Broadband Recommendations

Meeker County, Minnesota

August, 2018

DESIGN NINE
broadband planners

Contents

Cost Studies

NOTE: The costs contained in these estimates represent the best information available, based on similar costs from other projects, from vendor price lists, and/or estimates from contractors and construction firms. These estimates are generally reliable for up to six months. Note also that the time of year that the work is bid out can have a substantial effect on the estimate. We use an average weighted value for most costs to try to compensate for this, but as an example, construction work bid out in spring or early summer may have higher costs than a project bid out in late fall or early winter.

Tower Construction

The line items for each named tower include the cost of the tower, site preparation, estimated cost of electric service, generator cost and placement, cost of the tower, and labor to assemble and erect the tower, and backbone equipment.

Fiber Construction

Line items contained in the fiber construction estimate include the labor needed to install underground conduit, place the fiber in the conduit, place handholes and splice closures, and the equipment needed to provision the lit network.

Fiber and Wireless Construction Cost Factors

The cost estimates are developed using the the categories below. For each category, the items, labor, and activities associated with that category are calculated, using vendor price quotes, prices for labor and materials from previous construction projects, and other sources of cost information.

Buildings, Improvements, and Prefabricated Shelters

This category includes any buildings and shelters constructed as well as improvements to the buildings such as redundant HVAC systems, power improvements, fire suppression systems, security and surveillance systems, etc.

Outside Plant Construction Materials

Network construction includes the outside plant materials needed to build the network. Items like conduit, pedestals, cabinets, hand holes, and splice enclosures are all included in network construction.

Outside Plant Construction Labor

Labor is typically included with network construction for the bidding process but is separated here to help identify money that could be saved by leveraging local labor resources. Labor includes the placement of pedestals and hand holes, the underground or aerial placement of conduit, the construction of foundations (pads) for various structures throughout the network, and more. Several material costs such as concrete and gravel are included in labor depending on the type of job to be performed.

Network Equipment, Software, and Related Costs

Network equipment includes any network electronics that will be used in the network such as routers, switches, and CPE. Network equipment also includes some items that do not use any AC power but fall into a similar category such as patch panels, and patch cables. The equipment cost will vary widely depending on the type of architecture chosen.

Administrative and Legal

Specialized legal counsel will be required to review contracts with service providers, contractors, and other participants in the project. Legal costs can vary with a particular location and tend to go down over time. The most legal work is needed early in the first construction phase to develop business contracts with service providers, to review construction and vendor contracts, and to broker lease agreements for use of public or private property (where network equipment like cabinets or shelters have to be located).

Leases, permits, and rights of way

Some costs will be incurred based on the permitting requirements of the project. If the County is able to place the colocation facility and any cabinets in public right of way or on County properties at no charge, the cost of leases will be lower. If cabinets or shelters have to be placed on private property, the cost of the land or long term leases will increase. The cost of permits needed for crossing wetlands, streams, other sensitive areas, and DOT permits are also included in this category. Formal leases and negotiated lease payments are more desirable than providing some form of free access to services.

Project Management

Project management for a community network build requires thorough and detailed planning, experience in procuring construction materials for the project, and the ability to oversee and convey project information to contractors through the duration of the project, including construction inspection work (ensuring construction contractors have done their job properly).

Network Design and Engineering

This work include a full design of the outside plant network, cabinet and shelter specifications, and extensive detail (blueprints) that specifies how all fiber cable, towers, buildings, and

network equipment is to be installed. These documents have to be completed prior to bidding out any construction work, and are usually included as part of a construction bid package. The detail includes fiber optic cable route determination and size determination, active and passive network equipment selection and placement planning, splicing layouts and documentation, network configuration planning, and all engineering necessary to complete construction.

Network Integration and Testing

Some configuring and testing will take place after the network is built and before it is ready for use. In a dark network this involves labeling and documenting the routes of individual fiber strands, and testing of any other features of the network such as generators, air conditioners, and locks. In an active network the testing and integration includes integration requirements for a dark fiber network plus the configuring and installation of switches, routers, and other network equipment. Work in this category requires a skilled professional who is familiar with the network architecture and the business model (e.g. open access).

Miscellaneous

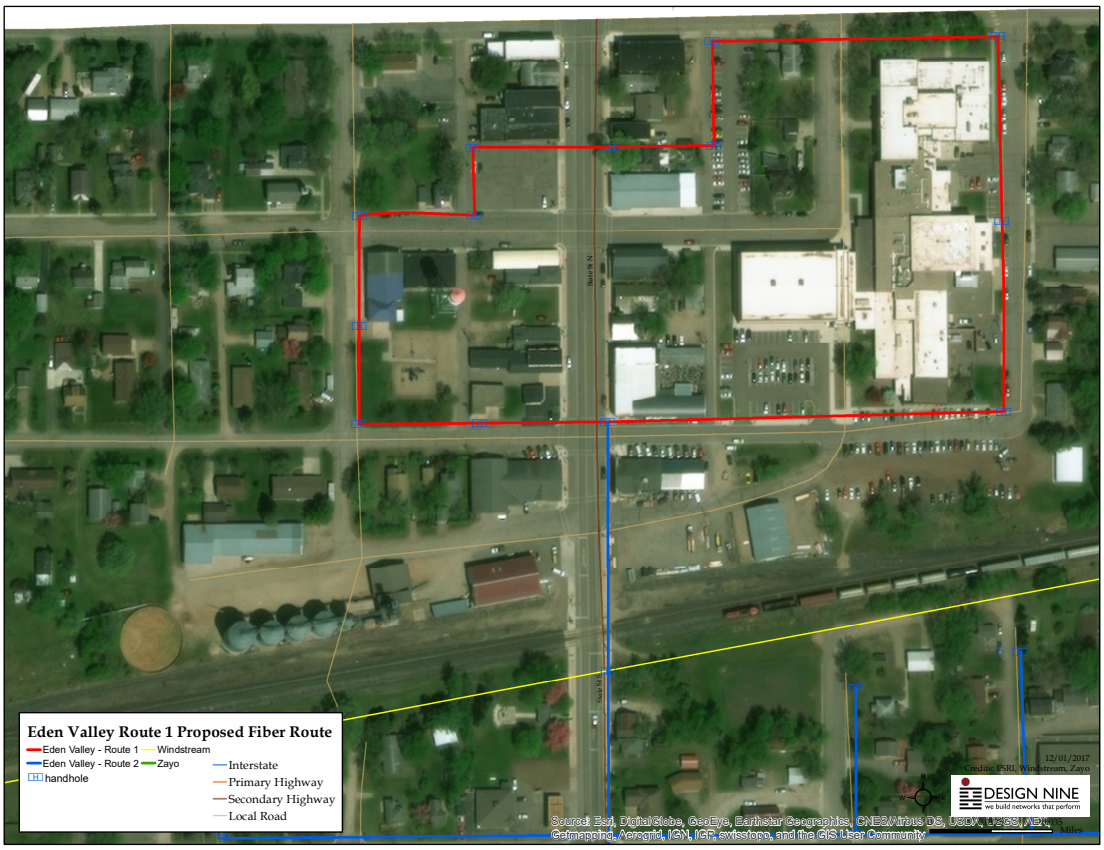
This category provides a small budget for miscellaneous expenses that will arise during the course of construction (e.g., bid advertisement costs, inventory tags, etc.).

Contingencies

The Contingency category is included and calculated as a percentage of the total estimated cost (e.g., 5% of total cost) to provide flexibility in managing the overall budget. Equipment costs can and do change between the time an estimate is made and construction commences. Labor costs can vary depending upon the time of year the work starts, the state of the local economy, and the state of the national economy. Material costs and lead times can vary based on demand on certain industries, energy costs, and location.

