Somerset County Broadband

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Executive Summary

Somerset County recognizes that broadband is no longer a luxury but is increasingly a necessity to attract and retain businesses and residents. The County seeks to find the most cost effective way to improve broadband access to its citizens. While some parts of the county are comparatively well served, more rural, less densely populated areas in the north have services that are highly variable, and even in the better-served southern county, there are areas that do not meet the current definition of broadband.

The Kennebec Valley Council of Governments (KVCOG) has secured a ConnectME planning grant for Tilson and Axiom to investigate options for broadband access improvements in Somerset County, working with the Somerset Economic Development Corporation (SEDC). KVCOG, SEDC, Tilson, and Axiom have together arrived at a plan that cost effectively provides several options for improvements. The plan is modular and consists of multiple discrete fiber builds designed to in effect extend the statewide Three Ring Binder network into more parts of Somerset County through a "deep fiber" strategy that combines "middle mile" and "last mile" elements. This includes:

1. Connect selected existing cellular towers throughout Somerset County to the Three Ring Binder middle mile dark fiber network, allowing Axiom to offer wireless internet service in areas that currently do not have adequate access. Fiber built to connect these towers will be designed with the capacity to directly connect homes and businesses along the route, or to connect future fiber network expansions.
2. Build lengths of fiber in defined corridors to facilitate the connection of businesses in the Skowhegan and Norridgewock areas.
3. Extend fiber up US 201 as far as The Forks to provide the infrastructure for local townships to more cost effectively build their own solutions and connect to Three Ring Binder, whether these are directly wired or wireless.

Much of northern Somerset County is remote wooded terrain with very few inhabitants. The more densely populated southern portion of the county is generally better served by the incumbent carriers, but coverage is not universal. The wireless option, therefore, provides a good balance of cost-efficiency and augmenting coverage where local gaps exist, if the County and Axiom are strategic about site selection.

An important caveat with the coverage data and maps contained in this document is that they use the Federal Communications Commission's (FCC) Form 477 data. Form 477 is a required semiannual filing for all internet service providers in the United States where providers must specify the fastest service they advertise in each census block they serve. It is not granular below the census block level, however, so if even one premise in a block has available a high level of service the entire block will show as that service being available. Therefore, in this document, southern Somerset looks as if it is generally well-served even though there are likely many gaps that do not show in the given data.

The document outlines an approach that will help the region make incremental progress toward several of the County's goals in improving broadband access, enabling a variety of potential solutions to fill broadband gaps with different broadband technologies and a range of additional public or private sector investment. It provides a necessary stepping stone to bring it within reach for towns to solve their own broadband issues. It does this through extensions of the Three Ring Binder, an asset that is vital but not ubiquitous, into parts of the county it does not currently exist in. Three Ring Binder provides a platform that allows all sorts of providers to offer services, so this approach extends that platform to enable private investment where there is a will and a business case. If private investment does not materialize, then this extension makes it easier for the county, towns, or someone else to build last mile connectivity. This approach, in other words, is Three Ring Binder but on a local scale.

As a next step, Tilson suggests identifying a way to prioritize the modular investments and buildouts contained in this document. While we have provided a budget estimate for each project that includes labor, materials, and an estimate of the make ready work required, further clarity would be required prior to commencing construction. This would chiefly include detailed engineering, pole attachment and make ready, and site/easement acquisition.

Lastly, Tilson suggests that, while the builds outlined herein are modular, the County should have a single organization in place to organize the work. This could be done by the county government, the economic development corporation, KVCOG, or another suitable group. Allowing each town or locality full responsibility for its local piece would be unduly time consuming and inefficient. The best approach would be to have this single fiber services organization establish a framework that towns or communities can buy into. In this way, towns that can get funding and service providers in place will ask the fiber services organization to provide a turnkey solution with all engineering, agreements, and payment structures in place. This kind of shared services model allows individual towns to benefit from economies of scale if they work with the single fiber services organization. Of course, if a town really wants to do it itself, it can, but it will certainly be more expensive and less efficient.

Defining Broadband

Prior to delving into Somerset County's specific situation, it is important to establish a baseline understanding of terminology and requirements. This section defines some key network terms and provides information on minimum recommended bandwidth for various broadband applications.

Network Terminology

In defining broadband, there are three main metrics that can be used to describe a connection: upload bandwidth, download bandwidth, and latency. These are defined as follows:

- Upload bandwidth is the capacity of a network connection to push data from the local network to the wide area network to which it is connected. In other words, upload bandwidth is a measurement of the capacity of the data "pipe" *from* the local network to the internet. Bandwidth is typically measured in megabits or gigabits per second, abbreviated Mbps and Gbps, respectively.
- Download bandwidth is the capacity of the local network to receive data from the wide area network. Typically, the wide area network will be the Internet. While many people focus on a connection's download bandwidth, it is important to note that all bandwidth measurements are maximums in an ideal environment. Actual *throughput,* the data transfer rate achieved in the real world, is often significantly lower than advertised bandwidth due to factors on the local network and the broader Internet.
- Latency is a measurement of the time it takes for information to travel to its destination on the network. Generally, network latency measures the round-trip time – that is, the time it takes for a *packet* of information to travel from its origin to its destination and back. Latency has a significant impact on a user's perception of connection speed. High latency connections, where for example there is a significant delay between clicking on a link and the page beginning to load, will feel very slow compared to low latency connections, where the response to clicking is immediate, even if the page then takes a few seconds to load. Latency is of paramount importance for "real time" network applications like phone or video conferencing. Typically measured in milliseconds (ms), latency below 50ms is considered normal for home cable broadband connections. An example of a high latency connection might be via satellite, where latency approaching 1000ms is not uncommon.

Broadband Technologies Overview

There are many competing technologies available for broadband networks. Each represents a balance between installation cost, operation cost, geographic range, and the five network characteristics discussed above. This section will discuss the four most common technologies: DOCSIS, DSL, LTE, and fiber.

DOCSIS

Data Over Cable Service Interface Specification, usually called DOCSIS, is the standard used by cable internet providers. There are multiple versions of DOCSIS; the current specification is version 3.0. Most US cable companies will begin to implement DOCSIS 3.1 on a wide scale in 2017.

All versions of DOCSIS use existing cable TV wiring to provide data connectivity. Each cable internet connection uses a *cable modem* to transmit and receive data, and convert between the cable company's infrastructure and a local networking interface, usually Ethernet.

Cable modems transmit and receive using the similar types of signals to those of cable TV. Cable providers can add or remove bandwidth by assigning more or fewer channels to the data network. The DOCSIS standard, among other things, defines ways for cable modems to take advantage of more channels for data. Since bandwidth on the cable companies' networks is a finite resource, as internet bandwidth needs grow, cable companies may be faced with removing less-watched TV channels from their lineups in order to free bandwidth for internet customers.

DOCSIS 3.0 is the current standard in US cable internet. While it can technically support up to 1Gbps, no cable provider offers such a service tier because it would use too many channels. In addition, gigabit speeds under DOCSIS 3.0 would require prohibitively expensive upgrades in the cable providers' head-end systems.

Instead, most operators plan to make head-end upgrades as part of the overall upgrade to DOCSIS 3.1. The newer standard is more efficient, and is designed to compete with FTTP offerings from Verizon, AT&T, Google, and others. Table 4 shows a comparison of the maximum bandwidth for each DOCSIS standard that can be typically realized. While DOCSIS 3.1 can theoretically support up to 10Gbps download, cable providers are only planning to implement a maximum of 5Gbps initially.

One important drawback to cable internet is that connection bandwidth is shared with other users in the area. If the network is not well-engineered, throughput will suffer during periods of high usage.

Table 1 — DOCSIS 3.0 vs 3.1

	DOCSIS 3.0	DOCSIS 3.1
Year Released	2006	2015
Download Bandwidth (Theoretical)	Up to 1Gbps	Up to 10Gbps
Upload Bandwidth (Theoretical)	Up to 100Mbps	Up to 1Gbps
Download Bandwidth (Typical)	50-200Mbps	Up to 5Gbps
Upload Bandwidth (Typical)	1-20Mbps	Up to 100Mbps

DSL

Digital Subscriber Line, or DSL, is a family of technologies that allows high speed internet using old-fashioned copper phone lines. While a proven technology, DSL has significant technical limitations that drive up the cost of deploying higher-speed DSL networks.

The two main DSL technologies in use in the United States are ADSL and VDSL.

ADSL, Asymmetric Digital Subscriber Line, is the more common technology. The “asymmetric” refers to the fact that ADSL lines have different upload and download bandwidths. When the technology was first introduced in the late 1990s, ADSL had a maximum download bandwidth of 1.5Mbps. Nowadays, DSL networks can achieve 24Mbps download under ideal conditions using an updated version of the technology called ADSL2+. ADSL2+ is the most common DSL technology in the United States.

VDSL, Very-high-bit-rate Digital Subscriber Line, is an improved version of DSL technology that can provide bandwidth rivalling the fastest DOCSIS 3.0 connections under ideal circumstances. VDSL is generally used for DSL speeds in excess of 24Mbps. Achieving speeds comparable to fast cable connections with VDSL is costly and technically demanding in real world conditions. VDSL is relatively uncommon in the United States, but deployments do exist. TDS in Maine offers VDSL service in some areas, for example.

The core weakness of all DSL technologies is that speed decreases quickly as the customer moves farther from the phone company’s DSL hub, called a DSLAM. While an ADSL connection might be able to attain 24Mbps, customers would have to be located within one third of a mile of the DSLAM to realize such speeds. Customers more than 2.5 miles from the DSLAM are limited to approximately 3Mbps, while DSL is generally not usable for customers more than about 3 miles from the DSLAM. Table 5 shows the theoretical maximum bandwidths for DSL technologies, under optimal conditions. VDSL can achieve speeds higher than below by using multiple physical pairs of wire and bonding them programmatically at the DSLAM into one connection, but this imposes a significant capital and operational cost in addition to requiring customers be near the DSLAM.

Table 2 — DSL Technologies Comparison

	ADSL	ADSL2+	VDSL	Maine DSL Deployments (Typical)
Download Bandwidth	Up to 8Mbps	Up to 24Mbps	Up to 52Mbps	1-18Mbps
Upload Bandwidth	Up to 0.448Mbps	Up to 1.4Mbps	Up to 16Mbps	0.5-2Mbps

The speeds shown in Table 2 for Maine deployments are the most common ranges of available speeds in the state. Some providers, notably TDS, offer higher-speed VDSL services in certain limited areas of up to 50 Mbps download and 20 Mbps upload.

Fixed Wireless and LTE

Fixed wireless technologies can be broadly broken down into two categories: LTE and non-LTE. LTE, or Long Term Evolution, is often thought of as a cellular phenomenon. While US cellular providers have all implemented LTE in some form on their networks, the technology can also be used for fixed applications. Wireless systems have certain advantages over wired ones, chief among which is their reduced capital cost in covering sparsely populated or remote areas. This must be balanced with the need, especially in a fixed broadband network, to provide adequate service to all subscribers throughout the footprint.

LTE is a mature technology that, as noted above, is being widely used worldwide. It provides a theoretical maximum download speed of 300Mbps with uploads of up to 75Mbps, but real world speeds typically max out around 30 Mbps download and 15 Mbps upload. Since LTE is a wireless technology, factors such as distance from the base station, atmospheric conditions, and the number of users using the base station will affect real-world throughput and latency. There are ISPs who provide fixed LTE connections, especially to remote communities. RedZone is an example of a fixed LTE service provider in Maine. Fixed wireless service providers typically provide a router that receives the wireless signal and converts it to standard Ethernet and/or Wi-Fi for use in residences and small businesses.

There are also non-LTE fixed wireless technologies, but the state of the art has been moving more towards standardizing on LTE. Non-LTE fixed wireless solutions consist of a range of different technologies and equipment, with varying performance levels. For example, Axiom operates non-LTE fixed wireless networks and typically offers download speeds of up to 10-20Mbps and upload speeds of up to 1-2Mbps, but faster speeds are available in some areas.

Fiber

Fiber optics use glass (or, in some cases, plastic) strands to carry data signals in the form of pulses of laser light. Each strand is significantly thinner than a human hair but has no theoretical maximum bandwidth. Fiber connections of 400Gbps have been demonstrated, but most FTTP networks have a bandwidth of 1Gbps per connection. As new technologies become available, FTTP networks can be upgraded by installing new equipment at each end of the fiber.

Fiber to the premises is generally considered the “gold standard” in speed, reliability, and latency. One important differentiator of FTTP networks compared to other technologies is that FTTP is symmetric. That is, FTTP networks offer the same upload and download bandwidth. As people use the internet more and more for applications, like video chat, that require significant upstream bandwidth, this can become an important consideration.

Broadly speaking, there are two main types of FTTP network: passive and active. In a passive network, multiple customers share the bandwidth from a common fiber strand. Conversely, customers in active networks each have their own dedicated fiber strand to the head end. Passive networks tend to have lower capital and equipment costs while active ones are generally perceived as “future-proof”. Both types of networks can still provide gigabit bandwidth to end users.

Summary of Network Technologies

The below table summarizes all the broadband technologies along the three characteristics of upload/download bandwidth and latency.

Table 3 — Comparison of Broadband Technologies

	Typical Download Bandwidth	Typical Upload Bandwidth	Typical Latency	Theoretical Max Download Bandwidth	Theoretical Max Upload Bandwidth
Cable/ DOCSIS	10-150Mbps	1-20Mbps	30-80ms	3.0: 1Gbps 3.1: 10Gbps	3.0: 100Mbps 3.1: 1Gbps
ADSL2+	3-18Mbps	0.768-1.4Mbps	40-80ms	24Mbps	1.4Mbps
LTE	15-35Mbps	5-20Mbps	60-100ms	300Mbps	16Mbps
FTTP	1Gbps	1Gbps	<15ms	10Gbps	75Mbps

Bandwidth Needs by Activity

The general trend in bandwidth needs for broadband connections is upward. Speeds that were thought of as “very fast” only a few years ago are commonly seen as minimum requirements now. As available speeds increase, people develop new and innovative uses for the improved speeds. These innovations make possible things that had previously been thought difficult or expensive at best, or within the realm of science fiction. Ten years ago, for example, the idea that people could have a video conference using only their laptop or phone was hardly thought of. Now it is commonplace.

The below table provides indicative download bandwidth requirements for a variety of common broadband uses. It’s certainly possible to add desired applications together to arrive at an estimate for one’s broadband needs.

Table 4 — Typical Bandwidth Requirements for Broadband Applications

Application	Minimum Recommended Download Bandwidth (Mbps)	Minimum Recommended Upload Bandwidth (Mbps)
Email or Basic Web Surfing	1.5	1.0
Stream Non-HD Short Videos	1.5	1.0
Stream Non-HD Movies	3.0	1.0
Stream HD Movies	5.0	1.0
Stream Ultra-HD (4K) Movies	25.0	1.0
Video Conferencing (FaceTime, Google Hangouts, etc)	2.6	2.6
Real-Time Multiplayer HD Gaming	4.0	4.0
Music Streaming	5.0	1.0
Telemedicine	20.0	20.0
Telecommuting (minimal large file transfers)	25.0	3.0
Telecommuting (including large file transfers)	50.0	20.0

In addition to minimum bandwidth requirements, it is also worth discussing the number of devices using a single internet connection. It has become common for residential and business users to share a single connection among multiple devices, typically using a Wi-Fi router. It is important to note that bandwidth requirements will typically increase as more devices are connected to the same internet connection, since each device can be used independently to stream movies, say, or surf the web. As the number of devices used on a given connection increases, so do bandwidth needs for that connection.

Somerset County Gap Analysis

Prior to discussing gaps, it is important to identify the level of service required to determine whether a given area should be considered served or unserved. In this document, we use the FCC's standard of 25 Mbps download and 3 Mbps upload. ConnectME, of course, has a different standard of 10 Mbps download and upload. Very few DSL services can provide 10 Mbps upload, however, and since DSL is by far the most geographically prevalent technology in Somerset County, we feel it more appropriate to use the FCC's standard of service in analyzing service gaps in Somerset County.

The most authoritative source of data on broadband availability is FCC Form 477 data, which includes mandated submissions from the carriers and providers. The FCC Form 477 data contains available broadband service speed and technology by provider and census block. While the Form 477 data provides an excellent spatial overview of service, it has some inherent limitations:

1. The low level of granularity. Data is reported at the census block level. A census block is considered served if a given speed and technology are available at one or more addresses within the block. The provider does not necessarily need to serve the entire block at the specified speed with the specified technology. Nevertheless, the case of only serving one premise in a census block would not be a random one. Collections of adjacent blocks that are all shown as served are much more likely to have most premises in those blocks served.
2. The aging of the published data. The most recent data set available is for June 2016 service. December 2016 service data isn't expected until about September 2017.
3. The data is based entirely on provider submissions and is not validated for accuracy by the FCC.

Tilson segmented the Form 477 data into multiple slices to show as many useful views as possible of the data. In this section, we examine services in the county by technology and by provider. It shows locations where each provider active in the county provides service, and color codes maximum advertised consumer download speeds. All data is shown at the census block level, though individual census block boundaries are not shown.

Somerset County is one of the most sparsely populated counties in Maine, with an average 13.3 people per square mile. Combined with somewhat higher than average poverty rates, broadband access levels vary significantly throughout the county. In general, the northern parts of the county are very sparsely inhabited. Most of the county's population is in the southern portion of Somerset. Overall, Somerset County is relatively served in its southern areas and relatively unserved in its northern parts. Virtually all the population centers have some degree of broadband service, even if it is only relatively limited DSL. Southern Somerset, with population centers like Skowhegan, is much better served. The map in Figure 1 shows population density in Somerset County overlaid with telephone service area boundaries and an indication of broadband service levels by the FCC's 25/3 definition. As can be seen, there is no telephone service (gray areas) in parts of the county that have no significant population centers. Keeping in mind this map while reviewing this section, the reader will also realize that there is of course generally no broadband service in these areas. Figure 2 shows the same FCC data without population density or telephone service information.

Diving deeper into countywide service levels, Figure 4 shows the maximum advertised download speed in each census block per the June 2016 Form 477 data. This reflects all terrestrial service offerings: cable, DSL, and fixed wireless, but not satellite. Service levels including satellite are shown in Figure 5.

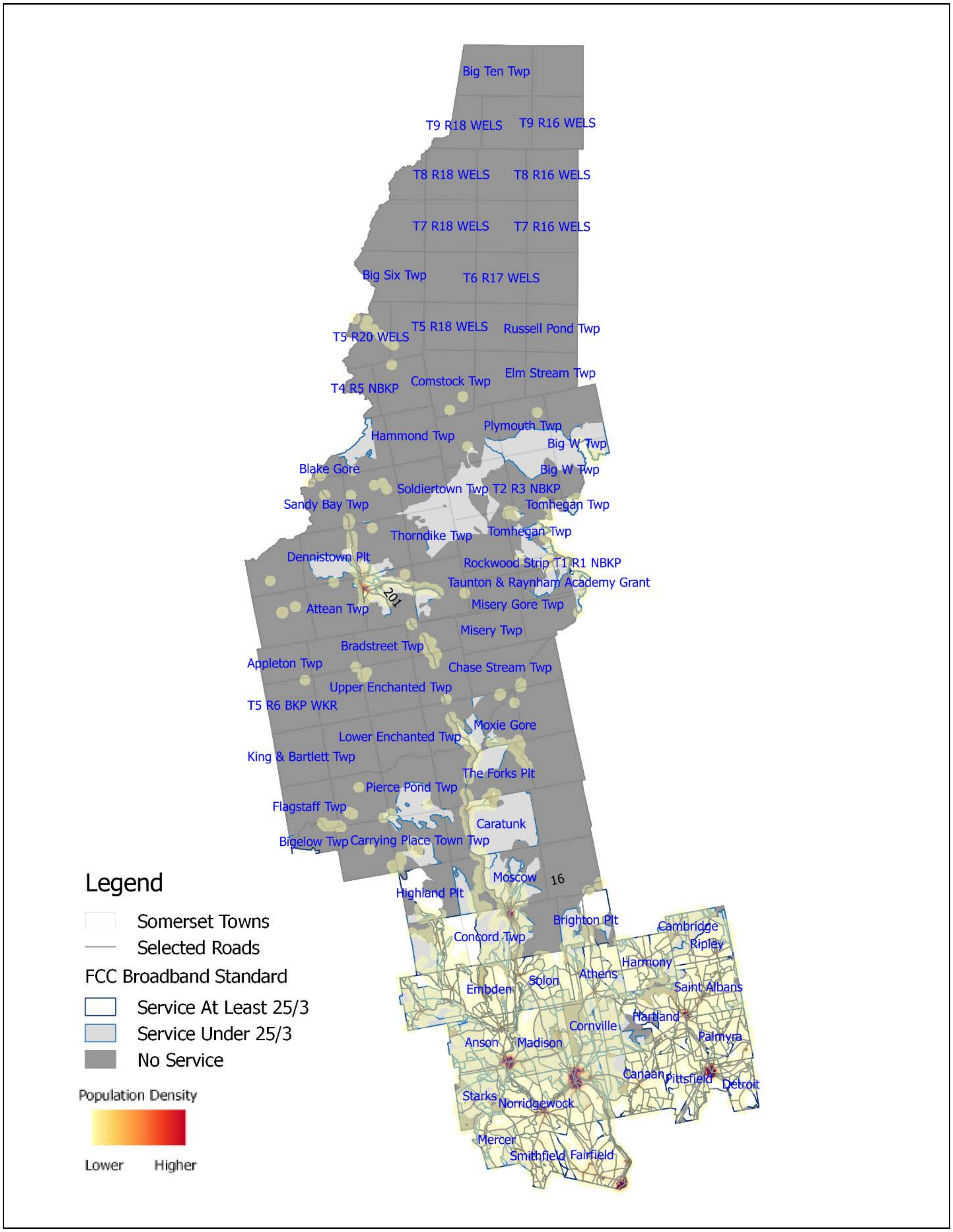


Figure 1 — Population Density and Telephone Service Availability

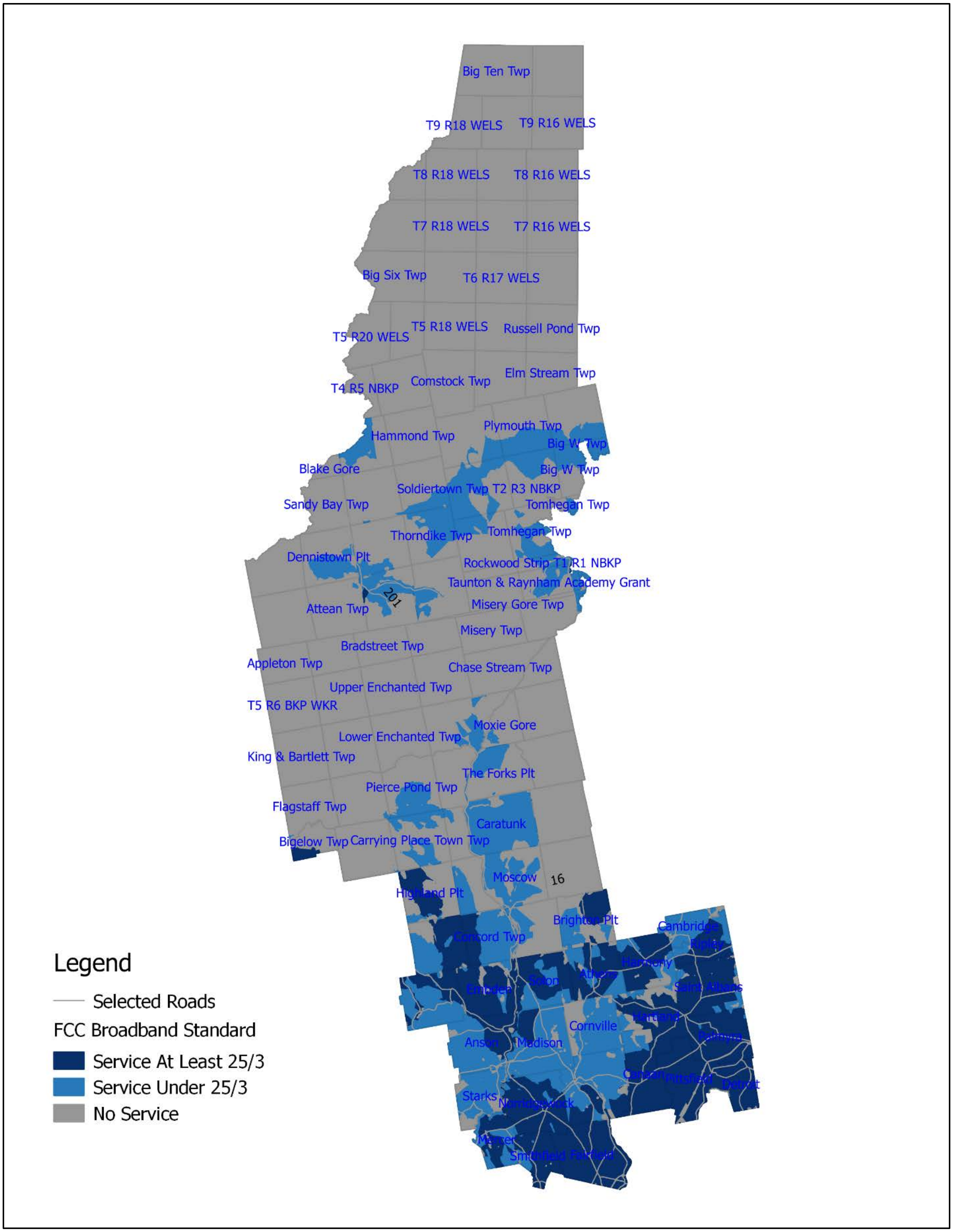


Figure 2 — Countywide Overview of Broadband Access by FCC Definition

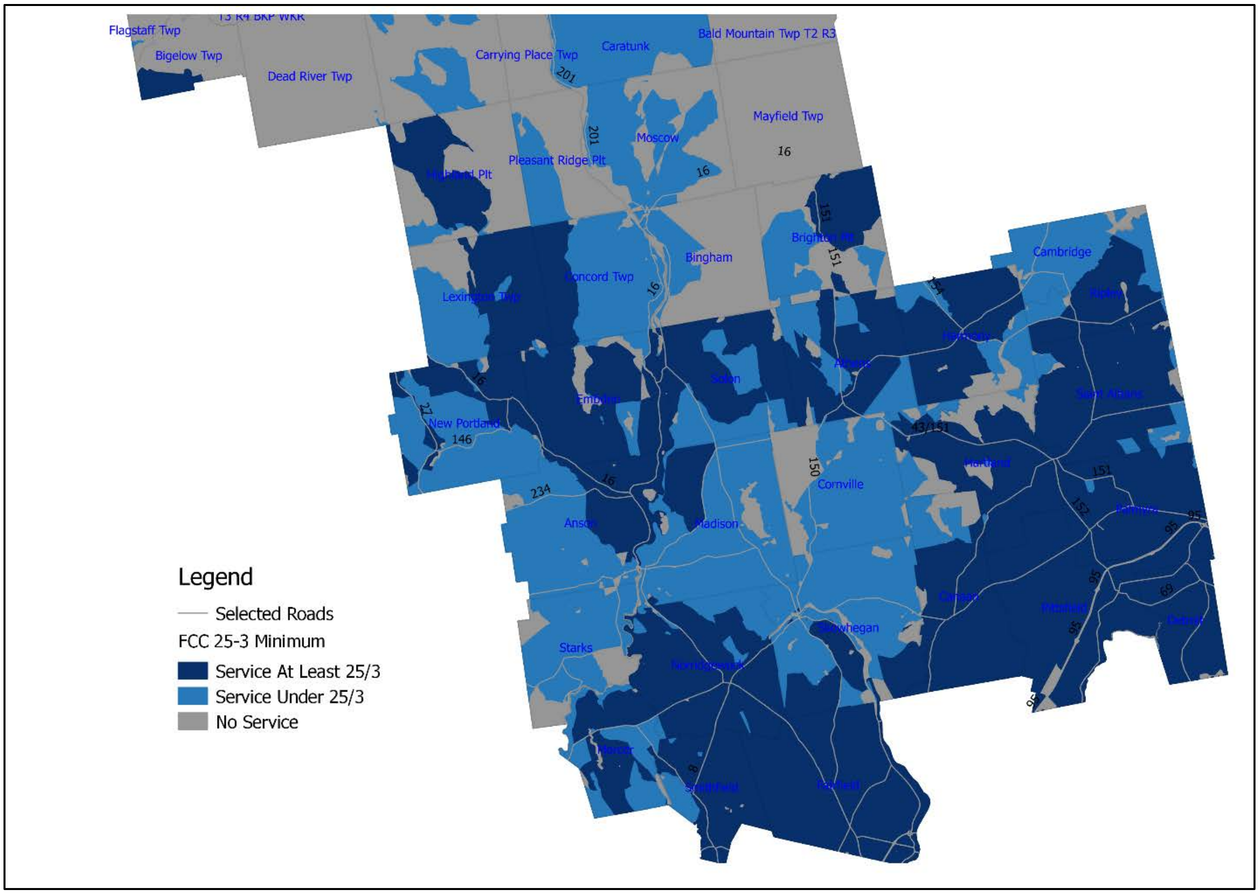


Figure 3 — Southern Somerset Service Levels by FCC Standard

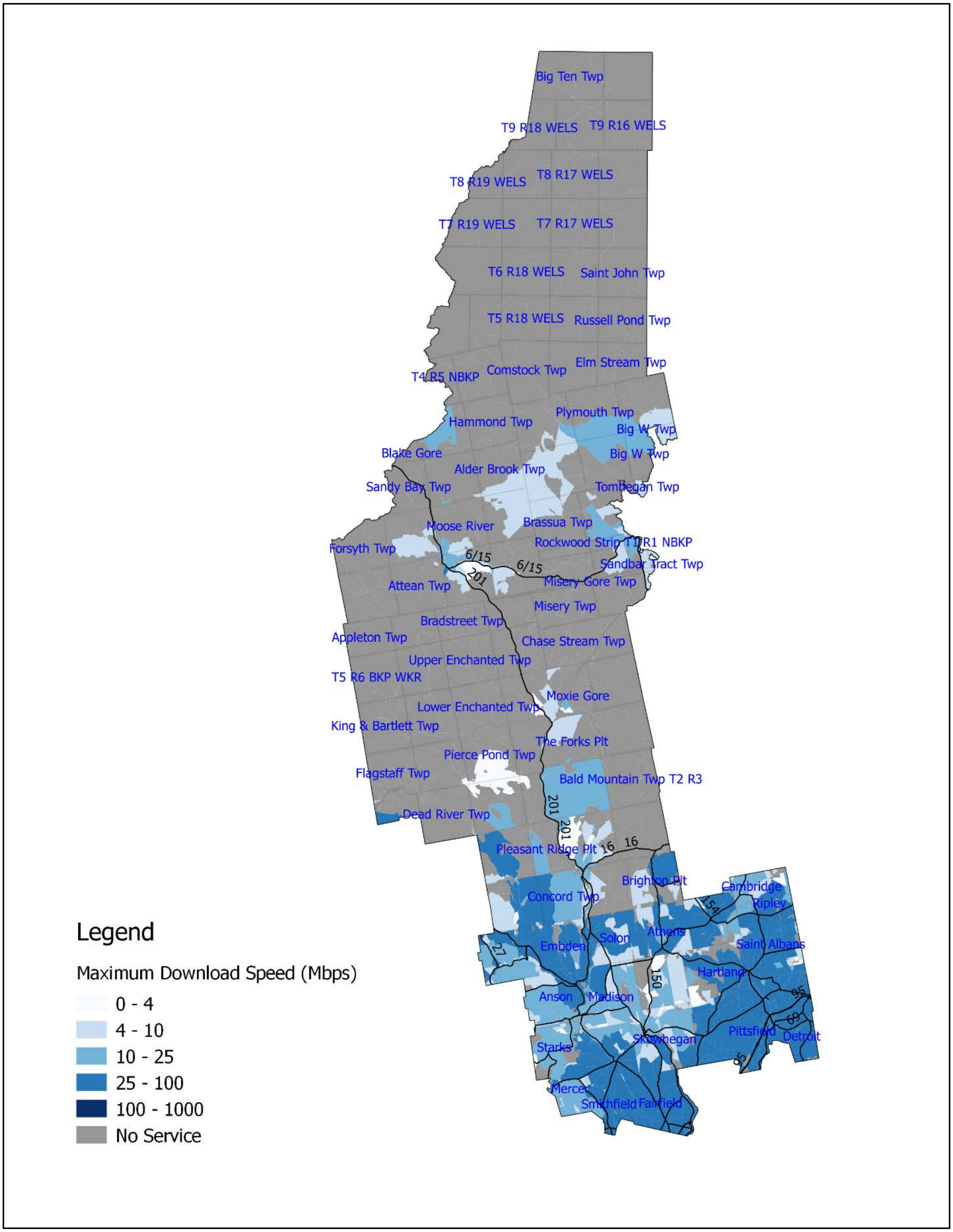


Figure 4 — Maximum Advertised Download Speed – Non-Satellite Services Only

As can be seen, the fastest available services are concentrated in the southern part of the county. Additional services up to approximately 25 Mbps are available in a handful of northern census blocks, mostly via DSL. Satellite service provides up to approximately 10 Mbps throughout the county.

