Blue Earth County, Minnesota

Broadband Feasibility Study

December 16, 2019

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CCG Consulting

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EXECUTIVE SUMMARY

Finley Engineering and CCG Consulting submit this report of our findings and recommendations for bringing better broadband to the rural parts of Blue Earth County. The county is typical of many rural counties in Minnesota where some towns and cities today have decent broadband and where some rural parts of the county have or will soon have fiber to residents. In the case of Blue Earth County, the vast majority of the geographic area of the county is not going to be getting fiber broadband unless ISPs can be attracted to make investments in the county.

Some rural parts of the county today are served by ISPs offering fixed wireless broadband, and it's likely that this technology will improve over time. However, many of today's wireless broadband technologies are not very fast, due in large part to the fact that the rural parts of the county lack the fiber that is needed to support rural wireless towers.

This report provides the information needed to have meaningful discussions with ISPs about serving the county. We've learned with experience that most ISPs say they are interested in expanding and in partnering with a county that needs broadband. However, no ISP gets serious about expanding until they understand the numbers. Only then can they decide if the opportunity is something that can be financed and that meets their requirements as an investment opportunity. These studies help the ISPs understand the cost of building broadband networks in the county and also the revenue stream that might be associated with that effort.

Our analysis shows that it is financially challenging to build fiber everywhere in the county. This is not surprising after seeing that there are over 4,000 households in the county that are rural and are outside of small towns and cities. That's a lot of rural households to reach with fiber. The financial analysis shows that building fiber everywhere is going to be hard to justify even for an ISP that attracts all of the potential grant money available today.

However, the studies show other alternatives. The most attractive option is what we call a hybrid fiber / wireless solution. This would build fiber to the towns of Amboy, Beauford, Cambria, Garden City, Good Thunder, Mapleton, Rapidan, St. Clair, and Vernon Center. This solution would also provide fiber broadband to a number of wireless towers that could deliver broadband to rural homes with speeds between 25 Mbps and 100 Mbps. Those speeds will probably improve over time with the expected introduction of more spectrum and from improving wireless technology. The hybrid business plan can succeed without needing a grant – although it performs even better with some grant funding. We see a number of counties and ISPs favoring the hybrid plan. In your case that would mean bringing fiber broadband to over a third of the rural homes in the county and wireless to all other rural households. Over time, the profits from this venture could be rolled back into expanding rural fiber.

We also looked at a third option that would only bring fiber to the small towns and cities. That option requires grant assistance but can work with a reasonable amount of grants.

The studies also explore other issues related to broadband. We look at the incumbent telephone and cable companies serving the county and the products they offer and the prices they charge. We look at other technologies like 5G and satellite broadband to help understand if they can offer a broadband

alternative. This report also makes specific recommendations about the next steps the county should consider.

FINDINGS

Following are the key findings of our investigation.

BASIC FACTS ABOUT THE COUNTY

The Study Area: The study area consists of those areas of the county that don't have broadband today that meets the state's goal of 100 Mbps download speeds. This includes the rural areas of the county served by Consolidated Communications, CenturyLink, Frontier Communications, Bevcomm, and Nuvera. This footprint includes the small towns and cities of Amboy, Beauford, Cambria, Garden City, Good Thunder, Mapleton, Rapidan, St. Clair, and Vernon Center.

Excluded from the study are:

- Areas served by Christensen Communications that already have fiber or will be getting fiber.
- Cities that already have broadband provided by cable companies including Mankato, Skyline, Pemberton, Madison Lake, Eagle Lake, and Lake Crystal.

We also studied a second study area that excludes the service areas of Bevcomm and Nuvera. Those companies are likely to build their service territories with fiber, but don't yet have a specific timeline for doing so.

Study Scenarios. We considered three scenarios:

- Fiber Everywhere. We looked at the feasibility of building fiber to all of the areas without broadband today.
- Hybrid Fiber / Wireless. We looked at bringing fiber to most of the small towns and cities and serving the rest of the rural areas using fixed wireless technology. In this study the towns of Cambria and Beauford were served in this scenario by wireless technology. Fiber is also offered to customers who live along the fiber routes of the ring connecting the towns.
- Fiber to Small Cities. This scenario looked at building fiber just to serve the towns of Amboy, Garden City, Good Thunder, Mapleton, Rapidan, St. Clair, and Vernon Center. Fiber is also offered to customers who live along the fiber routes of the ring connecting the towns.

Potential Customers – Passings. We used several different sources of data for counting homes and businesses in the study areas. The primary source of information was county GIS data. Most of the businesses in the county are in towns that have broadband today and we counted the remaining businesses using Google Maps and several databases showing rural businesses in Minnesota. The number of passings (potential homes and businesses) used for the rural study areas is as follows:

Entire Rural Area	Fiber Everywhere	Hybrid	Small Town
Small Town Residences	1,744	1,744	1,744
Small Town Businesses	138	138	138

Rural Residences	4,486	4,486	466
Rural Businesses	12	12	0
Total	6,380	6,380	2,348

Excluding Bevcomm & Nuvera	Fiber Everywhere	Hybrid
Small Town Residences	1,744	1,744
Small Town Businesses	138	138
Rural Residences	4,413	4,413
Rural Businesses	12	12
Total	6,307	6,307

Assumed Customers. Since there are so many residents of the county today without good broadband there are a lot of potential customers for an ISP that builds broadband in the county. The new customers assumed by the end of the fourth year of the financial analysis are follows for the three primary scenarios:

Entire Rural Area	Fiber Everywhere	Hybrid	Small Town
Residential	3,759	2,549	1,339
Business	92	89	86
Total	3,851	2,638	1,425

Excluding Bevcomm & Nuvera	Fiber Everywhere	Hybrid
Residential	3,714	2,525
Business	92	89
Total	3,806	2,614

Road Miles. Following are the miles of fiber construction required for each scenario:

Entire Rural Area	Fiber Everywhere	Other Scenarios
Backbone Ring	129.0 miles	129.0 miles
Fiber to Customers	979.8 miles	32.7 miles
Total	1,108.8 miles	161.7 miles

Excluding Bevcomm & Nuvera	Fiber Everywhere	Other Scenarios
Backbone Ring	129.0 miles	129.0 miles
Fiber to Customers	933.6 miles	32.7 miles
Total	1,062.6 miles	161.7 miles

ENGINEERING FINDINGS

Backbone Fiber Network. The proposed network design includes the construction of a fiber ring that provides a connection between the various cities and the network huts needed to serve customers. This fiber ring would be self-healing, meaning that it could continue functioning after a fiber cut. The recommended backbone fiber in the analysis is 129 miles long and built with 96 fibers to accommodate future growth. The route chosen in the study for the fiber backbone is shown in Exhibit III.

Aerial vs Buried Fiber. The entire network was designed using buried fiber. The soil in the county allows for relatively easy burying of fiber and the cost to bury fiber in the rural parts of the county would not be any higher than to place the fiber onto existing poles. A buried network will last longer and have fewer maintenance issues.

Total Asset Costs. Following are the assets required to launch the fiber network. These are the assets constructed during the first four years of each scenario.

Entire Rural Area	Fiber Everywhere	Hybrid	Small Towns
Fiber & Drops	$31,292,509	$ 7,230,368	$7,230,368
Electronics	$ 3,814,927	$ 2,548,535	$1,808,411
Huts/Land	$ 465,000	$ 465,000	$ 465,000
Operational Assets	$ 315,420	$ 309,185	$ 253,590
Total	$35,887,856	$10,553,088	$9,757,370
Cost per Passing	$ 5,625	$1,654	$1,824
Cost per Customer	$10,106	$4,000	$6,852

Excl. Bevcomm & Nuvera	Fiber Everywhere	Hybrid
Fiber & Drops	$30,667,479	$ 7,228,953
Electronics	$ 3,781,968	$ 2,533,680
Huts/Land	$ 465,000	$ 465,000
Operational Assets	$ 326,150	$ 309,060
Total	$35,240,597	$10,536,693
Cost per Passing	$ 5,588	$1,671
Cost per Customer	$ 9,259	$4,031

OTHER TECHNOLOGIES

We don't find it likely that 5G wireless is coming to the rural areas that don't have broadband today. 5G is going to require a significant amount of fiber and it's not likely that anybody is going to invest in the needed fiber in sparely populated rural areas. 5G is likely to eventually come to cities like Mankato but may not come to rural areas for years or decades.

There is a lot of talk about companies that are planning to build low-orbit satellites to provide rural broadband. To date there have only been about 70 of these satellites launched and the technology will require constellations of thousands of satellites to be effective. We're not likely to see any broadband from these products for perhaps the next five years, assuming the companies are able to launch the needed satellites. There have been no clues from the satellite providers about the potential speeds of the broadband or the prices that might be charged. These satellites differ from existing satellites, which sit over 20,000 miles above the earth – meaning there is a lot of delay in broadband signals. The low-orbit satellites will orbit between 200 and 1,200 miles above the earth.

BUSINESS PLAN RESULTS

The financial summaries of the various business plans are described in Section III.B of this report. There is also a short summary of all financial results in Exhibit VI.

Building Fiber Everywhere Looks to be a Daunting Challenge. It looks difficult to make a business case for fiber everywhere even should an ISP somehow get every grant imaginable to help pay for the venture.

This is for two reasons. First is an issue of scale. The county has a large area without broadband that will require over 1,100 miles of fiber to reach all potential customers. It's also a matter of cost. As can be seen from above, the cost of the network needed to reach all of the households and businesses without broadband will be over $10,000 per potential customer.

A Hybrid Fiber / Wireless Network Can be Profitable. There is a reasonable scenario for building fiber to the many small towns in the county and providing wireless broadband to everybody else. The wireless broadband would be superior to most of the wireless broadband provided in the county today since the wireless transmitters would be connected to fiber and would be able to offer broadband speeds between 25 Mbps and 100 Mbps. Over time, as wireless technology keeps improving these speeds could get faster.

This plan has some major benefits:

- Over a third of the rural homes and most of the businesses without broadband today would be offered fiber.
- The fiber ring in this scenario would provide a good base to make later pushes to bring fiber to rural areas.
- This business plan can work without grants. Any grants make this easier to finance.
- In other parts of the state, ISPs are starting with the hybrid scenario with a goal of using the profits from the venture to help pay for expansion of rural fiber.

It's Also Possible to Build Fiber to the Small Towns. This scenario is not as profitable as the hybrid scenario because it doesn't include the revenues from the wireless customers. But it looks feasible for an ISP to build to serve the many small towns without broadband today if they can win a reasonable amount of state and/or federal grant funding.

In much of the rest of Minnesota, projects to build fiber to towns the size of the ones in the county have already been the focus of the Minnesota broadband grants. The towns in Blue Earth County have not been

built because they are not close to small telcos interested in serving them. A service provider who wants to serve these towns needs to build fiber to reach the towns in addition to building in the towns.

Hard to Finance with Bonds. We looked at funding the network using municipal bonds. The extra borrowing costs associated with bonds, such as capitalized interest, make it difficult to use bond financing to fund fiber everywhere. However, bond financing could be used to fund some or all of the hybrid scenario. The county doesn't want to be the operating ISP and won't be the entity funding any network, but this analysis shows that the county could consider extending a loan to an ISP willing to build the hybrid option.

Will Require Significant Equity. One of the biggest constraints on commercial ISPs that want to expand is the need to contribute equity to a new venture. The various scenarios that were studied require ISP equity between $1 million and $5 million. This is a constraint since many ISPs don't maintain significant free cash. By now, most of the telcos and other ISPs in the state have already used cash reserves for expansion.

When ISPs have to contribute equity to a project they generally look around for the opportunity with the best returns. It's likely in Minnesota that ISPs can find expansion opportunities that are more financially lucrative than the ones in this county. To some extent every county without broadband is competing with every other county without broadband, because there is not enough funding available for the existing ISPs to build to all of the unserved areas in the state.

The Business is Sensitive to a Few Key Variables. All of the scenarios are sensitive to changes in a few key variables:

- Penetration Rate: The most important variable is customer penetration rate. We used a penetration rate of 60% in the analysis since that is a conservative penetration rate we see for other projects that build broadband to areas that don't have it today. We've seen rural overbuilds that have achieved penetration rates between 60% and 85%. All of the scenarios we studied would perform better with a higher penetration rate, so one of the next steps the county should contemplate is to try to better define the interest for buying broadband in the rural areas. This can be done using a statistically valid survey or else a canvassing effort.
- Broadband Prices: The financial results are also sensitive to broadband prices. The studies all used an assumed starting price of $60 for the basic (yet adequately fast) broadband product. There are rural ISPs in the state charging more than this and it's worth more research if you do a survey to look at price sensitivity in the rural part of the county.
- Interest Rate: The business plan scenarios are sensitive to interest rates, but not nearly to the extent of penetration rates and prices. We've had a long period of over a decade where interest rates have remained steady. It will be harder to achieve these business plans if there are ever any significant increases in future interest rates.

It is essential before deciding to get into the business to pin down the key variables. The financial results shown in Exhibit VI represent only a limited number of specific study results. Each of those scenarios would show different results by changing variables like penetration rates, prices, and interest rate on debt. 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 variable change in a business plan.

RECOMMENDED NEXT STEPS

We recommend the following next steps after this study.

1. **Consider a Residential Survey**. Probably the key factor that will make the opportunity attractive to an ISP is the number of residential customers in the rural parts of the county that would consider switching service to a fiber network. ISPs understand that demand varies by market and we've seen rural markets where 60% of customers are interested in better broadband and others where more than 90% are interested. It's possible that the 60% assumed in these studies is conservatively low. All of the financial scenarios perform much better with a higher customer penetration rate.

   There are two ways to understand residential demand for a new broadband network – a statistically valid survey and a canvass.

   There are several aspects needed to create a statistically valid survey:
   - The questions must be unbiased and not lead respondents to any answers.
   - A survey must be administered randomly. This is the reason that mail or online surveys don't create valid results because people that take the surveys are self-selected – they opt to take the survey. The most important aspect of a broadband survey is to make sure to talk to people who don't want and won't use a new fiber network – that's the only way to estimate the potential market penetration.
   - In a county of this size it would require in the range of 350 – 370 completed surveys to create results that are 95% accurate, plus or minus 5%.

   A canvass is more intense than a survey and tries to contact a lot of residents. Some other counties have done a canvass and call it something like a pledge-card drive. Volunteers try to talk to every resident in the county, and as long as they can talk to a significant percentage of residents the results can have the same validity as a survey. Since there are 6,000 homes and businesses in the county without broadband a canvass would be major undertaking.

2. **Find an ISP Partner(s)**. There are several potential partners already operating in or near to the county that might be interested in tackling some or all of the identified study areas. We suggest meeting with them, showing them the results of this study, and possibly expanding the search for partners if none of the nearby candidates show an interest. This study was created for two different purposes.

   The financial and engineering analysis are for the ISP partners because with this study in hand an ISP can now understand what it might cost to bring broadband to the county. Finley Engineering did the engineering analysis in such a way that they can provide costs to an ISP that is interested in serving some smaller portion of the county.

   This written report was created for the elected officials and the public. The primary purpose of the written report is to provide a document that defines the broadband issues in the county to a non-technical layperson. We've tried hard to keep jargon out of the report.

3. **Be Prepared to Provide Assistance to Service Providers.** Any state or federal grant program requires a showing of customer and community support. The county should be prepared to help an ISP partner by seeking customer support for the grants. The county could go even further – for example we've seen counties where there has been a local pledge drive to seek signatures from interested citizens.

4. **Educate and Motivate the Public**. We've seen that a motivated and vocal public can help to convince service providers to bring broadband and can also help to keep the pressure on politicians to maintain the grant programs. There are a number of steps the county can undertake to promote broadband.

5. **Be Persistent.** A lot of counties in Minnesota are looking for a broadband solution. It's highly unlikely that you'll find a broadband solution immediately. It's more likely that you'll find ISPs willing to build to parts of the county – and each area that gets broadband can then be taken off the list. The ultimate goal is to get fiber everywhere, and that could take many years. However, this study does show that a hybrid fiber / wireless solution could bring fiber to over a third of the households without broadband and would bring decent wireless broadband to everybody else.

I. BACKGROUND RESEARCH

In this section of the report, CCG will look at the incumbent providers in the county, at the products and prices of existing service providers in the market, and at the impact of the Connect America Fund. Like many counties in Minnesota, the county is served by a number of incumbent providers with separate core service territories.

A. Current Broadband Providers and Prices

The county has numerous ISPs offering broadband today. This includes incumbent cable and telephone companies and several wireless ISPs. Historic telephone service in the county was provided by a number of different incumbent providers. Most of the geographic area of the county is served by Consolidated Telephone. There are areas near the county borders that are served by other telcos including Bevcomm, Christensen Communications, Nuvera, Frontier Communications, and CenturyLink.

There are two incumbent cable operators operating in the county. Charter Communications operates in Mankato, Skyline, Eagle Lake, and other nearby areas. Mediacom, a company that serves a lot of smaller communities in Minnesota, operates in Pemberton, Lake Crystal, and Madison Lake. Consolidated offers cable TV in Mankato over DSL. There might be some rural customers that can buy cable from the company, although most rural DSL connections are going to be too slow to support that cable product.

This section of the report examines the triple play prices available to customers today in the county. It used to be easy to analyze the prices of services. Just a few years ago you could go to the web and find the prices charged by any telco or cable provider, and except for the rare special, most customers in a given town paid about the same thing for service. This is no longer true. Most telco providers have removed their "standard" prices from the web and so there is often no baseline cost you can compare. Further, companies have developed strategies to charge different rates to different customers.

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. This means that there is no longer anything that can be considered as a "standard" price in the market. Nevertheless, it's still necessary to understand the prices being charged for broadband.

Incumbent Telcos

A map showing the service areas of the incumbent telephone companies is included as Exhibit I.

> **Consolidated Communications** is a large incumbent telephone company headquartered in Mattoon, Illinois. 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 has over 670,000 customers and 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 fibers. The details of the partnership aren't public, but the news releases suggest the cities made substantial financial contributions to the new networks.

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 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 / 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 LD Administration Fee added to any phone line that can make long distance calls. There are $6+ of other fees also added to these rates that are revenue to the company (not taxes).

Cable TV. The company sells cable TV, but this is in Mankato and may not be available in the rural parts of their area included in 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 / month in 2019.

<u>Security</u>
The company sells and installs SimpliSafe home security systems.

Christensen Communications is a privately-owned telephone company that serves the Madelia and Lasalle areas. The company serves customers on the western border of the county. The company has built fiber to all of its customers.

The company doesn't post prices online for its services. *BroadbandNow* lists broadband prices for the company as:

100 Mbps	$ 79.95
1 Gbps	$249.95
Installation	$100+
Managed WiFi	$7.95 / month

The company also offers regulated telephone service within its service area. The rates are not published on the web.

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. In the county 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.

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.	$3.95
Wire Maintenance	$4.00

Telephone

City Phone	$31.28
Business Phone	$29.99

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	$48.95
Bevcomm TV	$94.95
Price includes 2 settop boxes	
DVR	$10.95
HDTV	$ 9.95

There are numerous bundles available.

Frontier Communications is the fifth largest telephone company in the US. The company changed their 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 second quarter of 2019 the company had 3.6 million broadband customers and 738,000 cable customers. The company serves in the southwestern corner of the county in the Lewisville and Truman exchanges.

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 also accepted money from the Connect America Fund to enhance DSL speeds in the county and took $5.54 million in Blue Earth County, paid over six years, to improve broadband speeds to at least 10/1 Mbps for 1,748 rural homes.

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
Lewisville	$15.09	$33.20	$37.00	$42.98
Truman	$15.09	$33.20	$37.00	$42.98

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).

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

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 for $34.99. Over time this will increase to some higher number. We've seen bills of customers paying $40.99, 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 many of the rural DSL customers in the county to speeds of at least 10/1 Mbps.

Frontier doesn't disclose the list price of these products. New customers get promotional prices with the disclaimer that after two years the prices will revert to the "list price at that time." 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.

Nuvera is a regulated telephone company that was recently rebranded from the historic name of New Ulm Telecom. The company serves a tiny pocket of customers in the county in the northwestern corner from the Courtland and Hanska exchanges.

Broadband
Their list price for residential broadband on DSL is:

Up to 7 Mbps	$44.95
Up to 14 Mbps	$49.95
Up to 28 Mbps	$59.95
Up to 55 Mbps	$74.95

Residential Telephone

Basic Line	$20.00
Long Distance	$0.15 per minute of $4.95 / month and $0.11 per minute.

$7.50 of fees added to this price.

Cable TV

Basic TV	$ 34.95
Entertainment Package	$ 97.95
Variety Package	$104.95
DVR	$ 12.95

CenturyLink serves a tiny slice of the eastern border of the county from its Waldorf exchange.

Cable TV Providers

Charter (Spectrum) Communications is the second largest cable TV company in the country with 25.9 million broadband customers and 16.3 million cable TV customers at the end of the second quarter of 2019. The company reached its current size after the 2016 acquisition of Time Warner Cable and Bright House Networks. The company has rebranded its triple-play products as "Spectrum." Charter is the incumbent cable provider in Mankato and surrounding communities like Skyline and Eagle Lake.

Charter was founded in 1993 and got its start as a cable company in 1995 when it acquired Cable South. Paul Allen, one of the founders of Microsoft, bought a controlling interest in the company in 1998. The company continued to grow through acquisition, buying a dozen smaller cable systems over the next decade. The company went through a bankruptcy in 2009 and was able to walk away from $8 billion in debt, with the majority of the equity in the company going to Apollo Management. Charter announced in late 2017 that they were partnering with Comcast in some markets to be able to provide cellular phone products.