Eden Valley Route One Estimate

This estimate provides a fiber ring in the downtown area of Eden Valley. The red indicates a suggested route for the underground fiber. This is a conduit/dark fiber plan, and fiber pairs would be leased out to private sector ISPs. ISPs would provide and manage their own network equipment. The design would allow providers leasing the fiber to provide a redundant fiber service ring for increased resiliency (i.e. a fiber cut would not cause loss of service).



Eden Valley Route 1 Cost Summary

ITEM/PROJECT	ESTIMATED
Eden Valley Route 1 Construction Materials	$15,923.75
Eden Valley Route 1 Distribution Labor	$78,854.50
Eden Valley Route 1 Structures, Cabinets, and Equipment	$42,450.00
Eden Valley Route 1 Drop Construction	$20,662.50
Network Construction Subtotal	$157,890.75
Project Management, Network Engineering, Integration, and Testing	$31,578.15
Engineering, Permitting	$3,540.00
Misc Fees, Advertising, Technical Services	$10,000.00
Bookkeeping and Administration	$2,500.00
Other Costs Subtotal	$47,618.15
Project Total	$205,508.90
Contingency at 10%	$20,550.89
Project Total (with contingency)	$226,059.79

Eden Valley Route 1 Route Overview

ITEM/PROJECT	VALUE
Miles of Fiber / Conduit Installed	0.59
Number of Handholes Installed	13
Splice Closures Installed	13
Cabinets Installed	1
Number of Customers Connected	15
Take Rate - Percentage of the Buildings Passed who are connected with a drop and ONT	30%
Aerial - Percentage of construction labor expected to be installed on utility poles.	0%
Boring - Percentage of construction installed by boring or other HDD methods.	70%
Trenching - Percentage of construction installed by trenching (Mini-ex, bucket, hand dig, trencher).	10%
Direct Bury - Percentage of construction installed by direct bury (plow, vibratory plow,	20%
Aerial Info	200 ft average separation between poles. Pole replacements for 5% of poles. Light make-ready for 15% of poles. No heavy make ready expected.
FOSCs	Fiber Optic Splice Closures (FOSCs) placed at each handhole, 4-5 drops per FOSC.
Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Eden Valley Route Two Estimate

This estimate provides fiber to the home to a mixed residential and business area adjacent to downtown Eden Valley. The fiber would pass under the railroad tracks and connect to the downtown fiber network. This estimate assumes that the downtown fiber network is constructed, as the two routes share a single "meet-me" cabinet that would be used by providers. This is also a dark fiber approach.

Eden Valley Route 2 Route Overview

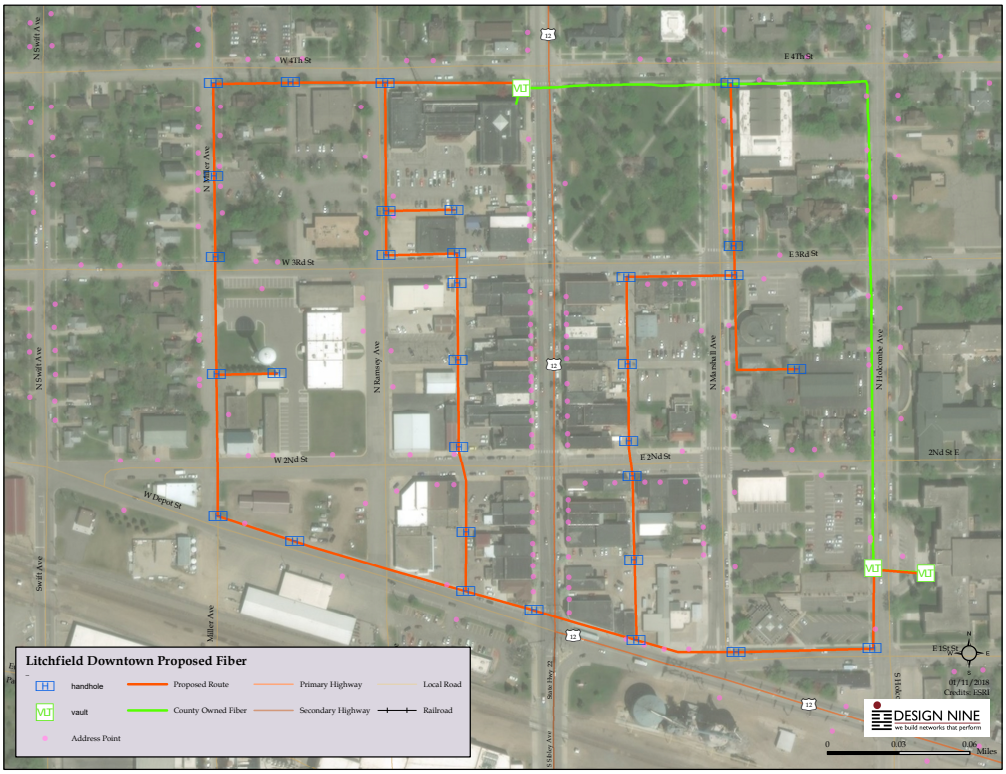
0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	2.43
2	Number of Handholes Installed	37
3	Splice Closures Installed	37
4	Cabinets Installed	0
5	Number of Customers Connected	53
6	Take Rate - Percentage of the Buildings Passed who are connected with a drop and ONT	30%
7	Aerial - Percentage of construction labor expected to be installed on utility poles.	0%
8	Boring - Percentage of construction installed by boring or other HDD methods.	70%
9	Trenching - Percentage of construction installed by trenching (Mini-ex, bucket, hand dig, trencher).	10%
10	Direct Bury - Percentage of construction installed by direct bury methods (plow, vibratory plow,	20%
11	Aerial Info	200 ft average separation between poles. Pole replacements for 5% of poles. Light make-ready for 15% of poles. No heavy make ready expected.
12	FOSCs	Fiber Optic Splice Closures (FOSCs) placed at each handhole, 4-5 drops per FOSC.
13	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Eden Valley Route 2 Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Eden Valley Route 2 Construction Materials	$53,204.38
2	Eden Valley Route 2 Distribution Labor	$251,168.50
3	Eden Valley Route 2 Structures, Cabinets, and Equipment	$42,450.00
4	Eden Valley Route 2 Drop Construction	$73,007.50
5	Eden Valley Route 1 - Railway Crossing Costs	$25,000.00
6	Network Construction Subtotal	$419,830.38
7	Project Management, Network Engineering, Integration, and Testing	$83,966.08
8	Engineering, Permitting	$14,580.00
9	Misc Fees, Advertising, Technical Services	$10,000.00
10	Bookkeeping and Administration	$2,500.00
11	Other Costs Subtotal	$111,046.08
12	Project Total	$530,876.45
13	Contingency at 10%	$53,087.65
14	Project Total (with contingency)	$583,964.10

Downtown Litchfield Cost Estimate

This dark fiber approach provides fiber access to downtown Litchfield businesses, and utilizes the existing fiber between the county courthouse and the county administration building (the green route). This design would allow providers using the fiber to create fully redundant fiber rings, which is increasingly important to businesses (i.e. a fiber cut in a redundant ring design does not cause loss of service).