An important caveat to satellite broadband service is the limitations that often come with such service. Satellite technology itself is by definition a high latency service. This refers to the time a signal takes to travel to and from the satellite for both the outbound request and the response, and is usually measured in milliseconds (ms). Since the satellites used to provide broadband service are in geostationary orbits approximately 22,000 miles above the equator, the latency of a satellite broadband connection is typically between 500-1000 ms. This makes satellite connections generally unsuitable for real-time applications, like video-conferencing. People can typically perceive network latency as a problem with these applications when latency approaches 300-400 ms. In fact, latency can be just as important in user perceptions of connection speed as available bandwidth.

Another drawback to satellite broadband is that providers typically impose usage caps on subscribers. Satellite broadband, therefore, is generally not economical for applications that require significant amounts of data to be transferred. Examples are myriad, but common ones might be streaming video or telemedicine. Exceeding the set data caps for one's service plan can result in excess fees or in available bandwidth being reduced for the remainder of the billing period, or both.

Detail of terrestrial service levels in the southern part of Somerset County is in the below figure.

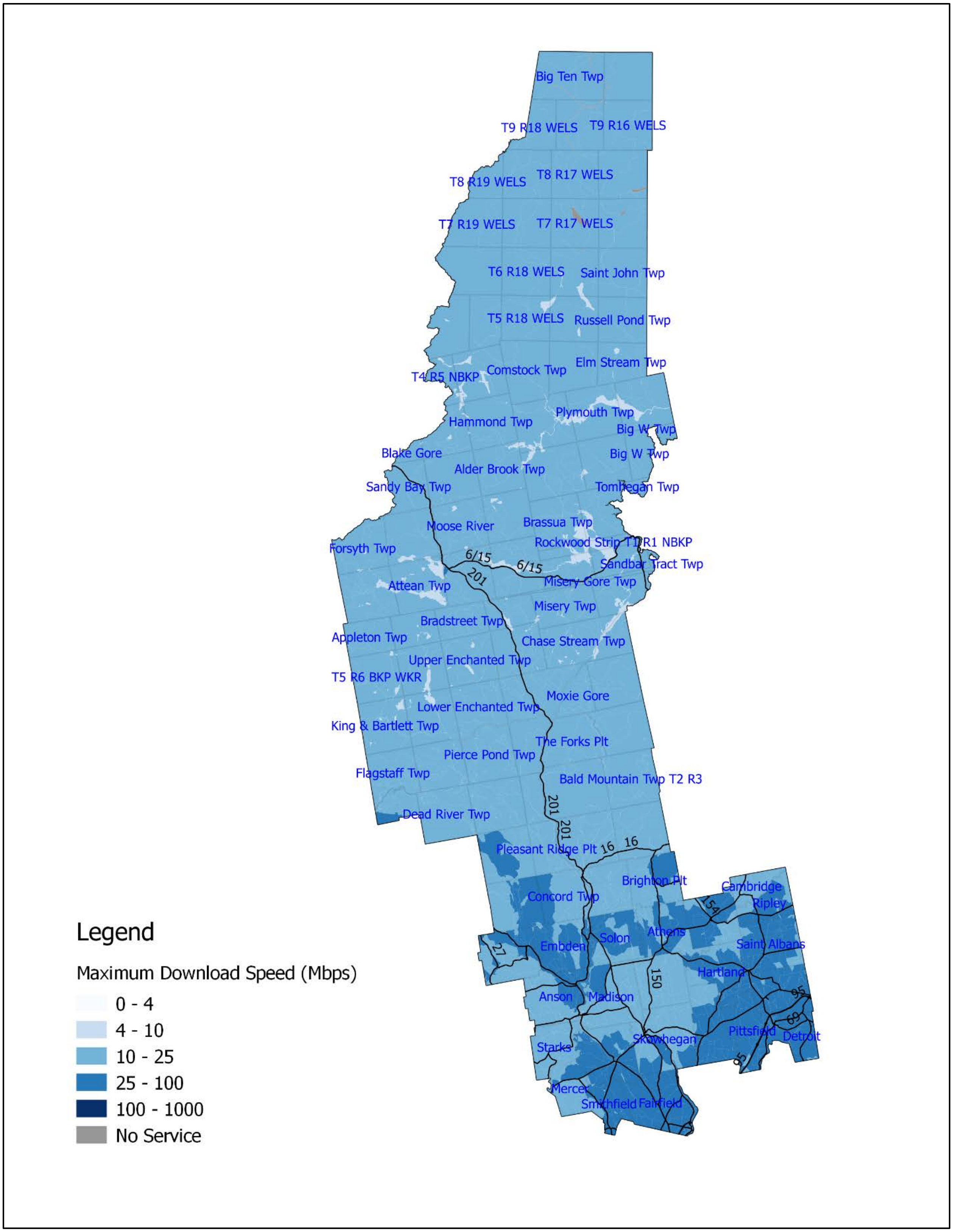


Figure 5 — Maximum Advertised Download Speed - Including Satellite

Cable

Cable is one of the most common broadband technologies, along with DSL. As can be seen in Figure 6 and

Figure 11, cable and DSL make up the bulk of available, fastest technology offerings in Somerset County. That is, the aggregate data shown in Figure 4 consists of largely cable and DSL services.

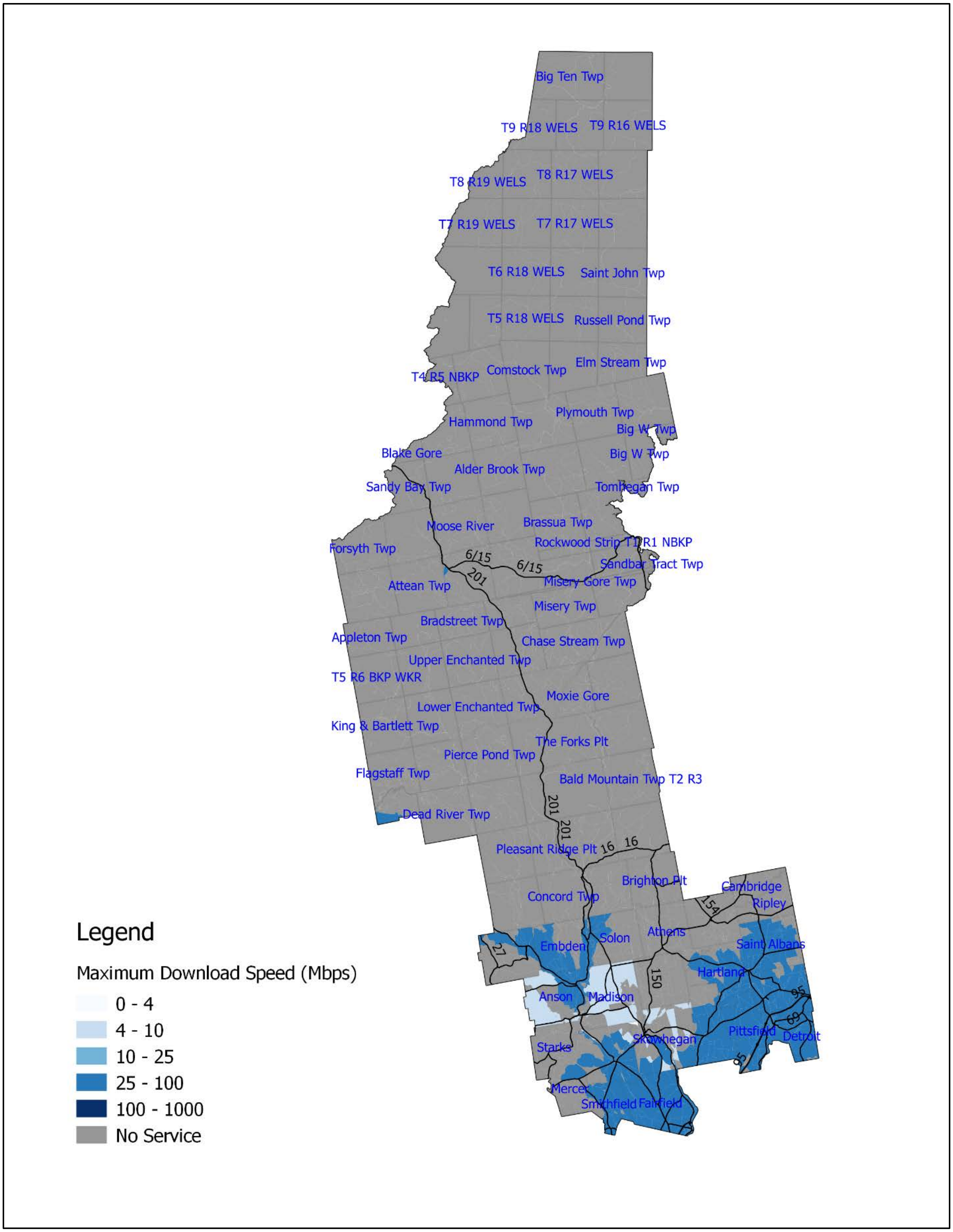


Figure 6 — Maximum Advertised Cable Speeds (All Providers)

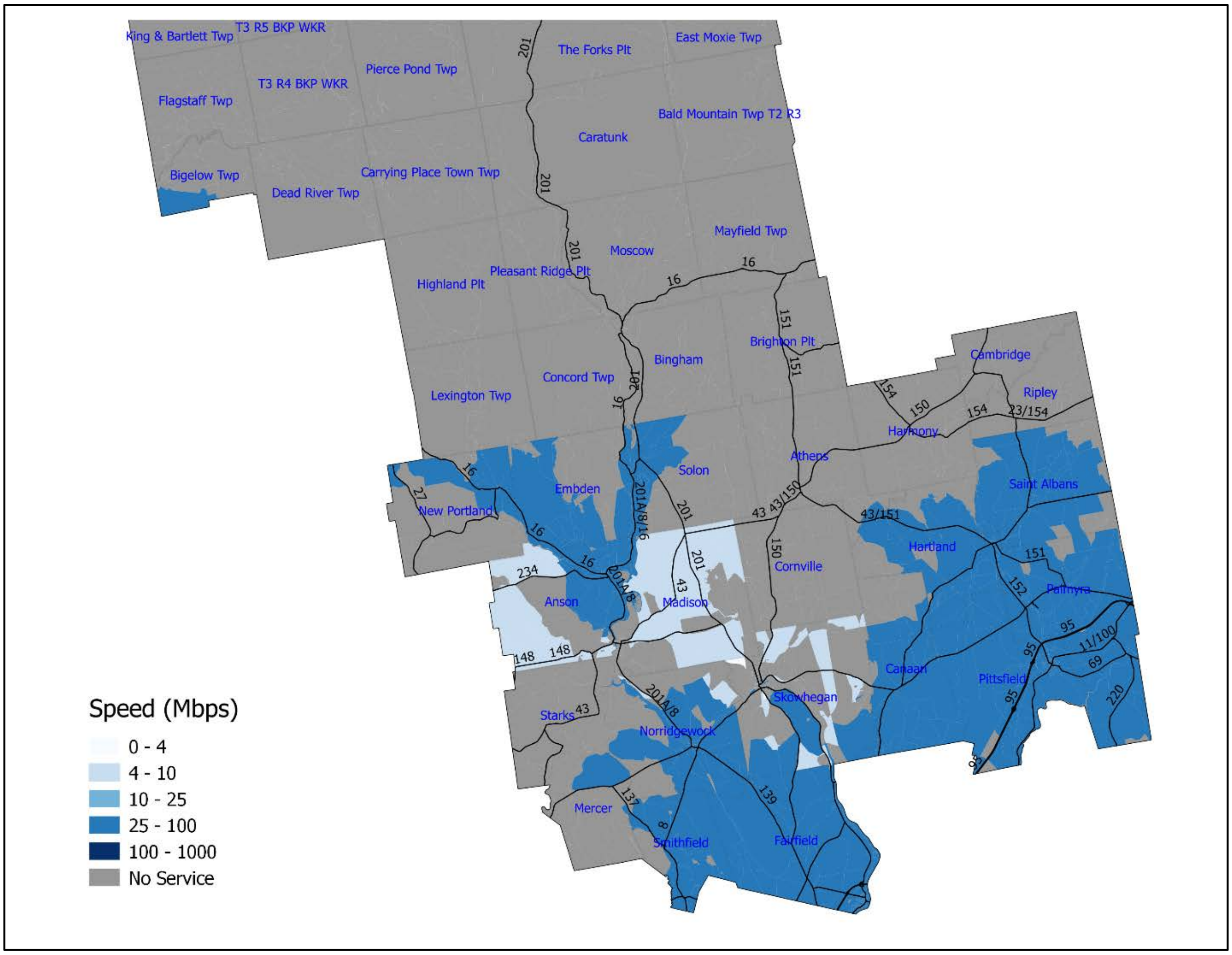


Figure 7— Southern Somerset Maximum Advertised Cable Speeds (All Providers)

Two key points can be gleaned from Figure 6 and Figure 7. First, cable services are concentrated in the southern part of the county, and second, the general service levels available are relatively high. In fact, cable service affords the highest advertised speeds in Somerset County, with speeds up to 100 Mbps. It is, however, not comparatively widely available. Cable companies have a minimum investment threshold that typically limits them to building out infrastructure in areas with a certain density. This is typically on the order of 20-25 subscribers per mile, a density that is only reached in southern parts of Somerset County. Much of northern Somerset is essentially uninhabited.

The two cable operators in Somerset County are Bee Line Cable and Spectrum/Time Warner. Their fastest advertised speeds are shown in **Error! Reference source not found.** and Figure 8, respectively.

Bee Line Cable

Bee Line Cable is a cable TV and internet service provider in central Maine. In Somerset County, Bee Line provides service in Anson, Madison, and Skowhegan and has franchise agreements with these three towns. It was founded in 1954 and is still owned by the founding family.

We have not included a map of Bee Line's advertised speeds because its Form 477 data is completely erroneous. This has been confirmed with Bee Line. Per an email with Bee Line's General Manager George Allen, the company currently offers service in:

- All of Skowhegan
- 95% of Madison, with approximately 10 miles of roads under construction in northern Madison (Thurston Hill Rd, Eames Hill Rd., Orchard Hill Rd., Horsetail Hill Rd. and the end of East Madison Rd.)
- All of Anson in-town, except generally for areas with fewer than 10 homes per mile. All of the West Mills Road (Route 148) span with fiber built on the way to Farmington is served currently, however.

Planned Investments

Bee Line is committed to building out coverage to all premises in the communities with which it has franchise agreements. Bee Line has upgraded its service recently and now offers 25 Mbps download and 5 Mbps upload speeds. Mr. Allen indicated in email that further speed increases are expected this year.

Investment Criteria (Triggers and Constraints)

In general, Bee Line is looking for cost-effective ways to provide universal coverage within its franchised communities. It usually looks for 10 subscribers per route mile as a condition for private investment, and is open to public funding, as well. Although Bee Line does not plan to invest outside its franchised areas, it is willing to consider leasing wholesale fiber connections to carriers who may provide service outside their franchises.

Working with Communities

Bee Line works with its franchised communities to continue to buildout and upgrade its service offerings.

Spectrum (formerly Time Warner)

Charter Communications recently completed its acquisition of Time Warner Cable and renamed the combined entity Spectrum Communications. Spectrum is now the second largest cable provider in the United States, after Comcast. Prior to the acquisition, Time Warner had over 16 million customers in 29 states. After the merger, Spectrum serves approximately 24 million customers in 41 states.

Figure 9 shows the maximum speeds Spectrum advertises in Somerset County.

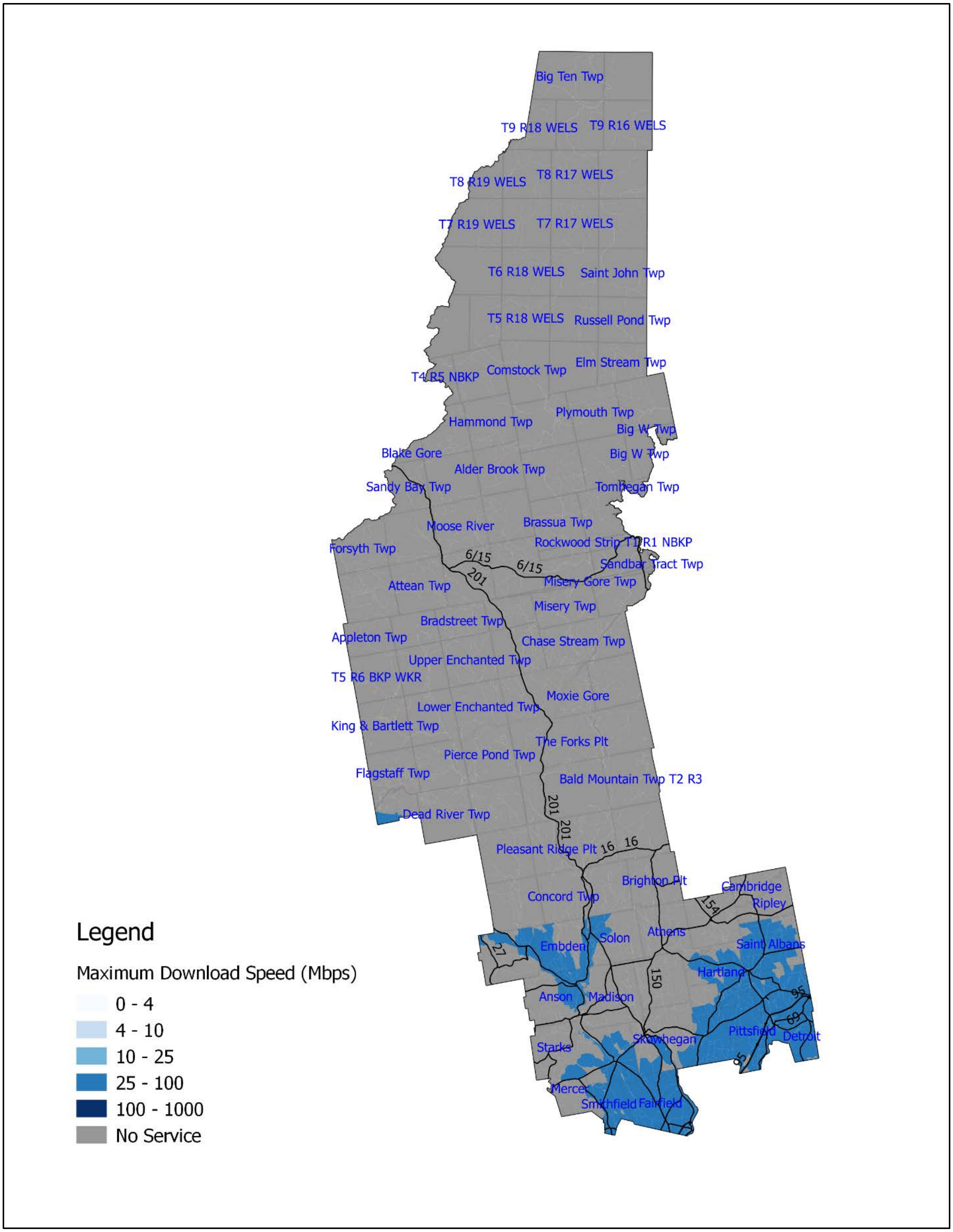


Figure 8 — Spectrum/Time Warner Maximum Advertised Download Speed

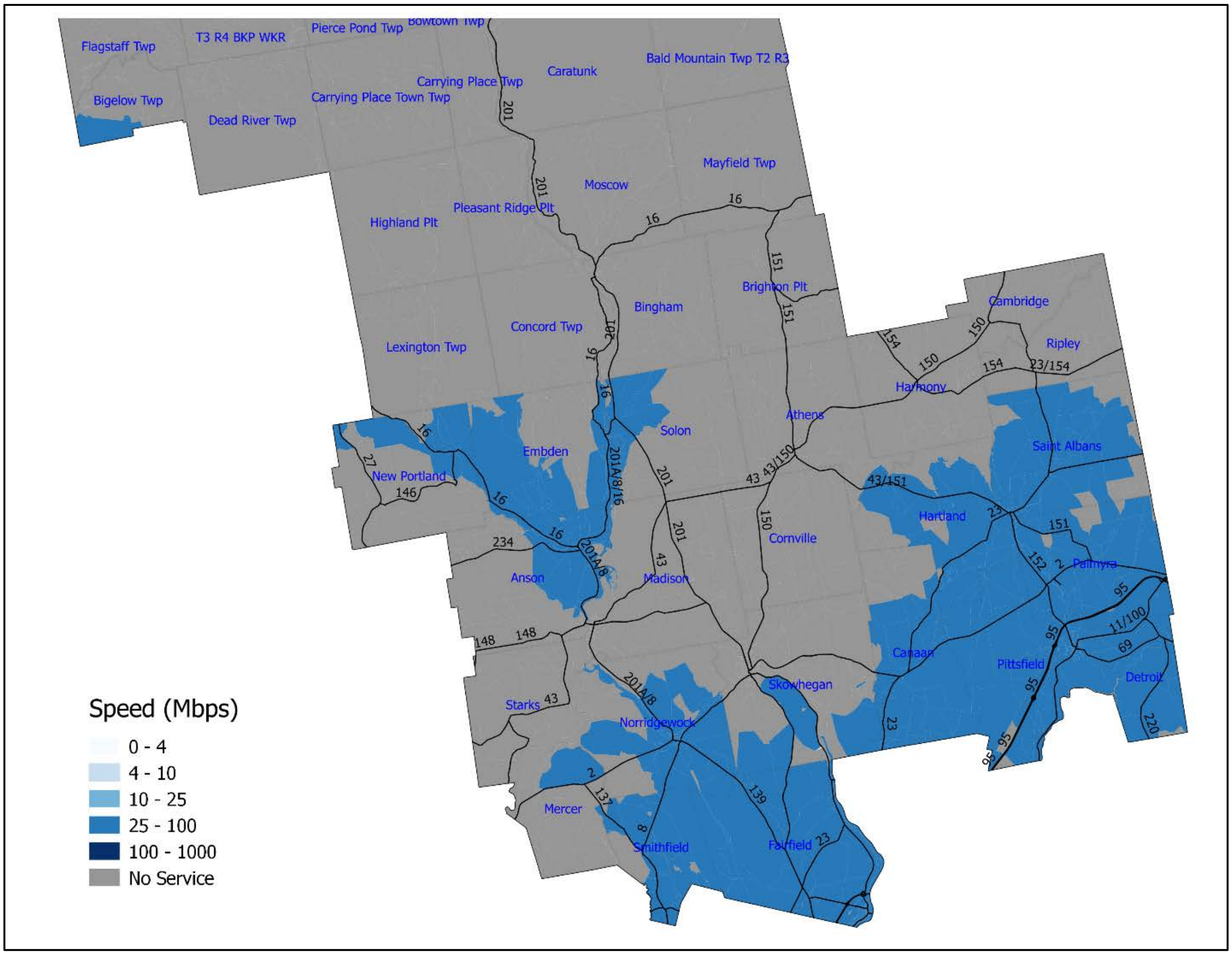


Figure 9 — Southern Somerset Spectrum/Time Warner Maximum Advertised Download Speed

Planned Investments

Prior to the merger, Time Warner had been in the process of upgrading its service areas to its Maxx service, which converted TV channels to digital to free up spectrum for internet service and enable faster internet speeds of up to 300 Mbps download. That process is now suspended except in New York State, which required its continuation as a condition of approving the merger.

With the initial acquisition of Time Warner by Charter/Spectrum now complete, however, Spectrum is moving to offering only two speed tiers in Maine, with download speeds of 60 Mbps and 100 Mbps and upload speeds of 5 Mbps and 10 Mbps, respectively. New customers can only choose the new Spectrum tiers (though they have to call Spectrum for the 100 Mbps tier, which is not yet available on the website).

Investment Criteria (Triggers and Constraints)

Spectrum looks for 20-25 subscribers per mile, or approximately 5 per quarter mile in order to make a private investment. In the carrier meeting in Skowhegan, Time Warner asserted its willingness to work with subscriber groups. If for example, a neighborhood or business park can bring in a group of committed subscribers, it would build a network extension to them. Time Warner is primarily interested in extending their current lines and looks to communities to provide feedback on where these line extensions might be supported by subscribers. Time Warner will not work in towns where Bee Line has a franchise.

Working with Communities

Time Warner has been historically open to working with communities in Maine that are not franchised by other cable providers. While it would like to segment communities and only build out to profitable sections, it realizes that may not be politically palatable. Time Warner has expressed a willingness, pre-merger, to partner with Axiom or other fixed wireless providers to provide targeted wireless service to less profitable parts of towns.

DSL

DSL services are much more widespread and variable than cable services. There are several DSL providers in Somerset County. Fairpoint is the largest provider, but TDS, OTT, and GWI also provide DSL services. Of these, only GWI is not an Incumbent Local Exchange Carrier (ILEC), or one of the companies who were formerly monopoly providers of telephone service. Figure 10 shows ILEC service areas in the county, while

Figure 11 shows maximum advertised DSL speeds in Somerset County across all providers.

