Lincoln County, Minnesota

Broadband Feasibility Study

December 22, 2017

Finley Engineering
CCG Consulting

Table of Contents

EXECUTIVE SUMMARY

Finley Engineering and CCG Consulting submit this report of our findings and recommendations for the feasibility of finding a broadband solution for those parts of the county without broadband today. The county is typical of many rural counties where a substantial part of the county has or will soon have good broadband, including fiber, while other parts of the county have little or no broadband. This disparity in broadband coverage will eventually harm those portions of the county without broadband and you can expect those areas to suffer lower housing prices and become places where families and business don't want to be located.

Our study area looked at the feasibility of bringing broadband to the parts of the county that are not expected to have fiber construction over the next few years. In Lincoln County that means the rural areas served Frontier Communications and CenturyLink. The western part of the county is served today by Interstate Telephone Cooperative, and those areas are expected to get fiber. The study area also excludes all of the towns in the county except Arco since the other towns are served by Mediacom.

We then looked at two different business plan scenarios for getting broadband to everyone: building fiber everywhere and building a hybrid network that is a mix of fiber and fixed wireless. Finley Engineering developed estimates of the cost of deploying each network option and CCG used these costs in the financial business plans to see if there is an economically viable model for providing broadband in the rural areas.

The primary purpose of the study was to determine the breakeven penetration level for the rural study area. This represents the number of customers necessary for the scenario to always remain cash positive throughout the life of the financing. This analysis told us the following:

- It does not look to be economically feasible to build fiber to the study area without significant grant funding. This is not a surprising finding and is directly the result of the high cost of building fiber to farms.
- The scenarios that mix fiber and wireless technology look feasible. The scenarios can work even without grant funding, but some level of grant funding make the scenarios safer for an investor.

The wireless network designed by Finley is intended to supply at least 25 Mbps download to rural homes in the county, which is a significant improvement for those homes with no broadband today. Some customers will be able to get speeds faster than that on the wireless network.

However, implementing a wireless network would not be a permanent solution. All of the broadband trends in the country show that the amount of bandwidth needed by a typical home will keep growing, and at some point in the future the wireless network will become obsolete in the same manner that happened in the past with dial-up and DSL broadband.

The report discusses the next steps the county needs to take after digesting the results of this study. These include such things as looking for a partner to bring broadband to those areas without it today. The goal would be to have a partner by next year to hopefully be ready for future state grant funding.

FINDINGS

Following are the key findings of our investigation:

THE PROBLEM

Lack of Rural Broadband: As the county already knows, there is a glaring lack of broadband in some rural parts of the county today. The county shares one characteristic that we are starting to see all over the country in that some parts of your county have, or will soon have, fiber while others have practically no broadband options. That kind of contrast will have long-term negative impacts on housing values and quality of life in the areas without broadband.

BASIC FACTS ABOUT THE COUNTY

The Study Area: The study area covers those parts of the county that don't have good broadband today and that are not expected to get fiber in the reasonable future. The areas in the western part of the county served by Interstate Telephone Cooperative were not included in the study area since they are expected to get fiber. That includes the towns of Hendricks and Lake Benton. The towns of Tyler and Ivanhoe were also excluded since they have fast broadband. We have provided a cost estimate for building fiber to those two towns in case a service provider is interested. The study area is then all of the remaining rural parts of the county that today get telephone service from Frontier Communications or CenturyLink. A map showing the full study area is included as Exhibit II.

Potential Customers: 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. We counted businesses in the service area by using a database provided by the state. The number of passings (potential homes and businesses) in the study area is 901. We note this is a small number of customers, which makes it harder to find a solution. It's likely that the only long-term solution for serving this number of customers spread over a wide area is by edging out from an existing service provider.

Road Miles: To bring fiber to the whole study area would require building fiber along 401 miles of streets and roads. It is probable that a final fiber design might find ways to pare a few of those miles and still reach everybody, so our projected fiber investment is conservatively high. Within that total there is an 18-mile fiber backbone.

THE POSSIBLE SOLUTIONS

Scenarios Studied: The study looked at two possible engineering solutions to bring broadband to the parts of the county that don't have good broadband today.

Build Fiber Everywhere**:** We first looked at the cost of building fiber everywhere in the study area.

Hybrid Fiber/Wireless Everywhere: We also looked at a scenario that would bring fiber to customers in Arco and those living near to the fiber backbone. Everybody else would be served using point-to-multipoint wireless broadband.

ENGINEERING FINDINGS

Backbone Fiber Network: The all-fiber and hybrid scenarios each include the construction of a fiber backbone. This is a fiber that is used not only to serve customers but also to provide a connection between network huts and towers in the various designs. Ideally a backbone fiber would be designed in a ring configuration so that it could continue to function in the case of a fiber cut. The recommended backbone fiber in the analysis is 17 miles long and built with 96 fibers to accommodate future growth. It's possible in the future that the telcos in the area could work together to create a ring.

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 each of the two different scenarios. These assets assume the business would have a 70% customer penetration rate. These asset costs would increase or decrease along with higher or lower numbers of customers.

Full Study Area	All Fiber	Hybrid
Fiber & Drops	$7,677,631	$ 707,509
Electronics	$ 708,431	$ 597,410
Huts/Towers	$ 131,698	$ 267,048
Operational Assets	$ 203,362	$ 182,171
Total	$8,721,122	$1,754,138

BUSINESS PLAN RESULTS

The county's hope for the project was to find solutions that can bring broadband to the county and that are financially sound, meaning that they can generate enough cash to be solvent. The county also has a goal of eventually bringing fiber to everybody.

Penetration Rate: The penetration rate is the percentage of potential customers in the study area that buy service. We began the study process using an arbitrary penetration rate of 70%. We then determined the needed penetration rate to make each option financially sustainable, and called this the breakeven penetration rate.

Business Plan Results

There are detailed financial summaries of the various business plans in Section III.B of this report. Following is a high-level summary of the two scenarios studied:

Full Study Area - Fiber: It doesn't look financially viable to immediately build fiber to the whole study area.

Hybrid Fiber and Wireless: This scenario looks to be financially viable. With zero grant funding this scenario can break even with a 50% customer penetration. Grant funding would make the project even safer.

RECOMMENDED NEXT STEPS

We recommend the following next steps:

1. **Find a partner(s)**. The very first step is to look for one or more operating partners. 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 as well as looking around for other potential partners to prepare for any possible DEED grants awarded next year, though there is no guarantee that the state will continue this grant program that's now in its fourth year. The hybrid fiber/wireless looks to be financially viable even without a grant, but our experience is that grants are what entice service providers to tackle new service territories.

2. **Be prepared to provide assistance to service providers.** The grant process requires a showing of customer and community support. The county should be prepared to help service providers by seeking customer support for the grants. There are steps that the county could take to improve the chances of getting grants in future years. The county might consider conducting a survey in the study area that would help to provide support for a grant filing. The county could also instead help to organize a marketing and pledge drive to get customers to presubscribe for broadband, if it's built.

3. **Educate and motivate the public**. We've always 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. The county could form a citizen's group of those living in the areas without broadband. Such a group might need some minor county funding for such efforts as explaining the need for broadband to citizens as well as gathering support from the public. We have seen such groups be effective in other communities.

4. **Be persistent.** There will probably not be one service provider to step up and serve everybody that needs broadband immediately. A more likely scenario is that the existing telcos or some other company will build into the study area slowly over time, perhaps with a series of DEED grants. This means that you can't get complacent and assume that by doing this study your job is done. You will probably need to work at this over multiple years to make sure that everybody gets broadband. These study results also show that it is unlikely that somebody is going to immediately build fiber everywhere. Even in the hybrid scenario there are a significant number of households that might get fiber, but the county is going to have to make a long-term commitment to keep pushing to get fiber everywhere

– an effort that might easily take a decade or more, until every home and business has the broadband the county thinks is needed.

5. **Consider the possibility of providing some county funding.** If no service provider seems willing to bring the desired broadband, the county needs to consider the option of providing some funding assistance. This was done recently in Swift County – the government there contributed a significant amount of bond funding to help finance the project. Yellow Medicine County also has offered funding to Farmers Telephone Cooperative to assist in building fiber. These companies expect the revenues of the projects to be able to cover the bond payments. There was something similar done a few years ago when Sibley and Renville counties contributed 25% of the cost of building a broadband network. In all these cases it was that pledge of financial support from the county that enabled the service provider to borrow the remaining needed funds.

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. Incumbent Providers

The county has numerous incumbent cable and telephone companies service different parts of the county. A map showing the service areas of the incumbent telcos is included as Exhibit I. Historic telephone service in the county was provided by a combination of Frontier Communications, CenturyLink, and the Interstate Telephone Cooperative. The cable TV service provider in the towns is Mediacom.

Incumbent Telcos

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

> **CenturyLink** is the third largest telephone company in the country with headquarters in Monroe, Louisiana. In the county the company only serves the rural areas in the northeast part of the county outside of Minneota. Several years ago the company purchased Qwest, which was formerly Mountain Bell and US West, and was part of the Bell Telephone system. The company provides service in and around Lincoln. CenturyLink had annual revenues in 2016 of $17.5 billion.
>
> As the incumbent provider, CenturyLink is considered the "provider of last resort" in its service areas. This means that CenturyLink is required to serve all residential and business customers for basic local services, and it must provide facilities to all customers. The rules that govern the way that CenturyLink serves customers in the county are embodied in their "General Customer Services Tariff," which is approved by the Minnesota Public Utilities Commission. This tariff contains all of the regulated products and prices, along with the terms and conditions under which CenturyLink will sell them to customers. The tariff sets forth rules for such customer service procedures as the manner and amount of customer deposits, the rules by which they will disconnect service for nonpayment, and the rules by which they will reconnect service. We'd like to note here that a recent trend is to get states to deregulate many services as competitive and take them out of the tariff; the Minnesota tariff has had many products removed in recent years.
>
> As a telco, CenturyLink sells the full range of residential and business voice services. CenturyLink also sells data products. They sell traditional TDM voice services based upon multiples of T1s. They also sell high-speed DSL service. In rural markets, for the last decade CenturyLink has provided DSL speeds of between 1 and 15 Mbps. CenturyLink has been upping those speeds in some markets by installing new DSL equipment. For instance, in some parts of the Twin Cities CenturyLink now supports DSL products with speeds up to 25 Mbps. DSL speeds are advertised in terms of "up to" speeds and customers

can get slower speeds than the speeds advertised. Some of the factors contributing to slower speeds include the distance the customer is from the CenturyLink central office, and the age and size of the copper wiring in a neighborhood. CenturyLink also builds fiber to some business customers and can sell a gigabit speed broadband.

In recent years CenturyLink has invested significant capital in improving data speeds in metropolitan areas. For example, in 2016 the company built fiber to pass 900,000 homes in major markets like Seattle, Phoenix, Denver, and the Twin Cities. There is no expectation that they are ready to invest in fiber in smaller markets.

CenturyLink also offers cable TV where the broadband is fast enough. Under the Prism trademark they are delivering cable over bonded pairs of copper using DSL and IPTV technology. In most markets CenturyLink partners with DirecTV for a cable product. The CenturyLink technicians install the satellite service and CenturyLink bills for the DirecTV on the telco bill. They also give a bundling discount, making it cheaper to buy DirecTV through CenturyLink than buying it direct.

CenturyLink accepted money from the Connect America Fund (CAF II) to enhance the DSL in rural markets. However, according to the FCC website for the award of this money, it's only going to benefit a few homes in the county. Those homes should be getting a DSL boost to at least 10 Mbps.

Frontier Communications serves the largest area of any other service provider in the county. Frontier is the fifth largest telephone company in the US after a recent purchase of Verizon customers. In the county Frontier serves the towns of Arco, Ivanhoe, and Tyler. It serves the rural areas around those towns as well as the rural areas around Canby and Porter.

The company changed their name from Citizens Communications Company in 2008. Frontier Communications has grown through acquisitions and continues to buy customers. 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.

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. At the end of the first quarter of 2016, Frontier had 3.4 million total customers that included 2.5 million broadband customers. For the first quarter of 2016, the company had revenues of $1.36 billion.

Much of Frontier's footprint nationwide is rural. Frontier is working to maintain and offer services over aging copper cables in the county and elsewhere. Frontier provides service in rural areas using DSL and, like elsewhere in the county, much of the DSL is of older types that can offer speeds of up to 12 Mbps download, but much of it with speeds only up to 6 Mbps.

Frontier also accepted money from the Connect America Fund to enhance DSL speeds in the county as well as in other parts of Minnesota. This will be discussed in more detail elsewhere in this report.

Interstate Telecommunications Cooperative Inc. is a member-owned cooperative serving a significant portion of east central South Dakota and a small portion of southwestern Minnesota. The company serves three exchanges – Hendricks, Lake Benton, and the areas around East Elkton – in the western part of Lincoln County.

The company is working on USDA Rural Utilities Service loans in the amount of $24.9 million to upgrade its plant and complete a fiber to the premise network to provide enhanced broadband services for its customers. The company received a grant award in 2015 from the Minnesota Department of Employment and Economic Development (DEED). The Border-to-Border Broadband Development Grant funded a portion of a state-of-the-art broadband project serving residential and business customers in the town of Hendricks MN.

Cable TV Providers

Mediacom is large cable company with corporate headquarters in New York City. Medicom is the incumbent cable provider in Hendricks, Tyler, Ivanhoe, and Lake Benton. 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.

The company reported earnings for the first quarter of 2017 of $463 million. The company has 1.37 million total customers and 1.2 million broadband customers. Many of the company's systems are older but it has been reported in the press that they plan to increase speeds nationwide.

Dish Network is a large satellite provider and has customers in Lincoln County. The company has around 14 million customers nationwide and annual revenues of over $14 billion. The company has average customer revenues of over $80 per month. Dish Network can be bought as a standalone service and is also available as a bundle for CenturyLink 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.

DirecTV is one of the largest cable providers in the US with more than 20 million customers. DirecTV merged with AT&T in 2015.

In Lincoln County, DirecTV is available as a standalone service and is also available as part of a service bundle with CenturyLink.

WISPs (Wireless ISPs)

There are also existing ISPs that deliver broadband using point-to-multipoint radios. This technology will be described in more detail in Section II below. There are numerous WISPs that offer this technology, including a number of them in Minnesota.