Charter recently announced in 2018 that they are upgrading all of their systems nationwide to a new technical standard, DOCSIS 3.1. This technology from CableLabs allows bonding of an unlimited number of spare channel slots for broadband. This will allow the company to increase data speeds and market a gigabit data product. A gigabit data path requires roughly 24 channels on a cable network using the new DOCSIS protocol.

Along with the introduction of gigabit broadband the company announced across-the-board speed increases for upgraded markets. They announced that the speed of their base broadband produce will now be 200 Mbps. This is an increase from 100 Mbps. However, there are many markets where they are not actually delivering the new faster speeds, and in some markets the standard product is offered at 100 Mbps.

While Charter is a giant company, their pricing structure is one of the simplest in the country. The company is going through some major turmoil in that they are moving prices in the recently acquired Time Warner markets to Charter prices, which in many cases are higher, especially since Time Warner was generous in handing out continuing specials and promotions.

Broadband Pricing

The company currently has only two broadband products. As mentioned above, the base product ranges in speeds in various markets between 60 Mbps and 200 Mbps. They also now have a gigabit product in some markets.

Broadband	
Charter Basic Internet (Standalone)	
Regular Price	$69.99
Activation Fee	$49.99

Charter has raised rates twice within the last year. A year ago the base broadband product was $64.99 / month.

Charter Internet (In a bundle)	
Regular Price	$59.99

Note that the basic Internet price above includes a $1 per month increase for 2019. The bundled rate was increased by $5 per month at the beginning of 2019—the biggest increase we can recall ever having seen for broadband.

Charter offers a WiFi router (optional) for a one-time activation fee of $9.99 plus $7.99 month.

There are no data caps on broadband monthly download.

The company has set a target price for a gigabit at $124.95. But in the competitive markets where the company competes against fiber, like Oahu, HI, the company is selling introductory 1 Gbps for $104.99.

Telephone Pricing

Residential Telephone Service is only available as part of a bundle and not as a standalone product. Depending upon the bundle, the voice product that comes with the most popular features adds $10 to $15 per month to the cost of a bundle. Charter does not advertise their business telephone rates.

Cable TV Pricing

While the company's broadband and landline prices are simple, their cable TV pricing is one of the most complicated in the industry and there are numerous bundling options. The basic cable rates are:

Basic Cable	$23.99
Expanded Basic	$52.99
Spectrum Select	$72.49 -- adds additional digital channels
Spectrum Silver	$92.49 – adds more channels and 1 movie channel
Spectrum Gold	$112.49 – adds the Movie Channel, Starz, and EPIX to the Spectrum Silver.

There are also numerous other ways to add digital tiers, foreign language programming, and premium channels.

There is a fee called a Broadcast Service Charge of $13.50 per month that is added to all of the TV prices list above. A year ago this was $9.95.

For all plans there is a fee of $7.50 per settop box. A DVR-capable box is $11.99 per month, plus they sell DVR service in packages ranging from $12.99 - $19.99.

They also offer inside wire maintenance for $4.99 per month.

Mediacom is the incumbent cable TV provider in Pemberton, Lake Crystal, and Madison Lake. They are 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 second quarter of 2019 the company had 1.3 million broadband customers and 747,000 cable customers. They offer the triple-play products either standalone or in bundles.

Residential Broadband

60/5 Mbps	$ 39.99	150 GB cap
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
Sells long distance packages at $0.05 per minute	

Cable TV

Basic	$29.95
Family TV	$80.49
Prime TV	$96.49
Local Surcharge	$14.73
Regional Sports Surcharge	$ 4.88

Dish Network is a large satellite provider and has customers in the county. The company had around 9.56 million cable customers nationwide at the end of the second quarter of 2019. Dish Network can be bought as a standalone service and is also available as a bundle for Frontier customers.

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 has been purchased by AT&T and they no longer report satellite customers separately from AT&T U-verse customers. DirecTV now offers an online version of its programming called DirecTV Now. Current prices after any promotional discounts are:

155 Channels	$ 78.00
160 Channels	$ 90.00
185 Channels	$117.00
250 Channels	$128.00
330 Channels	$181.00

WISPs (Wireless ISPs)

The county is served by a number of WISPs (wireless ISPs). These companies used a technology called fixed wireless where they mount a transmitter on a tower or other tall structure like a grain elevator or water tower. They then beam broadband to customers which is received through a dish receiver. All of the products sold by these companies are "up-to" speeds. The speed that a customer can receive is affected by the distance to the transmitting tower.

MVTV Wireless is a nonprofit cooperative with headquarters in Granite Falls. They cover 30,000 square miles in southwestern Minnesota. Their web site is https://www.mvtvwireless.com/. According to their coverage map they offer broadband in the western and northwestern part of the county.

Following are their listed broadband prices:

Residential	
Up to 3 Mbps	$39.95
Up to 6 Mbps	$49.95
Up to 10 Mbps	$59.95
Up to 15 Mbps	$69.95
Up to 25 Mbps	$79.95

Business	
Up to 6 Mbps	$ 62.95
Up to 10 Mbps	$ 87.95
Up to 15 Mbps	$112.95
Up to 25 Mbps	$212.95
Up to 35 Mbps	$312.95

Residential installation is $114.95. Business installation is $164.95. The price includes membership fee to the cooperative.

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
10/2 Mbps	$70.00
25/3 Mbps	$80.00

Radiolink is a WISP with headquarters in Ellendale, Minnesota. Their service map shows coverage in the eastern half of the county. Their website is at https://www.radiolinkinternet.com/.

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.

MidCo is a regional cable company that operates an extensive cable network. The company is headquartered in Sioux Falls, South Dakota and has most of their 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 from US Cable.

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

The company recently won a grant award from the CAF II reverse auction. In that award the company pledged to provide fixed wireless service capable of at least 100 Mbps across a large area that includes some of Blue Earth County. The company will have six years to construct this network starting in 2020. The company has not yet disclosed the prices for the wireless broadband.

Fiber Overbuilders

Jaguar Communications is a fiber-based ISP headquartered in Owatonna, MN. They own fiber in Blue Earth County and currently partner with the county to provide a fiber loop that connects county between the north and south parts of the county.

Jaguar currently provides fiber in parts of Mankato and in other communities like Madison Lake. They currently have no announced plans to provide rural fiber in the county, but the company has won Minnesota Border-to-Border grants in the past to built fiber in eligible areas.

Jaguar does not list their prices on the web, but they provide the full triple play services including home internet with speeds up to 1 Gbps.

Satellite Broadband. There are currently two satellite providers available in the county - Exede (which also markets under the name of Wildblue), and HughesNet. For both, the availability depends upon having a clear line of sight from a satellite dish to the satellites.

There are several issues that customers report with satellite broadband. First is latency, which means delay in the signal. 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, web sites that require real-time such as online education, and making 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.

The second biggest issue for satellite broadband is that many of the products have small monthly data caps. These caps limit the amount of data a customer can download in a given month. All of the services require contracts of up to 2 years. Here is a short summary of the providers:

Exede (Wildblue) offers broadband on an older satellite that had data speeds described by the company as up to 17 Mbps download although customer reviews say the average speed is more like 12 Mbps. The company now also offers broadband on a new satellite, ViaSat II. Following are the products offered on the new satellite:

Bronze 12 Mbps	$ 50.00
Silver 25 Mbps	$ 70.00
Gold 30 Mbps	$100.00

Customers can be throttled at busy times after reaching small monthly data caps. Those caps are 40 GB for the Bronze 12 plan, 60 GB for the Silver 25 plan, and 100 GB for the Gold 30 plan. To put those caps into perspective, the average home in the US used 274 GB per month in the first quarter of 2019. Online reviews say that speeds can be throttled as low as 1 Mbps.

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 throttled after meeting the data caps.

Cellular Data

There are four primary cellular companies in the country—AT&T, Verizon, T-Mobile, and Sprint. Only Verizon and AT&T have their own cell sites in rural counties like Blue Earth, and the other two carriers most normally pay to use those networks.

There are almost certainly some households in the county that use their cellphone data plans for household broadband. There are several problems with this. First, customer speeds decrease with distance from a cellphone tower. Speeds for cellular data generally are not fast. There are two different cellular data standards in use: 3G and 4G. 3G data speeds are capped by the technology at 3.1 Mbps download and 0.5 Mbps upload.

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 average.

	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 four carriers now offer “unlimited” data plans. The plans for AT&T, Sprint, and Verizon are not actually unlimited and have monthly data caps in the range of 20 - 25 gigabytes per month of downloaded data. These plans might provide some relief to homes that rely on cellular broadband, although there have been reports of Verizon disconnecting rural customers who use too much data on these plans. These plans allow a far smaller amount of broadband when using the cellphone as a hotspot, so the plans are not much more useful for home broadband than normal cellular plans. T-Mobile claims to offer unlimited data but begins throttling customers after 50 GB of data usage in a month.

B. The Connect America Fund

There are two federal broadband programs that come from the Connect America Fund, which is part of the FCC’s Universal Service Fund. Funding from these two programs will be used to improve broadband in some parts of the county.

The Universal Service Fund today is funded primarily from surcharges on telephony revenues. Originally, the USF was funded by surcharges on landline telephones and special access circuits only, but eventually a surcharge was also placed on cellphones.

The first program is aimed at the largest telcos like CenturyLink and Frontier Communications and is called Connect America Fund II (CAF II). The FCC has set aside $1.7 billion per year for the 6 years starting with 2016 to build or upgrade rural broadband. These funds were made available to census blocks that have little or no broadband today.

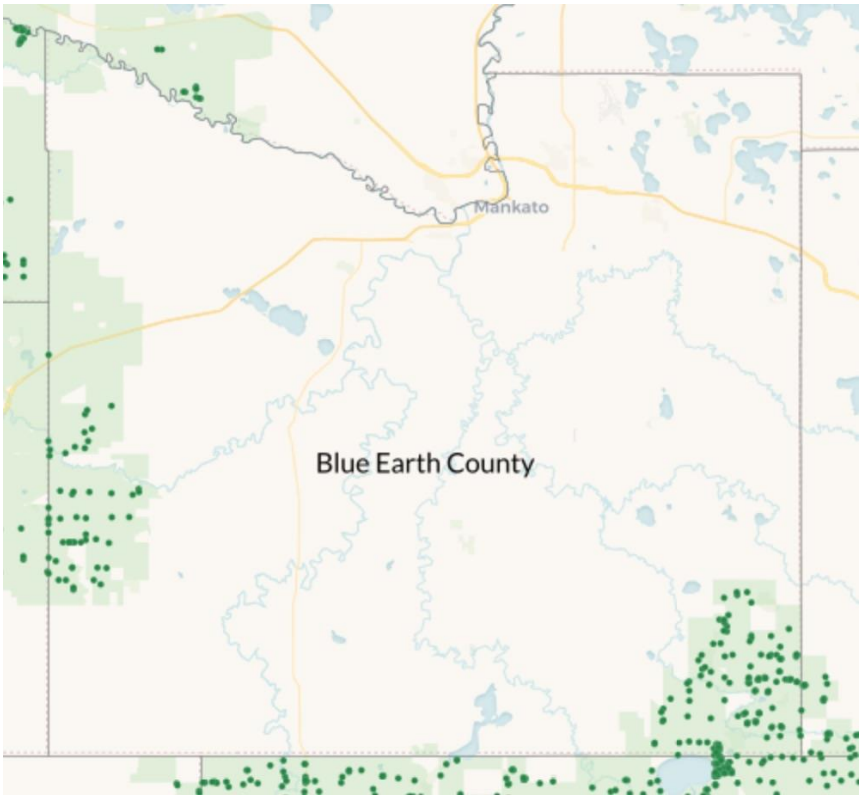
The FCC awards in the county were as follows:

- Consolidated accepted $2,303,981 per year for 6 years ($13,823,886 in total) to expand broadband in Blue Earth County for 3,803 homes - $3,635 per home.
- Frontier Communications accepted $118,895 per year, or $713,370, to bring better broadband to 131 rural customers - $5,445 per home.

These funds are being distributed to the telcos over 6 years, with the final year being 2020. There are buildout requirements and the telcos should have upgraded at least 60% of the customers in the whole state as of the end of 2018 and 80% by the end of 2019. The upgrades must all be done by the end of 2020.

Both companies used the funds to upgrade rural DSL. The CAF II program requires 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 own definition of broadband, which is 25 Mbps download and 3 Mbps upload. There is a map showing the areas that were supposed to get CAF II upgrades in Exhibit V. That map shows the areas that are supposed to be upgraded in pink. It's likely that areas nearby to the upgrade areas also are getting faster DSL.

In 2018 there was a second round of Connect America Fund awards that are commonly referred to as the Reverse Auction. The awards were made under FCC auction 903. In this grant program ISPs bid against each other, with the winner being an ISP willing to take the smallest amount of funding per customer. The winners of the Reverse Auction will receive their funding over 10 years and have 6 years to build the promised networks starting in 2020. Each winning bidder defined the speed of the technology they would deploy and are expected by the FCC to meet those speeds. An ISP that doesn't meet the speeds will have to return some of the grant funding.



The two winners of the Reverse Auction in the county are LTD Broadband and Midco – both deploying fixed wireless technology. LTD will be deploying fixed wireless that meets speeds of at least 25/3 Mbps. Midco pledged to deliver fixed wireless speeds of at least 100 Mbps. The green dots on the above map show the homes that are supposed to be covered by these grants.

C. The Consequences of Poor Broadband

Like many counties in Minnesota there are a few rural areas that have, or will be getting, fiber. This means the county will become a mixture of fiber "haves" and "have nots" often living within close proximity to each other. For example, the areas served by Christensen Communications will have fiber while those nearby will not. The areas served by Bevcomm and Nuvera are likely to be getting fiber, although a specific date for that has not yet been set. None of the cities or towns in the county have fiber today, but many of those towns are served by Charter and Mediacom which offer speeds significantly faster than the FCC's definition of broadband of 25/3 Mbps and the Minnesota definition of broadband of 100 Mbps.

CCG Consulting and Finley Engineering have studied a lot of different counties in the state and the most obvious feature of Blue Earth County is that the vast majority of the area is served by big telcos that have no plans to deploy fiber. While there may be other counties in the state with the same issues, your county has a higher percentage of the geographic area of the county that is considered unserved with broadband than other places we have studied. This means that the rural customers in Blue Earth County have few broadband options, including those living in towns of Amboy, Vernon Center, Garden City, Good Thunder, St. Clair, Mapleton, Cambria, Rapidan, and Beauford. In other counties we've seen communities the size of any of these towns that have already seen construction of faster broadband.

With that said, much of the rural parts of the county should be seeing faster broadband from Consolidated, Frontier Communications, and CenturyLink as a result of the CAF II program that was intended to improve rural DSL speeds to at least 10/1 Mbps. Additionally, the county has a number of fixed wireless providers that all advertise speeds of 25 Mbps, but as we've seen in other counties often deliver speeds much slower than that. None of these rural customers today have the option to buy the kind of broadband speeds that are available in Mankato and a few other cities in the county.

Lack of broadband causes all kinds of problems for rural homeowners including:

- Lower Property Values: There are numerous studies showing 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. That is a big negative for the small towns in the county without good broadband. Without a broadband solution, the rural parts of the county are going to 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.

  In Blue Earth County, this might mean that the rural areas with the slowest broadband will fare poorly over time compared to those parts of the county with good broadband. It is likely to become easier to sell a home or to build a new home where there is fiber. It's also likely, if it's not already true, that the areas without good broadband will see significantly lower property values and have a harder time selling a home.

- 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 students need to do homework. This is one of the major problems with satellite broadband, which has speeds up to 25 Mbps, but with tiny data caps and high latency the satellite broadband is largely 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 home use.

  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 video 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),[2] 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:

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

  - 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 scores 152, compared to 128 for students without a home computer.

- 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 commute to jobs with employers that would allow commuters to work a few days a week from home if they had an adequate broadband connection. Telecommuting is good for everybody. Avoiding a commute to a distant office saves a lot of money for employees. 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. Commuting is also a greener alternative, saving gasoline and cutting down on carbon dioxide emissions.

- Shopping: It's almost impossible to think about using broadband today without thinking about ecommerce on the web. Shopping from Amazon, the giant of the industry, as well as countless other retailers, has allowed rural America to buy things for homes and businesses that were hard or impossible to find just a decade ago.

- 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.

- 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 in the Twin Cities without losing a day and a drive to make the long trip.

Mayo Clinic is one of the national leaders in telemedicine and has been doubling the number of telemedicine patient visits nearly annually. Telemedicine is really valuable as a way to keep track of patients after an operation or to deal with patients that need regular sessions like counselling.

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.

- Agriculture: The agriculture industry is starting to rely on broadband to a significant degree. Consider some of the following.
    - 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. But the industry is 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.
    - The most data-intensive farming need 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.
    - Farmers are measuring yields as they harvest so they can record exactly which parts of their fields produced the best results.
    - 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.
    - Using sensors for livestock is the most technologically advanced area and there are now dairy farms that measure almost everything imaginable about every milking cow. The sensors for monitoring pigs, chickens, and other food animals are also advanced.
    - 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 envisioned future is that sensors will be able to sense a problem in equipment and a send 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 whole 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 crops 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.

The common thread of all of these developments in precision agriculture is the need for good broadband. Professor Nicolas Uilk, the head of the first degree-program in the country for precision agriculture at South Dakota State estimates that a farm needs 100 Mbps broadband to transmit the detailed map scans for crop fields. That means fiber to the farm.

- Economic Development and Jobs: One of the major issues that concerns most rural counties is the ability to retain the businesses that already operate there and to hopefully attract new ones. As vital as broadband is to residents it's even more vital to businesses. Many businesses now want their employees to have broadband at home so that they can work from home as needed while gaining access to data in company servers. A new business is going to consider the whole broadband profile of an area before deciding to locate there. There are numerous municipal fiber ventures that claim significant economic benefits from fiber networks they've built. Many of them have been able to lure new businesses or have seen existing businesses expand.

  The other related issue that we often hear about is what is called the "rural brain-drain." Most rural counties don't have enough good jobs to keep recent graduates home, and so large percentages of each graduating class migrate to larger cities and towns to pursue careers. One of the promises of fiber is the ability to create new jobs and to 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.

II. ENGINEERING DESIGN AND COSTS

Finley Engineering performed an engineering analysis and prepared a cost estimate of the cost of building fiber in areas of the county that don't meet the state's goal of having broadband capable of 100 Mbps download speeds.

A. Network Design

Before looking at the specific network designs, we gathered information about the county demographics 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

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 specific plans to bring fiber in the next few years. We started by looking at maps of existing service levels and found that some towns already meet the state's 2026 goal of 100Mbps download and 20Mbps upload. We also found that the area served today by Christensen Communications has fiber. Additionally, the areas served by Bevcomm and Nuvera are likely to be getting fiber, although the companies have not specified a date for upgrades.

We then researched and contacted all of the local wireline providers in the county. We inquired about what level of service they offered and what their plans for future upgrades were. Below is a summary of what we learned:

1. Consolidated. The company currently covers about 85% of the county's geographic footprint. Their service areas are mostly in various stages of upgrades. Consolidated is using CAF II funding from the FCC's Universal Service Fund to upgrade their existing DSL nodes, drive fiber deeper into the copper network and shorten copper loop lengths to increase speeds. These upgrades have resulted in noticeable speed improvements in some small towns but have limited effectiveness in rural areas. These upgrades don't meet the state's goals of 100/20 Mbps and are all included in all versions of the study.
2. Christensen Communications. The company built some FTTP in their existing exchange territory on the western county border. They anticipate completing a FTTP network covering all of their ILEC exchange areas in the county with the next 5 years. These areas are excluded from the study.
3. Nuvera Communications. The company has received ACAM funding from the FCC Universal Service Fund and is upgrading portions of their network. No firm timeline has been set for upgrading areas in the county. In general, they are building FTTP networks although some areas are being served with high speed fixed wireless. These areas were included in all versions of the study.
4. Bevcomm Communications. The company has received ACAM funding from the FCC Universal Service Fund and are upgrading portions of their network. No firm timeline has been set for areas in the county. The company will eventually be building FTTP networks for areas within the county. These areas were included in all versions of the study, but the study looks at versions that exclude these areas.
5. Charter. They provide service in and around the city limits of Mankato and nearby areas including Skyline and Eagle Lake over their existing cable plant with speeds of up to 120 Mbps. The company has announced at the national level that all service areas will be updated to DOCSIS 3.1, meaning that eventually speeds up to 1 Gbps should be offered. We were not able to determine what these plans are or a timeline for the county, but a safe assumption is that upgraded software and hardware will result in significantly increased speeds. These areas were excluded from the study.
6. Mediacom. They provide service in and around the city limits of Lake Crystal, Madison Lake, and Pemberton over their existing cable plant with speeds of up to 1 Gbps. These areas were excluded from the study.
7. Midcontinent (MidCo). While they are not currently listed as a provider in the county, they were awarded grants to provide broadband services in the county under the FCC's CAF II Reverse Auction. Under this program they will receive just under $1.25M over the next 10 years to provide 100/20Mbps speeds to 245 subscriber locations across the county. A map of these locations is included in section I.B of the report. MidCo will likely serve these locations and others in the county with fixed wireless, with transmitters fed by some amount of fiber. MidCo is also pursuing state grant funding in the current round of grant applications in 2019 that would cover the towns of Mapleton, Amboy, Good Thunder, St Clair, and Vernon Center. The studies do not exclude any of the areas with proposed wireless coverage by MidCo.