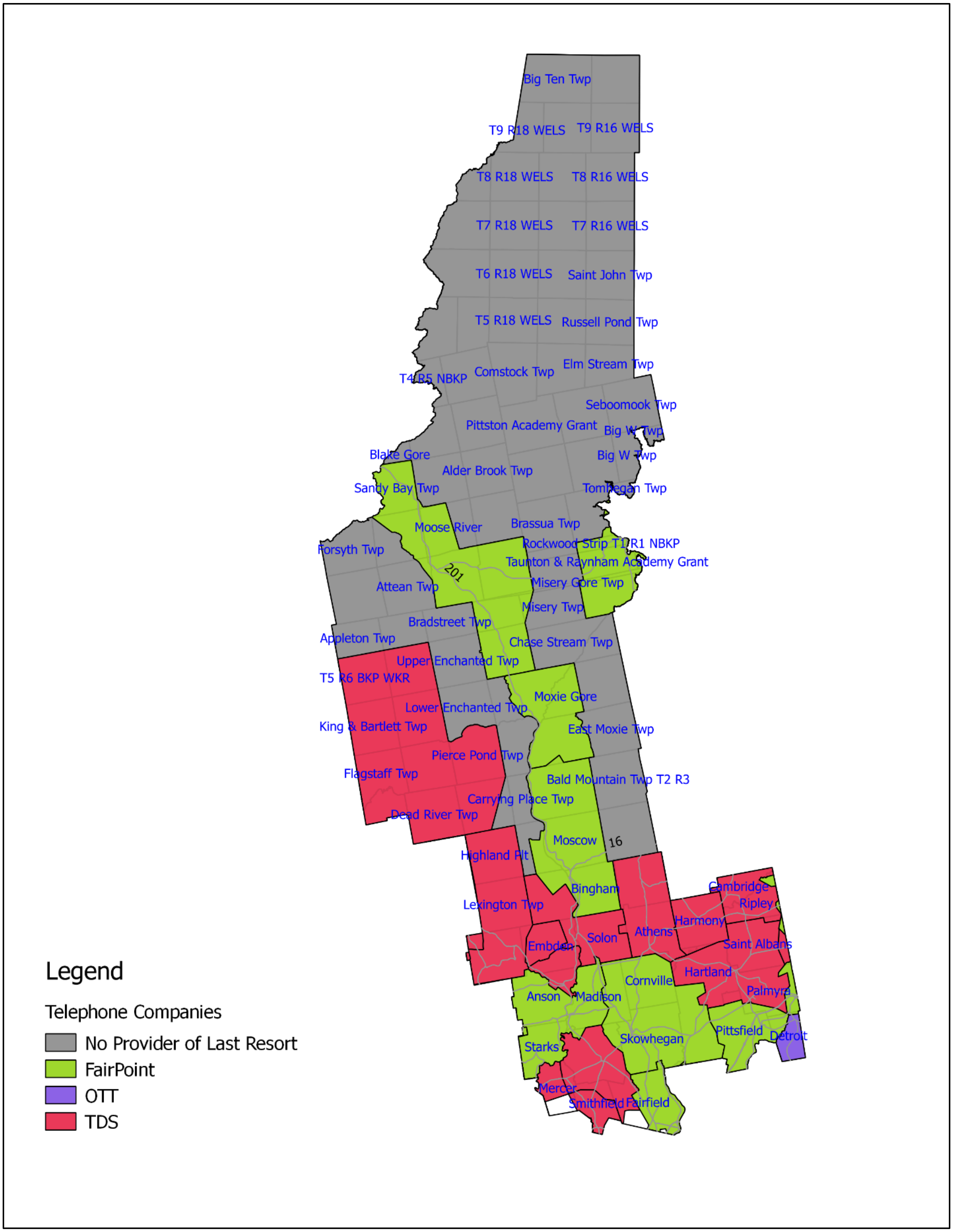


Figure 10 — Telephone Company Service Areas

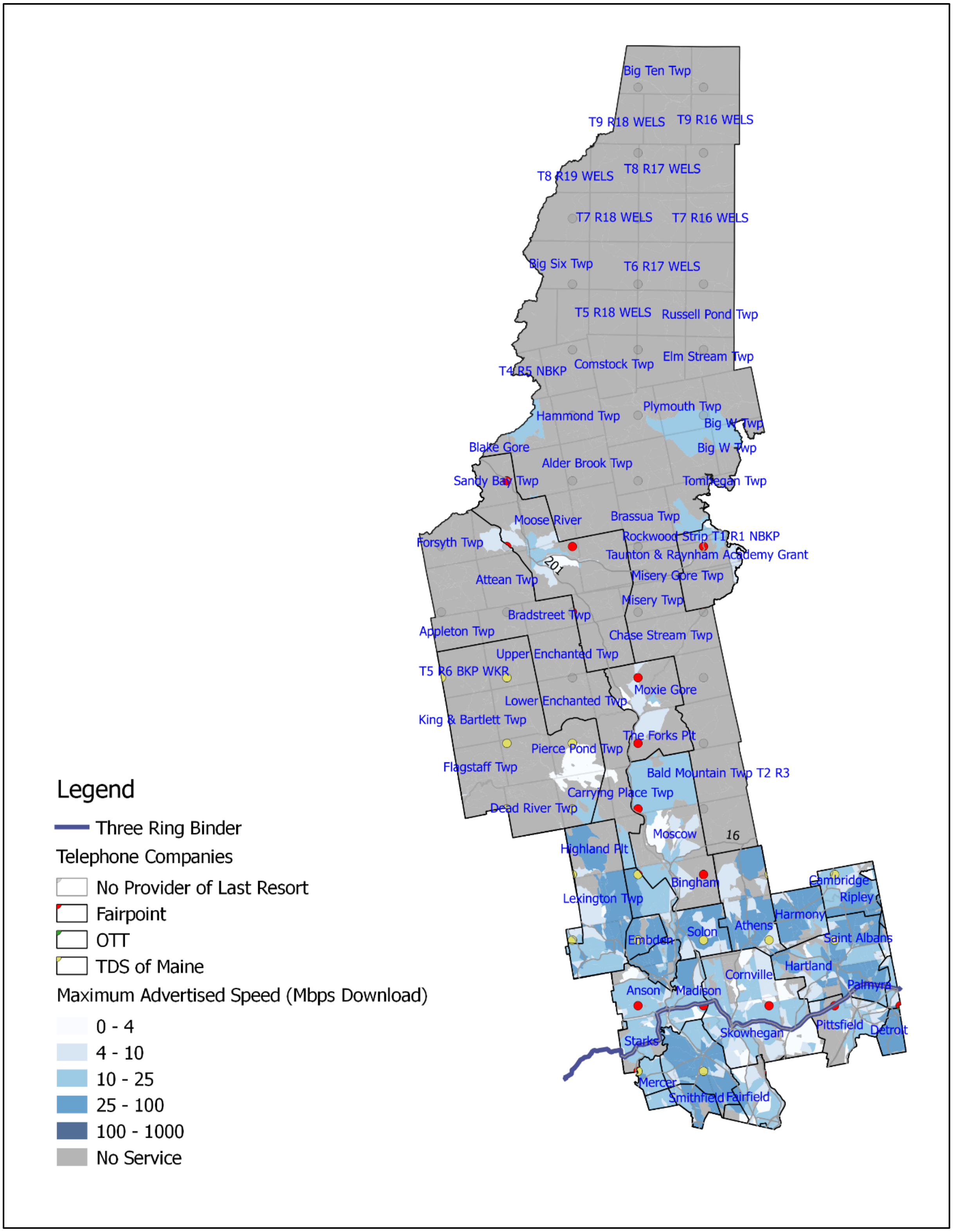


Figure 11 — Maximum Advertised DSL Speeds (All Providers)

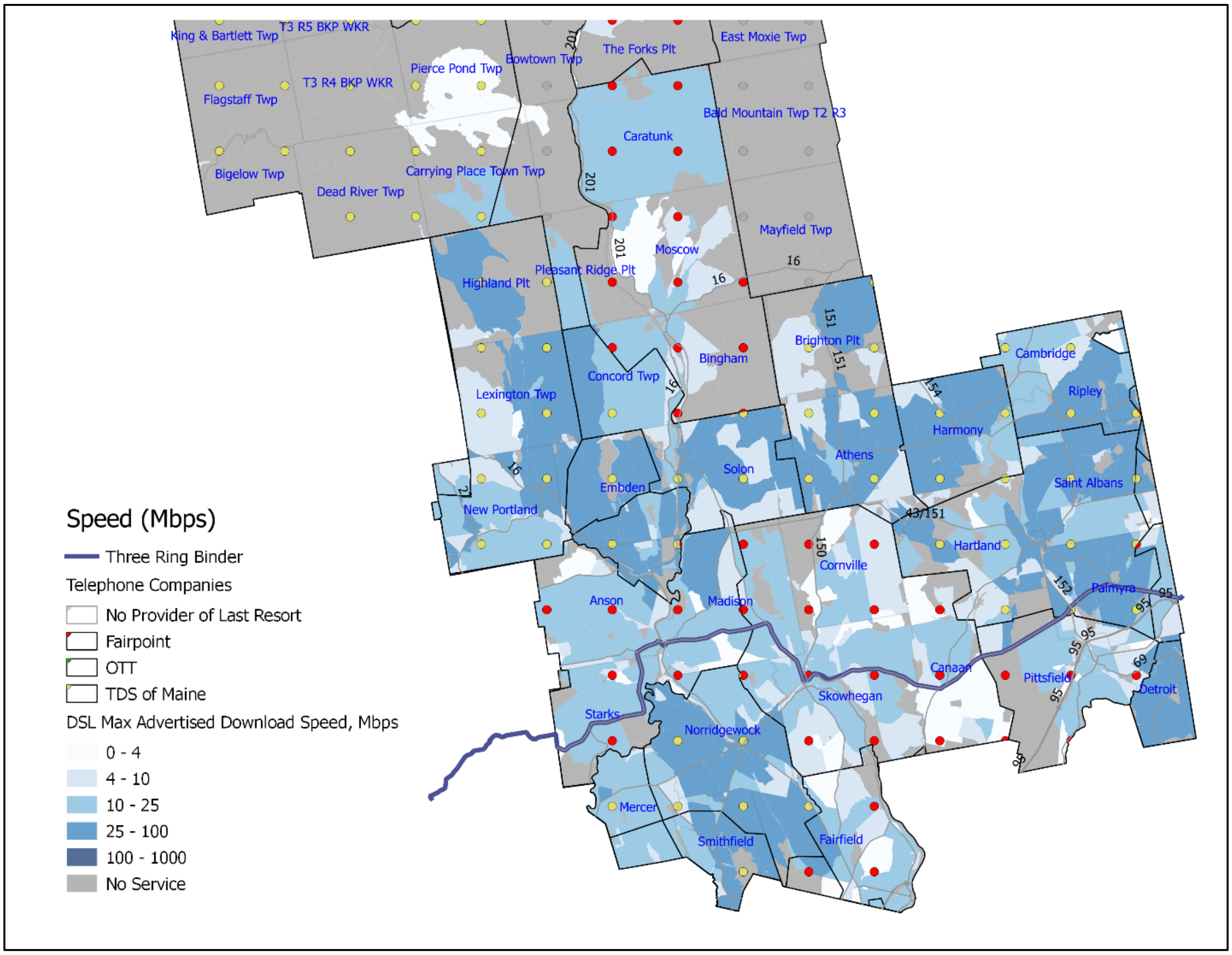


Figure 12 — Southern Somerset Maximum Advertised DSL Speeds (All Providers)

Again, the southern part of the county is better served than the more sparsely populated northern parts. Service quality varies widely, with some census blocks receiving reported speeds of up to 50 Mbps download and others maxing out at 4 Mbps. Although the reported speeds are not uniform throughout, the pattern of reported speeds is consistent with TDS having deployed VDSL in its telephone service area within the southern county.

Fairpoint

FairPoint is the local Incumbent Local Exchange Carrier (ILEC) in Maine, with operations in 17 states across the country. They provide traditional landline phone service and DSL. FairPoint typically operates fiber to the local DSL node, and standard copper to individual premises. It is one of the largest fiber operators in Maine, and reports it has over 17,000 route miles of fiber in Northern New England.

FairPoint purchased telephone infrastructure from Verizon in the 2000s and is itself currently in discussions to be acquired by Consolidated Communications. FairPoint owns many miles of fiber backbone that are connected to copper wires, which provide service to individual premises from "nodes" or remote terminals that serve neighborhoods. Data service using copper lines is known as Digital Subscriber Lines (DSL) and can deliver up to 24 Mbps down, but service is limited by the distance from the node and the number of subscribers or devices using the service at the same time. This technological limitation accounts for why subscribers are offered services of "up to" a certain speed and often are unable to get the highest level of speed that they have subscribed to. Fairpoint's advertised maximum consumer download speeds are reflected in Figure 13. While the map does not show upload speeds, Fairpoint does not offer upload speeds of 3 Mbps anywhere in Somerset County. This means that Fairpoint DSL does not meet the FCC's definition of broadband service.

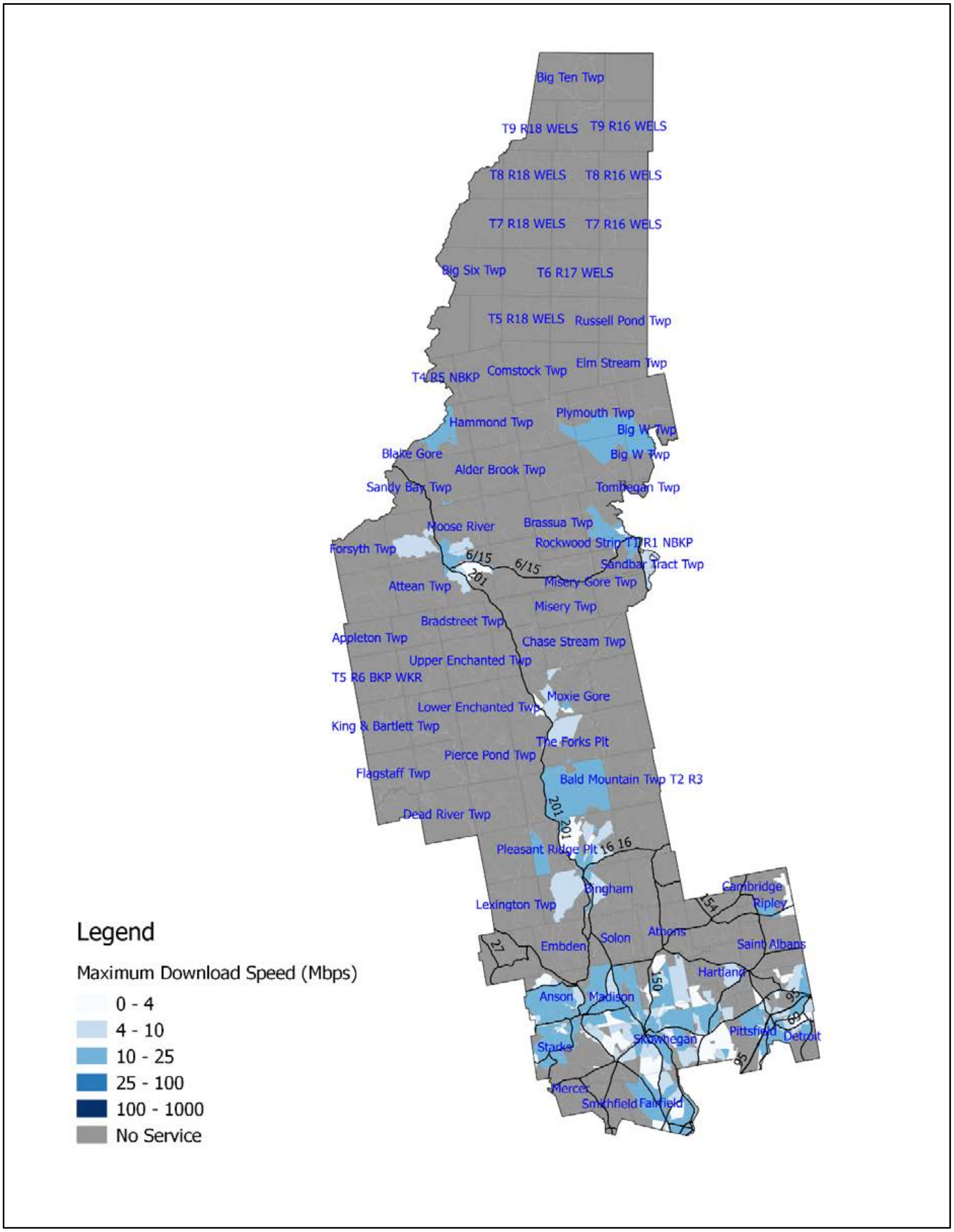


Figure 13 — Fairpoint Maximum Advertised Download

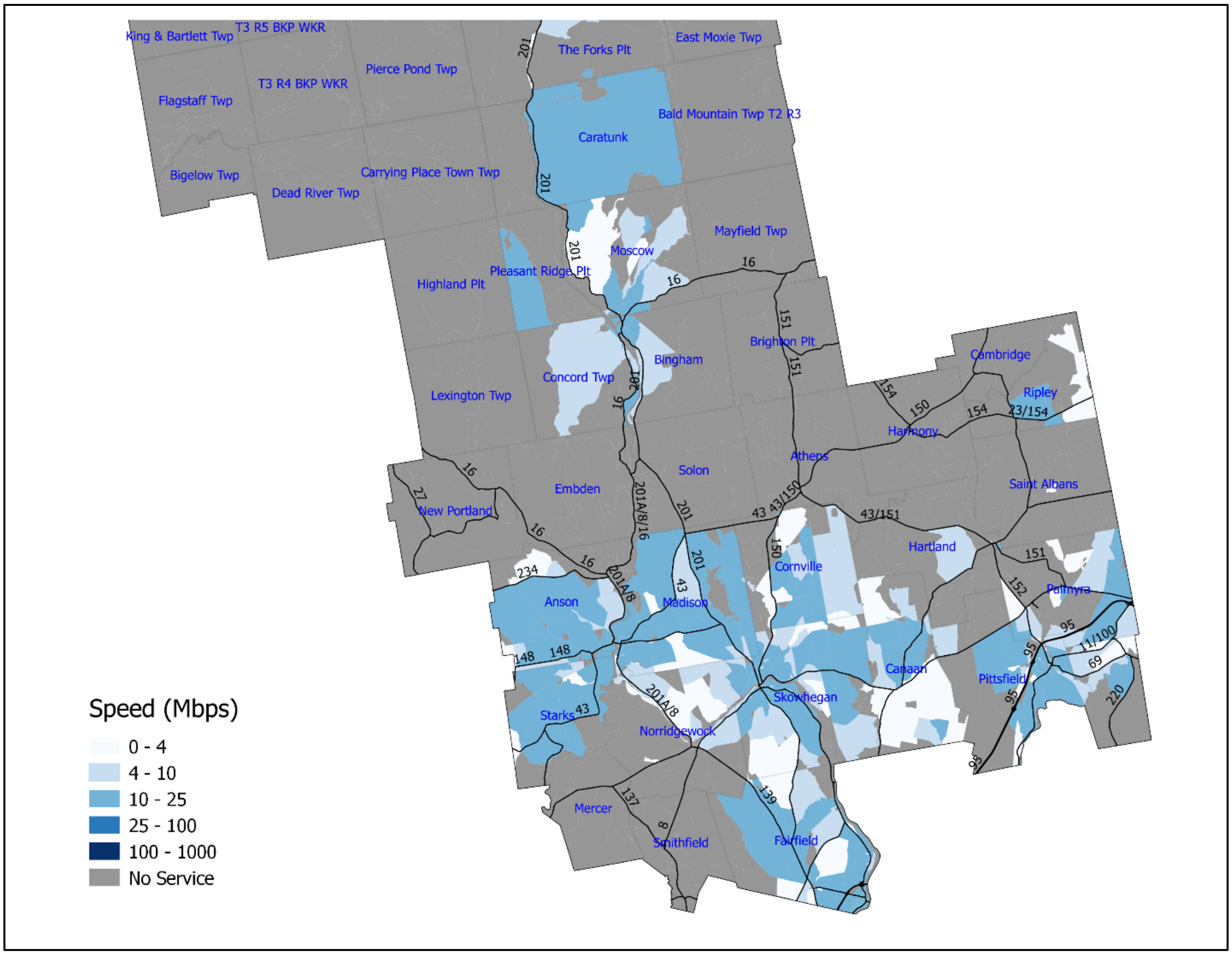


Figure 14 — Southern Somerset Fairpoint Maximum Advertised Download

Planned Investments

In interviews with Tilson, Fairpoint indicated it was working with over 60 communities in Maine and has made significant investment in upgraded facilities to improve users' connection speeds.

Investment Criteria (Triggers and Constraints)

FairPoint has indicated that it requires Connect America Program Funds (CAF II) to provide additional investment in eligible census blocks. In meetings with the carrier, FairPoint cited two new projects it already has planned, independent of CAF II funding, in the town of Bingham, four in Madison, one in Skowhegan, and one in Canaan. These projects consist mainly of equipment upgrades that will only provide service up to 10 Mbps down and 1 Mbps up.

CAF II is an FCC program that provides grants to ISPs to build out infrastructure in unserved or underserved census blocks. The CAF II program uses the FCC Form 477 data to identify service levels in each census block across the country. This is the same data used in the service maps in this document. Using the Form 477 and other data, the FCC determines the investment necessary to provide 25 Mbps down and 3 Mbps up in the census block. This is the reserve price. It then conducts a reverse auction for funds: ISPs bid and the lowest price (starting with a ceiling of the reserve price) wins the funds.

Working with Communities

FairPoint has expressed that it is somewhat limited in their ability to depart or go beyond the company's overall upgrade plans. In addition, FairPoint representatives have indicated that the company is not currently interested in local subsidies.

GWI

GWI offers DSL service in very limited portions of the County in and around Skowhegan, as shown in Figure 15. It is no longer investing in its DSL infrastructure and is moving to offering fiber to the home instead. GWI has focused its investment process on new fiber deployments and is actively expanding into the fiber to the premise market in Maine.

Investment Criteria (Triggers and Constraints)

In general, GWI seeks to serve homes, businesses, and towns that are close, or adjacent to, Three Ring Binder. The company is also willing to connect to any Middle Mile fiber whose owner is willing to provide transport services. GWI seeks approximately 12 subscribers per route mile to build new fiber.

Working with Communities

GWI is experienced in working with communities and recognizes that community engagement is critical. In addition to internet services, the company is willing to provide grant writing services and help communities go after public money that may be available for projects. They have assisted with applications to the Economic Development Administration (EDA), Northern Border Regional Commission (NBRC), and Tiger grants, among others.

The company sees community engagement as requiring clear goals, a local champion for the project, and a strong public outreach effort on the part of the community.

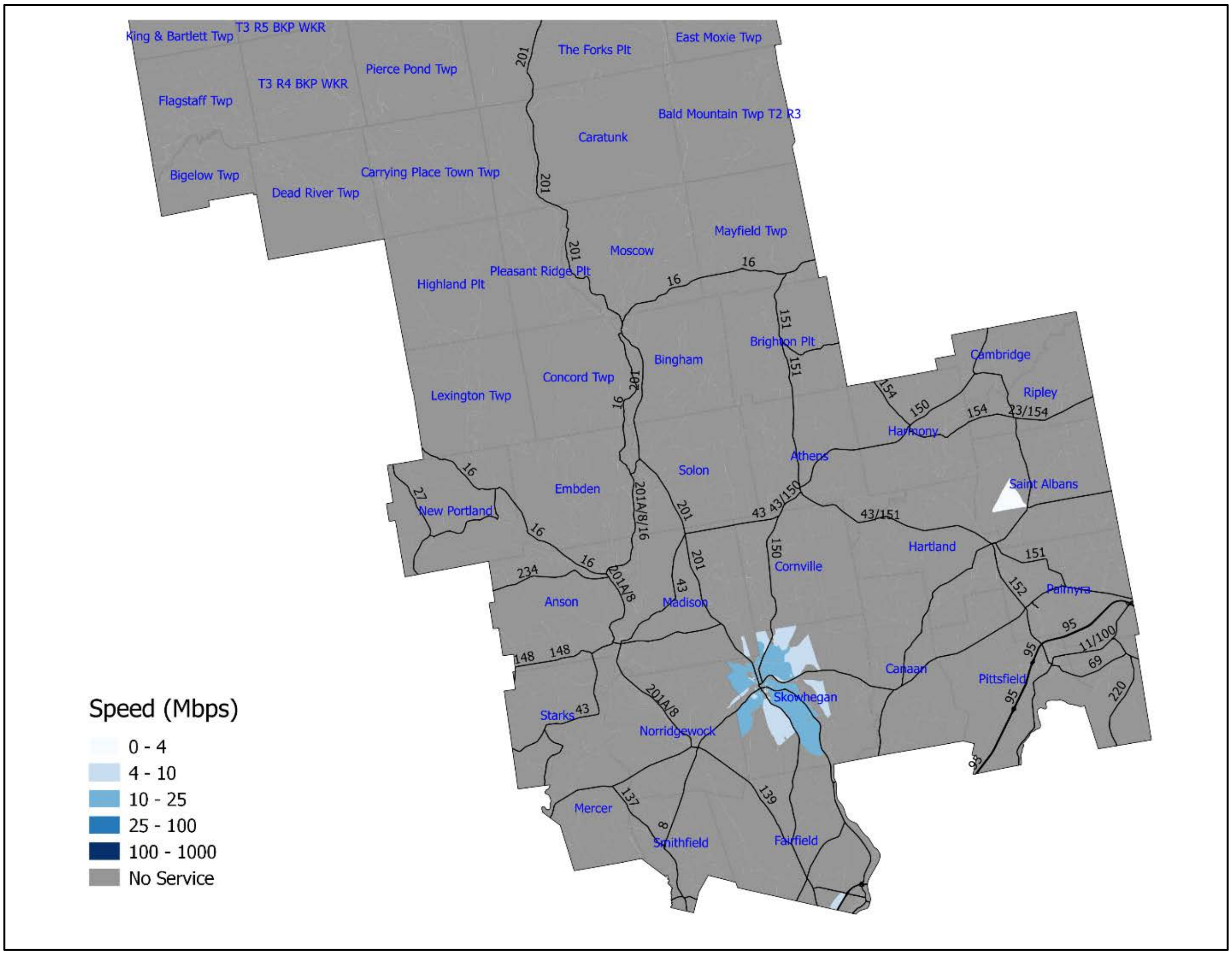


Figure 15 — GWI Maximum Advertised Download Speed

OTT

OTT is a Maine-based division of Otelco, Inc., and a provider of business voice, cloud computing, wholesale services, and high-speed data and Internet services. OTT is an ILEC (Incumbent Local Exchange Carrier) in Gray. OTT also provides high-speed Internet, phone, bundled service, home automation, and broadband phone in some parts of the state.

OTT owns 534 miles of fiber in Maine, and has points of presence in 30+ communities. Its fiber network includes 10 Gbps middle mile links to the Internet in Boston, Portland, and Bangor. Most of OTT's retail internet service is delivered via DSL. The company is interested in working outside its incumbent territories an also in providing fiber to the premises in areas where the business case provides a good return on investment.

As can be seen in Figure 16, OTT offers services up to 50 Mbps in a very limited corner of Somerset County, near Detroit.

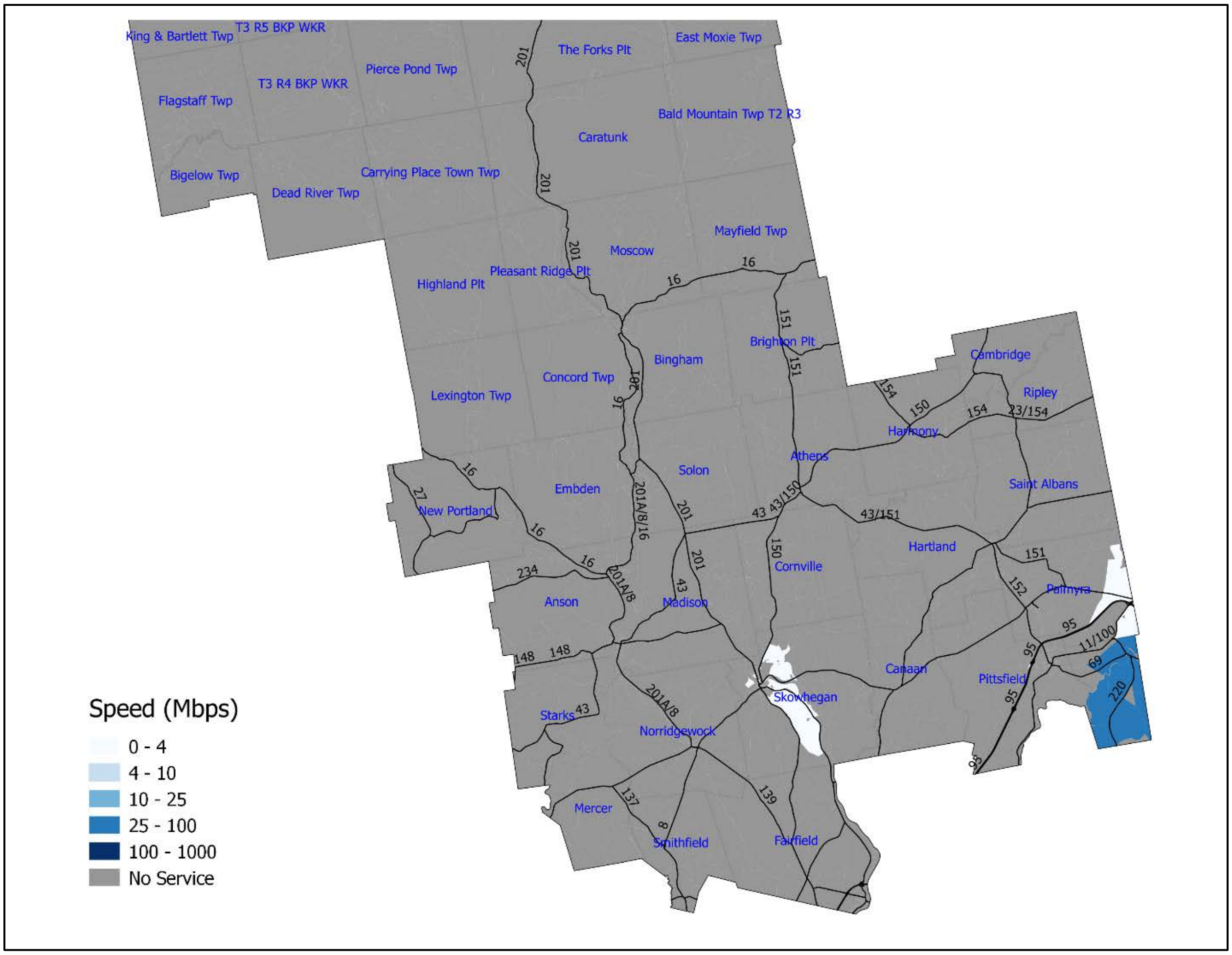


Figure 16 — OTT Maximum Advertised Download Speed

Planned Investments

OTT has planned some limited investments in Maine using ConnectME grants. These are in Lowell and Gray. In addition, they have applied to the FCC for Alternative Connect America Model (A-CAM) funding, which could provide funding for up to 2,000 homes in Penobscot County to receive fiber to the home. OTT has not announced plans for investment in Somerset County at this time. A-CAM is the most recent generation of FCC funding for smaller rural telephone companies, part of the FCC' obligation under federal telecommunications law to support universal access to telephone and advanced services.

Investment Criteria (Triggers and Constraints)

OTT has indicated to Tilson that it has capital to invest and is open to working with towns. They generally look for 20-25 subscribers per mile and 40-50% take rates. OTT has indicated that pole licensing is a significant cost component. Bridge crossings are also a large additional cost. In general, any prospective network construction would be considered if it provides a positive return within 1-2 years. OTT will extend fiber lines to new business customers with a three-year contract.

Working with Communities

OTT is open to working with communities where it can achieve its return on investment goals. These can vary with the proposed solution. A targeted build of fiber off an existing trunk would not require as many subscribers to provide a return, for example, but make-ready can take an inordinate amount of time. Community support in make ready and the overall project are critical.

TDS

TDS Telecom is a wholly-owned subsidiary of Telephone and Data Systems, Inc., which is a publicly traded company. TDS has been built by purchasing small telephone companies across the country, and is currently the seventh largest local exchange telephone company in the U. S.

In Maine, TDS owns the former Somerset Telephone and Hartland and St. Albans telephone companies, covering a wide swath of towns in the middle of the county (see Figure 17). TDS offers a range of different services and products in Maine and provides Internet, phone (business and residential), Voice over Internet Protocol (VOIP) systems, and cable TV services.

In reviewing the map below, it appears that TDS offers DSL service in excess of 25 Mbps download. In fact, TDS's Form 477 filings show that it offers VDSL service of up to 50 Mbps down and 20 Mbps up. VDSL is a high capacity version of DSL that can achieve these speeds within a short range of the local DSLAM (typically less than 1,000 feet)[1]. So, while it appears that TDS offers higher speed VDSL services in Somerset County, the nature of the Form 477 data precludes drawing conclusions about how widely available such services are in Somerset County. It is worth noting, however, that TDS has demonstrated a willingness to invest in its network to a much greater extent than Fairpoint has. Therefore, it would make sense for the County to work with TDS to better understand the geographical extent of its VDSL offering and identify ways to strategically and cost-effectively expand services into lesser-served areas.

[1] See the DSL section on page 3 for more information on DSL technologies.

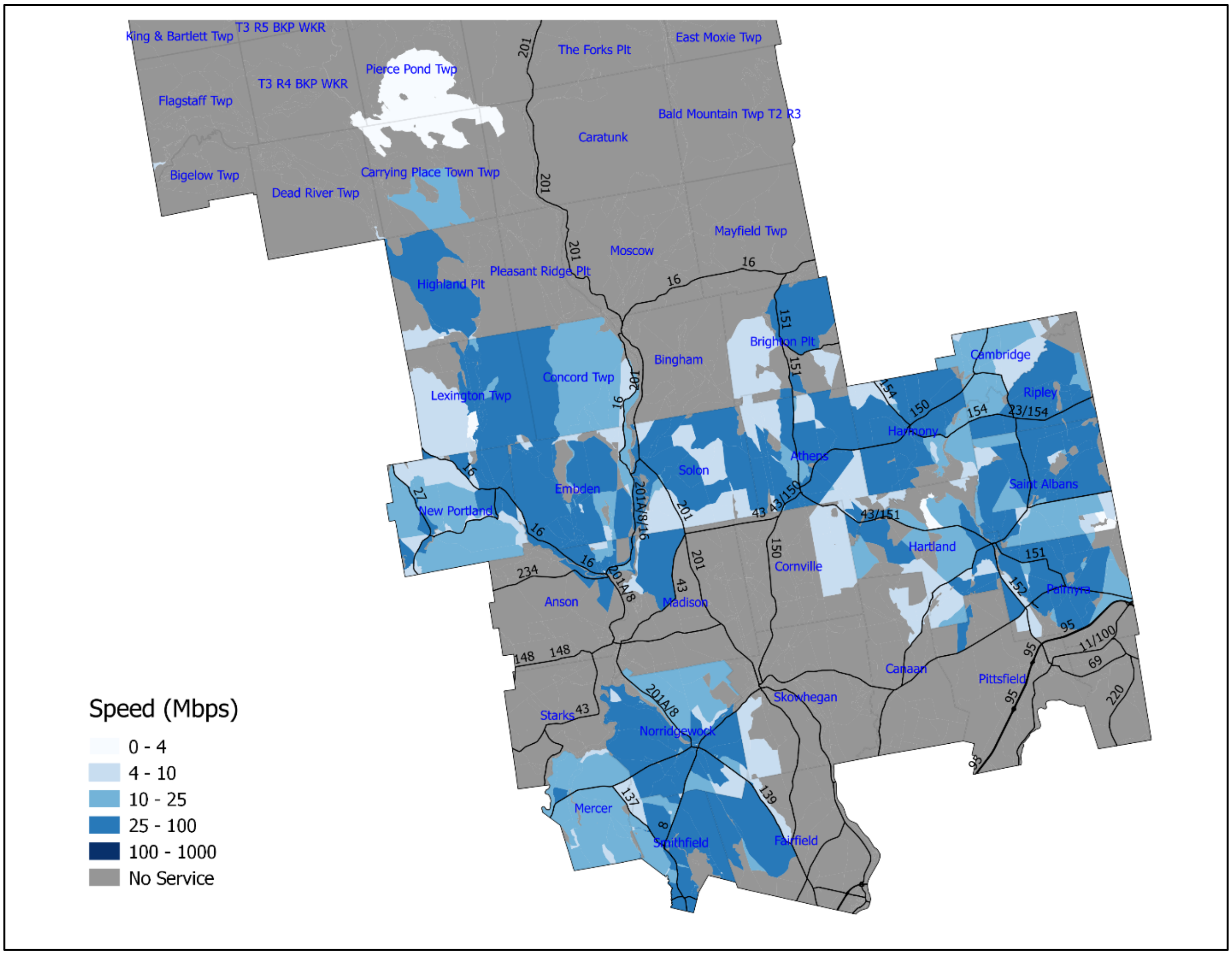


Figure 17 — TDS Maximum Advertised Download Speed

While TDS can offer up to 50 Mbps download and 20 Mbps upload using VDSL in some areas, the nature and economics of DSL technology make it likely that most Somerset TDS customers use slower ADSL technology. For some subscribers in Somerset County speeds of less than 10 Mbps down and 1 Mbps up are the norm. TDS's network architecture is a standard fiber and copper hybrid, with fiber to the node and copper to individually served premises.