Litchfield Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	1.27
2	Number of Handholes Installed	34
3	Splice Closures Installed	34
4	Cabinets Installed	1
5	Number of Customers Connected	46
6	Take Rate - Percentage of the Buildings Passed who are connected with a drop and ONT	30%
7	Aerial - Percentage of construction labor expected to be installed on utility poles.	0%
8	Boring - Percentage of construction installed by boring or other HDD methods.	70%
9	Trenching - Percentage of construction installed by trenching (Mini-ex, bucket, hand dig, trencher).	10%
10	Direct Bury - Percentage of construction installed by direct bury methods (plow, vibratory plow,	20%
11	Aerial Info	200 ft average separation between poles. Pole replacements for 5% of poles. Light make-ready for 15% of poles. No heavy make ready expected.
12	FOSCs	Fiber Optic Splice Closures (FOSCs) placed at each handhole, 4-5 drops per FOSC.
13	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

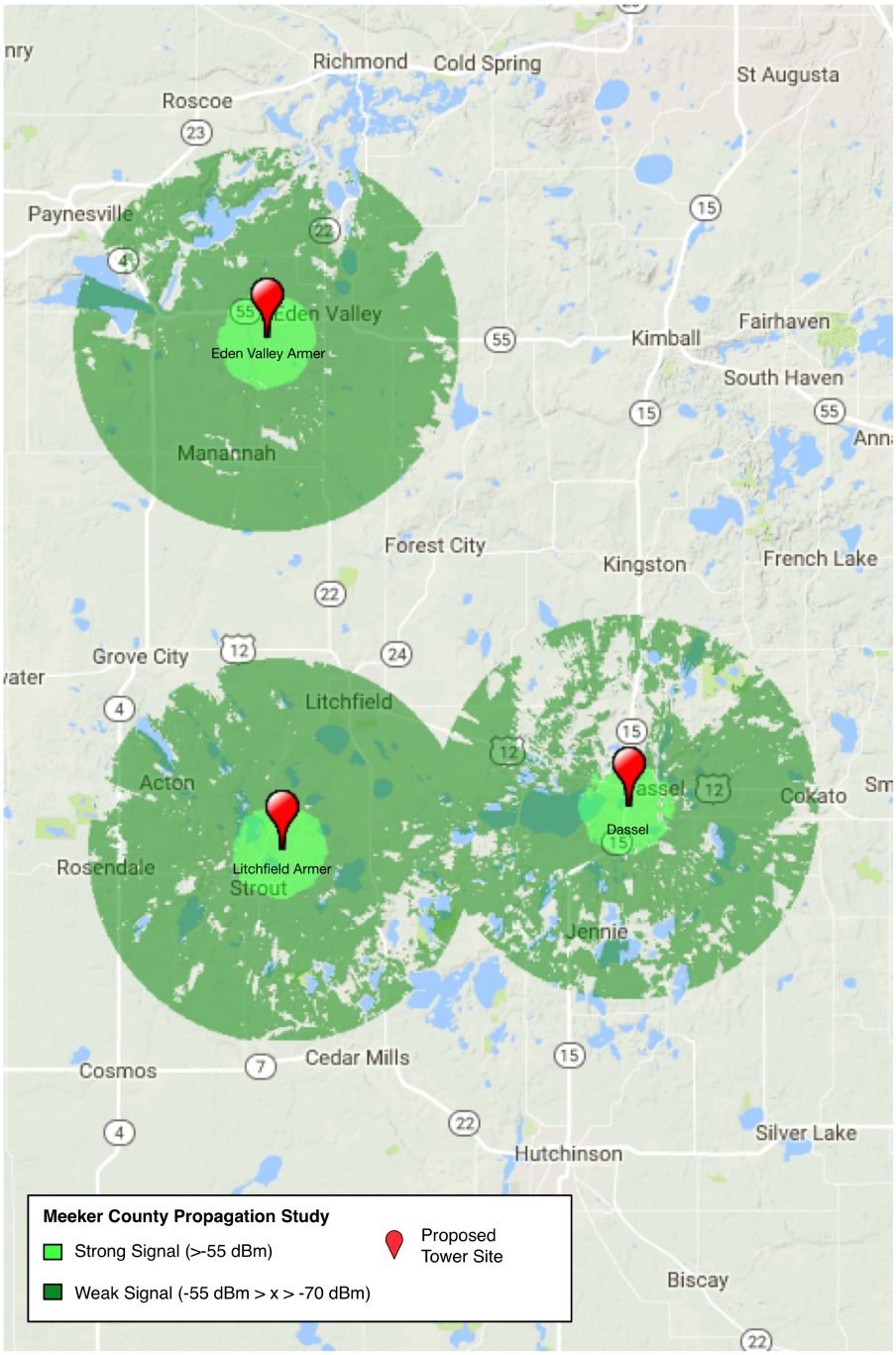
Litchfield Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Litchfield Construction Materials	$37,317.38
2	Litchfield Distribution Labor	$158,485.00
3	Litchfield Structures, Cabinets, and Equipment	$34,950.00
4	Litchfield Drop Construction	$63,365.00
5	Network Construction Subtotal	$294,117.38
6	Project Management, Network Engineering, Integration, and Testing	$58,823.48
7	Engineering, Permitting	$7,620.00
8	Misc Fees, Advertising, Technical Services	$10,000.00
9	Bookkeeping and Administration	$2,500.00
10	Other Costs Subtotal	$78,943.48
11	Project Total	$373,060.85
12	Contingency at 10%	$37,306.09
13	Project Total (with contingency)	$410,366.94

Broadband Wireless Studies

Making space on new or existing towers in Meeker County for private sector service providers could is a relative low cost way of improving Internet access in underserved areas of the county. WISPs (Wireless Internet Service Providers)

Three areas of the county were identified as having poor broadband service. The diagram below shows the estimated coverage areas using broadband LTE radio frequencies.



The wireless propagation studies in this section (as illustrated on the map on the previous page) look at the kind of wireless coverage and access that could be possible using proposed tower locations. The proposed tower locations listed below may not be the final locations for a wireless network. Further analysis including physical site surveys will be required to identify the final locations.

The newer LTE-based broadband wireless equipment that has just begun entering the marketplace appears likely to produce better results than traditional WiMax/WiFi frequencies, with somewhat better bandwidth and somewhat better penetration of light cover between the customer radio and a nearby tower.

While the propagation study predicts what is possible, line of sight and/or near line of sight is still required between the wireless customer and the radios on the nearest tower. Heavy tree cover at the customer location is the most common problem in obtaining a strong signal, and this can be mitigated in some cases by erecting a wooden utility pole at the customer site to get the customer radio above surrounding tree cover. Adding the utility pole increases the cost of wireless service substantially but this approach is usually effective in overcoming local line of sight and signal problems. The table below contains general information about each proposed tower location in the wireless propagation studies.

The payback for the initial cost of a new tower could be fifteen years or more. In Meeker County, one strategy may be to offer free or very low fee access to towers with the goal of rapidly improving broadband access in underserved areas. Other localities that are making tower space available to private sector WISPs frequently offer a three to six month grace period of no tower lease charges to give the WISP(s) time to conduct a marketing campaign and to sign up customers.

The wireless studies use 180 feet as the height for the transmitting radio equipment. The frequencies and wireless model represent the coverage that is possible with broadband LTE equipment. The other specifications used for the wireless studies are as follows:

- Frequency: 3650 MHz
- Antenna Gain: 17 dBi
- Client Antenna Gain: 19 dBi
- Tx Power: 30 dBm
- Threshold Rx: -70 dBm
- Strong Signal Margin: 15 dB
- Required Reliability: 80%
- Client Antenna Height: 20ft

Antenna Gain and Client Antenna Gain are set according to specifications of equipment commonly used in WISP deployments. Tx power is the strength of the transmitter and the Rx

threshold is the minimum receiving strength required for a customer to take service. Strong Signal Margin defines where coverage is above and below the minimum Rx threshold. Lastly, Required Reliability is an additional calculation done to further test the signal loss based on distance, for example, in bad weather.

The mapping below shows the coverage that might be possible by building new towers within the County as well as if only existing structures are utilized. If some existing towers within the county have available space that could be made available to wireless providers, the number of new towers could be reduced.

About the Wireless Cost Estimate

The estimate tables in this section show the estimated costs for the tower improvements and new towers. Additional cost estimate information will be included in the next draft of this report.

Tower Construction

The line items for each named tower include the cost of the tower, site preparation, estimated cost of electric service, generator cost and placement, cost of the tower, and labor to assemble and erect the tower, and backbone equipment.