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 the passings as follows:

Entire Rural Area	Fiber Everywhere	Hybrid	Small Town
Small Town Residences	1,744	1,744	1,744
Small Town Businesses	138	138	138
Rural Residences	4,486	4,486	466
Rural Businesses	12	12	0
Total	6,380	6,380	2,348

Excluding Bevcomm & Nuvera	Fiber Everywhere	Hybrid
Small Town Residences	1,744	1,744
Small Town Businesses	138	138
Rural Residences	4,413	4,413
Rural Businesses	12	12
Total	6,307	6,307

Road Miles

Blue Earth County has an extensive GIS system. 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. The studies only considered 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 road miles in the study area are as follows:

Entire Rural Area	Fiber Everywhere	Other Scenarios
Backbone Ring	129.0 miles	129.0 miles
Fiber to Customers	979.8 miles	32.7 miles
Total	1,108.8 miles	161.7 miles

Excluding Bevcomm & Nuvera	Fiber Everywhere	Other Scenarios
Backbone Ring	129.0 miles	129.0 miles
Fiber to Customers	933.6 miles	32.7 miles
Total	1,062.6 miles	161.7 miles

Basic Network Design

Fiber Backbone

The proposed service area is large, meaning it can't all be served from one central location. Generally, this circumstance indicates a network design that includes a fiber backbone network that performs the function of connecting the various parts of the service area into one coherent network. A map of the proposed fiber backbone for Blue Earth County 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.

The backbone routes we have chosen are 129 miles long. It is possible that other routes could be chosen to reach the same or similar locations. The network could also be constructed in phases or utilize another 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 into this design for Blue Earth 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 was served by edging out from the current service territories of one or more provider, or if only a portion of the county was going to get broadband that the backbone might not be needed or would be constructed in a different manner. This is especially true of Blue Earth County as many providers already have fiber routes throughout or adjacent to the study areas. 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 would be able to feed either FTTP huts or wireless towers depending upon the design chosen. The design placed huts at the following five locations to house equipment and fiber optic splitters for distribution to subscribers. Again, these huts could be located elsewhere, but we think this number of nodes is the best design for reaching all homes with fiber utilizing a centralized design that would maximize bandwidth capabilities. The nodes in the network are located at:

1. Good Thunder
2. Amboy
3. Mankato (would not provide service to served areas except for fixed wireless backhaul)
4. Mapleton
5. Butternut

The 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 electronics and other needed equipment upon recent quotes we have received from vendors like Calix, AdTran, Clearfield, Cienna, and others. Finley is vendor neutral and we are not proposing

any specific vendors. The costs chosen are representative of current electronic costs, which, unsurprisingly, are not greatly different by vendor.

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

Fiber Drops

The primary reason that the study was broken into separate study areas is due to the limitations on the distance a fiber signal can travel from a node. With PON technology (described below) the safe maximum distance to reach customers is 12 miles.

In looking at signal length we also had to consider the length of fiber drops. We found that the average length of the drops in the towns had relative short drops with an average length of 100 feet. But in the rest of the county the average length of fiber drops looks to be about 250 feet but there are many homes that are located far off of roads. The longest drop lengths were considered when looking at determining the number of huts and service areas needed to safely reach each subscriber.

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 a 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 any 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 Blue Earth County, the soil is mostly soft and deep with a few areas of rock that would allow for easy construction for buried fiber. We have also accounted for lakeside construction, which is usually more expensive due to wet soils, additional boring requirements, and 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 then 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 FTTP network. That is 12 miles of fiber along a road, not a 12-mile circle. The study shows the need for four 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.

Due to the concentration of customer in small pockets around lakes and small towns we elected to use a combination of remote splitter cabinets and splitters in the remote huts. From each splitter cabinet or 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 remote splitter cabinets would not require electronics. The major difference in 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 pricing 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 splitters with 64, 32 or 16 ports. An active Ethernet port provides up to 1 Gbps of upstream and downstream data to customers today 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, Finley only considered a 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 there is no way to know ahead of time which homes will buy service. Over the long life of a 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 FTTP 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 lower.

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 also considered a hybrid network that provides fiber to some homes and fixed wireless to others. The hybrid network begins by assuming nearly the same fiber backbone route used 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 can also be used to connect homes and businesses on the routes between towers. We've seen several DEED grants that received funding to serve customers along similar backbone fibers.
- 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. Usually the electronics on a fiber network are designed with redundant switchover, meaning that the network can quickly heal itself in case of an electronics failure. In addition, 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.

The wireless portion of the network was designed to connect to six towers. The design calls for leasing space on existing towers, however constructing 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 each potential customer. Before building this network we 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 analysis.

For this kind of network, the towers should be as tall as possible because the taller the tower, the easier 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 60 to 120 degree path, called a sector. Thus, it takes at least three transmitters to serve the full circle around one base station. Each sector can comfortably handle a set number of point-to-multipoint connections, and so multiple sectors means the ability to serve more customers.

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 100 Mbps are possible for customers close to a tower. The speed decreases with distance and there would be a lot of customers that could get speeds like 75 Mbps or 50 Mbps. The design is aiming to get everybody at least 25 Mbps.

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

- The primary frequency used for this technology today is WiFi. This is the same WiFi frequency used to deliver broadband inside homes. WiFi is really two frequencies – one at 2.4 GHz and another band at 5 GHz. Probably the biggest advantage of WiFi in this use is to use each frequency to serve different customers – matching each customer to the one that gives them the best signal.
- New radios also often include the 3.65 GHz frequency that was recently approved for rural broadband by the FCC. This frequency is being called Citizens Band Radio Spectrum (CNRS). There are several advantages of this frequency over WiFi. First, the channels in this frequency naturally allow for greater bandwidth deliver. The 3.65 GHz frequency handles trees much better

than WiFi. 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. The FCC has approved 80 MHz of free spectrum in this frequency for use by anybody and will be auctioning another 60 MHz. It's worth noting that unlike WiFi, the government will monitor interference on this spectrum and the speculation is that they will favor the providers who deployed the earliest.

- Radios used for this purpose today are largely software tunable and we envision networks that use both 3.65 GHz and WiFi, 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 limitation 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 their only other option is dial-up. So there could be some small amount of additional revenue available that is not reflected in the business plan.

Other Capital Costs and Considerations

Following are some of the additional capital costs that we considered in the financial models.

Headend Capital: The studies assume that any ISP that builds to these rural areas will already be delivering broadband products elsewhere or will be able to buy these services from one of the existing ISPs in the area. We did not build in the cost of a headend used to provide products like broadband, telephone service, and cable TV. Such a headend would be prohibitively expensive if used for the small customer base in the county.

The business plans include the electronics needed at the customer location to provide voice and broadband services. Since many of the service providers in the area don't offer cable TV, we did not include the cost of settop boxes. Most service providers charge a monthly fee for each box and the box rentals are profitable, so it would not be a material change for a service provider to account for these.

Other Assets: The business plan also includes the other assets needed to operate the business. This includes new vehicles for the outside technician. The business plan includes a computer for every employee along with furniture and office equipment.

Inventory/Spares: The business plan includes inventory. This inventory consists of spare fiber, settop boxes, ONTs, and spare cards for all the electronics.

Battery Backup: Historically, engineers designed many FTTP networks with battery backup for the ONT. However, many small fiber providers have stopped providing batteries. The batteries were installed to provide power to telephones in the case of a power outage at the home. However, there are fewer and fewer phones in existence that are powered from the phone line and most phones must be plugged into an outlet. When such a phone loses power it can't be powered by the battery. Our design does not include a battery backup, but a provider could provide optional batteries for customers who really want one.

B. Network Cost Estimates

Following are the cost estimates for constructing the network and the other assets needed for each business plan scenario.

Capital Assumptions in the Study

Capital is the industry term for the assets required to operate the business. The capital expenditures predicted in these models reflect the results of the engineering studies referenced in Section II.A of the report. The launch of a broadband network requires a significant investment in the fiber network and electronics and these items represent most of the cost of getting into the business.

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 include 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 in our estimates so that hopefully the actual cost of construction will be something lower than our projections. One way we were conservative was by adding an 8% construction contingency to the cost of the fiber in the all-fiber scenario and by adding a 5% contingency in the hybrid scenario.

However, it is important to remember that the engineering used to make these estimates is high level. Detailed engineering 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, but mostly relying upon 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.

Following is the capital required for the base case for each of the three primary scenarios. These represent the capital expended during the first 4 years, which for most projects are covered by borrowing before the business becomes cash positive.

The scenarios assumed different customer penetration rates. The fiber everywhere scenario assumes a 60% customer penetration rate. The hybrid scenario assumes 60% penetration for fiber customers and

30% for wireless customers. The small-town scenario assumes a 60% penetration rate. The capital costs would be higher or lower if there were greater or fewer customers than the penetration rates used to calculate these figures.

Entire Rural Area	Fiber Everywhere	Hybrid	Small Towns
Fiber & Drops	$31,292,509	$ 7,230,368	$7,230,368
Electronics	$ 3,814,927	$ 2,548,535	$1,808,411
Huts/Land	$ 465,000	$ 465,000	$ 465,000
Operational Assets	$ 315,420	$ 309,185	$ 253,590
Total	$35,887,856	$10,553,088	$9,757,370
Cost per Passing	$ 5,625	$1,654	$1,824
Cost per Customer	$10,106	$4,000	$6,852

Excl. Bevcomm & Nuvera	Fiber Everywhere	Hybrid
Fiber & Drops	$30,667,479	$ 7,228,953
Electronics	$ 3,781,968	$ 2,533,680
Huts/Land	$ 465,000	$ 465,000
Operational Assets	$ 326,150	$ 309,060
Total	$35,240,597	$10,536,693
Cost per Passing	$ 5,588	$1,671
Cost per Customer	$ 9,259	$4,031

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the hardware electronics for an ONT cost $467, 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 assumed that the service provider will supply a WiFi router for customers that want one. We've assumed these routers cost $110.

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. The fiber drops in the small towns in the study area are significantly shorter, and thus cost less to connect. The cost for fiber drops in the towns are estimated to be $1,041 while the more rural drops have been estimated to cost $1,415. Most of the cost of providing drops is labor.

The prices included in the study represent recent pricing being paid in several Minnesota projects to external contractors. The drops are the one portion of the fiber network where an ISP might be able to save significant cost compared to our study. For example, an ISP might be able to assemble their own construction team to build drops for less. They might find a local contractor that will build the drops for less.

Business Costs

The study includes 150 businesses, most which are in small towns. For purposes of this study we have assumed that the cost to get fiber to those businesses is the same as getting it to a residence. There might be a small number of those businesses where the cost could be higher, but the vast majority of businesses will be happy with the same kind of fiber connection being provided to residences.

C. Competing Technologies

Following is a more in-depth discussion of the technologies that are currently provided in the rural areas today.

Wireless Technologies

There is always a lot of confusion about wireless technology since there are so many different frequencies in use and different technologies used for each. It is likely that there are rural residents in the county today using the following wireless technologies for broadband:

Cellular Data

There are likely rural customers in the county today that use cellular data for their home broadband – mostly due to lack of other options. The US cellular companies have priced data prices higher than almost every other industrialized country with data prices as high as $10 per downloaded gigabyte.

Today's cellular network uses a technology called 4G. Cellular coverage in rural areas are hit and miss and we expect that there are areas in the county with poor cellular coverage, or at least poor cellular data coverage. The primary characteristics that matters with cellular data are data speeds and the distance a given customer is from a cell tower. Nationwide the cellular carriers in the US are average around 20 Mbps in data speeds, but the connection speed at rural cell sites is usually lower than that. Additionally, speeds drop off according to the distance a customer is from the service cell site and good cellular data speeds only are available within a few miles of a tower. A customer sitting 5 miles or more from a tower is probably getting very slow data speeds of only a few Mbps.

5G is the next generation of cellular service that will eventually replace the current 4G LTE. The new 5G standards propose an improved cellular experience for customers. There are 13 new technical improvements required to fully implement 5G. The most important of these are:

- The primary stated goal of the 5G standard is to be able to handle upwards of 100,000 simultaneous connections from a single cell site. We're all familiar with being unable to get a cell signal in a busy environment like an airport or stadium. This will fix that issue, but the real hope for the cellular companies is to be able to use cellular technology to be able to communicate with

Internet of Things devices. IoT is a term that refers to the many devices that we communicate with wireless, such as the many devices in a home today that are connected to WiFi. Today the IoT works almost entirely with WiFi and the cellular companies envision capturing much of that market – but they have a huge uphill battle to wrest the market away from WiFi.

- The standards set a speed goal to eventually achieve widespread cellular speeds of 100 Mbps download and 20 Mbps upload. Contrary to the cellular company press releases, the standards goal of 5G is not to create blazingly fast gigabit cellular service.
- The last important improvement is to achieve latency at near-fiber levels. Latency measures a delay in a signal, and today cellular signals have higher latency than fiber connections. This is the primary reason why it often feels sluggish to download a web page on a cellphone.

It's likely to take 7 or 8 years to introduce all of the improvements. The same thing happened with the transition from 3G and 4G and the first true 4G cell site that fully meets the 4G specifications was just activated in late 2018 – even though the cellular carriers have been selling what they call 4G service for a decade. This gradual introduction of the 5G improvements will mean a gradual improvement of 4G technology. In industry lingo, in 5 years we might see enough of the 5G standards implemented that from a technical perspective we'll be at 4.5G. Until then, from a technical perspective, the industry will grow through 4.1G, 4.2G, etc. Even though this will take a decade to be fully implemented, the cellular marketing folks are already making claims about having 5G cellular in 2019.

There are numerous articles on the web that talk about gigabit cellphone speeds. That technology relies on 5G hotspots fed by fiber – a technology that only delivers fast data speeds for less than 1,000 feet. It's hard to think that technology is ever coming to rural America, and probably not even to small town America.

The goal of achieving 100 Mbps cellular speeds is due to a major change in the way that the cellular network functions. Today's network is based upon the idea of roaming. For both voice and broadband purposes today's cellphone makes only one connection at a time to the cell tower that provides the strongest signal (and which has an open slot). 5G introduces a radical change and would allow for a handset to connect to multiple cell sites and draw broadband from each of them. This is done using MIMO (multi-input multi-output) antennas that can make and sustain multiple connections. This is the most difficult 5G challenge to implement in the real world. First, in most of the world there will still only be one or perhaps two cell sites in range of a handset. Faster speeds will only be available in places where the carriers have added numerous small cell sites. In practical terms this means that in most places in the US that cellular data speeds will remain at 4G speeds, even after 5G implementation – any place where a customer can see only one cell site will not get faster broadband speeds. Most rural customers are unlikely to be able to see more than one cell site at any given time.

The cellular companies are also likely to implement 5G in rural cell sites only after they finish urban ones. It would not be unusual to see a 3 – 5-year lag.

Is 5G cellular going to be a competitive threat for a fiber provider? There are several factors to consider in trying to answer that question.

What will be the real speeds? As just stated, the goal of 5G is to achieve 100 Mbps speeds – but in places where there is only going to be one cell tower in reach of a customer, like in rural America, the speeds won't increase much over today's 4G speeds.

Cell phone coverage is wonky. What is never discussed when talking about 5G is how wonky all wireless technologies are in the real world. Distance from the cell site is a huge issue, particular for some of the higher frequencies. More important is local interference and propagation issues. As an example, I live in Asheville, NC. It's a hilly and wooded town and at my house I have decent AT&T coverage, but Verizon sometimes has zero bars. I only have to walk a few blocks to find the opposite situation where Verizon is strong and AT&T doesn't work. 5G will not overcome the inherent topographical and interference issues that affect cellular coverage today.

Will require significant deployment of small cell sites. To achieve the 100 Mbps means deploying several small cell sites in a neighborhood, and that implies bringing fiber into neighborhoods. Many industry experts think this will only happen in business district and selected neighborhoods and that the wireless carriers won't be trying to achieve total 100 Mbps coverage even in cities.

Can the wireless networks handle that much traffic? For cellular to be a challenge to landline broadband means carrying huge amounts of data on the cellular network. A recent study by OpenVault showed that the average US home used 274 Gigabytes of data in the first quarter of 2019 – a number that is growing by 21% annually. Contrast this with cellular usage. Cisco recently reported that the average cellphone today uses 4 GB per month of cellular broadband. That's an average of 6 GB monthly for customers with 'unlimited' broadband plans and 1 GB for customers on measured broadband plans. That usage is growing by 31% annually. Cellular networks are already getting full and it's impossible to believe that those networks could ever carry as much data as households use today per customer, let alone keep up with the ever-increasing home broadband usage.

The conclusion is that rural customers only use cellular broadband when they have no other option. It's expensive and slow. There is no realistic expectation that rural cellular will improve enough, even with 5G to be able to handle the data traffic carried from the average home.

Traditional Point-to-Multipoint Broadband

The second kind of wireless network is a point-to-multipoint data network that is transmitted from one central transmitter to many individual points. This is the technology being used in the county today by companies like MVTV Wireless, LTD Broadband, and Radiolink.

There are several current slices of spectrum that can be used for this purpose and two more that will be coming on the market in the next few years:

- WiFi: WiFi is short for ***wi****reless* ***fi****delity* 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. Many of the wireless carriers in the county are advertising speeds up to 25 Mbps. We know of networks doing speeds up to 75 Mbps. Such a network must have fiber built to the radio transmitters and also can't carry too many customers on a given radio system.

- CMRS Spectrum - 3.5 GHz: The FCC approved in September this year 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.

  The FCC plans to set aside 80 MHz of this spectrum for public use, similar to WiFi and auction 70 MHz of the spectrum in June 2020. In all cases this spectrum is shared with military uses and the military will always get 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 this could go unused, in which case it would boost the speeds for fixed wireless broadband.

  The FCC is also making it a little easier for smaller companies to win some of this spectrum in the coming auction. The spectrum will be 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.

  There are already a few rural carriers using the public portions of the spectrum for fixed wireless service. This spectrum sits in the middle between the two WiFi bands used for fixed wireless today and has great operating characteristics.

  One of the most interesting aspects of the FCC order is that they are allowing non-carriers into the auction and also allowing anybody that wins spectrum to lease it to others. This could be good or bad. It's possible that speculators will go after the spectrum hoping for high lease revenues, which could drive the cost of using the spectrum too high. But it also might give a chance for smaller ISPs to use the spectrum who would not be able to buy licensed spectrum.

- White Space Spectrum: The FCC has been doing trials in what is called white space spectrum. This is spectrum that is 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 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. This extra speed could be combined with spectrum from other bands to create 100 Mbps broadband.

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.

5G Millimeter Wave Point-to-Multipoint Broadband

The newest technology being touted everywhere in the press is 5G broadband using millimeter wave spectrum. If you read many articles about 5G, you'd think that we're on the cusp having wireless broadband brought to most homes in America, providing homes with another option for broadband.

This technology uses millimeter wave spectrum. This is spectrum with extremely high frequencies of 24 GHz and higher. The only other common use of this spectrum has been in the full-body scanners at airports. The primary operating characteristic of millimeter wave spectrum is that the signal doesn't travel very far. Most engineers set the realistic distance of this technology at about 1,000 feet from a wireless transmitter.

Those short distances mean that the technology must rely on the placement of small transmitters on utility poles or street lights. Each transmitter can wirelessly transmit broadband to homes or businesses in the immediate area. Verizon began a trial of the technology late in 2018 in Sacramento and a few other cities and says they are achieving broadband speeds of 300 Mbps – with a hope over time that they can get that up to a gigabit.

The biggest impediment to the business plan is that it requires building fiber along each street served, making the cost at least as much as building fiber-to-the-home. The cost of putting fiber on poles can be expensive if there are already a lot of other wires on the poles (from the electric, cable, and telephone companies). In neighborhoods where other utilities are underground the cost of constructing fiber can be even higher. Another challenge for the technology is that the millimeter wave spectrum requires a clear path between the transmitter and a dish placed on the home – and that means that 5G is best deployed on straight streets without curves, hills, or dense tree cover.

The technology is only going to make financial sense in a few circumstances. This means neighborhoods without a lot of impediments like hills, curvy roads, heavy foliage or other impediments that would restrict the performance of the wireless network. This means not building in neighborhoods where the poles are short or don't have enough room to add a new fiber. It means avoiding neighborhoods where the utilities are already buried. An ideal 5G neighborhood is also going to need significant housing density, with houses relatively close together without a lot of empty lots.

This technology is also not suited to downtown areas with high-rises; there are better wireless technologies for delivering a large data connection to a single building, such as the high bandwidth millimeter wave radios used by Webpass. 5G technology also is not going to make a lot of sense where the housing density is too low, such as suburbs with large lots. 5G broadband is definitely not a solution for rural areas where homes and farms are too far apart.

Not all Wireless Technologies Are the Same

Since the county has fairly ubiquitous wireless broadband in the rural areas it's important to understand that there are different wireless technologies and not all are adequate for rural broadband. There are a number of factors that are needed to provide a quality wireless broadband connection:

- **Age of Technology**. The wireless technology deployed in the industry has made huge strides in recent years. Radios that are just a few years old do not have the same capacity as radios that can be purchased today. And even today it's possible to still buy radios with reduced capability since the best radios are significantly more expensive.