When we spoke with TDS, they described how the data demands for their system have been doubling every year, severely straining their DSL network.

Enterprise

TDS provides dedicated fiber-based internet access with guaranteed throughput with speeds ranging from 1 Mbps to 1 Gbps. This includes advanced routing support, static IP addressing, redundant power supply, and a Service Level Agreement for uptime and throughput.

Investments and Upgrades

Planned Investments

TDS has recently won $75.1 million per year for ten years in FCC Alternative Connect America Model (A-CAM) funding to upgrade services in 25 states including Maine. This is good news for Somerset County.

Carriers who accept the funding must meet all the FCC program requirements including declining legacy funding they now receive from FCC. Our conversations with TDS revealed that they will accept all the A-CAM funding they've been offered. In fact, A-CAM funding plays a significant role in TDS' strategy to upgrade infrastructure and service in Maine. Per the program rules, TDS must commit to providing 25/3 Mbps service in approximately 71% of the locations located in eligible census blocks in Maine within 10 years. Most customers in these areas whom TDS does not upgrade to 25/3 will receive reduced service improvements, with speeds of up to 10 Mbps download and 1 Mbps upload within 10 years.

TDS did not respond to Tilson's request for an update on the planned investment in light of their recent grant award.

Investment Criteria (Triggers and Constraints)

Since 2009, TDS has invested tens of millions of dollars into its overall network, including upgrading 55 remote terminals as well as the addition of 10 new sites. In Maine, TDS has spent $3-5 million, but customers' ever-increasing use of broadband Internet applications has outstripped TDS' ability to improve capacity. While TDS has made efforts to shorten its DSL loop lengths, which increases the speeds it can offer, it is waiting for FCC funding prior to making any new investments in existing DSL infrastructure. The effect of shortening these DSL loops is that more customers are closer to the sites. The closer customers are to the sites, the faster their Internet speeds should be, however as noted above, TDS cites that the significant increase in demand for Internet applications has undercut these network improvements.

Working with Communities

TDS emphasized that it has historically worked in collaboration with municipalities and other entities on solutions to improve TDS' service, provided that the communities are within TDS's service territory.

An example of a citizen-led TDS collaborative project occurred within the town of Hopkinton, NH. In that case, the community paid the 20% subsidy needed to complete a fiber project there. TDS is generally not pursuing scenarios which depend on local subsidy.It is primarily interested in working within its currently covered ILEC territory as opposed to expanding this footprint to new areas.

Fixed Wireless

Fixed wireless technology can provide a cost-effective way to reach customers who are otherwise uneconomic to serve. This is the reason for Tilson and Axiom's proposal to build fixed wireless capacity. Figure 18 shows census blocks served by fixed wireless providers in Somerset County.

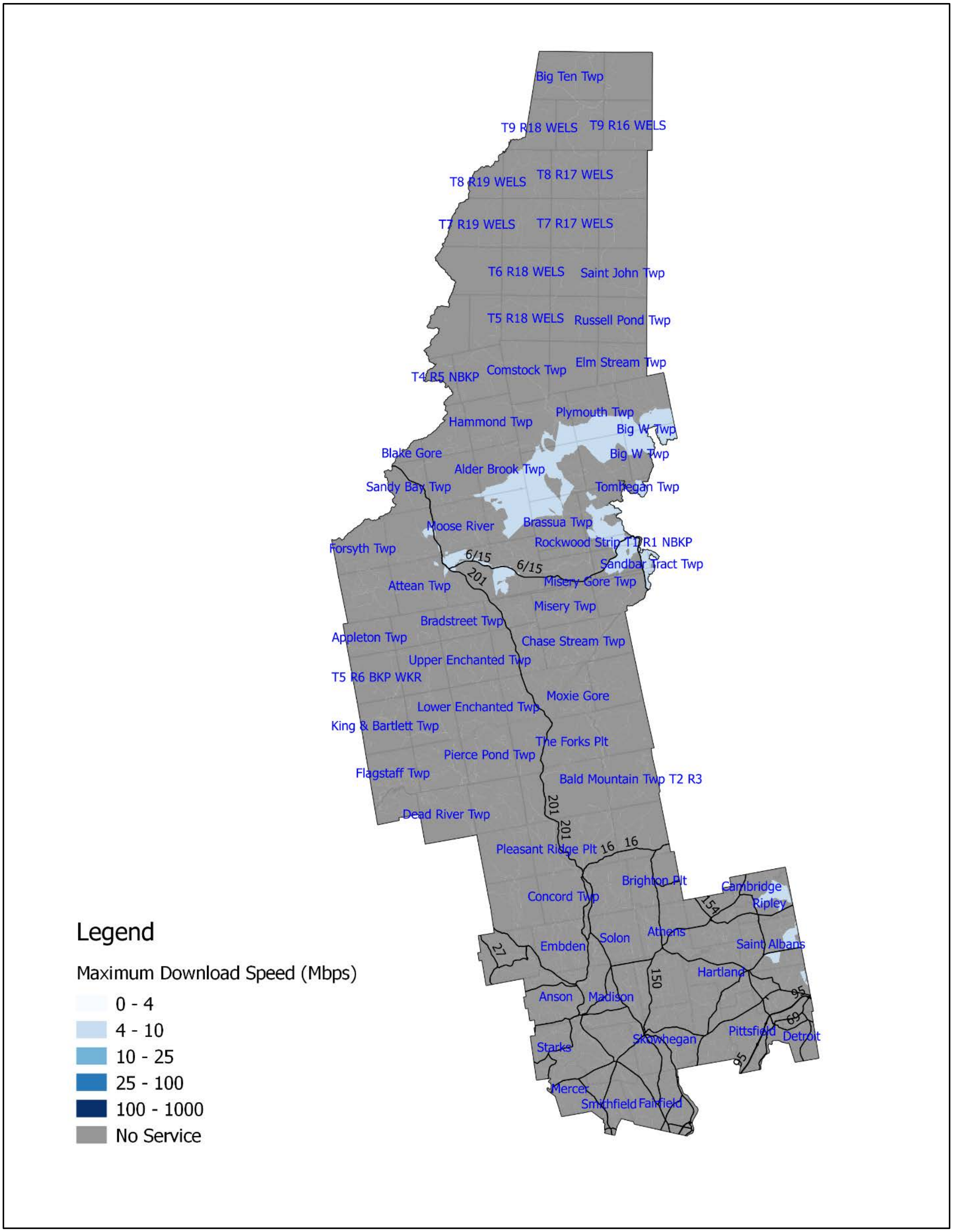


Figure 18 — Fixed Wireless Maximum Advertised Download Speed

Premium Choice Broadband

Premium Choice, a Maine-based ISP in business since 2007, is the only fixed wireless ISP in the county that files Form 477 data. Its coverage map is therefore identical to the one in Figure 18 above.

Regional Broadband Goals and Priorities

Somerset County is one of the most sparsely populated counties in Maine, with an average 13.3 people per square mile. This makes it uneconomic for profit-motivated broadband providers to build and offer service at a universal minimum of the FCC's 25/3 Mbps standard to all residents and businesses in the county. As shown in Figure 1 on page 14, most population centers in the county have some kind of broadband service, but service at or above the FCC's definition of 25/3 Mbps is far from universal.

In this project, SEDC and KVCOG seek to identify and price ways to improve broadband access. KVCOG and SEDC believe that the most effective way to provide a foundation for addressing issues attendant to sparse population and poverty, and to encourage low-impact economic development, is through available, affordable, reliable high-speed internet service.

Various elements in the County have been investigating broadband expansion for some time. There is a high level of interest in the prospect of improving broadband infrastructure, with high levels of turnout at community meetings. In general, broadband goals in Somerset County are to:

- Support small businesses and entrepreneurs
- Support home-based businesses and people who work from home
- Extend the abilities of tourists to work while on vacation, allowing them to stay longer
- Support telemedicine development in light of an aging population
- Support development of key corridors, such as:
    - Along Route 2 between Skowhegan and Norridgewock
    - Along Route 201 as far north as The Forks
    - In the eastern part of Somerset County, principally in the towns of Hartland, St. Albans, Palmyra, and Pittsfield
- Increase general reliability of digital infrastructure in the county

Although the County has not yet arrived at a formal prioritization of these goals, ensuing discussions will focus on ways to achieve as many of these as possible with the most efficient use of funds. While none of the proposals in this document forms an entire solution of any of these goals, the path outlined helps progress on several of these goals.

Cost Estimates and Designs

Tilson and Axiom have prepared a modular design approach to the project. Under this paradigm, The County's goal is aided by the fact that the Three Ring Binder network runs through southern Somerset County. Three Ring Binder is a 1100-mile dark fiber network spanning all 16 of Maine's counties, with connections to major internet peering points in Boston and other networks in New Hampshire. Three Ring Binder runs through southern Somerset County and provides many access points and a well-understood pricing model. Its path through southern Somerset County is shown in Figure 19.

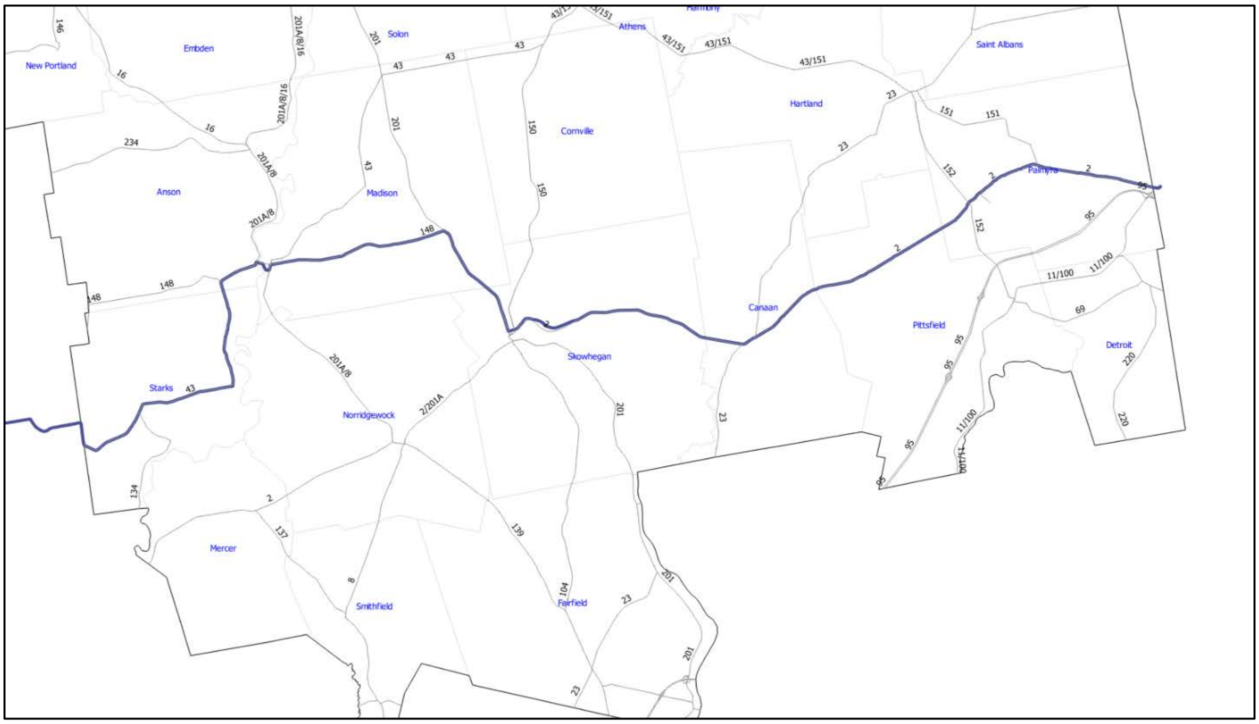


Figure 19 — Three Ring Binder in Somerset County

Working with Tilson and Axiom, KVCOG and SEDC have chosen a strategy of building fiber from the Three Ring Binder to selected, existing wireless communications towers. Axiom has selected these towers to provide service to as many area residences and businesses as possible, as cost effectively as possible. In addition, each fiber run has been designed to allow for direct connections of individual homes and businesses along the route and to allow for future expansion in the area. This is accomplished by locating pre-terminated connections near selected larger businesses and slack loops at intervals along the fiber runs. This hybrid approach in effect extends the Three Ring Binder up into Somerset County, providing a platform from which last mile connections can be made more affordably. Some fiber runs, such as that in downtown Skowhegan, are designed to enable connection to local businesses and have no corresponding wireless tower.

Figure 20 and Figure 21 show overviews of the proposed fiber builds countywide and only in southern Somerset, respectively.

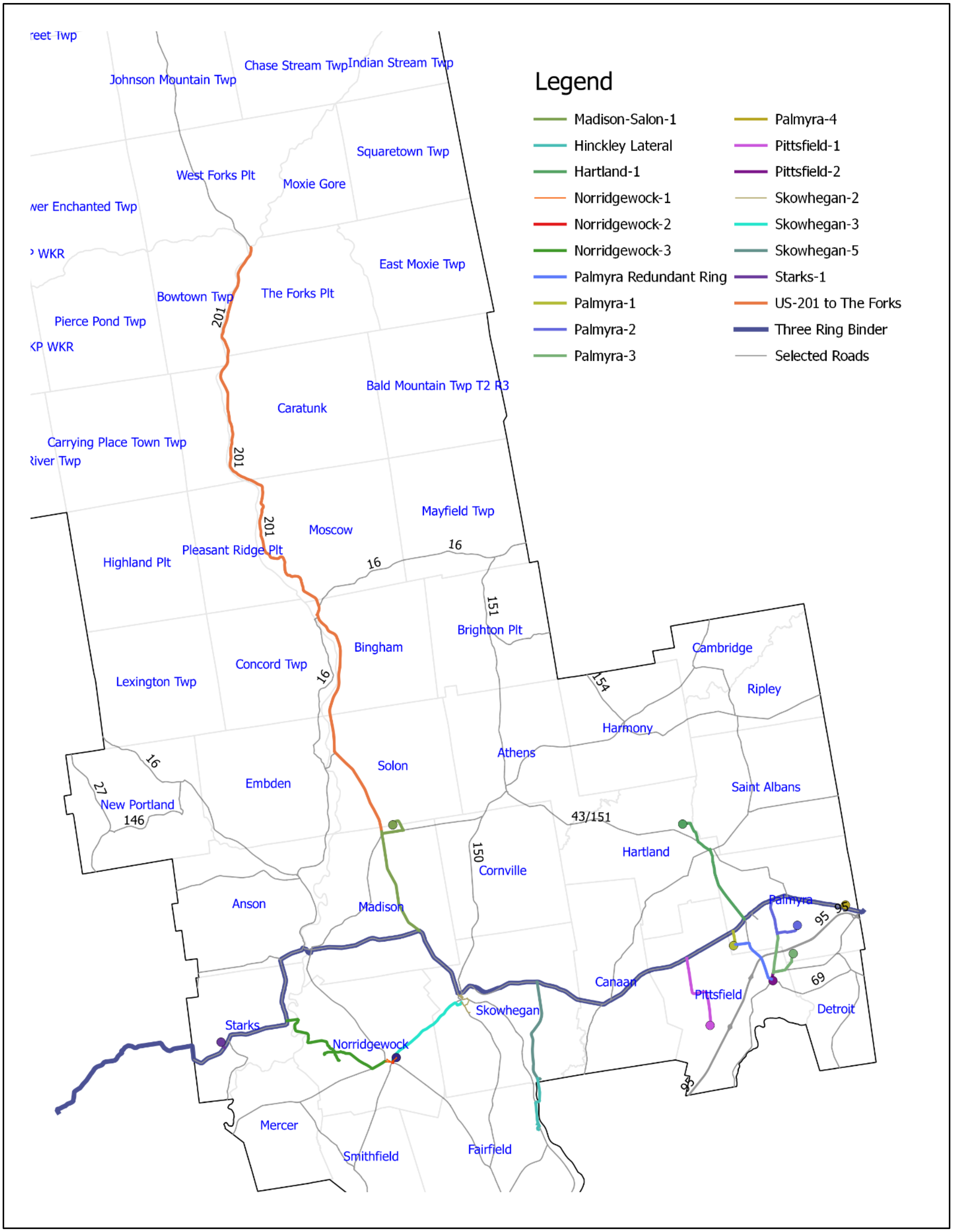


Figure 20 — Proposed Fiber Network Builds

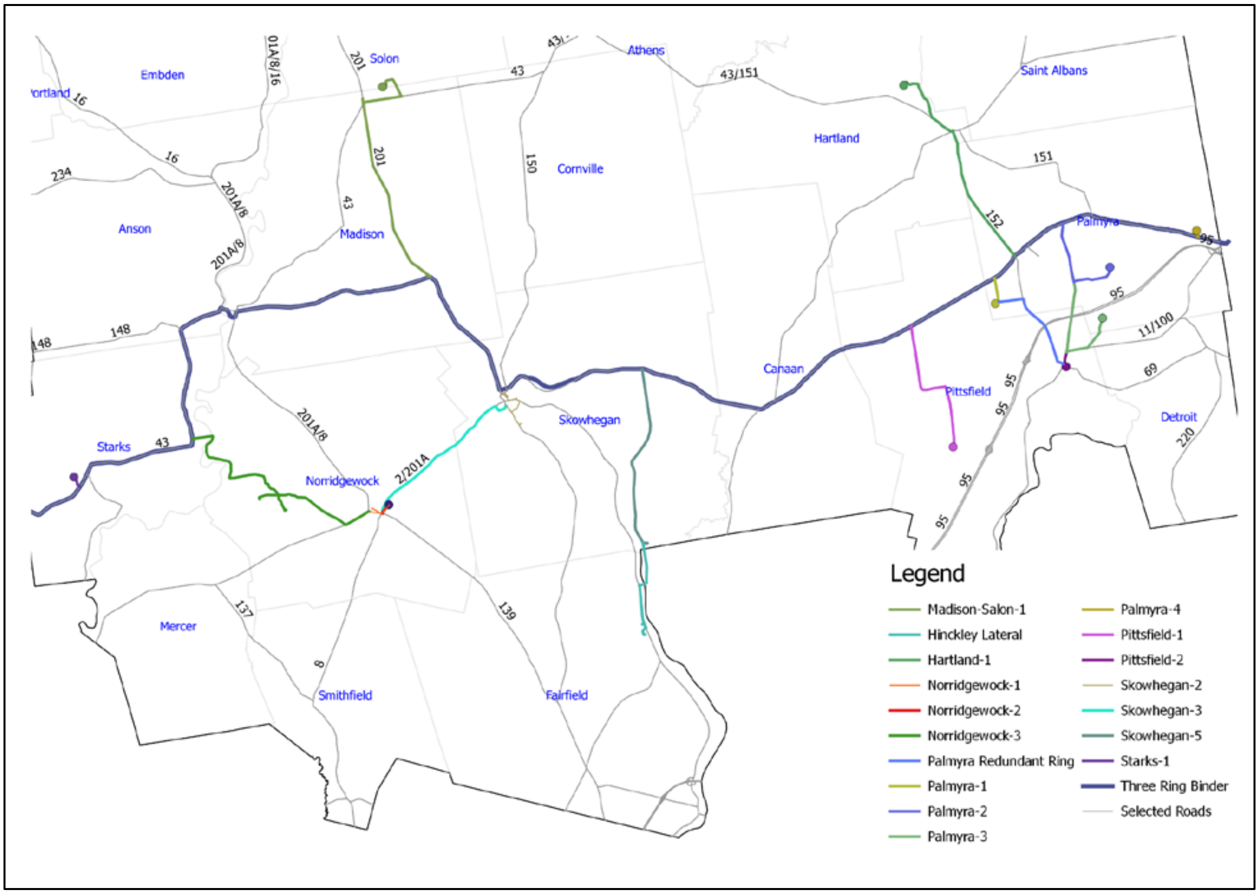


Figure 21 — Proposed Fiber Builds in Southern Somerset

Additional Project Budget Categories

All projects in this section show a high-level budget that includes labor and materials, as well as an estimate on make ready required. There are additional cost factors to consider, however. These include the following, and per-project estimates are provided below:

- Detailed Engineering and Project Management. Tilson has determined a high-level design for each proposed project. Detailed engineering will be required to arrive at construction-ready blueprints. In the detailed engineering, all parameters of each project will be carefully determined and backed up by firsthand measurements and observations. This will include everything from identifying exact fiber routes to equipment specifications, building entrances, and more. Project management will encompass all functions needed to ensure a smooth project execution and construction.
- Pole Licensing. Fees consist of a few different parts;
  - A one-time attachment application fee in the $500 range
  - A one-time fee charged by the utility to survey the requested poles to determine the amount of make ready required
  - Make ready (see below)
  - An ongoing license fee (captured in the Financial Modeling section on page 96). In Maine, pole license fees are typically in the $15-30 per year per pole range (payable in

two separate annual installments). This can vary depending on the pole’s location and owner.

- Make Ready is the process of ensuring available space on utility poles, as well as verifying each pole’s ability to carry the required cables and equipment. While we have included an estimate for make ready in each project based on our overall knowledge of and experience in Maine make ready management, the actual make ready costs could vary considerably from the estimates provided. A full ride-out will be required to collect data on each pole in order to arrive at a firm make ready cost.
- A contingency equal to 10% of the labor and materials estimate is added to the project cost.

Hartland 1

The Hartland design extends Three Ring Binder to a tower between Hartland and St. Albans.

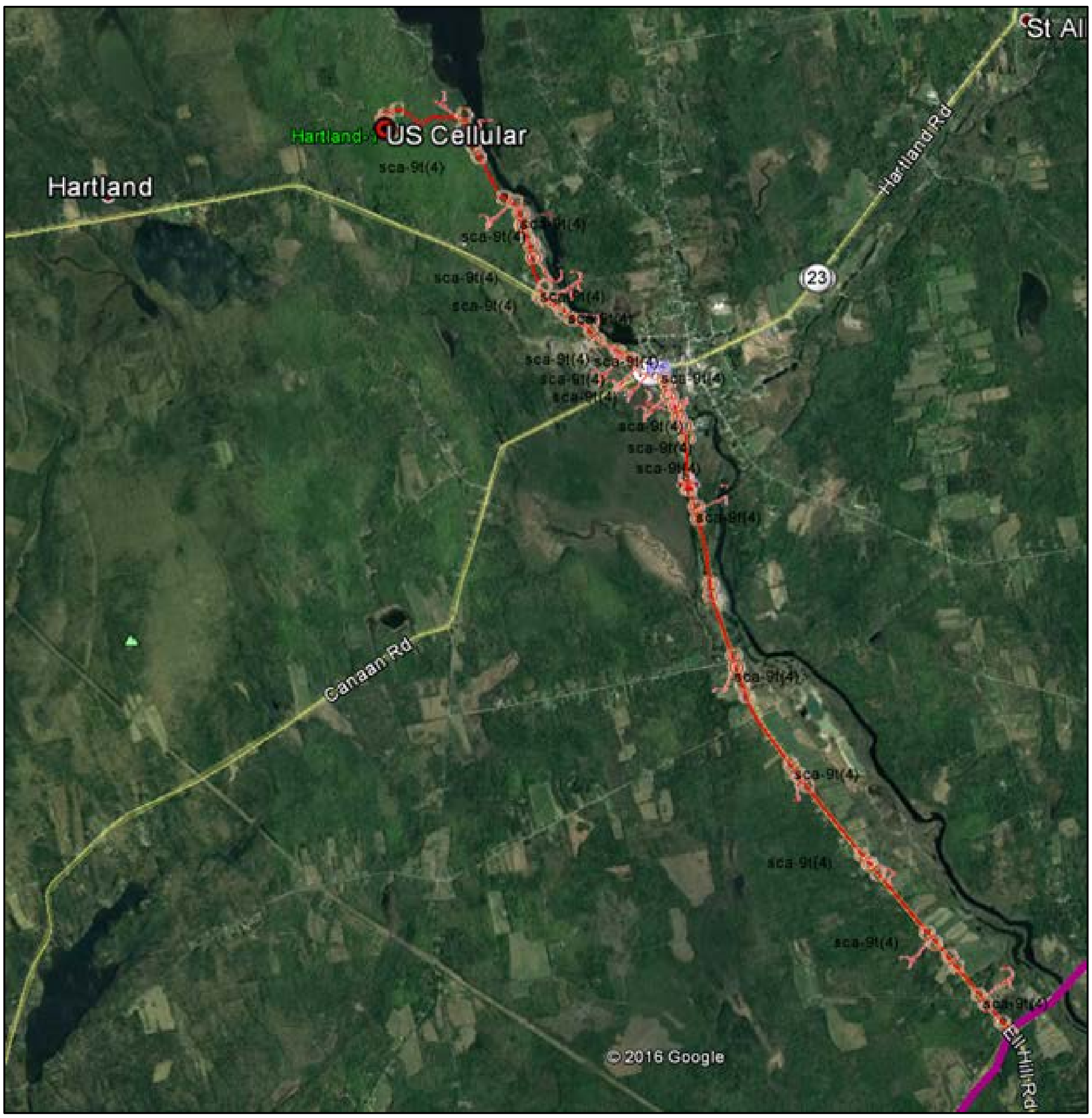


Figure 22 — Hartland 1 Fiber

As shown in Figure 23, the proposed tower would serve a mix of served and unserved areas. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

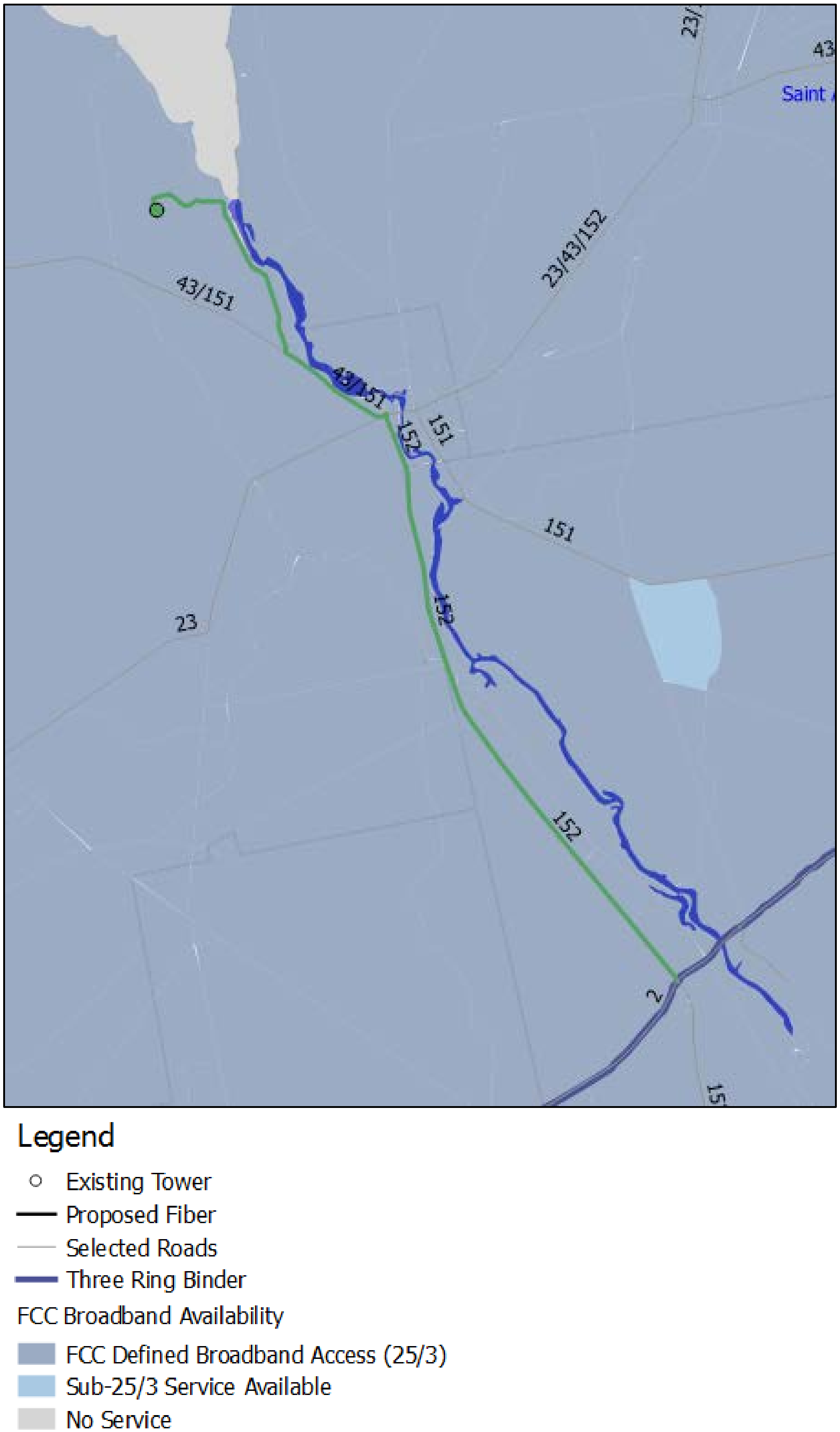


Figure 23 — Hartland-1 Fiber and Service Levels

The proposed budget for this build is in the below table.

Table 5 — Hartland 1 Budget

Item	Estimated Cost
Labor and Materials	$172,900
Make Ready	$63,900
Engineering & Project Management	$72,606
Contingency	$30,941
Total	**$340,347**

Hinckley – Lateral to KVCC

This proposed fiber build would connect the Hinckley campus of Kennebec Valley Community College and the Good Will facility to Three Ring Binder. It depends on the Skowhegan-5 build.

