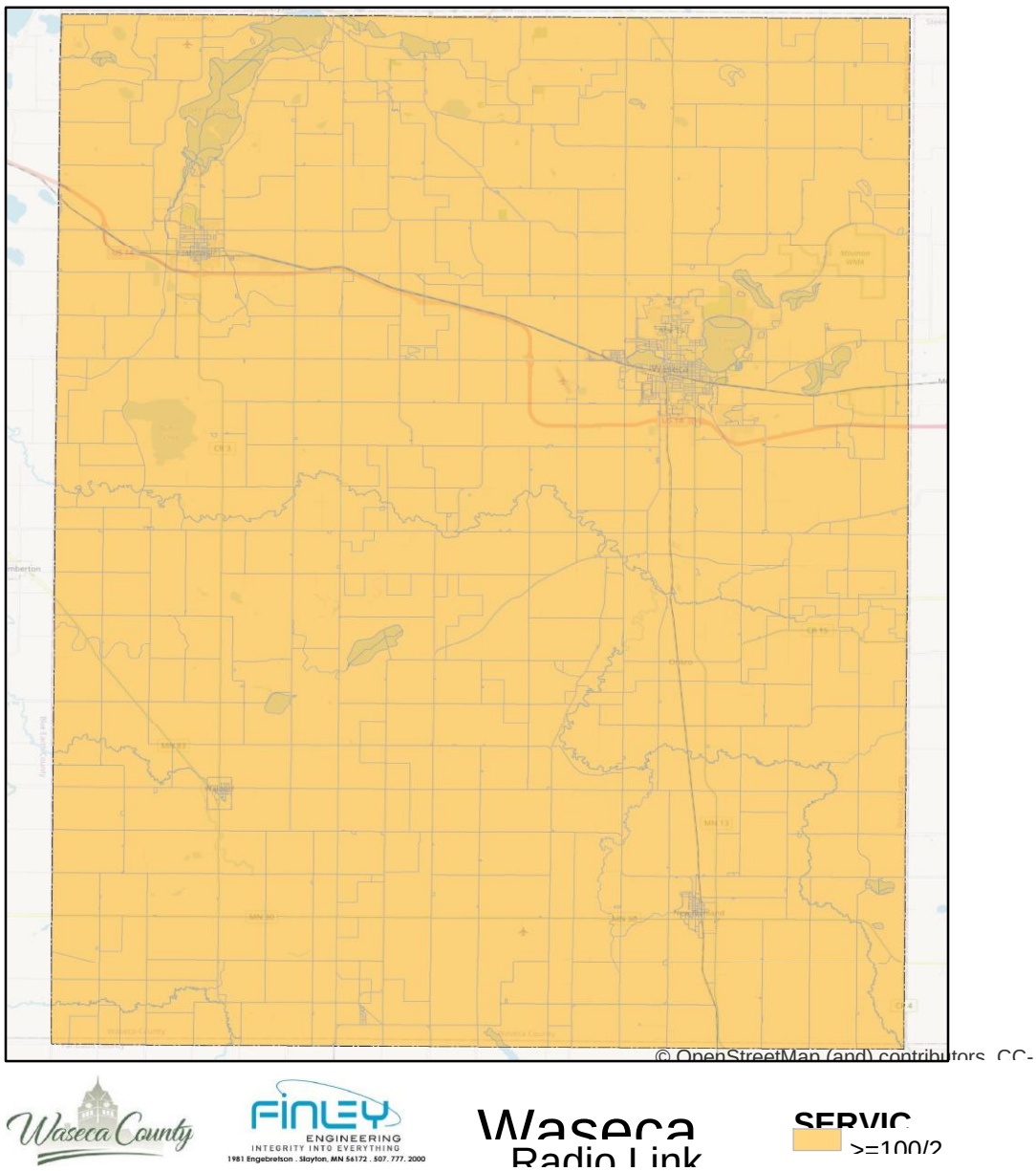
The FCC doesn't monitor what is reported and has allowed big reporting errors into the mapping databases. The 2018 Broadband Deployment Report reached the conclusion that the state of rural broadband was improving rapidly. It turns out there was a huge error in the data supporting that FCC report. A new ISP in New York, Barrier Free, had erroneously reported that they had deployed fiber to 62 million residents in New York. Even after the FCC was forced to correct the error, they still drew the same conclusions that broadband was getting better, even though the revised report showed million fewer homes with good broadband. This raises a question about what defines "reasonable and timely deployment of broadband" if having fiber to 62 million fewer people doesn't change the answer.

All these factors taken together mean that the FCC broadband databases and maps generally have significant problems in rural areas. The broadband speeds in towns might be reported reasonably correctly, although the speeds reported sometimes reflect marketing "up to" speed instead of actual speeds. Speeds for areas just outside of towns and cities are routinely overstated and often show broadband coverage where there is none. Rural areas served by DSL or fixed wireless generally overstate the broadband speeds – and these are the two technologies most widely used in rural America.

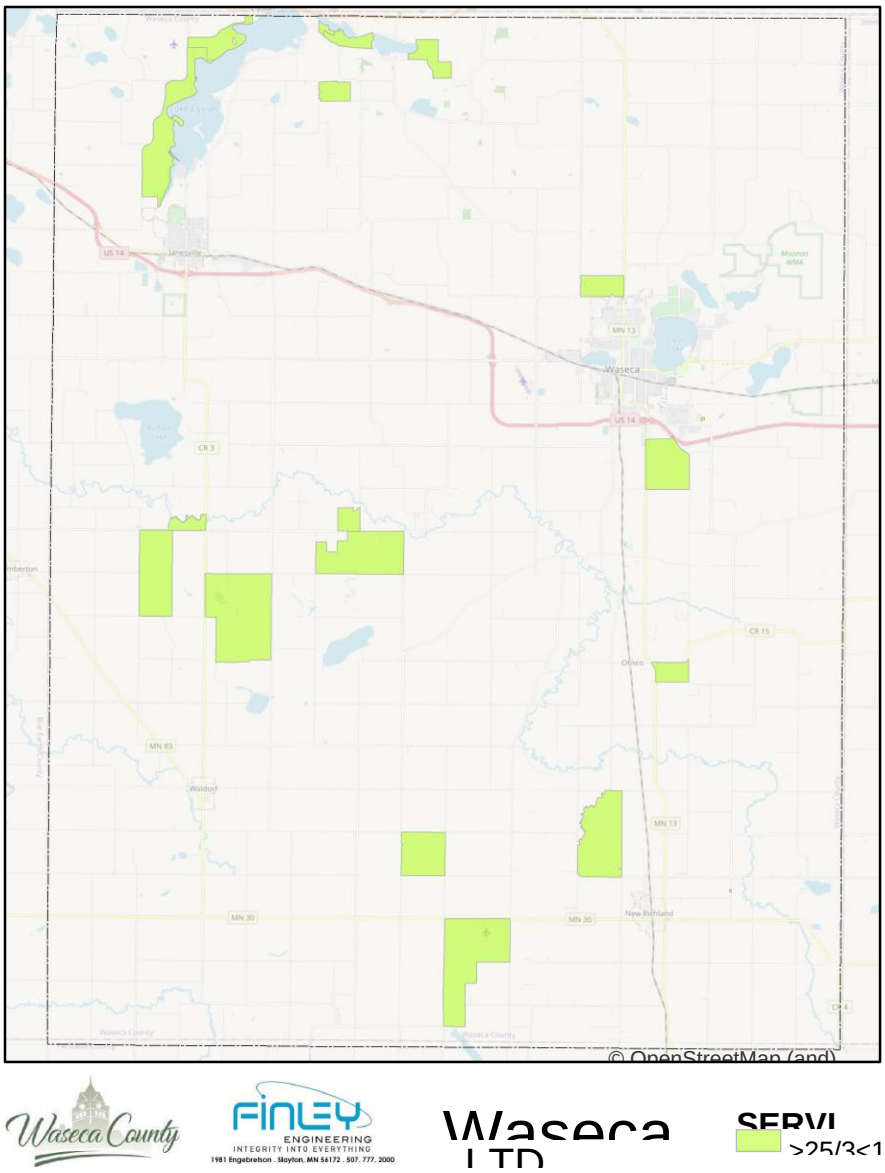
The maps in the county are better than what we see in some other counties in Minnesota. There are some areas where there are overstated broadband speeds and coverage in the FCC databases, but the problems are not so large as to be blocking federal grants.

The following highlights two ISPs that are reporting broadband speeds that are likely faster than what is delivered to customers. These maps were created using the most recently reported FCC data.

Radio Link. This wireless ISP is reporting speeds greater than 100/20 Mbps for the entire county. However, since the WISP doesn't offer voice service, this overstatement of broadband coverage should not affect the availability of federal grants. However, the Radio Link reporting does impact the data that is provided to Congress about the availability of broadband in the county – the FCC tells Congress that everybody in Waseca County can buy 100 Mbps download broadband.



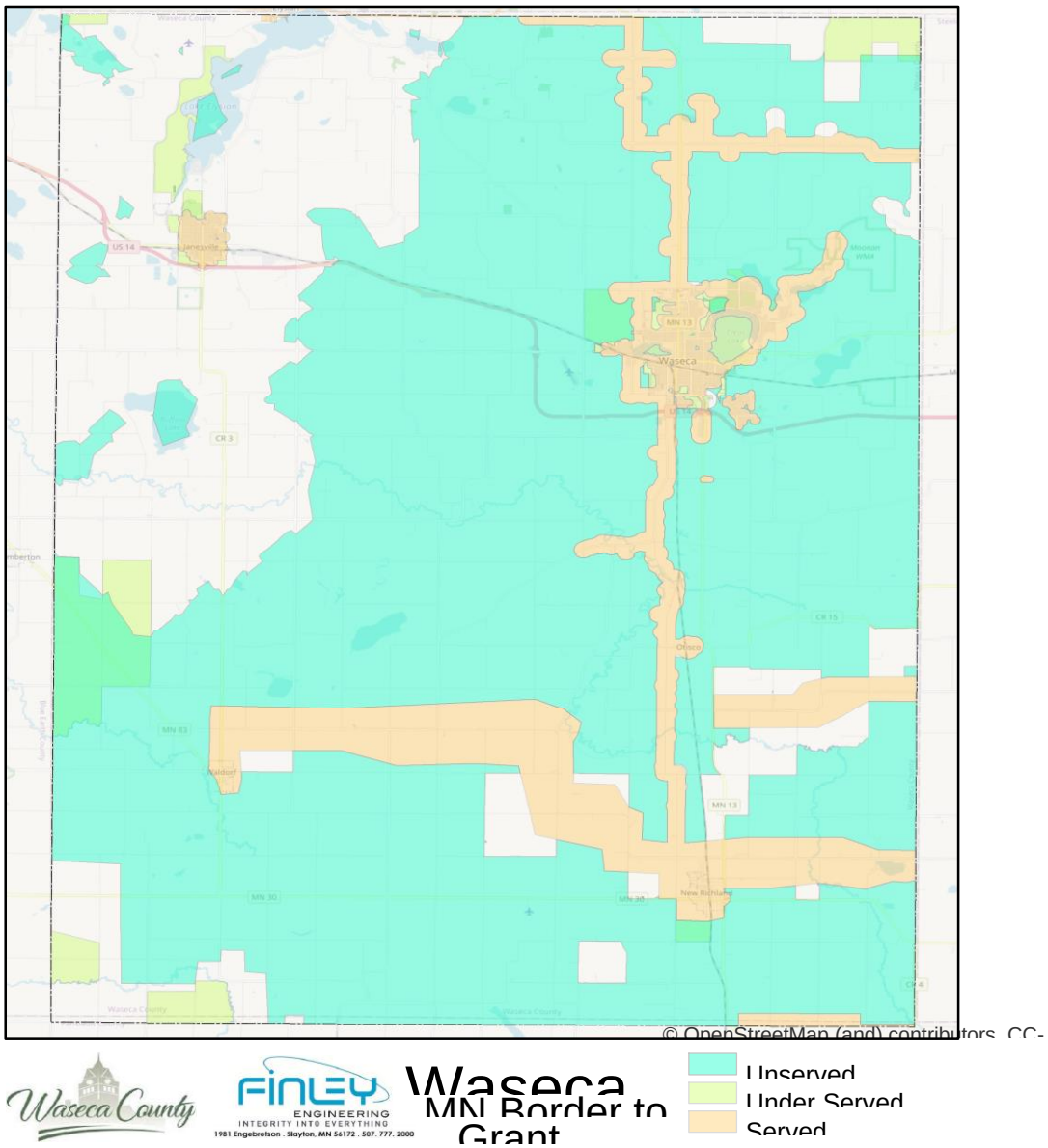
LTD Broadband. This wireless ISP reports most of its coverage area as having speeds under 25/3 Mbps but reports the following areas in green as having download speeds greater than 25/3 Mbps. It's not likely that every customer in these areas can buy broadband faster than 25/3 Mbps.



What's the Real Broadband Speeds in the County?

It's impossible to know broadband speed everywhere in the county because most of the rural area is served by a combination of DSL, fixed wireless, and satellite broadband. The speeds on all of these technologies can vary by the customer such that two neighbors using the same technology from the same ISP might get different speeds.

There is one source to look to for an alternate way to look at broadband speeds. The Minnesota Office of Broadband Deployment has compiled its own version of a broadband map that meets the state's definition of broadband. The State currently says that any connection that delivers a speed of 25/3 Mbps or faster is broadband. The state has created the following map for the county. The state believes that all of the areas shown in dark green do not have broadband speeds that meet the 25/3 Mbps threshold – and these are areas where the state will consider grant filing for the DEED grants.



Consequences of Inaccurate FCC Maps

The above series of maps reporting shows that there are ISPs reporting speeds faster than 25/3 Mbps that might not exist. It has been CCG's belief for years that the FCC has been hiding behind the bad maps because this gives them cover from having to take stronger action to fix rural broadband. It's likely that 90% or more of counties in the country have overstated broadband coverage on the FCC maps like what is seen on the map above. If the FCC were to acknowledge how bad the maps are, they would be required by Congressional mandate by Section 706 rules to undertake extraordinary efforts to fix the broadband problems. The bad maps have allowed the FCC to issue a report to Congress every year stating that rural broadband coverage has problems but is improving.

Unfortunately, the speeds reported by the FCC maps have other real-life implications. For example, the FCC constantly cites the statistics from the broadband mapping system when developing various policies

or making decisions that impact rural broadband. The FCC is fully aware of the inadequacies of their mapping data, and yet they still cite their own faulty data as proof that broadband isn't as bad in rural America as critics might suggest.

Probably the biggest impact from lousy FCC mapping is that the FCC maps are sometimes used to define where federal and state grants can or cannot be awarded. Since the maps overstate the broadband at many rural homes, those homes are excluded from being upgraded using the grant money. In October of this year, the FCC will be awarding the largest broadband grants ever and will be providing $16.4 billion in grants for selected rural areas that don't have broadband speeds of at least 25/3 Mbps. This grant program has been named the Rural Digital Opportunity Fund (RDOF). There will an additional $4 billion of RDOF grants awarded in 2021. These grants will continue to use the existing FCC broadband maps.

There are federal grant programs like the ReConnect grants administered by the USDA that allow a grant requester to challenge the FCC mapping data. There are no predetermined ways to undertake such a challenge, and the incumbent providers get to comment on the protests. The best way to challenge the FCC grants is with speed tests. They also can be challenged by on-the-ground observations by a qualified engineer that can show the presence or absence of the technology required to provide rural broadband.

New FCC Maps Coming

In August 2019, the FCC voted to consider changing the method of collecting data to support its broadband maps. The FCC finally decided to start the process to implement these new maps as this report was being written. The primary new change is that ISPs have to produce "polygons" (or geographic shapes) that cover areas where they have broadband customers today. The ISP maps can also cover areas without current coverage where an ISP could provide a broadband connection within ten business days of a customer request and without an extraordinary commitment of resources or construction costs exceeding an ordinary service activation fee.

The new polygons will fix some big holes in the current FCC maps. The polygons are going to make a noticeable difference when showing coverage for a cable company or a fiber-to-the-home ISP. Those networks have hard boundaries that stop at the "last home" to have broadband. Today's mapping by Census block doesn't recognize these hard boundaries and routinely counts customers outside these networks as having access to faster speeds. This mapping change will more adequately show the boundaries of cable or fiber-to-the-home networks.

Unfortunately, changing to mapping using polygons is not likely to make a significant change in the rural parts of Waseca County. The polygons might highlight areas better where the telcos have zero customers. But it won't change most of the reporting by the telcos and WISPs unless they get scrupulously honest with reporting actual speeds. If these companies continue to report marketing speeds, then the maps for the rural parts of Waseca County might continue to look the same as today.

Unfortunately, while the FCC is changing to the polygons for mapping, they are not requiring the ISPs to report more honestly about broadband speeds. We hear from customers all the time who are being sold a rural DSL product that is marketed to deliver speeds up to 25 Mbps while they are receiving only a few Mbps.

The Technology Gap

To a large degree, the broadband speeds available to customers is dependent upon the technology used to deliver the broadband. Our reports will discuss various technologies in more detail when we describe the engineering cost estimates to bring better broadband to the counties.

The general speeds available on various technologies is as follows:

- DSL delivered on one copper pair can deliver speeds as fast as 25 Mbps for a mile or two from the DSL transmitter, assuming the copper is in good condition and other factors are ideal. There are older and slower types of DSL deployed that might have maximum speed capability of 3 Mbps, 6 Mbps, 12 Mbps, or 16 Mbps.
- DSL delivered on two copper pairs can deliver twice the speeds. This technology is usually only deployed in cities and has maximum speeds of around 50 Mbps.
- A hybrid-fiber coaxial system (used by cable companies) can deliver fast broadband speeds. Networks using the DOCSIS 3.0 standard can deliver speeds up to around 400 Mbps. Networks upgraded to the most recent DOCSIS 3.1 standard can deliver speeds up to a gigabit. Cable companies typically sell broadband products with speeds a lot lower than the theoretical fastest speeds.
- High orbit satellite broadband can deliver speeds as fast as 75 Mbps. The problem with this broadband is that the satellites are so far above the earth that there is a lot of delays (latency) in the signal and it's hard to do real-time web activities like streaming video, connecting to a corporate WAN or a school server, making VoIP calls, or even shopping on some web sites.
- Fixed point-to-multipoint wireless is capable of speeds up to 100 Mbps, although the equipment and configuration of most networks deliver speeds significantly less than this, sometimes as slow as only a few Mbps.
- Fiber networks also deliver fast broadband. Fiber networks with the older BPON technology are limited to speeds of about 200 Mbps per system. More modern GPON technology can deliver speeds up to a symmetrical gigabit (same speed up and down). There are newer kinds of fiber-to-the-home technology that offer speeds up to 10 Gbps.

Every technology has some limitations in real-life networks that can produce slower broadband speeds. Consider the following factors that can affect the broadband speeds delivered over DSL:

- The distance between the customer and the DSL transmitter (called a DSLAM). DSL speed decreases with distance.
- The size of the copper wire serving the customer matters – the larger the gauge of the copper wires the stronger the DSL signal.
- The quality of the copper (copper wire slowly degrades over time, particularly if the copper gets in direct contact with the elements or with longstanding water).
- By the quality of the telephone wiring inside of a home (this varies a lot, particularly for wires that were installed by the homebuilder rather than by a telco).
- The type of DSL electronics used to serve a customer. There are still older DSL technologies in the field that have maximum download speeds of only a few Mbps and newer DSL that can deliver speeds as fast as 48 Mbps.
- The backhaul network that connect a local network to the Internet. DSL is like most broadband technologies and bandwidth is shared between users in each neighborhood. If the total usage

demanded by the neighborhood is greater than the bandwidth supplied to the neighborhood, then everybody gets slower speeds when the network is busy.

- And finally, speeds can be impacted by how a customer gets broadband to devices. For example, an old WiFi router can cut down the speed between what is delivered to the home and what makes it to computers and other devices inside the home.

All these factors mean that DSL speeds vary widely in the field. Two adjacent homes can have a significantly different DSL experience. It's extremely difficult for an ISP to understand DSL speeds for customers since the speeds can vary during the day. It's impossible for them to guess the speeds that are available to homes that don't buy service.

The same sorts of factors also apply to fixed wireless. Customer speeds vary according to distance from a tower, the spectrum used for any given connection, the types of impediments between the tower and the home (speeds are often slower in summer when the leaves are on trees). It's nearly impossible to map DSL and fixed wireless speeds in the field.

The Urban / Rural Gap

The most dramatic broadband and noticeable broadband speed gap is often called the Urban / Rural gap and is due to the big speed difference between broadband speeds offered on most cable TV networks and the DSL and other slower technologies available outside of towns. The "urban" designation used isn't entirely accurate, because this gap also describes the difference within the county between broadband speeds in the cities and the speeds in the rural area.

This gap didn't always exist. Both DSL and cable modem technology were developed in the late 1990s, and at first, the two technologies delivered nearly the same speeds. For example, in 2001 a customer in a town likely had the option between a 1 Mbps service from either the phone company or the cable company.

Over time the technology improvements provided more speed across the coaxial cables used in a cable network (the copper wires that plug into your TV) than with the much thinner wires used to deliver telephone service. As much as anything, the faster speeds on a cable network were due to the larger amount of wire available in a coaxial cable.

Even as both technologies got faster, the speed offered by both competitors was roughly the same. For example, by 2006 you probably could have bought a 6 Mbps connection in a town from a telco or cable company that had made the needed upgrades. After that time, however, the cable company technology improved a lot more than the telephone company DSL technology, and cable company executives decided they could win the competitive broadband battle by offering faster speeds than telephone companies, at the same price. Since then, all major cable companies have unilaterally increased download speeds to at least 100 Mbps.

That speed is significantly faster than the speed available to a customer served by any technology other than fiber. In the industry we always talk about the "last home" served by the cable companies, because at every street emanating from a town there is a last home connected to the cable network, and past that point customers can't buy broadband from the cable company.

Homeowners who live just past the last home are often frustrated when they can't convince a cable company to extend their lines. Cable companies generally have some metric where they won't pay to extend cable unless there is some pre-defined number of homes per road mile. A typical metric would be 20 homes per road mile – if a road has fewer homes than that the cable companies won't build. The cable companies have a second issue in that they don't extend their networks past the point where they have to amplify the signal too many times because that allows interference to enter the network and causes snow and interference on TVs and degraded broadband. Depending upon the specific wiring and technology used, cable company networks have a limit of 4 – 7 miles of coaxial cable, past which their signal begins to degrade.

We have some dramatic evidence of the urban/rural technology gap. The firm OpenVault tracks broadband usage in the US and around the world. In a report that was published in January 2020, the company says that 54% of homes now purchase broadband plans with speeds of 100 Mbps or faster. Another 23.6% of homes are subscribing to broadband between 50-75 Mbps. This means that nearly 78% of homes are subscribing to data plans of at least 50 Mbps and 54% to plans of at least 100 Mbps. OpenVault further says that the average subscribed speed in the US grew significantly between 2018 and 2019 from 103 Mbps to 128 Mbps.

The only technologies that can deliver broadband faster than 100 Mbps are fiber-to-the-home and cable coaxial networks. Fixed rural wireless can serve a tiny number of homes with speeds up to 100 Mbps, but not on any mass basis. In big cities, there are a few other technologies that can deliver fast speeds to apartment buildings such as metro Ethernet or direct microwave connections. The bottom line, though, is that people in cities are being offered fast data speeds of at least 100 Mbps per second. In rural areas, this only happens for those rural places lucky enough to have fiber-to-the-home. That's still only a small fraction of rural America.

The Business Broadband Gap

Businesses generally have the same issues as residents in terms of limitations of technology. A business operating in a rural area won't have any better broadband options than nearby residences.

However, there are some unique issues affecting business broadband:

- In many towns, the original cable company might not have built the cable network to reach business districts. Back in the 1970s and 1980s, the cable companies didn't expect to sell enough cable TV service to justify the cost of the network. Now that the cable company is usually the fastest broadband solution in a town, there are often still businesses that are not connected to the cable company networks.
- In towns, if any entities have fiber it's like to be either government locations like schools or some of the largest businesses. The telephone and cable companies are often willing to build fiber to a sufficiently large enough customer. Such fiber availability, if it even exists, is also often limited by how close a business might be to an existing fiber. In bigger cities like Mankato, there are usually several competitors willing to build fiber to reach selected business customers.
- Businesses have drastically different broadband needs. For example, there might be one business with a 100 Mbps connection from the cable company that is satisfied with the service. Next door could be another business that finds the 100 Mbps connection inadequate and that struggles to operate their business because of the broadband.

Microsoft Speed Data

Microsoft is in an interesting position when it comes to looking at broadband speeds. The vast majority of computers in the country download sizable upgrade files from Microsoft. Even many Apple computers are loaded with Microsoft Office products like Word, Excel, and PowerPoint.

Microsoft decided a few years ago to record download speeds of software upgrades. There is probably no better way to measure a broadband connection than during a big file download. Most speed tests only measure broadband speeds for perhaps 30 seconds. There are a lot of ISPs in the country that deploy a technology generally referred to as "burst." This technology provides a faster download for a customer for the first minute or two of a web event. It's easy for a customer to know if their ISP utilizes burst, because during a long download, such as one updating Microsoft Office, the user can see the download speeds drop to a slower speed after a minute or two. This burst technology has great benefits to customers since most web activities don't take very long. When customers visit a website, open a picture, or even take a speed test, the customer only needs bandwidth for a short time. The burst technology gives customers the impression that they have a faster download speed than they actually have (or it could be conversely argued that they have a fast speed, but just for a minute or two).

Microsoft measured downloads starting in September 2018 and found:

- The 2018 FCC data claimed that 24.7 million people in the US don't have access to download speeds of at least 25/3 Mbps. In September 2018 Microsoft claimed that 162.8 million people were downloading data at speeds slower than 25/3 Mbps.
- The FCC claimed in 2018 that 100% of the people in Waseca County had access to broadband of at least 25/3 Mbps. In September 2018 Microsoft said that only 17.7% of people in the county used broadband of at least 25/3 Mbps. That is an eye-opening difference.

It's important to note that the FCC and Microsoft are not measuring the same thing. The FCC is measuring the percentage of homes that have access and can purchase 25/3 Mbps broadband. Microsoft is measuring the actual speeds of downloads. There are a few reasons why the speeds might be different:

- Even where it's available, some people opt to buy broadband products slower than 25/3.
- Some households receive slower speeds due to issues in the home like poor-quality WiFi routers.
- The biggest difference is probably due to the ISPs overstating the speeds to the FCC that they make available to the public. As stated above in this report, the FCC doesn't challenge speeds reported to them by ISPs. In your case, Radio Link claims they can deliver speeds greater than 100 Mbps download to the whole county

The Microsoft findings have implications beyond rural broadband. The Microsoft measurements showed that a lot of customers in towns and cities also aren't achieving 25/3 Mbps speeds. The Microsoft numbers are astounding once it's recognized that cable companies provide two-thirds of all broadband in the country – and predominantly sell speeds that are claimed to be faster than 25/3 Mbps, usually at 100 Mbps or faster.

The Connect America Fund

Original CAF II

CenturyLink, Consolidated Communications, and Frontier participated in the original Connect America Fund II (CAF II). The FCC set aside $1.7 billion per year for the 6 years ending in 2020 for the big telcos to build or upgrade rural broadband. These funds were made available to census blocks that had little or no broadband at the time.

The FCC awarded these funds to CenturyLink and Consolidated in Waseca County as follows:

- CenturyLink accepted $1,062,598 per year or $6,375,588 to bring better broadband to 1,588 rural customers - $4,015 per home.
- Consolidated accepted $17,159 per year or $102,954 to bring better broadband to 18 rural customers - $5,720 per home.
- Frontier accepted $349,544 per year or $2,097,264 to bring better broadband to 665 homes - $3,154 per home.

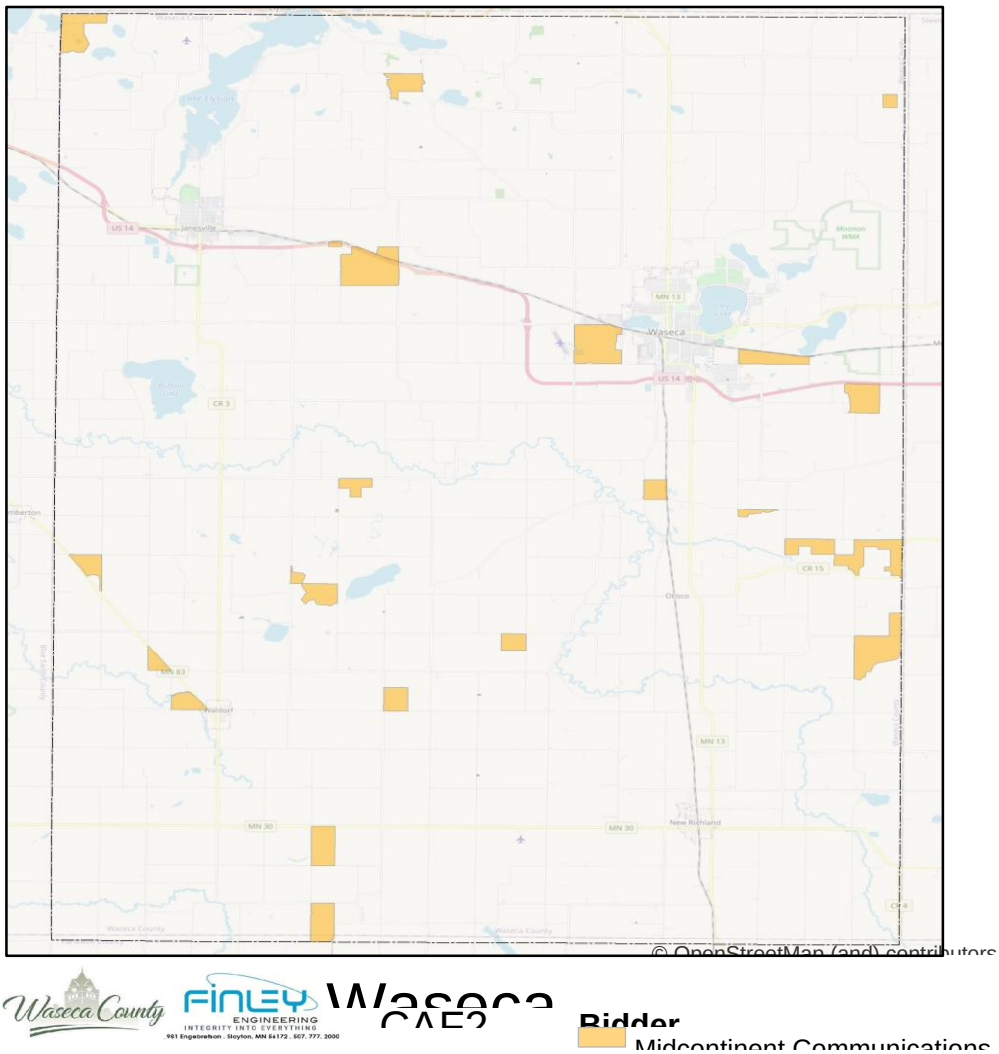
These funds were distributed over 6 years, with the final year being 2020. There are buildout requirements and the telephone companies should have upgraded at least 60% of the customers in the whole state at the end of 2018, 80% by the end of 2019, and everybody by the end of 2020.