- **Using Multiple Frequencies**. One reason that the newest radios perform better is that they are capable of using multiple bands of frequency. For example, a typical radio might be able to use spectrum bands including 2.4 GHz, 3.5 GHz, and 5.0 GHz. This allows better performance for several reasons. First, each frequency band has different operating characteristics in terms of distance and ability to penetrate obstacles. Having multiple frequencies available means an increased opportunity to find a good solution for each customer on the network. But probably even more importantly, the best radios can bond together multiple frequencies to the same customer. This means that they can get the full bandwidth capacity of multiple frequencies added together into one broadband connection.

- **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**. Even when a tower gets great bandwidth, there can be obstacles in the wireless last mile that can limit customer bandwidth. Most of these technologies require a line of sight, meaning that there has to 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 with rain or snow storms blocking some of the signal. The classic anecdote from wireless technicians is from a slow broadband connection caused by a pigeon or crow sitting in front of a customer antenna dish.

DSL and Copper Technology

The biggest telephone companies in the county, such as Consolidated, CenturyLink, and Frontier, are using DSL (Digital Subscriber Line) to deliver broadband. DSL works by using the higher frequencies that are available on a piece of copper wire. These frequencies are not used for voice service. DSL is used to provide an Ethernet data path over the copper that can be used to deliver customer broadband 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 important characteristic of DSL is that customer data speed decreases with the distance the signal travels.

The general rule of thumb is that DSL can deliver a decent amount of bandwidth for about 2 to 2.5 miles over copper. The vast majority of people in the rural areas of the county are more than 2 miles from a town; they are thus able to get only very weak and slow DSL if they're able to get any DSL at all. The large telcos will sometimes sell DSL with speeds that are barely faster than dial-up.

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 networks in the county are likely to be 50 – 70 years old or even older and have outlived their original expected service life.

Hybrid Fiber Coaxial Network

There are two companies that operate Hybrid Fiber Coaxial (HFC) networks in the county – Charter and Mediacom. 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. 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 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.

An HFC system handles delivery of customer services differently than an all-fiber network. For example, in an HFC network, all of the cable television channels are sent 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 of the customers in a given node share the data available to that node. This means that the numbers of customers sharing a node is a significant factor—the smaller the node the stronger and more reliable the data product. Before cable systems offered data services, 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 each node. It is this node-sharing that has 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 have to occur.

The amount of data that is available at a given node is a function of how many "channels" of data the cable company has dedicated to data services. Historically a cable network was used only for television service, but in order to provide data services the cable company had to find ways to create empty channel

slots that no longer carry programming. Most cable systems have undergone a digital conversion, done for the purpose of freeing up channel slots.

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. The cable networks in the county have used the DOCSIS 3.0 standard that allows them to bond together enough channels to create data products as fast as about 250 Mbps download. However, there is now 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 8–10 Gbps if a network carried only data and had zero television channels.

The one big data limitation of a DOCSIS network is that the standard does not anticipate symmetrical data speeds, meaning that download speeds are generally much faster than the upload speeds. This is not an issue for most customers, but it does give a fiber network a marketing advantage and there are customers who care about upload speeds. If an HFC network wanted to offer gigabit upload speeds they would need to dedicate an additional 24 empty channels just for the upload, something nobody is ever likely to do.

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 cascaded amplifiers on a coax route to 5 or less. They will want fewer amplifiers if they are trying to deliver top data speeds. As more amplifiers are added the data speeds drop, and so HFC networks are not a great technology for extending broadband into rural areas.

Improved Satellite Technology

There are several major companies planning on providing 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 22,000 miles above the earth. 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 TV broadband 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 fleet of satellites so that there is always one in the sky over a given customer.

Elon Musk and his company SkyLink have the early lead. The company launched two test satellites in 2018 and launched 60 satellites in May of 2019. Earlier this year the FCC established a rule where an operator must deploy satellites on a timely basis in order to keep exclusive right of the spectrum needed to communicate with the satellites. Under the current FCC rules, a given deployment must be 50% deployed within 6 years and completely deployed within 9 years. The company recently revised its launch scheduled with the FCC for the first phases of launches with the following schedule.

	Satellites	Altitude (Km)	50% Completion	100% Completion
Phase 1	1,584	550	March 2024	March 2027
	1,600	1,110		
	400	1,130		
	375	1,275		
	450	1,325		
Phase 2	2,493	336	Nov 2024	Nov 2027
	2,478	341		
	2,547	346		
	11,927			

This is an incredibly aggressive schedule and would require launching 120 satellites per month starting in November 2019 just to meet the 50% completion goal. Starlink also recently filed plans with the International Telecommunications Union (ITU) to launch an additional 30,000 broadband satellites in addition to the 11,927 now in the planning stages. The 20 new filings request to deploy 1,500 satellites each in 20 different orbital bands around the earth. These filings are clearly laying down the gauntlet for other planned satellite providers. Nobody knows if Starlink is serious about the huge number of planned satellites or if this is a play to gain more favorable regulatory rules around the world for spectrum.

The other company with six test satellites already launched is OneWeb, founded by Greg Wyler of Virginia in 2012. The company includes other investors like Virgin, Airbus, SoftBank, and Qualcomm. The company's plan is to launch an initial constellation of 650 satellites that will blanket the earth, with ultimate deployment of 1,910 satellites. They plan to deploy 30 of the 65-pound satellites with each

launch. That means 22 successful rocket launches are needed just to deploy the first round. The company is doing a polar orbit instead of an equatorial orbit and plans to start its marketing effort in Alaska.

Another interesting entrant into the market is Jeff Bezos and Amazon. They recently filed plans to enter the business and filed with the FCC under the name of Kuiper Systems LLC. Amazon has big plans and the FCC filing said the company wants to launch a constellation of 3,236 satellites in low earth orbit. That's 784 satellites in orbit at 367 miles above earth, 1,296 in orbit at 379 miles, and 1,156 in orbit at 391 miles. Like Elon Musk, Jeff Bezos also owns Blue Origins, which has developed an orbital-class rocket called the New Glenn.

We still know nothing about proposed broadband speeds or prices. Elon Musk recently acknowledged that he is likely to limit his business to serve only rural areas where he can charge a premium price. OneWeb recently provided a clue about the capacity of the satellites when it asked the FCC for permission to eventually create one million links to earth-based receivers, meaning customers. That's a good indication that the satellite providers in total are going to be able to serve perhaps a few million customers in the US. They are likely to limit their business to rural areas where they can command a premium price, not trying to bring broadband to every rural customer.

Skeptics are doubting if the 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 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 now 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 BUSINESS PLAN ANALYSIS

The goal of the financial analysis was to see if there is a way to profitably extend fiber to the rural parts of the county.

A. Business Plan Key Assumptions

This section of the report looks at the detailed assumptions that were made in creating the financial business plans. The business plans created are detailed and contemplate all aspects of operating a broadband network in the county. The business plan assumptions used in the forecast include our best estimate of the operating characteristics for such a business. As a firm, CCG consults to hundreds of communications entities that operate triple-play businesses. We not only work with clients to develop original business plans, but we work with them to help maximize profits with existing businesses. This has given us a lot of insight into how triple-play businesses work and we are experienced in how businesses really operate under all sorts of conditions. We believe that the financial results shown in these models are characteristic of similar operations elsewhere and we believe our assumptions are realistic.

The primary goal of these business models is to look at the various scenarios from the perspective of an ISP that would operate the business. We have created a few scenarios that contemplate municipal bond financing and a municipal ISP, but that was done mostly to demonstrate that in these rural scenarios that it's significantly more efficient for customers to be served by an existing ISP than by a new one created just to serve the county.

Since the county doesn't want an ISP the purpose of these models is to provide a way for ISPs to understand the broadband opportunities in the county. We've learned with experience that almost every ISP is theoretically interested in expanding and in partnering with a county that needs broadband. However, no ISP is really interested 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, which is the first step needed to find ISP partners.

Following are some of the key assumptions that were used in all of the scenarios studied:

Incremental Analysis

It's important to note that all of the projections were done on an incremental basis. This means that the studies only consider 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 the costs.

It's important to understand what an incremental analysis shows and does not show. An incremental analysis is basically 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.

An incremental analysis is not the same as a prediction of what the accounting books of the new venture might look like. For example, if one of the existing telcos 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 telco would be allocated to the venture in the accounting books. However, the cost of the salary of the general manager is not considered in an incremental analysis. 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 to the telco of entering the new market since the allocation of this expense would improve the financial performance of the existing business and would then not be considered when looking at the new venture.

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 three scenarios anticipate that the first customers will be added to the new networks in April of the second year after starting the project. It might be possible add some customers in the fall of the first year with careful planning and a smart construction plan.

Following are the major milestones as predicted by these forecasts:

- Financing: All of the forecasts assume that the financing is available in January 2020. This is illustrative only and basically establishes a starting date for the project—this could be changed to any other future date as needed.
- Construction: Fiber construction is done during the summer and fall of the first year. Core construction of the network is done in the summer during the spring and summer after financing. In the fiber everywhere scenario construction carries through the second year.

Revenue Assumptions

It has been our experience in recent years that new broadband businesses in rural markets do not need to offer low prices to get customers. Faster broadband and good customer service are the keys to success for areas that have not had adequate broadband before. Thus, for purposes of the study we tried to set broadband prices at market rates, meaning the rates that are similar to what is being charged in the county today. In highly competitive markets it's sometimes necessary for a new competitor to lower rates to get customers. But this study looks at rural markets where customers have few broadband alternatives and the goal should be to deliver a quality product at a fair price and not try to gain market share with big discounts.

As was described earlier, there are a few existing telephone companies already operating in the county. We considered the rates of the telephone companies as well as the broadband offered by the cable companies. The suggested pricing used in the studies somewhat averages the prices offered today by BevComm and by Christensen Communications. Those rates are representative of the rates we see in other parts of rural Minnesota.

In the all-fiber scenario, we assumed the delivery of the normal triple play of video, voice, and high-speed data. We also assumed that the products would be as simple as possible. As an example, the incumbent telephone companies in the county offer a wide range of different kinds of telephone products. We assumed that a new business would offer only a few options. For instance, for residential service we have assumed only a basic telephone line and a telephone line with unlimited long distance.

Telephone Rates

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

Basic Local Line	$20.00
Line with Unlimited Long Distance	$30.00

We've assumed 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.

Our assumption in the study is that the basic line would have the same limited local calling scopes that exist in the county today, as described below. This shows that the amount of free calling varies widely across the county with customers in some parts of the county having free calling to most of the county while other parts of the county have almost no free calling available.

Exchange	Phone Company	Can Call for Free
Amboy	Consolidated	Cambria, Eagle Lake, Garden City, Good Thunder, Lake Crystal, Madison Lake, Mankato, Mapleton, Pemberton, St. Clair, Vernon Center
Cambria	Consolidated	Amboy, Eagle Lake, Garden City, Good Thunder, Lake Crystal, Madison Lake, Mankato, Mapleton, Nicollet, Pemberton, St. Clair, St, Vernon Center
Delavan	Bevcomm	Blue Earth, Bricelyn, Easton, Elmore, Freeborn, Frost, Guckeen, Huntley, Minnesota Lake, Stevens IA, Wells, Winnebago
Eagle Lake,	Consolidated	Amboy, Cambria, Garden City, Good Thunder, Lake Crystal, Madison Lake, Mankato, Mapleton, Pemberton, St. Clair, Vernon Center
Garden City	Consolidated	Amboy, Cambria, Eagle Lake, Good Thunder, Lake Crystal, Madison Lake,

		Mankato, Mapleton, Pemberton, St. Clair, Vernon Center
Good Thunder	Consolidated	Amboy, Cambria, Eagle Lake, Garden City, Lake Crystal, Madison Lake, Mankato, Mapleton, Pemberton, St. Clair, Vernon Center
Janesville	Frontier	No free calling
Lake Crystal	Consolidated	Amboy, Cambria, Eagle Lake, Garden City, Good Thunder, Madison Lake, Mankato, Mapleton, Pemberton, St. Clair, Vernon Center
Lewisville	Frontier	Truman
Madelia	Christensen Comm	St James
Madison Lake	Consolidated	Amboy, Cambria, Eagle Lake, Garden City, Good Thunder, Lake Crystal, Mankato, Mapleton, Pemberton, St. Clair, Vernon Center
Mankato[3]	Consolidated	Amboy, Cambria, Eagle Lake, Garden City, Good Thunder, Lake Crystal, Madison Lake, Mapleton, Nicollet, Pemberton, St. Clair, St. Peter, Vernon Center
Mapleton	Consolidated	Amboy, Cambria, Eagle Lake, Garden City, Good Thunder, Lake Crystal, Madison Lake, Mankato, Pemberton, St. Clair, Vernon Center
Minnesota Lake	Bevcomm	Blue Earth, Bricelyn, Delavan, Easton, Elmore, Freeborn, Frost, Guckeen, Huntley, Stevens IA, Wells, Winnebago
New Ulm[4]	Nuvera	Lafayette
Pemberton	Consolidated	Amboy, Cambria, Eagle Lake, Garden

[3] Mankato calling scope also includes the areas of Judson, North Mankato, Rapidan, and Skyline

[4] The New Ulm area includes Courtland, Essig, Klosser, and Searles

		City, Good Thunder, Lake Crystal, Madison Lake, Mankato, Mapleton, St. Clair, Vernon Center
St Clair	Consolidated	Amboy, Cambria, Eagle Lake, Garden City, Good Thunder, Lake Crystal, Madison Lake, Mankato, Mapleton, Pemberton, Vernon Center
Truman	Frontier	Fairmont, Lewisville
Vernon Center	Consolidated	Amboy, Cambria, Eagle Lake, Garden City, Good Thunder, Lake Crystal, Madison Lake, Mankato, Mapleton, Pemberton, St. Clair
Waldorf	CenturyLink	New Richland

Customers buying the unlimited long-distance plan 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 study is less specific with business phone rates. In the models we have assumed an average monthly telephone revenue per business of $50 per business customer.

Cable TV Products

Offering competitive cable TV in a new rural market is a challenge. In the rural areas today the only realistic option for cable TV is satellite. There may be a few customers included in this study that can get TV over DSL from Consolidated. There are around 12 channels of HD programming available over the air for free in parts of the county, provided by local or regional television stations.

It's nearly impossible for a small ISP to compete on price with the current TV providers. Small companies that offer TV generally have significantly higher prices.

The study assumes that cable TV would be provided to customers that are served by fiber in the various scenarios. It's not assumed that customers on fixed wireless will be able to receive TV over broadband. It's further assumed that the ISP offering the cable TV product would be buying it wholesale from one of the national providers or from one of the local telcos.

The study assumed a 3-tier cable TV product with the following prices:

Basic TV	$35

Expanded Basic TV	$75
Premium Digital TV	$95

For simplicity the models do not forecast future rate increases although it's almost certain the cable rates are likely to increase every year. The studies all hold both the rates and the cost of buying programming the same, which implies that an ISP would pass all programming rate increases along to customers.

The study assumes that customers could also buy premium movie channels like HBO, Cinemax, and Starz! although it's not likely that many sales would be made since these products are now widely available on the web.

Finally, the studies assume that the ISP would lease settop boxes to customers for $5 per month – a rate significantly lower than the big cable companies. That's likely to be the biggest differentiator between a small company cable product and a large company.

The studies assume that most customers either keep satellite TV or else begin buying programming online from the many cable alternatives like DirecTV Now, Sling TV, Playstation Vue, etc. The studies predict that cable penetration rates peak at 12% penetration and over time drop to 7%.

There is a lot of discussion among small ISPs about offering cable TV. Several small telcos that have traditionally offered cable have dropped the product. But other small ISPs believe that a cable product is still needed to attract at least some portion of the residential market that prefer to buy all of their services from one provider.

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 might be something like 100 Mbps, 250 Mbps, and 1 Gbps.

The fixed wireless broadband products are also shown in three tiers. These speeds would be a lot slower and might be something like 10 Mbps, 25 Mbps, and 50 Mbps.

	Price	Percentage
Residential Fiber Broadband		
Tier 1	$ 60.00	80%
Tier 2	$ 75.00	17%
Tier 3	$ 90.00	3%
Business Fiber Broadband		
Tier 1	$ 75.00	75%
Tier 2	$ 90.00	15%
Tier 3	$105.00	10%

Residential Wireless Broadband		
Tier 1	$ 60.00	45%
Tier 2	$ 75.00	40%
Tier 3	$ 90.00	15%
Business Wireless Broadband		
Tier 1	$ 75.00	40%
Tier 2	$ 90.00	40%
Tier 3	$105.00	20%

Most ISPs charge more to businesses for broadband, and we've elected a $15 additive to business rates.

We note that there are a lot of different broadband pricing philosophies among small ISPs. The above pricing stream is what might be described as middle-of-the-road. Some pricing schemes provide some slow broadband products at low prices to satisfy customers that are price conscious. Some ISPs offer a wide range of speeds and might offer six different speeds. Another common pricing scheme is to only have one or two broadband products and make them fairly expensive. As will be demonstrated later in this report when looking at the sensitivity analysis, the prices charged for broadband are one of the most sensitive variables in this model. It would be important to understand the impact to the bottom line if considering a different pricing scheme.

It's been the experience of the industry that customers will buy the lowest speed product they are comfortable with in order to save money. The table above shows the assumptions about the percentage of customers who will buy each product. This shows that for fiber broadband that most customers would be happy with the lowest priced product as long as it is fast enough to satisfy their needs. The situation is different for wireless broadband since many households are likely to find the slowest speeds offered to be inadequate to meet their needs.

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 encoded 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. It would be surprising if there are any businesses in the rural parts of the county that would ask for dedicated broadband. It's not easy to offer a dedicated broadband product with fixed wireless without using a separate radio. Most wireless providers don't offer this option.

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. The only provider in the county today with a data cap is CenturyLink DSL, but it's been widely reported that the company often doesn't bill for data overages.

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 the community that will buy 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 of 60% as the starting point of our analysis. CCG has witnessed the construction of broadband in a number of 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 60% as a starting point for the analysis as a rate that we think is reasonably conservative.

Blue Earth County will be an interesting broadband market in a few years. There are a number of fixed-wireless providers today that advertise rates as fast as 25 Mbps. We assume that most customers can't achieve those speeds, but there are probably some who can. Two wireless providers – LTD Broadband and MidCo – received federal grants to provide faster wireless broadband. The grants require that customers be able to receive the speeds guaranteed in the grants. LTD guaranteed speeds of 25 Mbps and MidCo got a grant for 100 Mbps. If those companies are able to achieve those speeds, then the penetration rate on fiber might be lower than in some other rural markets with fiber since some customers might buy the wireless products if they cost less than fiber.

For the more promising scenarios we also calculated what we call the breakeven penetration rate. This calculates the number of customers that are needed for a project to reach cash breakeven – where the business would always be able to pay for operating expenses, debt, and the ongoing capital needed.

The only real way to understand the potential broadband penetration rate would be to do a residential survey or a canvass to quantify the potential customer interest in buying broadband from a new network. 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 any ISP interested in the county will want to understand the demand for rural broadband, and so we are recommending that the county consider a survey as a follow-up to this report.

Since there are so many residents of the county today without good broadband there are a lot of potential customers for an ISP that builds broadband in the county. The new customers assumed by the end of the fourth year as are follows for the three primary scenarios:

<u>Fiber Everywhere</u>	
Residential Customers	3,759
Business Customers	92

<u>Hybrid Fiber / Wireless</u>

Residential Customers	2,549
Business Customers	89
Small Town Fiber	
Residential Customers	1,339
Business Customers	85

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 from using obsolete or poorly placed WiFi routers in the home. A poor WiFi router translates to a poor broadband product.

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 can use the devices to help customers connect new devices 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.

In the study we assumed monthly rates for managed WiFi to be $7.00 for residences and $10.00 for businesses. We further assumed that 70% of residents would buy this product and 80% for businesses.

Other Future Revenues

The studies don't predict any revenues from future products, although there is a good likelihood that small ISPs will provide additional products over fiber. Already today we see small ISPs offering:

- Security: This is burglar alarms, motion detectors, smoke and CO2 detectors, and other devices to create a home security suite.
- Home Automation: We see companies now offering the service of connecting Internet of Things devices. This might include surveillance cameras, smart thermostats, smart lighting, watering systems, smart door locks, and other devices that automate the home or office.

There will probably be future products such as connections maximized for gaming, connections maximized for medical monitoring, connections maximized for virtual or augmented reality.

Expense Assumptions – ISP Operator

As a reminder, unless otherwise noted, all scenarios are created from the perspective of a small ISP offering the services. There is one scenario that compares small ISPs to a municipal ISP. The assumptions listed below are for the small ISP scenarios.

The following assumptions also assume that the same ISP owns the network and operates the business.

Expense Assumptions

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's often 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 for an existing ISP. 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 35% 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 the business will require the following new positions:

Fiber Everywhere	3 new CSRs
Hybrid Fiber / Wireless	2 new CSRs
Small Town Fiber	1 new CSR

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 the business will require the following new positions:

Fiber Everywhere	3 new technicians
Hybrid Fiber / Wireless	3 new technicians
Small Town Fiber	2 new technicians

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. The all-fiber scenario is large enough that some ISPs might hire an additional marketing person for this opportunity.

We anticipated that construction contractors will build the fiber network. We've also assumed that customer installations will be outsourced during the construction process and for the first few years

thereafter. However, once the bulk of customers has been added the forecasts assume that future installations will be done by company technicians.

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 three scenarios we've assumed the start-up costs are $150,000.

Sales and Marketing Expenses: Every scenario is going to require a significantly high customer penetration rate to be successful. We used the assumption that there would be a marketing effort to sign customers (instead of the word-of-mouth that often happens in rural markets). 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 such money would be spent earlier than shown in the model. There have been rural start-ups that have been able to sign up customers using community volunteers, so it's possible that the marketing costs could be lower than assumed in the models.