Project Management

Project Management, Network Integration, Configuration, and Testing for a telecom build requires thorough and detailed planning, experience in procuring construction materials for a telecom project, and the ability to oversee and convey project information to contractors through the duration of the project, including construction inspection work (ensuring construction contractors have done their job properly).

Some configuring and testing will take place after the network is built and before it is ready for use. This fee includes all of the project management, contractor supervision, procurement activities, and many other activities related to getting the network/towers built.

Engineering, Construction Inspection, and Permitting

This work include a full design of the outside plant network (towers), cabinet specifications, and extensive detail (CAD drawings where needed) that specifies how the wireless towers and network equipment (if any) is to be installed. These documents have to be completed prior to bidding out any construction work, and are usually included as part of a construction bid

package. The detail site plan engineering if required, and any other engineering, inspection work, and permitting necessary to complete construction.

Some costs will be incurred based on the permitting requirements of the project. If shelters/ cabinets are able to be placed on some properties at no charge, the cost of leases will be lower. If cabinets or shelters have to be placed on private property, the cost of the land or long term leases will increase. Some property owners prefer to receive ten or twenty years of lease payments up front, which can make this cost unpredictable. The cost of permits needed for crossing wetlands, streams, other sensitive areas, and State, County, or City permits are also included in this category.

Miscellaneous Fees and Technical Services

Many projects routinely incur a variety of mostly small amounts for fees and services. Typical items might include railroad crossing fees, lease and title fees, notary fees, legal fees for lease agreements or other legal matters, fees for archeological studies, etc.

Bookkeeping and Administration

Network projects create substantial amounts of paperwork, invoices, and related bookkeeping requirements. This amount may vary based on whether or not the Project has the work done by an outside firm or by Project staff. Projects funded by federal or state grants often have additional reporting requirements that increase the requirements placed on staff and grant administrators.

Contingency

We recommend that a small contingency fund be allocated for unanticipated expenses which could include higher than expected construction costs or retail costs, higher site leases than expected, archeological discovery and research, right of way acquisition, and other unplanned costs.

Wireless Tower Cost Estimates

This section of the report provides an estimate of the cost of constructing new towers where they may be needed. Any placement of new towers should be preceded by a careful viewshed analysis (how much area/users are likely to be able to receive service). Site acquisition and site preparation costs can affect the overall cost of such a project. Existing county properties (e.g. fire/rescue stations, county parks, dump transfer sites, etc.) may be candidates for towers.

Tower- Space Only Cost Estimate

For towers currently owned by Meeker County or other stakeholders that might be candidates for project use, modest upgrades to equipment at the base of the tower would make them "broadband-ready." Upgrades to existing towers typically may include adding or upgrading generators, additional cabinet or shelter space for service provider equipment, and sometime fencing and physical access changes.

	Item	Units	Estimated Cost (Conservative)	Total Cost
2	Small Telecom Cabinet	1	$6,000	$6,000
3	10kW Liquid Propane Generator	1	$6,000	$6,000
4	Cabinet Foundation and Installation	1	$800	$800
5	Spare Fuses	1	$20	$20
6	Power System Installation Materials	1	$40	$40
7	Samlex 1000W Inverter	1	$450	$450
8	Samlex SEC1230-UL Battery Charger	1	$300	$300
9	100ah 12v Non Spillable Backup Battery	1	$350	$350
10	DC Voltage Monitoring Device	1	$60	$60
11	Unmanaged Rack Mount PDU (6O)	1	$45	$45
12	Cabinet Installation Labor	1	$1,000	$1,000
13	Power System Installation Labor	1	$500	$500
14	Generator Installation Labor	1	$1,700	$1,700
15	Ubiquiti Access Point + 120° Sector	3	$375	$1,880
16	Project Management		18%	$3,446
17	Estimated Construction Cost			$22,591

New Tower Only Cost Estimate

New towers have a range of configurations and cost options. This estimate is for a new 180' tower with no radio equipment (that is, the cost of the bare tower). If located on existing county properties, the time needed to plan for construction can be shortened. If site acquisition or a site lease (of private property) is required, purchase or lease negotiations can add several months to the process. Note that some counties may require a full permitting process even if a new tower is placed on existing county-owned property. The permit process can add sixty to one hundred and twenty days to the time needed to put a new tower in service.

ITEM/PROJECT	Units	UNIT COST LOW	UNIT COST HIGH	TOTAL (AVG)
Labor and Contracting: $82,640.00				
Site Development (Clearing, Road Improvements, etc.)	1	$15,000.00	$15,000.00	$15,000.00
New Power Service / Installation	1	$1,250.00	$3,450.00	$2,350.00
180' Guyed Tower Construction Labor & Contracting	1	$50,000.00	$74,750.00	$62,375.00
Cabinet Installation Labor	1	$600.00	$1,150.00	$875.00
Power System Installation Labor	1	$300.00	$575.00	$437.50
Generator Installation Labor	1	$1,250.00	$1,955.00	$1,602.50
Materials: $35,735.00				
180' Guyed Tower Construction Materials	1	$17,500.00	$27,500.00	$22,500.00
Small Telecom Cabinet	1	$4,000.00	$6,000.00	$5,000.00
Cabinet Foundation and Installation Materials	1	$1,000.00	$1,500.00	$1,250.00
10kW Liquid Propane Generator	1	$4,000.00	$6,000.00	$5,000.00
Spare Fuses	1	$10.00	$20.00	$15.00
Power System Installation Materials	1	$20.00	$40.00	$30.00
Samlex 1000W Inverter	1	$350.00	$450.00	$400.00
Samlex SEC1230-UL Battery Charger	1	$200.00	$300.00	$250.00
100ah 12v Non Spillable Backup Battery	4	$250.00	$350.00	$1,200.00
DC Voltage Monitoring Device	1	$40.00	$60.00	$50.00
Unmanaged Rack Mount PDU (6O)	1	$35.00	$45.00	$40.00
Total:				$118,375.00
Project Management, Network Engineering, Testing				$29,593.75
Site Engineering, Surveying, Viewshed Analysis, Etc.				$9,500.00
Misc Fees, Technical Services				$7,500.00
Contingency				$11,837.50
TOTAL:				$176,806.25

Neighborhood Utility Pole Access Costs

A single wooden utility pole with a wireless connection to a 180' tower and local access radios could provide access to any residence with line of sight within a half mile or more. This would spread the cost of pole construction and equipment costs across several households or businesses. There are many areas in Meeker where there is a cluster of homes along a relatively short stretch of road. All of those homes could share the use of a single local utility pole access site.