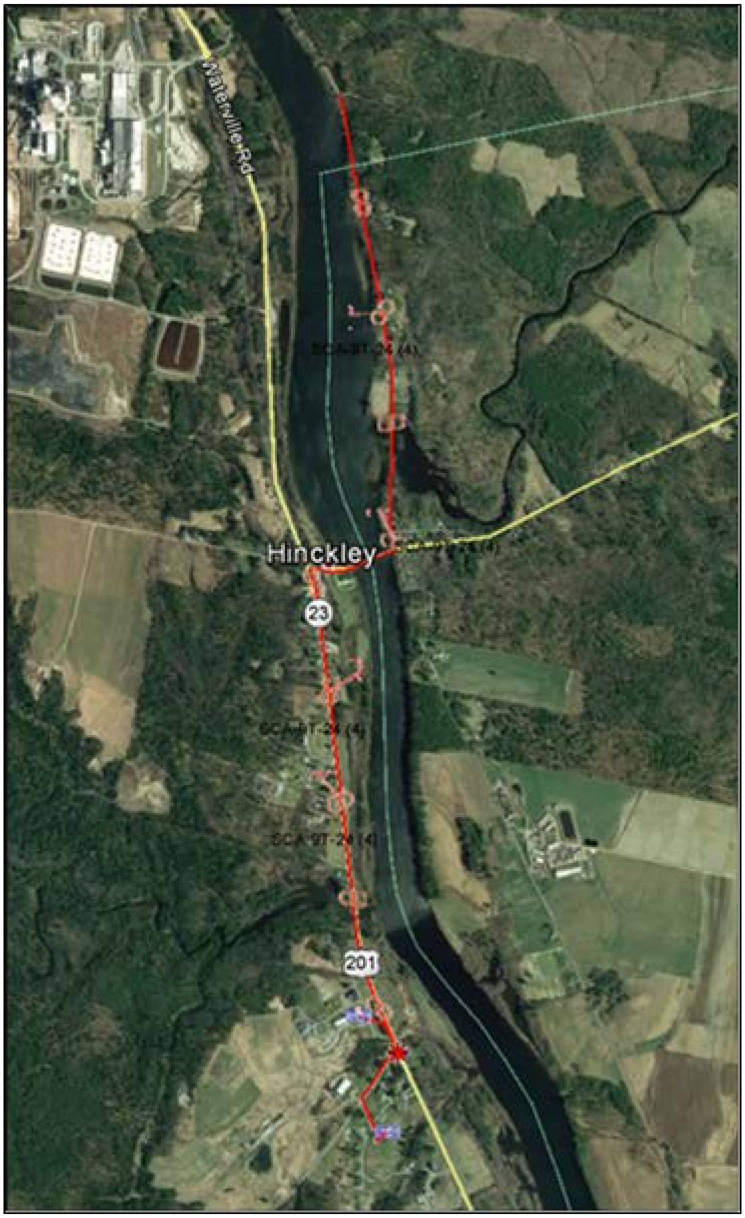


Figure 24 — Hinckley Lateral Fiber

Figure 25 shows the Hinckley Lateral in aqua and the Skowhegan-5 build it depends on in green. This route traverses the same mix of served, underserved, and served premises as Skowhegan-5, of course. The area around KVCC and the charter school are considered served by the FCC's definition, with the usual caveat on Form 477 data's lack of granularity.

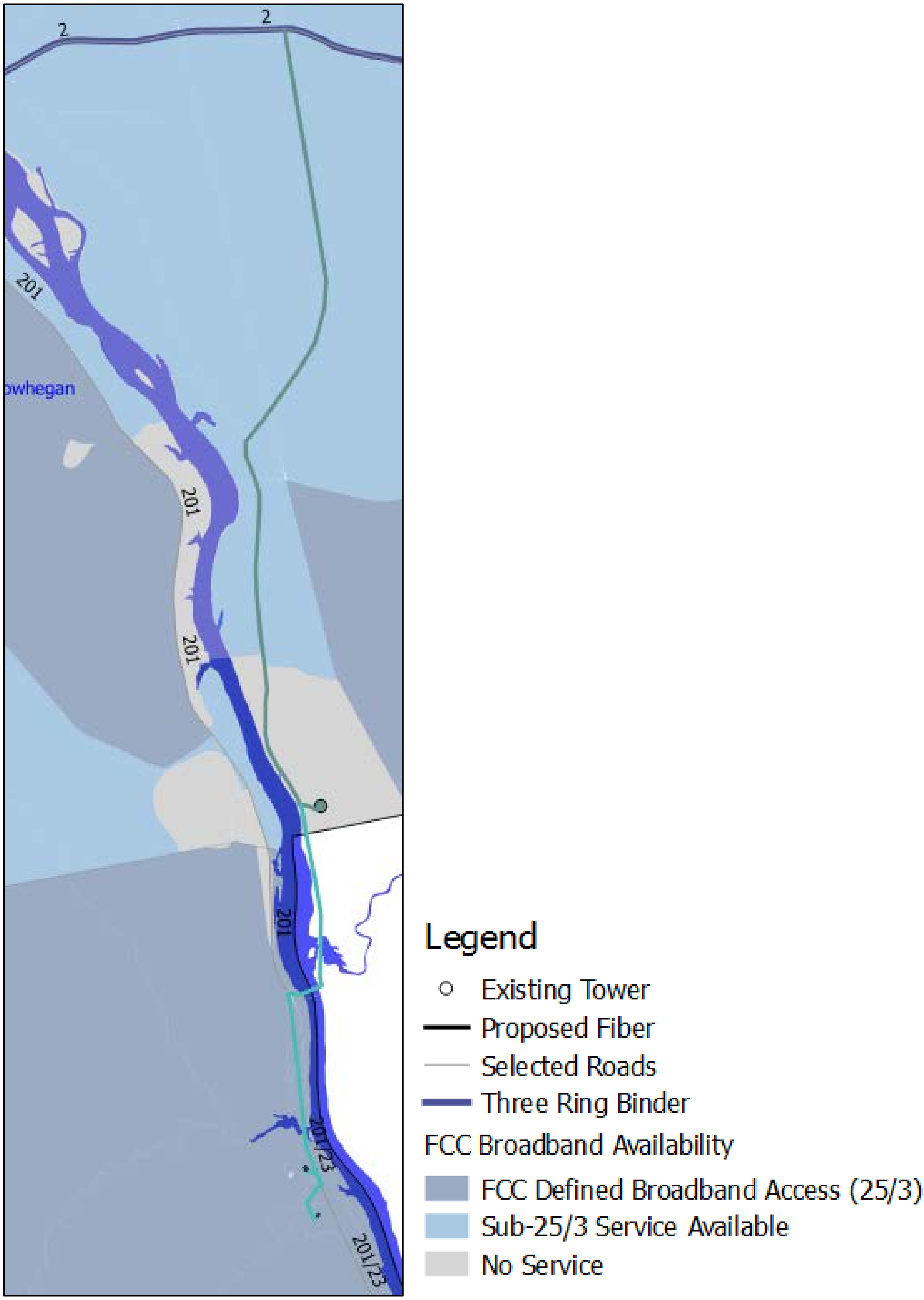


Figure 25 — Hinckley Lateral to KVCC and Service Levels

The budget for this piece is shown in the below table.

Table 6 — Hinckley Lateral to KVCC Budget

Item	Estimated Cost
Labor and Materials	$60,789
Make Ready	$33,600
Engineering & Project Management	$34,925
Contingency	$12,931
Total	**$142,245**

Madison-Solon

The Madison-Solon fiber build will extend the Three Ring Binder north along US-201 from its path on Route 148 to an existing tower on Horsetail Hill Road. The separate expansion along US-201 to The Forks depends on this Madison-Solon segment being built. For more information, see the Route 201 Corridor section on page 88. Three Ring Binder is shown in Figure 26 as a thick purple line.

Figure 26 — Madison-Solon Fiber

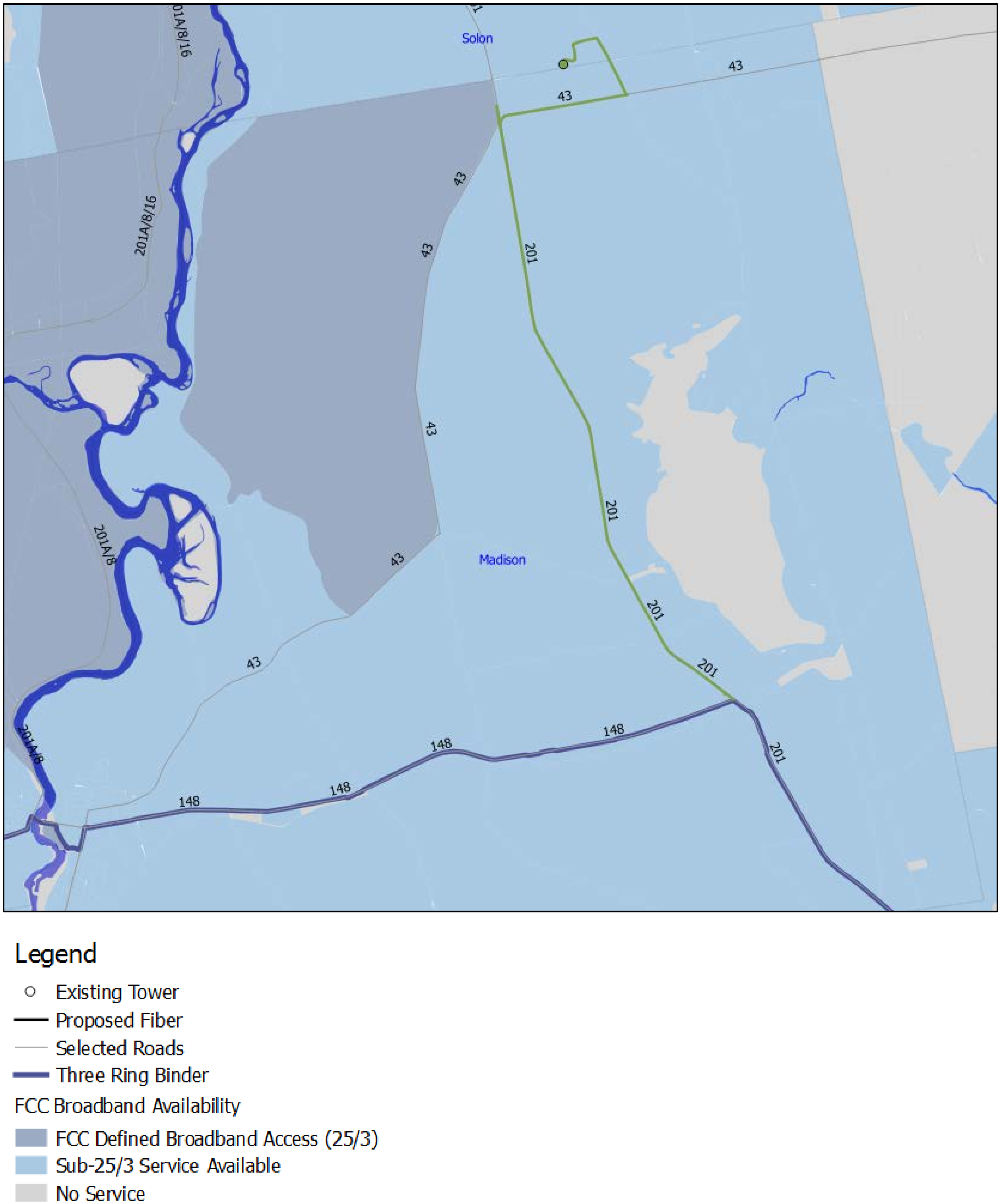


Figure 27 — Madison-Solon Fiber and Service Levels

As can be seen in Figure 27, much of the area lacks FCC-defined broadband service, with a mix of underserved and unserved areas. A well-served area is present between the proposed tower and the river, however. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

The proposed budget for this build is shown in the table below.

Table 7 — Madison-Solon Budget

Item	Estimated Cost
Labor and Materials	$203,199
Make Ready	$81,000
Engineering & Project Management	87,413
Contingency	37,161
Total	**$408,773**

Norridgewock 1

This build will provide the ability to connect various locations in downtown Norridgewock, including the New Balance factory. It depends on either Skowhegan-3 or Norridgewock-3 being built to connect to Three Ring Binder. If both are constructed, there will be a redundant ring to the east and west connecting Norridgewock to Three Ring Binder.

As can be seen in Figure 28, this area has service meeting the FCC's broadband definition. The Norridgewock-1 build is in orange, while Skowhegan-3 is in aqua and Norridgewock-3 is in green.

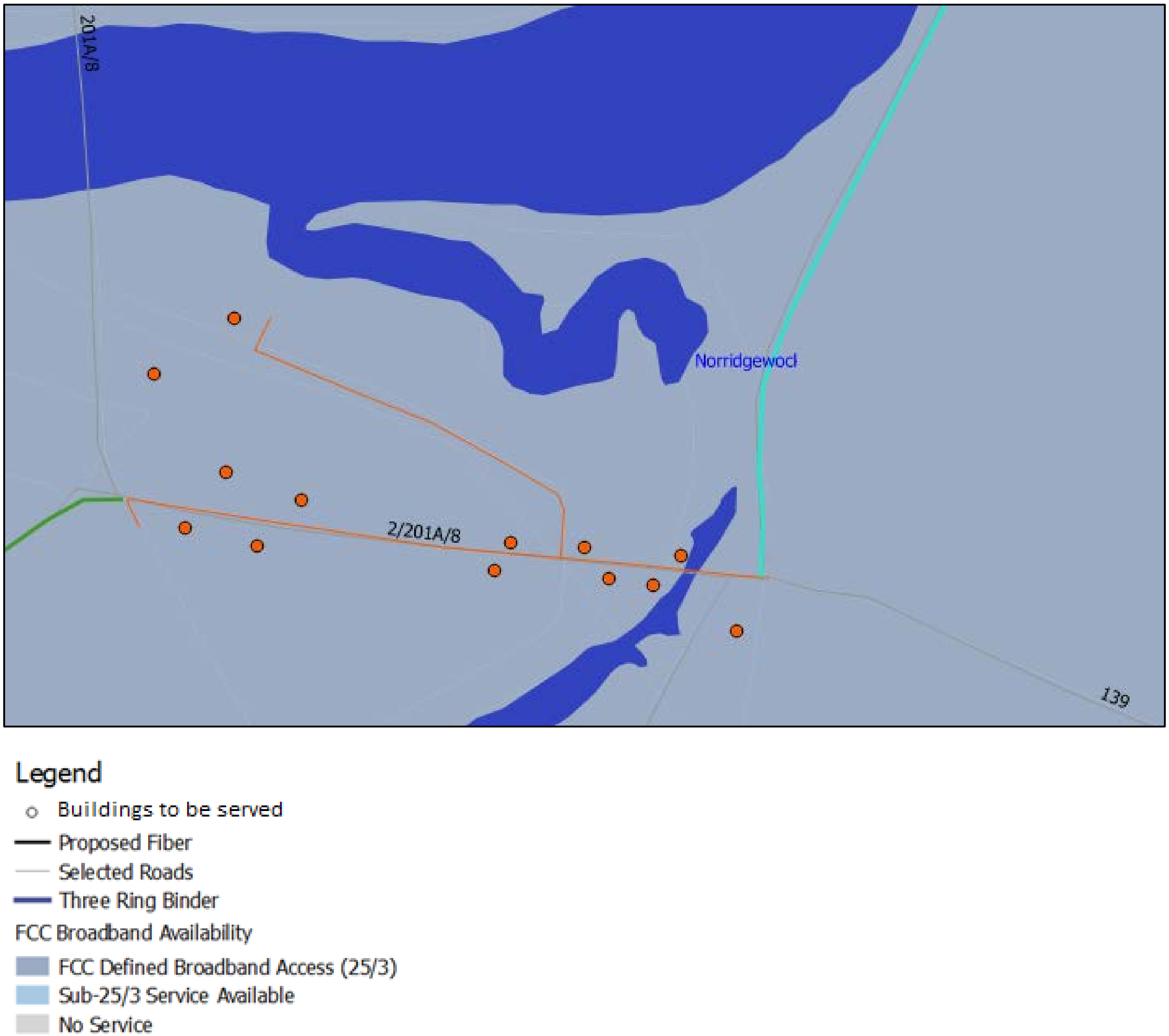


Figure 28 — Norridgewock-1 Fiber and Service Levels

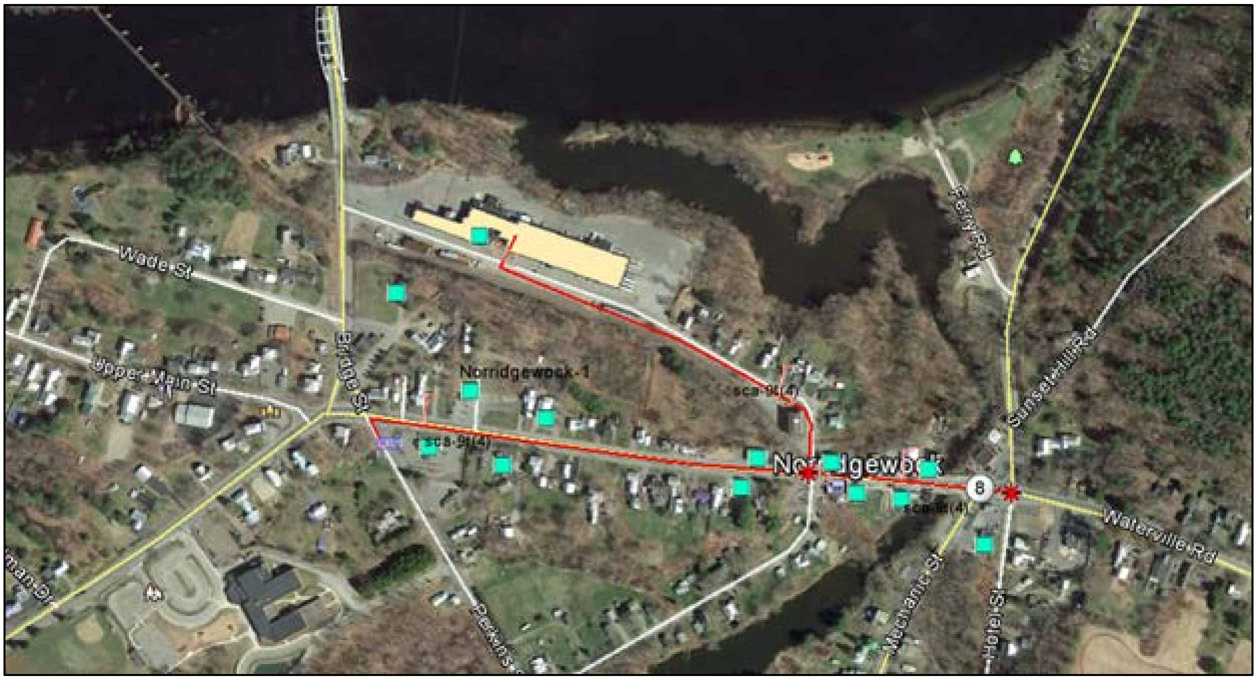


Figure 29 —Norridgewock 1 FIber

A budget for this build is in the below table.

Table 8 — Norridgewock-1 Budget

Item	Estimated Cost
Labor and Materials	$42,818
Make Ready	$45,000
Engineering & Project Management	$7,441
Contingency	$9,526
Total	**$104,785**

Norridgewock 2

This piece depends on Skowhegan 3 or both Norridgewock 1 and Norridgewock 3 being built to provide a connection to Three Ring Binder. It will connect an existing tower off US-2, to the northeast of Norridgewock, to Three Ring Binder. It is shown in red in Figure 30.

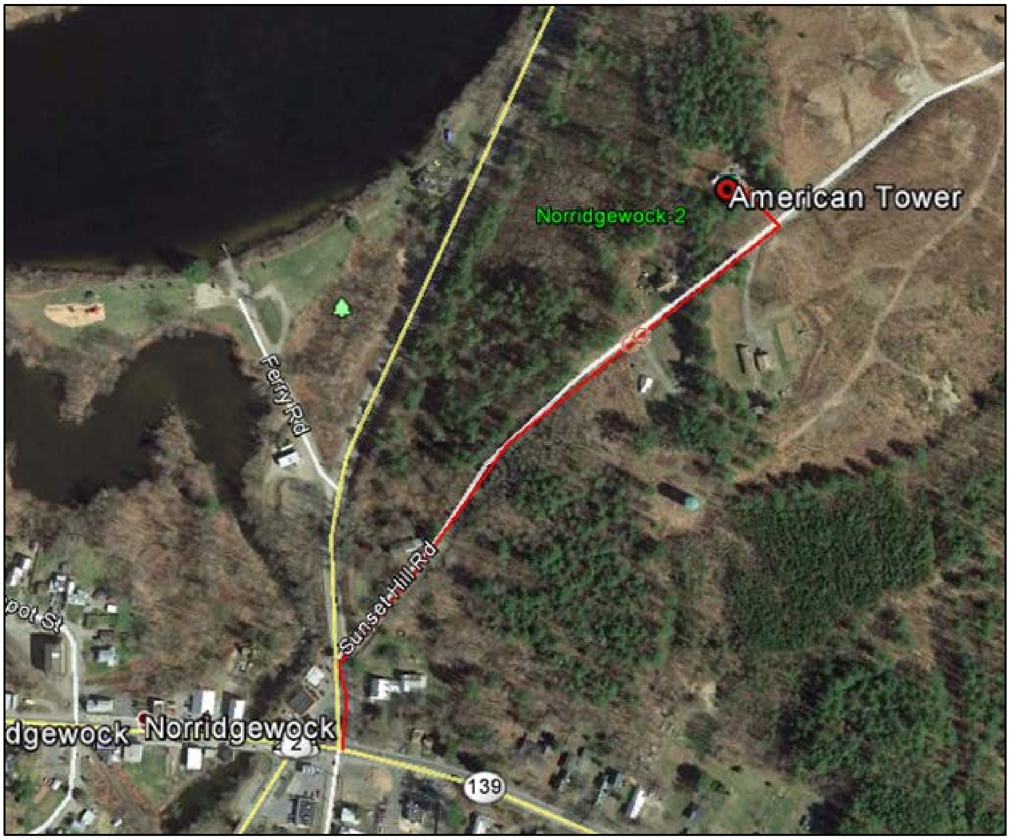


Figure 30 — Norridgewock 2 Fiber

Legend

- Existing Tower
- Proposed Fiber
- Selected Roads
- Three Ring Binder

FCC Broadband Availability

- FCC Defined Broadband Access (25/3)
- Sub-25/3 Service Available
- No Service

Figure 31 — Norridgewock-2 Fiber and Service Area

A budget for this build is in the below table.

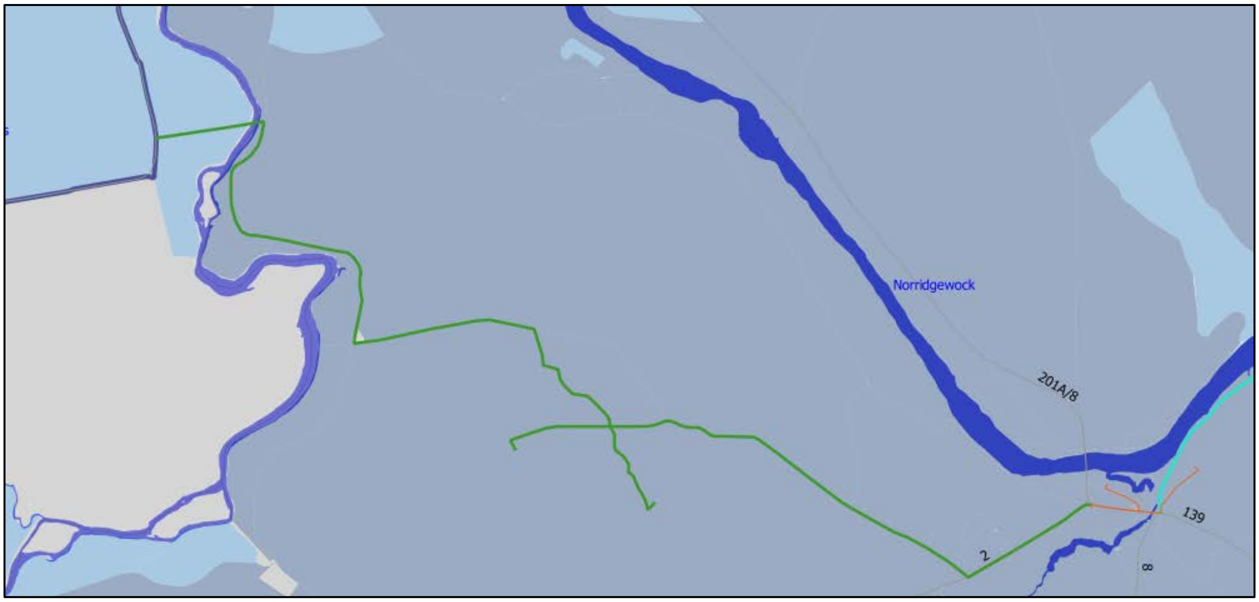
Table 9 — Norridgewock 2 Budget

Item	Estimated Cost
Labor and Materials	$11,020
Make Ready	$3,600
Engineering & Project Management	$3,907
Contingency	$1,853
Total	**$20,380**

Norridgewock 3

This adds route diversity and a second connection to Three Ring Binder. It also connects the airport and landfill. If Skowhegan 3 is not built, then this design would be required to provide connectivity to the other Norridgewock designs. As elsewhere, Three Ring Binder is denoted by the thick purple line along Route 43.

Figure 32 shows the route in context of FCC service data. As shown, the route proceeds along generally served areas. The Norridgewock-3 connector is in green, and Skowhegan-3 is in aqua. Norridgewock-1 is in orange.



Legend

- Existing Tower
- Proposed Fiber
- Selected Roads
- Three Ring Binder

FCC Broadband Availability

- FCC Defined Broadband Access (25/3)
- Sub-25/3 Service Available
- No Service

Figure 32 — Norridgewock-3 Connector

Figure 33 — Norridgewock 3 Fiber

The budget for this build is in the below table.

Table 10 — Norridgewock 3 Budget

Item	Estimated Cost
Labor and Materials	$179,164
Make Ready	$88,800
Engineering & Project Management	$93,194
Contingency	$36,116
Total	**$397,274**

Palmyra 1

The Palmyra fiber design extends Three Ring Binder to a tower located approximately ¾ mile south of US-2, two miles northwest of Pittsfield.

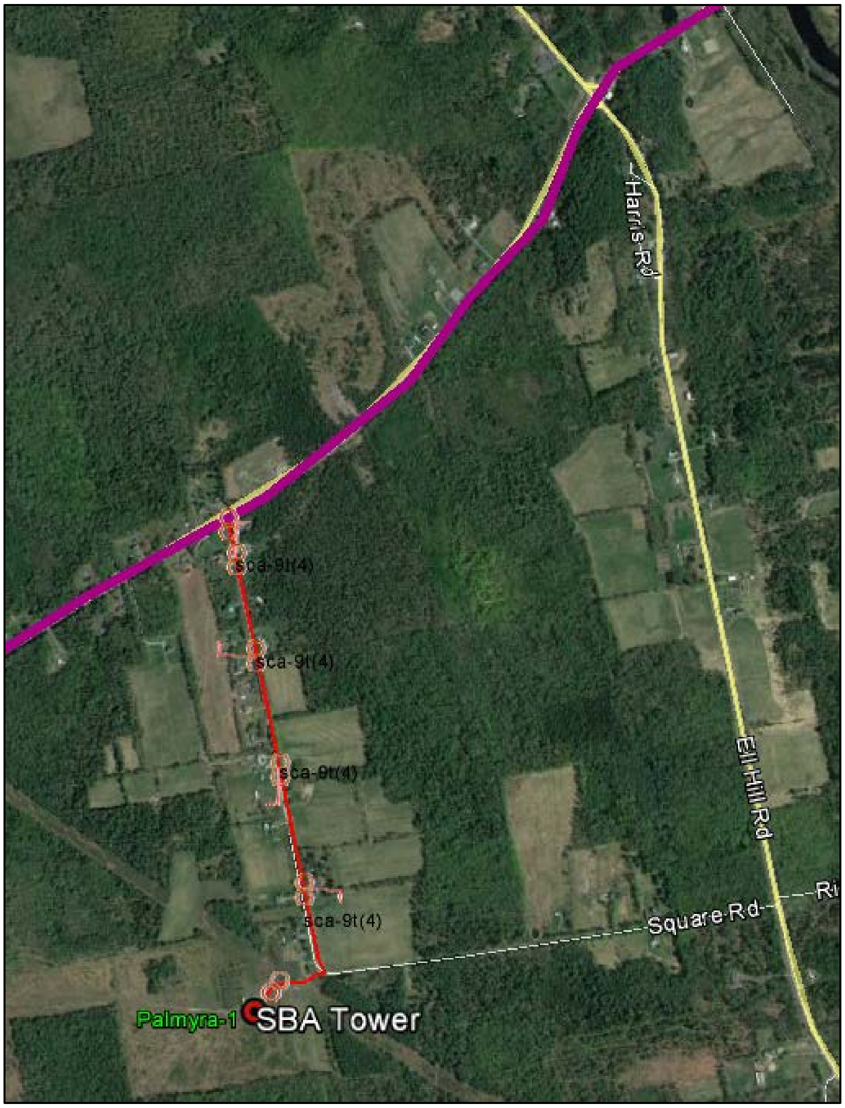


Figure 34 — Palmyra 1 Fiber

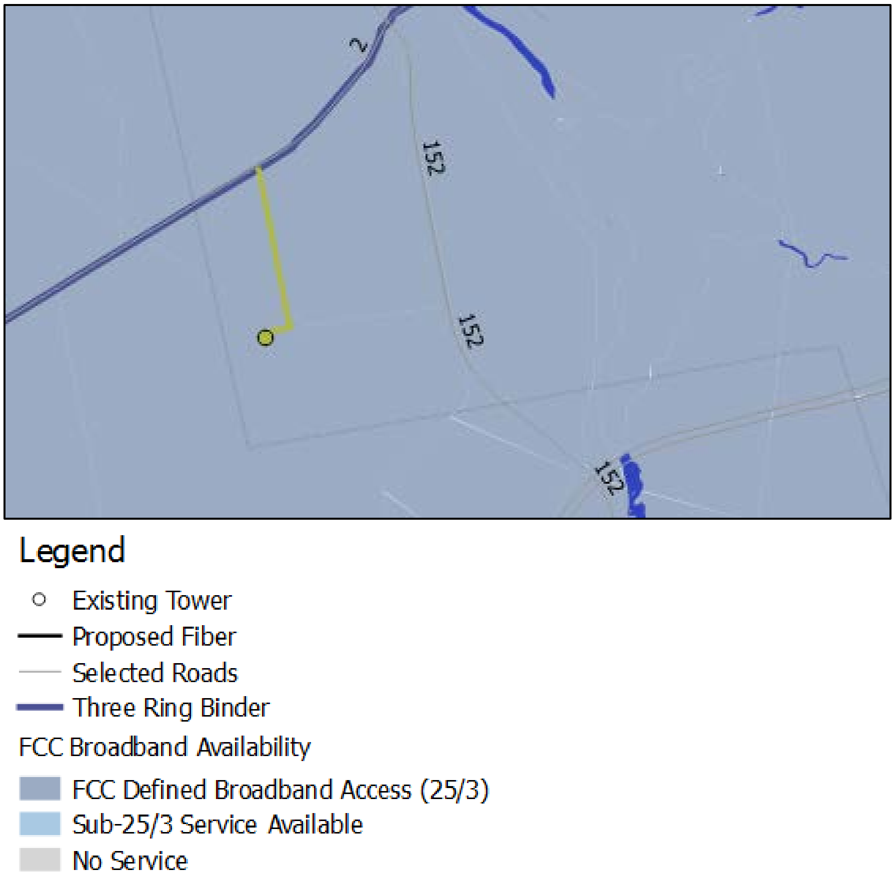


Figure 35 — Palmyra-1 Fiber and Service Levels

Figure 35 shows the Palmyra-1 build, which serves an area that the FCC Form 477 data shows as being served at at least 25/3 Mbps. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

The budget for this build is shown in the below table.