The telephone companies are using the funds to upgrade rural DSL. The CAF II program required that customers must be upgraded to data speeds of at least 10 Mbps download and 1 Mbps upload. Note that those speeds are far slower than the FCC's current definition of broadband, which is 25 Mbps download and 3 Mbps upload. This funding program covered almost every rural customer in the county (the program covered everywhere except the areas in the map below shown in orange). If these upgrades were made as promised, then the rural parts of the county would all have download speeds of at least 10 Mbps. We spoke to several people in the county who told us that rural speeds are far slower than 10/1 Mbps. We have not seen the promised speeds promised by this program almost anywhere in the country.

CAF II Reverse Auction

In July 2018, the FCC awarded $1.98 billion of grants to be dispersed monthly over 10 years. These grants covered areas that were not claimed by the big telcos in the original CAF II grants described above. This money was awarded by reverse auction, meaning that the funding went to the carriers in each geographic area that was willing to take the lowest amount of money per customer.

In Waseca County, the winner of the CAF II reverse auction was Midcontinent Communications, a. Following is a map showing the areas, in orange, of Waseca County that are covered by this grant. Midcontinent told the FCC that they would improve the broadband in these areas to speeds of 100/10 Mbps. The company has six years, until 2024 to make the upgrades.



The Gap in Broadband Availability

The National Telecommunications and Information Administration (NTIA) released the results of a survey in 2019 that looked at households that don't use the Internet.[4] The survey says there are around 28 million households in the US that don't use broadband at home. Some of these homes fall into the following circumstances:

- The most drastic case are homes that have no landline broadband options. Such homes are limited to getting broadband from high-orbit satellites (assuming they can see the portion of the sky where the satellites sit), or from cellular data from their cellphone plans. Almost every rural area has some homes that have no landline broadband options.
- The broadband availability gap also refers to homes that can't get broadband that meets the FCC definition of broadband.

[4] The NTIA survey results are at: https://www.ntia.gov/blog/2019/unplugged-ntia-survey-finds-some-americans-still-avoid-home-internet-use

Comparing Waseca County with the Rest of the World

There are numerous ways to compare Waseca County to the rest of the state, country, and world.

FCC Adoption Rate

It's worth first looking at how Minnesota compares to other states. In the 2019 annual report to Congress, the FCC reported on broadband adoption by various speeds by state. The adoption rate is the percentage of households that have purchased broadband that meets or exceeds various speed thresholds. For some reason that they don't explain well, in the 2019 broadband report to Congress the FCC reported broadband adoption rates for 2017. This means two things. The overall adoption rates are understated because we know that the overall number of homes buying broadband has been increasing every year. However, since the data used in the FCC report comes from the Form 477 data, the percentage of customers who that buy a given speed is likely overexaggerated. That makes for some confusing results, but since the same issues affect every state, the overall rankings of broadband adoption by state is probably reasonable.

In the annual report to Congress, the FCC reports on broadband adoption by various speeds by state. In the 2019 report to Congress, the FCC reported the following broadband adoption rates for Minnesota (meaning the percentage of customers who can buy the listed speeds at their home):

Homes buying at least 10/1 Mbps	62.3%
Homes buying at least 25/3 Mbps	56.7%
Homes buying at least 50/5 Mbps	50.7%
Homes buying at least 100/10 Mbps	16.0%
Homes buying at least 250/25 Mbps	1.0%

To put the FCC numbers into perspective, the percentage of homes that get at least 10/1 Mbps broadband (66.3%) puts Minnesota in the middle of the pack when compared to other states. The lowest coverage is in Mississippi at 44.3%, and the highest is Delaware and New Jersey at 86.2 %. It's worth noting that these numbers are based upon faulty FCC 477 data reported by the ISPs in the state and in many cases, the speeds being delivered are not nearly as good as the speeds being purchased.

FCC Availability of Broadband

The FCC also looks at the availability of broadband by county, meaning the percentage of homes that could buy broadband at various speeds. This is where the FCC data and the faulty nature of the maps are quickly evident. Here's what the FCC reported to Congress in 2019 about Waseca County:

Urban population:	9,314
% that can buy at least 25/3 broadband	100%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	100%
Rural population:	9,473
% that can buy at least 25/3 broadband	100%
% with 4G LTE coverage at 5/1 Mbps	100%

% with both 100%

The FCC data might be true for the cities, although we've found that there are often small pockets of most medium and larger towns that are not reached by the cable companies.

The rural percentages are startling because the FCC data shows that everybody in the rural parts of the county can buy 25/3 Mbps broadband. We know that are very few homes in the rural parts of the county that can buy broadband of 25/3 Mbps or faster.

How Does the US Rank with the Rest of the World?

Cable Company from the United Kingdom has been gathering data each year that compares broadband speeds and prices from around the world.

The most recent report on broadband speeds is from 2019.[5] The rankings are based upon many millions of speed tests, and the 2019 average download speed for the US is based upon over 132 million speed tests. The US ranked 15th in the world in 2019 with a national average download speed of 32.89 Mbps which is behind countries like Taiwan, Singapore, Sweden, Denmark, Japan, Netherlands, Spain, Norway, Belgium, and others. The average speed in the US has been increasing and was 25.86 Mbps in 2018 and 20.00 Mbps in 2017. During that time, the US climbed from 21st fastest to the current rank of 15th. The speed increases are largely due to upgrades in speeds in urban areas by cable companies, although there are also fiber-to-the-home builds in both urban and rural markets across the country.

Comparing Waseca County with the Rest of Minnesota

Finley Engineering and CCG Consulting have worked with a lot of other counties in the state and we've found that the FCC coverage is overstated in rural areas that are not served by fiber. There are four counties in the state – Aikin, Kittson, Mille Lacs, and Pennington that where the FCC believes that less than 50% of rural homes have access to 25/3 broadband. There are seventeen counties in the state, including Waseca County, where the FCC believes that everybody has access to 25/3 broadband.

The Gap in Broadband Affordability

The FCC reports that broadband adoption for the country is around 86%. Even after accounting for the rural areas that have no broadband option, there are many millions of customers that can get broadband at their homes, but that do not buy it. Numerous studies and surveys have asked people why they don't buy broadband when it's available. The number one reason that's always cited is the price – people say they can't afford broadband.

Statistics on Affordability

In larger cities, it's somewhat easy to equate broadband penetration rates to household incomes. This is because a Census block in a city might be as small as a block or two, and it's easy to match Census data to broadband data from the FCC.

[5] Broadband speeds around the world. https://www.cable.co.uk/broadband/speed/worldwide-speed-league/

An analysis of recent FCC 477 data shows that there is a direct correlation between household income and buying a home broadband connection. Only about half (53%) of households with annual incomes under $30,000 buy broadband. This contrasts sharply with 93% of homes with incomes over $75,000 buy broadband. There is no clearer evidence that there is an affordability gap for broadband.

There are studies available for those who want to dig deeper into quantitative and qualitative research into broadband affordability for low-income households. The first was published by the Benton Foundation and authored by Dr. Colin Rhinesmith.[6] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[7] This report looks at a study conducted in three low-income neighborhoods of Detroit.

Both reports say that low-income households with a limited budget appreciate the advantage of having broadband at home but can't fit it into their budgets. They find it difficult or impossible to prioritize broadband compared to paying rent or buying food. These studies indicate that a big part of the solution for getting broadband into homes will involve finding a way to pay for the monthly broadband access.

Comparing US Broadband Prices to the World

Cable Company of the United Kingdom also tracks broadband prices around the world. The most recent comparison of prices is from 2020.[8] The average price of broadband in the US in 2020 is $50. It's worth noting that these prices were gathered from advertised prices, and most big ISPs in the country advertise low temporary special prices that expire after a one or two-year period. The advertised price rarely includes the cost of a modem or WiFi router. The average price of the US ranks as the 119th most affordable out of 206 countries. However, it's worth noting that most of the countries that are more expensive than the US are either third world countries or island nations. The few exceptions of first world countries that are more expensive than the US are New Zealand, Norway, and Switzerland. However, since real US prices for most homes are higher than advertised prices, the US might have more expensive broadband than many of the countries ranked below us.

In that same report, the US looks better when looking at advertised prices compared to bandwidth. In that comparison the average cost per megabit of speed in the US is $0.26, placing the US 27th in terms of affordability. However, we know that many ISPs advertise speeds that are faster than what they actually deliver – but this may be true in other countries as well. We also know that many ISPs in the US charge prices to many customers that are higher than advertised prices. The real price of broadband in the US is higher than is shown in this analysis.

Broadband Prices in the County

Earlier in the report, we discussed the prices for the cable companies, telcos, WISPs, and fiber overbuilders. Since the county has so many incumbent service providers there is a wide range of prices

[6] Digital Inclusion and Meaningful Broadband Initiatives. https://www.benton.org/publications/digital-inclusion-and-meaningful-broadband-adoption-initiatives

[7] Broadband to the Neighborhood. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3103457

[8] Broadband prices around the world. https://www.cable.co.uk/broadband/pricing/worldwide-comparison/

being charged. The lowest broadband prices are at Manchester Hartland Telephone Company where customers can by a symmetrical 25 Mbps broadband connection for $34.95. By contrast, a 10 Mbps DSL connection from Consolidated Communications is $62.95. The cable company prices are somewhat high but are the same that is charged to over half of the homes in the country, making them typical by definition. The highest prices in terms of value are the prices charged by the WISPs and the telcos for rural DSL– not that the prices are higher than normal, but the bandwidth delivered is low compared to the prices.

ISPs Bridging the Price Gap

Federal Lifeline Program

The four telephone companies participate in the FCC's Lifeline program that is part of the Universal Service Fund. With the program, a qualifying customer can receive a discount of $9.25 per month off a telephone or broadband bill. The program works by the telephone companies providing a discount to customers and the FCC then reimburses the companies for the discount. This means it costs the telephone companies nothing to offer the discount – the discount is funded by the FCC.

To qualify, a customer must participate in one of the following programs: Medicare, SNAP (formerly Food Stamps), SSI, Federal Section 8 housing, VA Veterans pension, or VA survivor's pension. The FCC has recently established a web portal where participating carriers can check the eligibility monthly of households to see if they meet one of the above tests.

The telephone companies don't aggressively pursue giving this discount to eligible households – but they will enroll anybody that qualifies and who asks for the discount.

Cable Company Low-Income Programs

The three cable companies in the county each offer a low-income broadband connection for homes that quality.

> Mediacom. The program is called Connect2Compete and offers subsidized broadband for low-income homes with K-12 school students. The company provides a 25 Mbps connection for $9.95 per month. The program is available for students that qualify for federal or state school lunch programs.
>
> Midcontinent Communications. The company participates in the federal Lifeline program, identical to the telephone companies.

COVID-19 Programs. Most ISPs are offering additional benefits to customers during COVID-19. For example, most of the big telcos and cable companies are not disconnecting homes that are unable to pay during the pandemic. Most of these ISPs are also willing to install the above low-income broadband packages for students trying to work from home during the crisis. However, the feeling in the industry is that the big ISPs are likely going to want to collect all back billing from customers who were unable to pay during the pandemic, so there is likely to be a lot of homes disconnected from broadband due to nonpayment caused by the massive unemployment.

The Homework Gap

In 2010, the FCC adopted the National Broadband Plan, and one of the key provisions of that plan is that every American community should have gigabit broadband connections to public schools.

Since that time, the State Educational Technology Directors Association has increased that recommendation and recommend that large schools provide at least 1.4 Mbps of broadband per student for large schools and 2.8 Mbps per student in smaller schools in order to provide adequate bandwidth.

The group Education Superhighway[9] recently reported that at the end of 2019, only 2 of 1,230 public schools in Minnesota still don't have access to fiber broadband.

The bigger issue concerning education is what is being labeled nationally as the homework gap. This is a situation where students have broadband at school but don't have adequate broadband and/or computers at home to enable them to do homework.

The issue recently became a lot more serious when students were sent home due to COVID-19 and asked to finish the school year remotely. Many rural students with poor broadband have been unable to keep up with schoolwork from home.

How much bandwidth is needed to do schoolwork at home? It varies according to the specific set-up at a given school. The typical way for a student to connect to a school system network is through the creation of a virtual private network (VPN) connection. A VPN works by grabbing and reserving a dedicated data path between the home and a server, in this case a school server. While that student is connected to the school, that data path is dedicated to the student and can't be used for other purposes in the home without kicking the student off the VPN connection.

The VPN generally tries to establish both a download and an upload data path. The download path is used to download documents like homework assignments, with the biggest download being when the school homework involves viewing videos that are streaming from the school server. On the upload path, the VPN is used when a student sends completed homework or performs functions online line like taking a test. The biggest use of the upload connection comes if a student wants to connect with a video connection so that the teacher can see the students and vice versa. A 2-way video connection uses both upload and download bandwidth simultaneously.

A downloaded video might use from 1 to 3 Mbps depending upon the amount of action in the idea. The upload stream for video conferencing will require at least 1 Mbps, sometimes a little more. These same VPN connections are carved out of the broadband path for each student trying to work from home at the same time along with any adult trying to connect to a server when working remotely.

The Quello Study

Teachers have understood for many years that students without broadband and/or computers at home don't perform as well in class. There was recently a definitive study that quantified the impact of the homework

[9] https://www.educationsuperhighway.org/

gap. The study was just released in March 2020 and was done by the Quello Center that is part of the Department of Media and Information at Michigan State University.[10]

I call this a definite study because it used study techniques that isolate the impact of broadband from other factors such as sex, race, and family incomes. The study involved 3,258 students in Michigan in grades 8 – 11 from schools described as being in rural areas. The study was done in such a way to get results of schoolwork concerning students without violating student confidentiality.

The study showed significant performance differences for students with and without home broadband. Students with no Internet access at home tested lower on a range of metrics including digital skills, homework completion, and grade point average. Some of the specific findings include

- Students with home Internet access had an overall grade point average of 3.18 while students with no Internet access at home had a GPA of 2.81.
- During the study, 64% of students with no home Internet access sometimes left homework undone compared to only 17% of students with a high-speed connection at home.
- Students without home Internet access spend an average of 30 minutes longer doing homework each evening.
- The study showed that students with no Internet at home often had no alternative access to broadband, such as a library. 35% of students with no broadband also didn't have a computer at home. 34% of students had no access to alternate sources of broadband such as a library, church, community center, or homes of a neighbor or relative.

One of the most important findings was that there is a huge gap in digital skills for students without home broadband. To quote the study, "*The gap in digital skills between students with no home access or cell phone only and those with fast or slow home Internet access is equivalent to the gap in digital skills between 8th and 11th grade students*." Digital skills not only require competence in working with technology, but also means the ability to work efficiently, to communicate effectively with others, and manage and evaluation information. This is a devastating finding that students without home broadband fall three grades behind other students in terms of developing digital skills.

Lower digital skills correlate directly to performance on standardized tests. A student who is even modestly below average in digital skills (one standard deviation below the mean) tends to rank nearly 7 percentiles lower on their total SAT/PSAT score, 5 percentiles lower in math, and 8 percentiles lower in evidence-based reading and writing.

The study also showed lower expectations for students without broadband at home. For example, 65% of students with fast broadband have plans to pursue post-secondary education. Only 47% of students with no Internet access have such plans. Students who are even moderately lower in digital skills also are 19% less likely to consider a STEM-related career (that's science, technology, engineering, and math).

[10] http://quello.msu.edu/wp-content/uploads/2020/03/Broadband_Gap_Quello_Report_MSU.pdf

Another major study by the National Center for Education Statistics (NCES),[11] an agency within the US Department of Education looked at the homework gap. That study compared test scores for 8th-grade students both with and without a home computer. The results showed:

- On tests of reading comprehension, students who have a computer at home had an average score of 268 compared to a score of 247 for students without a computer.
- In testing for mathematics, students with a computer at home scored 285, while those without scored 262.
- In testing science, students with a computer scored 156 compared to 136 for students without a computer.
- In testing competency in information and communication technology, students with a home computer scored 152, compared to 128 for students without a home computer.

Other Uses of Broadband for Education.

The US Bureau of Labor Statistics reported earlier this year that the average American baby boomer held 12.3 different jobs between the ages of 18 and 52 - that was 12.5 jobs for men and 12.1 jobs for women. It's much harder to measure a change in careers, meaning a change to doing something drastically different than prior jobs, but researchers have looked at the data and said that most people change careers at least several times during their work life. The above statistics don't tell the whole story because many people are now working well past 65 years of age, including many older workers trying a new career at the end of their working life.

Many new jobs and careers today require online training. New employees are often expected to complete online training courses at the start of a new job. Many out-of-work adults pursue online training to learn a new career. Anecdotal evidence suggests that taking training or educational courses from a distance (across the country) requires more bandwidth since it's harder to hold a VPN session when the bandwidth varies.

The biggest group of online learners (outside of the COVID-19 crisis) are students pursuing a post-secondary education online. There are almost 20 million college and graduate students across the country, most of which have been recently been notified that most or all of the fall semester this year will be done online.

Secondary education has already been in the process of migrating online. Eduventures estimated that the percentage of students already tackling an online degree before the pandemic was 29% of those pursuing an associate degree, 42% for a bachelor's degree, 27% for a master's degree, and 3% of those working towards a doctorate. In the fall of 2020, nearly all secondary students will have some or all of the curriculum online.

The Computer Gap

Digital inclusion advocates have learned is that it's not enough to get affordable broadband to a home if they can't afford a computer or other devices to use the broadband. It's also now clear that cellphones are

[11] https://nces.ed.gov/pubs2017/2017098/index.asp

good tools for things like shopping online, but they are inadequate for students trying to do homework. Any plan to close the digital divide must find solutions for closing the computer gap.

A survey by Pew Research Center in 2019 shows a huge disparity between income and technology adoption. Consider the following results of that poll:

	Less than $30,000	$30,000 to $100,000	Over $100,000
Home Broadband	56%	81%	94%
Smartphone	71%	85%	97%
Desktop	54%	83%	94%
Tablet	36%	55%	70%
All the Above	18%	39%	64%

Other studies have shown that the percentages of homes that have any these technology tools is much smaller for homes making under $25,000 per year.

A big problem for low-income homes is that they can't afford both broadband and the cost of buying and maintaining a computer or similar device. Computers are some of the shortest-lived electronics we can buy and typically have to be replaced every 3 or 4 years.

The above numbers highlight the problem of getting broadband into low-income homes – a solution is needed to find both broadband and a computer. As will be discussed below, low-income homes also often need computer training.

The historical solution to the lack of computers was to put computers in libraries and public places. However, in communities like the rural parts of the counties, this solution is inadequate for many reasons. First, it requires students to travel to where the computers are. In communities where a lot of students don't have a computer it's difficult to have enough public computers to meet the demand. There is an additional issue that rural libraries often don't have good enough broadband to support multiple simultaneous users.

However, the best reason to get computers into homes compared to libraries is that numerous studies have shown that computers in the home have a huge positive impact on students compared to any other alternative. Computers have the biggest positive impact on students when they are part of daily life and convenient to use when needed.

We can't forget that computers aren't only for students. Adults need computers today just to participate in the modern world. Computers are needed to hunt for a job. Computers are needed to pursue online training and education. Computers are needed to consider jobs that all employees to work from home. Computers are needed today to interface with many government programs.

There are a number of different approaches that communities have tried to solve the computer gap that will be discussed below in the section talking about solutions for the digital divide.

The Gap in Broadband Skills

Studies have identified a big disparity in broadband skills that can be correlated to household income. The following statistics all apply to the US before the COVID-19 crisis. Workers with upper-income jobs have fared extremely well. For example, starting jobs for computer programmers, engineers, and similar tech graduates have been at an all-time high. However, over half of all the jobs in the country are classified as middle-skill jobs (with the three categories being high-skilled jobs, middle-skill jobs, and unskilled jobs). These jobs generally don't require a college degree. An analysis by the Benton Foundation a few years ago showed that over 80% of middle-skill jobs require some degree of digital literacy. Unfortunately, a lot of people seeking middle-skill jobs lack the digital skills needed to land these jobs.

This lack of sufficient digital literacy to find middle-skill jobs is perhaps the best way to describe the broadband skills gap. These are not jobs that need coders, but rather than need people to know basic computer skills like knowing how to use Microsoft Word or Excel. It means being able to type fast enough to do data entry, write emails, or other expected tasks in the average workplace.

In the early days of the computer age, the federal government operated many training programs that taught basic computer skills. Today it seems to be assumed that students graduate from high school with these skills. However, a student who has never had a home broadband connection or a computer and who only did homework on a cellphone probably doesn't have the needed digital skills. Since the federal, and most state governments don't offer any significant training programs in computer literacy, it's up to local communities to find their own solutions.

A Pew Research Center survey in 2016 showed that a lot of adults were interested in digital training. 60% of adults were interested in learning how to use online resources to find trustworthy information. In today's world of misinformation that percentage is probably even higher. 54% of adults were interesting in training that make them more confident in using computers and the Internet.

Future Broadband Gaps

The Future of Broadband Speeds and Capacity

This gap analysis so far has discussed existing broadband gaps. It's important to realize that there will be new broadband gaps coming in the future that we can already predict. One of the issues to consider when looking forward is that broadband speeds are a moving target – that is, the demand for residential and business bandwidth grows every year. This is not a new phenomenon and the need for bandwidth has been growing at nearly the same rate since the early 1980s. Home and business need for bandwidth has been doubling every three to four years since then.

As an example, 1 Mbps DSL felt really fast in the late 1990s when it was introduced as an upgrade from dial-up Internet. The first 1 Mbps DSL connection was nearly twenty times faster than dial-up, and many people thought that speed would be adequate for many years. However, over time, households needed more speed and the 1 Mbps connections started to feel too slow and ISPs introduced faster generations of DSL and cable modems that delivered speeds like 6 Mbps, 10 Mbps, and 15 Mbps. Cable modem speeds continued to grow in capacity and eventually surpassed DSL, and in most cities, the cable companies have

captured the lion's share of the market by offering internet speeds starting between 100 Mbps and 200 Mbps.

Cisco is one of the few industry players that projects future broadband speeds. Their past reports have been accurate predictions of actual landline broadband speeds, and a little less reliable when predicting the growth of new technologies like IoT or 5G.

One of the items forecasted by the Cisco in early 2020 is overall Internet speeds by world region. Following is their prediction of the average broadband speeds (in Mbps) for North America. This represents a 20% compounded growth, just a hair slower than the 21% predicted in their 2019 report.

2018	2019	2020	2021	2022	2023
56.6	70.1	92.7	106.8	126.0	141.8

It's worth noting that Cisco includes Canada with the US in defining North America. I haven't found equivalent numbers for Canada alone to know if they pull the composite number upward or downward. The big takeaway from the Cisco numbers is that broadband speeds are continuing to climb as ISPs either arbitrarily increase speeds or customers upgrade to faster networks.

Cisco also predicts the future of cellular broadband speeds, as follows:

2018	2019	2020	2021	2022	2023
23.6	31.2	40.1	48.2	54.4	62.4

It's worth noting that Canada has one of the fastest cellular networks in the world, which probably raises the North American Cisco numbers. The bottom-line takeaway from the Cisco numbers is that cellular broadband speeds are growing at an average rate of 21% per year.

The above numbers show that Cisco doesn't buy into the story that 5G is going to massively increase cellular broadband speeds. The most recent increases in broadband speeds come from a few factors. The big carriers have upgraded a lot of cell sites to full 4G in the past two years, finally utilizing the full power of the 4G specifications. The recent proliferation of small cell sites is relieving congestion from tall cell sites, which should result in faster speeds. Some of the future speed increases are likely due to the phase-out of 3G.

OpenVault published its *Broadband Industry Report for 1Q 2020* that tracks the way that the US consumes data. The results of the reports are as eye-opening as OpenVault reports for the last few years. OpenVault has been collecting broadband usage for more than ten years.

OpenVault reported big growth in broadband speeds in 2020 related to the pandemic. The company reported that as of the end of March that the average US home used 402.5 gigabytes of usage, up 17% from the 344.0 gigabytes reported just 3 months earlier at the end of 2019, and up 47% from the 273.5 gigabytes measured a year earlier. OpenVault says that most of the growth was realized in the last two weeks of March as employees and students started working from home in earnest.

The OpenVault numbers represent total bandwidth used by a home, meaning the numbers are a combination of download and upload usage. OpenVault validated the widely reported phenomenon that the demand for upload bandwidth is increasing far more than the need for downloading.

Another interesting way to look at broadband usage is by considering the median usage – which is the speed at which half of homes use more and half less broadband. The median broadband usage is the US has always been lower than average usage because of the large number of rural homes that are stuck using slow broadband connections. A home with a 1 Mbps download speed cannot easily use the same amount of bandwidth as a home with a 100 Mbps connection. Median usage for the first quarter was at 233.6 gigabytes, up 60% from 146.0 gigabytes from a year earlier, and up 22% from the 190.7 gigabytes used at the end of 2019. The big news in the growth of median speeds is that even homes with slower broadband connections are burning through more broadband.

One of the most startling numbers to come from OpenVault is what they call power users – homes that are using more than 1 terabyte of data per month. At the end of March, 10% of all US homes were using a terabyte of data, an increase of 138% over the 4.2% of homes that used a terabyte of data just three months earlier at the end of 2019. Even more interesting, 1.2% of homes used 2 terabytes of data at the end up march, up 215% from the end of December. The big ISPs like Comcast are supposedly not billing for data caps during the pandemic – but they must be licking their chops at the flood of new revenues this is going to create if broadband usage doesn't return to pre-COVID levels.

Demand for faster broadband products leaped upward, and at the end of March the percentage of homes subscribing to gigabit data products jumped to 3.75% of homes, up from 2.8% at the end of 2019 and up from 1.9% a year earlier. Amazingly, more than 1% of all homes in the US upgraded to a gigabit data plan in just the last three months – that's something that's been predicted for years. Those homes are not likely going to downgrade to slower speeds – so gigabit broadband is now becoming a significant segment of the market. OpenVault says that 12% of US homes now subscribe to speeds of 200 Mbps or faster.

The OpenVault data also validates what's been reported widely by ISPs – that the pattern of broadband usage is changing by the time of day. In the recent past the peak period for broadband usage – the busy hour – was always in the evenings. In the first quarter, the amount of usage in the evenings was flat and all of the increased usage came during the daytime as employees and students used broadband and video conferences to function.

These various statistics infer that the FCC should be periodically increasing the definition of broadband. The agency looked at broadband speeds in a docket in 2018 and concluded that they were going to keep the definition at 25/3 Mbps. The FCC recently suggested keeping the 25/3 definition for another year. However, there were a lot of compelling filings in that docket that argued that the definition of broadband should be 50 Mbps to 100 Mbps.

The point of this section of the report is that we can't get hung-up on the FCC's definition of broadband when looking at the broadband gap. Practically every home that uses broadband would acknowledge that they download and upload a lot more data today than they did just a few years ago.

It's also important to look into the future when considering broadband needs for the county. For example, if an ISP builds a new broadband solution today, that solution should be prepared to handle the broadband

requirements a decade from now. It's not hard to imagine that seven years from now that the national definition of broadband ought to be around 250 Mbps download. That doesn't mean that the FCC will continue to increase the regulatory definition. In 2018 the FCC rejected numerous filing asking them to increase the 25/3 Mbps definition. There is a political downside if the FCC increases the definition of broadband – it would reclassify numerous homes as not having broadband. Today the 25/3 Mbps definition of broadband is lower than the reality of what many homes need, but my guess is that there will have to a big difference before an FCC will react and change the definition.

The Upload Crisis

The COVID-19 crisis has highlighted another problem with many existing broadband products. One of the more interesting statistics that caught my eye was when Comcast reported in August of 2020 that upload traffic on their network was up 33% since March 1.

During COVID-19 I've gathered a number of anecdotes about problems with broadband. I was talking to a client who is working at home along with her husband and two teenagers. The two adults are trying to work from home and the two kids are supposed to be online keeping up with schoolwork. Each of them needs to create a VPN to connect to their office or school servers. They are also each supposed to connect to Zoom or other online services for various meetings, webinars, or classes.

These functions all rely on using the upload path to the Internet. The family found out early in the crisis that their broadband connection did not have enough upload speed to create more than one VPN at a time or to join more than one video call. This has made their time working at home into a major hassle because they are being forced to schedule and take turns using the upload link. This is not working well for any of them since the family has to prioritize the most important connections while other family members miss out on expected calls or classes.

The family's upload connection is a definite choke point in the network and is seriously limiting their ability to function during the stay-at-home crisis. But the story goes beyond that. We all recall times in the past when home Internet bogged down in the evenings when everybody in the neighborhood was using broadband to watch videos or play games. Such slowdowns occurred when the data pipe into the neighborhood didn't deliver enough bandwidth to satisfy everybody's request for broadband. In that situation, the normal consequence is that everybody in the neighborhood got a degraded broadband connection.

The same thing is now happening with the upload links, but the situation is worse on the upload path than it is for the download path. In a cable network, the upload link out of a neighborhood is set to be no more than 10% of the total bandwidth allowed for the neighborhood. If downloaded bandwidth is bogging down a neighborhood, people are asking to use more than 90% of the full capacity of bandwidth provided by the ISP. On the upload path, the same homes are now competing for only 10% of the broadband available to the neighborhood.

That's a far worse network situation because of the nature of the way we're now using broadband. On the download side, neighborhoods get busy due to streaming video. Services like Netflix stay ahead of demand by downloading content that will be viewed five minutes into the future. By doing so, the network can

have cumulative delays of as much as five minutes before the video stream collapses and stops working. The very nature of streaming creates a buffer against failure – sort of a network insurance policy.

Homes are not using the upload links in the same way. Connecting to a school server, a work server, or a video service all create a virtual private network (VPN) connection. A VPN connection grabs and dedicates some minimum amount of bandwidth to the user even during times when the person might not be uploading anything. A VPN carves out a small dedicated path through the broadband connection provided by the ISP.

The nearest analogy to this situation harkens back to traditional landline service. We all remember times, like after 911 when you couldn't make a phone call because all of the circuits were busy. That's what's happening with the increased use of VPNs. Once the upload path from the neighborhood is full of VPNs, nobody else is going to be able to grab a VPN connection until somebody "hangs up."

Residential customers have historically valued download speeds over upload speeds and ISPs have configured their networks accordingly. Many technologies allow an ISP to balance the upload and download traffic, and they can help congestion by providing a little more bandwidth on the upload stream. Unfortunately for cable companies, the current DOCSIS standards don't allow them to provide more than 10% of bandwidth on the upload side – so their ability to balance is limited.

One of the conclusions that can be reached by this analysis is that any new network built today ought to be capable of meeting the expected broadband speeds of the next decade. The only technologies capable of that are fiber-to-the-premise, cable company hybrid-fiber networks, and some wireless technologies using millimeter wave spectrum that are just now being trialed in a few markets.