The marketing budget for the first 4 years of operations for the three scenarios are as follows:

Fiber Everywhere	$268,000
Hybrid Fiber / Wireless	$200.000
Small Town Fiber	$150,000

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 the county likely is already buying and providing these products to customers.

The studies assume that a wholesale basic telephone line can be purchased wholesale at $3.50 per month. A line with unlimited long distance is assumed to be $6.50.

The studies assume that cable TV programming is 95% of the cost of the retail product. This is not strictly true, but the all-in incremental costs of buying a wholesale cable TV product normally are close to the retail prices charged.

Maintenance Expenses: There are a number of 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 was 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 $2 per customer. This function could be provided by ISP employees, in which case this cost would cover new employees, or this function could be outsourced.

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 was operated as a municipal business or as a nonprofit.

We have assumed no property taxes on assets, but it's possible that some amount of this 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. We've not included property tax on the fiber since we've not encountered this anywhere else in Minnesota.

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 directly 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 various 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 also accounting standard practices. Soft assets like software are instead amortized, using the same process as depreciation.

Expense Assumptions – Municipal Operator

Included in the analysis is one look at how the business would operate if it was municipally owned and operated. From an expense perspective, the primary difference between the municipal business and one operated by an ISP is staffing.

On an incremental basis and ISP is only likely going to have to add customer service representatives and outside technicians. An ISP is likely already going to have the staffing that can cover other functions.

However, if the County was to tackle this project there would be several additional hires required to make this work. At a minimum that would include:

- A general manager
- A marketing person
- An inside technician to take care of electronics
- Perhaps a part time billing person

Additionally, the salary loadings for municipalities (taxes and benefits) are usually higher than those for commercial ISPS, adding additional labor expense.

A municipal operator will likely have several other additional expenses such as:

- The need to buy a billing software platform. This might not be needed if there is an existing platform to bill water or electricity.
- A municipality likely doesn't already have a transport pipe to reach the Internet and will incur the new cost of transport.
- A municipality likely will have higher start-up expenses as part of establishing a new ISP.

Some of these extra expenses might be offset to some extent due to a lower interest rate on debt – but that depends on the amount of borrowing needed.

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:

- The models contain no "home run" revenues. These would be sales of larger broadband products such as selling bandwidth to the local schools. We know that every fiber business gets some of this kind of revenue, but we took the conservative approach of not showing it because we can't guess how much and when such opportunities might occur. We try to avoid predicting such revenues since it's possible they will never materialize.
- The engineering estimates include an 8% contingency on the fiber everywhere scenario and 5% contingency on the other two scenarios. We think the estimates of construction costs are solid and this contingency might not be needed.
- If the network is constructed by "edging out" from existing telcos, there could be some savings for ISPs in the cost of building fiber.
- 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, it is possible that upgrades will be needed less often than we have shown. Further, our assumption is 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 the new business could take to improve upon these projections.
    - Preselling: We've seen service providers that are able to get earlier revenues when they presell to customers. This gives them the opportunity to begin connecting the network to the homes of presold customers while the network is being built. This would allow customers to be turned on in "nodes" or neighborhood-by-neighborhood as construction to specific parts of the county was completed.
    - More Concentrated Build Schedule: It's always possible to build faster than shown in these forecasts if the ISP is able to execute on a faster construction schedule. The amount of network that can be built in a given time period increases by adding more construction crews.
    - Get Temporary Help: There are often other bottlenecks at small companies that can slow down customer installations. This could mean the need for more sales and marketing staff, additional customer service reps, or inside technicians needed to provision new customers. Service providers should strongly consider using temporary employees during the roll-out of a major new market.

B. Business Plan 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 the life of the plan as well as at the years when each plan achieves positive net income and debt breakeven. Those two new terms are defined as follows:

> **Positive Net Income**: The year when the business shows a positive profit defined in the normal accounting sense. This uses the taxation and public accounting definition of profitability and

includes depreciation and amortization, which are not cash expenses. The net income also does not consider repayment of debt principle and annual operating capital. Reaching positive net income is an important milestone for a new business and is one of the ways that the public will judge your success. Just note, though, that the business can have a positive net income and still not have enough cash to operate the business. But it's even more common for an asset-intensive business like this one for a business to reach positive cash flow but still have a negative net income—due almost entirely to depreciation expense on the network, which is a non-cash expense.

Debt Breakeven: The year when the business has generated enough excess cash that would enable the retirement of the remaining debt. Many loan and bond covenants don't allow excess cash from a business to be used for anything else, like dividends, until the debt has been retired.

The way to measure profitability in a new business is going to 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 for-profit business would generally use something like net income to measure profits.

It is important that a business always has cash in the bank to meet its obligations. In this particular business plan the ideal situation would be to always have at least $300,000 in the bank to have a cushion against nonlinear monthly expenditures. Not all expenditures are spent evenly throughout the year and a business must maintain a cash cushion to allow for those times of the year when the expenses are higher than normal or when the revenues are lower than normal.

Following are the results of the various scenarios. Note that a table of all of the financial results is included in Exhibit VI. That Exhibit makes it easier to compare different scenarios.

Fiber Everywhere Scenario – Without Bevcomm & Nuvera

Following are the results of the financial analysis for an ISP building fiber everywhere:

Commercial Financing for an ISP

	No Grant	With DEED Grant	With RDOF Grant	With Both Grants
Asset Costs	$35.23 M	$38.23 M	$35.23 M	$35.23 M
Grant	$ 0.00 M	$ 5.00 M	$18.00 M	$23.00 M
Equity	$ 5.95 M	$ 5.04 M	$ 4.71 M	$ 3.79 M
Bank Debt	$33.73 M	$28.55 M	$26.68 M	$21.48 M
Total Financing	$39.68 M	$38.59 M	$49.38 M	$48.26 M
Passings	6,307	6,307	6,307	6,307
Penetration Rate	60%	60%	60%	60%
Years until Positive Net Income	Year 17	Year 17	Year 13	Year 13
Years until Cash Covers Debt	Never	Never	Year 19	Year 13
Cash after 20 Years	(-$20.51 M)	(-$12.87 M)	$1.96 M	$10.59 M

What do these results tell us?

- Here are the key assumptions included in these scenarios:
  - This covers the rural study area served by Consolidated, Frontier, and CenturyLink less a few towns that have a cable provider. The Bevcomm and Nuvera areas are not included in these scenarios.
  - Fiber built to pass every home and business in the serving areas.
  - Assumes an ISP owns the network and operates the business.
  - This is financed with traditional bank loans that require 15% of the project to be funded with equity. That would mean that whoever builds this will need to bring between $4 million and $6 million in cash to the project in order to secure the needed loan. That requirement might eliminate a lot of ISPs from consideration – surprisingly few ISPs carry that much free cash.
  - The loans have a 20-year term and assume a 5.5% interest rate. We assume that there would be no principle payments required for the first 3 years. A bank would consider these to be a construction loan and generally charges interest only during the construction period.
- This project is not feasible with no grant money or even with a $5M state DEED grant. An ISP is going to need to secure a second federal grant to make this work. DEED and RDOF grants will be explained in more detail in the discussion on financing.
- The rural project is feasible with enough grant money. It would be challenging for an ISP to get as much grant funding as shown above – the amounts used probably represent the highest amount of grant funding that is possible. The analysis shows that combination of state and federal grants totally $18 million would create a small cash positive scenario.

County as the ISP - Bond Financing

This scenario examines the financial viability of the county serving as the ISP. We know that is not the county's preference, but we thought it would be informative to understand how the project might look if it was funding using municipal bonds. We've seen other projects in the state where some portion of a large fiber project has been funded with municipal bonds.

	No Grant	With DEED Grant	With RDOF Grant	With Both Grants
Asset Costs	$35.52 M	$35.52 M	$35.52 M	$35.52 M
Grant	$ 0.00 M	$ 5.00 M	$18.00 M	$23.00 M
Bond Debt	$48.10 M	$41.40 M	$28.00 M	$25.00 M
Total Funding	$48.10 M	$46.40 M	$46.00 M	$48.00 M
Passings	6,307	6,307	6,307	6,307
Penetration Rate	60%	60%	60%	60%
Years until Positive Net Income	Never	Never	Never	Never
Years until Cash Covers Debt	Never	Never	Never	Year 25
Cash after 20 Years	(-$37.85 M)	(-$28.56 M)	(-$ 7.10 M)	$0.90 M

As can be seen, financing with municipal bonds doesn't look easily feasible. Even with maximum state and federal grants this scenario barely breaks even with cash. In each case the project does much worse financially with municipal funding instead of commercial funding. This is due almost entirely to the difference in the cost of debt.

Cost of Bond Financing: While bond financing can have a relatively low interest rate it can still be significantly more expensive than traditional bank financing. Consider the following summaries of the cost components of the bonds listed above:

	No Grant	With DEED Grant	With RDOF Grant	With Both Grants
Asset Costs	$35.52 M	$35.52 M	$35.52 M	$35.52 M
Working Cash	$ 2.40 M	$ 2.07 M	$ 4.53 M	$ 2.16 M
Debt Service Reserve Fund	$ 3.32 M	$ 2.86 M	$ 1.93 M	$ 1.72 M
Capitalized Interest	$ 6.13 M	$ 5.28 M	$ 3.57 M	$ 3.19 M
Cost of Issuance	$ 0.69 M	$ 0.61 M	$ 0.44 M	$ 0.40 M
Rounding	$ 0.03 M	$ 0.06 M	$ 0.00 M	$ 0.00 M
Cost of the bond:	$48.10 M	$41.40 M	$28.00 M	$25.00 M
Grant	$ 0.00 M	$ 5.00 M	$18.00 M	$23.00 M
Total Financing	$48.10 M	$46.40 M	$46.00 M	$48.00 M

This demonstrates that the size of the debt is much larger for a municipal bond compared to commercial financing. This is due to several issues:

- Equity. Municipal bonds don't require equity (and municipalities almost never offer any) meaning that bonds are 100 debt financed.
- Working Cash. Since bonds are all borrowed up-front at the beginning of a project, there needs to be a borrowing the cash needed to cover early operating expenses that are incurred until the project creates enough revenues to cover expenses.
- Debt Service Reserve Fund (DSRF). Most bonds for fiber projects are revenue bonds and the buyers of bond issues think fiber is a somewhat risky bond offering. This means the bond borrowers are likely to require a DSRF equal to 1 year of bond payments as a safety net in case the municipality has trouble making the bond payments.
- Capitalized Interest. Bondholders begin earning interest as soon as the bonds are generated. This requires borrowing interest up front in order to make those payments before the project has revenues. In these examples the assumption is that the interest payments for the first 3 years are borrowed.
- Cost of Issuance. There is a significant cost incurred to issue bonds that includes attorneys, consultants, and fees for the companies that sell the bonds.
- Note that the amount of borrowing is larger for the scenarios with federal grants. This is due to the fact that the specific RDOF grant assumed is paid to the grant winner over 10-years. This requires some additional borrowing up front to cover the early cash needs of the business before the grant fund are received.

It's also worth mentioning again that the scenarios above include additional labor that would be required for a municipally operated ISP business compared to a commercial ISP.

Sensitivity Analysis

Each of the above financial forecasts is based upon numerous assumptions, but only a few of the assumptions have the potential to significantly change the results of the analysis. For example, the results of the studies would change only slightly by changing the assumed salary of one of the new employees. But the study results would change more from changing the interest rates on debt financing.

Following are the sensitivity results for the fiber everywhere scenario. This analysis begins in each case by comparing to the base case that included an RDOF grant.

Changing Customer Penetration Rate: The following shows the impact of increasing the customer penetration rate from 70% to 80%.

Effect of this Change

	Base Case	Revised
Asset Costs	$35.23 M	$36.57 M
Grant	$18.00 M	$18.00 M
Equity	$ 4.71 M	$ 4.84 M
Bank Debt	$26.68 M	$27.45 M
Total Financing	$49.38 M	$50.29 M
Passings	6,307	6,307
Penetration Rate	60%	70%
Years until Positive Net Income	Year 13	Year 13
Years until Cash Covers Debt	Year 16	Year 16
Cash after 20 Years	$1.96 M	$9.12 M

As would be expected, adding customers increases the needed capital (cost of the electronics and drops needed to add them to the network), and this increases the needed amount of financing.

The bottom-line impact to cash is an increase in cash flow over 20 years of $7.16 million, or $716,000 increase for every 1% increase in customer penetration.

Paying a Higher Interest Rate: This looks at the impact of increasing the interest rate by 50 basis points from 5.5% to 6.0%.

Effect of this Change

	Base Case	Revised
Asset Costs	$35.23 M	$35.23 M
Grant	$18.00 M	$18.00 M
Equity	$ 4.71 M	$ 4.76 M
Bank Debt	$26.68 M	$27.00 M
Total Financing	$49.38 M	$49.76 M

Passings	6,307	6,307
Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 16
Years until Cash Covers Debt	Year 19	Year 21
Cash after 20 Years	$1.96 M	(-$0.23 M)

As would be expected, a higher interest rate reduces long-term cash flow. In this case, increasing the interest rate by one-half of a percentage (50 basis points) lowers the cash generated over 20 years by $2.19 million.

Increasing Customer Prices: In this scenario, the broadband prices are increased by $5 per month for both residents and businesses.

Effect of this Change

	Base Case	Revised
Asset Costs	$35.23 M	$35.23 M
Grant	$18.00 M	$18.00 M
Equity	$ 4.71 M	$ 4.65 M
Bank Debt	$26.68 M	$26.38 M
Total Financing	$49.38 M	$49.03 M
Passings	6,307	6,307
Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 13
Years until Cash Covers Debt	Year 19	Year 16
Cash after 20 Years	$1.96 M	$6.97 M

This shows that the business is sensitive to prices. In this case, increasing the price of the broadband products by $5 increases the cash by a little more than $5 million over 20 years.

This raises the question of the right pricing for broadband. In order for the broadband product to be competitive it has to be reasonably priced below the competition. However, if broadband is underpriced it has a big negative impact on cash flow.

Today the fastest broadband products in the rural parts of the county are fixed wireless. The fastest products from those competitors range from $70 to $100 per month for speeds that range from 25 Mbps to 30 Mbps.

The base analysis for this study set the base broadband price at $60 per month for 100 Mbps symmetrical on fiber. It would not be unreasonable to set the base price at $65 based upon the market rate – and as this analysis shows that would add a lot of cash to every scenario being considered.

Eliminating the Construction Contingency: This examines the impact of decreasing capital expenditures. Specifically, this shows the impact of not having to spend the construction contingency, which is approximately $1 million. But the impact would be identical for reducing capital by that same amount for any other reason.

Effect of this Change

	Base Case	Revised
Asset Costs	$35.23 M	$33.57 M
Grant	$18.00 M	$18.00 M
Equity	$ 4.71 M	$ 4.41 M
Bank Debt	$26.68 M	$24.98 M
Total Financing	$49.38 M	$47.38 M
Passings	6,307	6,307
Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 13
Years until Cash Covers Debt	Year 19	Year 17
Cash after 20 Years	$1.96 M	$5.09 M

This shows that lowering capital expenditures by $1.66 million improves the cash flow over 20 years $3.13 million. That equates to improving cash flow by almost $1.9 million for every million that can be eliminated from the capital budget.

Using a Shorter Loan Term: This examines the impact of reducing the loan term from 20 years to 15 years. The primary change from shortening the loan is higher annual debt payments, and this scenario looks to see if that is possible.

Effect of this Change

	Base Case	Revised
Asset Costs	$35.23 M	$35.23 M
Grant	$18.00 M	$18.00 M
Equity	$ 4.71 M	$ 4.81 M
Bank Debt	$26.68 M	$27.25 M
Total Financing	$49.38 M	$50.06 M
Passings	6,307	6,307
Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 13
Years until Cash Covers Debt	Year 19	Year 17
Cash after 20 Years	$1.96 M	(-$2.52 M)

Shortening the loan term results in a negative cash position of over $2.5 million by the end of a 15-year loan. There is not enough cash flow in the business plan to support a shorter term loan.

Fiber Everywhere Scenario Including Bevcomm & Nuvera

As can be seen by a comparison with the above, this scenario is relatively close to the scenario that excludes Bevcomm and Nuvera:

Commercial Financing for an ISP

	No Grant	With DEED Grant	With RDOF Grant	With Both Grants
Asset Costs	$35.89 M	$38.89 M	$35.89 M	$35.89 M
Grant	$ 0.00 M	$ 5.00 M	$18.00 M	$23.00 M
Equity	$ 6.07 M	$ 5.16 M	$ 4.82 M	$ 3.86 M
Bank Debt	$34.38 M	$29.20 M	$27.33 M	$21.88 M
Total Financing	$40.44 M	$39.36 M	$50.15 M	$48.73 M
Passings	6,380	6,380	6,380	6,380
Penetration Rate	60%	60%	60%	60%
Years until Positive Net Income	Year 17	Year 17	Year 13	Year 13
Years until Cash Covers Debt	Never	Never	Year 20	Year 14
Cash after 20 Years	($21.05 M)	($13.41 M)	$1.36 M	$10.05 M

What do these results tell us?

- Here are the key assumptions included in these scenarios:
  - This covers the full study area, which is the rural areas served by Consolidated, Frontier, and CenturyLink less a few towns that have a cable provider. This includes the Bevcomm and Nuvera service areas.
  - Fiber built to pass every home and business in the serving areas.
  - Assumes an ISP owns the network and operates the business.
  - This is financed with traditional bank loans that require 15% of the project to be funded with equity. That would mean that whoever builds this will need to bring between $4 million and $6 million in cash to the project in order to secure the needed loan. That requirement might eliminate a lot of ISPs from consideration – surprisingly few ISPs carry that much free cash.
  - The loans have a 20-year term and assume a 5.5% interest rate. We assume that there would be no principle payments required for the first 3 years. A bank would consider these to be a construction loan and generally charges interest only during the construction period.
- This project is not feasible with no grant money or even with a $5M state DEED grant. An ISP is going to need to secure a second federal grant to make this work. DEED and RDOF grants will be explained in more detail in the discussion on financing.
- The rural project is feasible with enough grant money. It would be challenging for an ISP to get as much grant funding as shown above – the amounts used probably represent the highest amount of

grant funding that is possible. The analysis shows that combination of state and federal grants totaling $18 million would create a small cash positive scenario.

Hybrid Fiber / Wireless

This scenario provides fiber in the towns of Amboy, Beauford, Cambria, Garden City, Good Thunder, Mapleton, Rapidan, St. Clair, and Vernon Center. It also provides fiber along the fiber ring that is constructed to connect to the cities and to the wireless towers. All other customers are served with fixed wireless, all fed with fiber.

All of the scenarios shown below exclude Bevcomm and Nuvera. However, the results including these two areas are almost the same as below.

	No Grant	With DEED Grant	With RDOF Grant	With Both Grants
Asset Costs	$10.54 M	$10.54 M	$10.54 M	$10.54 M
Grant	$ 0.00 M	$ 4.58 M	$ 4.58 M	$ 9.17 M
Equity	$ 1.80 M	$ 0.96 M	$ 0.96 M	$ 0.65 M
Bank Debt	$10.18 M	$ 5.43 M	$ 5.43 M	$ 3.68 M
Total Financing	$11.97 M	$10.96 M	$10.96 M	$13.49 M
Fiber Passings	2,348	2,348	2,348	2,348
Penetration Rate	60%	60%	60%	60%
Wireless Passings	3,959	3,959	3,959	3,959
Penetration Rate	30%	30%	30%	30%
Years until Positive Net Income	Year 5	Year 4	Year 4	Year 4
Years until Cash Covers Debt	Year 17	Year 10	Year 10	Year 5
Cash after 20 Years	$2.94 M	$9.03 M	$9.03 M	$14.46 M

What do these results tell us?

- This scenario generates positive cash without a grant.
- The big question mark for this scenario is the penetration rate for the rural wireless. There are other wireless providers that cover most of these same service areas. The one benefit of this wireless scenario is that all of the wireless transmitters are fiber-fed, meaning that the speeds delivered will be the fastest possible with the wireless technology at any given time in the future.
- It's likely that the 60% penetration rate assumed for customers that can get fiber is a little conservative.

Sensitivity Analysis

Following are the sensitivity results for the hybrid fiber / wireless scenario. This analysis begins in each case by comparing to the base case that doesn't include any grant funding.

Lowering the Customer Penetration Rate: The following shows the impact of lowering the customer penetration rate from 60% to 55% for fiber customers and from 30% to 25% for wireless customers.

Effect of this Change

	Base Case	Revised
Asset Costs	$10.54 M	$10.22 M
Grant	$ 0.00 M	$ 0.00 M
Equity	$ 1.80 M	$ 1.78 M
Bank Debt	$10.18 M	$10.08 M
Total Financing	$11.97 M	$11.85 M
Fiber Passings	2,348	6,380
Penetration Rate	60%	55%
Wireless Passings	3,959	3,959
Penetration Rate	30%	25%
Years until Positive Net Income	Year 5	Year 5
Years until Cash Covers Debt	Year 17	Year 20
Cash after 20 Years	$2.94 M	$0.30 M

This effectively defines the breakeven scenario and the lower number of customers generate just enough cash to always maintain positive cash at the business.

An across-the-board decrease of 5% of penetration reduces cash flow by over $2.6 million.

Paying a Higher Interest Rate: This looks at the impact of increasing the interest rate by 50 basis points from 5.5% to 6.0%.