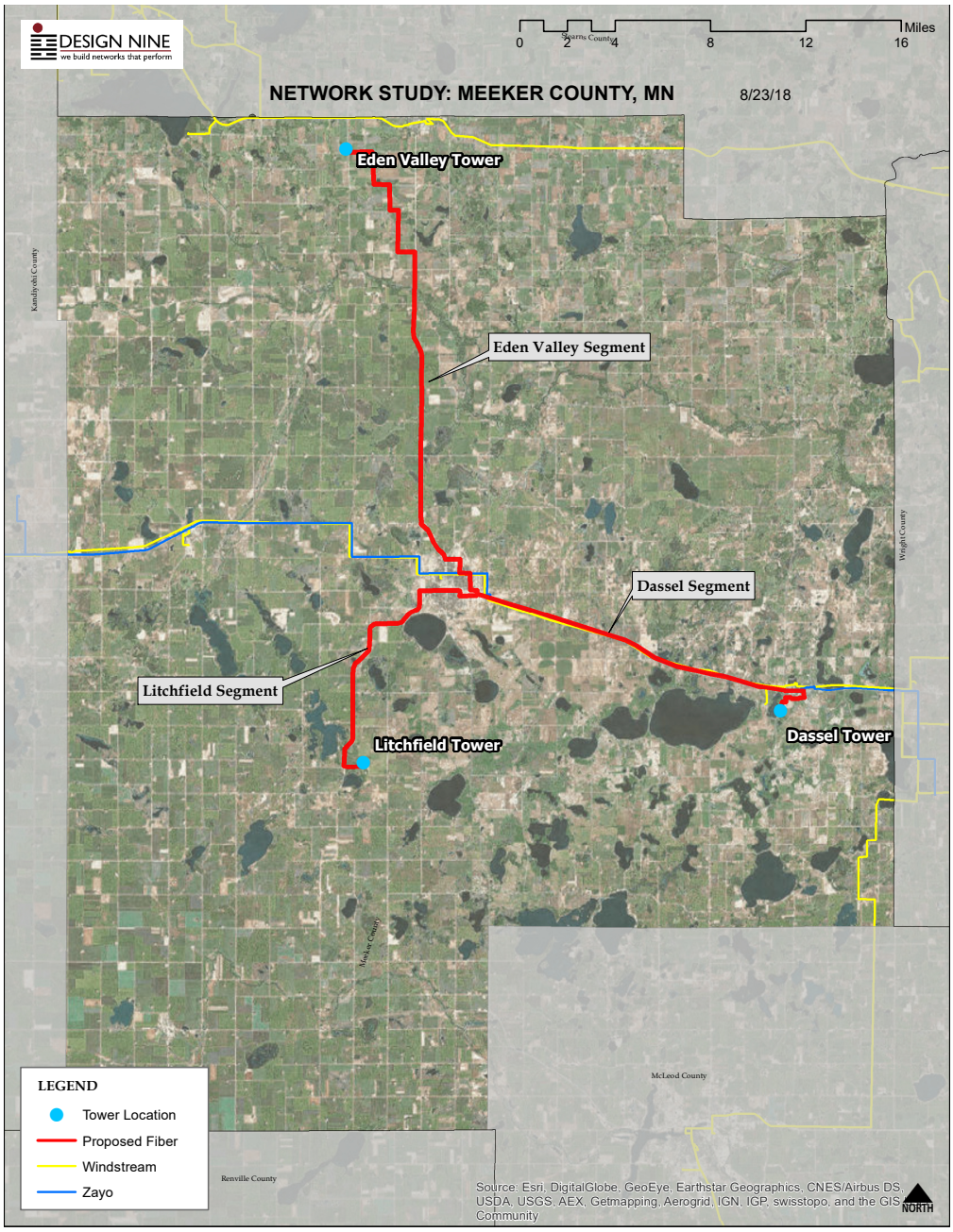
V1	VARIABLE	VALUE	NOTES
V2	Weight Variable	5	0-10 scale used in Best Estimate column (10 is best)
V3	Towers	1	Number of Towers
V4	Height	60	Tower Height
V5	Type	Wooden Utility Pole	Tower Type
V7	Backbone Radio System Licensed / Un-licensed	Un-licensed	
V8	Backbone Links	1	
	Site Development (Average)	1,000	

1	ITEM/PROJECT	UNITS	COST (LOW)	COST (HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE
2	Site Development (Clearing, Road Improvements, etc.)	1	- n/a -	- n/a -	- n/a -	- n/a -	$1,000
3	3x3 NEMA Box	1	$300.00	$600.00	$300.00	$600.00	$450
4	New Power Service / Installation	1	$500.00	$1,250.00	$500.00	$1,250.00	$875
5	60' Wooden Utility Pole Construction Materials	1	$2,500.00	$3,500.00	$2,500.00	$3,500.00	$3,000
6	Spare Fuses	1	$10.00	$20.00	$10.00	$20.00	$15
7	Power System Installation Materials	1	$20.00	$40.00	$20.00	$40.00	$30
8	Samlex 1000W Inverter	1	$350.00	$450.00	$350.00	$450.00	$400
9	Samlex SEC1230-UL Battery Charger	1	$200.00	$300.00	$200.00	$300.00	$250
10	100ah 12v Non Spillable Backup Battery	4	$250.00	$350.00	$1,000.00	$1,400.00	$1,200
11	DC Voltage Monitoring Device	1	$40.00	$60.00	$40.00	$60.00	$50
12	Unmanaged Rack Mount PDU (6O)	1	$35.00	$45.00	$35.00	$45.00	$40
13	60' Wooden Utility Pole Construction Labor & Contracting	1	$2,000.00	$3,000.00	$2,000.00	$3,000.00	$2,500
14	Power System Installation Labor	1	$300.00	$500.00	$300.00	$500.00	$400
15	Ubiquiti IsoBeam PTP System	2	$200.00	$400.00	$400.00	$800.00	$600
16	Ubiquiti Access Point + 120° Sector	3	$375.00	$500.00	$1125.00	$1500.00	$1,313
17	Total:				$8,780.00	$13,465.00	$12,122.50

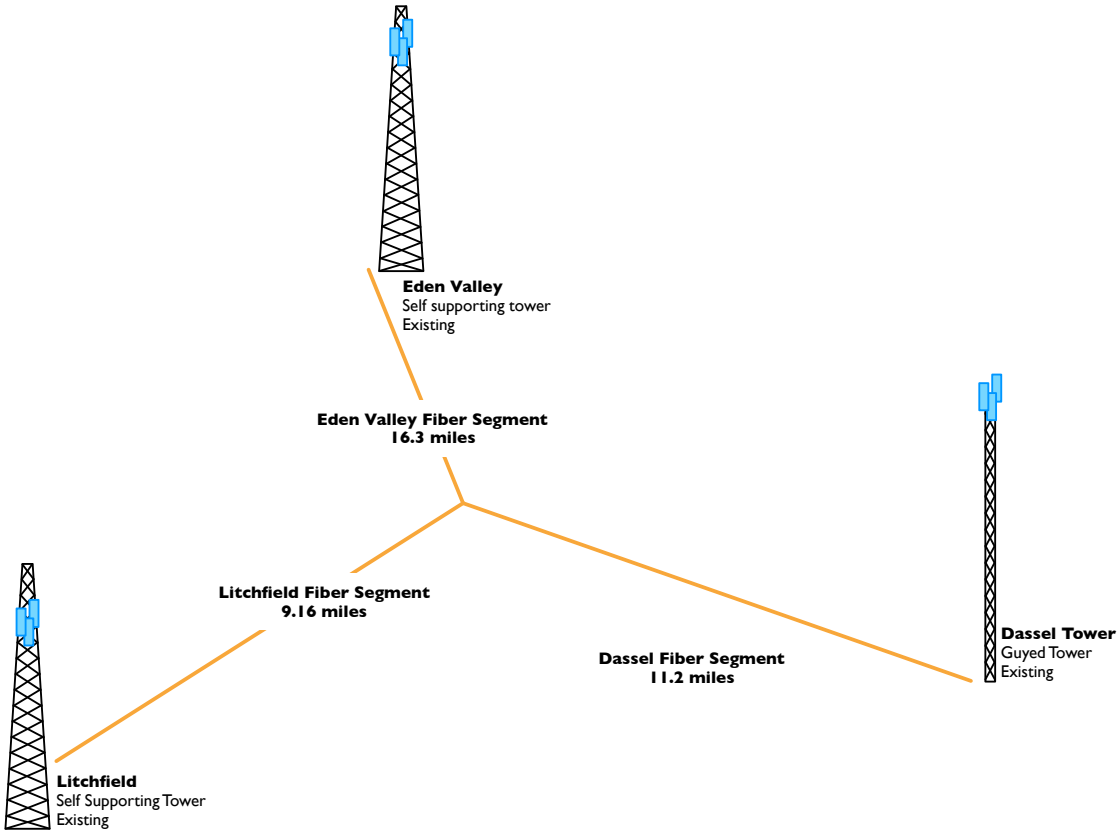
Connecting the Wireless Towers—Fiber Backhaul

Fiber between the three towers in the map below (Eden Valley tower, Dassel tower, Litchfield tower) would create a substantial middle mile fiber backbone in Meeker County. This middle mile backbone would support high quality fixed wireless broadband services distributed from the three towers, and would also support expansion of the fiber network over time to homes and businesses along the initial fiber segments, but also expansion via new fiber segments to other areas of the county.