The FCC and state governments should not support grants, or in other ways promote technologies that can't meet the expected future broadband needs. Any gap analysis needs to consider future needs and not just the speeds used by households today.

Section II. D. of this report looks at the existing technologies in place in Waseca County today, at how those technologies might improve in the future, and at other expected technologies we are likely to see introduced in the not-too-distant future.

The point that should be taken from the lengthy discussion on technology is that any technology built in Waseca County today should be ready to handle today's broadband needs as well as the expected broadband needs of the future.

The Consequences of the Broadband Gaps

There was a time when academics theorized about the impacts of poor broadband. We don't need to theorize today because you can go to any rural community with poor broadband, and residents and businesses will fill your ear with stories of the negative consequences of having poor broadband. The problems with the lack of broadband got magnified due to the COVID-19 crisis.

Impact of Poor Broadband for Citizens

Lack of good broadband causes major problems for rural homeowners:

- Lower Property Values: Numerous studies show that homes without broadband are worth less than similarly placed homes with broadband. Realtors have been reporting across the country that broadband is at or near the top of the wish list for most homebuyers today. From everything we hear, it is now difficult to attract people to move to rural places that don't have good broadband. Without a broadband solution, the rural parts of Waseca County will become undesirable places to live, and this is only going to get worse over time as broadband speeds keep increasing in the places that have broadband.

- Education: The concern for the schools is that they are unable to send computer-based work home with students since they know that many of them don't have good home Internet. It's incredibly hard to raise kids today in a home without adequate broadband. The issue is not just data speeds, but also the total amount of downloaded data that even elementary school students need to do homework. This is one of the major problems with satellite broadband, which has speeds up to 50 Mbps, but with tiny data caps and high latency, the satellite broadband is inadequate for doing homework. The same is true with cellular data; we have heard horror stories of people with kids ending up with astronomical broadband bills for using broadband from cellphone hotspots for homework.

  Schools want students to be able to use broadband outside the school. An increasingly common practice in places with adequate broadband is to have students watch video content at home as homework and then discuss it later in the classroom. That frees valuable classroom time from watching videos in class. The whole education process is increasingly moving to the web and kids without access to the web are lacking the tools that their peers take for granted.

  There was a major study performed to look at what is being called the homework gap by the National Center for Education Statistics (NCES),[12] an agency within the US Department of Education. That study compared test scores for 8th-grade students both with and without a home computer. The results showed:

  - On tests of reading comprehension, students who have a computer at home had an average score of 268 compared to a score of 247 for students without a computer.
  - In testing for mathematics, students with a computer at home scored 285, while those without scored 262.
  - In testing science, students with a computer scored 156 compared to 136 for students without a computer.
  - In testing competency in information and communication technology, students with a home computer score 152, compared to 128 for students without a home computer.

  Education is not only for K-12. Adults are using broadband to train for new job skills or to take advanced courses online. There is a huge range of undergraduate and advanced degrees that now

[12] https://nces.ed.gov/pubs2017/2017098/index.asp

can be achieved mostly online. Online training courses require decent broadband speeds, but also low latency since the training is usually done in real-time.

The COVID-19 crisis has highlighted the need for good home broadband for students since in many places in the country both K-12 and college students were sent home to complete the school year online. This has instantly created a crisis in rural homes outside of cities that don't have enough broadband to allow students to successfully do schoolwork from home.

A connection between a student and a school server is typically activated through the creation of a VPN (virtual private network). This is a dedicated connection of bandwidth that is carved out of the Internet path and that remains live for as long as the connection to the school WAN is open. One of the important aspects of a VPN is that it carves out upload bandwidth as well as download bandwidth. All of the types of broadband (other than on fiber) available in Waseca County have much smaller upload speeds than download speeds and even homes with adequate download bandwidth might not be able to establish a VPN connection due to the inadequacies of the upload path.

Many school systems are trying to recreate the classroom feel using videoconferences where a teacher and all of the students can see each other. That requires a 2-way video connection that can use a 1 – 3 Mbps connection for both upload and download. Students without good home broadband are not going to be able to participate in this kind of remote classwork.

Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. This makes it nearly impossible to make either kind of connection reliably over satellite broadband – one of the more common kinds of rural broadband connection.

Doing schoolwork from home is also going to use a significant amount of bandwidth during a month, and that raises the issue of data caps and data overage charges. Both satellite broadband and cellular broadband have small data caps – and all data usage about the data caps can be expensive.

- Working at Home: More and more jobs today can be done at home, even if only part-time. But people without adequate home broadband can't participate in this part of the economy. Increasingly, companies are willing to hire people who work out of their homes. The beauty of such jobs is that they can be done from anywhere.

  Working from home is one of the fastest growing parts of the national economy. Many of your residents could find work that would allow them to work at home and to make a larger income than they can make today locally – if they have great broadband. After years of experiments with telecommuting, companies have seen that employees are often more productive from home due to missing the various distractions that are in the work environment.

  The COVID-19 crisis highlighted the need for good home broadband when as many as 30% of the nationwide workforce was sent home to work in early March. Across the country employees that live in rural areas were unable to work from home due to inadequate broadband.

Working at home requires an encrypted VPN connection for most corporate and government WANs, in the same manner as described above work connecting to school WANs. Working at home is also coming to mean connecting by video conference with others as an alternative to face-to-face meetings. This requires a dedicated 1 – 3 Mbps connection for both upload and download – again, something that is a challenge for somebody working from home with a slow Internet connection.

Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. This makes it nearly impossible to make either kind of connection reliably over satellite broadband.

What's become painfully obvious due to the coronavirus crisis is that homes need more than the ability for a student to do homework or a person to work from home – because many homes have multiple students and possibly also more than one adult all trying to function on the Internet at the same time.

- Medical: We are finally starting to see a big uptick in the use of telemedicine. This is the process of using broadband to connect patients to specialists without having to make the long drive in for an appointment. Patients can talk to doctors using a video connection if the home has adequate broadband. The biggest benefit of telemedicine is being able to talk to a specialist without having to make a long trip to some distant city.

  It's going to be interesting to see if telemedicine stays after the end of the pandemic. In the past months, telemedicine visits have skyrocketed. During March and April of 2020, the billings for telemedicine were almost $4 billion compared to only $60 million for the same months a year earlier.

  As soon as Medicare and other insurance plans agreed to cover telemedicine, a lot of doctors insisted on remote visits during the first few months of the pandemic. In those early months, we didn't know a lot about the virus, and doctor offices were exercising extreme caution about seeing patients. But now, only four months later a lot of doctor's offices are back to somewhat normal patient volumes, all done using screening patients at the door for temperature and symptoms.

  There was a recent article about the topic in *Forbes*[13] that postulates that the future of telemedicine will be determined by a combination of the acceptance by doctors and insurance companies. Many doctors have now had a taste of the technology. It seems likely that the telemedicine platforms in place now will get a lot of feedback from doctors and will improve in the next round of software upgrades.

  One of the best uses that have been found for telemedicine is for administering non-intrusive assistance for things like counseling. Patients can make scheduled appointments without major disruption to work schedules.

[13] https://www.nytimes.com/2020/08/03/health/covid-telemedicine-congress.html

A growing area of telemedicine is the use of medical telemetry devices, which can monitor patients after they've had medical procedures. For example, Saint Vincent Health System in Erie, Pennsylvania has been using these technologies and has lowered readmission rates of patients after surgery by 44%. CoBank recently sponsored a trial in Georgia for rural diabetes patients and showed a significant improvement for patients who could be monitored daily and who could communicate easily with doctors.

The coronavirus crisis has highlighted the need for telemedicine. Doctor's offices and clinics all across the county have shifted some of their office "visits" to video meetings on Zoom or other video platforms to reduce contact between doctors and patients when it can reasonably be avoided. There have been widespread reports that some doctors are requiring video connection for all non-emergency visits. Councilors and mental health workers also report migrating most, or even all contacts with clients online. It's immediately become clear that patients without home broadband, or without a strong cellular signal can't make the needed video connection. There is a lot of speculation that video meetings and telemedicine are going to become mainstream by the end of the coronavirus crisis, once doctors understand how effective it can be in many cases.

- Taking Part in the Modern World: People with good broadband have access to features of the web that require bandwidth. Households with good bandwidth routinely use broadband for things like watching videos on services like Netflix, talking to friends and family on services like Skype, playing video games (many of which have largely moved online), taking online courses from numerous colleges, or even just browsing today's video-rich Internet. Many of the businesses people now interact with (utilities, insurance companies, shipping companies, etc.) assume that people have a broadband connection. Many people's social lives, for better or worse, have moved to the web; it is not uncommon to now have friends all over the country based upon some shared interest instead of based upon geographic proximity. Homes without broadband can't participate in any of these many activities and services available on the web.

  Taking part in the modern world has grown to mean a lot more than just watching videos. Consider some of the following ways that a lot of households routinely use bandwidth:
  - Security. Millions of homes now have video cameras at the front door or elsewhere on their property that they can view remotely. A video camera requires a 1 – 3 Mbps upload connection for low-resolution cameras and up to 16 Mbps upload for an HD quality camera.
  - Machine-to-Machine Traffic. Our devices often connect with the Internet without human intervention. Our computers and smartphones automatically upgrade software and apps. Many homes have files automatically backed-up in cloud storage. Numerous appliances and devices in our home periodically connect with the cloud wither providing updates or just to make sure that the connection is still live. Many cars now communicate with the cloud when they are within range of a home broadband connection to provide the status of all car sensors and to upload driving data that can later be used by the car owner. Cisco predicted early this year that this traffic would represent over 50% of all the traffic on the web by 2023.
  - Online Everything. Many of the functions we do have migrated to being only online – we couldn't even begin to make a full list of things that are largely now online. This includes both major and minor functions including things like applying for a job, applying for

government benefits, making insurance claims, making reservations for a restaurant, banking, and a slew of other activities. Homes without broadband are being left out of numerous activities that everybody else takes for granted.

- Keeping Talent at Home. An issue we often hear about in rural communities is what is called the "rural brain drain." Most rural counties don't have enough good-paying jobs to keep recent graduates at home, and so large percentages of each graduating class relocates to larger cities and towns to pursue careers. One of the promises of fiber is the ability to create new jobs and also provide the opportunity for people to either work at home or to create new businesses that allow them to stay where they want to live.

Impact of Poor Broadband for Businesses

There are numerous consequences of poor broadband for businesses. While some businesses have unique and specific requirements, there are several problems caused by poor broadband that affect most businesses.

Impact on Day-to-day Operations. Just like with households, most businesses are seeing their broadband needs growing rapidly year-over-year. Each one of the following routine business functions requires decent bandwidth. Businesses without adequate bandwidth must forgo or compromise on how they communicate with the world and function day-to-day.

- To Communicate with Customers. Businesses routinely have portals that make it easy for customers to place and track orders and to communicate with the business. Inadequate broadband means lower sales. The old days of calling purchasing agents are slowly going away and most commerce between companies is becoming automated – which improves accuracy and speeds up the ordering process. Businesses that operate busy e-commerce ordering sites need big amounts of bandwidth to make sure that all customers have a successful purchasing experience. A concern in the rural parts of the county is that many businesses report that their broadband is not even sufficient enough to consistently process credit card transactions. That requires almost the bare minimum of bandwidth, which speaks volumes about the quality of rural broadband in Waseca County. Businesses in the County report that they are unable to maintain e-commerce web sites for selling goods or services, taking customer reservations, or other routine functions necessary to conduct routine business.
- To Communicate with Vendors. Businesses also routinely use the portals of vendors and suppliers to buy whatever they need to operate.
- To Communicate with Other Branches of the Company. Many businesses are now part of larger corporations and maintain open data connections to communicate with other parts of the company and with headquarters.
- Working in the Cloud. It's now common for companies to work in the cloud using data that's stored somewhere offsite. This can be in one of the big public clouds like the ones offered by Amazon, Google, or Microsoft or it can be a private cloud available only to employees of the business. This is the change in the ways that companies operate that has probably created the most recent growth in bandwidth. A business doesn't need to be highly sophisticated to work in the cloud. Today banking is routinely done in the cloud. A lot of basic software like Microsoft Office has migrated to the cloud. Even interfaces with local, state, and federal governments have migrated to the cloud.

- Security Systems. Businesses often have their network and computer security monitored by offsite firms. Security today also means the use of video surveillance cameras, which require upload video streams to be viewed outside of the business.
- Sending and Receiving Large Data Files. Most businesses report that the size of data files they routinely transmit and receive has grown significantly larger over the last few years. Some surprisingly small businesses like photographers, architects, engineers, and others routinely want to send and receive big data files.
- VoIP. Many businesses now provide voice communications between their various branches using Voice over IP. A reliable VoIP system needs to have dedicated bandwidth that is guaranteed and that won't vary according to other demands for bandwidth within the business.
- Communicating via Video. We've finally reached the time when employees routinely communicate via video both inside and outside the business. We saw a huge surge in this during the COVID-19 crisis as students and employees increasingly used video conferencing services, but these services had already become routine for businesses before the crisis. Another specific concern in Waseca County is that rural broadband is so poor that tourists visiting the county are routinely unable to upload videos of their activities, which locks tourism destinations in the county from social media coverage.
- Email and Advanced Communications. While many businesses still rely on email, many have gone to more advanced communications systems that let parties connect in a wide variety of ways. Businesses are using collaborative tools that let multiple employees from various locations work on documents or other materials in real-time. These services require adequate download and upload bandwidth.
- Supporting Remote Employees. Many businesses now save money by allowing employees to work from home full or part-time. They need reliable broadband links to provide home-based employees with the same access to systems that are on site. A complaint heard often by rural businesses is that they must physically carry files to their homes or other places with good broadband to conduct routine business.
- Data Back-Up. Companies are wary of hacking and ransomware and routinely maintain several remote copies of all critical data to allow them to restore data after a problem. Data backup requires a steady and reliable upstream broadband connection.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. One common function of this sort is burglar alarm systems that monitor physical security and sensors inside equipment that monitors data security. Routinely used office equipment like printers, copiers, postage machines, and many others only function correctly when connected to the Internet.

Entrepreneurship. The fastest-growing part of many local economies is the growth of small businesses, many that start in the home. Small businesses often begin with a few employees and grow over time as they succeed. Start-up businesses generally are highly reliant upon good broadband. Lack of adequate bandwidth and reliable broadband connections means that small businesses have a difficult or impossible time starting in rural parts of the county.

Agriculture. Every industry has specific requirements for broadband. Since Waseca County relies heavily on agriculture, the easiest way to demonstrate this is to talk about how broadband is transforming agriculture. A similar list can be made of the specific uses of broadband for numerous other industries.

- The most data-intensive farming application is the creation of real-time variable rate maps of fields. Farmers can use smart tractors or drones to measure and map important variables that can affect a current crop like the relative amounts of key nutrients, moisture content, and the amount of organic matter in the soil. This mapping creates massive data files that are sent off-farm. Expert agronomists review the data and prepare a detailed plan to get the best yields from each part of the field. The problem farms have today is promptly getting the data to and from the experts. Without fast broadband, the time required to get these files to and from the experts renders the data unusable if the crop grows too large to allow machines to make the suggested changes.
- Using sensors for monitoring livestock is the most technologically advanced area and there are now dairy farms that measure almost everything imaginable about each milking cow. There are also advanced sensor systems monitoring pigs, chickens, egg farms, and other food animals. Ranchers that have good cellular data coverage over range areas can track the location of every member of their herds.
- There has been a lot of progress in creating self-driving farm implements. These machines have been tested for a few years, but there are not a lot of farmers yet willing to set machines loose in the field without a driver in the cab. However, it's common for smart field machinery to do most of the driving. The industry is quickly heading towards the day when driverless farming will be an easily achievable reality. Smart devices have moved past tractors and now include things like automated planters, fertilizer spreaders, manure applicators, lime applicators, and tillage machines. Machinery now comes with sensors that will alert a farmer of a problem and can even automatically order a replacement part before a working machine fails.
- One of the more interesting trends in farming is to record and report on every aspect of the food chain. When the country stopped eating romaine in late 2018 because of contamination at one farm, the industry started to develop a process where each step of the production of crops is recorded, with the goal to report the history of food to the consumer. In the not-too-distant future, a consumer will be able to scan a package of lettuce or other crop and know where the crop was grown, how it was grown (organic or not) when it was picked, shipped, and brought to the store. This all requires creating a blockchain with an immutable history of each crop, from farm to store, and making this history immediately available to stores and consumers.
- The industry has been developing soil sensors that can wirelessly transmit real-time data on pH, soil moisture, soil temperature, transpiration, etc. These sensors are still too expensive today to be practical – but the cost of sensors is expected to drop drastically with sales volumes. Research is even being done to create low-cost sensors that can measure the health of individual plants in orchards and similar environments.
- The smart farm today measures an immense amount of data on all aspects of running the business. This includes gathering data for non-crop parts of the business such as the performance of vehicles, buildings, and employees.
- The biggest broadband challenge for many farms is the ability to upload and download the large data files needed to communicate with software in the cloud, or with vendors or services that help them to process and understand their data. For example, land survey files can easily include terabytes of data that can overwhelm the normal rural broadband connection.

<u>Economic Development and Jobs</u>: Reliable and affordable broadband is still one of the key elements in traditional economic development to lure new companies to a community or to keep existing companies from leaving. As vital as broadband is to residents it's even more vital to businesses.

Businesses want more than just fast broadband. They often require multiple feeds of broadband from different ISPs, on diverse routes to guarantee that they don't lose connectivity.

Many businesses now want employees to have broadband at home so that they can work from home as needed while gaining access to data from company servers. A new business will consider the whole broadband profile of an area before deciding to locate there. Numerous municipal fiber ventures claim significant economic benefits from fiber networks. Many of them have been able to lure new businesses or have seen existing businesses expand.

The Reverse Donut Phenomenon. There is an interesting phenomenon to be aware of that CCG calls the reverse donut phenomenon. If Waseca County can attract fiber to the rural parts of the county, but not to the cities, then the rural areas would have faster broadband than the cities. At first, that wouldn't make much difference. But over time, as the need for broadband keeps growing, fiber-based broadband in the rural areas would be better than the cable-based broadband in the cities. That could have the effect of making people want to live in rural areas rather than in the larger town. Many counties find this problematical since they have structured the various services of the county based upon where people live today. Many counties also don't want their population to disperse to rural areas because it increases the cost for a host of services like road maintenance, school transportation, policing and public safety, and numerous other costs that fall to the county and the towns.

This is not an immediate issue, but the reverse donut is an inevitable outcome if the rural areas get fiber. This means that any broadband plan for Waseca County ought to have a goal for getting fiber-equivalent speeds everywhere. It makes sense to concentrate on the areas without good broadband first, but the County needs to not forget about the cities in the long run.

II. ENGINEERING DESIGN AND COST

Finley Engineering performed an engineering analysis and prepared a cost estimate of the cost of building broadband in unserved and underserved parts of Waseca County. Before looking at the specific network designs, we gathered information about the county and the existing broadband services in the county for use in all of the scenarios. Following is a description of the data we gathered and the approach we took to the engineering analysis.

Study Area

There is a map showing the study area in Exhibit II of the report. The areas shown in green are included in the study – this represents the vast majority of the geographic area of the county.

The county elected to look at a study that brings broadband to all parts of the county that are either unserved or underserved today and for which there are no plans to bring fiber in the next few years. We gathered maps and data from both the State of Minnesota and Federal databases. The state has speed goals defined as having 25/3Mbps (upload and download) to every home and business by 2022. The 2026 goal increases those speeds to 100Mbps download and 20Mbps upload.

In Minnesota, locations are said to be unserved if they lack access to 25/3Mbps, underserved if they lack access to 100/20Mbps, and served if they have 100/20Mbps service or greater from any provider. Areas with wireline service greater than 100/20Mbps were excluded from the study. We found that all cities (Waseca, New Richland, Janesville, and Waldorf) were considered "served" along with a few major highway routes that had middle-mile fiber. We also found that small portions of the rest of the county meet the 2020 speed goals of 25Mbps download and 3Mbps upload.

We then researched and talked with all of the local wireline providers in the county. We looked at data from recent FCC 477 filings and we inquired about what level of service they offered today and what their plans for future upgrades were. Below is a summary of what we learned:

1. CenturyLink – The company provides service in several exchanges in the eastern part of the county. Broadband is provided almost entirely using DSL technology. CenturyLink received CAF II grants from the FCC to upgrade their existing DSL nodes to provide broadband speeds of at least 10/1 Mbps. This meant driving fiber farther into the network and shortening copper loop lengths to increase speeds. These upgrades have limited effectiveness in rural areas as they rely on aging copper infrastructure to deliver last-mile services. All areas served by CenturyLink are included in the study area.
2. Frontier – The company provides service in several exchanges in the western part of the county. Broadband is delivered using DSL technology. Frontier also received CAF II funding to upgrade rural DSL speeds. These areas are included in the study area.
3. Consolidated – The company provides service in a small area on the western border of the county. Broadband is provided using DSL technology. Consolidated accepted a tiny amount of CAF II funding to upgrade existing DSL for 18 homes. These areas are included in the study area.
4. Manchester Hartland Telephone Company – They operate a small area in the Southeastern part of the county with a FTTP network. This area has been excluded from the study.

5. Bevcomm – Bevcomm operates a few small areas in the Northeast and Southwest part of the county. They have received ACAM funding and are upgrading portions of their network across the state. No firm timeline has been set for areas in the county. In general, they are building FTTH networks to fulfill these obligations. These areas are included in the study.
6. Mediacom – The company provides service in and around the city limits of Waseca and Janesville as well as a few isolated pockets across the county over their existing cable plant with speeds of up to 1Gbps. These areas were excluded from the study area.
7. Midcontinent – The company provides service in and around the city limits of New Richland as well as a small area around Lake Elysian over their existing cable plant with speeds of up to 1Gbps. These areas were excluded from the study. They were also awarded support in the recent CAF2 auction to provide 100/20Mbps service in select areas around the county. This is largely expected to be via fixed wireless.
8. Jaguar – Jaguar operates a fiber network in a few areas of the county from Waseca to New Richland to Waldorf. The company serves only selected businesses in the cities. Jaguar offers fiber broadband to residents who live close to fiber routes. These areas were excluded from the study.
9. LTD Broadband – The company offers fixed wireless service throughout the county. These areas were included in the study area.
10. RLI (Radio Link) – The company offers fixed wireless service throughout the county. These areas were included in the study area.

Passings: The telecom industry uses the term "passing" to mean any home or business that is near enough to a network to be a potential customer. We verified passings through the use of county GIS information that showed us the location of all occupied buildings in the study area. With this information, we determined that there are approximately 1,811 passings in the rural areas. We counted rural business passing using Google Maps. The passing for the study are as follows:

Residential Customers	1,780
Business Customers	31
Total	1,811

+

Road Miles: Waseca County has an extensive GIS system in place. This information was used as the primary resource for the study. Analysis of the GIS data, satellite imagery, and also MNDOT maps of streets and roads were used to determine fiber routes in the study area. There are approximately 515 miles of roads in the larger study area, and these are roads that are maintained all year, meaning they are plowed when it snows. Our study is conservative in that it assumes that fiber would be built along nearly all of these roads. It's likely in a detailed design that some efficiencies could be found that would result in small reductions in the road miles that need fiber.

The miles of fiber constructed in each study are:

All Fiber Scenario	514.8 miles of fiber
Hybrid Scenario	60.6 miles of fiber

A. Network Design

The engineering study looks at building fiber to pass every underserved home and business in the rural part of the county. Fiber broadband networks have been around as an end-user delivery platform since the late 1990s. The Fiber-to-the-Premise (FTTP) technology that is currently in the marketplace has been around for over 15 years and the technology is now mature and widely used around the world.

The design of fiber networks and the associated electronics are fairly straightforward, but every network differs in the details of how the network will be deployed, the method of construction, geography, topography, the number of customers, and the long-term goals of the fiber provider. Below is a description of the major component of a FTTH network and a discussion of the factors which influenced our design decisions for the network.

There are two primary types of fiber electronics used in FTTH networks – passive and active. Finley chose a passive network for several reasons, and a detailed comparison of the two technologies is included below.

All the network architecture, the design elements, and the electronic equipment used in this design have been used successfully by Finley in past projects. We note that Finley and CCG are both vendor-neutral are not recommending any specific vendors for network components. In the descriptions of our design below, you may see us referring to various brands of routers, switches, or FTTH electronics – but note that there are several vendors that can supply the needed devices and in some cases, we chose a typical vendor for purposes of developing a network cost estimate.

The Waseca County network is designed as an all Internet Protocol (IP) network; meaning that all traffic and connections are IP based. The FTTH network is broken into two distinct types of connectivity:

- Fiber network *(Physical network of connectivity from the central office to customers)*
- IP network *(IP packets with internet information on optical signals)*

The easiest way to understand the distinction is that the fiber strands (the physical network) carry IP packets that communicates to and from the Internet.

The basis for any FTTH network design relies mostly on the network topology, fiber cable fill percentage, and the number of potential broadband customers – these factors largely determine the size of fiber required, the requirements to terminate the fiber in cabinets or frames, and the type of buildings or cabinets required for the FTTH optical equipment.

Backbone Fiber. The network design assumed the construction of a backbone fiber. A map of the proposed fiber backbone is shown as Exhibit III. The purpose of the fiber backbone is to provide a path to bring fiber signal to and from the fiber nodes or wireless towers in the different network configurations.

Finley chose a 55-mile long backbone fiber route. Other routes could be chosen to reach the same or similar locations. The network could also be constructed in phases or utilize other provider's fiber. Typically, large networks like this would have multiple paths or rings to provide redundant connections points. These alternate paths allow the network to self-heal and do not lose service for a single fiber cut. We have designed multiple diverse routes where feasible into this design for Waseca County. In the case of the hybrid fiber and wireless network, these routes would serve the towns and towers and would allow a provider to use the faster payback of fixed wireless to gradually build more fiber over time.

It's also possible that if the county is served by an ISP that edges out from its current service territory that the miles of backbone fiber needed to be smaller. However, in a full fiber build, these same roads would still require fiber, so there would be no significant savings or change in overall price from eliminating the backbone or changing the route along different roadways.

This backbone configuration was chosen because it could be used to serve either FTTH huts or wireless towers depending upon the design chosen. The design placed huts at the following two locations to house equipment and fiber optic splitters for distribution to subscribers. Again, the buildings could be located elsewhere, but we think three nodes are the best design for reaching all homes with fiber utilizing a centralized design that would maximize bandwidth capabilities.

	Passings
Alton	899
Bryon	549
Woodville	363
Total	1,811

The remote electronics huts are sized to be large enough to accommodate all electronics, batteries, and equipment that would be required with some spare capacity. In all scenarios, we based pricing upon recent quotes we have received from vendors like Calix, AdTran, Clearfield, Cienna, and others. Finley is not proposing any specific vendors as we are vendor neutral. The costs chosen are representative of current electronic costs.

In pricing the fiber construction, Finley used pricing from the recent construction of fiber in similar conditions (soil type). The labor in the forecasts was estimated at current market rates and did not include the prevailing wage rate.

Fiber Drops. Drops are the fiber wires that connect from the fiber on a road to reach a customer. The average length of drops varies – for example, drops are longer for farms and shorter for homes located near to roads. After examining the area on Google Maps, we estimated that the average fiber drop is 200 feet.

The All-Fiber Network Scenario

The first option studied was an all-fiber design. There are several key factors to consider in the design of a rural fiber network:

- Whether to use buried fiber, aerial fiber, or some mix of the two.
- The design of the fiber electronics.

Since we don't know if one or more of the existing providers in the area might build broadband to the study area, we designed a network for the whole study area that stands on its own in terms of design. As mentioned earlier, that design assumes a fiber backbone and also the construction of two fiber nodes to hold electronics.

However, should the existing providers build out from existing fiber networks there would likely be some savings from our cost estimates. For example, a network might be designed with fewer huts if existing huts could be utilized. If the network was designed without a fiber backbone or incorporated into existing backbones by different providers there could be savings on the fiber costs and electronics.

We took the most conservative approach to the design. The network has been designed as if only one service provider would serve the whole area. In doing so we have not started with an assumption that there are existing fiber assets that might benefit the fiber build. This means that our estimated costs are, by definition, conservatively high.

In Waseca County, the soil is mostly soft and deep with a few areas of rock that would allow for easy construction for buried fiber. These areas are mostly along the Minnesota River and we have accounted for higher construction costs there. We also accounted for lakeside construction which is usually more expensive due to wet soils, additional boring requirements, and a higher density of potential subscribers. Finley determined that it is probably not any more costly to bury the rural fiber than to put the fiber on poles in those places where there are poles. An all-buried design has the added advantage of having lower future maintenance costs. The one downside to a buried network is that it is more susceptible to fiber cuts by anybody doing rural excavation near roads or at the end of driveways, and it is likely that a buried fiber network would incur these fiber cuts from time to time. This would be another reason to utilize redundant network paths as a single cut would not take the network down.

For electronics, the first design issue to consider is whether to centralize or distribute the electronics in the network. The second design issue looks at using a star versus a ring topology. A third issue in the design is to determine whether to use distributed splitter locations or local convergence points for splitter locations.

In the all-fiber study, we chose the locations of the huts so that no customer was more than 12 miles away from a hut, the maximum recommended distance for a signal on a FTTH network. That is 12 miles of fiber along a road, not a 12-mile circle. The study shows the need for three huts to act as PON local originating points.

The huts were designed using prefabricated buildings that are designed to weather all seasons of the year. These buildings are relatively inexpensive and allow for future flexibility. From each hut, there is a dedicated fiber built to each customer. This would allow for the option of serving customers with either Passive Optical Network (PON) electronics or with active Ethernet (only for high bandwidth customers). The major difference between the two technologies is the number of lasers in the network. In a PON network, one laser in a hut can light up to 64 home lasers (although it's more typical to light no more than 32 or 16). With active Ethernet there must be one laser in a hut for every laser at a home or business.

The cost of the network was determined using typical prices of PON electronics. A GPON network shares 2.4G downstream and 1.2G upstream which is split between the numbers of subscribers attached to a GPON splitter with 64, 32, or 16 ports. This network could be upgraded to XGSPON which would provide a 10Gbps shared connection over the same splitters. An active Ethernet port provides up to 1 Gbps of upstream and downstream data to customers and would be upgradable to 10 Gbps. There are not likely to be any customers in the rural parts of the county that would insist on having a dedicated Ethernet feed, which requires active Ethernet technology. An end-user will want a dedicated feed when they don't want

to share bandwidth with other customers anywhere in the network, and that sort of requirement is generally only made by very large data users, like a school system, or security-conscious customers like a military or government building. In today's market, the cost of using active Ethernet probably adds at least 15% or more to the cost of the network electronics. For this reason, we priced and entirely GPON design, although some active Ethernet could easily be incorporated.