Effect of this Change

	Base Case	Revised
Asset Costs	$10.54 M	$10.54 M
Grant	$ 0.00 M	$ 0.00 M
Equity	$ 1.80 M	$ 1.81 M
Bank Debt	$10.18 M	$10.28 M
Total Financing	$11.97 M	$12.09 M
Fiber Passings	2,348	6,380
Penetration Rate	60%	60%
Wireless Passings	3,959	3,959
Penetration Rate	30%	30%
Years until Positive Net Income	Year 5	Year 5
Years until Cash Covers Debt	Year 17	Year 17

Cash after 20 Years	$2.94 M	$2.47 M

As would be expected, a higher interest rate reduces long-term cash flow. In this case, increasing the interest rate by one-half of a percentage (50 basis points) lowers the cash generated over 20 years by $470,000.

Decreasing Customer Prices: In this scenario, the broadband prices are decreased by $5 per month for both residents and businesses.

Effect of this Change

	Base Case	Revised
Asset Costs	$10.54 M	$10.54 M
Grant	$ 0.00 M	$ 0.00 M
Equity	$ 1.80 M	$ 1.83 M
Bank Debt	$10.18 M	$10.35 M
Total Financing	$11.97 M	$12.18 M
Fiber Passings	2,348	6,380
Penetration Rate	60%	60%
Wireless Passings	3,959	3,959
Penetration Rate	30%	30%
Years until Positive Net Income	Year 5	Year 5
Years until Cash Covers Debt	Year 17	Year 19
Cash after 20 Years	$2.94 M	$0.91 M

This shows that the business is sensitive to prices. In this case, decreasing the price of the broadband products by $5 decreases the cash by a little more than $2 million over 20 years.

Eliminating the Construction Contingency: This examines the impact of decreasing capital expenditures. Specifically, this shows the impact of not having to spend the construction contingency, which is approximately $1 million. But the impact would be identical for reducing capital by that same amount for any other reason.

Effect of this Change

	Base Case	Revised
Asset Costs	$10.54 M	$10.31 M
Grant	$ 0.00 M	$ 0.00 M
Equity	$ 1.80 M	$ 1.75 M
Bank Debt	$10.18 M	$ 9.93 M
Total Financing	$11.97 M	$11.68 M
Fiber Passings	2,348	6,380
Penetration Rate	60%	60%

Wireless Passings	3,959	3,959
Penetration Rate	30%	30%
Years until Positive Net Income	Year 5	Year 5
Years until Cash Covers Debt	Year 17	Year 16
Cash after 20 Years	$2.94 M	$3.19 M

In this scenario the construction contingency is relatively small at $230,000. Eliminating that much from capital costs improves the cash flow over 20 years by $250,000.

Using a Shorter Loan Term: This examines the impact of reducing the loan term from 20 years to 15 years. The primary change from shortening the loan is higher annual debt payments, and this scenario looks to see if that is possible.

Effect of this Change

	Base Case	Revised
Asset Costs	$10.54 M	$10.54 M
Grant	$ 0.00 M	$ 0.00 M
Equity	$ 1.80 M	$ 1.84 M
Bank Debt	$10.18 M	$10.40 M
Total Financing	$11.97 M	$12.24 M
Fiber Passings	2,348	6,380
Penetration Rate	60%	60%
Wireless Passings	3,959	3,959
Penetration Rate	30%	30%
Years until Positive Net Income	Year 5	Year 5
Years until Cash Covers Debt	Year 17	Year 16
Cash after 20 Years	$2.94 M	(-$0.46 M)

Shortening the loan term results in a small negative cash position by the end of a 15-year loan. It might be possible to use a shorter-term loan by changing other variables like prices.

Small Town Fiber

This scenario provides fiber in the towns of Amboy, Beauford, Cambria, Garden City, Good Thunder, Mapleton, Rapidan, St. Clair, and Vernon Center. It also provides fiber along the fiber ring that is constructed to connect to the cities. This scenario does not serve the rural households outside of the towns or away from the fiber ring. This scenario is identical with and without including the Bevcomm and Nuvera service areas.

	No Grant	With DEED Grant	With RDOF Grant	With Both Grants
Asset Costs	$ 9.76 M	$ 9.76 M	$ 9.76 M	$ 9.76 M
Grant	$ 0.00 M	$ 4.58 M	$ 4.58 M	$ 9.17 M
Equity	$ 1.77 M	$ 0.93 M	$ 0.93 M	$ 0.62 M
Bank Debt	$10.05 M	$ 5.30 M	$ 5.30 M	$ 3.50 M
Total Financing	$11.82 M	$10.82 M	$10.82 M	$13.28 M
Fiber Passings	2,348	2,348	2,348	2,348
Penetration Rate	60%	60%	60%	60%
Years until Positive Net Income	Year 17	Year 13	Year 13	Year 13
Years until Cash Covers Debt	Never	Year 21	Year 21	Year 8
Cash after 20 Years	(-$7.19 M)	(-$0.09 M)	(-$0.19 M)	$6.25 M

What do these results tell us?

- It's not possible to serve fiber to the small town only without a grant. Even a single state or federal grant is barely enough to make this work. However, with state and federal grant funding this scenario can be profitable.
- This scenario would be a great starting point for an ISP because it would not only grab the customers from all of the small towns on fiber, but the backbone fiber provides a basis for future expansion into the rural areas.
- It's likely that the 60% penetration rate assumed for customers that can get fiber is a little conservative.

Sensitivity Analysis

Following are the sensitivity results for the scenario of only building fiber to the smaller towns and cities. This analysis begins in each case by comparing to the base case that included a DEED grant.

Changing Customer Penetration Rate: In this case the base scenario is just slightly negative, so the penetration rate was increased just enough to create a positive cash flow. That turns out to only require an increase from 60% to 61%.

Effect of this Change

	Base Case	Revised
Asset Costs	$ 9.76 M	$ 9.80 M
Grant	$ 4.58 M	$ 4.60 M
Equity	$ 0.93 M	$ 0.98 M
Bank Debt	$ 5.30 M	$ 5.55 M
Total Financing	$10.82 M	$11.13 M
Passings	2,348	2,348
Penetration Rate	60%	61%

Years until Positive Net Income	Year 13	Year 13
Years until Cash Covers Debt	Year 21	Year 20
Cash after 20 Years	(-$0.09 M)	$0.18 M

Increasing the penetration rate by 1% increases the cash flow by $270,000 per year. This result is somewhat linear, and so, for example, increasing the penetration rate by 3% ought to result in roughly an $810.000 increase in cash.

Paying a Higher Interest Rate: This looks at the impact of increasing the interest rate by 50 basis points from 5.5% to 6.0%.

Effect of this Change

	Base Case	Revised
Asset Costs	$ 9.76 M	$ 9.76 M
Grant	$ 4.58 M	$ 4.58 M
Equity	$ 0.93 M	$ 0.94 M
Bank Debt	$ 5.30 M	$ 5.35 M
Total Financing	$10.82 M	$10.88 M
Passings	2,348	2,348
Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 17
Years until Cash Covers Debt	Year 21	Year 22
Cash after 20 Years	(-$0.09 M)	(-$0.49 M)

As would be expected, a higher interest rate reduces long-term cash flow. In this case, increasing the interest rate by one-half of a percentage (50 basis points) lowers the cash generated over 20 years by $400,000.

Increasing Customer Prices: Since the base case was just barely negative, the prices were increased enough to create a positive cash scenario. It turns out that a $1 price increase for broadband at the beginning of the project produced a positive result.

Effect of this Change

	Base Case	Revised
Asset Costs	$ 9.76 M	$ 9.76 M
Grant	$ 4.58 M	$ 4.58 M
Equity	$ 0.93 M	$ 0.92 M
Bank Debt	$ 5.30 M	$ 5.23 M
Total Financing	$10.82 M	$10.73 M
Passings	2,348	2,348

Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 13
Years until Cash Covers Debt	Year 21	Year 20
Cash after 20 Years	(-$0.09 M)	$0.30 M

In this case, raising prices by only $1 creates an additional $390,000 over 20 years. This effect is largely linear and increasing prices by $3 should increase cash $1.17 million over 20 years.

Eliminating the Construction Contingency: This examines the impact of decreasing capital expenditures. Specifically, this shows the impact of not having to spend the construction contingency, which in this scenario is $233,000. The impact would be identical for reducing capital by that same amount for any other reason.

Effect of this Change

	Base Case	Revised
Asset Costs	$ 9.76 M	$ 9.76 M
Grant	$ 4.58 M	$ 4.58 M
Equity	$ 0.93 M	$ 0.93 M
Bank Debt	$ 5.30 M	$ 5.30 M
Total Financing	$10.82 M	$10.82 M
Passings	2,348	2,348
Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 13
Years until Cash Covers Debt	Year 21	Year 20
Cash after 20 Years	(-$0.09 M)	$0.14 M

This shows that lowering capital expenditures by $230,000 improves the cash flow over 20 years by about the same amount.

Using a Shorter Loan Term: This examines the impact of reducing the loan term from 20 years to 15 years. The primary change from shortening the loan is higher annual debt payments, and this scenario looks to see if that is possible.

Effect of this Change

	Base Case	Revised
Asset Costs	$ 9.76 M	$ 9.76 M
Grant	$ 4.58 M	$ 4.58 M
Equity	$ 0.93 M	$ 0.96 M
Bank Debt	$ 5.30 M	$ 5.43 M
Total Financing	$10.82 M	$10.96 M

Passings	2,348	2,348
Penetration Rate	60%	60%
Years until Positive Net Income	Year 13	Year 14
Years until Cash Covers Debt	Year 21	Never
Cash after 20 Years	(-$0.09 M)	(-$1.07 M)

Shortening the loan term to 15 years reduces cash by almost $1 million by the end of a 15-year loan.

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 Everywhere Looks to be a Big Challenge. It looks difficult to make a business case for fiber everywhere even should an ISP somehow get every grant imaginable to help pay for the venture.

This is largely an issue of scale. The vast majority of the rural areas in the county don't have good broadband today and only a few tiny pockets of the county are slated to be built with fiber by small telcos. Many other counties in the state will be getting a significant amount of fiber already and such counties then only have to find solutions for portions of the county – in this case the majority of the county doesn't have and won't be getting fiber.

A Hybrid Fiber / Wireless Network Can be Profitable. There is a reasonable scenario for building fiber to the many small towns in the county without good broadband and providing wireless broadband to everybody else. This would be different than most of the wireless being sold today in that the wireless transmitters would be connected to fiber and would thus be able to offer relatively fast broadband speeds between 25 Mbps and 100 Mbps. Over time as wireless technology keeps improving these speeds can even get faster.

There are several benefits of the hybrid plan:

- First, over a third of the rural homes and most of the businesses without broadband today would be offered fiber. The hybrid plan assumes construction of a fiber ring through the county that connects the towns and connects to wireless towers.
- The fiber ring pushes fiber deep into all corners of the county, making it easier for ISPs to edge-out over time to more rural customers.
- The business plan looks to be profitable under assumptions that are likely achievable.
- This business plan can work without grants. Any grants make this easier to be profitable.
- In other parts of the state ISPs are starting with the hybrid scenario with a goal of using the profits from the venture to help pay for expansion of rural fiber.

It's Also Possible to Build Fiber to the Small Towns. This scenario is not as profitable as the Hybrid scenario because it doesn't include the revenues from the wireless customers. But it looks feasible for an ISP to build to serve the many small towns without broadband today if they can win a reasonable amount of state and/or federal grants.

In much of the rest of Minnesota, project to build fiber to towns the size of the ones in the county have already been the focus of the Minnesota broadband grants. The towns in Blue Earth County have not been built because they are not close to small telcos interested in serving them. A service provider who wants to serve these towns needs to build fiber in the towns as well as the fiber needed to reach the towns – which is what this scenario accomplishes.

Requires Grant Funding. The only scenario that can possibly work without grant funding is the hybrid fiber / wireless scenario. Anybody who wants to construct fiber in the county is likely going to require significant state and/or federal grant funding.

Hard to Finance with Bonds. We looked at funding the network using municipal bonds. The extra borrowing costs associated with bonds, such as capitalized interest, make it difficult to find a scenario that could work with bond financing. Luckily, the county doesn't want to be the operating ISP and won't be the entity funding a network, but this does limit public-private partnership options where the county would fund the network and somebody else would operate it.

Will Require Significant Equity. One of the biggest constraints on commercial ISPs that want to expand is the need to contribute equity to a new venture. The various scenarios that were studied require ISP equity between $1 million and $5 million. This is a constraint in that many ISPs don't maintain significant funds of free cash. By now most of the telcos and other ISPs in the state have already expanded and used cash reserves.

When ISPs have to contribute equity to projects, they generally look around for the most lucrative options available. It's likely in Minnesota that ISPs can find expansion opportunities that are more financially lucrative than the ones in the county. To some extent every county without broadband is competing with every other county without broadband, because there is not enough funding available for the existing ISPs to build to all of the unserved areas in the state.

The Business is Sensitive to a Few Key Variables. All of the scenarios are sensitive to changes in a few key variables:

- Penetration Rate: The most important variable is customer penetration rate. We used a penetration rate of 60% in the analysis since that is fairly typical of the minimum performance we see ISPs achieve when they build fiber into areas with no decent broadband. The impact of achieving higher penetration rates is significant and could produce a big upside to all of the business plans. We've seen rural overbuilds that have achieved penetration rates between 60% and 85%, and one of the next steps the county should contemplate is to try to pin this number down. This can be done using a statistically valid survey or else a canvassing effort, which will be described in the recommendations of next steps to take after this study.
- Broadband Prices: The financial results are also very sensitive to broadband prices. The studies all used an assumed starting price of $60 for the basic (yet adequately fast) broadband product. There are rural ISPs in the state charging more than this and it's worth more research if you do a survey to look at price sensitivity in the rural part of the county.
- Interest Rate: The business plan scenarios are sensitive to interest rates, but not nearly to the extent of penetration rates and prices. We've had a long period of over a decade where interest rates have

remained steady. It will be harder to achieve these business plans if there are ever any significant increases in future interest rates.

It is essential before deciding to get into the business to pin down these key variables. This means that you can't take the financial results listed above or in Exhibit IV as the straight answer, because these variables can change the result of any financial projection. 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 variables change in a real business plan.

C. Financing Considerations

One of the most significant costs of building a broadband network is the financing cost needed to raise the money to pay for the network. In this section of the report we are going to look at all of the various ways that other communities have been able to fund broadband networks. If a community wants fiber badly enough then we've found that there is always a way to pay for it.

There are a number of different financing option to consider. Below we look at the following:

- Private Financing (loans)
- Public Financing (bonds)
- Grants
- Federal Programs
- State Programs
- Customer Financing
- Public Private Partnerships

Private Financing Options

The county is hoping for one or more ISPs to build broadband in the county. Those ISPs will be using some form of traditional private financing, meaning loans. 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 borrowing entity 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 required.

Equity can take a number of 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 an interest rate.
- 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 other valuable

asset to the business. In such a case the contributed asset generally has to 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, 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.

Bank Loans: While there are around 150 municipal fiber ventures in the country that largely have been financed through bonds, the vast majority of other fiber projects in the country have been financed with commercial lending sources. Most fiber projects have been built by for-profit communications companies or by cooperatives.

The 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 so years ago, banks would fund things 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 banks that are publicly traded have taken over most of the banking industry. Banks don't like long-term loans since the interest rates get locked in for many years, possibly depriving the banks from earning more on their own equity.

Most banks prefer not to make loans with a term much longer than 12–15 years, and very few telecom projects can generate enough cash in that time period to pay for the original investment. In the analysis for this study we looked at loan terms and the projects all do much better with 20-year loans instead of 15-year loans.

There are exceptions. A few of the large banks like Key Bank and Bank of America have divisions that will make bank loans to municipal ventures that look a lot like bonds. These loans will have long payment terms of 20 years or more and reasonable interest rates. However, most of these loans go for things like power generation plants and other projects that have a strong guaranteed revenue stream. These banks have done a tiny handful of telecom projects, but they view most broadband projects to be too risky. Banks are also averse to start-ups and prefer to make loans to existing businesses that already have a proven revenue stream.

There is one unique banking resource available to companies who want to build fiber projects. This 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. They tend to have somewhat high interest rates and somewhat short loan terms of 10–12 years.

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.

One of the issues of borrowing from a local bank is that they are going to have a relatively small lending limit. Most local banks won't make an individual loan for more than one or two million dollars. That obviously doesn't go far in a fiber project. However, local banks have become adept at working in consortiums of multiple banks to make larger loans. This spreads the risk of any one loan across many banks. Banks who do this usually take part in consortium loans for a number of projects. These smaller banks see this as a way to make loans to quality projects and quality customers that they could not loan to on their own.

To make this work you generally must start with a bank that is local to the project and let them help you put together the consortium. They essentially become the sponsor of the deal. This approach takes some extra work to put together, but there are many examples of this working for financing good projects.

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, up front 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.

Public Financing Options

We know the county is not interested in operating an ISP, but if no other solution surfaces, then the county could finance part of a broadband project. A number of counties in Minnesota have contributed money to broadband projects – and since counties rarely sit on much cash, these funds are generally backed by a county bond issue.

The two primary mechanisms used for public financing are revenue bonds and general obligation bonds. There are some major benefits of using bond financing. First, the term of the bond can match the expected life of the assets and it is not unusual to find bonds for fiber projects that stretch out for 25 to 30 years. Second, you can finance a project completely with bonds, meaning that no cash or equity needs to be put into the business up front.

Revenue Bonds: The primary historic source of money to finance this sort of telecommunications system is through the issuance of municipal tax-exempt bonds. Most of the municipal fiber networks that have been built have been financed through revenue bonds. Revenue bonds are backed by the revenues and the assets of the fiber network and the associated business. With a pure revenue bond, the county would not be directly responsible for repaying a revenue bond

should the project go into default. With that said, having a default would be a financial black-eye that might make it hard to finance future projects. So, to some degree the county would still be on the hook for the success of the revenue bonds, at least tangentially.

However, it is getting harder to finance a project with revenue bonds due to some failures on the part of other municipal networks. Among these are Monticello, MN; Crawfordsville, IN; and Alameda, CA. These kinds of failures have made investors leery about buying bonds that are only backed by the business. This reluctance has made financing with revenue bonds more expensive.

The cost of a bond issue cannot be judged only by the interest paid. In fact, the other financing costs of bonds can outweigh the interest rate in the effect on the bottom-line cost of repaying a bond issue. Because of market reluctance to buy revenue bonds, they often have higher interest rates than general obligation bonds, but they also can incur the following costs:

Debt Service Reserve Fund (DSRF): Many revenue bonds require borrowing additional funds to be kept in escrow as a hedge against missing future payments. The DSRF is often set to equal a year's worth of principle and interest payments. This money is put into escrow and is not available to operate the business.

Capitalized Interest: Bonds begin accruing interest from the day the money is borrowed. Since fiber businesses take a number of years to generate enough cash to make bond payments, the bondholders require capitalized interest that is used to make the interest payments for up to the first five years of the project. Basically, the project must borrow the amounts needed to make debt payments which can add a significant amount to the size of the bond issue.

Bond Insurance: Bond insurance is an up-front fee paid to an insurance company that will then pay one year of bond payments to bond holders in case of a default. We've seen bonds issued that have required both a debt service reserve fund and bond insurance.

For a number of years now the interest rates charged to bonds have been lower than the interest rate on commercial loans. But that has not always historically been the case. The difference between bond interest rates and commercial interest rates both change over time; that difference is referred to in the industry as the "spread." Sometimes the spread favors bonds and at other times it favors commercial borrowing. In our financial analysis we assumed that the interest rates are lower on bonds. Interest rates are also not the same for all kinds of bonds. For instance, the interest rate for revenue bonds can be considerably higher than general obligation bonds due to the perceived higher risk.

General Obligation Bonds (GO Bonds): If revenue bonds aren't an option, then the next typical alternative is general obligation bonds. 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.

In Minnesota many kinds of general obligation bonds require a referendum approval by a simple majority of voters. There are some kinds of economic development bonds and other types of GO

bonds that don't require a referendum, although government entities sometimes hold a referendum anyway just to make sure the public supports the initiative being financed.

There are other financing mechanisms that have been used by other municipalities to fund revenue-generating projects. These include:

Variable Rate Demand Obligations (VRDOs): VRDOs are a bond where the principal is paid in a lump sum at maturity. However, the borrower has the right to repay the bonds in whole or in part at any time (upon an agreed-upon notice). VRDOs are effective in circumstances when the borrower wants to match the repayment of the bonds to a revenue stream that varies year to year or a revenue stream that can vary from initial estimates and changes over time. In the case of the new telecommunications system, this type of financing provides the flexibility to make bond payments that match the actual revenues received. If revenues are slower than anticipated, principal payments do not need to be made. If revenues come in faster than anticipated, repayment of the bonds can be accelerated without penalty. We can recall having only ever seen this used once for a municipal telecom system by the city of Alameda, California. This kind of financing is used fairly routinely for other kinds of municipal needs.

VRDOs are most commonly structured as 7-day floating rate bonds. Interest rates are reset each week, and this adds a lot of risk to this type of financing. Unlike fixed-rate bonds, the borrower does not know what the interest rate will be on the VRDOs over the life of the issue. Interest rates on VRDOs are on the short end of the yield curve and have therefore historically been lower than interest rates on fixed-rate bonds even with the additional ongoing costs for a liquidity provider and a remarketing agent. There is typically a maximum rate stated which the VRDOs cannot exceed. But in a market where there is a significant increase in overall interest rates this kind of financing could end up being significantly more expensive.