The cost tables on the following pages provide an estimate of each of the three segments.



The diagram below shows the three towers and the fiber segments between each tower.



All Three Fiber Segments Built at the Same Time

In this cost study, the table shows the estimated cost of the three fiber segments if funding was available to build all of them at the same time (that is, some economies of scale).

Meeker Towers Fiber - Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	36.97
2	Number of Handholes Installed	327
3	Splice Closures Installed	35
4	Cabinets Installed	3
5	Number of Customers Connected	0
6	Take Rate - Percentage of the Buildings Passed who are connected with a drop and ONT	30%
7	Aerial - Percentage of construction labor expected to be installed on utility poles.	0%
8	Boring - Percentage of construction installed by boring or other HDD methods.	30%
9	Trenching - Percentage of construction installed by trenching (Mini-ex, bucket, hand dig, trencher).	10%
10	Direct Bury - Percentage of construction installed by direct bury methods (plow, vibratory plow,	60%
12	FOSCs	Fiber Optic Splice Closures (FOSCs) placed strategically for future splicing and extensions. One FOSC per every 10 handholes.
13	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Meeker Towers Fiber - Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Meeker Towers Fiber - Construction Materials	$599,854
2	Meeker Towers Fiber - Distribution Labor	$2,195,202
3	Meeker Towers Fiber - Structures, Cabinets, and Equipment	$42,450
4	Meeker Towers Fiber - Drop Construction	$0
5	Railroad Crossings - Additional Construction Costs	$20,000
6	Network Construction Subtotal	$2,857,506
7	Project Management, Network Engineering, Integration, and Testing	$428,626
8	Engineering, Permitting	$221,820
9	Misc Fees, Advertising, Technical Services	$20,000
10	Bookkeeping and Administration	$2,500
11	Other Costs Subtotal	$672,946
12	Project Total	$3,530,452
13	Contingency at 10%	$353,045
14	Project Total (with contingency)	$3,883,497

If the fiber segments could not all be built at the same time, the table below provides an estimate of the individual routes.

Tower Fiber Route Estimates - Run Individually

Dassell	$1,270,208
Litchfield	$1,742,658
Eden Valley	$1,029,067
Total	**$4,041,933**
Cost Difference From Combined	*$158,436*

Getting Business and Residents Connected

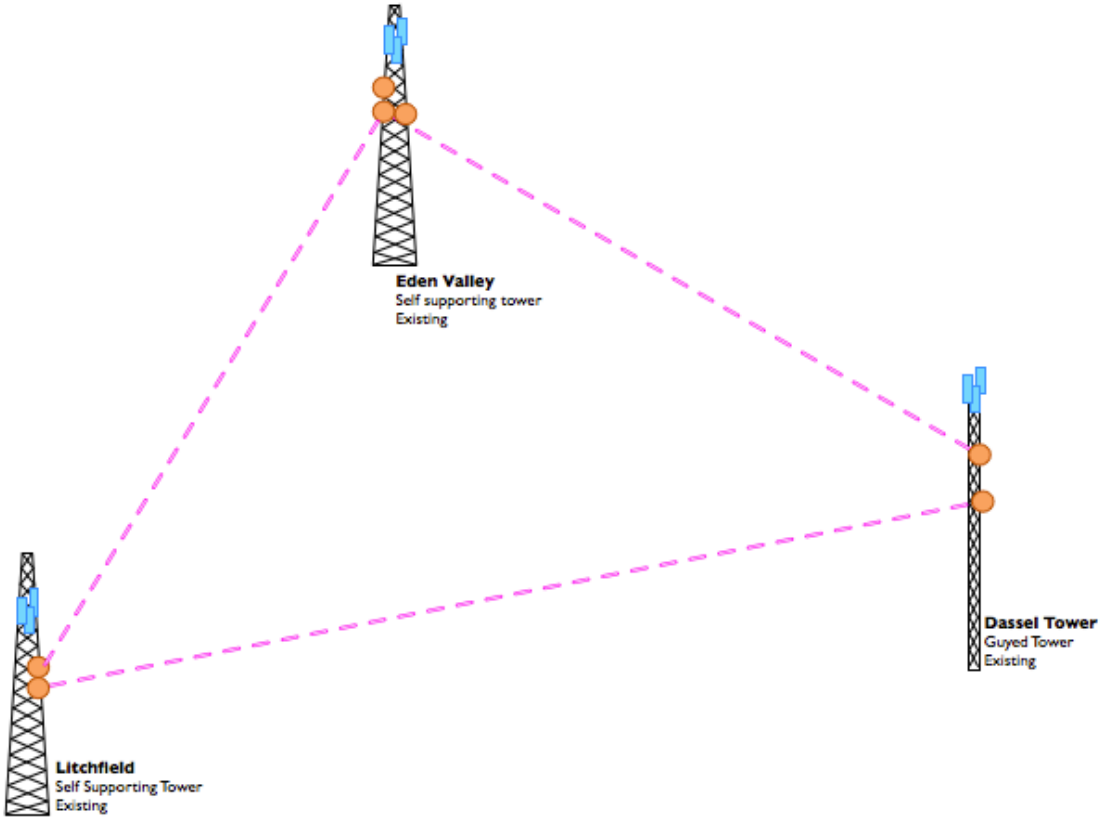
The estimates above do not include any fiber connections (drop cables) from the roadside to homes and businesses. Using a 300' buffer on each side of the three routes, more than 600 homes and businesses are passed, and because many homes in Meeker are a longer distance from the road, this is a low estimate.

- Litchfield Segment - 202 premises
- Dassel Segment - 230 premises
- Eden Valley Segment - 239 premises

The cost of the fiber drops will vary with the distance from the middle mile fiber on the road side. Drop costs will average in a range of $950 to $1700. Business drops that have to cross paved parking lots or pass by other buildings may cost more.

Connecting the Wireless Towers—Wireless Backhaul

As an alternative to building middle mile fiber between the three towers, high performance microwave radio links can be used. In this design, each tower has a microwave link connection to the other two towers, creating a redundant ring (a single radio failure will not affect network traffic). Like the fiber service between towers, this redundant design will be attractive to WISPs, who can put their local access radios on the towers and make use of the backhaul connections between towers to lower their operational costs.



Wireless Point to Point (PtP) Tower Backhaul Cost Estimate

Meeker Towers PTP Connections

ITEM	UNIT	UNIT COST	TOTAL
Tower Engineering Study Fees paid, or cost of services for tower analysis for proposed co-location on each tower.	3	$5,000	$15,000
Eden Valley to Litchfield Aviat WTM 4200 or *EQUIVALENT* Point to Point Licensed Wireless Radio Link INCLUDES: POWER SUPPLY, AC CORD POWER CORD, FIBER PATCH, SFPS, WTM4200, SOFTWARE LICENSES, ANTENNA VLHP 3 FT DIRECT MOUNT, FREQUENCY COORDINATION AND LICENSING, ENGINEERING, ADVANCED REPLACEMENT WARRANTY, OTHER SERVICES	1	$18,626	$18,626
Eden Valley To Dassell Aviat WTM 4200 *or EQUIVALENT* Point to Point Licensed Wireless Radio Link	1	$18,626	$18,626
Litchfield To Dassell Aviat WTM 4200 *or EQUIVALENT* Point to Point Licensed Wireless Radio Link	1	$18,626	$18,626
Wireless Systems Installation Mounting, cabling, and alignment. Work to be done by wireless contractor. Cost per day, 2 days per site	6	$1,650	$9,900
Tower Site Cabinet and Installation If co-lo space inside shelters is not available: Furnish and install 24RU outdoor equipment cabinet. American Products AM47P-26-24RU with Heat Exchanger, Heater, Insulation, Ground Bar Kit, 100 Amp service panel *OR EQUIVALENT*	3	$10,000	$30,000
Contractor Management and Support, Tower Site Identificatioon, Equipment/Labor Procurement Project Management, Contractor Oversight, Procurement, Coordination with site Owners, Coordination with Utilities, Network Design, Integration, Testing, Etc. - *COST PER SITE*	3	$13,000	$39,000
Electric Service, Tower Site Fit-up Cost per site, includes material/labor for H-frame and electrical equipment cabinet, electric meter-base, disconnect panel	3	$4,500	$13,500
Tower site switch Switch installed at tower base for interconnection with ISP equipment, supports VLANS & other managed layer 2 services for traffic separation.	3	$1,000	$3,000
Tower site - backup power contingency Cost per site, if co-location at site does not include adequate power backup - furnish and install generator, and battery backup system	2	$7,500	$15,000
Total for all three towers			**$181,278**

Estimated cost per tower for "Service Provider Ready": $60,426.00

Some costs in the table above may not be needed (e.g. engineering study if one has been completed recently, generator(s) if already on site, some electrical work, etc.).