Satellite Data

There are a number of satellite providers available in the county. In each case, the availability depends upon the ability to have a clear line of sight from a satellite dish to the satellites. The top four providers in the country are Exede (which also markets under the name of Wildblue), HughesNet, DishNet, and StarBand. In general, there are several issues with using 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 any real-time applications such as streaming video, voice over IP, gaming, web sites that require real-time such as education courses and testing, or 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 you to maintain a constant connection will perform poorly, if at all, with a satellite connection. The second biggest issue is the small 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. Finally, the service can be expensive. Here is a short summary of the four providers:

Exede (Wildblue): Exede uses the newest satellite and uses technology that has meant a significant increase in download speeds. Exede touts speeds up to 17 Mbps download although customer reviews say the average speed is more like 12 Mbps. Still, that makes it the fastest satellite service. They also tout an upload speed of almost 5 Mbps. The company launched a new satellite, ViaSat II, that will allow for services up to 200 Mbps. But most customers on the new satellite will probably stay on the same products offered today. That satellite will go into service in 2019.

Monthly plans range from $49.99 to $129.99 per month and vary by the size of the monthly data cap. There is also a $9.99 monthly fee for the modem as well as a $149.99 installation fee. The basic package comes with a monthly allowance of 10 gigabits of total download (same as the largest cellular plans). The premium service has a cap of 25 gigabits. This puts the price per gigabit at $5.50, about half the price of cellular data. Exede does allow unlimited download at night.

HughesNet: HughesNet is the oldest satellite provider. They have recently upgraded their satellites and now offer speeds advertised as 8 Mbps download and 0.4 Mbps upload. Their prices range from $49.99 to $129.99. The smallest package has a 10 gigabit download limit per month and the largest one is 20 gigabits. When including the $9.99 cost for the modem, the premium package equates to $7 per downloaded gigabit.

DishNet: DishNet is associated with Dish networks and can be bundled with their cable product. DishNet prices range from $49.99 to $79.99. They also charge $10 monthly for the modem. They have download speeds of 7 Mbps and upload at 0.8 Mbps. The monthly caps range from 10 gigabits per month on the smallest plan to 50 gigabits on the larger plan. For the largest plan, this works out to $1.80 per downloaded gigabit, making them the most affordable satellite provider.

StarBand: StarBand is a legacy satellite provider that works on older satellites. Their prices range from $59.99 to $119.99 with a $14.99 monthly charge for the modem. Their data caps range from 1 gigabit for the smallest plan up to 5 gigabits on the largest plan. That works out to a cost of $27 per downloaded gigabit for the largest plan, making them probably the most expensive broadband per gigabit in the country.

Cellular Data

There are four primary cellular companies in the country - AT&T, Verizon, T-Mobile, and Sprint. Only Verizon and AT&T have wide coverage in rural counties like Lincoln, although there are exceptions.

We expect that some households in the county 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. Most rural 4G networks operate at about 12 Mbps download and the upload varies by service provider. There are slightly faster 4G networks which have speeds up to about 25 Mbps download, which you might think of as 4.5G, but which are mostly available today in urban areas. For both of these standards, actual speeds in the field will vary by distance from the tower as well as by how busy a tower is, meaning actual speeds in rural areas tend to be fairly slow for most customers. Actual average 4G bandwidth in the country is just over 7 Mbps. But speeds in rural areas are largely determined by how far a customer is from a cell site.

While cellular data avoids the latency issue of satellite data, it is more expensive per downloaded gigabit than satellite data and for most customers will be slower.

B. Current Broadband and Other Prices

This section of the report examines the broadband 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 no baseline cost you can compare. Further, companies have developed strategies to charge different rates to different customers.

We know from experience that prices will vary widely by customer. Over the years, customers have purchased various specials or other promotional pricing and might be charged differently than their neighbors. It seems almost counterintuitive, but the customers paying the most from most incumbents are 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, if you want to compete against these companies, you must understand that there will be a range of prices.

CenturyLink

Historically the company's telephone rates were filed under a tariff on file at the Minnesota Public Utilities Commission. A few years ago every one of their telephone customers in the county would have been billed exactly the same rate for the class of service they were using (residential and business rates are different). We would have been able to look at bills for Qwest at the time and would have seen the same rates for every resident. But CenturyLink now has bundling discounts and they also run specials, and so you will be able to find different telephone rates in town. Because telephone is so competitive, the tariffed rates are now generally viewed as the highest rate that CenturyLink can charge and there will be customers paying less than the tariff rate.

CenturyLink sells DSL for broadband and these rates have never been regulated. So the company has always been free to charge different rates to different customers for the same services.

CenturyLink does not directly offer cable TV, but they bundle DirecTV on the same bill.

Telephone Rates

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

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

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

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

CenturyLink DSL

CenturyLink provides internet in Lincoln and the surrounding area. CenturyLink sells high speed Internet using DSL technology. They sell both a bundled DSL product, meaning that you purchase it along with a telephone line, and also a "Pure" product, meaning a customer can buy just DSL. As discussed above, CenturyLink offers a lot of specials, with special rates available on their web site for new customers. But as typical with most big ISPs, a subscriber's rates will increase back to "normal" rates at the end of a special promotion. Following are some of the rates charged for residential DSL. We say some of the rates because there are certainly going to be customers in the market on older specials that have different rates than these. Note that the quoted speeds offered by CenturyLink DSL are "best effort" speeds, meaning they are not guaranteed. In fact, rural customers typically get speeds significantly slower than the advertised speeds.

Residential DSL

CenturyLink currently advertises three special DSL products on their website. These are bundled prices that assume that the customer also buys a telephone line at the full regular price.

Bundled Pricing (bundled with either telephone service or DirecTV)

Fast	From 786k to 3 Mbps Download	$14.95 to $24.95 for a 1-year contract $39.95 Regular Pricing
Faster	From 7 Mbps to 12 Mbps	$29.95 for 1-year contract $39.95 Regular Pricing
Fastest	Over 12 Mbps	$29.95 for 1-year contract $39.95 Regular Pricing

As you can see, all of the DSL has a regular price of $39.95 and the speed a customer can get is related to the specific DSL technology that is deployed in their area. In addition to the base price, CenturyLink charges $6.99 per month for a DSL modem. Customers can provide their own compatible modem to avoid the fee, but the web is full of cautionary tales of customers who were unable to get "compatible" modems to work for them.

Pure DSL

Pure DSL is CenturyLink's name for a DSL line that is not bundled with telephone or DirecTV. The CenturyLink website shows the following current prices for Pure DSL. A customer must sign a 2-year contract to get the discounts. There is one price for the first year, a higher price for the second year, and after that the customer pays the list price:

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

Pure DSL also comes with the $6.99 CenturyLink DSL modem.

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

CenturyLink Business DSL

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

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

Frontier Communications

Frontier Communications is the incumbent telephone provider that serves the largest area of any telephone provider in the county. Frontier's rates are no longer tariffed, meaning that they can offer special prices or put products into bundles.

Frontier offers cable TV through bundles with Dish Network.

Telephone Rates

Frontier offers a base price of a basic residential telephone line for $27.99. They also have

a line with features and unlimited long distance for $40.99. Both of those lines also have an extra charge of $6.50 for a Subscriber Line Charge and up to $1 for an Access Recovery Charge (ARC).

Frontier DSL

Frontier only advertises residential DSL nationwide at speeds of 6 Mbps download and 768 kbps upload.

Residential DSL pricing is listed on the Frontier website as follows:

- Add DSL to an existing phone line for $19.99 per month.
- Standalone DSL with no phone line is $34.99 per month.
- Bundled DSL with a phone line with voice mail, caller ID, and call waiting is $47.98.

DSL customers can also add a 100-channel line-up including local channels from Dish Network for $19.99.

Again, there are many customers paying prices that are different from these. There are customers who might be paying lower rates due to past specials and customers paying more than the current specials. The bad news for rural customers is that the DSL costs the same everywhere, but in some places near the edges of the DSL coverage area customers might be getting speeds that are not much faster than dial-up.

Interstate Telecommunications Cooperative Inc.

The company is a member-owned cooperative that serves the Lake Benton exchange that extends into northwestern Lincoln County. Its most recent rates are as follows:

Telephone

Local Service with unlimited local calling	$22.50

No long distance rates are published

Cable TV

Best Seat Broadcast Basic	$48.95
Best Seat Video	$80.95
Best Seat Premium	$92.95

Other Premium Channels are offered ranging from $12.95 to $17.95

Bundles

Best Seat Video Plus:

Includes Telephone and Best Seat Video	$114.95

Best Seat Premium Plus:

Includes Telephone and Best Seat Premium $125.95

Best Seat Video Complete:
Includes Telephone, Best Seat Video, and Vroom High Speed Internet—Up to 6 Mbps/1 Mbps $152.95

Best Seat Premium Complete
Including, Telephone, Best Seat Premium and Vroom High Speed Internet—Up to 6 Mbps/1 Mbps $162.95

Internet

Published rates for Internet service include a designation for City or Rural. The company offers maximum available speeds up to 100 Mbps download by 10 Mbps upload in most cities and some rural areas. In some rural areas, the maximum available speeds offered are up to 50 Mbps download and 10 Mbps upload.

As example, Lake Benton, MN speeds and rates are published as follows:

City	
Up to 6 Mbps/1 Mbps	$39.95
Up to 8 Mbps/1 Mbps	$44.95
Up to 15 Mbps/3 Mbps	$54.95
Up to 30 Mbps/5 Mbps	$64.95
Up to 50 Mbps/10 Mbps	$89.95
Up to 100 Mbps/10 Mbps	$124.95

Rural	
Up to 6 Mbps/1 Mbps	$39.95
Up to 8 Mbps/1 Mbps	$44.95
Up to 15 Mbps/3 Mbps	$54.95
Up to 30 Mbps/5 Mbps	$64.95
Up to 50 Mbps/10 Mbps	$89.95

Mediacom

Mediacom is the incumbent cable TV provider in part of Lincoln. They offer the triple play products either standalone or in bundles. Following are their most recent prices from the end of 2016.

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

Residential Broadband

Launch	Up to 3/512k Mbps	$29.95	150 GB data cap
Prime	Up to 15/1 Mbps	$49.95	250 GB data cap
Prime Plus	Up to 50/5 Mbps	$59.95	350 GB data cap
Ultra Internet	Up to 100/10 Mbps	$79.95	999 GB data cap
Ultra Plus	Up to 150/20 Mbps	$99.99	2 TB data cap
Ultra 400	Up to 400/20 Mbps	$199.99	4 TB data cap

All broadband products also require the lease of a cable modem for $7.50/month.

Cable TV

Basic	$29.95
Family TV	$72.95
Prime TV	$88.95
Local Surcharge	Varies by market, up to $8.
Regional Sports Surcharge	Up to $3.

Bundles

The company has very large bundles such as the following:

Xtream Silver
Prime Plus Internet, DVR, Family TV, Phone, Voicemail $169.98

Xtream Gold
Prime Plus Internet, DVR, Movies, Family TV, Phone, Voicemail $189.98

Satellite Data

Satellite data is very expensive, but not quite as costly as cellular data. The best broadband prices for downloading 1 gigabit of data from the four major satellite providers are: Exede at $5.50 per gigabit, HughesNet at $7.00, DishNet at $1.80, and StarBand at an incredible $27. All of them have tiny monthly data caps and they generally cut a customer off for the rest of the month once the cap is hit.

C. The Connect America Fund

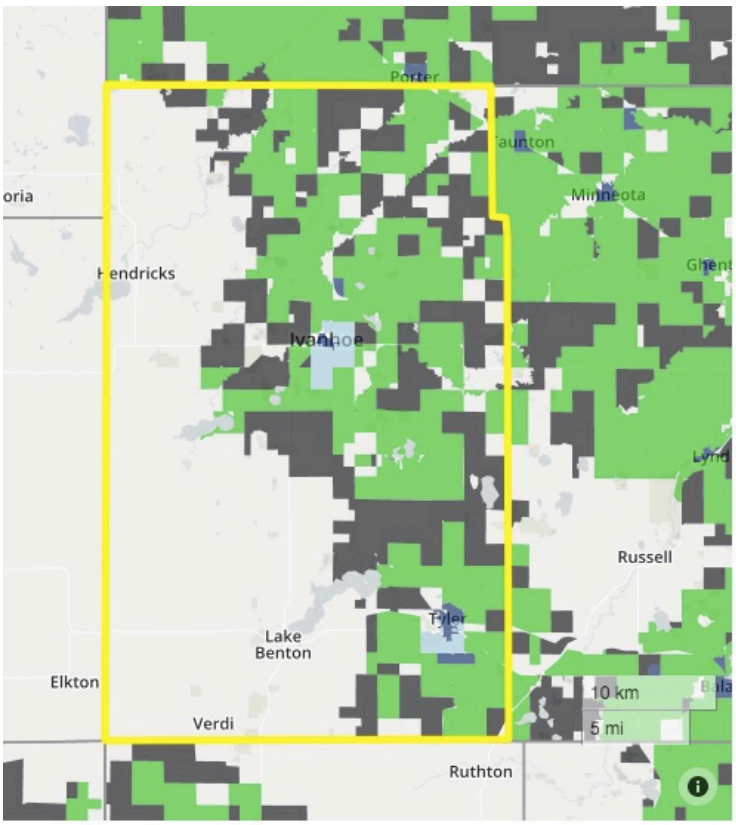
There are two federal broadband programs that come from the Connect America Fund, which is part of the FCC's Universal Service Fund. Funding from these two programs will be used to improve broadband in some parts of the county.

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 six 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 awarded $390,6518 per year for six years, or a total of $2,233,326 to expand broadband in Lincoln County. CenturyLink accepted funding of $18,430 per year to bring better broadband to 15 households in the rural part of the county. Frontier Communications accepted $372,221 per year to bring better broadband to 386 customers in the rural parts of their service areas.

Both companies originally said that they plan to use the money to improve rural DSL to the affected customers. But more recently Frontier has said that they might use point-to-point radios to meet their CAF II obligations. CAF II 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—25 Mbps download and 3 Mbps upload. Following is a map of the areas that are supposed to get CAF II upgrades, shown as green.