Capital Appreciation (zero coupon) Bonds (CABs): CABs are bonds that are issued at a deep discount and which do not bear any stated interest rate. Like a Series E savings bond, CABs are bought at a price that implies a stated return calculated on a basis of the bond being payable at par at maturity. With no stated interest rate there is no interest paid until maturity, at which time all of the compounded accreted interest is paid. With no interest payments required in the beginning years of the bonds, this would enhance the cash flow in the beginning years of the business.

CABs do, however, have several drawbacks over other types of available financing. First, the interest rates on CABs are typically higher than both the fixed-rate and VRDOs. Second, investors prefer not to have a prepayment option on CABs, which limits the flexibility of the government to call the bonds early if revenue collections are better than anticipated or if a restructuring of the debt is needed. This structure is used frequently for various government borrowings, but we've not ever heard of this being used for telecom—although there is no reason why it could not be used.

Comparing Bond and Bank Financing

Benefits of Bond Financing: There are several major benefits for using bond financing:

- The term of the bond can match the expected life of the assets and it is not unusual to find bonds for fiber projects that stretch out for 25 to 30 years. It's difficult to finance a commercial loan longer than 15 years. The longer the length of the loan, the lower the annual bond payments.
- Bonds can be used to 100% finance a project, meaning there is no need for cash or equity to fund the new business. Lack of cash equity is generally the requirement that creates a challenge for traditional commercial financing.
- Bonds often, but not always, have lower interest rates. The interest rate is dependent upon several factors including the credit-worthiness (bond rating) of the borrower as well as the perceived risk of the project.
- It's generally easier to sell bonds than to raise commercial money from banks. Sometimes bonds require a referendum, but once bonds are approved there is generally a ready market for buying the bonds and raising the needed funds.

Benefits of Commercial Financing: There are also a few benefits for commercial financing.

- Generally, the amount that must be borrowed from commercial financing is lower, sometimes significantly lower. This is due to several issues associated with bond financing. Bond financing often contains the following extra costs that are not included with commercial loans:
    - Surety: Bonds often require a pledge of surety to protect against default of the bonds. The two most common kinds of surety are the use of a debt service reserve fund and bond insurance. A debt service reserve fund (DSRF) borrows some amount of money, perhaps the equivalent of one year of bond payments and puts it into escrow for the term of the bond. They money just sits there to be used to help make bond payments should the project have trouble making the payments. Bond insurance works the same way and a borrower will pre-pay and insurance policy at the beginning of the bond that will cover some defined amount of payments in case of a default.
    - Capitalized Interest: Bonds typically borrow the interest payments to cover bond payments for some period of time, up to five years.

- Construction Loans: Another reason that commercial financing usually results in smaller debt is through the use of construction loans. A commercial loan will forward the cash needed each month as construction is done, and interest is not paid on funds until those funds have been used. However, bonds borrow all of the money on day one and begin accruing interest expense on the full amount borrowed on day one. Construction loans also means that a borrower will only draw loans they need while bond financing is often padded with a construction contingency in case the project costs more than expected.
- Deferred Payment: Commercial financing often will be structured so that there are no payments due for the first year or two. This contrasts with bonds that borrow the money required to make these payments. Fiber projects, by definition, require several years to generate revenue and deferring payments significantly reduces the size of the borrowing.

- Retirement of Debt: It's generally easy to retire commercial debt, which might be done in order to pay a project off early or to refinance the debt. This contrasts to bonds that often require that the original borrowing be held for a fixed number of years before it can be retired or refinanced.

Grants

The studies discuss two major potential sources of grants, but there are others.

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 amount of grants was $20 million and for 2015 was $10 million and was $20 million again in 2016 and 2017. The grants for 2019, 2020, and 2021 are also set at $20 million.

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 in a different manner 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. Almost all of the areas included in these studies 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 time getting funded.
- 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

Federal Broadband Grants: There are several federal broadband grant programs that might benefit this project.

Rural Digital Opportunity Fund Grant (RDOF). The FCC has created a massive grant program that will be awarded over the next few years. This grant program is being funded from the FCC's Universal Service Fund. 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 over $16 billion. The Phase II will award will follow and award the remaining $4.4 billion.
- 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, 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. The FCC is likely to publish a list of areas eligible for the Phase I grants. Unfortunately, the FCC will use its flawed mapping program to make this determination. This is likely to mean that many parts of the country that ought to be eligible for these grants might not be part of the program. The FCC is considering prioritizing areas it thinks are particularly needy. For example, it may give extra grant weighting to areas that don't yet have 10/1 Mbps broadband. The FCC is also planning on giving extra weighting to some tribal areas.
- The grant program is going to try to give priority to faster broadband technologies. The FCC is proposing extra weighting for technologies that can deliver at least 100 Mbps and even more weighting for technologies that can deliver gigabit speeds. They are also proposing 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 FCC is asking if they should keep the current test – where only 70% of customers must meet the speed requirements for an applicant to get and keep full funding.

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.

Farm Bill Grants. In the 2017 Farm Bill there was a broadband grant program of $350 million to be awarded over the next 5 years, or roughly $70 million per year.

Other USDA Grants. There are several small USDA grant programs that vary from a few million to $20 million per year (varies every year). However, these grants are awarded according to the economic need of the grant area and the grants typically go to the poorest parts of the country such as Indian tribal areas and Appalachia. It's unlikely that Blue Earth would ever qualify for these grants.

Other Federal Programs

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 offer significantly lower interest rates.

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. And then the agency making the guarantee will generally want a fee equal to several interest "points" up front. 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.

There are several federal agencies that might be willing to 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.

Rural Utility Service (RUS): This is a part of the Department of Agriculture. We cover their loan program in detail just below in this report. They also can provide loan guarantees. These come

with the same sorts of issues associated with the loans. These loans and loan guarantees can only be used in communities of that do not include cities of 20,000 population or greater, which would not be an issue in Blue Earth County.

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 over 20,000.

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 prior to 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 get prepared externally;
- 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. In comparing the RUS to other banks, we would classify them as conservative.
- 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 an RUS loan than with a bond.
- It is exceedingly hard to get a project funded for a start-up business. When one takes an RUS loan they essentially want the whole company as collateral. Thus, the bigger and the more successful the existing company, the easier to meet their loan requirements.
- Their collateral requirements are overreaching in other ways that make them hard to work with for municipal projects. For example, if your project was 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 generally not possible.

This makes the RUS a very unlikely funding source for a municipal venture or for any start-up venture. To the best of our knowledge, they have 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 granted by using a very detailed checklist and rating system. This system gives a big preference to making new loans to existing RUS borrowers.

However, the loan fund is really large and is currently at nearly $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 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.

There is a low likelihood that RUS would be a funding source for a project in the county.

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 is not an Opportunity Zone currently in Blue Earth County.

Qualified investments made inside that area 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 now, 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 optic network that will bring broadband to all of the homes in an opportunity zone should meet that test – there are lot of demonstrable benefits of fiber.

It's possible that in future years that the governor of Minnesota could designate some part of the county to qualify for this special tax treatment.

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. Eligibility of the county to use these funds would depend upon meeting the earnings test. However, much of rural America meets this test if you earmark the funds for the rural parts 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 (SDFI) 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 the end there are entities who end up each year with some amounts of New Markets Tax Credits that they must invest to gain the tax credits. The credits are often purchased by the large national banks or other firms that invest in infrastructure.

Generally, in practice, these funds act like a mix of loans and 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 for the principal. However, often some or even all of the principal will be excused, making this also look 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 processes for applying for this money are somewhat fluid. However, there are entities and consultants who help find New Market Tax Credits and who can help you through the maze of requirements.

New market tax credits are normally used to fund only a small portion of a project.

State Programs

There are existing Minnesota programs that might provide some assistance to fiber projects. Following are several specific loan and grant programs that could provide some support for a fiber project. None of these grants are large enough that they are going to make a difference in whether the full project gets funded, but any money you can raise this way will lower the overall cost of debt financing. Each of these projects is specific about what they will or won't fund.

Minnesota Angel Loan Fund: This is an economic development fund in Minnesota that is used to spur new start-up businesses. The funds come from the Minnesota Department of Employment and Economic Development.

This is a loan fund and the program can make 0% interest loans for up to a 7-year term. The loans can be for as much as 10% of the amount of equity received by the start-up after approval in the program. That is an important point, in that the start-up business needs to register with this fund before raising equity and not after.

At least one of the equity investors must be certified by the Minnesota Angel Tax Credit program and must also be qualified as an accredited investor per the US Security and Exchange Commission under Rule 501 of Section D. In a nutshell, that means that this must be a professional investor and might be something like an insurance company, a pension fund, an investment bank, or some other entity that invests in businesses as a normal course of business. This would not include small private investors like the sort of investors that buy municipal bonds for personal investment purposes.

The amount of the loan must be at least $20,000 but is capped at $250,000. The loan payment is a balloon payment for the full amount due at the end of the seventh year. If the business is sold before the end of 7 years, the fund will charge a 30% premium on top of the principal due.

This loan only covers 10% above the amount of qualified equity the new business raises, but the zero percent interest rate still makes it attractive. However, fiber projects are generally of such a magnitude that even a loan of $250,000 will probably not make a huge difference in affecting the overall interest rate or in making it easier to raise the rest of the funding.

Greater Minnesota Public Infrastructure Program: This is a grant program that is part of the Small Cities Development Program. The purpose of this grant is to help stimulate economic development and jobs through investments in public infrastructure. Applicants must be home-rule cities that are outside of the 7-county metropolitan area. The money is available for any publicly owned infrastructure project and includes projects like water and wastewater, economic development projects, utilities, and streets. It seems by the description that municipally owned fiber projects should qualify.

The grants can be up to $1 million and a community can't receive more than $1 million in total over any 2-year period. The big catch of this program is that the municipality must make a cash contribution to the project. The community must put in equity equal to at least half of the amount of the grant. This matching can be either cash or in-kind. Fiber projects are often 100% debt

funded, but perhaps a community that is willing to contribute land, buildings, or other in-kind assets to a fiber project should consider pursuing this grant as a way to stretch their contribution.

Minnesota Community Development Funding: This is a grant program that is aimed at municipalities of fewer than 50,000 people or counties with fewer than 200,000 residents. The grants are available for three different categories of projects—Housing, Water Projects, and Comprehensive Grants. Any project that is funded must meet certain tests, and one of these is that it provides benefits to people of low- and moderate-income.

The Comprehensive Grants are the ones that might be granted to fiber projects. A comprehensive grant can be up to $1.4 million. There is some expected matching by the community taking the grant, but this is not a specific formula like with the Greater Minnesota Public Infrastructure Program. Rather, the amount of matching is determined and negotiated as part of the grant process. However, the general rule of thumb is that the greater the matching the more likely a grant.

Comprehensive grants can be provided for economic development projects. This fund has never made a grant for a telecom project, but it appears that such programs could be eligible if they can demonstrate the benefit for low- and moderate-income households. A strategy might be to have at least part of the broadband project aimed at low-income households.

Customer Financing

When all else fails, an idea that we have seen work in other communities is for the citizens to step up and agree to somehow directly fund some or all of a broadband project. When you consider that the cost of building rural fiber can be $15,000 or more per home passed, getting some assistance directly from potential customers is sometimes the only solution that can attract the rest of the needed funding. There are several examples of places where this has been done in the country:

Property (or Other Kind of Tax) Revenues. It is possible to obtain some or all of the cost of a broadband network through a pledge of future tax revenues. That pledge can then support a bond. This is different than most bonds for a broadband network where the network would be secured by revenues of the broadband venture. But a pledge of some other kind of tax revenue is one of the easiest ways to get a bond. There are some real examples of this kind of financing:

- Lyndon Township, Michigan: This is a township of about 1,000 homes that voted to raise property taxes to fund to build a fiber network. The township then partnered with a local broadband cooperative to provide services. The project is a win/win for citizens. Property taxes increased about $25 per month per household. The township provides free access to the cooperative which is charging about $25 for broadband – making the total cost of getting broadband about $50 per month. This is an area that had no broadband before the project.
- UTOPIA, Utah: UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. They also have pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota: Cook County funded about half of their fiber network using a federal grant awarded from the Stimulus funding program in 2008. The county held a

referendum and used a sales tax increase to pay for the matching funds needed to build the project.

Direct Customer Contributions: It's also possible to pay for some of a broadband project through direct contribution of possible customers. This has never been done on a large scale because it would be exceedingly difficult to get a lot of residents to agree to write a check to fund a network. But there are some examples to consider:

- Contribution to Aid in Construction: Most utilities have a program where they will agree to extend their network to customers if those customers agree to pay the cost of the connection. We are aware in the broadband area of numerous cases where small pockets of rural home raised the needed money to get connected to a nearby broadband network.
- Ammon, Idaho: This is the only municipal attempt at funding a network in this way. The City of Ammon will connect customers to a fiber network if they will contribute $3,500 up-front to cover the cost of construction. This program is just getting started and it reportedly has a few hundred homes interested. But it's an unusual combination of a city prompting citizens to pay for the needed network themselves.

Public Private Partnerships

A public private partnership (PPP) is formed when a government entity and commercial entity fund a project together. There is no one model for a PPP and such an arrangement can be structured in many different ways. The main benefit of a PPP is that the commercial operator of a project benefits by getting some bond financing from the municipal partner. This allows the business to blend the benefits of bond and commercial financing and is one of the ways that makes it easier to get through the first few years of the project.

The general benefits of bond financing are what makes public money attractive to a commercial partner—low interest rates, long repayment term, and small or no payments for the first few years. But the downside is that there are more overall financing costs and in the long run a bond makes a project cost more in terms of cash. The safety of a bond in the first few years, though, can be very attractive.

Combining Public and Private Financing. There are benefits to combining the two kinds of financing:

- Banks will often consider the financing that comes with bonds as the equivalent of equity, meaning that the commercial partner will not require as much, or even no, cash equity.
- In terms of the amount borrowed, the two methods work well together if construction loans are used to cover the construction and bond financing is used for the longer-term financing costs.
- Combining the two methods works to produce a payment term that is longer than a traditional commercial loan.
- Combining the two methods also usually means lower debt payment during the first few critical years while the network is being built.
- Both municipalities and commercial telcos have a natural borrowing limit—meaning that there is always some upward limit on the amount of money they can borrow. Combining both kinds of financing can mean that neither partner has to hit their debt ceiling. Just as an aside, the debt ceiling is often the main impediment to funding project 100% with bonds. Fiber projects are generally large projects and the required funds can easily exceed the ability of a government to fund it 100%.

There are numerous PPP broadband projects around the state. Here are two interesting models in Minnesota to consider:

- RS Fiber: RS Fiber is a new broadband cooperative that was formed in Renville and Sibley counties. The project was funded from various sources including a loan for 25% of the project supplied a bond backed by the cities and counties involved in the project.
- Swift County: The county government there contributed a significant percentage of the cost needed to construct a broadband network in the county. The bond proceeds were loaned to Federated Telephone Cooperative and are expected to be paid back over time.

Other Sources of Financing

We've seen entities get very creative in finding sources of financing. Take the example of the RS Fiber Cooperative formed in Sibley and Renville counties. Their financing includes two unique revenue sources we have not seen used before:

- **Loans from Individuals**: The Cooperative borrowed money directly from people and businesses in the service area. These loans had loan contracts and covenants like any other loans. The money borrowed in this manner reduces the amounts that have to be borrowed from the larger external sources, and generally these loans avoid the large fees associated with external financing.
- **Loans from Cooperatives**: Since RS Fiber is a cooperative, they found that they were able to borrow from an electric cooperative at low interest rates. Cooperatives are a unique type of business that is required by law to either invest their profits back into the business or else return it as dividends to members. Because the level of dividends is limited by law, cooperatives often find themselves with large cash reserves. They are allowed to loan out these cash reserves, but only to other cooperatives.