Table 11 — Palmyra-1 Budget

Item	Estimated Cost
Labor and Materials	$73,126
Make Ready	$31,800
Engineering & Project Management	$9,227
Contingency	$11,415
Total	**$125,568**

Palmyra 2

This design extends the Three Ring Binder (in purple) to a tower approximately 1 mile north of Interstate 95 and 4 miles west of Newport.

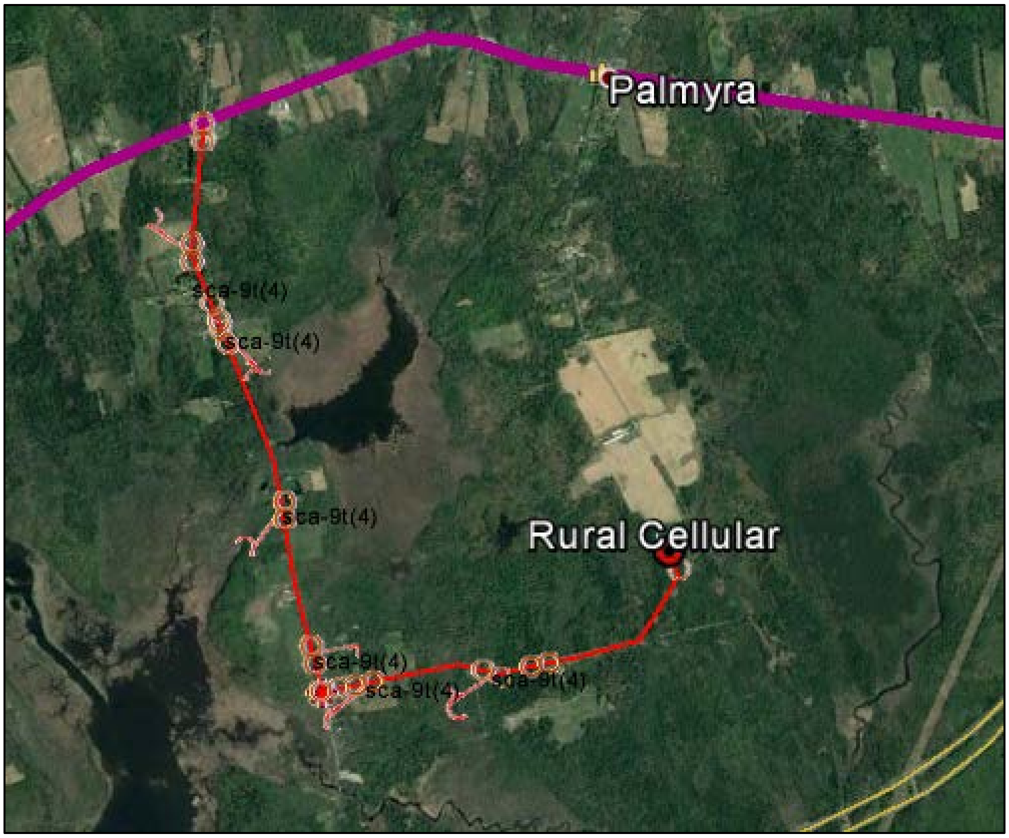


Figure 36 — Palmyra 2 Fiber

As shown in Figure 37, the Palmyra-2 tower seems to mostly serve an area where the FCC data show services present of at least 25/3 Mbps. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

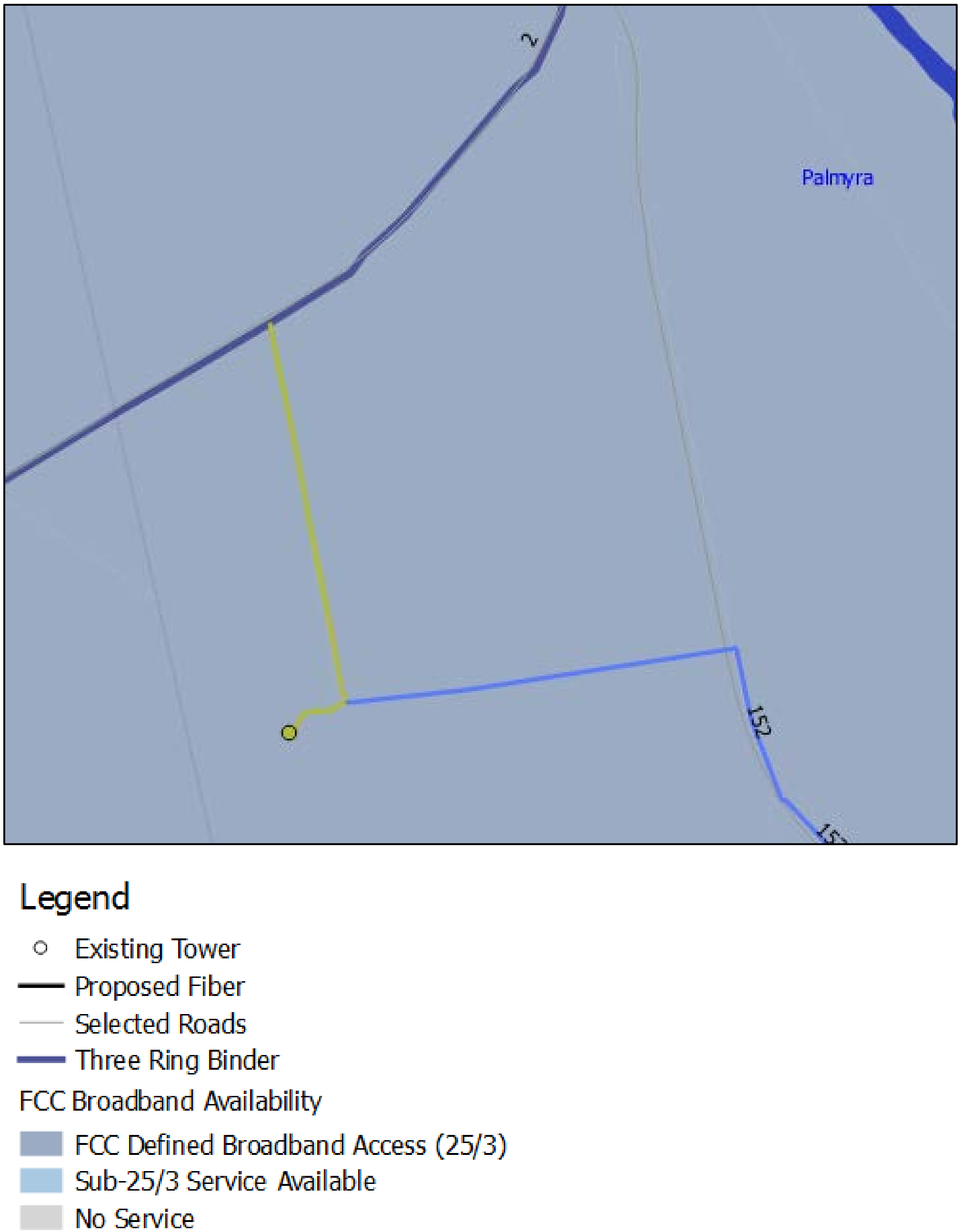


Figure 37 — Palmyra-2 Build and Service Levels

The below table shows the proposed budget for this build.

Table 12 — Palmyra 2 Budget

Item	Estimated Cost
Labor and Materials	$82,866
Make Ready	$35,400
Engineering & Project Management	$33,534
Contingency	$15,180
Total	**$166,980**

Palmyra 3

The Palmyra 3 build will extend from Palmyra 2 to an existing tower approximately 1.5 miles south of the Palmyra 2 tower, on the south side of Interstate 95. It depends on Palmyra 2 (in orange below) being built, or on the Pittsfield 2 (in blue below) and Palmyra Redundant Ring (not shown below) designs. As shown below, this tower would likely serve areas that already meet the FCC 25/3 Mbps broadband definition. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

Legend

Existing Tower
Proposed Fiber
Selected Roads
Three Ring Binder
FCC Broadband Availability
FCC Defined Broadband Access (25/3)
Sub-25/3 Service Available
No Service

Figure 38 — Palmyra-3 Design and Service Levels

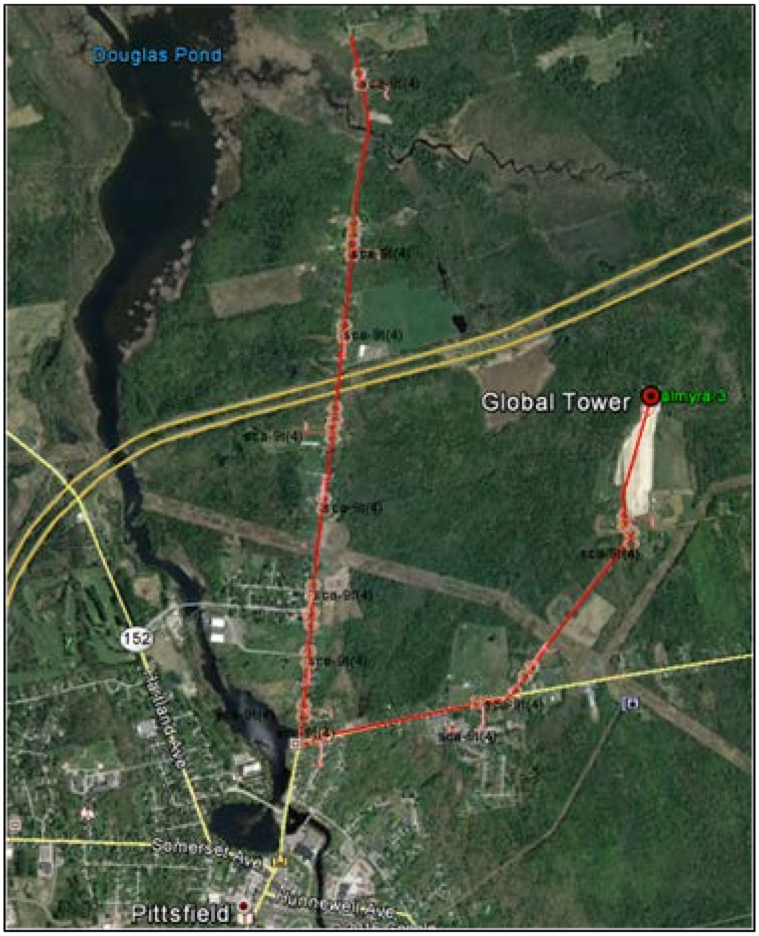


Figure 39 — Palmyra 3 Fiber

The budget for the Palmyra 3 fiber build is in the below table.

Table 13 — Palmyra 3 Budget

Item	Estimated Cost
Labor and Materials	$8,469
Make Ready	$2,400
Engineering & Project Management	$40,928
Contingency	$5,180
Total	**$56,977**

Palmyra 4

The Palmyra 4 design is to extend Three Ring Binder to a tower just west of Newport, and northwest of the interchange with Interstate 95 of Route 11.

Figure 40 — Palmyra 4 Fiber

As shown in Figure 41, the Palmyra-4 design would seem to serve an area that the FCC reports as largely served at 25/3. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

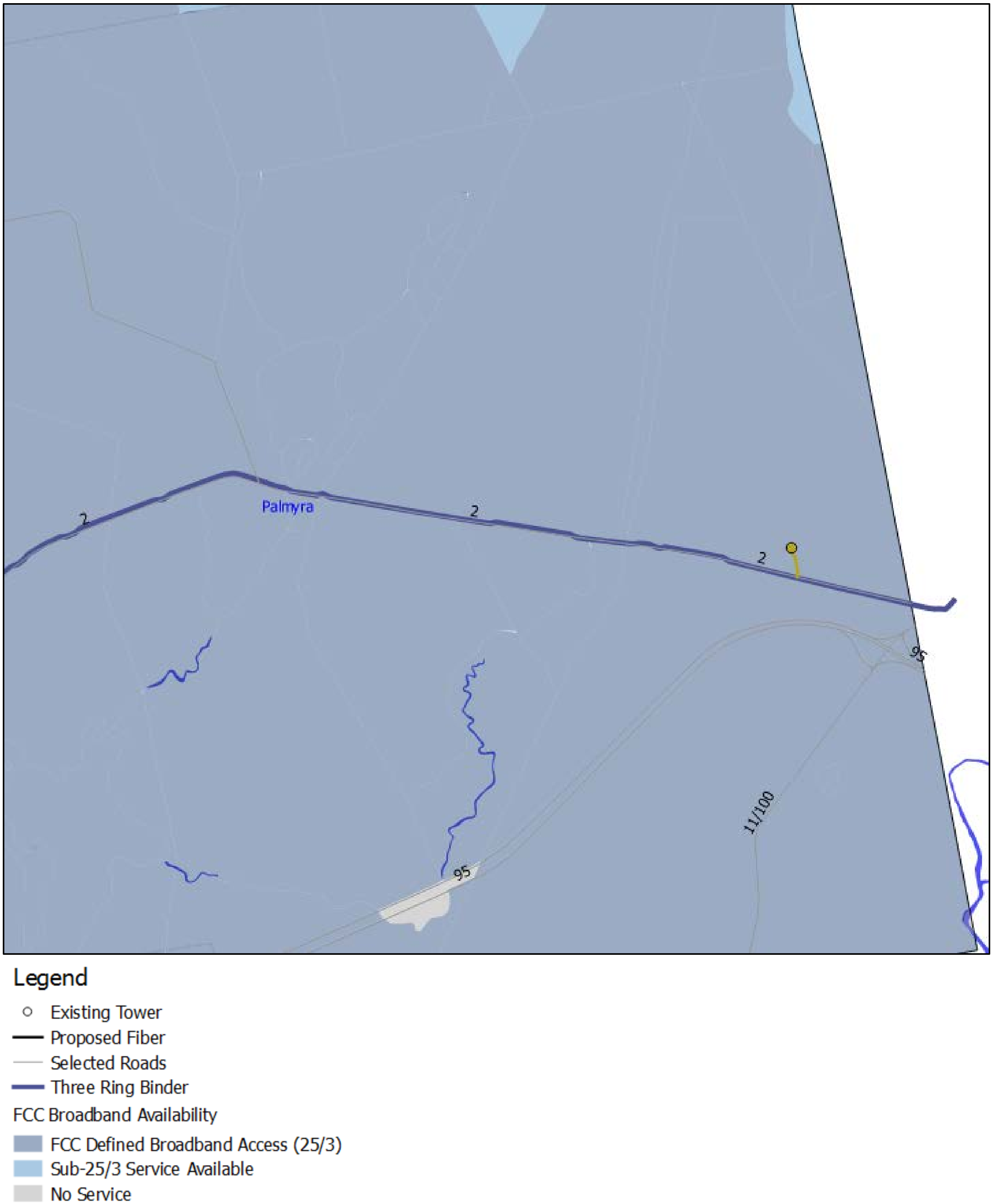


Figure 41 — Palmyra-4 Fiber and Service Levels

The budget for Palmyra 4 is in the below table.

Table 14 — Palmyra 4 Budget

Item	Estimated Cost
Labor and Materials	$72,740
Make Ready	$27,300
Engineering & Project Management	$1,930
Contingency	$10,197
Total	**$112,167**

Pittsfield 1

This build connects an existing tower south of US-2 to Three Ring Binder. The tower is located approximately one mile east of Interstate 95, about four miles southwest of Pittsfield.

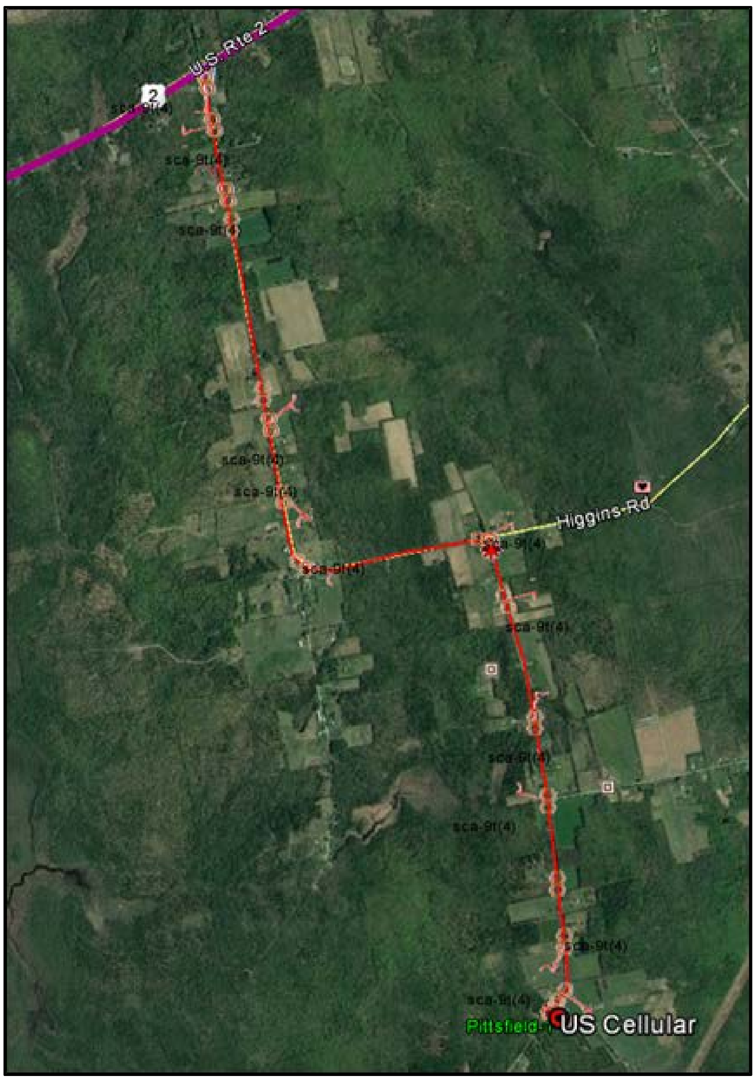
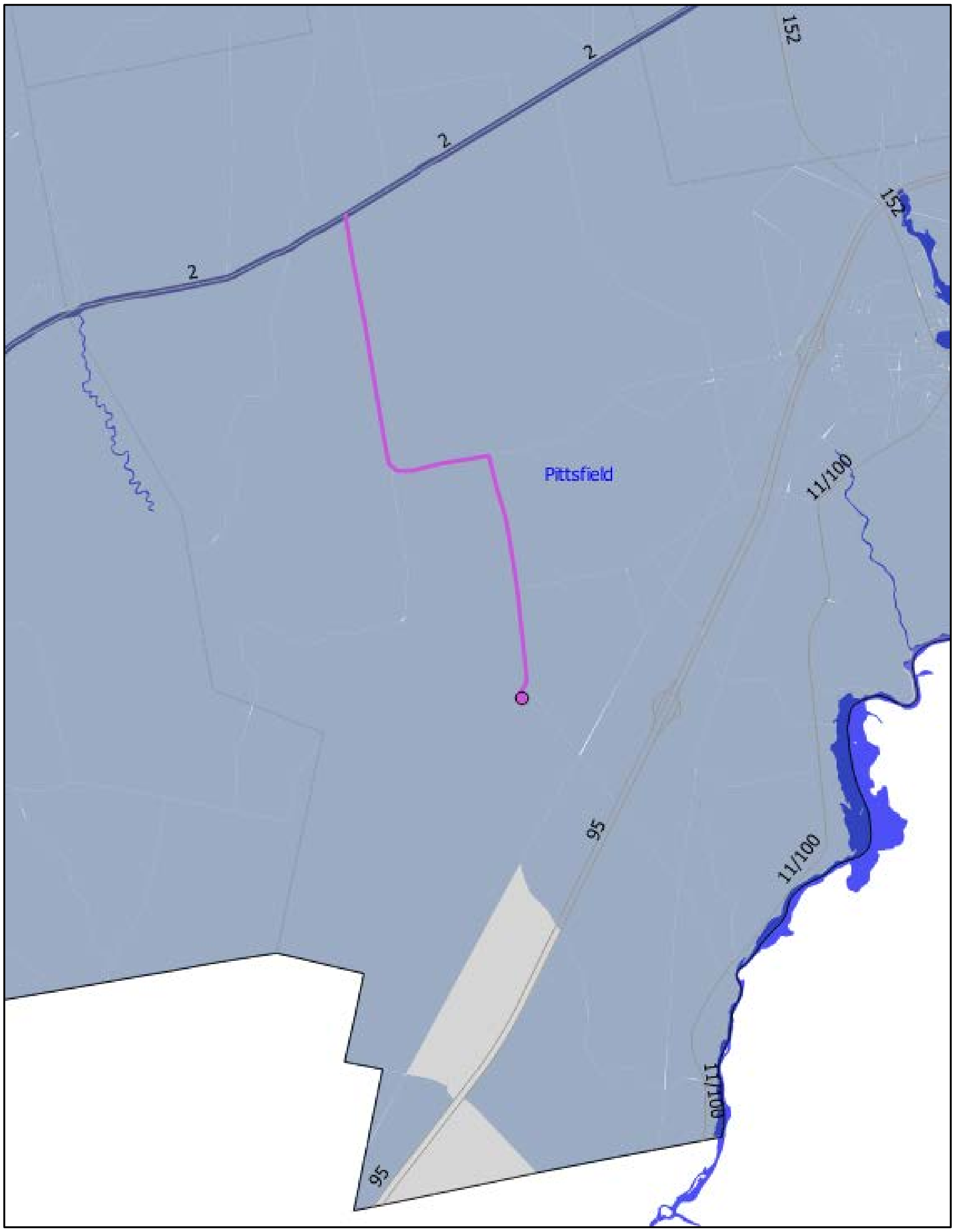


Figure 42 — Pittsfield 1 Fiber

As shown in Figure 43, this proposed fiber build will largely serve areas that already have access to broadband by the FCC's definition.



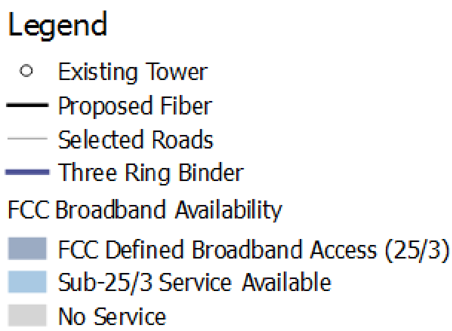


Figure 43 — Pittsfield-1 Fiber and Service Levels

The budget for this design is in the below table.

Table 15 — Pittsfield 1 Budget

Item	Estimated Cost
Labor and Materials	$115,131
Make Ready	$42,000
Engineering & Project Management	$48,524
Contingency	$20,566
Total	**$226,221**

Pittsfield 2

Pittsfield 2 connects either the Palmyra Redundant line or the Palmyra 2 and 3 lines to a tower located just off Route 69 in downtown Pittsfield.

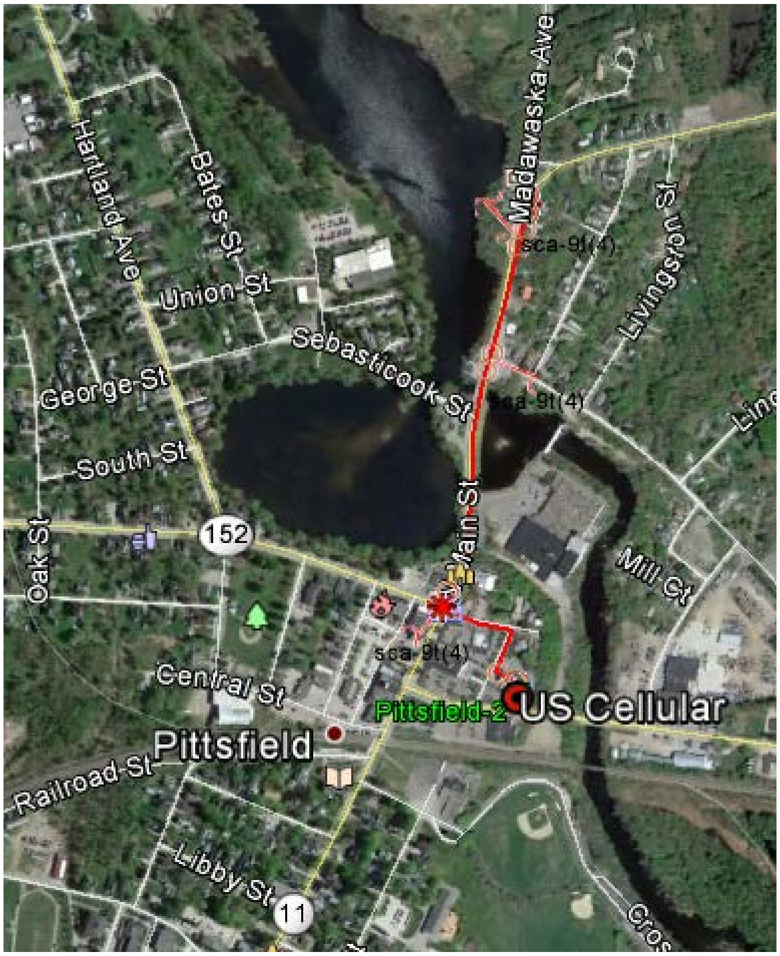


Figure 44 — Pittsfield 2 Fiber

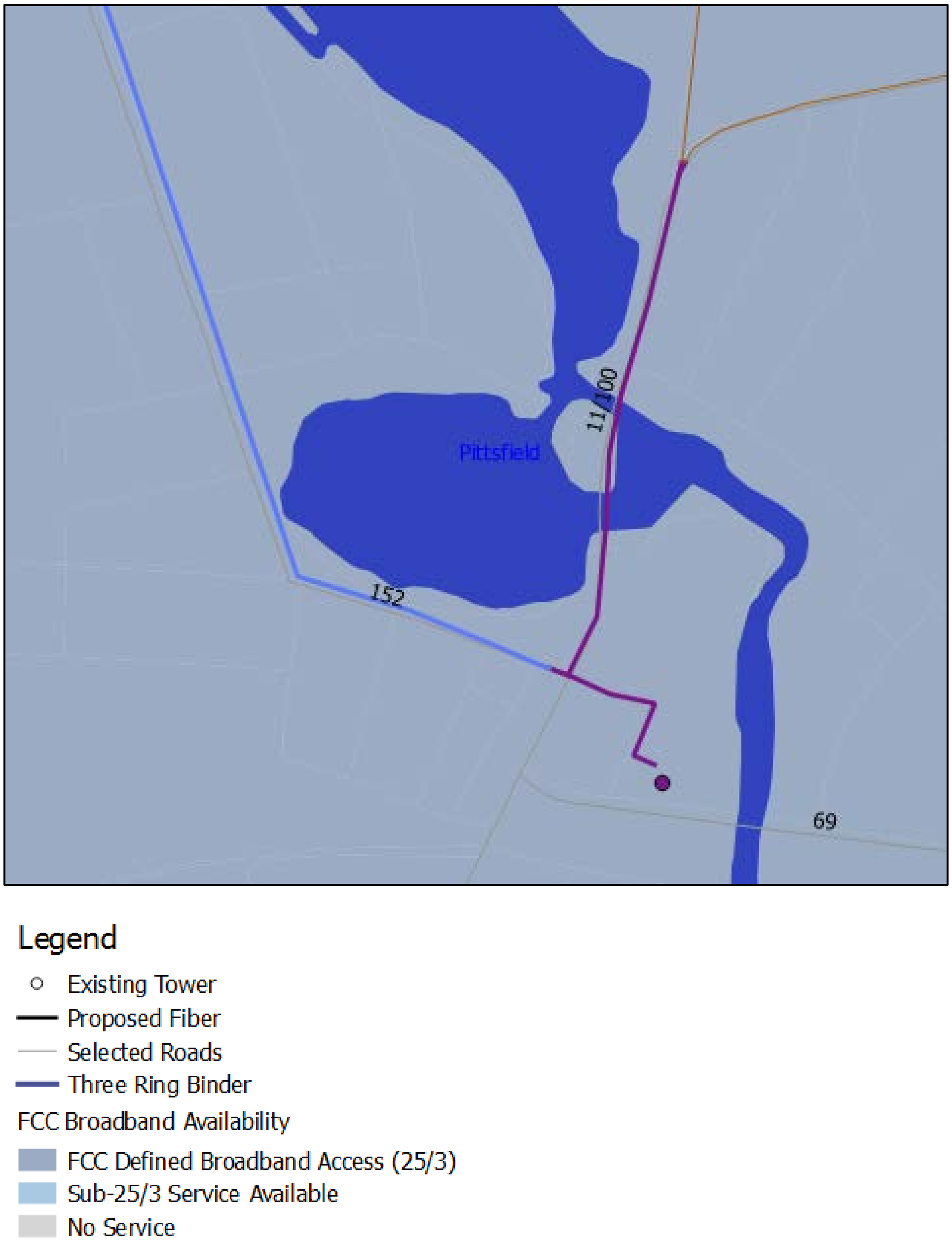


Figure 45 — Pittsfield-2 Fiber Build and Service Area

As shown in Figure 45 the Pittsfield-2 tower design would seem to serve largely already-served premises. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

The budget for this design is in the below table.

Table 16 — Pittsfield 2 Budget

Item	Estimated Cost
Labor and Materials	$42,847
Make Ready	$11,500
Engineering & Project Management	$5,495
Contingency	$5,984
Total	**$65,826**

Downtown Skowhegan (Skowhegan-2)

The proposed downtown Skowhegan buildout is to serve (via Three Ring Binder) several downtown businesses. This fiber build is termed Skowhegan-2 in Tilson's fiber designs. It is shown in Figure 22. As with other designs, Three Ring Binder is a thick purple line and the proposed fiber is in red. Businesses to be served are turquoise squares. Per client request, the fiber is routed across a Town-owned footbridge over the Kennebec River. In order to build this design, the builder will need to secure permission from the Town to use its footbridge.

Also, the proposed Skowhegan-3 build, which connects Skowhegan to Norridgewock, depends on this segment being built. For more information on Skowhegan-3, please see page 79.

As can be seen Figure 46, the buildings in the area lack FCC-defined broadband service. A fiber buildout connecting them to the Three Ring Binder is a logical method to enhance service while allowing for future expansion.