County Summary

Lincoln County, MN

Total Price Cap (PC) County Locations: 2,138

PC Carrier	State	Eligible Locations	Support Amount
CenturyLink	MN	15	$18,430
Frontier Communications	MN	386	$372,221
Total		**401**	**$390,651**

Minnesota State Summary

PC Carrier	Eligible Locations	Support Amount
CenturyLink	114,739	$54,035,149
Consolidated Communications	4,266	$2,516,502
Frontier Communications	46,910	$27,551,367
Windstream Communications	4,440	$1,519,856
Total	**170,355**	**$85,622,874**

Map Legend

- Eligible
- Ineligible - Exceeds Threshold
- Ineligible - Below Benchmark
- Ineligible - Other
- Elected Frozen

These upgrades will create some dilemma for any other provider that wants to bring broadband to the rural parts of the county. The customers affected by CAF II funding are rural and have no broadband today. That means that the customers in the CAF II areas will be glad to have something faster than dial-up. However, the DSL speeds that are required by the program are already inadequate today for many homes. When considering that household demand for broadband has been growing at a rate that doubles every three years, by the end of six years these areas will have four times the demand for broadband than they have today. But one would expect these companies to get some customers in these rural areas, making it a bit more of a challenge to a competitor that doesn't have faster speeds or similar prices.

The other Connect America Fund program has a much greater impact on the county. The program is called ACAM and is awarded to the smaller telcos in the country. Companies accepting the ACAM funding have 10 years to use the funding, with 2017 to be the first year. It is expected that Interstate Telephone Coop will use ACAM funding to help bring fiber broadband to their service areas.

D. The Consequences of Poor Broadband

As the county is already aware, there is a glaring lack of broadband in a lot of the rural parts of the county. But like many counties in Minnesota there are also 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 Woodstock Communications will have fiber while those nearby will not. And while the towns in the county don't have fiber, they are served by Vast Broadband with a cable TV network that was recently upgraded to offer speeds up to 200 Mbps.

It's also important to note that the rural customers covered by this study have no good broadband options today. These customers are outside of towns and don't get cable broadband. And they are far enough outside of town to not receive CenturyLink or Frontier DSL, which extends for a few miles from locations that have a DSL hub. For most of the rural areas on our study most customers don't have any landline broadband speeds faster than dial-up. There are some rural customers that can get fixed wireless service provided by point-to-multipoint radios. The quality of this broadband can vary widely around the states; we've seen speeds as slow as 1 Mbps or as fast as 50 Mbps. Customers that can't get any of these products are left with buying satellite broadband, using their cellphones for broadband, or having no broadband at home.

There are significant economic implications for having parts of the county without good broadband. 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. This means it is going to become hard to attract people to live in the rural parts of the county and, more significantly, homes without broadband are going to become harder to sell. 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 Lincoln County, this might mean that the rural areas without 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. And it is likely that this will lower the property values in the areas without broadband.

This also has implications for economic development. For example, it's not hard to foresee companies that would rather operate in a part of the county that has fiber rather than locating in places that don't have it.

- Education: 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 15 Mbps, but which tiny data caps that make it impractical for a home with children. 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 cellphones 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.

- Working at Home: More and more jobs today can be done at home, even if only part time. But people living without adequate 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.

  Many of your residents commute to jobs in other counties and many of those employers 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 a lot of 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: There has been talk for well over a decade of the Internet improving medical care in rural areas and for the elderly. We are finally starting to see some of this come to pass. There are now the beginnings of telemedicine in rural Minnesota and other rural areas where patients are able to connect to specialists in the urban areas without having to make the long drive in for an appointment. We now see support for children with special needs being provided by Skype. Over the next decade, telemedicine is expected to become routine. For residents without good broadband in their homes, telemedicine is being done from doctor's offices in county seats and other towns with broadband.

  One of the most recent and common uses of broadband in the medical world is using medical telemetry devices, which might be something like a specialized Fitbit, that 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%.

  In the last few years there have been over 100 start-up companies exploring technologies that will allow people to stay in their home longer as they age. Most of the new technologies being explored involve the use of real broadband. There are dozens of different approaches being investigated and it's certain that some of these technologies will be in play within the coming decade. This is one use of broadband that looks to be sufficiently funded because these new technologies are competing with the extraordinarily high cost of moving elderly people to institutional care.

- Agriculture: The agriculture industry is starting to rely on broadband to a significant degree. There are numerous new inventions like drone farm equipment, sensors that monitor crops or livestock, or useful software services in the cloud that are of huge benefit to farmers. Farming areas without broadband are going to be at a competitive disadvantage to those with broadband. It's expected that the use of sensors and monitors that look at soil wetness, pests, nutrient levels and other key metrics will have significantly higher yields than farms using older technologies.

- 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.

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 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. 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.

II. ENGINEERING DESIGN AND COSTS

Finley Engineering performed an engineering analysis and prepared a cost estimate of the cost of building broadband in unserved and underserved parts of the county.

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 plans to bring fiber in the next few years. We started by looking at maps of existing service levels and found that the city limits of Tyler, Lake Benton, Hendricks, and Ivanhoe meet the state's 2026 goal of 100Mbps download and 20Mbps upload. These areas were excluded from some versions the study.

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

1. Interstate Telecommunications Cooperative, Inc. – Working on RUS funding to complete FTTH buildouts in their exchanges. They operate the Lake Benton, East Elkton, and Hendricks exchanges that cover the western half of the county. These areas are excluded from all portions of the study since they plan on starting fiber construction by no later than 2020.
2. Mediacom – They provide service generally within the city limits of Ivanhoe, Lake Benton, Hendricks, and Tyler over their existing cable plant with speeds of up to 150 Mbps. Mediacom has been upgrading their networks with new electronics to provide increased levels of service. Since Tyler and Ivanhoe are not also served by Interstate Telephone Cooperative we have also provided an estimate of the cost to build fiber in those towns in case some service provider is interested.
3. Woodstock Communications – The company operates the Ruthton exchange that has a very small footprint in the county along the southern border. This area was excluded from the study since they have already built fiber to serve the customers in this exchange.

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 following number of rural passings as 901.

Road Miles: 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. These are roads that are maintained all year, meaning they are plowed when it snows. Our study is conservative in that it assumes that

fiber would be built along 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.

Basic Network Design

Fiber Backbone

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

The backbone we have chosen is 18 miles long. Obviously other routes could be chosen to reach the same or similar locations. 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 from a single fiber cut. The remaining areas of Lincoln County are shaped such that redundant paths would only be feasible on a full FTTH build where smaller distribution fibers could be utilized to create these paths. A ring configuration for the backbone would not make economic sense due to the long narrow shape of the study area. For a hybrid fiber and wireless network, it would likely be cheaper to connect with a larger provider or providers at multiple points in the network to provide these redundant connections.

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, the backbone might not be needed or would be constructed in a different manner. 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 by 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 two locations to house equipment and fiber optic splitters for distribution to subscribers. Again, the buildings could be located elsewhere, but we think two nodes are the best design for reaching all homes with fiber utilizing a centralized design that would maximize bandwidth capabilities.

1. North Remote – Located north of Ivanhoe, would serve the northeastern portion of the county. Ivanhoe may be omitted in some versions of the study; however, the node would still be required due to the distance limitations of the FTTH electronics.
2. South Remote – Located north of Tyler, would serve the southeastern portion of the county. Tyler may be omitted in some versions of the study; however, the node would still be required due to the distance limitations of the FTTH electronics.

In all scenarios, we based pricing upon recent quotes we have received from vendors like Calix, AdTran, Clearfield, Cienna, and others. Finley is not proposing any specific vendors as we are vendor neutral. The costs chosen are representative of current electronic costs.

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

Fiber Drops

The primary reason that the study was broken into separate study areas is due to the length of fiber drops. We found that the average length of the drops in the towns were relatively short with an average length of 100 feet. But in the rest of the county the average length of the fiber drops looks to be about 400 feet and there are numerous homes that are located far off of roads. This longer drop length adds considerably to the cost of building homes to the rural areas.

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 Lincoln County, the soil is mostly soft and deep with a few areas of rock that would allow for easy construction for buried fiber. Finley determined that it is probably not any more costly to bury the rural fiber than to put the fiber on poles in those places where there are poles. An all-buried design has the added advantage of having lower future maintenance costs. The one downside to a buried network is that it is more susceptible to fiber cuts by anybody doing rural excavation near roads or at the end of driveways, and it is likely that a buried fiber network would incur these fiber cuts from time to time. This would be another reason to utilize redundant network paths as a single cut would not take the network down.

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

In the all-fiber study, we chose the locations of the huts so that no customer was more than 12 miles away from a hut, the maximum recommended distance for a signal on a FTTH network. That is 12 miles of fiber along a road, not a 12-mile circle. The study shows the need for two huts to act as PON local originating points. Which as stated earlier allows us to serve heavy as well as light bandwidth users.

The huts were designed using prefabricated buildings that are designed to weather all seasons of the year. These buildings are relatively inexpensive and allow for future flexibility.

From each hut there is a dedicated fiber built to each customer. This would allow for the option of serving customers with either Passive Optical Network (PON) electronics or with active Ethernet. 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 we priced an entirely GPON design, although some active Ethernet could easily be incorporated.

In the design, Finley used large enough fibers for each part of the network to accommodate potential customers in a given area. In a competitive environment, you are not going to know at the time of design where customers are going to be on the network. Over the long life of 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 FTTH networks, there are options for how many customers to serve from one neighborhood fiber point. The technology will allow up to 64 customers to share a PON system. Since there are not many customers in the rural areas, the rural network was designed with a 1x16 fiber split while the towns were designed with a 1x32 fiber split. Having a lower split allows the signal to travel farther. If, in the final design, there are a few customers more than 12 miles from a hut, they could be accommodated by placing them on a fiber that has a split of 1x8 or even 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 next considered a hybrid network. This network built fiber to the homes along the backbone and to homes in Arco. The design then assumes that other customers would be served using point-to-multipoint wireless technology.

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

- The ultimate goal of the county is to find a way to serve all homes and businesses in the county with fiber. Building a backbone provides the basis for future fiber expansion even if some parts of the county start using wireless technology.
- A design that includes a fiber backbone to serve the wireless towers will also connect homes and businesses on the routes we chose. We've seen several DEED grants that received funding to serve customers along similar backbone fibers.
- 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 network was designed with 5 total towers. This includes leasing space on four existing towers and building one new tower.

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 an actual network we would highly recommend doing a more detailed propagation study to determine the optimum location of the new towers. Such a study would consider trees and other details not included in our study.

For this kind of network, the towers should be as tall as possible because the taller they are, the easier it is to reach to homes. Any tower that is taller than 190 feet must be registered with the FCC and meet some additional obligations (such as having a flashing light on the top). The towers included in this study are 300 feet tall. But again, with final engineering, the heights could be changed if needed for any or all towers. Finley determined that the cost to change the height of a tower would save $48,350 per tower to instead build 190-foot-tall towers.

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 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.

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. 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. Licenses for this frequency are currently on hold from the FCC and new rules should be in place by early 2018 to promote the use of this frequency to build high-reliability wireless networks.

- 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.
- There is another wireless technology that will be available in a few years for rural wireless broadband. The frequency is referred to as white space radio and uses the same frequencies that are deployed by UHF television channels (channels above channel 13). The FCC recently finished an auction where TV stations offered their frequencies which were then sold in an auction to bidders. The frequencies were bought by the wireless carriers like T-Mobile and AT&T. Dish Networks also bought spectrum. The surprise buyer was Comcast which is now entering the wireless business and has announced partnering with Charter to do so.

  Now that the auction is over it is expected that the FCC will release some portions of this spectrum for public use. The benefit of this frequency is that it can carry a larger data signal (wider channels) as well as travel farther than existing frequencies. This frequency is not going to be available everywhere in the US, but the areas where it's likely to not be available are mostly near the oceans since some of this frequency is used by the Navy. The promise of the white space frequency is that it probably could be used to serve 50 Mbps service to about the same number of customers on a 3.65 MHz network getting 20 Mbps.

Another side benefit of wireless networks is that they don't follow 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 all they can get today is dial-up. So there could be some small amount of additional revenue available that is not reflected in the business plan.

Product Assumptions

We assumed that the all-fiber network would be capable of delivering the triple play products of broadband, telephone, and cable TV. We have assumed that the wireless customers would not be able to receive cable TV but could get VoIP.

Other Capital Costs and Considerations

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

<u>Triple Play Capital</u>

The studies all assume that any ISP that builds to these rural areas would either already be delivering the triple play elsewhere or else would be able to buy these services from one of the existing ISPs in the area. We already know that a rural business as small as this one would not be able to support the construction of a large headend building, a full cable TV headend, a telephone switch, and the other assets needed to provide those products.

The business plans include the electronics needed at the customer location to provide services. For example, in the versions that assume the delivery of cable TV, there are settop boxes provided to customers. There are also voice gateways provided to deliver Voice over IP (VoIP). These are small boxes that allow the use of existing telephone wiring and telephones served from a broadband network, nearly identical to the little devices supplied with VoIP services like Vonage.

Other Assets: The business plan also includes the other assets needed to operate a triple play business. This would include 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 spare fiber, settop boxes, ONTs, and spare cards for all the electronics.

Battery Backup: Historically, engineers designed many FTTH 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.

In one of the oddest rulings we have ever seen out of the FCC, in 2015 they ordered that every voice provider must offer a battery backup solution for customers that buy telephone service that is not delivered on copper. Here is what the FCC ordered:

- The ruling only covers residential fixed voice services that do not provide line power (which is done by telephone copper). This does not apply to business customers.
- The back-up power must include power for all provider-furnished equipment and anything else at the customer location that must be powered to provide 911 service.
- From the effective date, companies must describe to each new customer, plus to every existing customer, annually the following:
    - The solutions offered by the company to provide 8 hours of backup for phone service, including the cost and availability.
    - Description of how the customer's service would be affected by loss of power.
    - Description of how to maintain the provided backup solution and the warranties provided by the company.
    - How the customer can test the backup system.
- Within three years of the effective date of the order, a provider must provide a back-up solution that is good for 24 hours and follow the above rules.
- What all of this means is that in the future, providers are required to offer an optional battery backup plan for customers, but they will be able to charge enough to recover their costs. We have not included this cost in the study since the assumption is that the business would be able to charge the full cost of buying any such optional battery backup systems to the customer.

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 this is by far the biggest 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.

Telecom capital includes several broad categories of equipment including fiber cable, electronics for FTTH, huts and wireless towers, wireless electronics, and customer devices like cable settop boxes, VoIP gateways, and WiFi modems. In addition to capital needed for the network, there are operational capital costs predicted 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 including a 10% construction contingency in the cost of the primary assets to cover any cost overruns.

However, it is important to remember that the engineering used to make these estimates is high level. Detailed engineering is expensive and would involve have an engineer examine all places in the potential network to look at local construction conditions. But 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. Finely 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.