EXHIBIT I: SERVICE AREAS OF THE INCUMBENT TELEPHONE COMPANIES

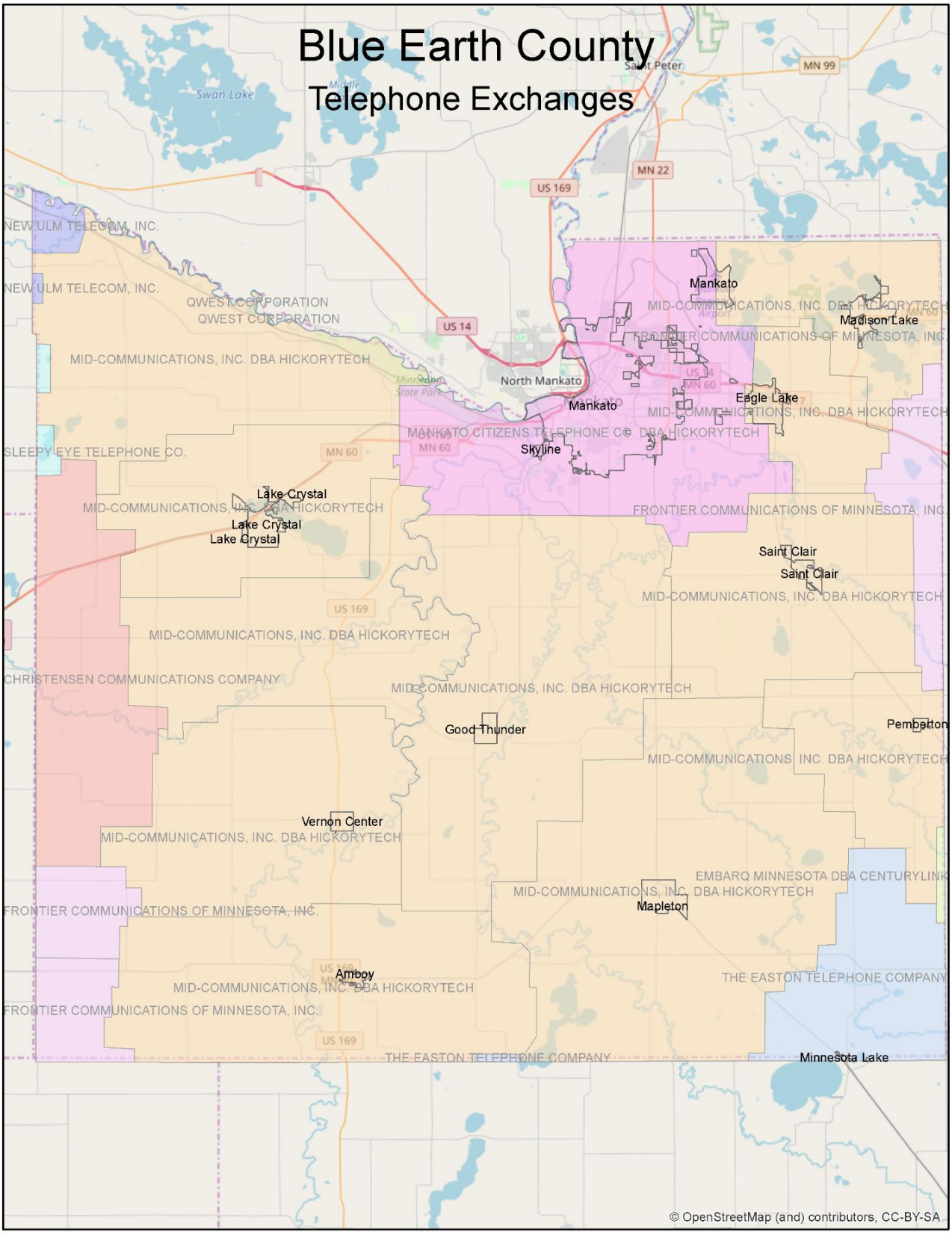


EXHIBIT II: EXISTING BROADBAND / STUDY AREA

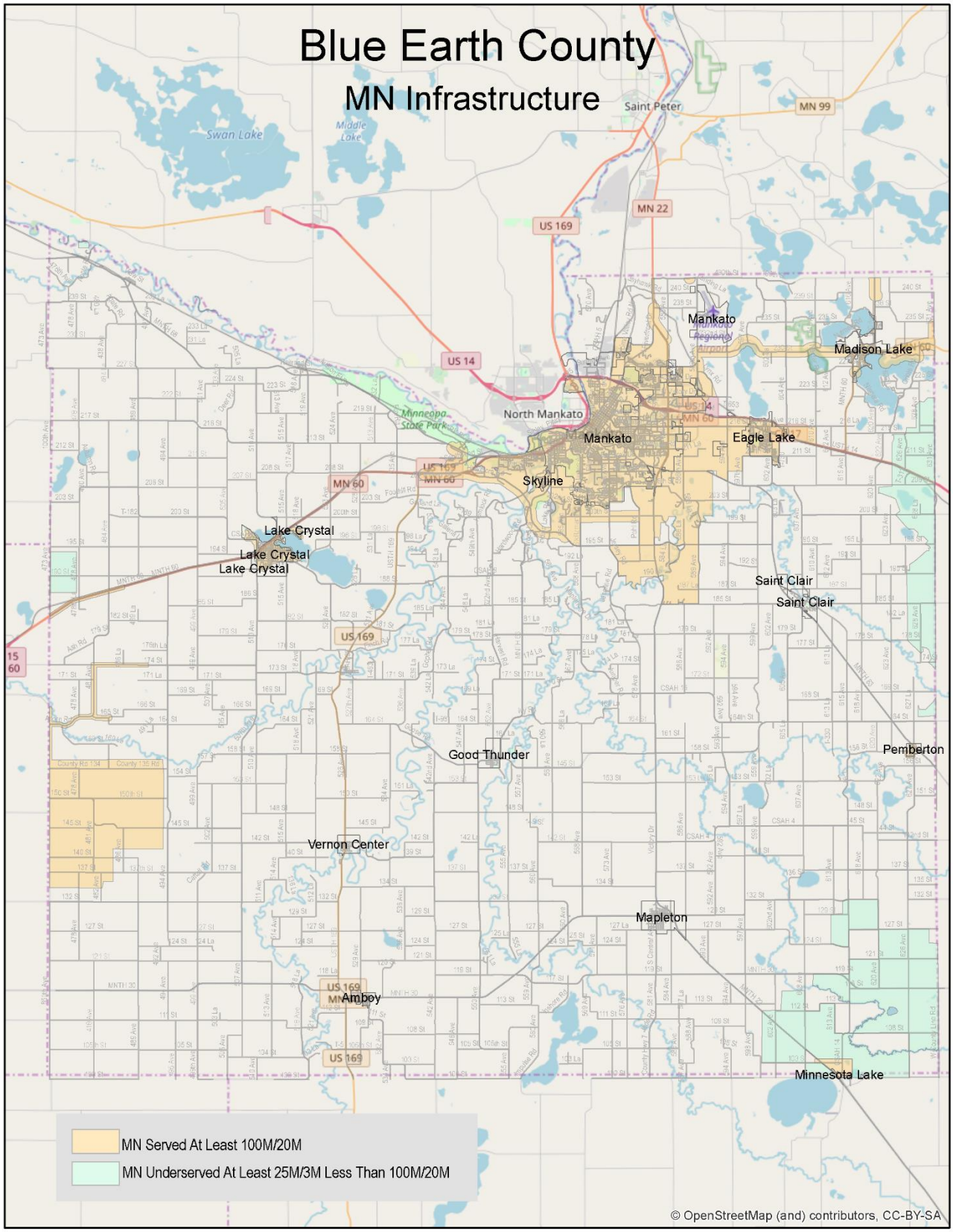


EXHIBIT III: MAP OF THE BACKBONE FIBER FOR ALL-FIBER SCENARIO

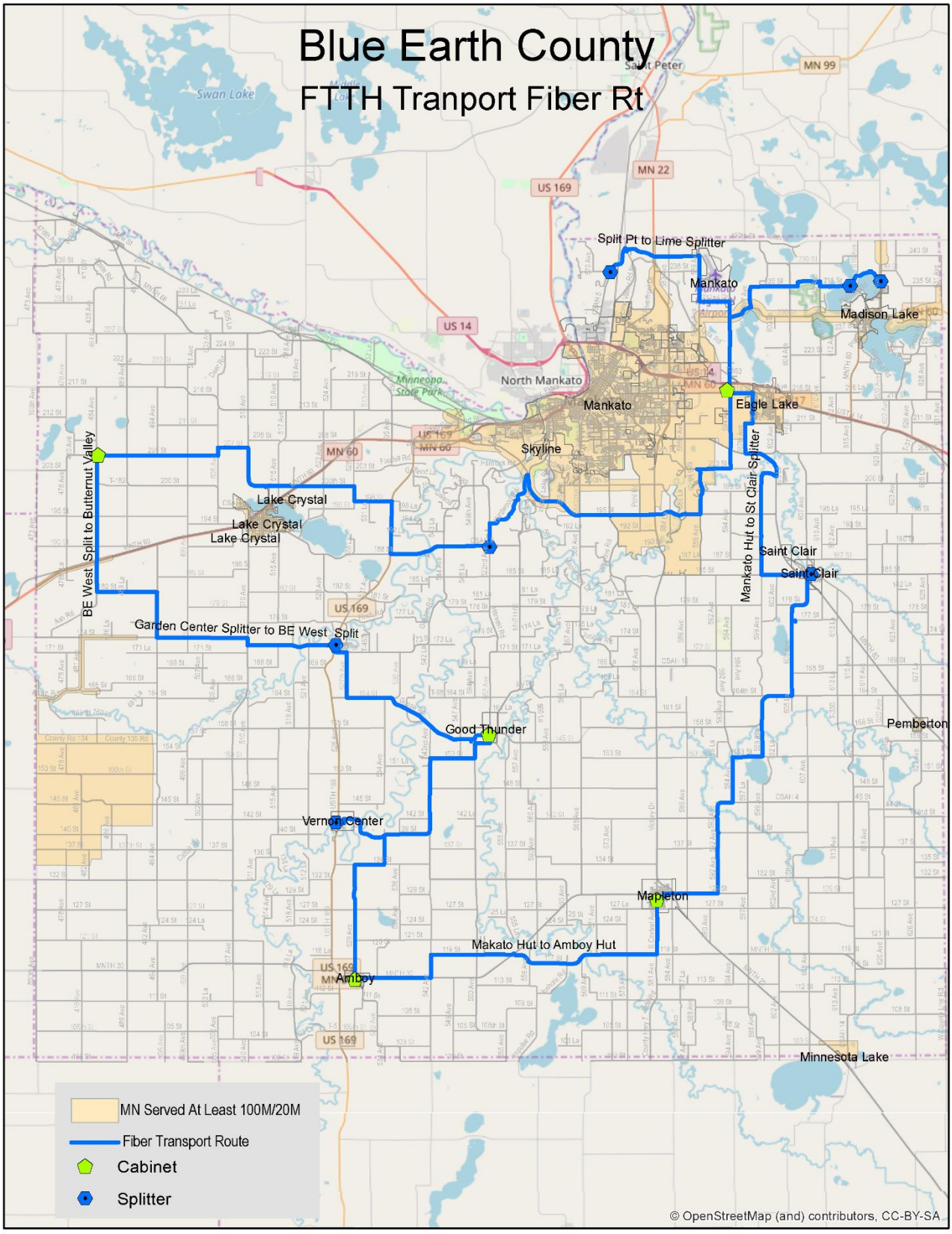


EXHIBIT IV: MAP OF THE BACKBONE FIBER FOR HYBRID SCENARIO

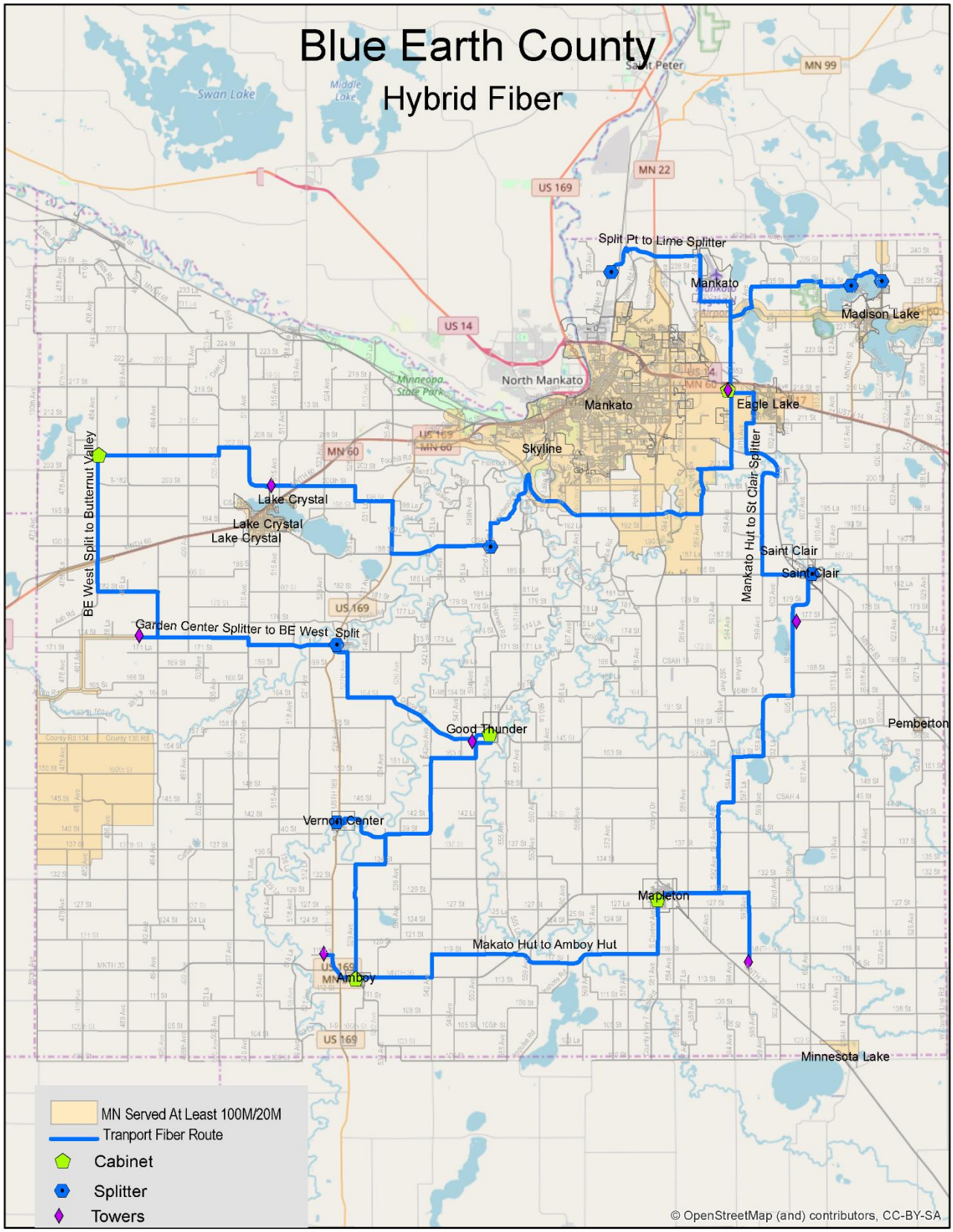


EXHIBIT V: MAP OF THE CAF II COVERAGE AREAS

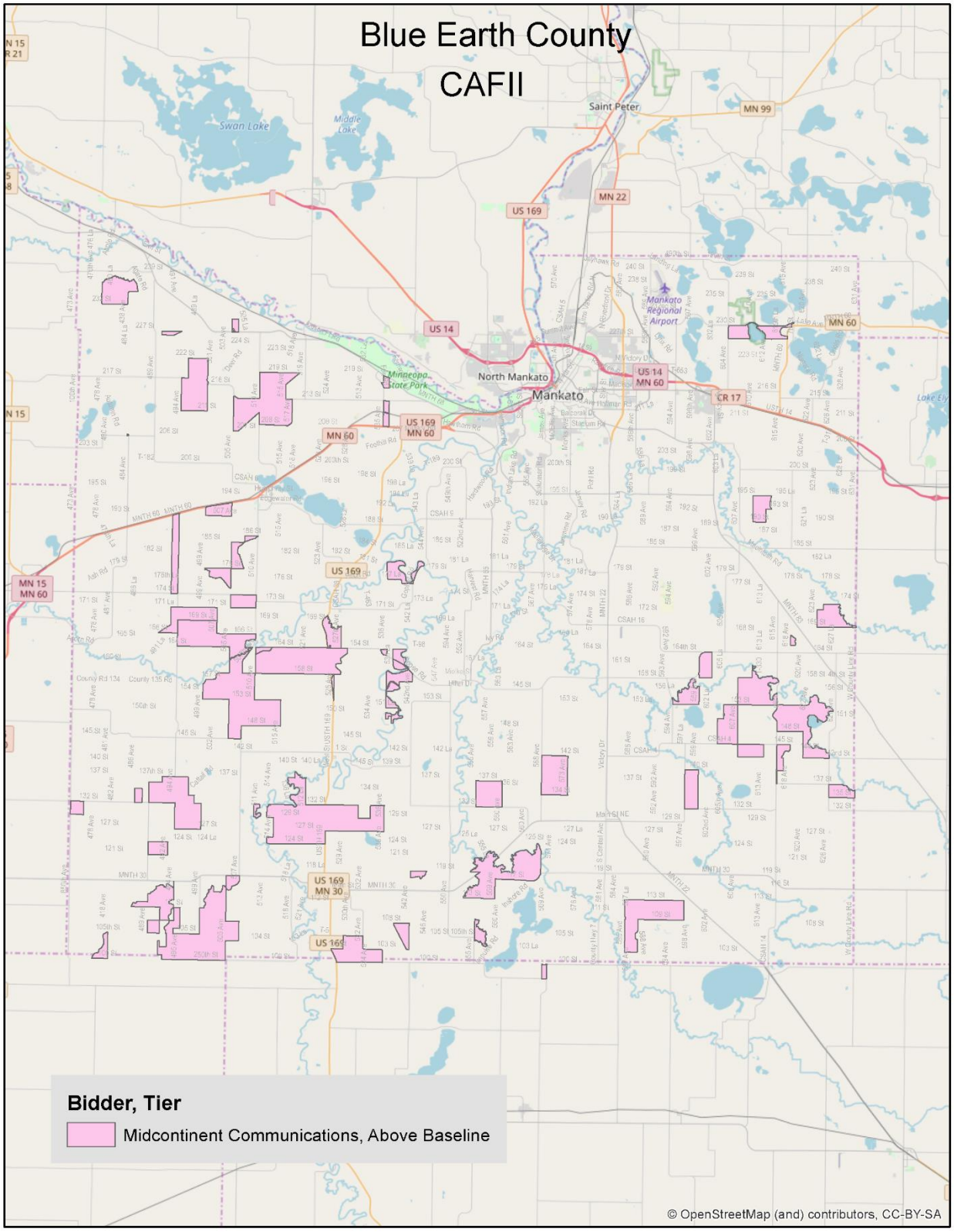


EXHIBIT VI: SUMMARY OF FINANCIAL RESULTS

		Assets	Take Rate	Fiber Passings	Wireless Passings	Grant(s)	Equity	Debt	Total Financing	Cash End of Loan	Net Income Positive	Cover Debt
Total Rural Area All Fiber												
1	**At 60% with RDOF Grant**	$35.89 M	60%	6,380		$18.00 M	$4.82 M	$27.33 M	$50.15 M	$1.36 M	Year 13	Year 20
2	**No Grant**	$35.89 M	60%	6,380			$6.07 M	$34.38 M	$40.44 M	-$21.05 M	Year 17	Never
3	**With DEED Grant**	$35.89 M	60%	6,380		$5.00 M	$5.16 M	$29.20 M	$39.36 M	-$13.41 M	Year 17	Never
4	**With Both Grants**	$35.89 M	60%	6,380		$23.00 M	$3.86 M	$21.88 M	$48.73 M	$10.05 M	Year 13	Year 14
5	**Higher Interest Rate***	$35.89 M	60%	6,380		$18.00 M	$4.88 M	$27.65 M	$50.53 M	-$0.89 M	Year 17	Year 21
6	**15-Year Loan Term****	$35.89 M	60%	6,380		$18.00 M	$4.93 M	$27.93 M	$50.85 M	-$3.09 M	Year 13	Year 16
7	**$5 Higher Prices**	$35.89 M	60%	6,380		$18.00 M	$4.77 M	$27.05 M	$49.82 M	$6.41 M	Year 13	Year 17
8	**70% Penetration**	$37.15 M	70%	6,380		$18.00 M	$4.95 M	$28.03 M	$50.97 M	$8.92 M	Year 13	Year 16
9	**No Contingency**	$34.18 M	60%	6,380		$18.00 M	$4.51 M	$25.58 M	$48.09 M	$4.55 M	Year 13	Year 17
10	**Muni Bonds No Grant**	$36.09 M	60%	6,380				$48.90 M	$48.90 M	-$39.08 M	Never	Never
11	**DEED Grant**	$36.09 M	60%	6,380		$5.00 M		$42.10 M	$47.10 M	-$29.73 M	Never	Never
12	**RDOF Grant**	$36.09 M	60%	6,380		$18.00 M		$30.00 M	$48.00 M	-$9.31 M	Never	Never
13	**Both Grants**	$36.09 M	60%	6,380		$23.00 M		$27.00 M	$50.00 M	-$1.63 M	Never	Never
	***Goes $1.87 M negative Cash**											
	****Goes $3.73 M negative Cash**											
Without Bevcomm / Nuvera All Fiber												
14	**At 60% with RDOF Grant**	$35.23 M	60%	6,307		$18.00 M	$4.71 M	$26.68 M	$49.38 M	$1.96 M	Year 13	Year 19
15	**No Grant**	$35.23 M	60%	6,307			$5.95 M	$33.73 M	$39.68 M	-$20.51 M	Year 17	Never

16	**With DEED Grant**	$35.23 M	60%	6,307		$5.00 M	$5.04 M	$28.55 M	$38.59 M	-$12.87 M	Year 17	Never
17	**With Both Grants**	$35.23 M	60%	6,307		$23.00 M	$3.79 M	$21.48 M	$48.26 M	$10.59 M	Year 13	Year 13
18	**Higher Interest Rate**	$35.23 M	60%	6,307		$18.00 M	$4.76 M	$27.00 M	$49.76 M	-$0.23 M	Year 16	Year 21
19	**15-Year Loan Term**	$35.23 M	60%	6,307		$18.00 M	$4.81 M	$27.25 M	$50.06 M	-$2.52 M	Year 13	Year 17
20	**$5 Higher Prices**	$35.23 M	60%	6,307		$18.00 M	$4.65 M	$26.38 M	$49.03 M	$6.97 M	Year 13	Year 16
21	**70% Penetration**	$36.57 M	70%	6,307		$18.00 M	$4.84 M	$27.45 M	$50.29 M	$9.12 M	Year 13	Year 16
22	**No Contingency**	$33.57 M	60%	6,307		$18.00 M	$4.41 M	$24.98 M	$47.38 M	$5.09 M	Year 13	Year 17
23	**Muni Bonds No Grant**	$35.52 M	60%	6,307				$48.10 M	$48.10 M	-$37.85 M	Never	Never
24	**DEED Grant**	$35.52 M	60%	6,307		$5.00 M		$41.40 M	$46.40 M	-$28.56 M	Never	Never
25	**RDOF Grant**	$35.52 M	60%	6,307		$18.00 M		$28.00 M	$46.00 M	-$7.10 M	Never	Never
26	**Both Grants**	$35.52 M	60%	6,307		$23.00 M		$25.00 M	$48.00 M	$0.90 M	Never	Year 20

Hybrid Fiber / Wireless

27	**60% / 30% No Grant**	$10.54 M	60% / 30%	2,348	3,959		$1.80 M	$10.18 M	$11.97 M	$2.94 M	Year 5	Year 17
28	**With DEED Grant**	$10.54 M	60% / 30%	2,348	3,959	$4.58 M	$0.96 M	$5.43 M	$10.96 M	$9.03 M	Year 4	Year 10
29	**With Both Grants**	$10.54 M	60% / 30%	2,348	3,959	$9.17 M	$0.65 M	$3.68 M	$13.49 M	$14.46 M	Year 4	Year 5
30	**Higher Interest Rate**	$10.54 M	60% / 30%	2,348	3,959		$1.81 M	$10.28 M	$12.09 M	$2.47 M	Year 5	Year 17
31	**Shorter Loan Term**	$10.54 M	60% / 30%	2,348	3,959		$1.84 M	$10.40 M	$12.24 M	-$0.46 M	Year 5	Year 16
32	**Lower Prices**	$10.54 M	60% / 30%	2,348	3,959		$1.83 M	$10.35 M	$12.18 M	$0.91 M	Year 5	Year 19
33	**55% / 25% Penetration**	$10.22 M	55% / 25%	2,348	3,959		$1.78 M	$10.08 M	$11.85 M	$0.30 M	Year 5	Year 20
34	**No Contingency**	$10.31 M	60% / 30%	2,348	3,959		$1.75 M	$9.93 M	$11.68 M	$3.19 M	Year 5	Year 16
35	**35% / 25% Penetration**	$9.39 M	35% / 25%	2,348	3,959	$4.11 M	$0.95 M	$5.38 M	$10.43 M	$2.14 M	Year 13	Year 16
36	**Muni Financing**	$10.54 M	60% / 30%	2,348	3,959	$4.58 M		$8.60 M	$13.18 M	$11.73 M	Year 4	Year 7

Small Town Fiber

37	**60% All Fiber**	$9.76 M	60%	2,348		$1.77 M	$10.05 M	$11.82 M	-$7.19 M	Year 17	Never
38	**With DEED Grant**	$9.76 M	60%	2,348	$4.58 M	$0.93 M	$5.30 M	$10.82 M	-$0.09 M	Year 13	Year 21
39	**With Both Grants**	$9.76 M	60%	2,348	$9.17 M	$0.62 M	$3.50 M	$13.28 M	$6.25 M	Year 13	Year 8
40	**Breakeven Penetration - 61%**	$9.80 M	61%	2,348	$4.60 M	$0.98 M	$5.55 M	$11.13 M	$0.18 M	Year 13	Year 20
41	**Price Breakeven - +$1**	$9.76 M	60%	2,348	$4.58 M	$0.92 M	$5.23 M	$10.73 M	$0.30 M	Year 13	Year 20
42	**Higher Interest Rate**	$9.76 M	60%	2,348	$4.58 M	$0.94 M	$5.35 M	$10.88 M	-$0.49 M	Year 17	Year 22
43	**Shorter Loan Term**	$9.76 M	60%	2,348	$4.58 M	$0.96 M	$5.43 M	$10.96 M	-$1.07 M	Year 14	Never
44	**No Contingency**	$9.52 M	60%	2,348	$4.58 M	$0.92 M	$5.20 M	$10.58 M	$0.14 M	Year 13	Year 20