In the design, Finley used large enough fibers for each part of the network to accommodate potential customers in a given area. In a competitive environment, you are not going to know at the time of design where customers are going to be on the network. Over the long life of fiber, it is to be expected that many of the homes in the rural areas might become customers, and it's certainly possible over time for many more homes to be built throughout the service area.

The fibers were sized to potentially serve everybody in the rural areas, with additional spare fiber strands to act as replacements for any fibers that go bad, and to accommodate future new homes.

When designing FTTH networks, there are options for how many customers to serve from one neighborhood fiber point. The technology will allow up to 64 customers to share a PON system. Since there are not many customers in the rural areas, the rural network was designed with a 1x16 fiber split while the towns were designed with a 1x32 fiber split. Having a lower split allows the signal to travel farther. If in the final design, there are a few customers more than 12 miles from a hut they could be accommodated by placing them on a fiber that has a split of 1x8 or even less.

Customer Electronics

The customer electronic devices used to serve customers in a PON network is referred to in the industry as an ONT (Optical Network Terminal). This is an electronic device that contains a laser, and which can connect to the fiber optic signal using light from the network and convert that signal to traditional Ethernet on the customer side of the network.

Traditionally, ONTs were placed on the outside of buildings in a small enclosure and powered by tapping into the electricity after the power meter. Today there is also an ONT that can be placed indoors, and which plugs into an outlet, much like the cable modems used by cable companies. Some companies still put the ONT on the outside of the home to give their technicians 24/7 access to the units. Other providers are electing internal units because of the greater protection from the weather. The industry is split on this choice, but it appears that internal ONTs are becoming the most predominant choice for new construction. The cost of the two kinds of units is nearly identical and so the study doesn't choose between the two types of units.

ONTs are also available in multiple configurations. The most common unit is the one that can be used to serve either homes or small businesses, with larger units designed to serve large businesses. The study assumes that only the smaller standard units are used since we don't think there are any complex businesses in the service area. The network could easily accommodate the larger ONTs if needed.

Hybrid Fiber and Wireless Network

We next considered a hybrid network. The topography is conductive to a wireless network except for the river areas along the south and eastern edges of the county. The hybrid design would serve those along the fiber ring with fiber and the other rural subscribers with wireless. The design assumes that 1,679 customers could be served using point-to-multipoint wireless technology and that most of the towers would have redundant fiber backhaul.

The wireless network begins by assuming nearly the same fiber backbone route as in the all-fiber study. There would be a few short lateral fibers built to get to existing tower sites. We see the following benefits for this network design:

- The ultimate goal of the county is to find a way to serve all homes and businesses in the county with fiber. Building a backbone provides the basis for future fiber expansion even if some parts of the county start using wireless technology.
- A design that includes a fiber backbone to serve the wireless towers could also be used to connect homes and businesses on the routes we chose. We've seen several DEED grants that received funding to serve customers along similar backbone fibers. However, this might be hard to get funded since there are several wireless providers in the area.
- Fiber allows the delivery of large amounts of bandwidth to the towers, which then results in the highest quality wireless product. While it is possible to feed towers with point-to-point radios instead of fiber, with a fiber network the amount of bandwidth that can be delivered to a given tower is nearly unlimited, which will be important as wireless technology improves over time.
- Fiber networks are generally among the most reliable components of modern networks. The electronics on a fiber network are usually designed with redundant switchover, meaning that the network can quickly heal itself in case of an electronics failure. Also, other than an occasional fiber cut, the fiber is generally reliable. Microwave backhaul systems are also reliable, but not as reliable as fiber systems as they are more susceptible to interference and inclement weather.
- There is a possibility in the county to lease a portion of the backbone network. This would reduce upfront construction costs but would increase operating costs to cover a lease.

The wireless network was designed with six total towers. The design calls for leasing space on existing towers, but new towers may be required and is not accounted for in the design.

These locations were used in the study to create a network that is capable of being within 6 airline miles of most potential customers. We have included a propagation map of wireless coverage as Exhibit IV. Before building an actual network, we would highly recommend doing a more detailed propagation study to determine the optimum location of the new towers. Such a study would consider trees and other details not included in our study.

For this kind of network, the towers should be as tall as possible because the taller they are, the easier it is to reach homes. Any tower that is taller than 190 feet must be registered with the FCC and meet some additional obligations (such as having a blinking light on the top).

At each tower is a set of radio transmitters and receivers that will communicate with customers. Each tower site has more than one transmitter and each transmitter is designed to transmit in a 30 to 120-degree path, called a sector. Thus, it takes at least three transmitters to serve the full circle (360 degrees) around

one base station. Each sector can comfortably handle a set number of point-to-multipoint connections, and so multiple sectors mean the ability to serve more customers. These systems are modular so it's possible to employ a "pay as you grow" model where sectors are added as more customers are turned up and the network is loaded more heavily.

We are always asked how fast the customer broadband connections are in a wireless network, and in this kind of network, the answer is: it depends. As mentioned earlier, the two most important limiting factors affecting data speeds are the specific spectrum being used and the distance between a customer and a tower, with customers who are close capable of getting faster speeds than those who are farther away. The overall goal with our design was to try to design a network capable of delivering a minimum of 25 Mbps to customers although speeds up to 100Mbps would be possible where conditions are favorable. Several factors dictate the speed that a customer might receive:

- A customer must have a clear line-of-sight to get optimum service. Factors such as vegetation and crossing over water can impact performance.
- Distance to the tower, longer distances mean lower speeds.
- Channel size, larger channel sizes mean faster speeds. However, larger channel sizes are not always possible due to factors such as interference and spectrum license availability.
- Equipment specs
- Sector loading, too many subscribers on a single sector can impact the overall experience for all.
- Backhaul capacity, this is not a concern for this network as all towers are served by fiber.

There are several different frequencies of radios that can be used for wireless deployment.

- The primary frequency used for this technology today is WiFi. This is the same WiFi frequency used to deliver broadband inside homes. Traditional WiFi uses two frequencies – one at 2.4 GHz and another band at 5.8 GHz. 5.8GHz would primarily be used as there is more spectrum available and can deliver more speed in most cases. But no frequency is perfect with foliage and some customers, particularly those farther away from the tower might need to take some steps like cutting down trees to improve reception.
- CBRS or 3.65 GHz frequency. There are several advantages of this frequency over WiFi. First, the 3.65 GHz frequency handles trees much better than 5.8GHz. Licenses for this frequency were sold in an auction that just closed in September 2020.
- Radios used for this purpose today are largely software tunable and we envision networks that use both 3.65 GHz and 5.8GHz, and which might be able to accommodate future frequencies allowed by the FCC.

Another side benefit of wireless networks is that they don't care about political boundaries, and so it is likely that a network would be able to pick up some customers outside the county. The 6-mile radius is only a rule of thumb for delivering quality bandwidth. Many wireless companies sell slower products at greater distances; there might be many customers 10 miles from a tower willing to pay for 5 Mbps broadband if all they can get today is dial-up. There could be some small amount of additional revenue available that is not reflected in the business plan.

B. The Technology

Fiber Technology

The following is a more in-depth look at fiber technology.

The fiber design considered two technologies. Active Ethernet technology has been in widespread use for more than 30 years; GPON has been used for over 15 years. These are both mature technologies that are widely used and well-understood in the industry.

Gigabit Passive Optical Network (GPON**)**

This technology was chosen as the primary way to deliver broadband. GPON makes use of optical splitters so that as many as 32 customers can share the same fiber (i.e., light source). If fewer customers are served from the same light source there is more potential bandwidth for each customer.

A GPON network can be designed in numerous configurations, but all designs include the same key elements. All networks start at a network core where the connection is made to the Internet. At this core, the ISP generally inserts the signals for the various products being delivered to customers.

From the core there are direct fibers to Optical Line Terminal (OLT), which are the devices that provide the light source for customers. These OLTs can be located in the same location as the fiber core or else can be spread around the city in neighborhood nodes, generally in huts or large cabinets.

There is one fiber leaving the OLT for each "PON" which is the local network consisting of up to 32 customers. These fibers go to splitter cabinets where each fiber is then "split" into the 32 separate fibers that go to customers. The splitter cabinets can be located at the same location as the OLT electronics, or they can be moved deeper into the network to be closer to customers. The name "passive" for the technology comes from the fact that the splitter site doesn't require electronics or power – the splitting is just what it sounds like – one fiber is spliced and split into 32 individual paths. The paths from the splitter are "home runs" meaning that there is a dedicated fiber between a splitter site and each customer.

One of the biggest benefits of the GPON network is a savings in fibers in the network. Only one fiber is needed to serve an OLT and one fiber goes from the OLT to each splitter. The fiber is only divided into individual customer fibers at the splitters, which can be deep into the network. The GPON technology chosen provides 2.4 Gbps down and 1.2 Gbps upstream from each group of 32 customers.

Another advantage of PON is the number of electronic interfaces is reduced by the split since one laser at the OLT can communicate with up to 32 customers. Increased bandwidth can be gained by reducing the number of customers on a PON – reducing a PON to 16 customers would double the bandwidth available per customer. Most fiber builders today choose GPON for residential service because it provides acceptable bandwidth and is less expensive than competing technologies.

One consideration when designing PON networks is the optical distance from an OLT port to the customer ONT; the design of the 2.5 GPON network includes an allowance for 1.32 split and a distance limitation of 20 km (12.4 miles) design limit. This design was selected based on current vendor optical transmission

availability. Due to the limited size and distances within the electric service territory, the number of remote cabinets resulting from detailed engineering will be mostly constrained by cabinet capacity rather than distance.

Future expansion of the network could utilize several technologies such as course wave division multiplexing (CWDM) or dense wave division multiplexing (DWDM) to increase bandwidth without having to remove, rearrange, and/or replace equipment in the network.

The current vendors for PON equipment include Alcatel-Lucent, Adtran, Zhone, Nokia, and Calix. Today passive optical networks use the gigabit passive optical network (GPON) technology primarily, even though more advanced versions do exist and are discussed below.

Advantages.

- Lower Cost (typically 10-20% less than Active E for the core fiber electronics).
- Can support both RF Broadcast TV and digital IPTV.
- More efficient use of bandwidth at the customer premise. A GPON network delivers 2.4 Gbps of data to a small cluster of houses and an individual customer will normally have access to much of this bandwidth for data transmission, thus giving the customer a faster bandwidth experience at the home.
- For the most part the technology can utilize existing home wiring. The PON network is designed to tie into existing telephone and cable wiring if they are conveniently located and in good working order.
- Requires no field electronic devices. The key attribute of a PON network is that it is passive. This means that no power is needed except in those locations, generally at central offices and major hubs or huts, where the provider places electronics.
- Can easily provide traditional T1s for larger business customers using business ONTs.

Disadvantages.

- Customer must be within 12 miles of a hub when using a 1x32 splitter. This means with large installations that multiple hubs are required.
- More customers potentially are affected by a fiber failure in the field.

Active Ethernet (Active E**)**

Each network node in the design is capable of offering metro Ethernet services using active Ethernet technology. This technology provides a direct data connection to a single customer.

An Active E network is essentially a fiber “home run” from the Central Office or other node, meaning that one fiber goes from the electronics core directly to the customer. This technology has several advantages and is well-suited for serving large businesses where the customer requires more stringent network uptime and higher bandwidth. An Active E network also can provide symmetrical data capabilities (upstream and downstream data rates are the same) at high data speeds. The downside to Active E is that more fibers are required in the network since fibers are not shared between customers. Electronic costs are generally also higher since there is a dedicated laser at both ends of the connection to every customer. Active E also has higher data capabilities and can inexpensively provide for data rates up to 10 gigabits per second. Faster speeds are possible, but with significantly higher electronics costs. One

of the biggest advantages of Active E is that it's easy to change the connection to a single customer as customer requirements change – the laser serving that customer can be changed without affecting any other part of the network.

The primary vendors in the Active E equipment market are Cisco, Calix, Adtran, and Nokia-Alcatel-Lucent. Since PON equipment has won a much greater market share than Active E equipment, this part of the industry has been in a bit of a decline for a few years. Active E is easier to engineer and expand and is useful for customizing solutions for small volume specialized applications.

Advantages.

- Can serve customers up to 36 miles from last active field device.
- Requires less pre-planning and engineering.
- A single point of failure will often affect fewer customers
- Offers true non-blocking 1 Gbps and faster speeds.
- Easily upgradeable to 10 Gbps by switching optics.

Disadvantages.

- Shares data and CATV bandwidth in the same data stream. Today an Active E system can cost-effectively deliver up to 10 gigabits of data to each home, but more typically these networks are designed to deliver 1 gigabit. This is not a shared pipe with neighbors and each customer can get a dedicated gigabit pipe. However, this one data stream must support CATV, data, and voice together. Thus, if a customer is watching multiple HDTV sets, the amount of bandwidth left for data will be something less than a gigabit.
- Usually requires additional home wiring. Since Active E provides only one bandwidth (the data stream), the video service (IPTV) always requires a high bandwidth data wire, such as category 5 or 6 wire to each TV location. The increased use of WiFi and advances in WiFi speeds have mitigated some of this.
- More physical space is required for electronics because there are more fiber terminations onto the electronics. If the electronics are in the field, the cabinets housing the electronics and fiber terminations can become relatively large. This means most cabinets need to be on private land and not on public rights-of-way.
- Fewer customers served per electronic chassis. Since only one customer can be served per laser, fewer customers can be served from a single card.
- Larger fiber cables are typically used due to the requirement of a single fiber per customer from the ONT to the electronic chassis. The use of larger fiber cable in an aerial application may significantly increase make-ready costs.

C. Competing Technologies

Existing Technologies

There are at least six broadband technologies used in the county today to deliver broadband. Each of these technologies will be explained below.

- Consolidated, Frontier, CenturyLink, and Bevcomm serve Waseca County with copper telephone wires using DSL technology.

- The two cable companies use hybrid fiber/coaxial (HFC) technology to provide triple-play services.
- Jaguar uses active Ethernet technology to bring fiber directly to customers.
- There are several wireless ISPs (WISPs) that are delivering broadband using point-to-multipoint wireless technology.
- Some rural homes buy broadband from satellites.
- Some rural homes get broadband using the data on their cellphone plans.

DSL over Copper Wires

CenturyLink, Frontier, Consolidated Communications, and Bevcomm provide broadband using DSL (Digital Subscriber Line). DSL is used to provide a broadband path over the copper. Most of the geographic areas of Waseca County is served with telephone company copper wires. These networks were mostly built between the 1950s and early 1970s. The copper networks were originally expected to have an economic life of perhaps forty years and have now far exceeded the economic life of the assets. The copper networks are deteriorating as a natural process of decay due to sitting in the elements. Maybe even more importantly, the copper networks have deteriorated due to neglect. The big telcos started to cut back on the maintenance of rural copper in the 1980s as the companies were deregulated from some of their historic obligations. By 2000 there has been almost no routine maintenance by any of the big telcos. At some point, the copper networks will die even though regulators continue to act like they will keep working forever.

DSL works by using frequency on the copper that sits just above the frequencies used for telephone service. There are different kinds of DSL standards, each of which has a different characteristic in terms of how much bandwidth they deliver and how far the signal will travel. The most efficient forms of DSL can deliver up to 24 Mbps service over a single telephone wire. Most of the DSL in Waseca County is of older varieties and delivers slower speeds.

The most important characteristic of DSL is that data speed delivered to customers decreases with the distance the signal travels. This means that rural customers often get slow DSL, which in the worst cases is not much faster than dial-up.

The general rule of thumb is that most of the types of DSL can deliver a decent amount of bandwidth for 2-3 miles over copper. The telephone companies transmit DSL from each of their historic central offices. They also might transmit DSL from deeper in the copper network from field cabinets, such as one that might be placed at the opening into a subdivision. The vast majority of rural households in Waseca County are more than 2-3 miles from a town or a field transmitter, meaning that most rural customers in the study area can get only very weak and slow DSL if they’re able to get any DSL at all.

DSL signal strength is also affected by the quality of the copper. The newer the copper and the larger the gauge of the copper wires, the better the signal and the greater the bandwidth. Many of the copper wires in Waseca County are likely to be 50 or more years old and have outlived their original expected service life.

Hybrid Fiber Coaxial Network

Mediacom and Midcontinent operate a hybrid fiber coaxial (HFC) network. Hybrid refers to the fact that an HFC network uses both a fiber backbone network and a copper network of coaxial cable to deliver service to customers. HFC networks are considered lean fiber networks (meaning relatively few fiber strands) since the fiber is only used to deliver bandwidth between the headend core and neighborhood nodes. At each neighborhood node is a broadband optical receiver that accepts the fiber signal from the headend and converts it into a signal that is sent over coaxial cable to reach homes and businesses.

The coaxial copper wires in those HFC networks are also aging, like the telephone copper wires. The coaxial networks were likely originally built in the 1970s. Coaxial cable networks exhibit signs of aging sooner than telephone copper networks because the wires act as a huge antenna, and older networks attract so much noise that it becomes harder to transmit the signals through the wires. HFC networks probably are better maintained that telco copper networks because the HFC networks have to pass an annual 'leakage' test that measures the amount of external noise that enters the cable networks. Leakage occurs at splice points and anywhere copper wire is exposed.

An HFC system delivers customer services differently than an all-fiber network. For example, in an HFC network, all the cable television channels are transmitted to every customer and various techniques are then used to block the channels a given customer doesn't subscribe to.

In an HFC network, all the customers in a given node share the broadband in that node. This means that the number of customers sharing a node is a significant factor - the fewer the customers, the stronger and more reliable the broadband signal. Before cable systems offered broadband, they often had over 1,000 customers on a node. But today the sizes of the nodes have been "split" by building fibers deeper into neighborhoods so that fewer homes share the data pipe for a given neighborhood. It is the architecture of using neighborhood nodes that have always given a cable network the reputation that data speeds will slow down during peak usage times, like evenings. If nodes are made small enough then this slowdown does not necessarily occur.

The HFC networks have undergone several major upgrades over the years, most with the intent of providing better and faster broadband. The amount of bandwidth available to deliver Internet access that is available at a given node is a function of how many "channels" the cable company has dedicated to data services. Historically a cable network was used only for television service, but in order to provide broadband service, a cable company had to find ways to create empty channel slots that no longer carry TV programming. Most cable systems have undergone a digital conversion to free up channel slots. In a digital conversion, a cable company compresses video signals and puts multiple channels into a slot that historically carried only one channel.

The technology that allows data to be delivered over an HFC system follows a standard called DOCSIS (Data Over Cable Interface Specification) that was created by CableLabs. All except a few tiny and rural cable networks have upgraded in the past to the DOCSIS 3.0 standard that allows them to bond together enough channels to create broadband speeds as fast as about 250 Mbps download. A few years ago cable companies started upgrading to a new standard, DOCSIS 3.1, that theoretically allows all of the channels on the network to be used for data and which could produce speeds as fast as 6–8 Gbps if a network carried

only broadband and had zero television channels. Since there are still a lot of TV channels on a cable network, most cable companies have increased the maximum broadband speeds to between 500 Mbps and 1 Gbps using DOCSIS 3.1.

The one big data limitation of a DOCSIS network is that the standard does not allow for symmetrical data speeds, meaning that download speeds are generally much faster than the upload speeds. This is an inherent design in DOCSIS 3.0 and 3.1 where no more than 1/8 of the bandwidth can be used for upload. CableLabs has developed an upgrade being called DOCSIS 4.0 that will allow for nearly symmetrical data speeds. This will require even more empty channel slots on a cable network and the new standard assumes that cable company would increase the total system bandwidth of the network to at least 1.2 GHz of bandwidth before trying to implement the new standard. So far, the big cable companies have been silent on the topic of the new technology and there is speculation that few of them will be interested in this expensive upgrade.

There is a distance limitation on coaxial cable, but since these networks are not often built in rural areas this rarely comes into play. Unamplified signals are not generally transmitted more than about 2.5 miles over a coaxial network. This limitation is based mainly on the number of amplifiers needed on a single coax distribution route. Amplifiers are always needed for coax distribution over a couple of thousand feet. Modern cable companies try to limit the number of amplifiers on a coaxial route to five or less since adding amplifiers reduces broadband speeds.

Metro Ethernet

Metro Ethernet is the primary technology used to deliver large bandwidth to a single customer over fiber. This technology is used in Waseca County to deliver fiber today to cell towers, and other large bandwidth users like schools. This technology is often also referred to as active Ethernet.

Metro Ethernet technology generally uses lasers that can deliver 1 gigabit or 10-gigabit speeds, although lasers as fast as 400 Gbps are available. ISPs can choke these speeds to slower levels based upon what a customer is willing to pay for.

Many ISPs dedicate a fiber for each metro Ethernet customer, but that's not mandatory. For example, an ISP could light a fiber to deliver 10 Mbps and string that fiber to multiple customers each buying 1 Mbps service.

Metro Ethernet is used in the county anywhere fiber delivers bandwidth today like to schools, cellular towers, and perhaps some businesses and government locations in the cities.

Satellite Broadband.

There are currently two satellite providers available in the US – Viasat (which was formerly marketed as Exede or Wildblue) and HughesNet. For both, the availability depends upon having a clear line of sight from a satellite dish at a customer location to a satellite.

The most limiting aspect of satellite broadband is latency, which means a delay in the signal. These satellites are parked at over 22,000 miles above the earth, and when an Internet connection must travel to

and from a satellite, there is a noticeable delay; that delay makes it hard or impossible to do real-time transactions on the web. Current satellite latency can be as high as 900 milliseconds. Any latency above 100 milliseconds creates problems with real-time applications such as streaming video, voice over IP, gaming, online education, and connections to corporate WANs (for working at home). When the latency gets too high such services won't work at all. Any website or service that requires a constant connection will perform poorly, if at all, with a satellite connection.

Satellite broadband also comes with tiny data caps, meaning a customer is highly limited by the amount of data they can send or receive during a month.

Cellular Broadband.

There are rural homes in every county using their cellphone data plans for home Internet access. There are a number of issues with this, First, the amount of broadband available is small. Most cellular data plans are for less than 10 gigabytes of total broadband usage in a month.

The cellular companies also offer "unlimited" data plans, but these plans only provide only 20-30 gigabytes in a month, after which they get restricted to extremely slow speeds. There have been reports across the country of cellular carriers that refuse to honor unlimited plans for rural customers who use the broadband for home Internet access. The unlimited plans typically restrict the amount of broadband that can be "tethered," meaning connected to a computer or other device other than the cellphone. CCG has talked to rural customers across the US who have monthly cellular data bills over $500 per month if they use cellular data to support students doing homework.

AT&T, T-Mobile, and Verizon have started to offer what they call fixed cellular data plans, although none of these plans may be available in the county. With these plans, the carriers place a small dish on a customer's home and use cellular frequencies to deliver fixed wireless broadband. These plans also have data caps, but they are larger than the caps on regular cell phones. For example, the AT&T fixed cellular plan has a monthly data cap of 215 gigabytes. Currently, AT&T only offers this plan in places where they are the incumbent telephone company. T-Mobile has plans to offer this nationwide to cover 90% of home as a condition to satisfy the merger with Sprint – what nobody knows yet is far this effort will reach into rural places. Verizon just launched the product in July 2020 and currently only offers it in three test markets.

Point-to-Multipoint Wireless.

There are several wireless ISPs (WISPs) using this technology to deliver rural broadband in the county. The network generally consists of radios placed at a tower or another tall location, and connections to homes and businesses are beamed wireless. There are several current frequencies of spectrum that can be used for this purpose and more that will be coming on the market in the next few years:

> WiFi: WiFi is short for wireless fidelity and is meant to be used generically when referring to any type of 802.11 network. The FCC has currently set aside two swaths of frequency for WiFi: 2.4 GHz and 5.7 GHz. In a point-to-multipoint network, these two frequencies are often used together. The most common way is to use the higher 5.7 GHz to reach the closest customers and save the lower frequency for customers who are farther away.

In practical use, in wide-open conditions, these frequencies can be used to serve customers up to about 6 miles from a transmitter, although speeds can be slow at the far end of six miles. Nationwide many wireless carriers advertising speeds in the range of 25 Mbps. We know of networks doing speeds up to 75 Mbps for short distances. Such a network must have fiber built to the radio transmitters and also can't carry too many customers on a given radio system.

The FCC has approved the use of 6 GHz WiFi for indoor and has also decided to release a portion of this bandwidth for use in outdoor point-to-multipoint networks. There are around 100,000 existing outdoor microwave links using the frequency and the FCC plan forces WISPs to somehow work around existing applications.

CBRS Spectrum - 3.5 GHz: In 2019 the FCC approved the use of the 3.5 GHz spectrum band known as the Citizens Broadband Radio Service or CBRS. This is a huge swath of spectrum covering 150 MHz of spectrum between 3550 and 3700 MHz. This spectrum sits in the middle between the two WiFi bands used for fixed wireless today and has great operating characteristics.

The FCC has set aside 80 MHz of this spectrum for public use, similar to WiFi, and auctioned the remaining spectrum of 70 MHz in early September 2020 as this report was being written. In all cases, this spectrum is shared with military users and the military always gets priority to use the spectrum.

The spectrum also must be shared among users in the public space – something that will be monitored by authorized SAS administrators. The FCC named five administrators in the docket: Amdocs, CommScope, Federated Wireless, Google, and Sony. It's expected that the cellular carriers are going to heavily use the public bandwidth for delivering 5G, so in many places, this spectrum might be too busy for using in a point-to-point application. However, in some rural markets, the public spectrum could go unused, in which case it would be available to boost the speeds for fixed wireless broadband.

The FCC made it easier for smaller companies to win some of this spectrum in the auction. The spectrum was auctioned by county, one of the smallest coverage areas ever used by the FCC. There is hope that the bigger carriers won't pursue the licensed spectrum in rural areas since they can use the free spectrum. The FCC has provided bidding credits to smaller entities to help them bid against the larger carriers.

White Space Spectrum: The FCC has been doing trials in what is called white space spectrum. This spectrum is in the same range as TV channels 13 through 51, in four bands of frequencies in the VHF and UHF regions of 54–72 MHz, 76–88 MHz, 174–216 MHz, and 470–698 MHz. The FCC order refers to whitespace radio devices that will work in the spectrum as TVBD devices. The FCC approved greater use of these frequencies for point-to-multipoint radios.

The FCC auctioned a lot of this frequency in 2018, with the buyers ranging from the big cellular companies and Comcast. This was called an incentive auction because TV stations that gave up their spectrum got a share of the sale proceeds. The FCC is now expected to make some of this

spectrum available for rural broadband. The rules have not yet been worked out, but they will probably be something similar to what governs WiFi and be available to anybody.

There are two possible uses for the spectrum. On a broadcast basis, this can be used to make better hotspots. A 2.4 GHz WiFi signal can deliver just under 100 Mbps out to about 100 meters (300 feet). But it dies quickly after that and there may be only 30 Mbps left at 200 meters and nothing much after that. Whitespace spectrum can deliver just under 50 Mbps out to 600 feet and 25 Mbps out to 1,200 feet.

There is potential for the spectrum to extend point-to-multipoint radio systems in rural areas. White space radios should be able to deliver about 45 Mbps up to about 6 miles from the transmitter.

One issue to be worked out is that the FCC rules require the radios using this frequency to use what they are calling cognitive sensing. What this means is that an unlicensed user of the spectrum will be required to vacate any requests for usage from a licensed user. While this would not be a problem where there is only one user of the white space spectrum, where there is a mix of licensed and unlicensed users the unlicensed provider needs to pair radios with other spectrums to be able to serve customers when they have to cede usage to a licensed user.

C-Band Spectrum. On February 7, 2020, the FCC announced an upcoming auction in December 2020 of the C-Band spectrum. This spectrum sits between 3.7 GHz and 4.2 GHz. The spectrum has historically been used by satellite companies for communication between satellites and earth stations. This is a prime spectrum for 5G cellular broadband, but also could provide a huge benefit to fixed wireless providers in rural America.

The C-Band spectrum sits next to the recently released CBRS spectrum at 3.5 GHz. Just as additional spectrum benefits 5G, fixed wireless technology improves significantly by combining multiple bands of frequency. Rural carriers have been arguing for years that the FCC should allow for the sharing of spectrum. Proponents of rural broadband argue that two uses of the spectrum can coexist since most 5G spectrum is only going to be needed in urban areas. They believe that such spectrum can be used in a point-to-multipoint configuration without interfering with urban 5G. The big cellular carriers have always been reluctant to share spectrum mostly because it causes them extra effort, so only the FCC, and in this case, Congress, can make it happen.

Several factors are critical to the long-term success of point-to-multipoint radios for rural broadband:

- Using Multiple Frequencies. The newest radios are much improved over radios from just a few years ago because they use spectrum bands including 2.4 GHz, 3.5 GHz, and 5.0 GHz. Radios will get even better if they include white space spectrum, CBRS spectrum, or C-Band spectrum. Having more spectrum matters because each frequency band has different operating characteristics in terms of distance and the ability to penetrate obstacles. Having multiple frequencies available means an increased opportunity to find a good solution for each customer in the service area.

- Adequate Backhaul. The best fixed wireless coverage comes when there is fiber at the transmitter. Customer broadband speeds are diminished if a tower doesn't receive enough bandwidth – this is the primary reason why many WISPs deliver speeds under 10 Mbps.

- Terrain/Topology. There are often physical barriers like hills or heavy woods that can limit or block customer bandwidth. Most of these technologies require a line of sight, meaning that there must be a clear unimpeded visual path between the tower and the customer. Customers that live in valleys or behind hills might not be able to get service. If the signal has to pass through trees or other obstacles the strength of the signal is diminished. The signal can also degrade in rain or snowstorms.

Future Technologies

This section looks at new technologies that are likely coming within the next years to the US.

Next-Generation Fiber Technologies. There are two next-generation and competing fiber-to-the-home technologies that will allow connections to customers to be upgraded to 10 Gbps broadband and even faster - NG-PON2 or XGS-PON. The current widely deployed GPON technology will eventually hit a technology wall. The technology delivers 2.4 Gbps downstream and 1 Gbps upstream for up to 32 customers, although many networks are configured to serve 16 customers at most. This is still an adequate amount of bandwidth today for residential customers and can easily provide a gigabit product to every customer if desired.

GPON technology is over a decade old, which generally is a signal to the industry to look for the next generation replacement. This pressure usually starts with vendors who want to make money pushing the latest and greatest new technology - and this time it's no different. After taking all the vendor hype out of the equation it's always been the case that any new technology is only going to be accepted once that new technology achieves an industry-wide economy of scale. That almost always means being accepted by at least one large ISP.

The most talked-about technology is NG-PON2 (next generation passive optical network). This technology works by having tunable lasers that can function at several different light frequencies. This would allow more than one PON to be transmitted simultaneously over the same fiber but at different wavelengths. That makes this a complex technology with multiple lasers and the key question is if this can ever be manufactured at price points that can match other alternatives.

The only major proponent of NG-PON2 today is Verizon, which is starting to deploy the technology to serve small cell networks. There is some doubt if Verizon alone can drag the rest of the industry along. Verizon might achieve economy of scale if they also use this technology to supply bandwidth to their fiber-to-the-curb technology that builds fiber in neighborhoods and beams broadband to homes using millimeter wave spectrum. So far that product has only been deployed as a test in four communities, but Verizon says they plan to pass 30 million homes eventually with the technology.