We have assumed that there is capitalized labor in several of the asset cost estimates. Capitalized labor is when a company uses its own employees to build an asset and then adds the cost of those employees into the cost of the asset. It has been assumed that there would be employees and/or temporary installers involved in installing service for some fiber and wireless customers (although in the initial construction this would mostly be done by contractors).

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.

Following is the capital required for the base case for each of the three scenarios at a 70% customer penetration. These represent the capital expended during the first four years, which for most projects are covered by borrowing before the business becomes cash positive. The capital costs would be higher or lower if there were greater or fewer customers than the 70% used to calculate these figures.

All-Fiber Scenario

	Full Study Area
Land	$ 40,000
Vehicles	$ 35,000
Tools	$ 25,000
Buildings	$ 131,698
Furniture	$ 1,500
Computers	$ 6,000
Settop Boxes	$ 36,927
Fiber Electronics	$ 708,431
Fiber Drops	$ 1,149,242
Fiber Network	$ 6,528,389
Inventory	$ 50,000
Capitalized Software	$ 8,935
Total	$ 8,721,122

Hybrid Fiber and Wireless

	Full Study Area
Land	$ 40,000
Vehicles	$ 35,000
Tools	$ 25,000
Buildings / Towers	$ 267,048
Furniture	$ 1,500
Computers	$ 6,000
Voice Gateways	$ 18,450
Settop Boxes	$ 2,559
Fiber Electronics	$ 316,196
Wireless Electronics	$ 281,214
Fiber Drops	$ 101,118
Fiber Network	$ 606,391
Inventory	$ 50,000
Capitalized Software	$ 3,672
Total	$ 1,754,138

Costs for Ivanhoe and Tyler

The two cities already have fast broadband provided by Mediacom and are considered as served by the State of Minnesota. However, a service provider might wish to build fiber in these cities, so

we've calculated the cost of doing so as follows:

Ivanhoe

Miles of Fiber	10.45
Passings	268

Investment at 60% Penetration:

Fiber	$ 701,278
Drops and Installations	$ 167,118
FTTP Electronics	$ 91,156
Total	$ 959,552

Tyler

Miles of Fiber	18.15
Passings	520

Investment at 60% Penetration:

Fiber	$1,218,010
Drops and Installations	$ 323,856
FTTP Electronics	$ 166,212
Total	$1,708,078

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the hardware electronics for an ONT cost $317. In the projections it was assumed that the installation would be done by external contractors. It could be less expensive to do this using existing company personnel at the service providers.

This design uses ONTs that are designed to deliver only voice and data. There are older ONTs on the market that allow for delivery of a separate analog TV data path, but newer networks assume that the cable TV offering will be digital and delivered over the IP data path. This requires the use of IPTV where video is 100% digitalized and delivered in an IP data format to the settop box. IPTV is becoming the video delivery method of choice in the fiber industry and is even being considered by cable companies. In the scenarios that considered cable TV, it was assumed that a basic settop box costs $115 and an advanced one costs $240.

Fiber Drops: Fiber drops are the fiber that connects between the distribution fiber and a customer's location. 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.

The cost for a fiber drop in the towns is estimated to cost $538 each. The much longer drops in the rural areas were estimated to cost $1,804 each.

There are ways that the nonrural drops could be done at lower cost using pre-connectorized drops. These are drops that come in preset standard lengths and that can be plugged into the ONT without the need for splicing. There could be some modest savings using this method if it's determined that the actual drop lengths are somewhat predicable and fit the available lengths of drops that are available.

It might be possible to save some on labor costs should a builder be able to somehow assemble their own construction team for the rural drops. But the prices included in the study represent recent pricing being paid in several Minnesota projects to external contractors. Starting the in the fifth year there are only a few drops added each month and it's assumed that this would be done by company technicians, for a substantial saving on labor costs.

Business Costs

We assumed that the businesses in this area would be able to use the same ONTs and drops as residences, with identical costs. There may a few businesses that would require more expensive ONTS, but that would add only a tiny amount of extra cost to the study.

Wireless Radios

Customer wireless CPE costs $484 including the cost of installation. This consists of a small dish and associated electronics. This assumption includes installation by external contractors and it's possible that this could be done less expensively with the personnel of a service provider.

Triple Play Services

We have assumed that the ISP operating this network would already be providing these services for other customers in the area. Thus, there was no cost in the model for a voice switch or a cable TV headend. To be conservative we have added in some routers and servers, but these might not be needed.

Other Assets

The business plan also includes the other assets needed to operate a triple play business. This would include new vehicles for the outside technician. The business plan includes a computer for every employee and furniture and office equipment. The business plan includes inventory, which would consist of spare fiber and spare electronics.

Backhaul Options

Each of the telcos in the area already has a backbone connection to get bandwidth to and from the open Internet. The forecasts assume that the new customers would be served by one or more of these telcos, and thus there would not be a need for a new and separate backbone connection to the Internet. This means there would be no additional transport cost, but there would be an additional cost to buy bandwidth.

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 rural customers all over the US that use their cellphone data plans as a way to get or to supplement a home broadband connection. There are several reasons why this is a major problem and concern. Cellular data is the most expensive bandwidth in the US. The cell phone companies sell it at between $8 and $15 per downloaded gigabit of data. To put that into perspective, a significant percentage of households today already download over 100 gigabits of data per month. Somebody using that much bandwidth with cellular data would be spending $1,000 a month.

The cellphone companies justify the high prices by arguing that they must limit usage to avoid network congestion. They have argued that big users tie up networks and make it hard for others to get good service. A few years ago, Michael Powell, ex FCC Chief and head of the NCTA, admitted that data caps are not about congestion but are about 'pricing fairness,' which means they are not about fairness at all, but about charging more to large data users.

We also know that data caps are about money due to the recent practice of zero-rating. That is the practice where wireless carriers will give customers unlimited access to data and video that they sponsor but count video from anybody else against monthly data caps. If you can watch all you want of DirecTV Now on your AT&T cellphone then there is obviously plenty of capacity at cell sites.

There is some validity in the cellular companies' claims in that cellphone networks were not originally designed to deliver data. The cell towers were spaced to maximize voice coverage. Data transmissions travel for a shorter distance than voice and so the data coverage from any given cell tower is not as good as the voice coverage. Further, cell towers can only handle some set number of customers for data purposes. This is why you can't get coverage when you're in a sports stadium or convention center with a lot of other people.

Another issue with cellular data is that the speeds in rural areas are not as fast as those in urban areas. Cell phone companies have made a lot of upgrades over the last decade or so, upgrading first from 2G to 3G data and then to 4G data with a few intermediate steps in between. While most urban areas now have 4G data, the vast majority of rural cell towers are still at 3G data speeds.

Like all wireless bandwidth, the speeds seen by customers is directly in proportion to how far they are from the cellular tower. Cellular data speeds diminish quickly with distance; people who are not close to a cell tower are going to get relatively slow speeds.

While we don't expect to see it deployed in the county, AT&T has begun offering fixed cellular service in places where they are the incumbent telephone company. Customers are guaranteed speeds of at least 10 Mbps down and 1 Mbps up. The broadband product is priced at $60 per month with a contract or $70 per month with no contract. Installation is $99. The product comes with a WiFi router that also includes 4 Ethernet ports for wired connections. However, there is one big drawback for this product in that it comes with a monthly data cap of 160 gigabytes per month. Extra data above this limit costs $10 for each 50 gigabytes (or fraction thereof). A household that uses these connections in the same manner as most households with landline data connections will experience bills greater than $100 per month or more.

5G Cellular

There have been a lot of press announcements recently about the upcoming 5G cellular technology and the press releases from both AT&T and Verizon would make one believe that we will be seeing gigabit speeds for cellphones. What are the real facts about 5G? Consider some of the following:

First, there is no standard yet for 5G and a standard isn't expected until late 2018. The Next Generation Mobile Network Alliance (the group that will be developing the standard) states that the standard is going to be aimed at enabling the following:

- Data rates of several tens of megabits per second should be supported for tens of thousands of users.
- 1 gigabit per second can be offered simultaneously to workers on the same office floor.
- Several hundreds of thousands of simultaneous connections to be supported for massive sensor deployments.

How does this stack up against AT&T's claims that 5G will be bringing gigabit speeds? According to OpenSignal (who studies the speeds from millions of cellular connections), the average LTE download speeds in the 3rd quarter of last year for the major US carriers were 6 Mbps for Sprint, 8 Mbps for AT&T, and 12 Mbps for both Verizon and T-Mobile. This is what we are getting today from 4G. The 5G standard is going to be aimed at improving speeds for regular outdoor cellular usage to 'several tens of megabits per second,' which means speeds of maybe 20–30 Mbps.

The gigabit hype comes from the part of the standard that will address the capability of what are called millimeter waves (very high frequencies). The 5G standard will include the ability to use high frequencies to deliver very fast speeds. However, this is a very different application than cellphones and so while everyone reading the announcements of gigabit wireless are expecting those speeds for cellular data—it will just not be the case.

The 5G standard is going to allow for combining multiple very high frequencies together to create a high bandwidth data path of a gigabit or more. But there are characteristics of millimeter wavelengths that limit this to indoor usage inside the home or office. For one, these frequencies won't pass through hardly anything and are killed by walls, curtains, and to some extent even clear

windows. In addition, the signal from these frequencies can only carry large bandwidth a very short distance—perhaps sixty feet. This technology is really going to be a competitor to WiFi while using cellular standards. It will allow the fast transfer of data within a room or an office and will provide a wireless way to transmit something like Google's gigabit broadband around an office without wires.

These millimeter waves are not going to be of any use outdoors, or at least no farther away than a patio. This technology cannot be used for roaming cellphones. The use of multiple antennas for multiple high frequencies is going to require an intricate and complicated antenna array at both the transmitter and the receiver. In any case, the distance limitations of the millimeter frequencies means this will never be used for outdoor cellphone coverage.

So the 5G standard might enable really fast speeds inside the home, at a convention center, or maybe a hotel, assuming that those places have a fast internet connection. But the 5G standard is not shooting for gigantic increases in cellphone speeds.

The problem with this kind of hype is that it convinces nontechnical people that it's a bad idea to invest in fiber because gigabit cellular service is coming soon. While nothing could be further from the truth, the positive press along with the market confusion over this are probably great for AT&T and Verizon.

Point-to-Multipoint Data

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 recommended in this report for the hybrid network designs.

There are three 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:

- 900 MHz: This spectrum has been available for this application for many years. This is the spectrum used back in the 70s and 80s to provide the bandwidth for garage door openers and cordless phones. This spectrum got saturated; in urban areas there were many stories about people opening their neighbors' garage doors when they made a phone call.

  This spectrum can still be used today in a point-to-multipoint radio system. The best characteristic of this spectrum is that it travels well through impediments like trees and it can go for a long distance—over ten miles. The down side is that, since it has a low frequency, the channels aren't very big and it can only deliver a few megabits per second of data speed.

- 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 3–4 miles from a transmitter. They have a theoretical cap of 28 Mbps on the bandwidth that can be delivered, and in ideal conditions they can achieve that much speed. But the signals are disrupted by trees and leaves and can be degraded by rain, snow, or even just heavy humidity. The ideal condition is in the flat, open southwest desert; everywhere else performs worse than the ideal.

- 3.65 GHz: The FCC authorized the 3.65 GHz–3.70 GHz frequency for trials of public use in 2006, and is just now making it available for widespread use in rural applications. This spectrum is promising because the existing trials showed that it can penetrate trees much better than the 2.4 GHz WiFi. We are recommending this frequency in this study.

  There are a few limitations of this spectrum. The spectrum cannot be used close to existing government installations or satellite earth stations that use the spectrum. Since these facilities are mostly near to a few submarine bases, it should not be an issue in Minnesota.

  The spectrum will be licensed for a very affordable $280 fee. However, the license is not exclusive and every user of the spectrum will be expected to coordinate with other users. This is not like a normal FCC license and it is not first come first serve. Everyone using the spectrum in a given area is expected to work with others to minimize interference. The FCC will act as the arbiter if parties can't work this out together.

  There are different rules for using the spectrum depending upon how it is deployed. The FCC rules suggest using radios that use other spectrum in addition to 3.65 GHz. For radios that only use this spectrum the usage is limited to the 25 MHz band between 3.65 and 3.675 GHz. Radios that allow for a shift to other frequencies when there is contention can use the full 50 MHz channel within this frequency.

  The frequency can support bandwidth on one channel up to 37 Mbps download. It's possible to bond channels within the frequency band or with other unlicensed spectrum to get even faster throughput. It's theoretically possible with bonding to get speeds of 100 Mbps.

  Radios for this frequency are readily available from most of the major point-to-multipoint radio manufacturers. The price of the base stations and customer CPE are slightly higher than the cost of radios in the unlicensed bands.

  In practical application, this spectrum can be used to deliver up to 25 Mbps at six miles from the transmitter, with more bandwidth for those customers who are closer than that. It can theoretically transmit to the horizon, but at greatly diminished speeds. The network proposed by Finley Engineering has the goal of delivering 25 Mbps or more to customers.

- 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 earlier this year, with the buyers ranging from the big cellular companies and Comcast. This was called an incentive auction, because TV stations that give up their spectrum will share in the sale of the spectrum. 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. That's easily twice as far as what can be delivered today using unlicensed spectrum. Physics limit this to about 45 Mbps of total bandwidth for a single channel, but it will be possible to bond together multiple channels. While not at fiber speeds, this spectrum can enhance rural broadband. It is likely to be at least a few more years before the FCC releases this spectrum and equipment becomes available from vendors.

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.

Microsoft's White Space Concept

As we were writing this report Microsoft proposed a concept that is aimed towards bringing white space radio broadband to the 23 million people in the country that don't have broadband. Some of the early press about the company's announcement read it to mean that the company would be launching a major broadband initiative.

But a closer reading of their whitepaper shows an idea that still has a number of hurdles to cross. Here is what Microsoft actually said in both their whitepaper:

- Microsoft will partner with telecom companies to bring broadband by 2022 to 2 million of the 23.4 million people that don't have broadband today. We have to assume that these "partners" are picking up a significant portion of that cost. Those partners could be rural telcos, electric coops, or even government entities. Microsoft is not proposing to be an ISP or a service provider.