Tower Lease Revenue and Expenses

Tower Space Revenue Estimate

Tower revenue is limited. It takes WISPs many months to acquire enough customers on a new tower to break even, and even longer to begin to show a profit. Fees for tower space need to be modest to attract one or two providers, and it is good practice to offer several months of free service while the WISP markets in the new service area and tries to sign up customers.

Because of interference problems, two providers are the most that are desirable on a tower, and offering towers on an exclusive basis (e.g. an open auction for tower space) could bring in more revenue from a single provider.

It may be advantageous to bid out all three towers

Tower Leasing Revenue Projection (One Tower)

Service Item	Description	Monthly Fee	Max Number of WISPs per Tower	Projected Annual Revenue
Tower Space for One Tower	10 feet of vertical space leased to one ISP	$200	2	**$4,800**
Tower Space for Three Towers	10 feet of vertical space leased to one ISP	$200	2	**$14,400**

Tower Space Operational Expenses

Assumptions include:

- Each provider on a tower will install their own electric service (meter) and pay their own utility costs.
- Site leases on private land can be negotiated for $1000/year with a single up-front payment of $10,000 (for ten years).

If several towers are built (e.g. three), there will be some efficiencies gained in costs so that revenue would likely exceed expenses—costs like legal services and insurance will not increase proportionally with more than one tower.

Tower Lease Annual Expense Projections

Budget Item	Description	Annual
Legal Services	Legal counsel on an as-needed basis for review of construction and service contracts, IRU agreements, and other business documents.	**$1,500**
Accounting	Part time accounting and bookkeeping services will be required	**$2,400**
Generator Maintenance/ Fuel	Generators require periodic maintenance and occasional fuel (propane) tank refills.	**$950**
Site Maintenance	Routine tasks like trimming weeds and grass around the tower.	**$600**
Site Leases	Some towers may be placed on private property which would require annual site leases. This will vary depending on the availability of local government properties that may be available for tower placement.	**$1,000**
Insurance	Some insurance is likely to be needed (general liability, unemployment, asset insurance, umbrella policy).	**$2,500**
Total Costs	**Projected annual expenses**	**$8,950**

Community Dark Fiber Revenue and Expenses

Community Dark Fiber Revenue Estimate

This revenue estimate is based on one downtown dark fiber deployment (e.g. Litchfield) and an estimate of fifty businesses and institutions getting fiber drops. The cost of some fiber drops would be included in the initial construction, but additional drops will likely require funding support from the service provider using the dark fiber and/or the business getting connected. It will be desirable to include as many drops as practical and reasonable in the initial construction to help get businesses connected quickly.

Dark Fiber Lease Revenue

Service Item	Description	Monthly Fee	Estimated Customers Receiving Service	Projected Annual Revenue
Recurring Revenue				
Dark Fiber Pair	One fiber pair from cabinet to handhole nearest customer	$25	50	**$15,000**
Non-Recurring Revenue				
One Time Splicing Fee	Drop splicing cost at customer handhole	$200	50	**$10,000**

Community Dark Fiber Expense Estimate

As a dark fiber network, operational expenses will be few and relatively modest. Not included is the time/salary costs that may be attributed to local government staff or donated time and effort from volunteers who contribute to the effort.

Recurring Costs		
Budget Item	Description	Annual
Network Ops	No 24/7/365 network management needed for dark fiber	**$0**
Legal Services	Legal counsel on an as-needed basis for review of construction and service contracts, IRU agreements, and other business documents.	**$1,000**
Accounting	Part time accounting and bookkeeping services will be required	**$1,200**
Maintenance	Should be very limited.	**$1,200**
Spares/ Supplies	Patch cables, spare handholes, fiber repair kits	**$1,200**
Utilities	Electric power needed at the cabinet where service providers will install equipment. Cost of service included in fiber pair lease fee.	**$1,200**
Locates	Once some fiber has been constructed, it will be necessary to provide locates. Public Works staff can be trained to do this work, or a private locate firm can do this work.	**$1,500**
Pole Use Fees	No aerial fiber is anticipated.	**$0**
Storage	Storage space for spare conduit, fiber, splice closures, handholes and other spare parts will be needed. A rental storage unit or used shipping container would be adequate.	**$600**
Site Leases	Most desirable to identify a rent-free spot for the cabinet or shelter.	**$0**
Break-Fix reserve fund	A reserve fund to cover fiber damage repairs. A regular annual contribution to the fund will be needed. Note that fiber damage caused by a third party (e.g. a contractor) would require that party to pay for the cost of repairs.	**$2,000**
Insurance	Some insurance is likely to be needed (general liability, unemployment, asset insurance, umbrella policy).	**$2,500**
Total Costs	**Projected annual expenses**	**$12,400**
Non-Recurring Costs		
Training	Local government staff may need training to perform locates, fiber splicing.	**$3,500**
Tools and Equipment	A splicer and an ODTR (Optical Time Domain Reflectometer), will minimize the need for outside contractor costs for occasional splicing needs and fiber strand testing.	**$12,500**

Wireless Tower/Fiber Backhaul Network

Wireless Tower/Fiber Backhaul Revenue Estimate

This revenue estimate is based on leasing fiber pairs on the roughly 37 miles of fiber that would be constructed to connect three wireless towers together.

One potential source of revenue would be to lease fiber pairs to cellular providers who want fiber to cellular towers along the route(s) of the fiber. The table below makes some modest estimates of the potential revenue.

A second source of revenue would be WISPs placing equipment on the towers who want connectivity between the towers via fiber to improve service quality and increased bandwidth on the towers. Given the distances involved, special pricing would needed that would be different from what would be charged to cellular providers.

Other possible revenue sources could be network connectivity between K12 schools that are near the fiber routes. Public safety agencies might also be interested in the data connectivity between towers to improve remote voice/data access and/or to provide redundancy to existing wireless public safety voice/data systems.

Revenue Estimate for Tower Fiber Segments

Recurring Revenue					
Service Item	Description	Monthly Fee	Estimated Average Distance	Cellular Towers Connected	Projected Annual Revenue
Dark Fiber Pair	One fiber pair leased to cellular provider	$75/mile	8	4	**$28,800**
Dark Fiber Pair	One fiber pair leased to one WISP with equipment on the towers	Bundled service dark fiber pairs to all three towers for $250/ month	n/a	n/a	**$3,000**
				Total Estimated Annual Revenue	**$31,800**

Tower Fiber Expense Estimate

As a dark fiber network, operational expenses will be few and relatively modest. Not included is the time/salary costs that may be attributed to local government staff or donated time and effort from volunteers who contribute to the effort.