The market question is if Verizon can create enough economy-of-scale to get prices down for NG-PON2. The whole industry agrees that NG-PON2 is the best technical solution because it can deliver 40 Gbps to a PON while also allowing for great flexibility in assigning different customers to different wavelengths. Still, the best technological solution is not always the winning solution and cost is the greatest concern for most of the industry. Today the early NG-PON2 electronics are being priced at 3 - 4 times the cost of

GPON, due in part to the complexity of the technology, but also due to the lack of economy of scale without any major purchaser of the technology.

Some of the other big fiber ISPs like AT&T and Vodafone have been evaluating XGS-PON. This technology can deliver 10 Gbps downstream and 2.5 Gbps upstream—a big step up in bandwidth over GPON. The major advantage of the technology is that it uses a fixed laser which is far less complex and costly. Also, these two companies have used this in a lot more FTTH networks than Verizon.

While all of this technology is being discussed, ISPs today are already delivering 10 Gbps data pipes to customers using Active Ethernet technology. For example, US Internet in Minneapolis has been offering 10-Gbps residential services for several years. The Active Ethernet technology uses lower-cost electronics than most PON technologies but still can have higher costs than GPON since there is a dedicated pair of lasers and a dedicated fiber for each customer. A PON network instead uses one core laser and one core fiber to feed to multiple customers.

It may be many years until this is resolved because most ISPs building FTTH networks are still happily buying and installing GPON. One ISP client told us recently that they are not worried about GPON becoming obsolete because they could double the capacity of their network at any time by simply cutting the number of customers on a neighborhood PON in half. That would mean installing more cards in the core without having to upgrade customer electronics.

The bottom line of this discussion is that Finley Engineering chose not to consider NG-PON2 for the primary technology to deliver FTTH services. The technology is still too expensive and since it has not yet been accepted widely in the industry it might never get long-term support by vendors. However, if the price becomes competitive then anybody building a new network should use the faster electronics.

The Finley design allows for an eventual migration to XGS-PON or NG-PON2 through what is called an overlay. That means introducing the new technology while maintaining the current network. This would allow for an orderly transition over time while bringing a faster 10-gigabit connection to customers that need it immediately. The fiber network design can accommodate these future technologies and faster speeds.

Improved Fixed Wireless – 6 GHz WiFi. Early in 2020, the FCC approved the use of 6 GHz spectrum for outdoor use for rural broadband. WiFi spectrum is already the workhorse for fixed wireless radios which use 70 MHz of spectrum in the 2.4 GHz spectrum band and 500 MHz in the 5 GHz spectrum band. The 6 GHz spectrum adds seven 160 MHz channels to the WiFi environment (or alternately adds fifty-nine 20 MHz channels.

That's a huge addition of spectrum and potential bandwidth that can be added to a given wireless tower transmitter. The upside will be a combination of faster speeds – in open environments this should mean speeds of 100 Mbps download. The new spectrum could also allow for more customers to be served from a given transmitter – but we'll have to wait to see what comes out of labs. It's likely to take a year or more for vendors to work the new spectrum into transmitters. Wireless ISPs would need to replace customer electronics to use the new spectrum.

This same spectrum also means faster WiFi inside of homes and businesses. WiFi performance was already getting a lot better due to WiFi 6 technology. Wi-Fi 6 introduces a few major upgrades in the way that WiFi works to decrease congestion. The first is the introduction of orthogonal frequency-division multiple access (OFDMA). This technology allows devices to transmit simultaneously rather than wait for a turn in the queue. OFDMA divides channels into smaller sub-channels called resource units. The analogy used in the industry is that this will open WiFi from a single-land technology to a multi-lane freeway. WiFi 6 also uses other techniques like improved beamforming to make a stronger connection to a specific device, which also lowers the chances of interference within a room.

Adding the 6 GHz spectrum will drive performance to yet another level. The 6 GHz spectrum adds seven 160 MHz channels to the WiFi environment (or alternately adds fifty-nine 20 MHz channels. For the typical WiFi environment, such as a home in an urban setting, this is enough new channels that big-bandwidth devices like a TV can grab a dedicated channel. This is going to increase the perceived speeds of WiFi routers significantly.

When the extra bandwidth is paired with OFDMA technology, interference inside homes ought to be a thing of the past, except perhaps in super-busy environments like a business hotel or a stadium. Undoubtedly, we'll find ways over the next decade to fill up WiFi 6 routers and will eventually be begging the FCC for even more WiFi spectrum. But for now, this should greatly improve all but the toughest WiFi environments.

It's worth a word of caution that this improvement isn't going to happen overnight. A home needs both a WiFi 6 router and WiFi-capable devices to take advantage of the new WiFi 6 technology. Devices will also need to be designed and equipped to use the 6 GHz spectrum. Older existing devices will not see a huge benefit from the new technology, but as homes buy new devices there will be a marked improvement. It's likely going to take most homes years to migrate into the combined benefits of WiFi 6 and 6 GHz spectrum.

5G Cellular Technology. Today's cellular network uses a technology called 4G LTE, although there are still many rural cell sites using 3G technology. Nationwide, the cellular carriers in the US average data speeds for 4G LTE are around 25 Mbps download, but the connection speed at rural cell sites are usually slower than that average. Additionally, speeds drop with greater distance between a customer and a cell site, and good cellular data speeds only are available for 2-3 miles from a cellular tower. A customer that is more than 3 miles from a tower will get slower cellular data speeds. This matters more in rural areas since the cellular towers are a lot further apart than in larger towns.

The cellular carriers are in full 5G marketing mode. If you believe the TV commercials, you'd now think that the country is blanketed by 5G, as each cellular carrier claims a bigger coverage area than their competitors. However, almost all of their claims are marketing hype.

In 2020 there will be no cellular deployments that can be legitimately called 5G. Full 5G will not arrive until the carriers have implemented the bulk of the new features described in the 5G specifications. For now, none of the important features of 5G have been developed and introduced into the market. 5G deployment will come in stages as each of the 5G features reaches markets – the same thing that happened to 4G. For now, all the major 5G improvements are still under development in the labs.

From what is discussed in the IEEE forums, most of the 5G features are 2 - 5 years away. The same thing happened with 4G and it took most of a decade to see 4G fully implemented – in fact, the first US cell site fully meeting the 4G standards was not activated until late 2018. Over time, we'll see new 5G features implemented as they are released from labs to field. New features will only be available to those that have phones that can use them, so there will also be a 2 to 3-year lag until there are enough phones in the market capable of using a given new feature. This means every 5G phone will be out of date as soon as a new 5G feature is released.

Most of what is being called 5G today refers to the introduction of new bands of spectrum. The new spectrum does not equal 5G – the 5G experience only comes with 5G features. Existing cellphones cannot receive the new spectrum bands, and so the carriers are selling new phones that can receive the new spectrum and labeling that as 5G.

Even when 5G is fully implemented, the cellular data speeds are not going to be blazingly fast. The 5G specification calls for 5G cellular speeds of about 100 Mbps – which was also the specification for 4G but never realized. There will be reports of fast speeds using the new spectrum, but that will die down quickly. At first, anybody lucky enough to grab the new spectrum will likely have a great experience. This will mostly be because almost nobody else is using the spectrum at a given cell site. As more phones can use the new spectrum, the performance will drop back to normal 4G speeds – and maybe even a little slower. Much of the first wave of spectrum being released is in lower frequency bands such as 600 MHz for T-Mobile and 850 MHz for AT&T. These lower frequency bands don't carry as much data as higher frequencies.

5G is likely not coming to rural America for a long time. It's still more likely today for a rural caller to snag a 3G connection than a 5G one using the new frequencies. Rural cell sites aren't under the same stress as urban ones due to fewer customers trying to use a given cell site, so there is no urgency for the carriers to upgrade to 5G. Even when true 5G features come to rural cell sites, it's not going to make much difference to customers since rural cell sites are far apart - the cool bells and whistles with 5G involve having smaller cell sites close together.

5G Hot Spots. There are commercials on TV showing cellphone speeds of over a gigabit. This is not 5G. This is a phone equipped to use the frequency bands above 20 GHz which are being called millimeter wave spectrum. This is an ultra-high frequency and is can carry 10-30 times more data faster than traditional cellular frequencies.

It's easiest to think of this technology as a 5G hot spot, similar to a hot spot that might be found in a coffee shop, only mounted outdoors on a pole. The signal only travels a short distance, from 400 to 1,000 feet depending upon the frequency and local conditions. The technology needs line-of-sight and can be easily blocked by any impediment in the environment – it's been reported that if a customer turns their back on a transmitter that their body blocks the signal. The signal won't pass from outdoor transmitters into buildings. This technology only makes sense where there are a lot of people, such as downtown urban corridors, stadiums, and business hotels.

There is a lot of speculation in the industry that this is a novelty product being deployed to convince the world that 5G will be blazingly fast everywhere. The cellular carriers seem desperate to deploy something they can call 5G, and super-fast cellphones are a good way to get headlines. However, it's extremely

unlikely that any carrier is going to invest in cell sites that have to be within 1,000 feet of each other except perhaps in major downtown business districts. This technology will likely never reach to residential neighborhoods in cities, suburbs, small towns, or rural America. A lot of industry experts are also asking why anybody needs gigabit broadband for cellphones since the largest bandwidth for most cellphones is receiving a single video stream. The fact that a user can't pass from outdoors to indoors is also a huge impediment for practical use.

Fiber-to-the-Curb. One of the most intriguing new technologies is fiber-to-the-curb. Verizon is pioneering the technology and is calling it fixed wireless access (FWA). The technology consists of building fiber along streets and then beaming wireless using millimeter wave spectrum to customers. Historically this kind of technology has been referred to as fiber-to-the-curb.

Verizon introduced the technology in 2018 and deployed trials in parts of Houston, Indianapolis, Los Angeles, and Sacramento. In June of this year, Verizon introduced the second generation of the technology, with the first new market being Detroit.

The first-generation technology required mounting an antenna on the home to receive the signal. The new generation of technology hangs a receiver on the inside of a window that faces the transmitter on the pole outside the home. Verizon claims the new technology can be self-installed by customers. One of the key requirements for using the technology is that there must be a good line-of-sight between the transmitter on the pole and a customer. That means no intervening trees or other impediments.

Verizon claimed that the first-generation equipment technology could deliver speeds up to 300 Mbps for up to 2,000 feet from a pole. Many engineers in the industry think a more realistic distance is 1,000 feet or less. Verizon is no longer making any distance claims. Verizon claims the second generation can deliver speeds up to a gigabit,

Verizon claims that the technology will meet all 5G specifications. However, there are no 5G features yet being used in the field, and this is a millimeter wave radio path to a home. When 5G is finally introduced in the field, this application might benefit some if it can use the 5G features that tailor bandwidth paths to customer demand. But since most 5G features are intended to benefit cellular traffic, this specific technology is not likely to be improved much when layering on 5G features.

From a deployment perspective, this is an expensive technology to deploy. It means building fiber deep into residential neighborhoods. The industry analysts at MoffetNathanson looked at the first-generation equipment and said they didn't see how the technology could be any cheaper than building fiber-to-the-home. The expensive part of a FTTH network is the fiber along a street, and that is still needed for this technology as well.

Verizon claims to have plans to pass 30 million residents with the technology. The pricing on the product is simple at $50 for Verizon Wireless customers and $70 for anybody else. This technology will compete well against cable since the cable companies currently sell gigabit broadband at prices of $100 or higher. This product should also have faster upload speeds than cable broadband, but Verizon isn't talking yet about upload speeds. Any neighborhood that gets this technology ought to see some price competition – and if not price competition, at least expanded customer choice.

This technology doesn't make sense everywhere. It's a technology aimed at streets with single-family homes or rows of small businesses. It's not going to handle apartment buildings where there are units that don't face the street with the fiber. The technology doesn't work well in neighborhoods where utilities are buried and there are no poles. The technology won't work well on streets with heavy vegetation or streets that are highly curved. This technology will be hard to justify in places with neighborhoods with large lots and lower housing density, and this technology makes no sense in rural areas.

This is a new technology and the only company currently offering it is Verizon. It's too early to have any customer or industry reviews to talk about how it works. However, if it operates anything like how Verizon claims, it could be a serious competitor to cable company broadband.

The Need for Small Cell Sites. Communities of all sizes are seeing requests for adding small cell sites. These are small cellular sites that are placed on poles rather than on the big cellular towers. It's likely that when a cellular company or one of their subcontractors makes such a request, they will tell you this is for 5G.

For now, these cell sites are being added to bolster the 4G networks. It's not hard to understand why the 4G cellular networks are stressed. The cellular companies have embraced the "unlimited" data plans, which while not truly unlimited, have encouraged folks to use their cellular data plans. According to Cisco the amount of data on cellular networks is now doubling every two years – a scorching growth rate that would mean a 60-fold increase in data on the cellular networks in a decade. No networks can sustain that kind of traffic growth for long without becoming congested and eventually collapsing under the load.

The cellular companies have a 3-prong approach to fix the performance problems for 4G. First, they are deploying small cell sites to relieve the pressure from the big cellular towers. One small cell site in a busy neighborhood eliminates a lot of stress from the closest big cellular tower.

The cellular companies also have been screaming for new mid-range spectrum, because adding spectrum to cell sites and cellphones expands the data capability at each cell site. Unfortunately, it's a slow path between the FCC approving new spectrum until the time when new spectrum is installed in cell sites and enabled in smartphones. The FCC has awarded several bands of mid-range spectrum in the last year and is looking at more.

Finally, the cellular carriers are counting on 5G. There a few aspects of 5G that will improve cellular service. The most important benefit comes from frequency slicing that will right-size the data path to each customer and will get rid of today's network that provides a full channel to a customer who is doing some minor broadband task. 5G will also allow for a customer to be connected to a different cell site if their closest site is full. Finally, the 5G specifications call for a major expansion of the number of customers that can be served simultaneously from a cell site. Unfortunately for the cellular carriers, most of the major 5G improvements are still five years or more into the future.

There is a fourth issue that is a likely component of the degrading cellular networks. It's likely with expanding broadband needs that the backhaul links to cell sites will become overloaded and stressed. It doesn't matter if all of the above improvements have been made at cell sites if the backhaul is inadequate – because poor backhaul degrades all broadband services. The big cellular carriers have been working furiously to build fiber to cell sites to eliminate leased backhaul. But much of the backhaul to cell sites is

still leased and the lease costs are one of the major expenses for cellular companies. The cellular companies are reluctant to pay a lot more for bandwidth, and so it's likely that at the busiest times of the day that many backhaul routes are now overloaded.

Low Orbit Satellite Technology

Several major companies are planning to provide fleets of low-orbit satellites to provide broadband service. This includes efforts by SkyLink (Elon Musk), Project Kuiper (Amazon), and OneWeb that have announced plans to launch swarms of satellites to provide broadband. Following is a list of the satellite plans that have been announced:

	Current	Future	Total
SkyLink	11,927	30,000	41,927
OneWeb	650	1,260	1,910
Telesat	117	512	629
Samsung		4,600	4,600
Kuiper		3,326	3,326
Boeing	147		147
Kepler	140		140
LeoSat	78	30	108
Iridium Next	66		66
SES 03B	27		27
Facebook	1		1
Total	13,153	39,728	52,881

Low-orbit satellites have one major benefit over the current broadband satellites which sit more than 22,000 miles above the earth. The new satellites are proposed to orbit between 200 and 800 miles high. By being significantly closer to the earth the data transmitted from low-orbit satellites will have a latency of between 25 and 35 milliseconds—about the same experienced in a cable company HFC network. This is much better than the current latency for high-orbit satellites which has been reported as high as 900 milliseconds. The low-orbit satellites will be able to easily support real-time applications like VoIP, video streaming, live Internet connections like Skype, or distance learning.

One of the most interesting aspects of the technology is that a given satellite passes through the horizon for a given customer in about 90 minutes. This means that there needs to be a large fleet of satellites so that there is always one in the sky over a given customer.

In March, OneWeb filed for Chapter 11 restructuring when it was clear that the company could not raise enough cash to continue the research and development of the satellite product. In July, a bankruptcy court in New York approved a $1 billion offer to take over the company filed jointly by the British Government and Bharti Airtel. Airtel is India's largest cellular company. The restructured company will be owned with 45% stakes by Britain and Bharti Airtel, with the remaining 10% held by Softbank of Japan, the biggest original shareholder of OneWeb. Other earlier investors like the founders, Intelsat, Totalplay Telecommunications of Mexico, and Coca-Cola have been closed out of ownership by the transaction.

There is speculation that the British government purchased the company to create tech jobs in the country and that all R&D and manufacturing for OneWeb would immediately shift to England from Florida. There is also speculation that the mission of the company will change. Greg Wyler, the original CEO of the company had a vision of using the satellites to bring broadband to parts of the world that have no broadband. He chose a polar orbit for the satellites and was going to launch the business by serving Alaska and the northern territories of Canada like Nunavut. I've seen speculation that the revamped company is likely to concentrate instead on wholesale connections to telcos and ISPs, such as providing backhaul for rural cell sites.

Elon Musk's satellite venture StarLink was recently in the news when the company raised nearly $2 billion' to continue the development of the business. The company still has a long and expensive road to success. The company has raised over $3.5 billion to date before this latest raise, but a recent Bloomberg article estimates that the company will need to raise an additional $50 billion between now and 2033, which is when the company is projected to be cash-positive.

StarLink now has over 600 satellites in orbit, but the business plan calls for over 4,000 satellites in the first constellation. Keeping the first constellation in place will be an ongoing challenge since the satellites have an estimated life of 4 to 5 years. StarLink will forever have to be launching new satellites to replace downed satellites. StarLink has even more ambitious plans and has told the FCC that it might eventually launch over 30,000 satellites – but they need to fund and launch the original batch first.

The US government and the FCC seem to be in StarLink's corner. StarLink has tentatively been permitted to participate in the upcoming RDOF grants auction in October. It would be incredibly unusual to award giant federal grants for a product that is still on the drawing board and for an ISP that has raised only 10% of their needed funding.

StarLink recently started serving a few beta customers – likely as a way to spur fundraising. There were some speed tests posted on Reddit that showed download speeds between 35 Mbps and 60 Mbps, upload speeds between 5 Mbps and 18 Mbps, and latency between 31 and 94 Mbps. These speeds are a lot slower than the gigabit speeds that were announced as early goals. However, this is a beta test and speeds might get faster.

The last LEO player that is still active is Jeff Bezos's venture that is still using the preliminary name of Project Kuiper. The FCC recently approved the concept of Project Kuiper to move forward and FCC Chairman Ajit Pai recently said he supported the company's plans to start the process of FCC licensing of the technology. Project Kuiper has one advantage over other competitors in that Jeff Bezos could self-fund much or all of the venture. It was reported that for the month of July 2020 that Bezos's net worth had climbed by $9 billion. Funding is going to be a constant hurdle for the other two major competitors, but Project Kuiper might be the fastest to deploy if funding is not an issue.

The most recent announcement made at Christmas 2019 is that Apple is considering launching satellites that will provide only data for cellphones. This could free apple phones from having to rely on a cellular carrier.

Skeptics are doubting if the various satellite companies can launch all of the planned satellites. To put their plans into perspective, consider the number of satellites ever shot into space. The United Nations

Office for Outer Space Affairs (NOOSA) has been tracking space launches for decades. They report at the end of 2019 that there have been 8,378 objects put into space since the first Sputnik in 1957. As of the beginning of 2019, there were 4,987 satellites still in orbit, although only 1,957 were still operational. There was an average of 131 satellites launched per year between 1964 and 2012. Since 2012 we've seen 1,731 new satellites, with 2017 (453) and 2018 (382) seeing the most satellites put into space.

While space is a big place, there are some interesting challenges from having this many new objects in orbit. One of the biggest concerns is space debris. Low earth satellites travel at a speed of about 17,500 miles per hour to maintain orbit. When satellites collide at that speed, they create a large number of new pieces of space junk, also traveling at high speed. NASA estimates there are currently over 128 million pieces of orbiting debris smaller than 1 square centimeter and 900,000 objects between 1 and 10 square centimeters.

NASA scientist Donald Kessler described the dangers of space debris in 1978 in what's described as the Kessler syndrome. Every space collision creates more debris and eventually there will be a cloud of circling debris that will make it nearly impossible to maintain satellites in space. While scientists think that such a cloud is almost inevitable, some worry that a major collision between two large satellites, or malicious destruction by a bad actor government could accelerate the process and could quickly knock out all of the satellites in a given orbit. It would be ironic if the world solves the rural broadband problem using satellites, only to see those satellites disappear in a cloud of debris.

III. FINANCIAL PROJECTIONS

This section of the report looks at the detailed assumptions that were made in creating the financial business plans. Waseca County does not want to operate as a retail ISP, and the purpose of these studies is to try to lure ISPs to bring better broadband to the rural parts of the county. The primary goal of the business models is to look at the various scenarios from the perspective of an ISP that would operate the business.

The purpose of the financial models we created is to provide a way for ISPs to understand the broadband opportunities in Waseca County. We've learned with experience that almost every ISP is theoretically interested in expanding. However, no ISP is likely to be interested in a market until they understand the numbers. Only then can they decide if the opportunity is something they can get financed and that meets their requirements as an investment opportunity. These studies help the ISPs understand the opportunity of expanding broadband into the rural parts of the county. We've also structured our analysis such that we could help an ISP that wants to consider building to just a portion of the county.

The business plans created are detailed and contemplate all aspects of operating a broadband business. The business plan assumptions represent our best estimate of the operating characteristics of such a business. As a firm, CCG consulting consults with hundreds of ISPs that currently provide rural broadband. This has given us a lot of insight into how rural ISPs operate. We believe that the financial results shown in these models are characteristic of similar operations elsewhere and we believe our assumptions are realistic.

A. Services Considered

Following is a discussion of the products and services considered in the study.

High-Speed Internet Bandwidth

The network design delivers a symmetrical gigabit bandwidth product to every customer in the service areas. Additionally, the network could provide speeds up to 100 gigabits for the largest businesses, although there are probably not any entities in the study area that want 10 Mbps service today – but there could be in the future.

Telephone Services (VoIP)

Voice over IP (VoIP) is a digital telephone service that transmits a telephone call to customers using their broadband connection rather than establishing a more traditional analog telephone connection. VoIP has been around the industry for a few decades. The first major vendor of VoIP was Vonage, which still delivers VoIP over the open Internet. Most VoIP arrangements now use secure private broadband connections rather than the open Internet.

The study assumes that the retail provider of telephone service will purchase wholesale VoIP. This product is available from numerous vendors. These vendors own a digital telephone switch and they deliver calls to and from customers from that switch to the ISP. Our clients tell us that offering voice is still mandatory when selling to businesses since many businesses insist on having a vendor that delivers all their

communications needs.

The alternative to using VoIP is to buy a telephone voice switch and then establish connections between that switch and the public switched telephone network. These connections are referred to in the industry as "interconnection." We've found through analysis that it's hard to justify buying a switch and paying for interconnection costs unless a service provider expects to serve at least 5,000 telephone lines.

Managed WiFi

Many small ISPs now offer managed WiFi, which means that the ISP installs and controls the WiFi network at the customer premise. It's become obvious over the past several years that a large percentage of the problems experienced by customers have been due to poor WiFi networks rather than to the broadband connection. ISPs began selling a product where they would install a high-quality WiFi modem. If a house is large, the ISP installs a meshed network with several networked WiFi routers. Since these routers are part of the ISP network, they can monitor the performance to make sure they are operating properly. Many ISPs also offer related services like helping customers connect new devices to the WiFi system – something that can be done easily from the ISP end.

This is a profitable product. A quality WiFi router costs around $110 and ISPs are charging between $5 and $10 per month for the service. CCG know of ISPs that have already sold this product to more than 80% of their customers.

Other Future Products

Today many ISPs are expanding their product lines to add additional product lines that rely upon broadband. Perhaps the best example of this is Comcast. They now offer a wide range of new products. For example, they have sold home security monitoring to many millions of customers. They are now probably the largest single nationwide provider of smart home products and they have a line of products such as smart lighting, smart watering systems, smart door locks, smart thermostats, etc. Comcast has also been selling a cellular product to compete with the big wireless carriers. Comcast even recently tested bundling solar panels with their other products in a few markets.

CCG finds it likely that any ISP operating a fiber network will eventually offer some of these same kinds of products along with products that have yet to be developed. This could include things like medical monitoring to help the elderly live in their homes longer. It might involve intensive gaming connections, including virtual reality and holograms.

It's impossible to build a business case for products that have yet to be developed, but it's reasonable to believe that any fiber-based ISP will offer new products over the time frame of this study. Our business plans incorporate a generic small future revenue for "new products" which is undefined. The assumptions used will be described under the revenue assumptions below.

Wholesale Bandwidth Products

Wholesale bandwidth products are those sold to other carriers or to large business customers. Such products can be a major source of revenue for ISPs in larger cities.

The following are the kinds of customers that buy wholesale connections:

- Cellular towers in most markets buy fiber connectivity and bandwidth to connect to the traditional tall cell towers. In the last few years, we've seen the cellular companies building small cell sites placed on power or light poles. Both kinds of cell sites require a fiber connection.
- Nationwide businesses like hotel chains, banks, manufacturers, etc. usually have an arrangement with a single ISP to serve all of their locations nationwide. These ISPs will consider buying from a new fiber network, but they probably already have reasonably priced connections from TDS or Windstream.
- Complex businesses like hospitals and universities usually have complex needs and look for ISPs that can provide a lot more than just bandwidth.
- Businesses with multiple locations in Waseca County need connections between branches. This might include grocery stores, local banks, or other businesses that might operate multiple locations inside the County.
- Giant bandwidth users. This could be things like data centers or large stock trading houses that want large bandwidth with low latency.

The following are the typical wholesale products that are sold to the above kinds of customers:

- Dark Fiber. This involves selling a fiber that is not connected to electronics. The ISP buying the dark fiber is responsible for providing and operating the electronics necessary to use the fiber. Dark fiber might be sold by the mile of fiber, or else by a set fee per dark fiber connection.
- Transport. Some wholesale providers only sell connections between points A and B. This might mean the retail ISP might need to buy several transport paths to serve a customer – for example, there might be one transport connection between an end-user connection and the wholesale hub and a second transport connection between the wholesale hub and the ISP hub.
- Dedicated Bandwidth. Dedicated bandwidth means that the customer doesn't share it with anybody else. The typical products on an FTTP network share bandwidth at some point in the network, but some businesses are willing to pay to buy raw, unshared bandwidth. The network can deliver speeds up to 100 Gbps.

We've not included any wholesale revenues in the studies, although there might be a chance to sell bandwidth to entities like cellular carriers.

B. Financial Assumptions

Incremental Analysis

It's important to note that all of the projections were done on an incremental basis. This means that the studies only considered new revenues, new expenses, and new expected capital costs. This is the most common way that businesses of all sorts look at potential new ventures since the incremental analysis answers the question of whether any new business line will be able to generate enough revenue to cover its costs.

It's important to understand what an incremental analysis shows and does not show. Incremental analysis is mostly a cash flow analysis. It looks at the money spent to launch and operate a new venture and compares those costs to the revenues that might be generated from the venture.

Incremental analysis is not the same as a prediction of what the accounting books of a new venture might look like. For example, if one of the existing ISPs in the area was to undertake one of these business plans, they would allocate some of their existing overhead costs to the new venture. The classic textbook example of this is that some of the existing cost of the general manager of the ISP would be allocated to the venture in the accounting books. However, the cost of the salary of the existing general manager is not considered in an incremental analysis since that salary is already being paid by the existing business. If these studies were to show an allocation of the general manager, then they would not be properly showing the net impact of entering the new market.

Timing

Timing is critical to any business plan. The faster that a business can start generating revenues the sooner it can cover costs. These studies are somewhat conservative in the predictions of the speed of the roll-out of the business venture. That means that if an ISP could get customers faster than predicted by the projections that they can have better results than we've shown.

All scenarios anticipate that the first customers will be added to the new network in the tenth month after starting the project. In Minnesota that's going to depend to some extent on the winter season ISPs don't tend to build broadband networks in the winter. It could be possible for an existing ISP with customers in the region to start customers a little earlier.

The following are the major milestones as predicted by these forecasts:

- Financing. All the forecasts assume that the financing is available in January 2021. This is an illustrative date and could be changed to any other future date.
- Construction. Fiber construction is assumed to last for two years.

Pricing Strategy

We assumed that the products would be as simple as possible. The incumbent telephone companies offer a wide range of different telephone products. We assumed that an ISP would offer only a few telephone options. For example, for residential service, we have assumed only two products - a basic telephone line and a telephone line with unlimited long distance. Broadband is also simplified with only three tiers of speeds for residential or business customers. Businesses could buy customer speed packages as negotiated.

There are different pricing strategies used around the country by various ISPs for broadband. Following is a discussion of some of the more common models and a discussion of the pros and cons of the various approaches to pricing.

- Competition. When building broadband into a market that already has existing competition it's important to consider the prices of the competition as well as predicting how they might react to competition. In rural areas with little or no existing broadband, this is usually not a factor.

- Market Rates. This asks the important question of what people are willing to pay for broadband. As somebody who works for a lot of ISPs, I observe that a lot of ISPs are not good at this. I regularly see ISPs that set prices too low based upon the assumption that nobody will change providers with prices near to existing market rates. However, I have seen numerous clients charging market rates for broadband that get similar penetration rates to ISPs with lower rates.
- General Pricing Philosophy. ISPs often come to the market with predetermined notions of how prices ought to work. A pricing philosophy is often based upon the overall goals for the business and the way that an ISP thinks about business. For example, some ISPs have a goal of maximizing cash flow or of maximizing profits (not the same thing). Other ISPs are more community based and want to bring fast broadband to as many households as possible. These basic philosophies are often the driving force behind a pricing strategy.

  For example, some ISPs believe in simplicity and only offer a few products. Other ISPs stress bundles and price accordingly. Some ISPs think that the way to sell a lot of services is by having low prices. Other ISPs think it's better to have higher prices and fewer customers. Some ISPs think it's important to the community to have a low-priced product for low-income households. Some ISPs charge the same prices to residents and businesses – others charge businesses a lot more.

Those various philosophies result in a couple of different pricing schemes that we see in the marketplace. A few key examples include:

- One Broadband Product. A few ISPs like Google Fiber, Ting, and a handful of smaller ISPs have one broadband product. They sell a gigabit of speed for a set price. Google Fiber had gone to a 2-product offering, but recently announced they are returning to the flat-rate $70 gigabit product as the only broadband offering. Any ISP with this philosophy is likely not trying to capture a huge share of the market but is content to sell a high-margin product to a smaller number of homes.

- Low Basic Price. Some ISPs set the price for the basic product low. This is done more often by municipal ISPs, but there are small commercial ISPs with the same philosophy. As an example, in these markets, somebody might set the price of the basic product on the fiber network as something like 50 Mbps for $40.