- Microsoft hopes their effort will act as a ***catalyst*** to push white space broadband to the rest of the country. Microsoft is not themselves planning to fund or build to the remaining rural locations. They said for that to be able to happen that some combination of public grants and private money would needed to be found to do this. At this point in time there is no federal broadband funding program. Since these radios won't meet DEED speed standards they also might not be eligible for DEED grants. We also have to wonder where the commercial partners are going to be found who are willing to invest the $8 billion to $12 billion that Microsoft estimates this will cost to do this everywhere.
- Microsoft only thinks this is viable if the FCC follows their recommendation to allocate three channels of unlicensed white space spectrum in every rural market. The FCC has been favoring creating one channel of unlicensed spectrum per market. The skeptic in me says that this white paper and announcement is a clever way for Microsoft to put pressure on the FCC to free up more spectrum. If so, does that mean this will quietly die if the FCC sticks to their own proposed solution?
- The white paper admits that for this idea to work that manufacturers must mass produce the needed components. This is the classic chicken-and-egg dilemma that has killed other deployments of new spectrum. Manufacturers won't commit to mass producing the needed gear until they know there is a market, and carriers are going to be leery about using the technology until there is a standardized mass market product available. This alone could kill this idea just as happened to the FCC's plans for the LMDS and MMDS spectrum in the late 1990s. Those spectrums were touted as being good for broadband, but a market never developed.

There are a number of major hurdles that must be overcome to use the spectrum:

- First, the technology has to work. The white space band is going to carry a mix of licensed and unlicensed users. Since the spectrum carries for such great distances there is a lot more chance of interference between licensed and unlicensed users. The FCC has proposed solving this problem by using radios for unlicensed use that can sense a licensed use and that then vacate the spectrum. If this create challenges for grabbing an open channel for an unlicensed use then nobody will trust using this spectrum. There have been trial of the technology, but they were not done in a busy spectrum environment where there are a bunch of licensed users.
- Second, somebody has to be willing to fund the $8 B to $12 B Microsoft estimates this will cost. There may or may not be any federal grants ever available for this technology, and there may never be commercial investors will to spend that much on a new technology. The fact that Microsoft thinks this needs grant funding tells me that a business plan based upon this technology might not stand on its own.
- Third, the chicken-and-egg issue of getting over the hurdle to have mass-produced gear for the spectrum must be overcome.
- Finally, the FCC needs to adopt Microsoft's view that there should be 3 unlicensed channels available everywhere – something that the licensed holders are going to strongly resist. If that doesn't work then there might not be enough rural unlicensed spectrum to make this viable.

Wireless vs Fiber

In general, wireless technologies are not as good as fiber for delivering data. There are many who claim that wireless is the future and that it is a waste of time to build fiber. Most of the time people making these claims are talking about broadcast networks like cellular systems. They believe that 4G and future 5G cellular technologies are going to deliver large amounts of broadband and that fiber is not really needed. There are many reasons why that is not true; consider the following:

- In the US, the FCC has chopped almost all of our spectrum into tiny channels. This was done years ago before there was any concept of needing fast data, but these channels make it a challenge to cobble together a fast data product over wireless. To make a fast connection means tying together a number of channels at the same time from different frequencies. This can be done, but what it means in practice is that from any one cell site, only a few users can be using big wireless data at the same time.
- Wireless data capabilities drop off significantly with distance. The physics of wireless spectrum dictates that the higher the frequency, the shorter the distance that data can be sent.
- The best frequencies for sending data a long way are the somewhat longer frequencies like 700 and 900 MHz. These frequencies have small channels and can only deliver a few megabits of data. These are some of the primary frequencies used in 3G and can send out the smaller data pipes for 10 miles or more.
- The higher the frequency, the less the distance. For instance, the primary WiFi frequency is 2.4 GHz. It can send out a strong signal, perhaps 100 Mbps, but this is only good for about 150 feet from a hotspot.
- The other free frequency is 5 MHz. It can do up to about 200 Mbps, and theoretically up to almost a gigabit, but this is only good within a room. It won't travel more than about 60 feet from a hotspot.
- What these data limitations mean is that in order to have robust broadcast wireless data you must have cell sites that are close together. That means having them deep into neighborhoods. The cellular companies are already starting to build mini-cell sites in cities to get cell sites close together and ultimately there might be a few in every block. But each of those cell sites has to be fed by fiber and so it would be as expensive to build this fiber-fed wireless network in rural areas as it is to put fiber into homes and businesses.

Contrast this with fiber that has almost limitless data capacity. Today, consumer fiber networks are already delivering gigabit speeds. That is fifty times faster than the best rural wireless solution available today. There is even a 10-gigabit residential fiber product in St. Paul, which is 500 times faster than the best wireless solution. While the wireless solutions are not going to get better because they are limited by physics and not by technology, fiber can always be improved by using faster and cheaper lasers. The difference between the two technologies is so gigantic that there is no real comparison.

When people talk about gigabit wireless, they are talking about having a wireless technology that will deliver that much speed within a room. This has only been done in a lab, but those kinds of speeds will eventually be available within your living room. While there will undoubtedly be technological improvements in techniques to deliver rural wireless, those improvements will

probably increase the capacity of the signal a few times, but not nearly to the speeds that fiber can deliver today.

Not all Wireless Technologies Are the Same

One of the primary scenarios considered for this study is one where towns would get fiber and the rural areas would get wireless broadband connected with a fiber backbone built to supply bandwidth to wireless towers. Rural customers would be connected using point-to-multipoint wireless technology—meaning that a wireless beam is sent from a tower directly to a customer location.

It's important to understand that not all wireless technologies are adequate for this application. 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 and the best radios are significantly more expensive. This study anticipates a wireless network that can deliver at least 20 Mbps download to customers with the capability of providing even faster speeds to some customers who live relatively close to a tower. This means that the studies contemplate using the best radios on the market today. If a fiber network was built to bring better bandwidth to older existing radios they would not be able to deliver the same kind of bandwidth described in this study.

- **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, 3.65 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. This is why the new technology can deliver speeds up to 100 Mbps in some situations.

- **Adequate Backhaul**. A wireless broadband network has two major segments—the wireless connection to customers (last mile) and the backhaul connection that brings bandwidth to the radios on the tower. If towers don't get enough bandwidth then the amount of bandwidth available to customers is diminished.

  This study recommends radio towers that use fiber backhaul. A fiber connection is capable of providing enough backhaul bandwidth so that customers can get the maximum speeds allowed by the technology. The alternative to fiber backhaul if to use microwave radios to supply the backhaul. These generally (but not always) use a different frequency that the ones used to serve customers. Wireless backhaul can be sufficient to supply bandwidth to a tower with a reasonably small number of customers. But typical wireless backhaul

delivers up to about 800 Mbps of total bandwidth to be shared with customers. There are newer radios that can deliver up to 2 Gbps of backhaul bandwidth, but only for a short distance of about a mile, and so these radios are generally only used in urban settings.

There are numerous WISP networks that use wireless backhaul networks in a chain or ring configuration. This means that all of the towers in the chain or ring must share the bandwidth that is delivered to the first wireless tower. For example, if there was one 800 Mbps radio serving four wireless towers in a chain, then all four towers (and the customers on them) would share that one 800 Mbps connection. This is the primary reason that many rural WISPs only deliver speeds of a few Mbps to customers. Their limitation is the backhaul, not the radios.

- **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 story that a wireless technician will tell is of the inevitable slow connection caused by a pigeon or crow sitting in front of a customer dish.

DSL and Copper Technology

In the county any telco not using fiber, such as CenturyLink and TDS, 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 are more than 2 miles from a town; they are 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 as slow as 124 kbps, or just 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. Most of the copper wires in the county are 50 years old or older and have outlived their original expected service life.

Hybrid Fiber Coaxial Network

Mediacom is the only company that operates a Hybrid Fiber Coaxial (HFC) network in the county. 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 only a 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. If nodes were made as small as PON fiber networks (less than 32 homes), then the data delivery issues would be similar, but cable company nodes today are typically between 100 and 500 homes, with an average size being around 250 homes.

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. Most of the cable companies in the country are currently using DOCSIS 2.0 or 3.0 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.

Improved Satellite Technology?

There are several companies that are looking for the funding to build a newer satellite network using satellites placed in orbits much closer to the earth than the current satellites providing broadband. This would solve the latency issue discussed above. The biggest company looking at this is Elon Musk. He already owns SpaceX, the company that is commercially launching satellites. Musk says it will require a $10 billion investment to build the satellite network.

The satellites would use frequencies between 10GHz and 30GHz, in the Ku and Ka bands. Musk says that SpaceX is designing every component from the satellites to earth gateways and customer receivers. There is a detailed filing with the FCC of his plans for the network at https://cdn.arstechnica.net/wp-content/uploads/2016/11/spacex-Technical-Attachment.pdf.

The specifications say that the network could produce gigabit links to customers, although that would require making simultaneous connections from several satellites to one single customer. And while each satellite has a lot of capacity, using them to provide gigabit links would chew up the available bandwidth in a hurry and would mean serving far fewer customers. It's more likely that the network will be used to provide speeds like 50 Mbps to 100 Mbps.

Those speeds could be revolutionary for rural America. The FCC and their CAF II program is currently spending $9 billion to bring faster DSL or cellular service to rural America with speeds that must be at least 10/1 Mbps. Musk says this whole venture will cost about $10 billion and could bring faster Internet not only to the US, but to the world. Still, at this point there is no way to guess if this will ever happen or if the satellites will operate as claimed.

III. FINANCIAL BUSINESS PLAN ANALYSIS

The goal of the financial analysis was to see if there is a way to provide profitable broadband to the parts of the county without broadband. That study area excludes the following:

- The areas in the western part of the county served today by Interstate Telephone Cooperative. It is expected that these parts of the county will be getting fiber. This excluded area includes the towns of Hendricks and Lake Benton.
- The towns of Tyler and Ivanhoe are also excluded since they have fast broadband today from Mediacom.
- This means the study area is the rest of the rural parts of the county including the small town of Arco.

We looked at the following specific scenarios:

- **Build Fiber-to-the-Premise**: This scenario looks at the economics of building fiber to every home and business within the study area.
- **Hybrid Model**: This scenario builds fiber to Arco and also to any homes or businesses that are located near to the fiber backbone contemplated by the studies. The remaining customers who are the most rural are offered fixed wireless broadband.

Within these scenarios we looked at different options.

- Where an option looked financially feasible we calculated the breakeven customer penetration rate—that is the number of customers needed for a scenario to remain financially viable over time.
- We looked at different scenarios for how the various options would be improved if they could receive funding from the Minnesota DEED grants.

Finally, we looked at what we call sensitivity analysis. We wanted to see the impact of changing the other important variables in the studies. We looked at the impact of higher interest rates on debt. We also considered the impact of increasing the rates for broadband products.

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 for these business plans was to determine the breakeven scenario. This tells us the minimum number of customers needed for a given scenario to pay for itself. Breakeven is defined as a business plan with the minimum number of customers where the operating revenues always cover the full costs of operating the business – that means operating expenses, debt payments, and ongoing future capital requirements needed for growth and maintenance.

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 business line will be able to generate enough revenue to cover the full cost of entering the new market.

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 a service provider can do better than these plans by taking steps to launch the new business faster than what is shown in these projections.

Following are the major milestones as predicted by these forecasts:

- Financing: All of the forecasts assume that the financing is available in January 2018. This is illustrative only and basically establishes a starting date for the project—this could be changed to any other date as needed.

- Construction: Core construction of the network is done during the spring and summer of 2018. That doesn't mean that all of the construction needs to be finished by then and some of the rural construction can be completed in 2019.

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 being charged in the county today for faster broadband. In highly competitive markets it's sometimes necessary for a new competitor to lower rates to get customers. But in this market, particularly in the rural parts of the county, the goal should be to deliver a quality product at a fair price and not try to gain market share with big discounts.

We looked at the rates of the independent telephone companies operating in the county. This includes an analysis of the rates of Interstate Telephone Cooperative and Woodstock Telephone. We also considered the rates charged by CenturyLink, Frontier, and Mediacom. We decided to use rates that are at or close to those used by Interstate Telephone. Those rates are reasonably high, but also fair and representative of the rates that we see in other rural parts of 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

Our study used the following very simplified pricing for residential phone service:

Basic Local Line	$29.00
Line with Unlimited Long Distance	$45.00

We've assumed that both kinds of lines include a full package of features like voice mail, caller ID, etc. If a provider charged extra for these features they would probably get a little more revenue than predicted by our business plan.

The above prices include any Subscriber Line Charge that is added to the basic rate. All of the telcos in the county charge this rate today, which is a regulatory fee defined by the FCC that the telephone companies bill and keep as revenue.

Our business plan keeps the assumptions simple and the basic telephone rate includes a few dollars per month for long distance. It's been our experience recently that most customers make long distance calls using cell phones. Those that want to make many long

distance calls from a landline usually opt to buy the unlimited long distance plan. Our assumptions are probably a little conservative in that there could be some customers that still make a lot of long distance calls and pay on a per minute basis.

Our assumption in the study is that the basic line would have the same limited local calling scopes that exist in the county today. Today customers in any one telephone exchange only get free calling to a small number of other places, as shown below. Customers must pay long distance to call anywhere else on their landline. Following are the long distance calling scopes for the exchanges in and around the county today. Most customers in the county are served from telco central offices located inside the county, but a few are served from locations outside the county.

Exchange	Phone Company	Can Call for Free
Arco	Frontier	Tyler
Canby	Frontier	Porter, St. Leo
East Elkton	Interstate Coop	East Gary, Hendricks, Lake Benton, and 27 exchanges in South Dakota
Hendricks	Interstate Coop	East Elkton, East Gary, Lake Benton, and 27 exchanges in South Dakota
Ivanhoe	Frontier	None
Lake Benton	Interstate Coop	East Elkton, East Gary, Hendricks and 27 exchanges in South Dakota
Minneota	CenturyLink	Ghent, Marshall
Porter	Frontier	Canby, St. Leo
Tyler	Frontier	Arco, Ruthton

Customers buying the unlimited long distance plan would be able to call anywhere, including all parts of the county, as part of their plan. These plans today often include Canada and even some other international locations.

The above prices do not include taxes and other fees that are billed and submitted to tax authorities. This includes several state and federal taxes as well as a fee to help fund the FCC's Universal Service Fund.

The study is less specific with business phone rates. Businesses are often interested in other features that include such things as easily being able to put a call on hold or transfer calls to another phone line. Businesses also differ in terms of how many lines they buy, although

many of the small businesses in this county would likely have only one telephone line. In the models we have assumed a 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 of the county today every existing TV customer is using satellite. This means there is already a lot of competition for cable.