Legend

- Buildings to be served
- Proposed Fiber
- Selected Roads
- Three Ring Binder

FCC Broadband Availability

- FCC Defined Broadband Access (25/3)
- Sub-25/3 Service Available
- No Service

Figure 46 — Skowhegan-2 Build and Service Levels

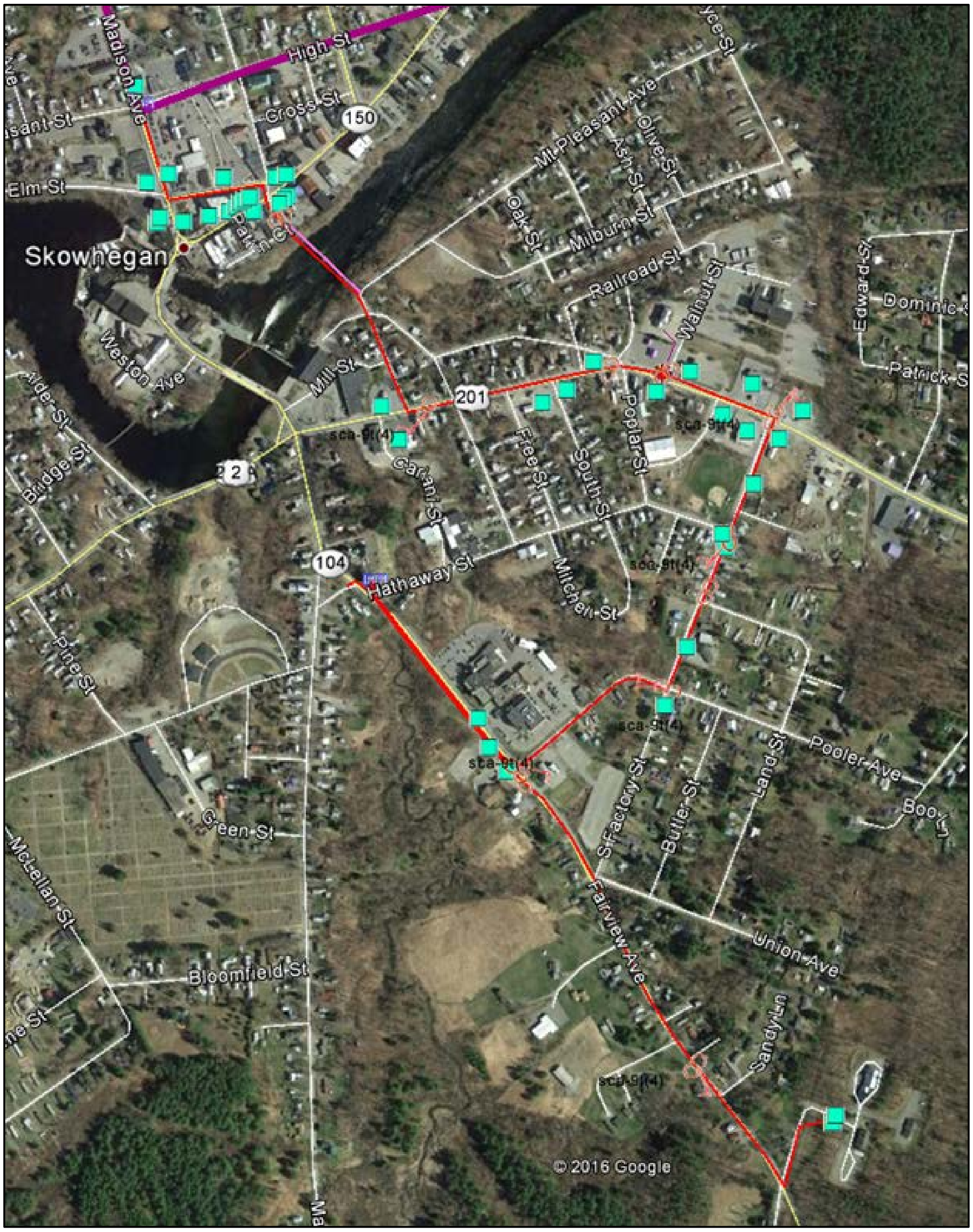


Figure 47 — Downtown Skowhegan Fiber (Skowhegan-2)

Proposed budget for this design is shown in Table 17.

Table 17 — Downtown Skowhegan Budget (Skowhegan-2)

Item	Estimated Cost
Labor and Materials	$82,771
Make Ready	$39,500
Engineering & Project Management	$25,952
Contingency	$14,822
Total	**$163,045**

Skowhegan-Norridgewock (Skowhegan-3)

The Skowhegan-to-Norridgewock connector extends Three Ring Binder southeast along US-2 to Norridgewock. This corridor passes several businesses, as shown in Figure 48. It can also provide a connection between New Balance factories in Skowhegan and Norridgewock if the Norridgewock-1 design is constructed. Note that this fiber build depends on the Downtown Skowhegan (Skowhegan-2) build.

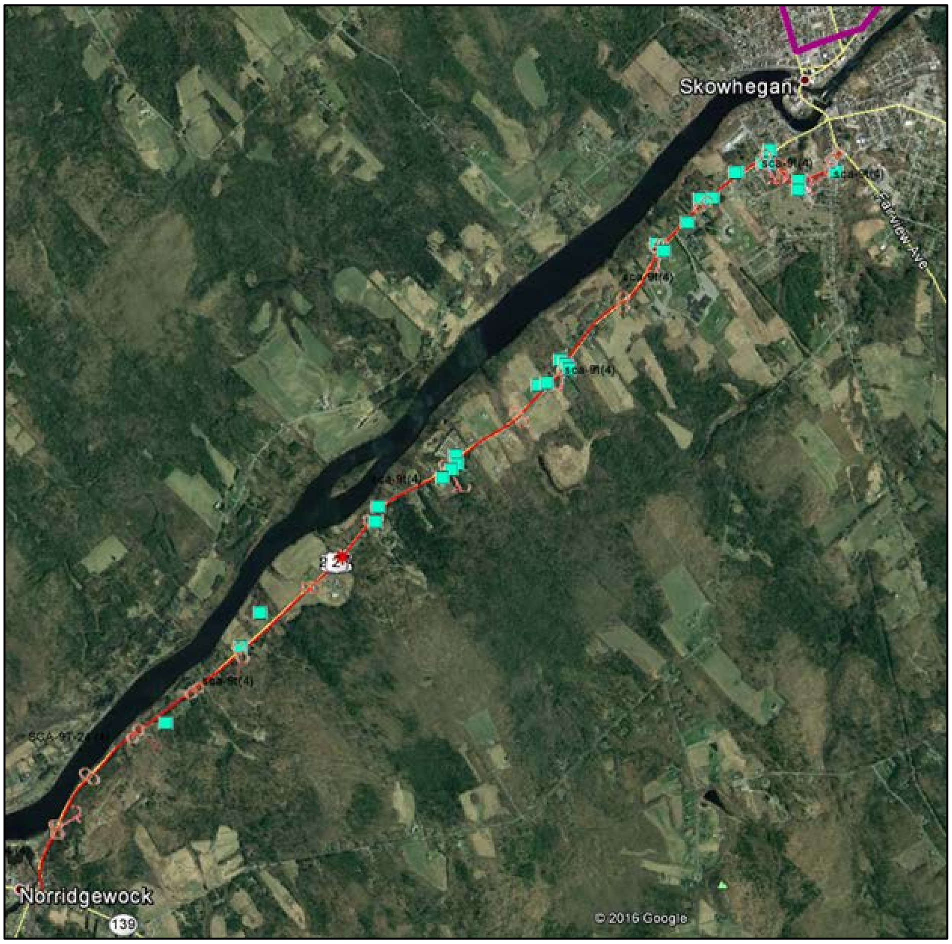


Figure 48 — Skowhegan to Norridgewock Connector (Skowhegan-3)

As can be seen in Figure 49, this fiber build runs through areas with varying degrees of broadband service. Norridgewock is comparatively better served, but there are no areas of no service along this route.

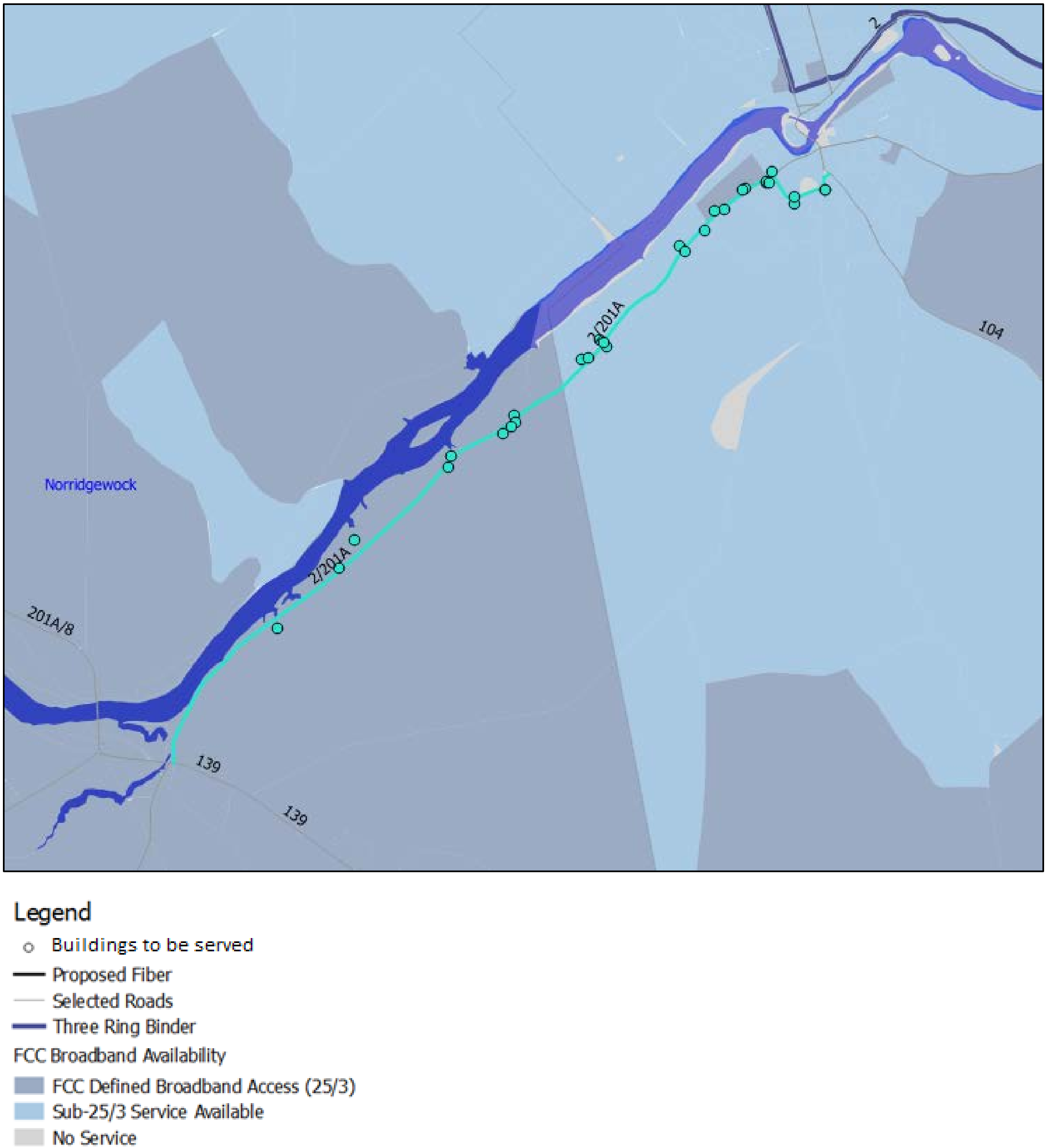


Figure 49 — Skowhegan to Norridgewock (Skowhegan-3) Route and Service Levels

A proposed budget for this piece is in the below table.

Table 18 — Skowhegan to Norridgewock (Skowhegan-3) Budget

Item	Estimated Cost
Labor and Materials	$118,832
Make Ready	$85,000
Engineering & Project Management	$56,213
Contingency	$26,005
Total	**$286,050**

Skowhegan-5

The Skowhegan-5 build extends fiber down Eaton Mountain Road to an existing wireless tower across the river and directly east of the Sappi Paper mill in Skowhegan, just north of Hinckley. Note that the Hinckley Lateral build depends on this build. The Hinckley Lateral would connect the Hinckley campus of Kennebec Valley Community College and the Good Will school. For further information, please see the Hinckley – Lateral to KVCC section on page 48.

As shown in Figure 50, this build could potentially serve a mix of served, underserved, and unserved areas, as well as an un-studied area of neighboring Kennebec County. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

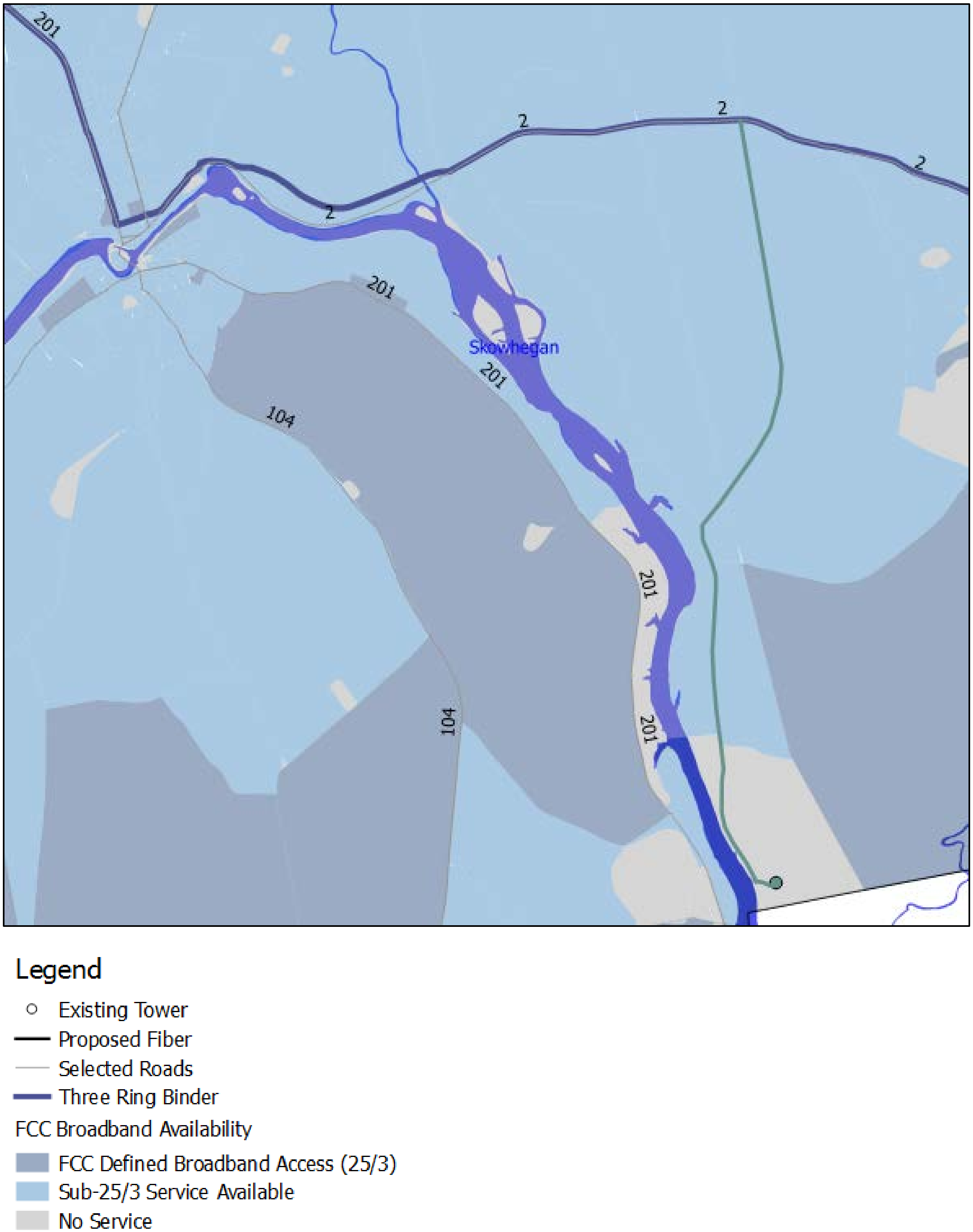


Figure 50 — Skowhegan-5 Fiber Build and Service Levels

The proposed budget for this build is in the below table.

Table 19 — Skowhegan-5 Fiber Budget

Item	Estimated Cost
Labor and Materials	$145,416
Make Ready	$61,500
Engineering & Project Management	$60,222
Contingency	$26,714
Total	**$293,852**

Palmyra Redundant

This piece connects the Pittsfield 2 tower (which depends on Palmyra 2 and Palmyra 3) with Palmyra 1, to provide route redundancy. For more information, see Pittsfield 2 on page 73.

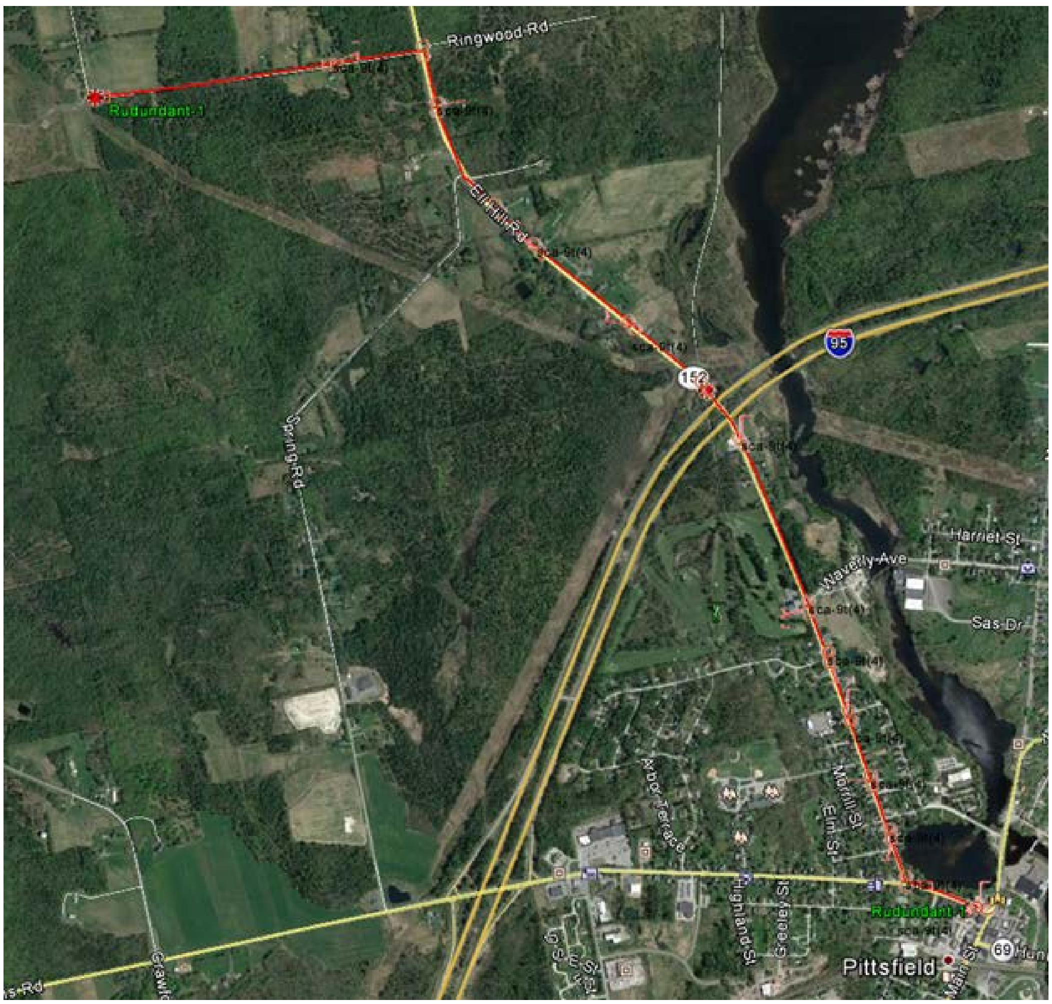


Figure 51 — Palmyra Redundant Fiber

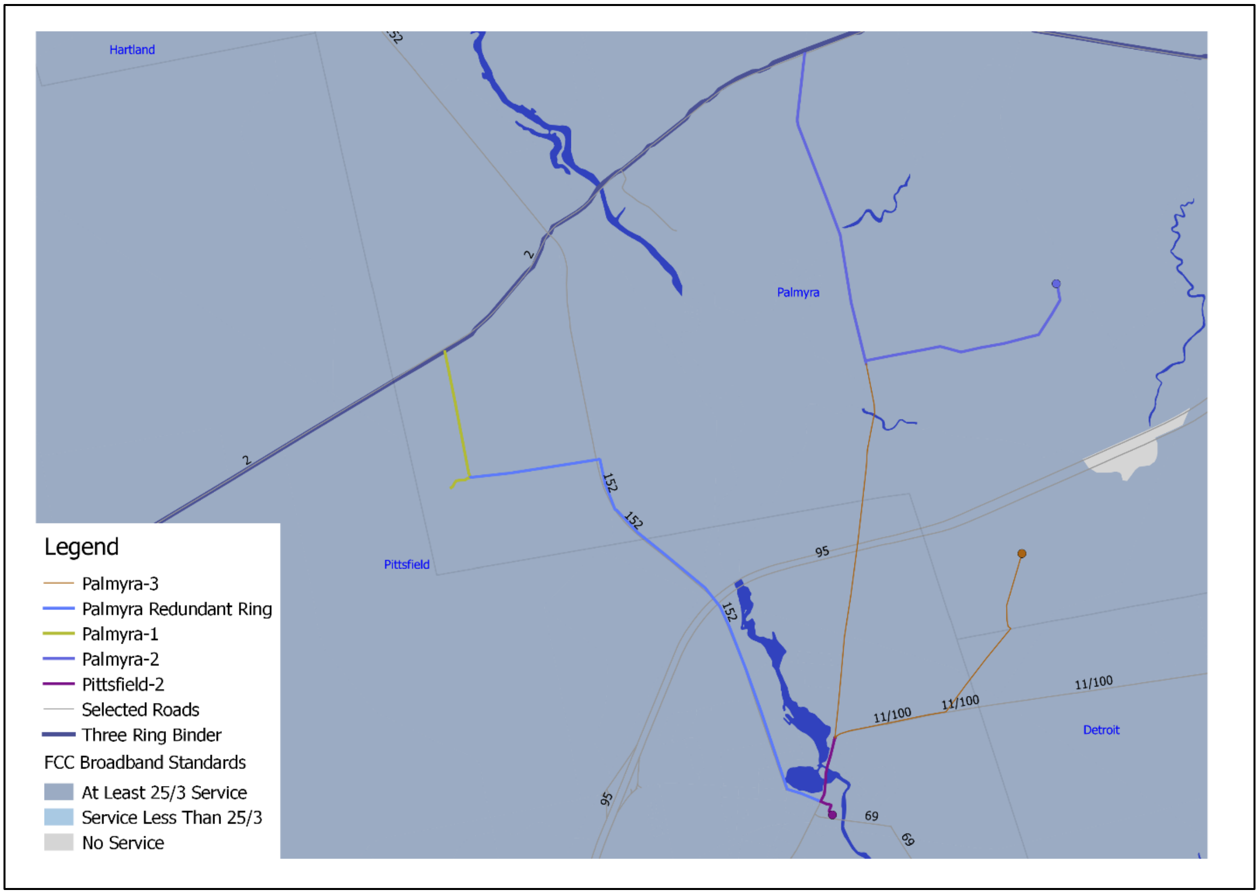


Figure 52 — Palmyra Redundant Design in Context with Service Levels

As shown in Figure 52, the Palmyra Redundant design provides route diversity to several other proposed builds. This entire area is shown as being served with at least 25/3 speeds by the FCC, so the desirability of spending the money to build out further connectivity should be carefully weighed.

A budget for the redundant design segment is in the below table.

Table 20 — Palmyra Redundant Budget

Item	Estimated Cost
Labor and Materials	$28,764
Make Ready	$10,500
Engineering & Project Management	$33,647
Contingency	$7,291
Total	**$80,202**

Starks

The Starks tower, located off Route 43, can provide wireless broadband service to the surrounding area. Exact characteristics of RF propagation and service levels can be determined by detailed RF engineering studies. In Figure 53, the Three Ring Binder is shown as a thick purple line, while the proposed fiber build is in red.

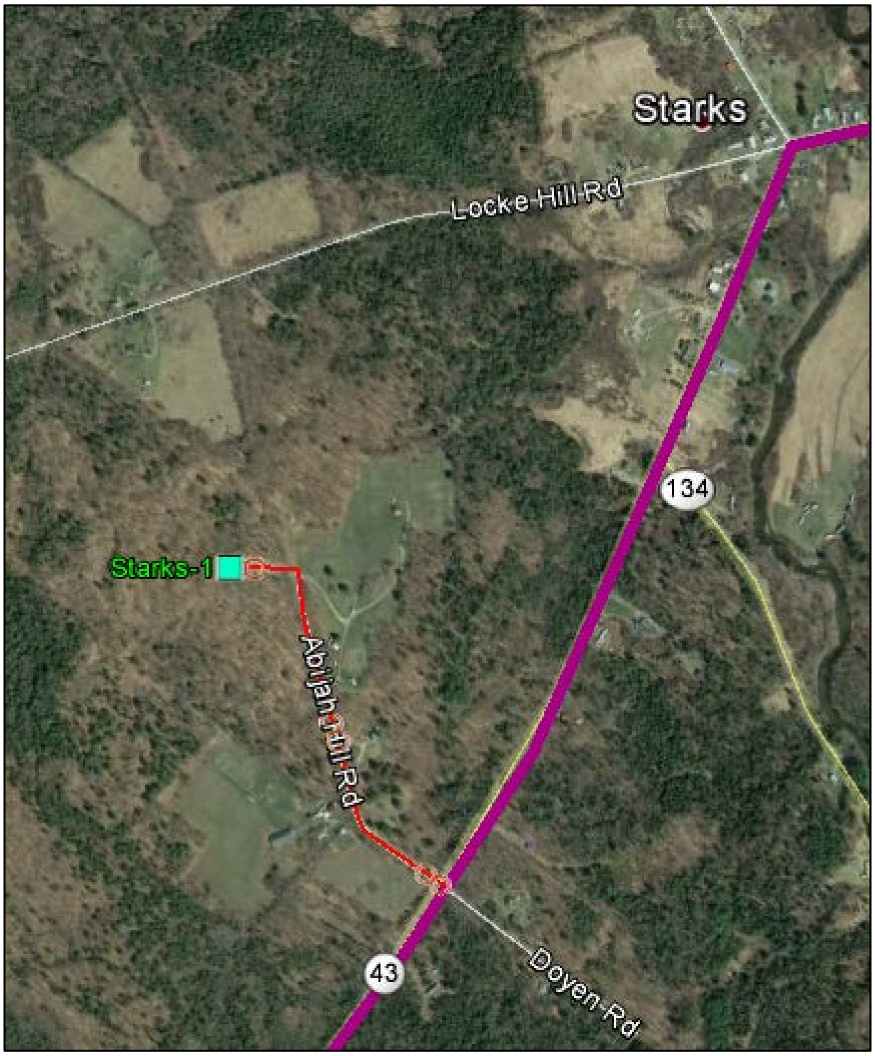


Figure 53 — Starks Tower and Connector

As can be seen in Figure 54, the Town of Starks lacks FCC-defined broadband service, with a mix of underserved and unserved areas. A detailed RF engineering study of this tower will be necessary to determine which specific areas and premises could benefit from it, as well as working with the selected ISP to determine feasible service levels.

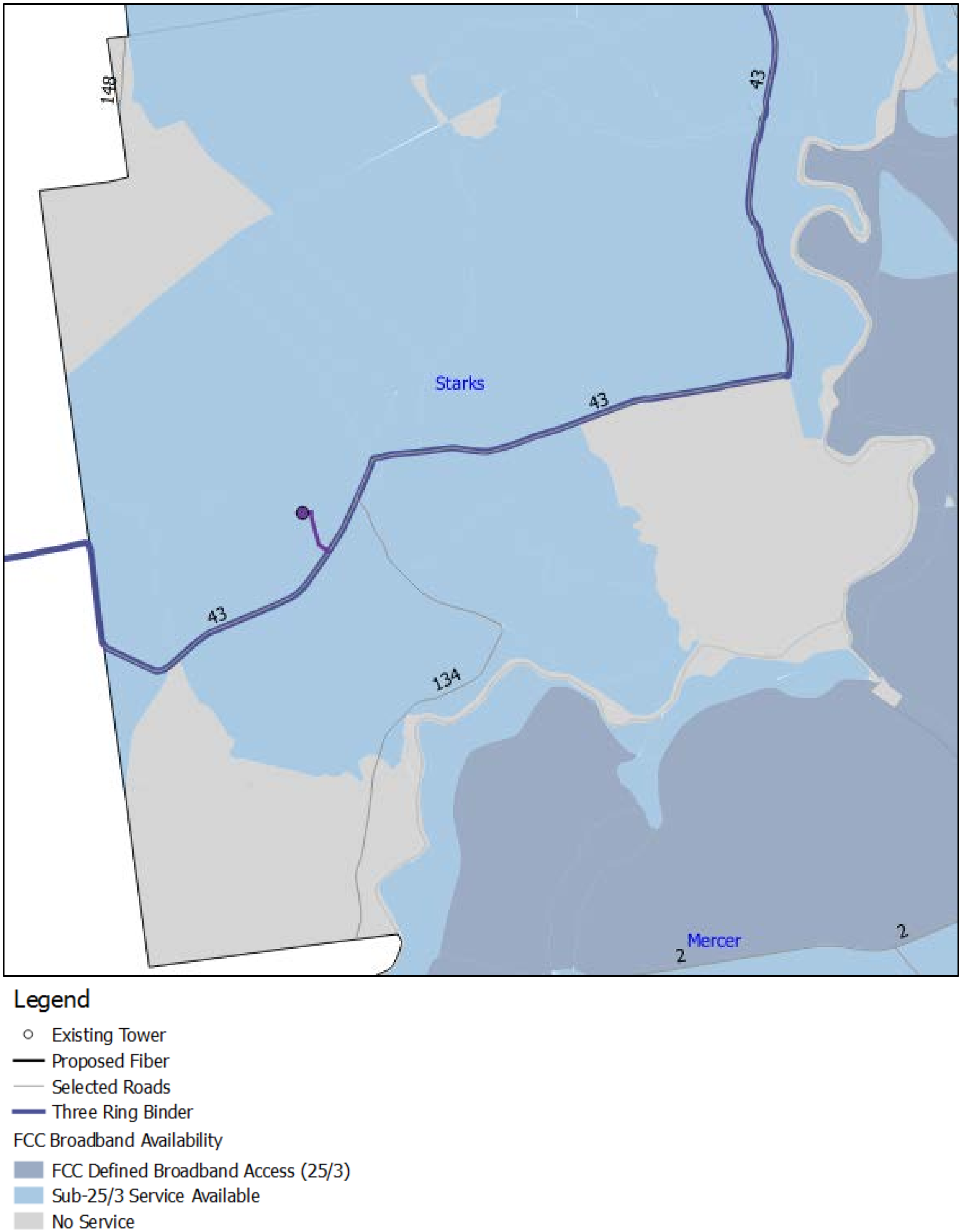


Figure 54 —Starks-1 Tower and Broadband Availability

Proposed budget for this fiber build is shown in Table 21.

Table 21 — Starks Budget

Item	Estimated Cost
Labor and Materials	$11,828
Make Ready	$600
Engineering & Project Management	$4,193
Contingency	$1,662
Total	**$18,283**

Route 201 Corridor

The design up Route 201 extends connectivity to The Forks. It depends on the Madison-Solon Connector being built to provide connectivity to Three Ring Binder. This design runs through one of the only populated corridors in northern Somerset County. As shown in Figure 55, this area is also bereft of broadband service at the FCC's 25/3 standard.