  CCG Consulting has access to the prices and the resulting customer counts from nearly 200 ISPs and what we have learned is that most customers will buy the basic broadband product if the speed is okay. A basic product set at 5 Mbps likely wouldn't sell, but in today's market, a product with a decent speed like 50 Mbps or greater will be perceived as acceptable to most households.

  As mentioned above, it's debatable if an ISP with low rates captures more of a market – but it's obvious that low rates leave a lot of margin on the table. In setting rates, we began by considering existing market rates in Waseca County. These are "permanent" rates and don't recognize advertising special rates that last for a year before reverting to full price. ISPs often make the mistake of setting permanent rates to compete with existing provider's special rates.

  Waseca County has a wide array of existing ISPs in the county today – more than we typically see in a rural county. The following are the core residential broadband rates available in the county today. The base products available in rural areas are DSL and fixed wireless. However, in setting

fiber prices, with fast speeds, the market rate also should consider the prices charged by cable companies in the cities on the edge of the county:

- CenturyLink DSL starts with a list price of $47 for 7 Mbps DSL. The price for 12 Mbps DSL is $52 and 20 Mbps is $62. From what we see around Waseca County, it's unlikely that many homes in the rural areas are seeing speeds even as fast as 12 Mbps on CenturyLink.
- Frontier DSL is at least $44.99 per month with customers not covered by a promotional package.
- Consolidated DSL prices start at $62.95 for DSL up to 10 Mbps. The next price tier is $72.95 for up to 20 Mbps.
- Bevcomm DSL starts at $49.95 for up to 4 Mbps. The top tier DSL is $79.95 for 25 Mbps. When Bevcomm upgrades to fiber, products range from $49.94 for 30 Mbps to $149.95 for 1 Gbps service.
- Manchester Heartland Telephone Company offers broadband on fiber starting at $34.95 for 25/25 Mbps through $85 for 100/100 Mbps.
- Mediacom's primary residential product starts at $69.99 for 60/1 Mbps with prices to $139.99 for 1 Gbps.
- Midcontinent's prices vary from $40 to $100.
- LTD broadband has a $30 product for speeds up to 3 Mbps with prices then ranging to $80 for 25/3 Mbps.
- Radio Link also has a $30 product for speeds up to 3 Mbps. The price for a product up to 30/10 Mbps is $85.

In the rural areas, an ISP bringing fiber will be able to offer substantially faster broadband than anything available today. In our experience, ISPs don't have a big problem selling a superior product. A customer buying a 5 Mbps service for $50 is usually willing to pay a little more for service that is twenty times faster.

The forecasts used $60 as the starting price for broadband. That is reasonably in the range of the DSL prices that are far slower and is less expensive than the cable companies in the cities. In a market with this many different providers that seems like a decent compromise price to establish a market rate.

- Price Steps or Tiers. Most ISPs price with tiers (like the above examples for incumbents). Probably the key attribute to tier pricing is the price differential between tiers. Consider three different pricing structures that begin with a $60 broadband product:

	Rate 1	Penetration	Rate 2	Penetration	Rate 3	Penetration
100 Mbps	$ 60.00	95%	$60.00	80%	$60.00	60%
250 Mbps	$ 90.00	4%	$75.00	15%	$70.00	30%
Gigabit	$120.00	1%	$90.00	5%	$80.00	10%
For 1,000 Customers:						
Revenue	$61,800		$64,000		$65,000	
Increase			4%		5%	

The difference in the steps or tiers is that Rate 1 prices are set $30 between products, Rate 2 is at $15, and Rate 3 is at $10. The impact of smaller tiers is that it's easier to upsell customers to faster products. I derived the relative rate structure for the various tiers based upon what I've seen at various ISPs. Customers might voluntarily choose a fast product when the step between tiers is small, and they are more likely in the future to upgrade anytime they feel their speed is bogging down or inadequate. Conversely, when the steps are too large, customers buy and then stick with the lowest-priced tier rather than jump their bill too much.

It's an interesting phenomenon and to some degree is psychological. Consider in the examples above that more customers are likely to buy the gigabit product in Rate 3 for $80 than will buy the 250 Mbps product in Rate 2 for $75. Since both speeds are faster than what households likely need you might think there would be a small difference between the public reaction to the prices – but our experience is that customer reaction to different pricing strategies is much like the above.

CCG has seen that having too many price options confuses customers. The above examples have tiers with three prices. We know of ISPs with seven to ten price tiers and we see that this confuses customers. We have seen the most effective rate structures having no more than four tiers, which can be explained to customers on a fiber network as fast, faster, and fastest and gigabit.

- Setting Business Rates. Philosophies vary widely on business rates. Most of the ISPs in the county don't disclose their business rates and often negotiate with businesses. The incumbent telephone companies and cable companies generally charge a lot more to business than to residential customers. At one time the philosophy behind this was that businesses consume more resources and cost more to serve than residential customers. While that might still be true for medium and large businesses, ISPs will tell you that the average home today uses considerably more bandwidth than the average small retail store. The exception might be a coffee shop supporting a public hotspot, or a business that deals in large files like photographers or engineers.

  We know a few ISPs that charge the same rates to businesses and residences, although that is rare. Most ISPs follow the incumbent pricing practices and charge more for businesses.

  One thing that a first-time ISP learns quickly is that most businesses care more about reliability than price. They want their broadband and telephones to always work during business hours. They don't want to pay more than they can afford, but they are not afraid to pay for a quality connection. While customers might be glad to save money with a new ISP, the chances are that they decided to change ISPs due to outages they have had in the past with their current provider and if they perceive fiber to be a more stable technology. One of CCG's clients recently did a survey of businesses in a new market and over half of them had experienced a half-day or longer broadband outage during the last year. For most businesses, such outages are the deciding factor they cited when they talked about the willingness to talk to a new network provider.

- Rate Bundles. The large cable companies are well-known for having bundles of products where they provide a discount to customers buying more than one product. Generally, customers have no idea which products the discount applies to. Most smaller ISPs don't offer bundled discounts. Most smaller ISPs set prices at rates they perceive to be competitive and don't discount them further. We know a few ISPs that built a business plan and forecasts upon list prices and then found

themselves in financial stress when a marketing person at the company decided they could sell more by offering discounts that weren't in the business plan.

Interestingly, Verizon recently announced that they are doing away with bundled rates for new customers – they are the first large ISP to do so. It will take a few years for customers with older plans to migrate to unbundled rates. Verizon describes the new rate structure as more open and honest and says that this is what customers want. We'll have to see if this spreads around the industry, particularly to cable companies that compete with Verizon.

- Introductory Rates. The big telcos and cable companies are also well-known for advertising low introductory rates that increase dramatically after a term contract of one to three years. Most of the rates you'll see from these companies on the web or in advertising are the introductory rates, and the real rates of these companies are generally buried in the small print if shown anywhere.

  Customers dislike the introductory rate process because they invariably get socked with a big unexpected rate increase when rates jump back to list prices. The time of big introductory discounts might be starting to come to an end. AT&T decided last year to stop renegotiating with customers after the end of the introductory period. This has cost AT&T nearly two million customers on DirecTV, but the company says they'd rather have fewer customers that are profitable than maintain customers that don't contribute to the bottom line of the company. A few medium-sized cable companies have made this same change.

  Most small ISPs don't offer introductory rates. Such rates require having customers signing contracts and then ties up staff when those contracts end, and customers want to negotiate low rates again.

- Low-Income Pricing. This is covered in more detail Section I.C. of this report. Some ISPs offer products to low-income households. Most try to set rates to make it affordable, and most have some criteria for how customers qualify for the low rates, such as having students using the free lunch program. Most ISPs try to set the rates at a level that at least covers costs and perhaps earns a tiny margin.

Rates Used in This Study

Telephone Rates

The studies used the following very simplified pricing for residential phone service:

Basic Local Line	$15.00
Line with Unlimited Long Distance	$25.00

The studies assume that both kinds of lines include a full package of features like voice mail, caller ID, etc. The above prices also include any extra fees that the incumbent telcos show separately on the bill, but which are part of the rate. These rates would not include true taxes on the service, such as the tax that supports 911.

Customers who buy the unlimited long-distance plans would be able to call anywhere in the country as part of their plan. Similar plans today often include Canada, Mexico, and even some other international locations.

The studies recommend a mix of business telephone rates. A basic business line is priced at $25. A line with unlimited long-distance is priced at $40. There also might be businesses that own a PBX or keysystem and lines for that service are priced at $35.

Cable TV Products

Offering competitive cable TV in a new rural market is a challenge. The study areas being considered by this study are not wired today by a cable company. That means anybody already purchasing cable TV is buying from a satellite provider.

Even should you find an ISP partner willing to offer cable TV, there is little margin in the product, so adding cable TV would make little difference to the financial analysis. It's nearly impossible for a small ISP to compete on price with the satellite TV providers and small ISPs that offer TV generally have significantly higher prices. That makes it hard to attract customers to the product even if it's delivered on fiber.

Broadband Products

The studies do not specify data speeds, but we assume that broadband over fiber will be far faster than any broadband available today in the rural areas. We have shown data speeds by 3 tiers. A typical mix of products in three tiers on fiber might be something like 100 Mbps, 250 Mbps, and 1 Gbps.

	Price	Percentage
Residential Fiber Broadband		
Tier 1	$ 60.00	70%
Tier 2	$ 70.00	25%
Tier 3	$ 80.00	5%
Business Fiber Broadband		
Tier 1	$ 75.00	55%
Tier 2	$ 85.00	35%
Tier 3	$ 95.00	10%

Most ISPs charge more to businesses for broadband, and the studies assume a $15 additive to business rates.

These would all be shared data products, meaning that the overall bandwidth to provide them is shared among multiple customers. This is not to say that the data path to a given customer is not secure, because the transmission to any specific customer is encrypted for privacy purposes. Still, there might be some business customers that will want a dedicated data product that is not shared with anyone else. The fiber network can accommodate this by providing such customers with an

active ethernet connection. Prices for these services would cost a lot more than shared data services.

The financial models assume that the data products don't have data caps and provide unlimited broadband usage to customers. If there were data caps, then customers that exceeded those caps would be charged more than the basic prices. In the county today both CenturyLink and MediaCom charge data caps. The only telco with a data cap is CenturyLink DSL, but it's been widely reported that the company often doesn't bill for data overages.

Managed WiFi

This is a relatively new product that's been around for a few years. ISPs have found that one of the biggest problems with home broadband is due to obsolete or poorly placed WiFi routers in the home. A poor WiFi router translates to a poor broadband experience.

Many ISPs are now offering managed WiFi. This product places carrier-class WiFi routers in the home that are placed and operated by the ISP. High-quality routers and the placement of multiple routers for larger homes usually means better broadband coverage throughout a home. ISPs often assist customers when adding a new device to the wireless network. The managed WiFi routers provide a secondary benefit to an ISP because they provide a network monitoring location inside the home, meaning that the ISP is more easily able to pinpoint problems.

The studies assume a monthly rate for managed WiFi of $5.00 for residences and $10.00 for businesses. It's further assumed that 65% of residents would buy this product and 40% of businesses.

Network Capital Costs

The telecom industry uses the term capital costs to describe is the industry term for the cost of assets required to operate the business. The capital expenditures predicted in these models reflect the results of the engineering analysis done by Finley Engineering and described in Section II of this report.

Below is a summary of the specific capital assets needed for each base scenario. The amount of capital investment required varies by the technology used as well as by the number of customers covered by a given scenario.

Capital for broadband networks includes several broad categories of equipment including fiber cable, electronics for FTTP, huts and wireless towers, wireless electronics, and customer devices like cable settop boxes and WiFi modems. In addition to capital needed for the network, there are operational capital costs predicted in the projections for assets like furniture, buildings, computers, vehicles, tools, inventory, and capitalized software.

We have tried to be realistic, but a little conservative in our estimates, so that hopefully the actual cost of construction will be something lower than our projections. However, it is important to remember that the high-level engineering was used to make these estimates. The detailed engineering needed to be more precise is expensive and would involve having an engineer examine all places in the potential network to

look at local construction conditions. That kind of engineering is generally not done until a project is ready for construction. Instead, the engineering was done using some field examination of the county, along with maps and other tools. Finley has made many such estimates over the years and we know that this level of engineering is generally good enough to assess if a project is worth further consideration.

The studies all assume that the provider of service will not build a new cable TV headend or buy a new voice switch for the provision of cable TV or telephone service. If the new provider is an ISP that already offers those products elsewhere, the assumption is that they would transport in the products over the fiber backbone. These services are widely available today on a wholesale basis.

The following are the capital required for the base case for each of the three primary scenarios. These represent the capital expended during the first 5 years, by which time most of the customers have been connected. The scenarios assume different customer penetration rates. The first scenario assumes a 65% customer penetration rate. The hybrid scenario assumes a 60% penetration rate.

	All Fiber	Hybrid
Fiber	$12,972,108	$ 1,525,391
Fiber Drops	$ 1,158,371	$ 94,100
Electronics	$ 1,084,808	$ 1,503,569
Huts/Land	$ 223,000	$ 223,000
Operational Assets	$ 267,155	$ 176,690
Total	$15,705,442	$ 3,522,750
Cost per Passing	$ 8,672	$ 1,945
Cost per Customer	$13,342	$ 3,242

We knew the project would require grant funding as soon as we saw the price per passing. Generally, broadband projects must have costs below $2,500 per passing to be able to be financially self-supporting.

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the hardware electronics for an ONT cost $317, including the cost of the labor for installation at the home, including inside wiring. In the projections, it was assumed that the installation would be done by external contractors. It might be less expensive to do installations using existing company personnel or local contractors who can install at a lower cost.

We've also assumed that most businesses use the same ONT electronics used to connect to homes. Only larger businesses would require a larger ONT with more data ports.

We've assumed that the ISP will supply a WiFi router for customers that want one. We've assumed these routers cost $115.

Fiber Drops: Fiber drops are the fiber that connects from the street to the customer premises. In this study the cost of fiber drops is significant. The assumption has been made that with the volume of drops needed plus the anticipated speed of network deployment the drops during the first four years of the project would be installed by external contractors.

Drop costs vary according to the length of the drop. For example, fiber drops are usually much shorter inside town compared to rural drops that reach back farm lanes. The cost of fiber drops in the study is assumed to be $941.

The prices included in the study represent recent pricing being paid in for projects in your region. The drops are one portion of the fiber network where an ISP might be able to save money compared to our estimates. An ISP might be able to assemble its own construction team to build drops for less or they might find a local contractor that will build the drops for less.

Wireless Electronics. The study assumes that the cost at a residence or business to connect a fixed wireless customer is $1,065. This includes a dish to receive the wireless signal, wiring to reach the inside of the home, and electronics inside the home to terminate with a broadband connection.

Customer Penetration Rates

One of the most important variables in the study is the customer penetration rate or the percentage of the homes and businesses in Waseca County that will buy broadband service.

The analysis looks at customer penetration rates in several different ways. The base scenario begins with what we call expected rates. We used an expected penetration rate for the all-fiber scenarios of 65%. CCG has witnessed the roll-out of broadband in several rural markets in the last few years and we have seen customer penetration rates in those markets range between 60% and 85%, with a few even higher. We arbitrarily chose 65% as a starting point for the rural area as a level that we think is reasonably conservative. Note that the national average broadband penetration rate is now around 87%, and that rate does not tend to be lower in most rural areas, except perhaps in areas with abject poverty.

There is not a lot of competition in the rural parts of the county today that would compete with fiber broadband set at decent market rates. There are two wireless ISPs that have rates higher than what is being suggested by the studies – and likely relatively slow rates under 25 Mbps (or far less). There is rural DSL which might be relatively inexpensive, but which is likely extremely slow and not available for some customers. Customers can buy cellular hot spots that can run up bills of several hundred dollars per month for anybody that uses any significant amount of broadband. And there is satellite broadband that is both expensive and which has high latency that makes it hard to use. At this point, the only significant competition on the horizon will be the wireless broadband from Midcontinent, which the company claims will deliver 100 Mbps of broadband.

An ISP could get an accurate look at potential market penetration using a statistically valid survey. We have found that surveys are a great tool for understanding customer interest and are a good way to predict future customers. Surveys are not perfect, but the results obtained from a survey done properly generally provide a good prediction of customer demand. We think that it's likely that any ISP interested in coming to Waseca County will want to better understand broadband demand, so the County might get a request for conducting a survey (unless the ISP conducts their own). We've listed this possibility under the next steps to take after receiving this report. It's always important for a survey to be current. For example, if we had conducted a survey for this study before the COVID-19 crisis the results would likely be invalid

– we are sure that homes where students and adults tried to work from home want broadband more now than before the pandemic.

Expense Assumptions

As a reminder, unless otherwise noted, all scenarios are created from the perspective of a regional ISP offering the services. The following assumptions also assume that the same ISP owns the network and operates the business.

Expenses are the recurring costs of operating the business once it's built. We strive when building financial projections to be conservatively high with expense estimates. It could be less costly for an existing service provider to add a new market than what is shown in these projections.

As mentioned earlier, expenses are estimated on an incremental basis, meaning that the models only consider new expenses that would be needed to open the new market. In an incremental analysis, it's assumed, for example, that the existing ISP is already paying for positions like a general manager, an accountant, etc. and that the ISP only needs to hire employees needed to open a new market and add additional customers.

The primary expense assumptions are as follows:

Employees: Labor is generally one of the largest expenses of operating a broadband network. The models assume that an ISP will need to hire additional staff to take care of the new customers. We have assumed salaries at market rates with an annual 2.5% inflation increase for all positions. We've assumed that the benefit loading is 40% of the basic annual salary. That would cover payroll taxes and other taxes like workers' compensation, as well as employee benefits.

As stated earlier, these models are incremental and only consider the additional labor needed because of the customers added. At a minimum, the new business would require the following two additional types of employees:

Customer Service Representative: Takes new orders, answers customer questions about billing, services, etc. We've assumed that an existing ISP would add one new customer service representative.

Install/Repair Technician: These technicians provide maintenance and repair calls. The technicians would maintain both network electronics and facilities as well as customers. We've assumed that an existing ISP would add one new technician to the payroll to serve this area.

The scenarios all assume that other positions are already staffed by an ISP. That might include such functions as a general manager, marketing staff, accountants, etc.

Start-Up Costs: To be conservative, there are some start-up costs included in each scenario. There are expenses associated with launching a new business or new market and rather than list them all specifically we have included them as start-up costs. There are start-up costs even for an existing

ISP when entering a new market. In all scenarios we've assumed the start-up costs are just under $80,000.

Sales and Marketing Expenses: We assumed that there would be a marketing effort to sign customers. It would be too risky to spend the money to build a network without knowing for sure that there are enough interested customers to allow the business to pay for itself. Marketing expenses shown in the models are likely going to be for that effort. It's possible that marketing expenses could be incurred earlier than we have projected in the models. There have been rural start-ups that have been able to sign up customers using community volunteers, so it's possible for marketing costs to be lower than assumed in the models.

Delivery of Products: The projections assume that the new business will not construct a headend to provide the services. It's likely that any ISP tackling Waseca County is already buying and providing retail products to customers.

The studies assume that a wholesale basic telephone line can be purchased wholesale at $6.00 per month. A line with unlimited long distance is assumed to cost $9.50. It's possible to buy telephone lines for less than these estimates.

The studies assume there is no cable TV product.

Maintenance Expenses: There are routine maintenance expenses that the new business would incur on an incremental basis. These include:

- Vehicle expenses to maintain the vehicles required for the field technicians.
- Computer expenses to support the computers used by employees.
- Tools and equipment expenses.
- Power expenses to provide power to the network.
- General maintenance and repair of the outside plant network and the electronics to repair damaged or nonfunctional electronics.
- Internet Backbone. Since this is an incremental analysis, we have shown only incremental increases in the cost of internet bandwidth. If this business were served by a new ISP then the cost of bandwidth would be higher to also cover the cost of transport to reach the Internet.
- Internet Help Desk. The monthly fee for this service covers several different functions. This fee would cover those functions used to deliver broadband such as spam monitoring and security. This also includes network monitoring. The fee includes the help desk function, which is the function of assisting customers with broadband and network issues. The models assume a monthly cost of $4 per customer. That is a conservatively high number and anticipates buying a whole suite of outsourced services. This could be done for less and some of these functions can also be done by ISP employees.
- Tower Rental. The hybrid scenario assumes leasing space on the existing towers in the county to locate wireless transmitters.

Software Maintenance: Triple-play providers maintain a complex software system called BSS/OSS (billing and operational support systems). This software provides a wide range of functions: order taking, provisioning new customers, tracking of customer equipment, tracking of

inventory, creation of customer bills, tracking of customer payments (or nonpayment). Since most such software is billed to providers on a per-customer basis we have assumed an expense for this maintenance.

Billing: Billing costs are shown as the incremental cost used to bill customers. We assumed that there would be some mix of mailing paper bills, of charging bills to credit cards, and of charging bills directly as debits to bank accounts.

Taxes: The model assumes that the business that operates the business will pay state and federal income taxes. These taxes would not apply if this were operated by a municipal business or a nonprofit corporation.

We have assumed no property taxes on assets, but some taxes might apply. There are a few places in the country that charge property taxes on fiber networks, but most of the country doesn't. The issue of charging or not charging is usually county specific.

The forecasts do not include any taxes that are assessed to customers. For example, this business would be expected to charge and collect various telephone taxes. These kinds of fees are normally added to the customer bill, and thus customers pay these taxes. The models don't show these taxes and the assumption is that the taxes would be collected and sent to the tax authorities on the customers' behalf. They are not shown as revenue or expense to the forecasts, but rather are just a pass-through.

Overhead Expenses: The forecasts include only incremental overhead expenses. Again, since this is an incremental model it does not include allocated expenses such as an allocation of the general manager's salary. But there are incremental costs attributable directly to the new business. This would include things like legal expenses, accounting audit expenses, consulting expenses, business insurance, and other similar expenses that are directly related to entering a new market.

Depreciation and Amortization Expense: The forecasts include both depreciation and amortization expense. These are the expenses recognized by writing off assets over their expected accounting lives. For example, the depreciation rate for a vehicle is 20% per year (is written off over 5 years). The cost of a new vehicle is then depreciated monthly to write off the asset over the 5 years, or 60 months. All hard assets are depreciated except land. Depreciation rates are set according to the expected life of the assets—something that is usually determined to comply with IRS rules and accounting standard practices. Soft assets like software are instead amortized, using the same process as depreciation.

E. Financial Results

It is never easy to summarize the results of complicated business plans to make them understandable to the nonfinancial layperson. In the following summary are some key results of each study scenario that we think best allows a comparison of the numbers between scenarios. These summaries look at the amount of cash generated over 25 years as the key indicator of the viability of each scenario

The way to measure profitability in a new business will differ according to the structure of the business. A municipal business, for example, generally measures success by the ability of the business to generate enough cash to operate without any external subsidy. While a for-profit business would generally use something like net income to measure profits.

The following are the results of the various scenarios. Note that a table of all the financial results is included in Exhibit V, which makes it easier to compare scenarios.

Why the Projections Are Conservative

We always try to make our business plans conservative. By conservative, we mean that an actual business plan ought to perform a little better than we are projecting. Following are some of the conservative assumptions used in the business plan:

- Capital costs could be lower if the network was constructed by "edging out" from an existing ISP.
- In the model, we show an increase in the cost of wholesale bandwidth over time. However, industry costs for raw data might be less than we are projecting and might even drop over time.
- Our model assumes a regular replacement of electronics. However, upgrades may be needed less often than we have shown. Further, we assume that the cost of electronics at the time of each upgrade would cost as much as the equipment that is being retired. The experience of the electronics industry is that electronics get cheaper and more efficient over time, so the cost of upgrades is probably going to be less than is shown in the model. The vendors in the industry have also gotten better at having phased upgrades that allow for keeping older equipment in place and not having to replace everything at once, making upgrades less expensive than we have projected.
- There are steps that an ISP could take to improve upon these projections.
    - Preselling. ISPs can add customers earlier than these models by preselling to customers. This allows ISPs to begin connecting the network to the homes while the network is being built.
    - Adding Customers Sooner. These models assume that most customers will be gained by the end of the fifth year. There is a significant boost in cash from selling faster and adding customers sooner.
    - Get Temporary Help. There are often other bottlenecks at small companies that can slow down customer installations. This could mean the need for temporary sales and marketing staff, customer service reps, or outside technicians to speed installations.

All Fiber Scenario

This scenario looks at the feasibility of bringing fiber to all of the rural parts of Waseca County.

As a reminder from above, here are the basic assumptions included in the following scenarios:

- This covers the rural parts of the county that do not have and are not expected to be served with fiber.
- Fiber is built to pass every home and business in the serving areas. The construction is completed over two years.
- Our base study assumes a 65% customer penetration rate.
- Commercial loans have an assumed 25-year term and a 4.5% interest rate.

- Bank financing for infrastructure would normally include construction financing so that there are no principal payments during the time of construction. Construction financing also means that cash is only borrowed as needed while the project is being built.
- Bank financing is likely going to require cash equity. The analysis assumes that a bank would require 15% of the cost of the project to be funded with ISP cash. It could turn out that a bank wouldn't require equity if there is a lot of grant funding.

The Need for Grants

The first scenario below looks at the building fiber to the whole study area without any grant funding. The second scenario shows the impact of an ISP winning the FCC's RDOF grants that will be awarded later in 2020. The final column shows the amount of total grant funding needed for the project to reach a cash breakeven.

	No Grant	FCC RDOF Grant	Breakeven Grant
Asset Costs	$15.71 M	$15.71 M	$15.71 M
Grant	$ 0.00 M	$15.65 M	$13.63 M
Equity	$ 2.42 M	$ 1.72 M	$ 1.91 M
Debt	$16.15 M	$11.45 M	$12.73 M
Total Financing	$18.57 M	$28.82 M	$28.27 M
Cash after 10 Years	($12.95 M)	$ 2.52 M	$ 0.75 M
Cash after 25 Years	($ 9.25 M)	$ 6.92 M	$ 4.75 M

The above results show that an ISP could not profitably build fiber everywhere in the county without grant funding. This is a common finding when looking at building fiber in rural areas.

This second column shows that the significant impact of winning an RDOF grant. We estimate that the RDOF grant should be around $15.65 million, paid over ten years. The RDOF grant is nearly the same amount as the required capital to build the fiber network. It may be surprising that an ISP will still need to borrow a lot of money if they win such a large grant. This is due to the grant being paid over 10 years while construction and adding the customers is done over four years. This forces the ISP to borrow money that will be repaid by future grant payments. An ISP winning the RDOF grant can make $2.5 million in cash after 10 years and $6.9 million after 25 years.

Finally, we look at the minimum amount of grant funding that is required for the project to reach breakeven. That could be a mix of federal, state, and local grants. We show that building fiber everywhere will require a grant of over $13.6 million.

Sensitivity Analysis

Changing Customer Penetration Rate:

The base breakeven analysis assumed a 65% customer penetration rate. We also looked at penetration rates of 60%, 70%, and 75%. The impact of changing penetration rates higher or lower by 5% was a change in cash over 25-years of just over $1.2 million. This means that the impact on the business of a 1% change in penetration rate (from 60% to 61%) is about $240,000 over 25 years. This high sensitivity to a small change in customer penetration rate makes it vital to understand market demand because a failure to achieve a target penetration rate could mean a business that loses money. But this also means that a project that achieves a high penetration rate could generate a lot of cash over 25 years. For example, a project with a 10% higher penetration rate of 75% would make $2.4 million more cash over 25 years.

Changing Broadband Prices:

We looked at a scenario that changed broadband prices. Changing prices by $5 per month changed cash flow over 25 years by $1.5 million. That means that a $1 change in broadband prices changes 25-year cash flow by approximately $300,000.

We also looked at the impact of raising broadband rates over time. The base scenario assumes no rate increases and the base broadband product stays at $60 for 25 years. We used a conservative rate increase of less than 1% per year, and this increased cash over 25 years by $2.1 million. Note that the base rate that started at $60 was still less than $70 after 25 years – a rate that sounds conservatively low.

Changing Financing Terms:

We looked at the impact of changing the various financing parameters.

Interest Rate. We looked at a scenario that changed the interest rate by 50 basis points, or 0.5 % (such as changing the interest rate from 4.5% to 5.0%). This changed cash flow by just over $350,000 over 25 years. This means a change of 10 basis points, or 0.10% will change cash flow over 25 years by $35,000. The impact is the same amount for both higher and lower interest rates.

Loan Term. We looked at the impact of increasing the loan term from 10 years to both 15 and 20 years. Increasing the loan term to 15 years decreases cash flow by $1.35 million. Cash flow is lower because a longer loan terms mean higher interest expense over the life of the project. Increasing the loan term another 5 years to 20 years lowered cash by an additional $1.45 million.

Adding 5% to the Cost of Fiber:

We also looked at the impact of changing the cost of the network. In this case, we chose to change the cost of fiber by 5%, or about $610,000. This changed cash over 25 years by $970,000. To put that into perspective, changing the cost of the network by $1 million changes cash flow over 25 years by almost $1.6 million.

Combining Multiple Changes. We looked at a few scenarios that combine the impact of several of the variables described above. We called the first scenario the 'best case'. This is not a prediction of the best that the business could do, but rather a look at the combination of positive changes compared to the base case. The best case scenario includes achieving a 75% penetration rate, lowering fiber costs, implementing periodic rate cases over time, and finding a 4% (lower) interest rate. These changes accumulated to improve the cash flow over 25 years by $7.16 million - the predicted cash generated over 25 years increases to $14.1 million.

We also created what we're calling the 'worst case'. Again, this is not the worst that the business might perform, but it includes downsides to the baser study for having a higher fiber cost, paying a higher interest rate, achieving only a 60% penetration rate. These negative impacts have been offset by assuming the business would be able to raise rates periodically in the future at less than 1% per year. These changes resulted in a reduction of cash generated over 25 years of $5 million, with an overall cash return for the 25 years at $1.95 million.

Hybrid Scenario

The hybrid scenario looks at building fiber to serve wireless towers and homes along the fiber routes. The rest of the rural county would be served by wireless broadband that would offer speeds of at least 50 Mbps download, with homes close to towers getting speeds up to 100 Mbps.

The Need for Grants

	No Grant
Asset Costs	$ 3.52 M
Grant	$ 0.00 M
Equity	$ 0.60 M
Debt	$ 4.00 M
Total Financing	$ 4.60 M
Cash after 10 Years	$ 0.87 M
Cash after 25 Years	$ 0.13 M

These results show that the hybrid solution can be financed without grants. Getting grants would improve these results. It would be possible to win RDOF grant funding for this scenario, although a company building fixed wireless would receive substantially less grant than a fiber overbuilder. At least some of the project would also be eligible for Minnesota DEED grants, although those grants don't seem to favor middle-mile fiber routes like the ones that would be built to reach the wireless towers.