No small provider can really compete on price with the satellite providers and landline prices are almost always significantly higher than satellite prices. For a small company the cost to buy the programming is much higher than what is paid by the huge satellite companies. Still, some rural telcos have surprisingly high cable TV penetration rates, particularly cooperatives where customers choose to buy from a company that they also own. But it's been our experience that when any small provider moves into a new rural market a lot of the existing customers are going to elect to stay with their satellite cable product.

Small providers are at an additional disadvantage in that they are forced to raise cable rates every year since the cost of programming goes up significantly every year. For the past decade, programming costs have risen steadily by around 7% per year, but in the last few years has exceeded 10% annually for many small cable operators. This is one of the main causes of the annual rate increases done by cable companies.

What we think matters most in this kind of model is the difference between the cable retail rates and the programming costs—what is called gross margin in accounting terms. We've made the assumption in the models that this margin will stay the same going into the future. The easiest way to do that from a modeling perspective is to not increase either the cable TV prices or the cost of programming over time. That holds the margin per customer the same and it makes the assumption that any cable TV provider will pass on any increases in programming costs to customers. In recent years the majority of our clients have adopted that philosophy and have decided that they will not eat increased programming costs.

The whole industry expects that something drastic is going to change with the cable TV product during the coming decade. There is now a lot of alternate programming available on the Internet and perhaps it's expected that a lot of households will cut the cord and will not buy traditional cable products. This has been reflected in the study by showing the penetration rate for cable dropping over time. But nobody has a good crystal ball on how cable might change, so this is probably the one assumption in the study that might have the most variance compared to what has been projected in these studies.

The industry might also undergo other changes. For example, the major cable companies are now offering skinny bundles, which means small line-ups of just the essential channels that customers say they want to watch. It might be possible in the future for this business to offer something like skinny bundles and be more profitable than what is shown in the

studies. The other extreme is also possible in that it might become economically infeasible for small companies to offer cable TV. The margins on cable TV in the model are small enough that either of these two extremes would not have a major impact on the overall financial results.

The model assumes the following cable TV products. These are the basic prices offered today by Interstate Telephone Cooperative. Some other ISP that builds the area is likely to have a different price and product structure. These products would be the same for residents and businesses.

Basic Cable: $48.95. This is the line-up of network channels like ABC, NBC, CBS, FOX, and PBS plus a few other local or low-cost channels.

Expanded Basic Cable. $80.95. This is a larger channel lineup that includes most of the popular channels that customers like to watch.

Premium Cable. $92.95. This is the full channel lineup and adds additional channels.

Movie Channels: These are extra and can be added to the other packages. These are priced close to cost in the projections since there is not much margin on movie channels for small cable operators.

Pay-per-View: A few years ago pay-per-view generated decent revenue for many cable operators. But today most small cable providers either don't carry pay-per-view movies or offer them largely at cost. Many cable operators still carry pay-per-view special events like wrestling, but the amount of net margin from this is generally small and so it is not included in the studies.

Broadband Products

For purposes of this study we have mimicked the pricing of Interstate Telephone Cooperative. Note that the pricing is not specific by speed, but rather includes six tiers, from slow to fast. The models assume the following rates for fiber-based broadband:

Residential	
Tier 1	$39.95
Tier 2	$44.95
Tier 3	$54.95
Tier 4	$64.95
Tier 5	$89.95
Tier 6	$124.95
Business	
Tier 1	$49.95
Tier 2	$54.95

Tier 3	$64.95
Tier 4	$74.95
Tier 5	$99.95
Tier 6	$134.95

The study also considers a point-to-multipoint wireless product in the rural areas that is priced as follows. Interstate Telephone Cooperative doesn't offer wireless broadband and these prices mimics the pricing of MVTV, the largest wireless provider in the region. Note that MVYV's speeds range from 2.5 Mbps to 25 Mbps, but with a fiber-fed network the speeds on a new network would be faster.

Residential	
Tier 1	$49.95
Tier 2	$59.95
Tier 3	$69.95
Tier 4	$74.95
Tier 5	$99.95
Business	
Tier 1	$62.95
Tier 2	$87.95
Tier 3	$112.95
Tier 4	$149.95

Most ISPs charge more to businesses for broadband.

It's typical that customers will buy the lowest speed product they are comfortable with in order to save money. The studies assume that most customers will buy the lower several speed products.

These are 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 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.

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. Very few small ISPs impose data caps. There are data caps on CenturyLink DSL, but it's been widely reported that the company often doesn't bill for data overages.

Customer Penetration Rates

The factor that has the most probable impact on the revenues is the number of customers projected to buy services, which we refer to in the industry as the customer penetration rate.

In the forecasts, we looked at customer penetration rates in several different ways. We started the analysis using what we call expected rates. The expected rates are an estimate on our part that allowed us to build the starting models. We used an expected penetration rate of 70% as the starting point of our analysis. This is not to say that we are predicting that a broadband business would do that well in these areas. We have 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 80%, with one or two even higher. The 70% penetration rate was used to construct the first model for each scenario, but from there we then calculated the breakeven penetration rate.

There is no reason to think that the rural portions of the study area won't do as well as other rural markets we've seen. The biggest issue when considering the all-fiber of the hybrid models that include the towns is how well a competitor might do in the towns. We have seen competitive overbuilds in similarly sized towns in other parts of Minnesota that have achieved penetration rates in the range of 45% to 60%, with a few even higher – in towns that have an existing broadband provider. But it's almost certain that a new broadband network would fare much better in the rural parts of the service area than in the towns.

The only real way to understand the potential broadband penetration rate would be to do a survey or a canvass and quantify the potential customer interest in the service area in buying broadband from a new network. But we find that surveys are the most accurate once the facts are clearer. Customers are going to want to know the range of the prices being considered.

Because we can't be sure about the customer penetration rates we instead look at the penetration rate issue by calculating what we call the breakeven penetration rate. This represents the minimum number of customers that are required for a scenario to reach cash breakeven. Cash breakeven looks at the total expected cash derived from revenues and then compares it to all of the cash needs of the business, which includes operating expenses, any payments on debt and ongoing capital costs for maintaining and growing the network. We calculate the breakeven penetration rates by lowering customer penetration in the models until they reach a point where the future business cannot maintain a positive cash balance. We discuss the specific breakeven penetration rates for each scenario below.

Other Future Revenues

The forecasts also suppose that these businesses will generate additional revenue over time from business lines that are not specifically identified in the projections. As service providers continue to see declines in telephone and cable TV customers (as shown in these

projections) many of them are entering new business lines. 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.
- Managed WiFi: This is a product where the service provider helps to improve the WiFi system in homes by placing networked WiFi routers, and then also making it easier in the future to add devices to the WiFi network.

The business plan is not specific about which future products might be introduced and in fact it could be products that we don't even envision today. Since we can't know the specific products the forecasts include the net margin—the cash profits—from these future revenue sources rather than trying to predict both the revenue and expenses. The forecasts also add this slowly. For example, the forecasts predict that there will be new products of some sort sold to only 3% of customers by 2020 with an average margin for those few customers at $10 per month. This doesn't add a lot of bottom line to the model, but we are certain that over time all small ISPs will offer services that are not included in the base forecasts.

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. For example, if we predict the new business might need to hire additional staff for customer service or for field technicians we often find that existing staff at service providers are able to pick up much of the new work load without having to hire more employees.

We made the following assumptions about expenses:

Employees: Labor is generally either the largest or second largest expense of operating a broadband network (cable TV programming is the other large expense). Our models assume that a service provider will need to hire additional staff to take care of the added 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 32% of the basic annual salary. That would cover payroll taxes and other taxes like workman's 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 1/2 of a new position for the various scenarios. Obviously this only applies to an existing service provider which would add the rural customers in the county to an existing employee base.

Install/Repair Technician: This function installs new customers and visits customers for needed maintenance and repairs. We've assumed the business will need 1/2 new position for the various scenarios.

There are obviously other functions that must be done in a new business. For example, a service provider must have a general manager. There will generally be an accountant or bookkeeper of some sort. There might be intermediate management in charge of the technicians or customer service representatives. There might be full-time marketing people. But as described above, this analysis would not show these functions unless it was necessary to hire new employees due to adding the new market.

We anticipated that construction contractors will build the fiber and/or wireless networks. We've also assumed that the installations at the customer site would 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.

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 shown.

Cable TV Programming: Almost all small cable operators purchase cable signal from the National Cable Television Cooperative (NCTC), a cooperative of small cable providers. NCTC currently provides programming to nearly 20 million subscribers, meaning they get some of the best prices for programming in the industry.

As described above, in these models the assumption has been made that the gross margin on cable TV per customer will remain the same throughout the study period. This was done in the model by showing no increase in cable rates and also no increases in cable

programming costs. This assumes that the service provider will pass all programming cost increases on to customers. Should they not do this then the forecasts will perform worse than shown.

Delivery of Triple-play Products: The projections assume that the new business will not construct a headend to provide the triple play services. If the service provider is already offering these products then the assumption is that they would deliver the same product to the new customers in the same manner that they delivery to existing customers. If the county or some new provider was to operate the business it's assumed that they would buy the wholesale services from another service provider.

Since this is an incremental model the assumption is made that the service provider will pay to gain wholesale access to the products. This includes a monthly fee to pay for voice lines and a monthly fee for use of the cable TV headend.

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 entity 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. And the fee includes the help desk function, which is the function of assisting customers with broadband and network issues.

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.

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.

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 leasing space on a tower to a cellular company or 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.
- The engineering estimates include a 10% contingency. We think the estimates of construction costs are solid and this contingency might not be needed.
- If the network was constructed by "edging out" from existing telcos, then there would be some savings 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 broadband 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 service provider insists on a faster construction schedule. Basically, for these kinds of networks, the amount of network that can be built 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.
    - Evaluate Based Upon Speed to Market: Any given service provider might tackle the business plan in a different sequence than shown in these forecasts. For example, in the hybrid scenario they might determine that the fastest way to launch the business might be to deploy rural wireless customers before fiber customers.

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. There is also a table of all of the financial results included in Exhibit V at the end of the report. We 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 have cash in the bank to meet its obligations. In this particular business plan the ideal situation would be to always have at least $400,000 in the bank to have a cushion against nonlinear monthly expenditures. Not all expenditures are spent evenly throughout the year and so you need to have 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:

Fiber Everywhere

This scenario looks at building fiber everywhere. These scenarios assume normal commercial financing that would require 20% equity (cash) put into the project.

Anticipated Cost

	No Grant	W/DEED Grant	Breakeven Grant
Asset Costs	$ 8.7 M	$ 8.7 M	$ 8.7 M
Grant	$ 0.0 M	$ 4.4 M	$ 8.1 M
Debt	$ 8.1 M	$ 4.2 M	$ 0.0 M
Equity	$ 2.0 M	$ 1.0 M	$ 1.0 M
Total	$10.1 M	$ 9.6 M	$ 9.1 M
Passings			
Fiber	901	901	901
Penetration Rates	70%	70%	70%
Years until Positive Net Income	Never	Never	Never
Years until Cash Covers Debt	Never	Never	Year 25
Cash after 25 Years	($12.3 M)	($6.2 M)	$ 0.6 M

Results

- This scenario looks at three levels of grants. First is no grant funding. Second is a $5M Border-to-Border grant, which is the largest grant they will award under current rules. Finally, is a scenario showing the total amount of grants needed to reach breakeven.
- Current Border-to-Border grant rules will provide grants up to 50% of the cost of building qualifying assets.
- Note that the third scenario is illustrative only. You can't know the precise amount of grant versus telco contribution to the project until you are negotiating with a specific telco. This particular scenario assumes that the telco supplies $1 million with the rest coming from a combination of Border-to-Border and County grants.
- It doesn't look financially viable to immediately build fiber to the whole study area. This might possibly work if the Border-to-Border grant matching can be increased above 50% (higher grant matching levels have been discussed by the state).

Hybrid Fiber/Wireless

This scenario looks at building fiber to Arco plus to rural customers living near the backbone fiber used to create the fiber backbone and to support the wireless towers. The scenario would provide broadband to the rural areas using point-to-multipoint radios. These scenarios assume normal commercial financing that would require 20% equity (cash) put into the project.

Anticipated Cost

	No Grant	Full Grant
Asset Costs	$ 1.8 M	$ 1.8 M
Grant	$ 0.0 M	$ 0.7 M
Debt	$ 2.0 M	$ 1.3 M
Equity	$ 0.5 M	$ 0.3 M
Total	$ 2.5 M	$ 2.4 M
Passings		
Fiber	100	100
Wireless	801	801
Total	901	901
Penetration Rates	70%	70%
Years until Positive Net Income	Year 4	Year 3
Years until Cash Covers Debt	Year 11	Year 8
Cash after 25 Years	$ 2.8 M	$ 3.7 M

Results

- In this scenario the project would be eligible for a Border-to-Border matching grant of up to $730,000.

- The assumed 70% penetration rate is probably a realistic goal considering that none of the houses and businesses in the study area have good broadband today.
- This scenario looks financially feasible and can be profitable for the service provider.

Breakeven Analysis

Probably the most important result from the financial analysis is to understand the breakeven penetration rate needed to make each scenario viable. Breakeven is defined as a business case where the business always maintains positive cash flow, meaning that the revenues of the business cover the operating expenses, debt payments, and ongoing operating capital costs. Knowing the breakeven penetration rate is important because it allows assessment of the risks of the project.

The results of the breakeven analysis are as follows:

> **All Fiber**: There does not appear to be any scenario where building fiber everywhere can achieve financial breakeven with the existing DEED grants.
>
> **Hybrid Fiber & Wireless**: For the rural study area the breakeven penetration rate, even without a grant, is 50%. That seems easily achievable considering that none of the study area has good broadband today. We didn't calculate the breakeven with a grant, but it has to be down in the mid-30% range—something that would be easily achievable.

Sensitivity Analysis

While each of the financial forecasts is based upon numerous assumptions, only a few of these 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 significantly if changing the interest rates on debt financing.

The following sensitivity analysis looks at the impact of changing those assumptions that can most affect the results. We looked at the sensitivity analysis using the hybrid scenario. Since the all-fiber scenarios do not look to be profitable, we are not showing the sensitivity results for those scenarios here, but they are included in Exhibit V.

The sensitivity analysis specifically tested the following variables:

- Changing the customer penetration rate
- Changing the interest rate on debt.
- Changing customer data prices by $5 per customer per month.