Recurring Costs		
Budget Item	Description	Annual
Network Ops	No 24/7/365 network management needed for dark fiber	**$0**
Legal Services	Legal counsel on an as-needed basis for review of construction and service contracts, IRU agreements, and other business documents.	**$1,000**
Accounting	Part time accounting and bookkeeping services will be required	**$1,200**
Maintenance	Should be very limited.	**$1,200**
Spares/ Supplies	Patch cables, spare handholes, fiber repair kits	**$1,200**
Utilities	Electric power needed at the cabinet where service providers will install equipment. Cost of service included in fiber pair lease fee.	**$1,200**
Locates	Once some fiber has been constructed, it will be necessary to provide locates. Public Works staff can be trained to do this work, or a private locate firm can do this work.	**$1,500**
Pole Use Fees	No aerial fiber is anticipated.	**$0**
Storage	Storage space for spare conduit, fiber, splice closures, handholes and other spare parts will be needed. A rental storage unit or used shipping container would be adequate.	**$600**
Site Leases	Most desirable to identify a rent-free spot for the cabinet or shelter.	**$0**
Break-Fix reserve fund	A reserve fund to cover fiber damage repairs. A regular annual contribution to the fund will be needed. Note that fiber damage caused by a third party (e.g. a contractor) would require that party to pay for the cost of repairs.	**$2,000**
Insurance	Some insurance is likely to be needed (general liability, unemployment, asset insurance, umbrella policy).	**$2,500**
Total Costs	**Projected annual expenses**	**$12,400**
Non-Recurring Costs		
Training	Local government staff may need training to perform locates, fiber splicing.	**$3,500**
Tools and Equipment	A splicer and an ODTR (Optical Time Domain Reflectometer), will minimize the need for outside contractor costs for occasional splicing needs and fiber strand testing.	**$12,500**

Tower Wireless/Wireless Backhaul

Point to Point Wireless Backhaul Revenue Estimate

Revenue from the point to point is going to be limited, but the overall cost of that network compared to fiber is much lower.

If the cost is modest (as proposed), a WISP placing equipment on the towers would be interested in leasing a high capacity circuit (e.g. 300 Meg) between all three of the towers to reduce their capital costs of expanding their service area.

Other possible revenue sources could be network connectivity between K12 schools that are near the towers (an additional point to point circuit to the school(s) would be added). Public safety agencies might also be interested in the data connectivity between towers to improve remote voice/data access and/or to provide redundancy to existing wireless public safety voice/data systems.

Point to Point Wireless Circuit Lease Revenue Estimate

Recurring Revenue			
Service Item	Description	Monthly Fee	Projected Annual Revenue
Tower Connectivity	Bundled service dark fiber pairs to all three towers	$250/month	**$3,000**

Point to Point Wireless Backhaul Expense Estimate

As a dark fiber network, operational expenses will be few and relatively modest. Not included is the time/salary costs that may be attributed to local government staff or donated time and effort from volunteers who contribute to the effort.

Recurring Costs		
Budget Item	Description	Annual
Network Ops	Cost to monitor backbone radios and provide NOC services (configuration, troubleshooting, dispatch, outage monitoring). Cost per year, does not include costs for truck rolls or repair labor.	**$6,000**
Legal Services	Covered in Tower Space Expense table	**$0**
Accounting	Covered in Tower Space Expense table	**$0**
Maintenance	Should be limited, perhaps one truck roll and tower climb per year	**$1,200**
Spares Reserve Fund	Recommended that one replacement radio be kept on hand for emergency replacement. Assumption of one failed radio every three years, or contribution of $6000/year	**$6,000**
Utilities	Covered in Tower Space Expense table	**$600**
Site Leases	Assumption that existing towers will not require a site lease.	**$0**
Insurance	Covered in Tower Space Expense table	**$0**
Total Costs	**Projected annual expenses**	**$13,800**

Aggregated Revenue and Expense Estimate

The table below shows a small net deficit for the three tower network with the wireless point to point backhaul network. A single additional user of the backhaul network (e.g. K12 schools, public safety) would put the system into the black.

Aggregated Wireless Tower Revenue and Expenses		
Budget Item	Description	Annual
Tower Space Revenue	Potential revenue from leasing tower space to one or two WISPs.	**$14,400**
Wireless Backhaul Revenue	Potential revenue from leasing wireless backhaul circuit(s) to WISPs	**$3,000**
Tower Space Costs	Expenses related to leasing tower space to WISPs	**-$8,950**
Wireless Backhaul Costs	Expenses related to maintaining the wireless backhaul network	**-$13,800**
Total Costs	**Projected annual expenses**	**-$5,350**

Appendix A: Glossary

Active network: Typically a fiber network that has electronics (fiber switches and CPE) installed at each end of a fiber cable to provide "lit" service to a customer.

Backhaul: A network segment or connection between two portions of the network. Also used in the phrase "Internet backhaul," which refers to how traffic leaves the local network and gets connected to the worldwide Internet.

Colo facility: Colo is short for Colocation. Usually refers to a prefab concrete shelter or data center where network infrastructure converges. A colo or data center can also refer to a location where several service provider networks meet to exchange data and Internet traffic.

Dark fiber: Dark fiber is fiber cable that does not have any electronics at the ends of the fiber cable, so no laser light is being transmitted down the cable.

Lit network: A "lit"network (or lit fiber) is the same as an active network. "Lit" refers to the fact that the fiber equipment at each end use small lasers transmitting very high frequency light to send the two way data traffic over the fiber.

FTTH/FTTP/FTTx: Fiber to the Home (FTTH), Fiber to the Premises (FTTP), and Fiber to the X (FTTx) all refer to Internet and other broadband services delivered over fiber cable to the home or business rather than the copper cables traditionally used by the telephone and cable companies.

Symmetric connection: The upload and download bandwidth (speed) is equal. This is important for businesses and for work from home/job from home opportunities.

Asymmetric connection: The upload and download bandwidth (speed) are not equal. Cable Internet and satellite Internet services are highly asymmetric, with upload speeds typically 1/10 of download speeds. Asymmetric services are problematic for home-based businesses and workers, as it is very difficult to use common business services like two way videoconferencing or to transfer large files to other locations.

IP video: Video in various forms, including traditional packages of TV programming, delivered over the Internet rather than by cable TV or satellite systems.

Latency: The time required for information to travel across the network from one point to another. Satellite Internet suffers from very high latency because the signals must travel a round trip to the satellite in stationary orbit (22,500 miles each way). High latency makes it very difficult to use services like videoconferencing.

Fiber switch: Network electronic equipment usually found in a cabinet or shelter

CPE: Customer Premises Equipment, or the box usually found in a home or business that provides the Internet connection. DSL modems and cable modems are examples of CPE, and in a fiber network, there is a similarly-sized fiber modem device.

Handhole: Handholes are open bottom boxes with removable lids that are installed in the ground with the lids at ground level. The handholes provide access to fiber cable and splice closures that are placed in the handhole. Handholes are also called pull boxes.

Passive network: Refers to infrastructure that does not have any powered equipment associated with it. Examples include wireless towers, conduit (plastic duct), handholes, and dark fiber.

Pull boxes: Pull boxes (also called handholes) are used to provide access to fiber cable and splice closures. They are called pull boxes because they are also used during the fiber cable construction process to pull the fiber cable through conduit between two pull boxes.

Splice closures: Splice closures come in a variety of sizes and shapes and are used to provide access to fiber cable that has been cut open to give installers access to individual fiber strands. Splice closures are designed to be waterproof (to keep moisture out of the fiber cable) and can be mounted on aerial fiber cable or placed underground in handholes.

Splicing: The process of providing a transparent joint (connection) between two individual fiber strands so that laser light passes through. A common use of splicing is to connect a small "drop" cable of one or two fiber strands to a much larger (e.g. 144 fiber strand) cable to provide fiber services to a single home or business.

SCADA: Supervisory Control and Data Acquisition. Used by the electric utility industry and some other utilities (e.g. water/sewer) to manage their systems.