Sensitivity Analysis

Changing Customer Penetration Rate:

We assumed that the hybrid scenario would not get as many customers as an all-fiber scenario, and we lowered expected take rates from 65% to 60%. We then looked at a penetration rate of

55%, 65%, and 70%. The impact of changing penetration rates high or lower by 5% was a change in cash over 25-years of $1.24 million. This means that the impact on the business of a 1% change in penetration rate (from 60% to 61%) is just under $250,000. That makes it vital to understand market demand because a failure to achieve a target penetration rate could mean a business that loses money.

Changing Broadband Prices:

We looked at a scenario that changed broadband prices. Changing prices by $5 per month changed cash flow over 25 years by $1.4 million. That means that a $1 change in broadband prices changes 25-year cash flow by approximately $280,000.

We also looked at the impact of raising broadband rates over time. The base scenario assumes no rate increases and the base broadband product stays at $55 for 25 years. We used a conservative rate increase of less than 1% per year, and this increased cash over 25 years by almost $2.1 million. Note that the base rate that started at $55 was still less than $65 after 25 years – a rate that sounds conservatively low.

Changing Financing Terms:

We looked at the impact of changing the various financing parameters.

Interest Rate. We looked at a scenario that changed the interest rate by 50 basis points, or 0.5 % (such as changing the interest rate from 4.5% to 5.0%). This changed cash flow by just over $350,000 over 25 years. This means a change of 10 basis points, or 0.10% will change cash flow over 25 years by $70,000.

Loan Term. We looked at the impact of decreasing the loan term from 25 years to 20 years. This increased cash over 25 years by $270,000. We also looked at the impact of lowering the loan to a 15-year term and this increased cash flow over 25-years by $760,000. We find it likely that a lender might not provide loans longer than 15 years for this technology.

Adding 5% to the Cost of Fiber:

This change looks at the impact of changing the cost of the network. In this case, we chose to change the cost of fiber by 5%, or about $73,000. This changed cash over 25 years by $120,000. To put that into perspective, changing the cost of the network by $1 million changes cash flow over 25 years by about $1.64 million.

What Conclusions Can We Draw from the Financial Results?

There are a number of conclusions we can draw from the results of the business plan analysis:

Building Fiber in Rural Areas Requires Significant Grant Funding

Building fiber everywhere in the rural parts of Waseca County will require a grant of at least $13.6 million at a 65% penetration rate. The amount of grant needed would be higher at lower penetration rates and lower at high penetration rates. The $13.63 million in grants is a breakeven number – meaning that this amount of grant would allow the business to breakeven financially. An ISP would likely not build unless they found a higher amount of grant funding.

This is an expected finding in rural counties. The cost of building rural broadband in areas with low customer density translates into a high network cost per potential customer. With that said, some factors can lower the amount of needed grant money. Some of the variables that drive the financial results – such as customer penetration rates and broadband prices – can significantly alter the financial outlooks of a fiber business and could result in lowering the amounts of needed grants.

The good news is that the RDOF grant opportunity, at an expected level of around $15.65 million is higher than the minimum amount of grant needed. Hopefully, one of the ISPs in the area pursues RDOF funding to build fiber in at least some parts of the rural county.

Will Require Significant Borrowing and some Equity

If an ISP tackles building fiber using RDOF grants it still must borrow a significant amount of money since the RDOF grant is paid to an ISP over ten years. This means the ISP must borrow upfront to cover grant money coming in the future. The future grant payments can be used to reduce the debt, but it still means taking on a significant level of debt – and this might be an issue with some ISPs.

With traditional bank financing, the project also might require as much as $2 million in equity. An ISP that wins a substantial amount of grant funding might avoid this requirement, but most lenders like anybody borrowing a lot of money to have 'skin in the game'. In recent years, commercial loans have required between 10% and 20% equity from a commercial borrower. Our analysis assumed an equity requirement of 15% from banks, and most of the scenarios we considered would require equity between $1.6 million and $1.8 million. While that might not sound like a lot of money, most ISPs typically don't sit on very much free cash.

Financial Performance is Sensitive to a Few Key Variables

All the scenarios are sensitive to changes in a few key variables.

- Broadband Prices: The most important variable is broadband prices. The studies use an assumed starting price of $60 for the basic fiber broadband product. The hybrid study assumed a starting price of $55 for the wireless product.

  There are rural ISPs in Minnesota charging more than $60, so there is probably upward movement possible for pricing. But all ISPs understand that the higher the price, the lower the number of households that will subscribe.

The study showed that changing price by just $1 per month changes the cash flow over 25 years in the fiber model by $300,000. The impact over 25 years for the hybrid model is $280,000. Since price is under an ISP's control, an ISP will have some flexibility in setting initial prices as a way to assure future cash flow.

- Penetration Rate: Customer penetration rates are almost as important as prices. In the all-fiber study, changing the customer penetration rate by 1% (going from 60% to 61%) changes cash over 25 years by $240,000 in the fiber model. In the hybrid model, the impact is slightly larger at $250,000.

  This means there is a significant risk for a business that underperforms with penetration and a potential upside bonus for a business that can exceed expectations. This means that any ISP that wants to build broadband in the county is going to want to take a harder look at residential demand for broadband. That's something that can only be done in two ways. The easiest is to conduct a statistically valid survey to understand the market demand for broadband. The second is some sort on canvass or pledge drive where an ISP tries to sign-up customers before they undertake financing and construction of a fiber network.

- Loan Terms. Another sensitive variable is loan term, or the length of the loans used to finance a network. The all-fiber scenario assumes a 10-year loan, to match the grant funding. The cash flows of the fiber scenario are reduced by $1.35 million if an ISP was able to finance the network for 15 years.

- Interest Rate: Interest rates matter, but the impacts are not as large as some of the other variables. Changing the interest rates by one-half percent (changing rates from 4% to 4.5%) changes cash flow for a fiber and the hybrid scenarios by about $350,000.

A Hybrid Network Can be Constructed Without Grant Funding

The hybrid scenario that builds fiber to connect to wireless towers looks to be financially viable without grant funding. An ISP undertaking this scenario would likely still seek grants if available.

A lot of ISPs consider a hybrid model to be the first step towards eventually building fiber. The low costs mean that some profits will be generated that can be rolled back into fiber construction over time.

An ISP should pin down these key variables before tackling the business. To some extent the effects of the variables are additive. For example, the improvements that might be achieved through raising the rates or lowering the interest rate on debt can be added together if both change. The better an ISP understand these variables, the more solid any financial projection becomes.

IV. OTHER ISSUES

A. Funding for Broadband Networks

For a large percentage of broadband projects, the biggest challenge is finding the funding. This section of the report looks at the various ways that have been used to fund broadband networks. Like the rest of this report, this is written largely from the perspective of ISPs that might serve the county, but it also addresses ways that the county might participate.

There are different financing options to consider. Below we look at the following:

- Private Financing (loans)
- Grants
  - Federal Programs
  - State Programs
- Loan Guarantees
- Customer Financed
- Public Financing
- Public-Private Partnerships

Private Financing Options

When commercial ISPs build networks, they must rely on traditional private financing, meaning loans. The following are the key elements that determine the cost of bank financing:

> **Equity**: Most forms of private financing require some equity. Equity means that the borrower brings some sort of cash or cash equivalent to the business as part of the financing package. The amount of equity required will vary according to the perceived risk of the venture by the lender. The higher the risk, the more equity is required.
>
> Equity can take different forms:
>
> - Cash: Cash is the preferred kind of equity and lenders like to see cash infused into a new business that can't be taken back out or that doesn't earn interest.
> - Preferred Equity: For a stock organization (like an LLC or other type of corporation) the business can issue some form of preferred stock that then acts as equity. Preferred equity usually gets some sort of interest rate return, but the payments are not usually guaranteed like they are for bank loans. If the business gets into a cash crunch, they must pay bank loans and other forms of debt before they pay preferred equity interest.
> - Assets: It's possible to contribute assets as equity. For example, a new fiber venture might be seeded by having one of the partners contribute an existing fiber route or another valuable asset to the business. In such a case the contributed asset often must be assigned a market value by an independent appraiser.
> - Non-recourse Cash: Non-recourse cash means accepting a contribution to the business that is not guaranteed to be paid back. To give an example, in Sibley and Renville counties in Minnesota, a fiber business was launched in the form of a cooperative. The local government provided an economic development bond to the business as a non-recourse

loan. This means that the new fiber business will make their best effort to make the bond payments, but if they are short of cash then the government entities that issued the bonds would have to make the bond payments. The banks involved in that project looked at the contributions from the bonds to be the same as equity.

Loan Term: The retail banking industry, as a whole, does not like to finance long-term infrastructure projects. This is the primary reason why the country has such an infrastructure deficit. Fifty or more years ago, banks would fund projects like power plants, electric and water systems, telephone networks, and other long-term revenue-generating assets. But various changes in banking laws have required banks to maintain larger cash reserves which makes them less willing to make long-term loans. Banks have also increased their expectations over time to want to earn higher interest rates. Many attribute this to the fact that giant publicly traded banks have captured most of the banking market. Banks don't like long-term loans since the interest rates get locked in for many years, possibly depriving the banks of earning more on its equity.

Most banks prefer not to make loans with a term much longer than 12–15 years, and many telecom projects can't generate enough cash in that time to repay the loans. Our base scenario assumed financing over 10 years and we also looked at 15 and 20-year loan terms.

Collateral. The biggest issue that banks have in lending to broadband projects is the lack of collateral, which is the assets they inherit if the project fails. Banks like hard collateral like buildings, vehicles, shares of stock, and things they know they can readily sell for a reasonable price. Banks don't like broadband networks as collateral, because even a little bit of web searching shows them that failed networks are sometimes sold for pennies on the dollar.

It's important to understand the importance of collateral. Communities often ask an ISP operating nearby to build fiber in their town. What they generally fail to realize is that the ISP likely has to pledge their entire business as collateral to secure the loan to finance a new market – meaning that if the new venture fails they can lose the whole business.

Return on Bank Equity. Banks don't only consider the interest rate when making loans. A bank concentrates on its return on equity and will consider a combination of factors like interest rates, upfront and monthly loan fees, the likelihood that a borrower will pay a loan off early or default on a loan, etc. A bank will look at a dozen financial parameters before making an offer of interest rate and term – all based up their analysis of return on bank equity. There is a misperception that interest rates are negotiable, but the same project offered to multiple banks is likely to get a nearly identical financing package offered by all of the banks.

Start-ups. Banks are also averse to start-ups and prefer to make loans to existing businesses that already have a proven revenue stream. It's extremely hard for a first-time ISP borrower to be able to borrow the kind of money needed to build a large telecom project.

Commercial Banks: There are a few unique banking resources available to companies that want to build fiber projects. One is CoBank, a boutique bank, and a cooperative. This bank has financed hundreds of telecom projects, mostly for independent telephone companies and for electric cooperatives. CoBank is a relatively small bank and has strict requirements for financing a project. They are leery of start-ups and

we can't think of a start-up they have financed recently. They also expect significant equity to be infused into a new venture.

Cooperatives also have another bank that lends only to cooperatives. This is RTFC (Rural Telephone Financing Cooperative) that is owned by cooperatives.

One interesting source of bank financing is local banks. Historically local banks were the source in many communities for car and home loans. But over the last few decades, those loan portfolios have migrated to other lenders and local banks have been struggling for a decade to find worthwhile projects in their regions. We know of many commercial projects for small telcos that have been financed by local banks.

The biggest challenge of borrowing from a local bank is that they typically have a relatively small lending limit. Most local banks won't make an individual loan for more than a few million dollars, and that doesn't go far in a fiber project. However, some local banks have become adept at working in consortiums of multiple banks to make larger loans. This spreads the risk of a large loan across many banks. A banking consortium usually begins with a local bank in the area of the project, with the local bank taking the role of finding other banking partners and of servicing the loan. This approach requires a lot of extra effort from a local bank, but the approach has been used to finance good telecom projects.

Federal Loans

Rural Utility Service (RUS): This is a part of the Department of Agriculture and is the only federal agency that makes direct loans to broadband projects. The Rural Broadband Access Loan and Loan Guarantee Program (Broadband Program) furnishes loans and loan guarantees to provide funds for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide broadband in eligible rural areas. These loans can't be used for any town with a population greater than 20,000. The RUS acts much like a bank and follows similar lending practices. I like to describe the RUS as a bank from the 1950s because their lending rules were set by Congress to loan money for rural electrification and have never been modernized.

RUS makes broadband loans and loan guarantees to:

- Finance the construction, improvement, and acquisition of facilities required to provide broadband including facilities required for providing other services over the same facilities.
- Finance the cost of leasing facilities that are required to provide broadband if the lease qualifies as a capital lease under Generally Acceptable Accounting Procedures (GAAP). The financing of such a lease will be limited to the first three years of the loan amortization period.
- Finance the acquisition of facilities, portions of an existing system, and/or another company by an eligible entity, where acquisition is used in the applicant's business plan for furnishing or improving broadband. The acquisition costs cannot exceed 50 percent of the broadband loan amount, and the purchase must provide the applicant with a controlling majority interest in the equity acquired.
- Finance pre-loan expenses, i.e., any expenses associated with the preparation of a loan application, such as obtaining market surveys, accountant/consultant costs for preparing the application, and supporting information. The pre-loan expenses cannot exceed 5% of the broadband loan excluding any amount requested to refinance outstanding telecommunication loans. Pre-loan expenses may

be reimbursed only if they are incurred before the date on which notification of a complete application is issued.

RUS is allowed to make loans to a wide range of entities. Borrowers can be either nonprofit or for-profit and can be one of the following: corporation; limited liability company (LLC); cooperative or mutual organization; Indian tribe or tribal organization as defined in 25 U.S.C. 450b; or state or local government, including any agency, subdivision, or instrumentality thereof. Individuals or partnerships are not eligible entities.

To be eligible to receive a loan under this program, the entity must:

- Submit a loan application. We note that the loan application requires a lot of work including such things as pre-engineering, surveys, mapping, financial business plan models, environmental impact studies, and other things which make the application expensive to have prepared;
- Agree to complete the build-out of the broadband system described in the loan application within 3 years from the date the borrower is notified that loan funds are available;
- Demonstrate an ability to furnish, improve, or extend broadband in rural areas;
- Demonstrate an equity position equal to at least 10% of the amount of the loan requested in the application; and
- Provide additional security if it is necessary to ensure financial feasibility as determined by the administrator.

In practical terms here is how the RUS loans have been administered over the past few decades:

- The rules say that a project needs at least 10% equity, but in reality, this is often expanded to be anywhere from 20% to 40% at the discretion of the RUS. In effect, the RUS acts as a bank and they will require enough equity that the project can adequately cover debt payments.
- The loan terms are generally in the range of 12 years, sometimes up to 15 years for fiber projects. This is much shorter than the terms available on bond financing, meaning the annual payment would be higher under a RUS loan than with a bond.
- It is exceedingly hard to get a project funded for a start-up business. The RUS typically wants the whole company of the borrower pledged as collateral. Thus, the bigger and the more successful the ISP, the easier to meet their loan requirements. On the flip side, large ISPs don't want to pledge the whole company as collateral and often stop using RUS for this one reason.
- RUS collateral requirements are overreaching in other ways that make them hard to work with for municipal projects. For example, if the project is going to share fiber with some existing network, such as one built by a school system, they would want that asset as collateral. This is often not possible.

These rules make the RUS a very unlikely funding source for a municipal venture or any start-up ISP venture. To the best of our knowledge, the RUS has never yet successfully funded a municipal venture and they rarely approve a project for a start-up business unless it is extremely well funded by a demonstrably successful company.

The other big drawback of these loans is that they take a long time to process. They often have a backlog of loan applications at the RUS of 12–18 months, meaning you have to wait a long time after application to find out if they will fund your project. Very few existing companies are willing to wait that long unless they are certain they will be funded. And if you are coordinating these loans with other forms of financing

this wait is not practical. The loans are awarded using a detailed checklist and rating system. This system gives a big preference for making new loans to existing RUS borrowers.

However, the loan fund is quite large and currently sits at more than $1 billion. Congress generally has been adding additional funds to the RUS pot each year. The RUS also has some discretion and they have it within their power to make a grant as part of the loan. This is something that can't be counted on, but we know of projects where the borrower only had to pay back only 80% of what they borrowed. The interest rates can be lower than market in some cases, but for the last several years, with low interest rates everywhere, the RUS loan rates were not much cheaper than commercial loans.

These loans also require a significant paperwork process to drawdown funds along with significant annual reporting requirements.

Loan Guarantees

Another way to help finance broadband projects is through federal loan guarantees. A loan guarantee is just what it sounds like. Some state or federal agency will provide a loan guarantee, which is very much like getting a co-signer on a personal loan. These programs guarantee to make the payments in the case of a default and thus greatly lower the risk for a lending bank. In return for the lower risk, the banks are required to offer a significantly lower interest rate.

These guarantees are not free. There is an application process to get a loan guarantee in much the same manner as applying for a bank loan or a grant, meaning lots of paperwork. The agency making the guarantee will generally want a fee equal to several interest "points". To some extent, this process works like insurance and the agency keeps these fees to cover some of the cost of defaults. If they issue enough loan guarantees, then the up-front fees can cover eventual losses if the default rates are low. These points are a payment to the agency for issuing the guarantee and are not refundable.

Several federal agencies might make loan guarantees for telecom projects. The following agencies are worth considering:

HUD 108 Program: The Department of Housing and Urban Development has a loan and loan guarantee program that is allotted for economic development. There is both federal money under this program as well as money from this program given to the state to administer. While these loans and loan guarantees generally are housing-related, the agency has made loan guarantees for other economic development projects that can be shown to benefit low- or moderate-income households. If enough of a fiber project can be said to benefit low-income residents, then these loans can theoretically be used for a fiber project.

Small Business Administration 504 Loan Program: This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.

USDA Business and Industry Guaranteed Loans (B&I): The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that

spur economic development. Such a project must, among other things, provide employment and improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over $10 million or greater percentages of smaller loans.

Opportunity Zones. Congress created a new tax opportunity as part of the 2017 Tax Cuts and Jobs Act. The Act created Opportunity Zones in which investors can get special capital gains treatment and other tax breaks for investing in qualified infrastructure within an opportunity zone. Each state governor then designated specific opportunity zones.

Unfortunately, there are no opportunity zones within or near to Waseca County other than a tiny zone in Mankato.

Qualified investments made inside an Opportunity Zone can get special tax treatment. The first benefit is that taxes can be deferred from past investments if the gains are invested inside of an opportunity zone. For example, if an investor had a capital gain from the sale of a property, they could invest those gains and not pay taxes on the gains immediately but have those gains deferred until as long as 2047. Investors have until 2026 to make such investments.

An investor also gets tax forgiveness on new investments made inside the opportunity zones if that investment is held for at least 10 years. Most of the opportunity zones include sizable areas of low-income residents and a qualified investment must meet a test of benefitting that community in some significant way. A fiber network that will bring broadband to all the homes in an opportunity zone should meet that test – there are a lot of demonstrable benefits of fiber.

New Market Tax Credit. The New Markets Tax Credit (NMTC) Program was established in 2000 as part of the Community Tax Relief Act of 2000. The goal of the program is to spur revitalization efforts of low-income and impoverished communities across the United States and Territories. Most of rural America qualifies for new market tax credit financing. New market tax credits are normally used to fund only a small portion of a project.

The NMTC Program works by giving big tax credits to investors that are willing to invest in infrastructure projects in qualifying communities. The tax credits are so lucrative that often the other terms for accepting the funding are modest. The tax credit equals 39% of the investment paid out—5% in each of the first 3 years, then 6% in the final 4 years, for a total of 39%.

The Community Development Financial Institutions (CDFI) Fund and the Department of the Treasury administer the program. The process of how the Treasury allots credits is a complicated one and we won't cover it, but in essence, there are entities around the country each year that are awarded tax credits and these entities work as brokers to provide the credits to specific projects. The credits are often purchased by the large national banks or other firms that invest in infrastructure.

Generally, in practice, these funds act as a mix of loans and tax credits to the recipient. For instance, a community that received these funds might have to pay some modest amount of interest during the 7 years of the tax credit, and at the end would have a balloon payment for the principal. However, often some or even all of the principal will be excused, making this look almost like a grant.

Because the entities that get the credits change each year, and because you apply with the entities that hold the credits, and not with the federal government, the process for applying for this money is somewhat fluid. However, there are consultants who specialize in New Market Tax Credits who can help a borrower through the maze of requirements.

Grants

It's hard imagining the construction of fiber networks in rural areas without some grant support.

Federal Broadband Grants: Several current federal broadband grant programs might benefit this project – and there will likely be new grant programs in the future.

Rural Digital Opportunity Fund Grant (RDOF). The FCC has created a massive $20 billion grant program that will be awarded in 2020 and 2021. This grant program is being funded from the FCC's Universal Service Fund. The following are a few key elements of this new grant program:

- The FCC proposes awarding the money in two phases. The Phase I award will be awarded in late 2020 and will award around $16.4 billion. The Phase II will award will follow and award the remaining $4.4 billion, plus any money left from the Phase I grants.
- The grants will be paid out to grant recipients over 10 years. Grant recipients need to understand the time value of money because they will likely have to borrow money and then use the grant funding to make the grant payments.
- The money will be awarded using a reverse auction. This means that ISPs will bid on the amount of grant money they are willing to accept for a given geographic area, with the ISP willing to take the least amount getting the grant.
- The Phase I auction will only be awarded in areas that are wholly unserved using the definition of not having any broadband capable of delivering speeds of 25/3 Mbps or faster. This unfortunately is going to use the lousy FCC maps to determine the eligible areas. This means that many parts of the country that ought to be eligible for these grants will not be part of the program.
- The grant program will give priority to faster broadband technologies. The FCC will weight technologies that can deliver at least 100 Mbps, and weight even more for technologies that can deliver gigabit speeds. There is a grant disincentive for technologies with a latency greater than 100 milliseconds.
- Recipients must complete construction to 40% of the grant eligible households by the end of the third year, with 20% more expected annually and the whole buildout to be finished by the end of the sixth year.
- Grant winners will be expected to agree to become the carrier of last resort for the grant areas. Applicants must be able to obtain Eligible Telecommunications Carrier (ETC) status to apply, meaning they must be a facilities-based retail ISP. This will exclude entities such as open access networks where the network owner is a different entity than the ISP. Applicants will also need to have a financial track record, meaning start-up companies need not apply. Applicants must also provide proof of financing.
- Grant winners will be subject to controlled speed tests to see if they are delivering what was promised. The current FCC speed test requires that only 70% of customers must meet 70% of the promised speeds requirements for an applicant to get and keep full funding.

ReConnect Grants.[14] In the 2017 Farm Bill, Congress created a grant program called ReConnect. The program awarded $200 million in grants, $200 million in loans, and $200 million in a combination of grants and loans in 2019. Congress reauthorized an additional $600 million to be awarded in 2020, and that amount has been supplemented with an additional $100 million as the result of a COVID-19 stimulus grant. Those grant applications were due earlier this year. There is a lot of hope in the industry that Congress will continue to renew these grants. These grants are administered and awarded by the US Department of Agriculture.

e-Connectivity Grant Program. In March of 2017, Congress passed a one-time $600 million grant/loan program to build rural broadband. The project was labeled as the e-Connectivity Pilot. There is a lot of hope that Congress will continue this program.

Community Connect Grants.[15] This program specifically targets the poorest parts of the country and ones with little existing broadband. This program awarded $34 million in 2018 and $30 million in 2019. Grant awards for the program are generally between $100,000 and $3 million and require at least a 15% matching from the grant recipient.

BroadbandUSA Program.[16] This program is part of the Department of Commerce's National Telecommunications and Information Administration (NTIA). The agency isn't currently offering any grants, but the agency provides an annual database of grants that can sometimes be used for broadband (and are often used for other purposes).

EDA Grants. The U.S. Economic Development Administration (EDA) has been able to make broadband grants in the past – often as part of larger economic development initiatives. EDA grants are reserved for the poorer parts of the country, based upon wages in a region. We list this grant program, but it's likely that the county won't qualify for these grants. [17]

There is no specific EDA grant program that is aimed at broadband, but rather there are several grant programs that are aimed at general economic development activity. We know localities, such as in coal country in Virginia that have been able to get some significant EDA grants for broadband expansions.

It seems likely to use that EDA funding will be more easily found for broadband development since many rural counties now see the lack of broadband as their number one economic development issue. This was magnified during the pandemic and it's clear that rural America is not ready to take part in a digital society where workers and students try to operate out of the home.

Currently, the EDA is administering some grant funding from the FY 2020 Coronavirus Aid, Relief, and Economic Security (CARES) Act. The EDA is currently making grants on a first-come-

[14] https://www.usda.gov/reconnect

[15] https://www.rd.usda.gov/programs-services/community-connect-grants

[16] https://www.broadbandusa.ntia.doc.gov/new-fund-search

[17] This website shows the current EDA assistance programs. The website is updated frequently. https://www.eda.gov/funding-opportunities/

first-serve basis from about $150 million in broadband funding. The projects must already be shovel ready and ready to begin immediate implementation.

Other CARES funding has been given directly to the states in the form of block grants. Some of the CARES funding specifically targets broadband relief for issues directly related to the current pandemic. For example, some states are using some of this money to provide hot spots for the general public in areas with poor broadband, are providing computers and tablets to K12 students who have to work from home, and are even buying temporary wireless hotspot plans for K12 homes that need connectivity during the pandemic. These funds are temporary and must be spent by December 2020. However, there is a lot of hope that additional funding will be made available next year.

HUD Community Development Block Grants (CDBG). Grants under this program can be used to build fiber or wireless networks to areas lacking in broadband access. Any grant application must meet all three of the following objectives:

- The project must benefit low- or moderate-income neighborhoods
- The project must eliminate "slums/blight".
- The project must demonstrate an urgent need.

The last criteria can now be demonstrated in any community without adequate broadband. Years ago, this was a challenge to prove to HUD. The big hurdle for many grant applicants is the second objective of eliminating blight. We've seen an argument made that improving broadband improves incomes, which ultimately improves impoverished communities. For example, luring tenants to closed storefronts with good broadband meet this test.

The CDBG grants have wide latitude in considering grant applications and can be used in the following ways that benefit broadband:

- The acquisition, construction, reconstruction, rehabilitation, or installation of public facilities and improvements (which include fiber or wireless infrastructure improvements).
- The acquisition, construction, reconstruction, rehabilitation, or installation of distribution lines and facilities of privately-owned utilities, which includes placing underground new or existing distribution facilities and lines.
- Digital literacy classes as a public service.
- Economic development – grants/loans to for-profit businesses, particularly businesses that focus on broadband/Internet access and technology.

It's worth noting that the CDBG program also makes block grants to states which then can administer grants. These state grants must still follow the same federal guidelines for eligibility as listed above.

It's hard to use this money to support a widespread network that serves different neighborhoods, but it can be useful to supplement other grants to serve any pockets of the county that can meet the three tests.

State Grant Programs

Minnesota Border-to-Border Grants: These grants were awarded annually from 2014 to 2017, but no grants were awarded in 2018. The grant program was funded for 2019 with a guarantee that the grants will be funded for two more years (this could always be changed by the legislature). The grants are set by the Minnesota legislature and are administered through DEED (Department of Employment and Economic Development). In 2014 the program awarded $20 million in grants – awards were $10 million in 2015 million and $20 million again in 2016 and 2017. The grants for 2019, 2020, and 2021 are also set at $20 million – but there is hope this will be supplemented from COVID-19 funds.

There are a few key rules for Border-to-Border grants that are important to remember:

- The grants can only be awarded to serve areas that are defined as unserved or underserved. The grant defines unserved and served area differently than is done for federal grants. Unserved areas are those that have no landline broadband alternative available that can deliver speeds of 25 Mbps. Underserved areas are those that don't have broadband speeds of at least 100 Mbps. All of the areas included in this study are considered as unserved.
- The largest grant award is $5 million, although the majority of the grants awarded in previous years were for less than this.
- The grants can only be given to the entity that is going to own and operate the network – that generally means the money is given to an ISP and not to a local government.
- The entity getting the grant has to be an operating entity already in business. The grants won't fund a start-up company. Because of this almost every grant award so far has gone to telephone companies, with a few to cable companies.
- The grant money must be used within 2 years of the award.
- Anybody applying for a grant has to show proof that they have secured the financing required for the matching part of the grant.
- The grants will provide up to 50% of a project. But projects that ask for less than 50% have an easier chance of being funded. The DEED office has considered increasing the percentage that can be funded by the grants.
- Not all assets are eligible for the grants. Generally, only the direct assets that will provide 100 Mbps broadband are eligible. For example, the grants will cover fiber technology but won't pay for most wireless technology.
- While it's not an official rule, we've seen that in any given year the awards are spread around to different parts of the state as much as possible

Contributions from the County

At least a few dozen counties in Minnesota have let it be known to ISPs that they are willing to kick in some funding to help get fiber in rural areas. These awards can be made in the form of outright grants or loans. The awards we've heard of range from a few hundred thousand up to $6 million.

Unless a county is sitting on excess cash, any grants would likely need to be funded from a bond issue. There are several aspects of bond funding that must be considered if the county considered borrowing the money to make a grant or loan to an ISP:

Any bond used for this purpose would likely have to be some kind of general obligation bond. General obligation bonds are backed by the tax revenues of the entity issuing the bonds. This backing can be in the form of various government revenues such as sales taxes, property taxes, or the general coffers of a government doing the borrowing. Even if the bond was backed by debt payments promised by an ISP, the bonds would ultimately need to be guaranteed with tax revenues.

One of the best features of using bond funding for a project is that it can have a low interest rate if the bond is considered as tax-free for bondholders. It can be tricky to use a bond for broadband, that is to be provided to an ISP, that would meet the non-taxable tests. The easiest way to do this would be to have the bond declared to be for economic development reasons, with no solid expectation that the county would get the money back, even if it is loaned to an ISP. Any county interested in making this kind of contribution should consult with a bond and tax expert.

It might be necessary to hold a public referendum to approve general obligation bonds. This might be waived for an economic development bond, but many local governments hold a referendum anyway just to make sure the public supports the initiative being financed.

B. Finding an ISP Partner

If the county decides to provide a grant or a loan to an ISP, in our mind that would create a public/private partnership. The following is a description of how other local governments are finding and choosing potential ISP partners.

The Best Characteristics for an ISP Partner

Experience. We know of several investor-driven ISPs looking to invest in and operate broadband networks, but which have never built or operated a network. This isn't to say that such a group can't be a good partner, but it's a higher risk to work with an ISP that doesn't already have customers and that hasn't worked in a partnership before.

There are a few horror stories in the industry of public/private partnerships that went awry because of a lack of experience by the ISP partner. In the following two examples the ISP management team was made up of folks with industry experience but who had never worked together as a team before.

- The first example is Utopia in Utah. This is a collaboration of small towns that are working together through the Utopia organization to create economy-of-scale for the business. State law in Utah doesn't allow municipalities to be an ISP, so Utopia works as an open-access network where the cities build the network and various ISPs compete for customers.

  Utopia started by hiring an external management team that had not worked in the open-access environment before. Several things went wrong – the networks were late in getting constructed and came in over budget. The ISPs did not sell as aggressively as the business plan had supposed. Utopia ran out of cash before construction was complete and almost folded, but the business was eventually saved through several rounds of refinancing and is now large enough to be financially stable. It took almost a decade of financial duress to get to that point.