Following are the results of each of these scenarios, compared to the base expected case. This comparison lets you see the bottom line impact of each change.

Sensitivity Analysis for the Hybrid Scenario

With a 60% Penetration Rate: This looks at lowering the customer penetration rate to 60%.

Effect of this Change

	Base Case	Revised Study
Loan	$ 2.0 M	$ 1.9 M
Equity	$ 0.5 M	$ 0.5 M
Penetration Rate	70%	60%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 11	Year 14
Cash After 25 years	$2.8 M	$1.8 M

As would be expected, fewer customers means lower cash flow. In this case, the cash generated over the study period decreases by $1.0 million.

Paying a Higher Interest Rate: This looks at the impact of increasing the interest rate by 100 basis points from 5.5% to 6.5%.

Effect of this Change

	Base Case	Revised Study
Loan	$ 2.0 M	$ 2.2 M
Equity	$ 0.5 M	$ 0.6 M
Interest Rate	5.5%	6.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 11	Year 11
Cash After 25 years	$2.8 M	$2.5 M

As would be expected, a higher interest rate reduces long-term cash flow. However, the impact is fairly small over the study period decreases cash by $0.3 million.

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

Effect of this Change

	Base Case	Revised Study
Loan	$ 2.0 M	$ 1.9 M
Equity	$ 0.5 M	$ 0.5 M
Interest Rate	5.5%	5.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 11	Year 10
Cash After 25 years	$ 2.8 M	$3.4 M

This demonstrates that the business plan is sensitive to prices. In this case, increasing the price of the broadband products by $5 increases the cash by $600,000 over the study period.

What Conclusions Can We Draw From the Financial Results?

We note in every scenario that the amount borrowed is higher than the costs of the assets being constructed. This is due to three things. First, there are always costs for any service provider to enter a new market, which we classify as start-up costs. Second, every scenario has operating expenses to cover during the time-period while the network is being constructed and before there are enough customer revenues to cover expenses. Finally, most commercial financing requires the payment of interest starting with the time that money is drawn from the loan. This form of financing is known generically as construction financing and is the primary way that service providers borrow to construct new networks.

We also note again that all of the forecasts are conservative and that it's possible for a service provider to construct these networks for less than we've estimated if they work hard at it. Our forecasts include normal industry construction pricing, but there are ways to cut these costs, such as by having company employees do some of the work instead of contractors. We don't think the potential savings could be large enough to materially change our recommendations, but the financial results shown in these forecasts could be improved to some degree.

There are some specific conclusions that can be reached from examining the results of the financial analysis:

- **Fiber Everywhere:** There doesn't seem to be a reasonable business plan for funding fiber to everybody today without some grant funding or other subsidies. The county is much like much of rural America where the density of customers outside the town is low, meaning that the cost of building fiber is too expensive to fund with only normal commercial financing.

  Even with grant financing it's hard to justify building the fiber. For example, the fiber scenario cannot be justified with the 50% matching currently being offered by DEED.

- **Hybrid Fiber and Wireless Plan:** The scenarios that brings fiber to Arco and to those living along the backbone fiber route look to be reasonably financed. For example, the breakeven penetration rate, even without any grant funding is 50%. Since the scenario is profitable a service provider should be able to raise the funds needed to implement the hybrid solution.

Wireless Broadband is Not a Permanent Solution

We know that the county funded this study because you have been hoping for a solution that can bring fiber broadband to everybody. But the financial analysis shows that it is going to be difficult to fund fiber to everybody immediately. The customer density in the most rural parts of the county is so low (very few homes or farms per mile of road) that the cost of building fiber is extremely high when viewed as a cost per customer.

So our studies have looked to wireless technology to bring broadband today. The wireless technology we have recommended can deliver at least 20 Mbps broadband to every home, farm, and business in the county. For customers without a good broadband solution today this is finally going to bring them an adequate broadband solution that will let them enjoy the various benefits of broadband described earlier in this report. We expect most rural homes will want such a connection.

But we don't look on this as a permanent broadband solution. Since 1980 the broadband needs of homes have roughly doubled every three years. That demand can be expressed in terms of the needed broadband speeds as well as the total amount of downloaded data a typical home requires to meet normal broadband demand. To put this into perspective, if a home needs 6 Mbps download today to be happy (a typical DSL speed), then nine years from now that same house is likely going to want 48 Mbps download speeds (doubles three times).

It's hard for people to visualize the impact of anything that grows at an exponential rate. Look around at other things that increase at exponential rates. Computer processing speed has been doubling about every 18 months since the early 60s. This phenomenon is known as Moore's law, named for the engineer who noticed it. It is this exponential growth that means that the computing power in your smart phone is far faster than the best PC you could buy for your home a decade ago. Because of exponential growth, your smartphone is now far more powerful than the best supercomputer of 20 years ago.

Every industry expert expects the need for broadband to keep growing. Every year the size of files and programs we connect to become larger and the download speeds needed to be effective grow. It's been that way since we've gotten online and there is no end in sight for new uses for broadband. As just one example, both Netflix and Amazon now offer customers the ability to watch video in the 4K format, which requires 8 times more bandwidth than HD video.

It's not just video that's causing the bandwidth growth. Everything we do online takes more bandwidth over time. Files get larger, web pages get busier, and we use more and more applications at the same time. As an example, when social media sites began embedding video in the last few years the bandwidth needed to be on a service like Facebook grew much larger.

Another growing area of broadband usage is surveillance cameras. These are particularly useful on farms to allow for monitoring of animals and remote parts of the property. We are just now starting to see the use of smart home devices—things in the homes that connect to the internet. Just this past Christmas saw the release of virtual reality headsets for the first time—the precursors for home devices that will allow for immersive entertainment similar to the Start Trek holodecks—and big users of bandwidth.

These things are just the beginning. There are future things still on the drawing boards. Just as we couldn't have known 20 years ago how the Internet would change our lives and our homes, we can't imagine today all that's coming in the next 20 years.

The bottom line of all of this is that an "adequate" broadband connection today is not going to be adequate a decade from now. While customers in the rural parts of the county will be happy if somebody can bring them a 20 Mbps wireless solution today, within a decade that is going to feel like a slow speed and within two decades it's going to feel as slow as the terrible broadband connections these rural areas suffer with today.

Wireless is a temporary solution when viewed over a timeline of the next decade or two. Getting wireless to your county is a great solution for today, but eventually everybody is going to need something faster. That something faster might be some future wireless technology and not necessarily fiber to each home, but even faster wireless technology is going to require building fiber close to every home. Perhaps the fiber will be strung along the roads with a wireless connection to the home, but that would still require about the same investment as we've estimated today for an all-fiber network.

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:

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

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 the project and partner with somebody else to operate the business. It would also be possible for the county to act as the bank for broadband expansion, as was done in Sibley County and in Swift County. For the sake of those options it's worth understanding the difference between public financing and commercial financing.

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 bond 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 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.

Private Financing Options

The traditional way for commercial ventures to get financed is through bank loans. The interest rates on such loans are generally higher than bonds. Still, there are some ways to mitigate the financing costs so that a project doesn't have to rely on only bank loans. Here are some thoughts on financing the fiber business if it is a non-municipal venture:

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 would be taking cash in an obligation that is not guaranteed to be paid back. To give an example, in Sibley and Renville counties, a fiber business was recently 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 who issued the bonds would have to make bond payments. The other sources of financing for that project looked upon these bonds as a form of 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 years ago or so, banks would fund things like power plants, electric and water systems, and other long-term revenue-generating assets. But various changes in banking laws, which have required banks to maintain larger cash reserves, along with a general desire to go after higher interest rate projects mean that banks have largely stopped doing this kind of lending. It's not impossible to finance an infrastructure project at a traditional bank, but the general parameters of bank loans make it a challenge.

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. Bank loan rates are generally a few percentage points higher than bond rates, which also makes it harder to prove feasible.

Also, bankers generally expect a significant amount of equity from the borrower. The banking industry has gotten much more conservative over the last decade and they now might require 40% equity where a decade ago for a similar project they might have required 20% equity. Since fiber projects are relatively expensive, it's difficult to raise the kind of equity needed to make a project work.

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 of them to be too risky. Banks are also somewhat

adverse to start-ups and prefer to make these kinds of 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.

The final 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.

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.

Grants

There are a handful of possible source of grants:

DEED Grants: We are now in the fourth consecutive year that the Minnesota legislature has provided grant money for rural broadband that is 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 this year.

There are a few key rules for DEED grants that are important to remember:

- The grants can only be awarded to serve areas that are defined as unserved or underserved. Unserved areas are those that have no landline broadband alternative available. Underserved areas are those that have a landline option but which don't have a broadband provider that offers download speeds of at least 100 Mbps.
- 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.
- The entity getting the grant has to be an operating entity already in business. They won't give a grant to a start-up that doesn't yet have customers or a company that is still in the process of being formed. Because of this almost every grant award so far has gone to telephone companies, with a few to cable companies.
- DEED grant money must be used within 2 years of the award.
- Anybody applying for a DEED grant has to show proof that they have secured the financing required for the matching part of the grant.
- The DEED 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 broadband directly to customers are eligible.
- While it's not an official rule, these are awarded by the state and 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 is no current federal broadband grant program. But there is a lot of talk in Washing DC of creating a massive $1 trillion dollar infrastructure program. The White House has suggested that this plan include $25 billion for broadband funding, spread over 10 years.

Of course, none of us has a crystal ball and so there is no way to predict if this will happen, or if it does how it might work. We do have experience with several federal broadband grant programs in the past that suggest that the program would probably be similar to the DEED grants in that any federal grant would also require funding by the entity accepting the grant.

One troubling aspect of the current White House proposal is that they envision that the federal government would kick in $200 billion with the rest of the $1 trillion coming from the private sector. If that ratio was applied to all projects that would imply a program that would not award more than a 20% grant with the remaining sources coming from somewhere else. But if combined with programs like the DEED grants such a program could be very helpful.

In looking at past federal grant programs they always had the requirement that money only be awarded to "shovel-ready" projects. The fact that you have undertaken this study and built business plans puts the county well down the path of meeting that requirement.

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 Lincoln County.

Another source of federal funding is to borrow directly from the government using federal loan programs. The predominant such plan is administered by the Department of Agriculture in the Rural Utility Service Program.

> 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 percent 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 percent 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.

There is one other federal program that we have seen used to help finance broadband projects, known as New Market Tax Credits.

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 three years, then 6% in the final four 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 seven 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.

These funds are not likely to fund a whole, or even a large percentage, of a fiber project, but they might be used to find 5% to 10% of the needed funds of a project and can be a very affordable piece of a funding package. In some cases the terms for getting these credits are so good that other pieces of the financing might look at the tax credit money as equity.

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 seven-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 seven 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 or 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:

- Leverett, Massachusetts: In Leverett, MA, the citizens all voted to raise property taxes to fund and build a municipal fiber project. This is a relatively small town of about 2,000 people, but there was enough demand for broadband that a ballot initiative passed easily to use property revenues to pay for the fiber.
- 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 that are interesting models to consider:

- RS Fiber: RS Fiber is a new broadband cooperative that was formed in Renville and Sibley counties. The project was funding 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 amount of dividends are 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