- Another example is Lake County, Minnesota. The county decided to borrow money to build a county-wide fiber network. This is one of the northernmost counties in the state and quite remote. There are 11,000 residents in 2,100 square miles. They hired an outside firm to construct the network and run the ISP. The project went way over budget and the project ran out of money with a backlog of almost 1,000 customers they couldn't connect to the network.

  The project was funded through a combination of a $10 million federal grant and a low interest government loan for $56 million. The county also bonded over $7 million locally for the project plus floated loans to keep the project afloat. The project went completely underwater financially and didn't make enough money to cover debt payments. In 2019 the county sold the network to an ISP for $8.4 million. The federal government had to write off about $40 million in debt and the county still must cover the original bonds plus the internal loans made to the project.

Experience Working with Municipalities. It's a plus to work with an ISP that has worked with local governments before. CCG has witnessed several public private partnerships where the two parties get frustrated with each other over time. This is due to two factors – frustration with the decision-making process and a difference in goals and expectations.

Commercial ISPs become quickly frustrated with the municipal decision-making process. Most local governments have a specified legal process that must be followed to make certain kinds of decisions. This might mean listing the topic for a public meeting and waiting for a period of public comment on the issue. Commercial ISPs are used to making decisions quickly and they don't like the drawn-out processes that a government partner requires. Government entities get frustrated as well since their commercial partners push them to make decisions quickly when they can't.

A more fundamental issue in public-private partnerships is a fundamental difference in goals. The issue commonly arises when the two parties didn't thoroughly discuss their long-term goals for broadband before a partnership began. Commercial ISPs are often most worried about cash flow and profit margins. If they've invested equity in a broadband network, they become unhappy if the business doesn't meet their earnings goals. Governments often have a different set of goals – serving every household, offering low-priced broadband to low-income houses, providing subsidized broadband to nonprofits and anchor institutions. In many cases, these kinds of fundamental differences can't be overcome and eventually ends up in a dissolution of the partnership.

The differences between the two kinds of entities often surface when there is a discussion of rates. Cities often push back against rate increases – particularly in election years. Cities push partners for low rates in general, and often want an ISP to give low rates for low-income households and even free rates to groups like nonprofits.

These kinds of issues are less likely to be a huge problem if the ISP has worked successfully with other municipalities before. A government entity that is working with an ISP that has not partnered in this manner before should have an in-depth discussion upfront about expectations. It's a lot easier if the two parties decide upfront that they aren't compatible instead of getting a divorce after the partnership has been launched.

Financial Strength. Municipal entities often have a hard time judging the financial strength of partners. Unfortunately, most public/private partnerships are not with big well-financed ISPs. The more typical partnerships are with telephone companies, electric cooperatives, or fiber overbuilders. It's typical for commercial ISPs of this type to overstate their financial security – and they may even believe what they say in doing so. But there are a few fundamental things about ISPs that a city should understand:

- Every ISP has a natural borrowing limit. There is only so much debt that bankers and other lenders will allow them to carry. By definition, when an ISP nears that lending limit it means that bankers think the company is pushing its financial limitations. Any ISP that has borrowed to its limit can't afford to make financial mistakes, and that means the partnership and all their other ventures need to perform as expected. It's not unusual to see a budding partnership be dependent upon obtaining financing, and it's not uncommon for the ISP to not get the hoped-for funding.
- The biggest issue with ISPs and borrowing is collateral. Banks don't look at fiber networks as good collateral for loans because there is very little value from repossessing a fiber network. This means the only good collateral that most ISPs have is the value of their existing company. Even surprisingly large ISPs might have to pledge their entire company to borrow a sizable amount of money to build an expensive network. It's often necessary for owners of ISPs to make personal guarantees on loans, meaning that both the corporate business and owner's personal assets are on the line with a new fiber project. ISPs are highly unlikely to disclose to a government partner the details of how they raise money – among other reasons they fear public disclosure laws and don't want its financial position discoverable as a public record.

Capacity to Grow. One of the hardest things to judge is the ability of an ISP to grow quickly. A traditional ISP like a telephone company may have a lot of customers – but they acquired them slowly over decades. ISPs (and all other types of businesses) often get stressed to the breaking point when they try to grow too fast. It's not unusual for an ISP to somehow assume that existing middle and upper management can handle a growth scenario while still somehow handling the existing responsibilities they've always had.

Just because a company is a great ISP doesn't mean that the company is capable of growing quickly. Unfortunately, there is no way to judge this unless the ISP has already been growing before the creation of the partnership.

The bottom line to this discussion is that a government needs to conduct due diligence before handing a large grant or making a large loan to an ISP partner.

How do You Find Potential Partners?

We've seen almost every partnership between counties and ISPs get started through three different processes:

Request for Information (RFI). It's typical for communities that want broadband to issue an RFI aimed specifically at soliciting potential ISP partners. These RFIs typically describe the situation in the community, typically describe whatever work has already been accomplished (such as this feasibility study) and describe the role the municipality wants to take in a partnership.

An RFI asks ISPs to describe themselves and their capabilities. An RFI generally doesn't go so far as to request a specific solution but rather asks the ISPs to discuss how they might tackle broadband issues in the community.

An RFI is generally the first step to determine which ISPs might be interested in partnering. After the RFI the process typically moves to one of the two processes described below.

Request for Proposal (RFP). An RFP is typically a lot more in-depth. In addition to asking ISPs to introduce themselves, an RFP might ask for specific proposed solutions. It might go further in detail asking about the financial strength of the ISP business and details of how they operate in other markets.

Direct Negotiation. It's routine for governments to interact directly with potential ISP partners rather than go through an RFI or RFP process. This might involve a local government reaching out to ISPs in the area, or it might be in response to an ISP making an unsolicited proposal to a local government to bring broadband.

Comparing the Three Options. It's first worth considering the issue from the perspective of an ISP. ISPs are leery of public records laws. They are often highly reluctant to provide financial information, customer lists, or other information that they feel is confidential. They don't trust that local governments will fight to keep such information confidential. ISPs are leerier of spelling out specific details of their business plan and how they approach a broadband market – they don't want that information to be available to their competitors.

Many ISPs are not willing or able to respond to an RFI or an RFP that asks for lengthy written responses to a long list of questions. Businesses that sell equipment and services are used to the idea of making proposals and usually have a pile of pre-prepared canned responses to the typical questions they are asked by a prospective customer. However, an ISP may never have been asked to make a proposal in writing in the specific and detailed way that might be needed to respond to an RFI or an RFP. Some ISPs refuse to participate in an RFI or RFP for this and related issues. We know there are ISPs that won't consider cities that insist on going through the formal RFP process. They know other communities will talk to them directly without the formal process.

ISPs prefer direct discussions where nothing is put into writing during the negotiation stage. That's the same process that ISPs typically use when they partner with other ISPs – they sit and talk out the pros and cons and mutually decide if there is a potential for a partnership. As often as not, such discussions end up with the realization that a partnership is not a good idea, and the parties amicably go their separate ways, and nothing they discussed is in writing.

Here is the process that I like best, having been through a lot of discussions between governments and ISPs:

> For most local governments, the best first step is to invite known ISPs for a high-level discussion about whether any kind of partnership makes sense. This process might involve several meetings where an ISP might come back with ideas, and then another meeting where the local government reacts. For smaller cities and rural governments this is likely the only approach that will work since small and rural communities are unlikely to attract ISPs from a distance.

I like the RFI process when it makes sense. For example, I was working with a geographically isolated community where there was no local ISP candidate within fifty miles. An RFI made sense since the community didn't have a wish list of local ISPs to consider. An RFI also might make sense for larger communities. In this case, I define larger to mean that the cost of the project is large – perhaps more than $25 million. I've known communities that found an ISP partner through an RFI that they would never have otherwise found.

If a community issues an RFI it should ask for basic information only. That might include asking an ISP to provide their history, telling about the products they normally sell and talking about the management team. While cities might have a hundred questions for a prospective partner, the ISP is going to be a lot happier if the details of their business are not put into writing at the early stage of meeting and negotiating.

I think RFPs only make sense for larger cities – probably those with network costs over $100 million. It's not likely that a small ISP will respond to such an RFP. Even in an RFP, I recommend not asking for sensitive financial information about the ISP – that can always be provided if the likelihood of a partnership develops.

Establishing Compatible Goals

At some point during the early stages of the process, it's vital for both sides to thoroughly discuss their goals for the project. Misalignment of goals is the number one issue that plagues any partnership eventually. Both parties need to fully hear, understand, and be fully comfortable with the goals of the other partner.

Goals generally can be stated simply and don't have to be complicated. Goals for the local government might be things such as serving the entire community, keeping rates affordable, and so forth. Goals for an ISP might be to generate a specific target of cash flows/profits. It's important to ask an ISP if they intend to operate the business for the long-run or if their strategy is to grow large enough to sell their business. Local governments are often hesitant to assist and ISP that has the goal of selling the market.

It's important to not only see each other's goals, but a municipality must understand the ISP's goals. This is one situation where a municipality might want to discuss these goals with a consultant or somebody with broad industry experience. It's not unusual for two partners to be talking a different language when discussing financial issues and it's vital to fully comprehend what a partner is telling you about their goals.

The alignment of goals is a make-or-break point in a potential partnership. Many of the differences that a municipality and an ISP might have can be negotiated, but you can't negotiate a difference in philosophy. If an ISP has a goal that a municipality can't live with, such as selling out in ten years – then our advice is to not pursue the partnership. When an ISP tells you a goal of that nature, they mean it.

How to Rank Potential Partners?

There are hundreds of questions that a local government might ask an ISP that might range from big important questions like, "Can you bring funding to this project?" to questions that are important but have

less impact on creating a partnership such as, “What’s your process of disconnecting customers who don’t pay?”

I advise prospective partners (government or otherwise) to place their questions into three categories, 1) make or break questions, 2) questions that might disqualify a potential partner, and 3) all other questions.

Every community will have its list of make or break questions based upon its priorities for what a partner should bring to the table. Make or break questions might be things like 1) “How much funding can you bring to the project?”, or 2) “Are you willing to serve everybody in the community?”

The first two categories of questions are the important ones that should be used to qualify and rank potential partners. Other less critical questions are important, but probably don’t get considered unless it’s close between two candidates. You choose a partner based upon the most important aspects of the relationship.

There are several techniques used to compile rankings. Most rankings of this sort are done by compiling the rankings by a team of reviewers. The most important questions might get weighted somehow to have the biggest impact on the composite answer. At the end of this process is a numerical answer that reflects the composite opinion of those doing the ranking. Likely, such rankings are not the final answer and often the ranking process will send a government back to ask more questions. Since this is not a purchase of service, but a partnership, it’s also highly unlikely that it would be mandatory to take the ISP that ranked the best.

EXHIBIT I: SERVICE AREAS OF THE INCUMBENT TELEPHONE COMPANIES

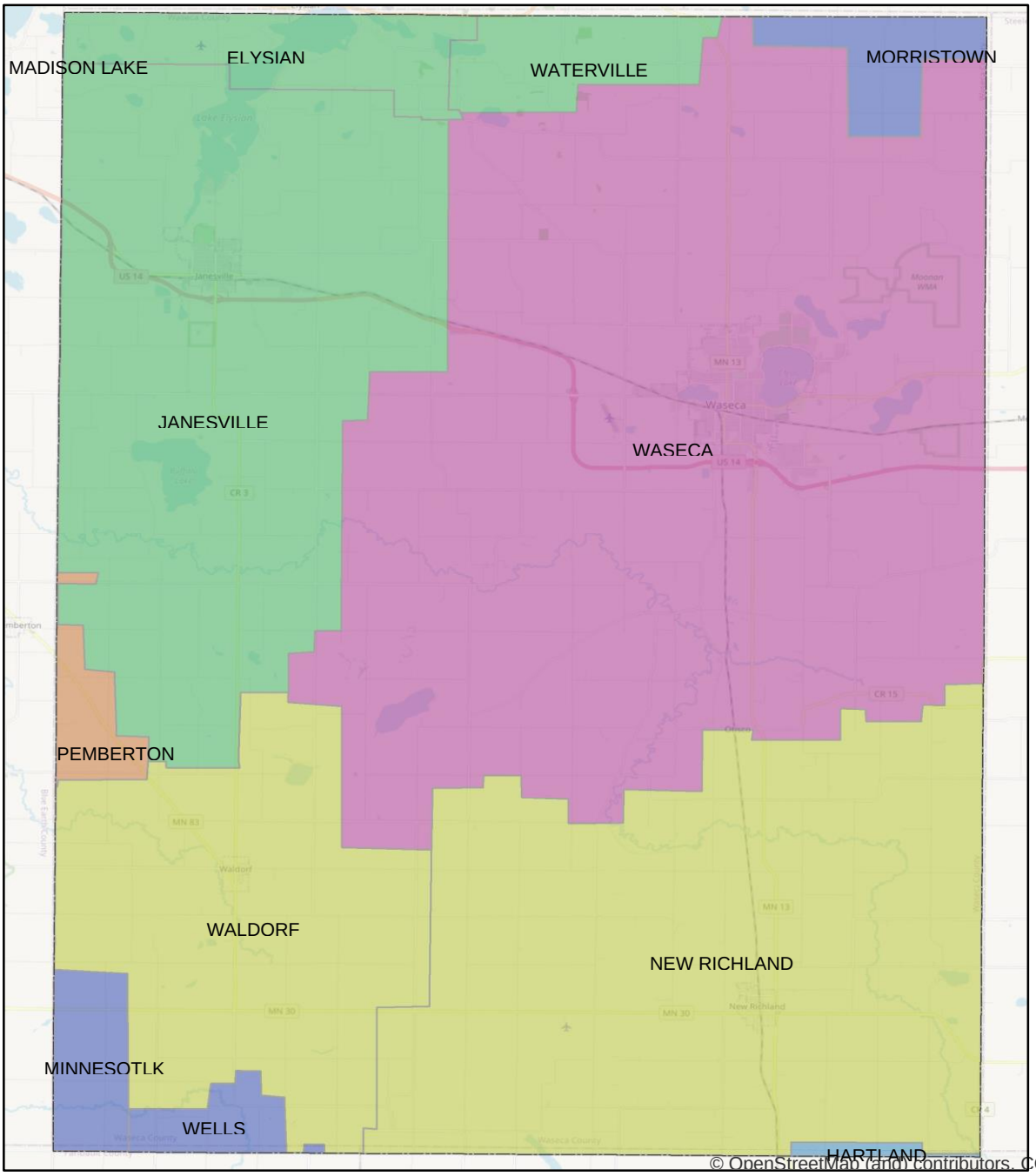


EXHIBIT II: STUDY AREA

The study area is shown in green and is the same as the area identified by the State of Minnesota as eligible for state broadband grants.

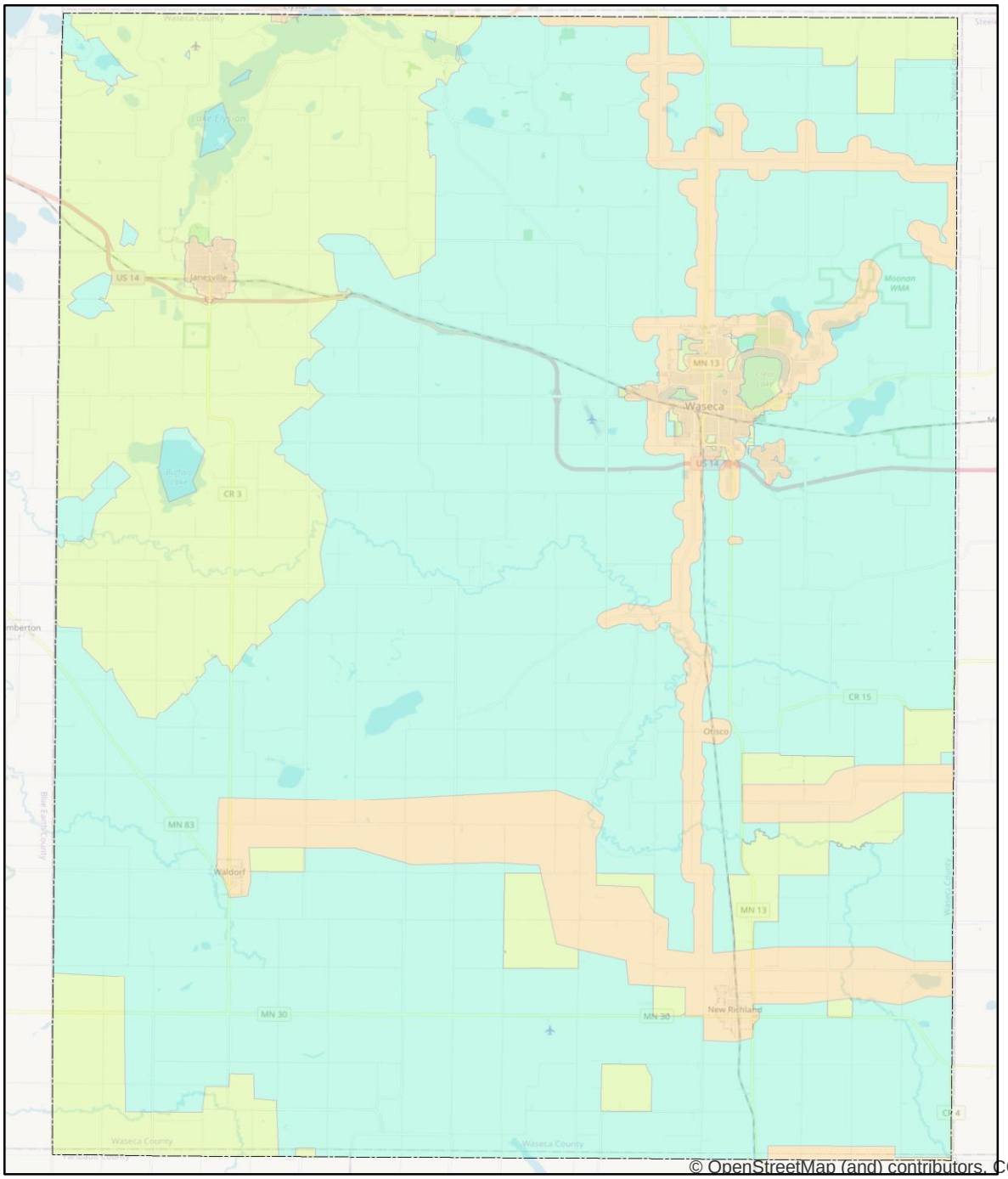
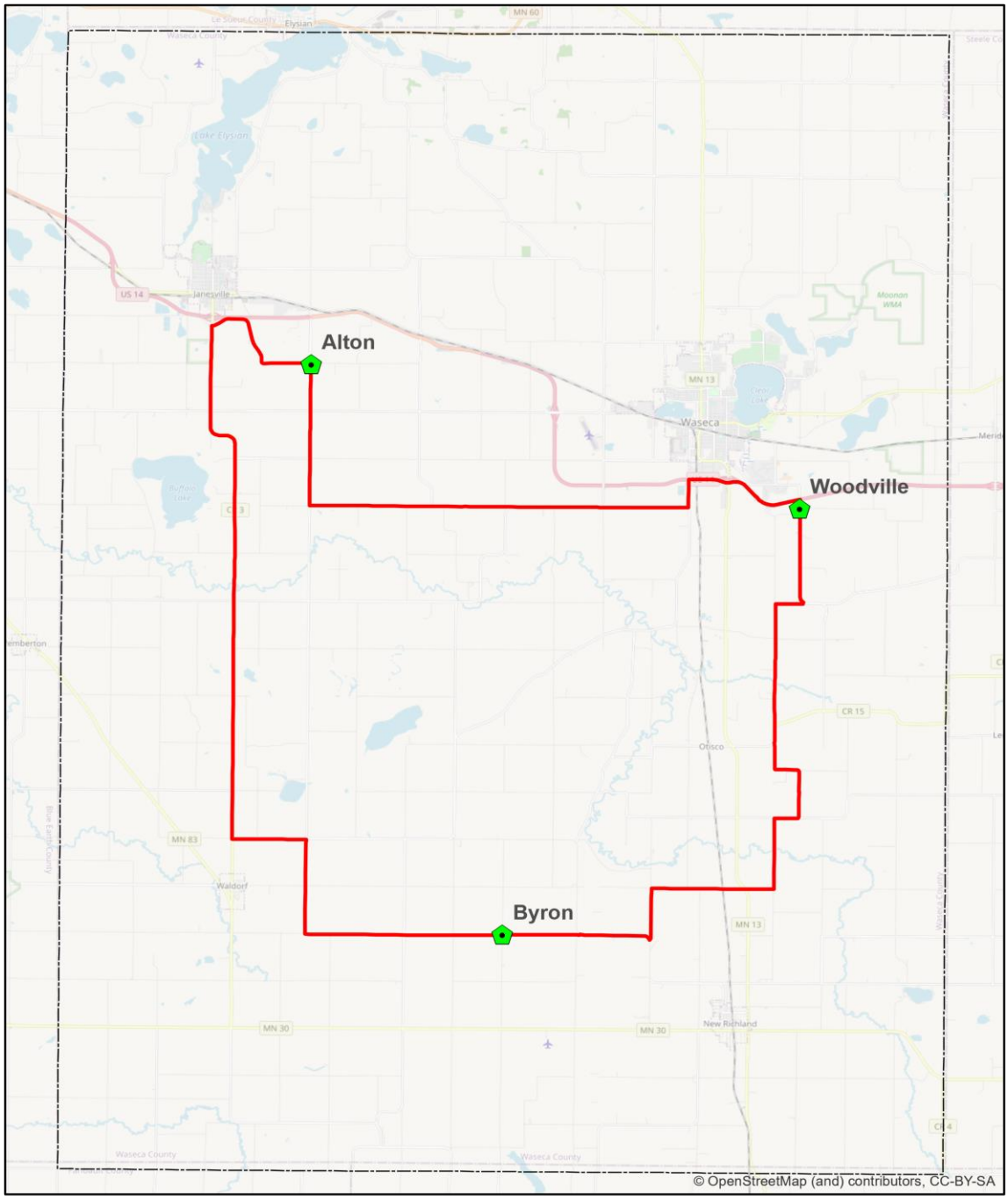


Exhibit III – Backbone Fiber Design



Waseca County

FTTP

TRANSPORT FIBER

HUT SITES

C

Exhibit IV – Hybrid Network Design

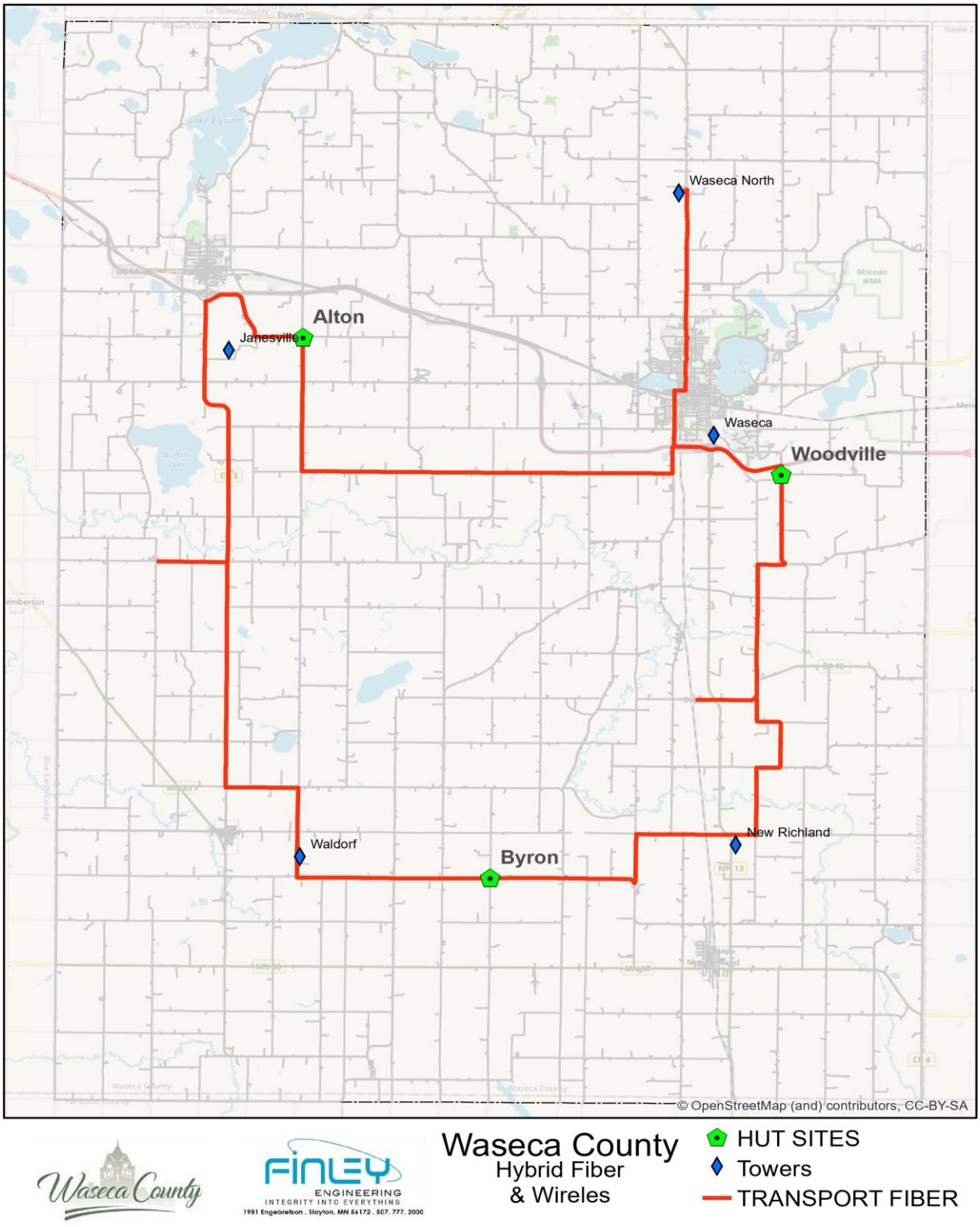


EXHIBIT V: Summary of Financial Results

		Year 5 Assets	Take Rate	Debt	Equity	Grant	Cash Year 10	Cash Year 25
	ALL FIBER							
1	**No Grant**	$15.71 M	65%	$16.85 M	$2.42 M		-$12.95 M	-$ 9.25 M
2	**With 70% RDOF Grant**	$15.71 M	65%	$11.45 M	$1.72 M	$15.65 M	$ 2.52 M	$ 6.92 M
3	**Breakeven RDOF (61%)**	$15.71 M	65%	$12.73 M	$1.91 M	$13.63 M	$ 0.75 M	$ 4.75 M
4	**60% Penetration Rate**	$15.56 M	60%	$11.42 M	$1.71 M	$15.65 M	$ 2.25 M	$ 5.75 M
5	**70% Penetration Rate**	$15.84 M	70%	$11.50 M	$1.72 M	$15.65 M	$ 2.78 M	$ 8.12 M
6	**75% Penetration Rate**	$16.00 M	75%	$11.58 M	$1.74 M	$15.65 M	$ 3.13 M	$ 9.34 M
7	**Higher Prices**	$15.71 M	65%	$11.43 M	$1.71 M	$15.65 M	$ 3.00 M	$ 8.44 M
8	**Lower Prices**	$15.71 M	65%	$11.50 M	$1.73 M	$15.65 M	$ 2.04 M	$ 5.39 M
9	**Rate Increases**	$15.71 M	65%	$11.48 M	$1.72 M	$15.65 M	$ 2.69 M	$ 9.02 M
10	**Higher Interest Rate**	$15.71 M	65%	$11.55 M	$1.74 M	$15.65 M	$ 2.20 M	$ 6.56 M
11	**Lower Interest Rate**	$15.71 M	65%	$11.40 M	$1.71 M	$15.65 M	$ 2.84 M	$ 7.27 M
12	**15-Year Loan Term**	$15.71 M	65%	$10.78 M	$1.62 M	$15.65 M	$ 6.08 M	$ 5.58 M
13	**20-Year Loan Term**	$15.71 M	65%	$10.68 M	$1.60 M	$15.65 M	$ 7.72 M	$ 4.12 M
14	**5% Higher Fiber Cost**	$16.32 M	65%	$12.13 M	$1.82 M	$15.65 M	$ 1.89 M	$ 6.16 M
15	**5% Lower Fiber Cost**	$15.09 M	65%	$10.83 M	$1.62 M	$15.65 M	$ 3.16 M	$ 7.67 M
16	**Best Look**	$15.38 M	75%	$10.85 M	$1.63 M	$15.65 M	$ 4.32 M	$14.08 M
17	**Worst Look**	$16.18 M	60%	$11.23 M	$1.68 M	$15.65 M	$ 7.91 M	$ 1.95 M

		Year 5 Assets	Take Rate	Debt	Equity	Grant	Cash Year 10	Cash Year 25
	HYBRID							
18	**No Grant**	$3.52 M	60%	$4.00 M	$0.60 M		$ 0.87 M	$ 0.13 M
19	**55% Penetration Rate**	$3.41 M	55%	$3.98 M	$0.60 M		$ 0.55 M	-$ 1.09 M
20	**65% Penetration Rate**	$3.63 M	65%	$4.00 M	$0.60 M		$ 1.18 M	$ 1.38 M
21	**70% Penetration Rate**	$3.75 M	70%	$3.98 M	$0.60 M		$ 1.49 M	$ 2.47 M
22	**Higher Prices**	$3.52 M	60%	$3.85 M	$0.58 M		$ 1.21 M	$ 1.54 M
23	**Lower Prices**	$3.52 M	60%	$4.13 M	$0.62 M		$ 0.50 M	-$ 1.32 M
24	**Rate Increases**	$3.52 M	60%	$4.00 M	$0.60 M		$ 1.07 M	$ 2.19 M
25	**Higher Interest Rate**	$3.52 M	60%	$4.03 M	$0.60 M		$ 0.76 M	-$ 0.22 M
26	**Lower Interest Rate**	$3.52 M	60%	$3.95 M	$0.59 M		$ 0.95 M	$ 0.46 M
27	**15-Year Loan Term**	$3.52 M	60%	$4.35 M	$0.65 M		$ 0.12 M	$ 0.89 M
28	**20-Year Loan Term**	$3.52 M	60%	$4.10 M	$0.62 M		$ 0.59 M	$ 0.40 M
29	**5% Higher Fiber Cost**	$3.60 M	60%	$4.08 M	$0.61 M		$ 0.83 M	$ 0.00 M
30	**5% Lower Fiber Cost**	$3.45 M	60%	$3.90 M	$0.59 M		$ 0.88 M	$ 0.25 M
31	**Best Look**	$3.75 M	70%	$4.00 M	$0.60 M		$ 1.45 M	$ 7.57 M
32	**Worst Look**	$3.41 M	55%	$4.05 M	$0.61 M		$ 0.14 M	-$ 1.07 M