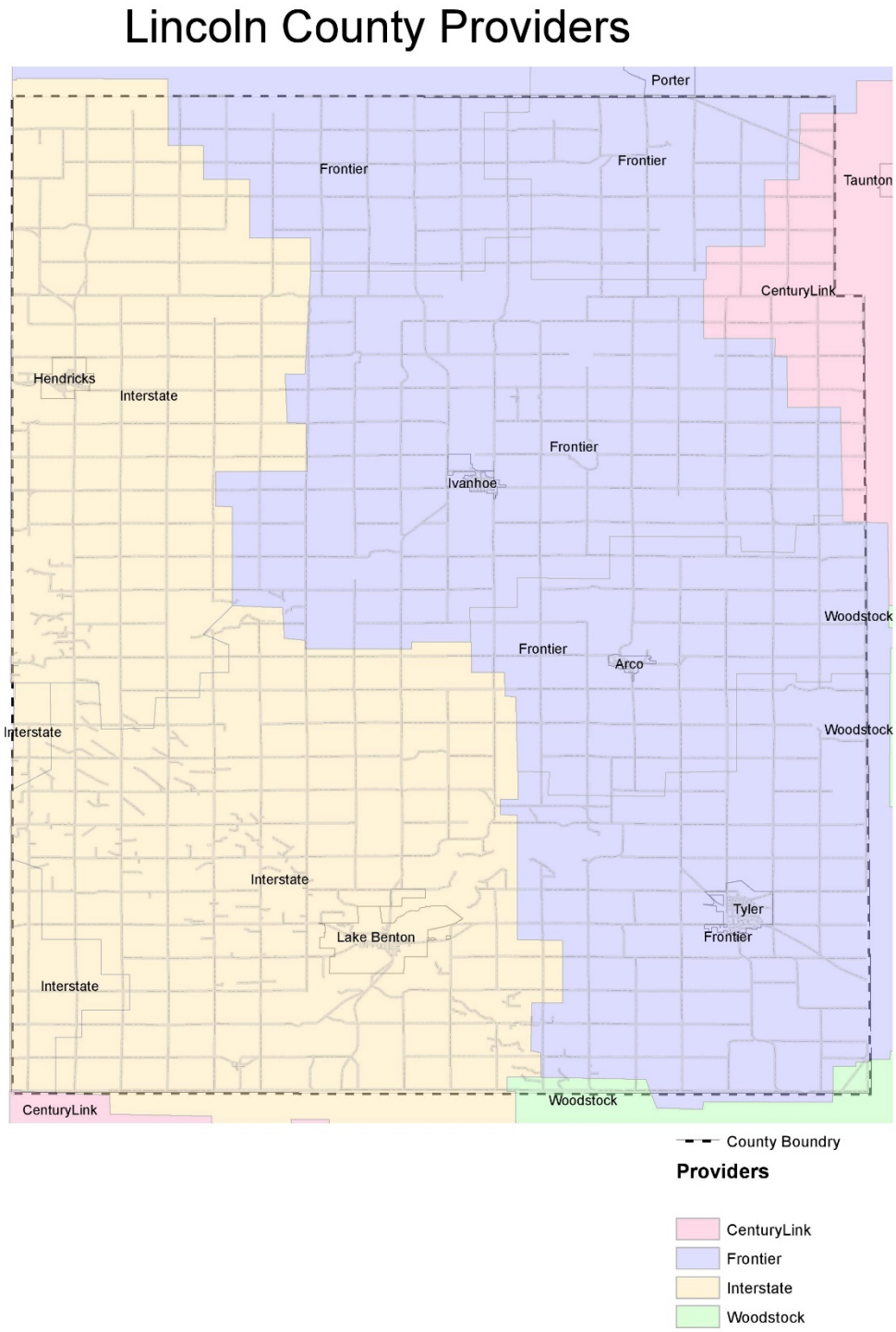


EXHIBIT II: STUDY AREA

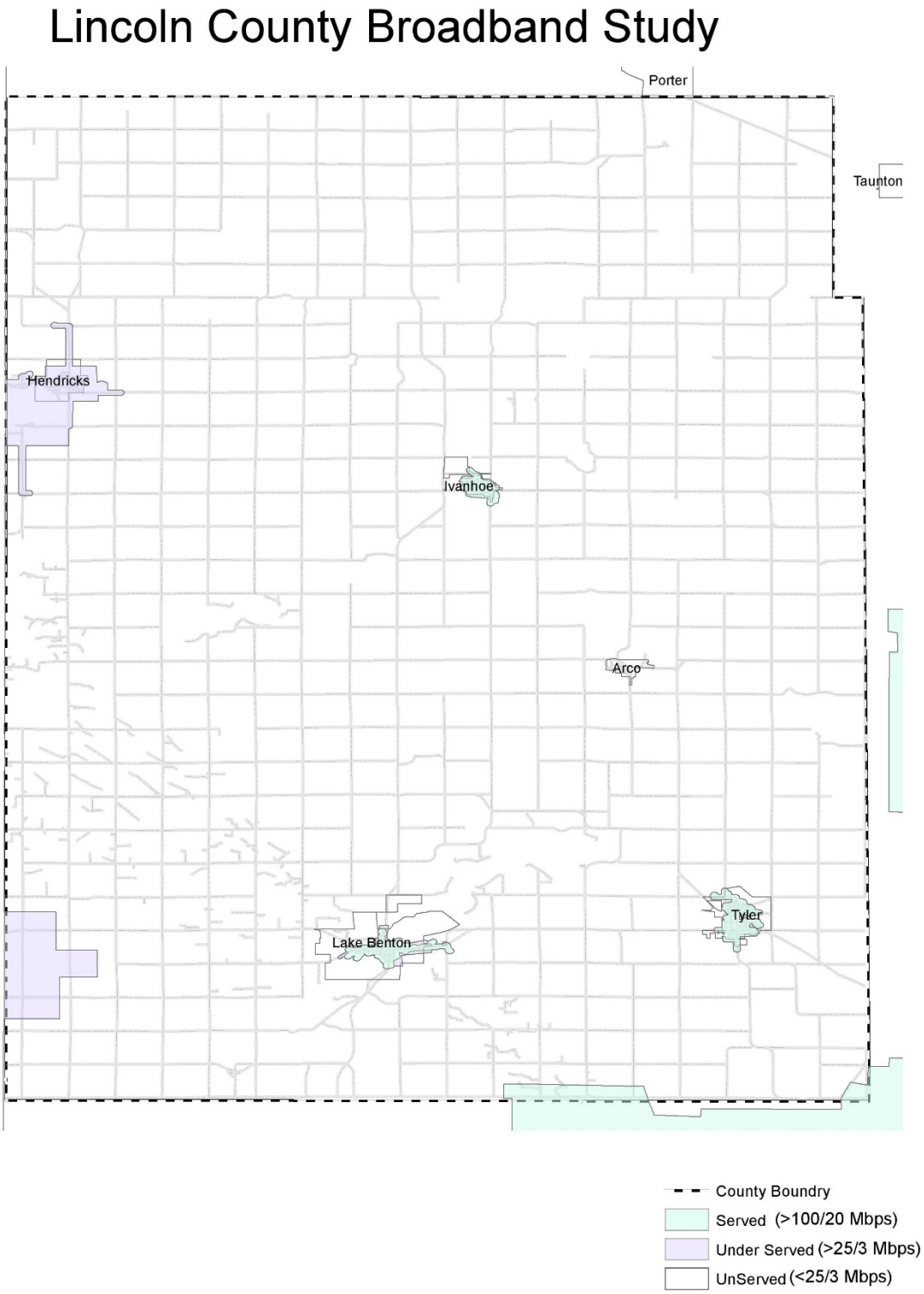


EXHIBIT III: MAP OF THE PROPOSED FTTH DESIGN

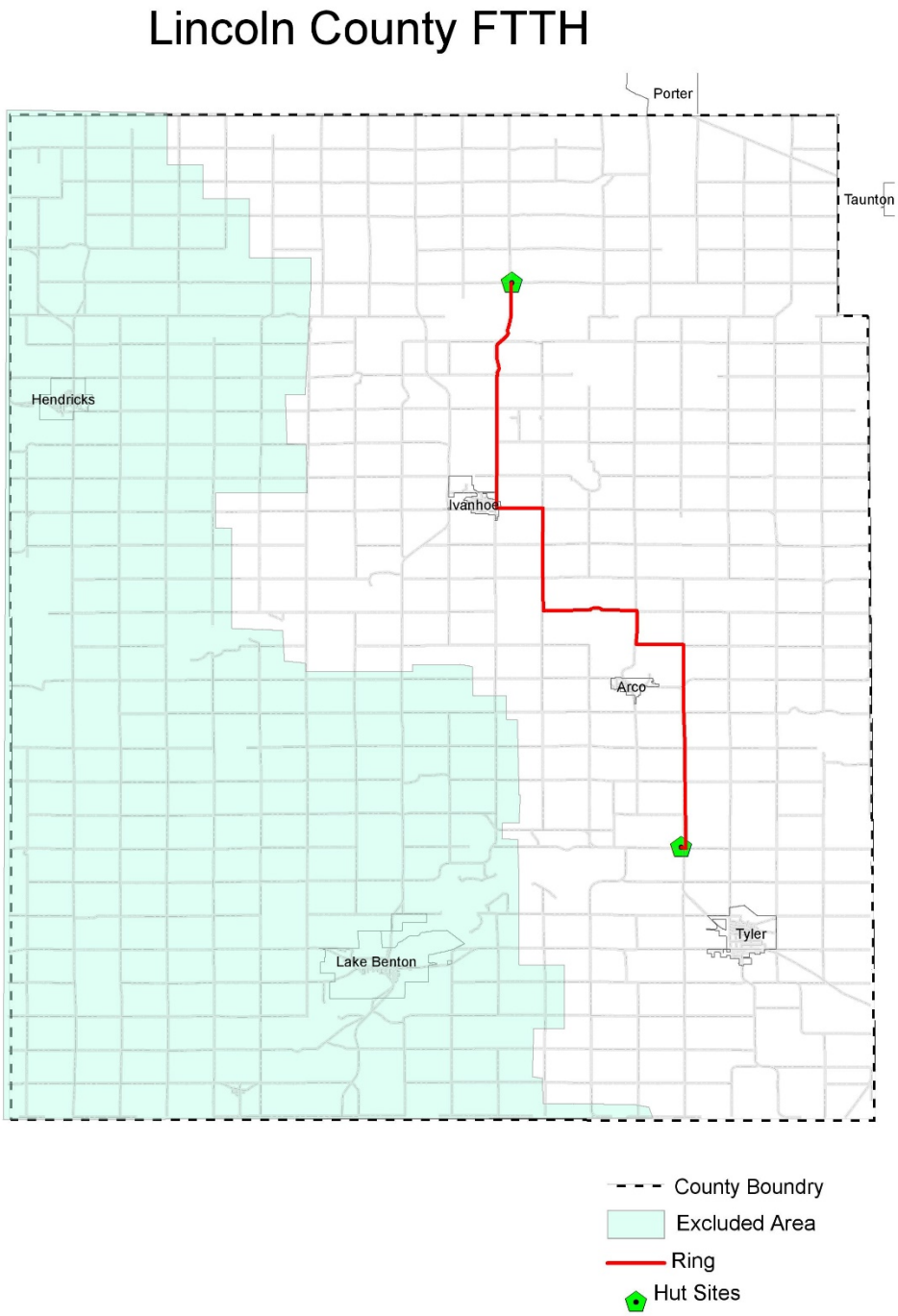


EXHIBIT IV: MAP OF THE PROPOSED HYBRID DESIGN

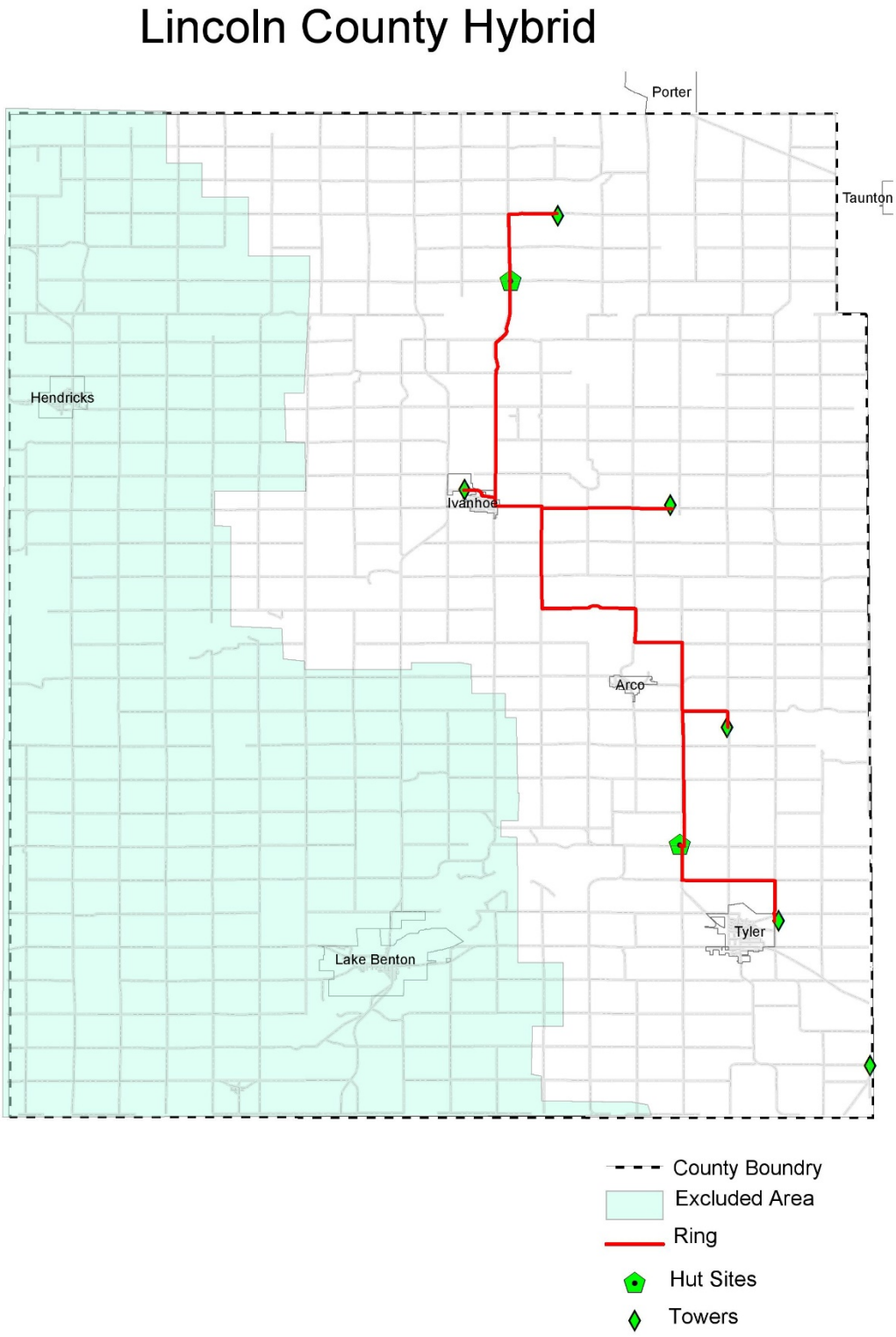


EXHIBIT V: SUMMARY OF FINANCIAL RESULTS

	Assets	Take Rate	Grant	Equity	Debt	Total Financing	Year 25 Cash	Net Income Positive	Cover Debt
All Fiber									
70% Penetration	$8.7 M	70%		$2.03 M	$8.10 M	$10.13 M	-$12.33 M	Never	Never
60% Penetration	$8.5 M	60%		$1.98 M	$7.93 M	$9.91 M	-$13.20 M	Never	Never
With Border-to-Border Grant	$8.7 M	70%	$4.36 M	$1.05 M	$4.20 M	$9.61 M	-$6.24 M	Never	Never
With Breakeven Grant	$8.7 M	70%	$8.10 M	$1.00 M	$0.00 M	$9.10 M	$0.58 M	Never	N/A
With Higher Interest Rate	$8.7 M	70%		$2.06 M	$8.25 M	$10.31 M	-$13.52 M	Never	Never
With $5 Higher Data Prices	$8.7 M	70%		$2.02 M	$8.08 M	$10.09 M	-$11.48 M	Never	Never
With 20% County Grant	$8.7 M	70%	$6.11 M	$0.53 M	$2.68 M	$9.45 M	-$3.83 M	Never	Never
Hybrid Fiber & Wireless									
70% Penetration	$1.8 M	70%		$0.49 M	$1.95 M	$2.44 M	$2.81 M	Year 4	Year 11
60% Penetration	$1.7 M	60%		$0.48 M	$1.93 M	$2.41 M	$1.78 M	Year 4	Year 14
Breakeven Penetration	$1.8 M	50%		$0.48 M	$1.90 M	$2.38 M	$0.51 M	Year 10	Year 25
With State Grant	$1.8 M	70%	$0.73 M	$0.33 M	$1.30 M	$2.36 M	$3.66 M	Year 3	Year 7
With State Grant and Bond	$1.8 M	70%	$0.73 M		$2.00 M	$2.73 M	$2.92 M	Year 4	Year 10
With Higher Interest Rate	$1.8 M	70%		$0.49 M	$1.98 M	$2.47 M	$2.64 M	Year 4	Year 11
With $5 Higher Data Prices	$1.8 M	70%		$0.48 M	$1.93 M	$2.41 M	$3.39 M	Year 4	Year 10
With 20% County Grant	$1.8 M	70%	$0.73 M	$0.25 M	$1.00 M	$2.33 M	$4.05 M	Year 3	Year 5