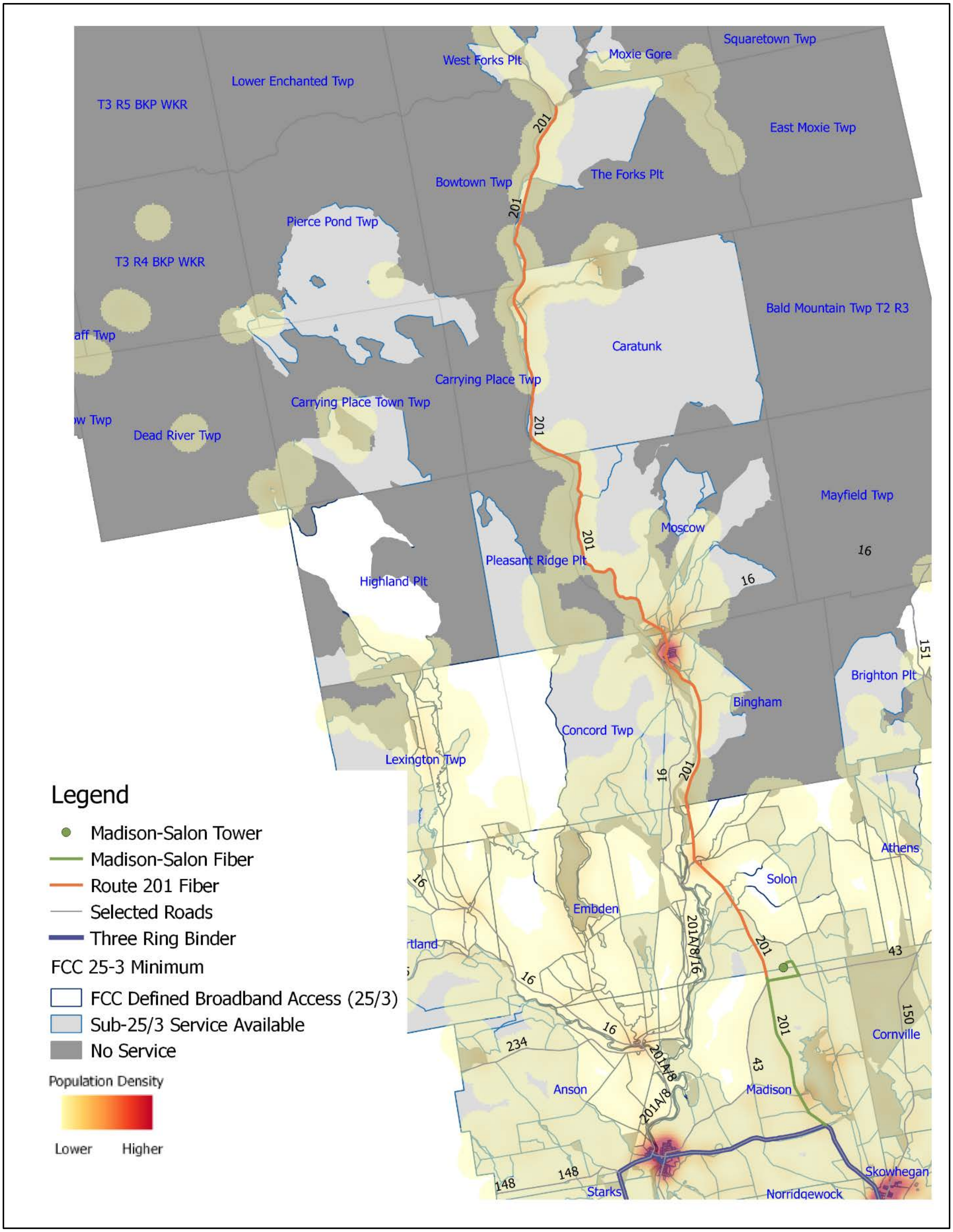


Figure 55 — Route 201 Fiber and Service Levels with Population Density

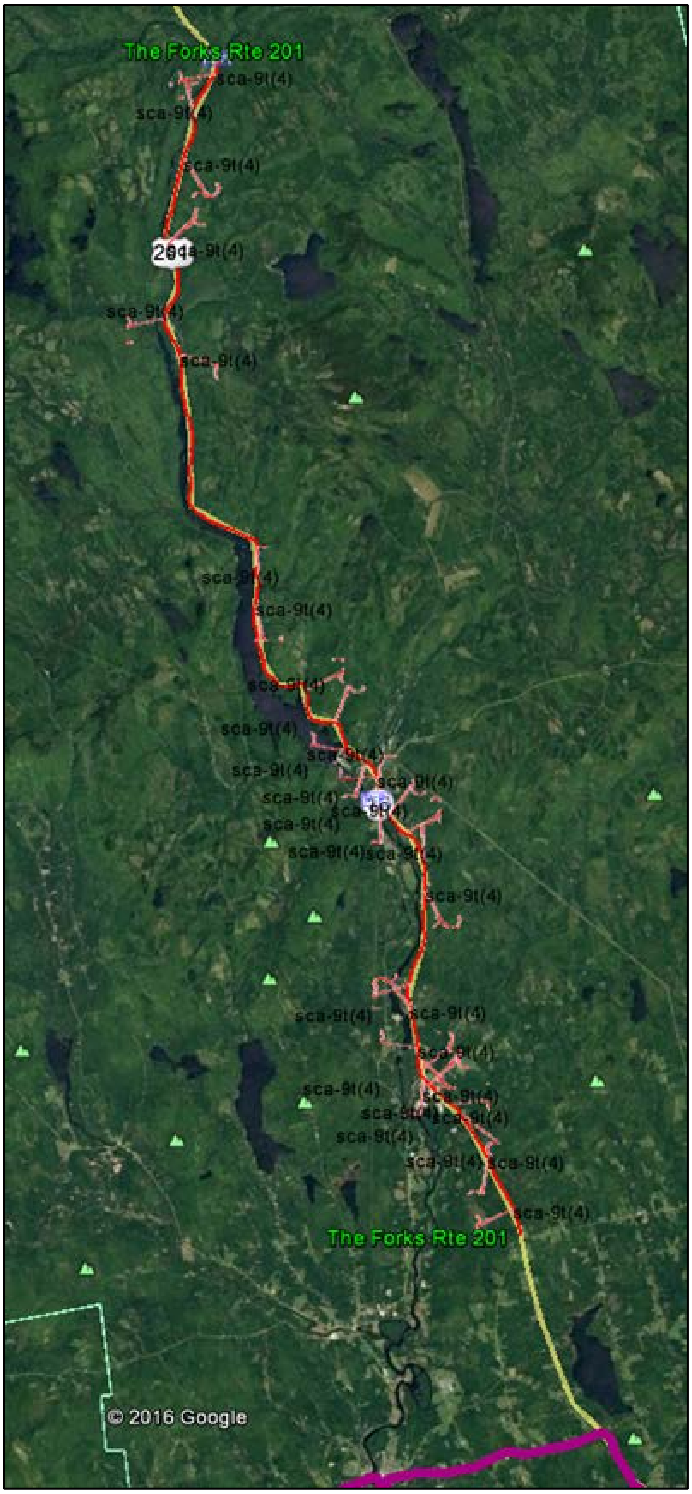


Figure 56 — Route 201 Corridor Fiber

The budget for this proposed design is in the below table.

Table 22 — Route 201 Corridor Budget

Item	Estimated Cost
Labor and Materials	$893,705
Make Ready	$556,500
Engineering & Project Management	$393,305
Contingency	$184,351
Total	**$2,027,861**

Operating and Financing Models

In general, discussion of the business model of a proposed fiber network should encompass two main concepts: the operating model and the financing model. The operating model describes how the network will be run: the disposition of revenues and expenses, who can or does provide services on the network, and the like. The financing model describes how the network construction will be paid for.

Operating Models

Before delving into specific operating models, we will discuss the concepts of dark vs lit networks, and open vs closed access.

Dark vs. Lit

A key distinction in fiber optic networks is that of dark versus lit. Dark networks refer to the infrastructure itself: fiber cables, splice cases, and the like. Lit networks refer to providing services on a dark network. Management of dark networks is relatively straightforward and largely consists of tracking who leases each fiber strand, while lit network management encompasses providing all services offered on the network. A network's operating model is determined by who provides dark and lit services.

Open vs. Closed Access Models

Operation of a network involves not only who owns and operates is, but how the network is operated and which service providers can use it. There are two main models for allowing service providers to access the network: open access and closed access.

Open Access Model

In an open access model, the network owner provides nondiscriminatory, transparent pricing for service providers to access the network, with a goal of market competition. In a pure open access model, the network owner does not compete with retail providers on the network for end user customers. However, some open access models can involve a network operator that offers both retail service and wholesale access to the network.

Open access networks fall into two major categories: dark networks and lit networks. Dark Fiber Open Access Networks sell or lease dark fiber capacity to service providers. In this model, service providers must provide the electronics to light the network and transmit data across the fiber. In Lit Fiber Open Access Networks, a network operator provides electronics to enable connectivity, and allows service providers to provide services using its electronics.

Closed Access Model

In a closed access model, the network owner chooses which service provider or providers to allow on the network. Often, the owner will choose an exclusive provider for the network, who may then market services under its own name. Closed access networks provide the greatest control for the network owner. Through offering exclusivity for a given customer class (e.g., businesses or residential customers), closed access network owners can often obtain higher service commitments or price breaks.

Conversely, a closed model provides less potential for different businesses to expand the number of market niches served by the network. For example, a company that orients itself to providing local residential broadband may or may not be the best company to sell services to large cellular companies or enterprise customers requiring specialized services and customer care. A company that tries to be all things to all users may not succeed in doing so, even with a network that is technologically advanced.

Operating Models and Responsibilities

Operating models can best be thought of as tradeoffs between risk, responsibility, and control. Each of these three parameters increases or decreases with the others. As the level of control increases, for example, so do risk and operating responsibility.

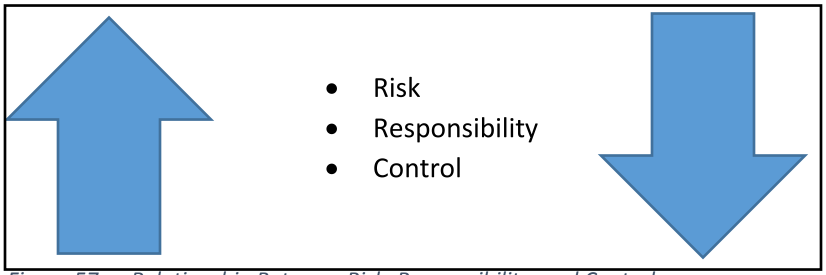


Figure 57 — Relationship Between Risk, Responsibility, and Control

These parameters are provided as a framework to structure thinking about network operations, but the boundaries between them are not sharp and absolute. For example, a governmental (or other) entity "operating its network" can itself include a range of possibilities depending on factors besides just whether the network is dark or lit. It can mean setting up internal operations (e.g. hiring employees, buying bucket trucks, operating customer service centers, etc.), or some or most operational functions can be provided by a contractor or contractors. Use of contracted services doesn't necessarily mean that the County does not operate its network in some sense. However, arrangements to use a primary contractor to provide a turnkey operational solution have many similarities to a public-private partnership where an Internet Service Provider operates and delivers its service over a publicly-owned network.

In thinking about the operating structures involving private partners, it is vital to bear in mind that the parameters of these agreements are open to substantial negotiation. There are myriad ways to structure these agreements. These can address, for example, responsibility for paying operating costs, revenue sharing, payment arrangements, service levels, speeds, network build-out, prices, or other factors that help Somerset County address its goals. For example, the County could make bulk purchases provide free or discounted service to low-income residents. It could also require the operator to offer low-income residents certain tiers and pricing of services, or to build a minimum standard of connectivity available to all premises in defined areas of the County. Another important consideration is payment structures. Somerset County could also agree with an owner or operator on how each entity gets paid, for example a set fee, minimum or maximum amount, percent of revenue, or no revenue sharing but using the County's negotiating leverage to achieve the best deal for residents.

Lastly, a question that arises might be why not just pay a third party to build, own, and operate a network for the County. This could certainly be a viable solution if the County did not want to set up the organization to manage the network. But the advantage to the County building and owning the network is that it gives Somerset County a platform on which additional services can be launched, just as Three Ring Binder did for the State of Maine. As an example, building fiber into underserved or unserved areas of Somerset County can provide a path to world-class broadband speeds for premises that can be directly connected to fiber (or for which other fiber networks can be built and connected to the County network). It can also be used for other purposes, such as to support better cellular service in Somerset County.

Recommendation

Tilson recommends that Somerset County further explore ways to build and own fiber, and lease capacity to internet providers on an open-access basis. Since Axiom has been an integral part of this process to date, it is reasonable that the County would expect to use Axiom to provide wireless services from the existing towers while Axiom or other ISP(s) could provide direct fiber to the premises for homes and businesses along the designed fiber routes, or even build out their own networks and connect those to the designed fiber routes.

Operating Costs

Partnering with a private firm or firms to be the network operator typically involves shifting all or some of the operating costs on to the private partner (along with some corresponding amount of the revenue derived from the operations). The amount of cost sharing would be determined in negotiations. Figures for operating costs, and ways to reduce them in certain scenarios, are discussed in the Financial Modeling section starting on page 96.

Risks

Once the contract is in place between the County and the network operator(s), the operator accepts most of the risk in running the business in exchange for increased control. The county can mitigate their risk of a partner’s non-performance by structuring the contract so that frequent renegotiations take place. It can also make payment under the contract partly contingent on the network operator’s successes or failures as measured by established metrics.

Control

Risk and control are highly correlated in this type of partnership. A network owner who relinquishes control and transfers risk generally stands to benefit from the network operator’s business acumen. Network provisioning, maintenance, customer support, and billing are key activities that a government entity typically does not have experience in, while relinquishing control to the private entity allows for the opportunity to earn and sustain revenues.

Funding and Financing Models

There are several options for funding and financing the business model of a public broadband network. Common funding sources include:

- **User Fees**. Revenue is generated by charging the user for service, typically on a voluntary subscription basis.
- **Re-purposed County Telecom Expenditures**. The county redirects funds that would have been incurred for leased circuits to government facilities and instead spends them on the amortized cost of building the network. This funding model is generally most useful in the early stages of developing a network, but would be insufficient for the full expenditure.
- **Special or Enterprise Funds**. The excess funds from some source other than general tax revenue, such as revenue generated by an existing electric utility, or franchise fees.
- **Grants**. Government entities are in some cases able to fund a portion of network development through state or federal grant funding. However, grant funding specifically for general broadband

infrastructure development is often not available for areas that do not have large gaps in broadband service availability compared to state or national norms. Somerset will likely use a ConnectME Infrastructure grant for a significant portion of any network buildout.

- **Taxes.** Government entities may use general tax revenue from residents and businesses to help build and/or operate a network. This can be a controversial revenue source, especially in some jurisdictions that have existing networks and competitors offering broadband service.
  There are a number of publicly owned networks whose construction was funded by revenue-backed bonds. Networks built by revenue bonds are susceptible to financial pressure if the networks fail to gain enough subscribers. Failure to make debt payments resulting from undersubscription is a leading cause of failure among publicly owned networks.
- **Anchor Contract.** In this model, the governmental entity selects a partner to provide a turnkey solution. The governmental entity's only responsibility is to write a check for a contractually defined period of time. The partner develops, constructs, and owns the network. The partner may also operate the network or, more likely, subcontract out the operations and provision of lit services. In return for its payments, Somerset County would receive a defined broadband service. The partner would earn extra revenue from the lease of dark strands on the network. Network owners operating under this model are exposed to very little operation or execution risk (aside from counterparty risk) but also surrender the bulk of their control to the partner except as allowed for in the negotiated contract.

Since broadband networks are capital-intensive, it is common to pay for their costs over time. Again, there are a variety of options. Common strategies include:

- **General Obligation Borrowing**. The county borrows against general tax revenue.
- **Revenue Borrowing**. The county borrows against future revenues of the network, such as those generated by user fees. Although this has the advantage of not impacting tax revenues directly, it is important to think through the degree to which revenues are assured. If revenues from voluntary sources such as user fees do not materialize at forecasted levels, there can be a mismatch between funding and financing models
- **Pay As You Go.** The county makes incremental payments out of current revenues or cost savings realized by offsetting existing telecom spending. This approach is best suited for a targeted or incremental approach to building out a network.

Partnering with one or more private parties can be part of the capital cost strategy with larger networks, such as if Somerset County were to coordinate with neighboring counties on a cross-county northern Maine fiber network extension of Three Ring Binder. For example, infrastructure funds, like Macquarie Capital, invest in networks and can act as both developer and financier. Macquarie developed a 3,200-mile fiber network in Kentucky to connect schools and government buildings, and raised its own debt to finance the network. In return, the state makes availability payments to Macquarie over a 30-year period. The network is operated by Fujitsu. Typically, funds like this seek underserved areas and larger projects of at least $50 million.

Financial Modeling

Tilson used the high-level costs and standard assumptions for operating expenses to develop a basic business case model for the proposed fiber builds. For simplicity's sake, we split the 18 proposed fiber builds into three categories, and analyzed each category as a whole:

1. Tower builds, which consist of fiber builds meant to serve an existing cellular tower. These are Hartland-1, Hinckley Lateral, Madison-Solon, Norridgewock-2, Palmyra-1, Palmyra-2, Palmyra-3, Palmyra-4, Pittsfield-1, Pittsfield-2, Skowhegan-5, and Starks-1.
2. User builds, which have no tower directly associated with them and are mainly designed to serve businesses along the route. These are Norridgewock-1, Norridgewock-3, Palmyra Redundant, Skowhegan-2, and Skowhegan-3.
3. Route 201, which consists of the dark fiber build proposed from the northern terminus of the Madison-Solon design, up Route 201 to The Forks.

In analyzing each category, we assumed that all builds the category consists of would be constructed. Next, we proceeded under the assumption that fibers would be licensed per strand mile, rather than per premise. Strand-mile licensing consists of charging a set lease fee per strand-mile. One strand-mile is a mile length of a single fiber strand; thus, someone wishing to lease a mile length of four strands would pay four times the per-strand-mile rate. We selected this method, rather than charging based on the number of connections a lessee wished to make, because the high-level network design is strictly for fiber and the ability to connect to that fiber. It does not include any aggregating equipment for the simple reason that standard practice is for the lit services provider to provide its own such equipment. This is how most dark fiber networks operate, including Maine Fiber Company and its Three Ring Binder network.

We then took the categories and key assumptions, outlined below, and ran them through our proprietary network financial model. The model can analyze a variety of network cost and revenue factors for both lit and dark networks. Model outputs start on page 98.

Key Assumptions

We made standardized assumptions for capital and operating expenses based on our knowledge of network construction and operation.

Capital Expense Assumptions

- Engineering. Prior to construction, SEDC and KVCOG will need to conduct detailed engineering of the proposed build. Tilson estimates this cost at $10,877 per route mile of network.

Project Type	Estimated Detailed Design and Engineering Cost
Tower Builds	$402,877
User Builds	$216,448
Route 201	$393,305

- Drop Cost. Each premise, equipment cabinet, or tower to be connected will need to have a drop cable connected from the main network to it. To facilitate this, Tilson has included slack loops and pre-terminated connection points throughout the designed fiber routes. Nevertheless, we have assumed that each connection to the network will incur a $750 one-time capital expense.

- Make Ready. We have included an estimate for make ready costs for each build. These are reflected in the individual project budgets in the Cost Estimates and Designs section. While these figures are as accurate as can be based on a desktop study, a full ride-out and survey would be required to determine actual costs in conjunction with negotiations with pole owners.

Operating Expense Assumptions

Dark fiber management is comparatively much simpler than managing lit services, but it still requires a nontrivial effort to ensure a smoothly functioning network. The main categories of cost for managing a dark fiber network are:

- General Overhead. This includes billing, lease management, interconnection requests management, legal, and general management. We estimate that building out all three parts of the proposed network will incur a cost of approximately $80,000 per year in general overhead. Of that $80,000 we allocate a general fixed overhead of $20,000, and the remainder per project in accordance with its number of likely customers. We have included a 3% annual escalator, as well. In estimating these costs, we assumed a model in which there were multiple dark fiber lessees and an active effort to obtain new users and respond to requests to interconnect and extend the network. We will also discuss below a strategy for getting started in which there is only a single or very small number of "anchor" users, and how that might limit these costs.

Network Portion	First Year Management & Overhead	Route Miles	Average Strand Count
Fixed Cost	$20,000	N/A	N/A
Tower Builds	$20,000	37.0	100
User Builds	$30,000	19.9	112
Route 201	$10,000	36.2	144

- Maintenance and Repair. Maintenance and repair work will largely consist of tree trimming and repairing broken fiber cables. For this, we assume an annual cost of approximately 2% of capital expense, with a 3% annual escalator.
- Pole Licensing. The network owner will be required to pay rental fees to pole owners for poles that carry the fiber cables. Called pole licenses, these fees are typically in the $15-25 per pole per year range in Maine. We have assumed a value of $20.
- Marketing. We assume $10,000 per year in ISP outreach and marketing, with a 1% escalator. As mentioned in the discussion of "General Overhead," we assume here an active effort to reach out and acquire new users. A more passive strategy, which relies on one or a small number of anchor users to cover costs is also possible, but may lead to lower levels of utilization of the asset over time.

As a general matter, both "General Overhead" and "Marketing" costs would benefit from economies of scale. While the Somerset County network analyzed here has better economies of scale collectively than any of the network portions individually, or than individual towns or segments, it is still a relatively small network. Collaboration with other similarly situated towns, counties, or regions to share management and marketing costs would provide an opportunity to improve the economics. The more networks and customers that can be brought under common management, the smaller the per-customer costs.

Revenue Drivers

The key revenue drivers for the project (or any dark fiber network) are the number of strand-miles leased and the monthly price per strand-mile. For context, Three Ring Binder charges between $16 and $30 per strand-mile per month, depending on the specific route leased. In modeling the proposed network builds, we assumed 15% of strand-miles leased in the first year with no escalator. This is a very conservative approach, since any new leases year-over-year will by definition improve the modeled results. In addition, we model a $500 one-time connection fee. To simplify the assumptions, we assume that the percent of strand-miles licensed is directly proportional to the number of connections – that is, if 15% of strand-miles are leased, then that means 15% of the identified premises passed on the route are also connected.

Model Outputs

We first examined each build option independently to determine how lease rates and number of strand-miles leased influence revenue. In all cases, we look for the combination that covers operating expenses. For each below option, we'll show a breakdown of annual operating costs for the first five years. There will also be a brief discussion of a simplified scenario where there is only one tenant on the network, and how that impacts the operating expenses. In general, whatever the scenario the network owner (most likely the County or SEDC) would need to find an anchor tenant who is willing to cover the anticipated operating costs. Therefore, it is vital that the anchor tenant be a company stable enough to commit to this. If Somerset County is unable to find such an anchor tenant for a given build option, it should think carefully about whether it wants to take on the cost of running the network itself before committing to a build.

It is also important to stress that the figures discussed in this section assume that capital costs have been funded independently of operating revenue.

Tower Builds

A sensitivity analysis of strand-mile lease percentages and average price per strand mile shows the following earnings before interest, taxes, depreciation, and amortization (EBITDA) in the second year (when the nonrecurring revenue from new connections abates):

Table 23 — Tower Builds, Second Year EBITDA Under Different Lease Scenarios

		Monthly Price per Strand Mile				
		$ 10.00	**$ 20.00**	**$ 30.00**	**$ 40.00**	**$ 50.00**
Percent of Strand-Miles Leased	**15%**	($105,446)	($99,890)	($94,334)	($88,778)	($83,222)
	25%	($101,742)	($92,482)	($83,222)	($73,962)	($64,702)
	35%	($98,038)	($85,074)	($72,110)	($59,146)	($46,182)
	45%	($94,334)	($77,666)	($60,998)	($44,330)	($27,662)
	55%	($90,630)	($70,258)	($49,886)	($29,514)	($9,142)
	65%	($86,926)	($62,850)	($38,774)	($14,698)	$9,378
	75%	($83,222)	($55,442)	($27,662)	$118	$27,898
	85%	($79,518)	($48,034)	($16,550)	$14,934	$46,418
	95%	($75,814)	($40,626)	($5,438)	$29,750	$64,938

As can be seen, it's likely that building only the tower option under a standard price-per-strand mile model will require an operating subsidy under most combinations of price and percentage of strand miles leased. We have included prices higher than Maine Fiber Company's for illustrative purposes, but it's unlikely that the general market for dark fiber will support a higher cost per strand mile than MFC charges.

If the network owner is unable or unwilling to subsidize operating expenses, then it would not be advisable to proceed without a committed long-term anchor user or users who are willing pay in excess of the standard per-strand-mile rate in order to make possible the operations (and possibly construction) of the segments that they would use. Another way to look at the above table is that it shows, for a given price per strand mile and percent of strand-miles leased, the amount of subsidy the County could ask its anchor tenant(s) to contribute to the network operating costs. Remember that the above includes the fiber built to 12 towers. If a wireless ISP user, for example, can get revenue from enough customers off those 12 towers, it could be worthwhile for them to pay the extra. This extra amount could be reduced as more tenants lease space on the network, and the anchor tenant could be asked to pay a proportionally smaller share than it might otherwise as a sweetener to encourage an anchor tenant signing up first.

Under the preceding assumptions, the below table shows projected cash flows for the network for each of the first five years with 15% of strand-miles leased at $20 per strand-mile. The bump in revenue in the first year is from the nonrecurring connection fee included in the model and discussed above. These figures do not include capital cost recovery.

Table 24 — Tower Builds Projected Cash Flow, First Five Years

	1	2	3	4	5
Recurring Revenue	$11,112	$11,112	$11,112	$11,112	$11,112
NonRecurring Revenue	$12,375	-	-	-	-
Operating Expenses	$109,702	$111,002	$112,339	$113,714	$115,129
EBITDA	**($86,215)**	**($99,890)**	**($101,227)**	**($102,602)**	**($104,017)**

The below operating expenses assume that the network owner will need to manage a network with multiple tenants on it. In the most conservative case, it is reasonable to assume that the tower build option will only have one fiber lessor: the wireless ISP. So, we can remove some operating expenses from the total due to the simplified arrangement. In particular, it's reasonable to remove the Marketing expense entirely and reduce the Management & Overhead category to $10,000. This brings annual operating expenses to approximately $70,000. With twelve towers contemplated, this works out to the network operator chipping in approximately $500 per month per tower to cover the fiber network's operating costs. While not a small amount, if there are enough customers being served from the tower there could be a business case for it. Of course, if only a subset of the tower builds is completed, the operating expenses would scale accordingly to a certain extent.

Table 25 — First Five Years Estimated Operating Expenses, Tower Build

	1	2	3	4	5
Dark or Underlying Network Opex Costs	**$101,530**	**$102,530**	**$103,558**	**$104,615**	**$105,701**
Management and Overhead	$30,000	$30,900	$31,827	$32,782	$33,765
Maintenance and Repair	$40,557	$40,557	$40,557	$40,557	$40,557
Pole Attachment Costs	$20,973	$20,973	$20,973	$20,973	$20,973
Marketing	$10,000	$10,100	$10,201	$10,303	$10,406

User Builds

As with the tower builds, it's probable that building only the user option will require an operating subsidy. We have included prices higher than Maine Fiber Company's for illustrative purposes, but it's unlikely that a dark fiber tenant would be able to make a business case for paying more per strand mile than MFC charges.

Table 26 — User Builds, Second Year EBITDA Under Different Lease Scenarios

		Monthly Price per Strand Mile				
		$ 10.00	**$ 20.00**	**$ 30.00**	**$ 40.00**	**$ 50.00**
Percent of Strand-Miles Leased	**15%**	($91,763)	($88,420)	($85,077)	($81,733)	($78,390)
	25%	($89,534)	($83,962)	($78,390)	($72,818)	($67,246)
	35%	($87,305)	($79,505)	($71,704)	($63,903)	($56,102)
	45%	($85,077)	($75,047)	($65,017)	($54,988)	($44,958)
	55%	($82,848)	($70,589)	($58,331)	($46,073)	($33,814)
	65%	($80,619)	($66,132)	($51,645)	($37,157)	($22,670)
	75%	($78,390)	($61,674)	($44,958)	($28,242)	($11,526)
	85%	($76,161)	($57,217)	($38,272)	($19,327)	($382)
	95%	($73,933)	($52,759)	($31,585)	($10,412)	$10,762

As in the case of the tower builds, another way to look at the above table is that it shows, for a given price per strand mile and percent of strand-miles leased, the amount of subsidy the County could ask an anchor tenant to contribute to the network operating costs. This extra amount could be reduced as more tenants lease space on the network, and the anchor tenant could be asked to pay a proportionally smaller share than it might otherwise as a sweetener to encourage an anchor tenant signing up.

Under the preceding assumptions, the below table shows projected cash flows for the network for each of the first five years with 15% of strand-miles leased at $20 per strand-mile. These figures do not include capital cost recovery.

Table 27 — User Builds Projected Cash Flow, First Five Years

	1	**2**	**3**	**4**	**5**
Recurring Revenue	$6,686	$6,686	$6,686	$6,686	$6,686
Nonrecurring Revenue	$6,375	-	-	-	-
Operating Expenses	$93,506	$95,106	$96,752	$98,446	$100,188
EBITDA	**($80,445)**	**($88,420)**	**($90,066)**	**($91,759)**	**($93,501)**

The User build option includes $50,000 per year budgeted for management and overhead. This increase relative to the corresponding line item from the Tower build option is due to the fact that the User build option will likely be more complex since it would connect at least one ISP and possibly some larger end users. If the User build had only a very small number of lessees leasing fiber, then it would be reasonable to reduce the management and overhead plus marketing annual expense by $50,000, to $10,000. With the resultant simplified total operating cost of approximately $43,506 in the first year, the network owner would be more likely to find an anchor tenant willing to cover the network's operating costs.

Table 28 — First Five Years Estimated Operating Expenses, User Build

	1	2	3	4	5
Dark or Underlying Network Opex Costs	**$93,506**	**$95,106**	**$96,752**	**$98,446**	**$100,188**
Management and Overhead	$50,000	$51,500	$53,045	$54,636	$56,275
Maintenance and Repair	$21,964	$21,964	$21,964	$21,964	$21,964
Pole Attachment Costs	$11,542	$11,542	$11,542	$11,542	$11,542
Marketing	$10,000	$10,100	$10,201	$10,303	$10,406

Route 201

Modeling the operating budget of the Route 201 build up to The Forks yields the results in the below tables. A dark fiber network running up Route 201 will most likely require an operating subsidy in the tens of thousands of dollars annually.

Table 29 — Route 201, Second Year EBITDA Under Different Lease Scenarios

		Monthly Price per Strand Mile				
		$ 10.00	**$ 20.00**	**$ 30.00**	**$ 40.00**	**$ 50.00**
Percent of Strand-Miles Leased	**15%**	($94,719)	($86,909)	($79,098)	($71,288)	($63,477)
	25%	($89,512)	($76,495)	($63,477)	($50,460)	($37,442)
	35%	($84,305)	($66,081)	($47,856)	($29,631)	($11,407)
	45%	($79,098)	($55,667)	($32,235)	($8,803)	$14,628
	55%	($82,848)	($70,589)	($58,331)	($46,073)	($33,814)
	65%	($80,619)	($66,132)	($51,645)	($37,157)	($22,670)
	75%	($78,390)	($61,674)	($44,958)	($28,242)	($11,526)
	85%	($76,161)	($57,217)	($38,272)	($19,327)	($382)
	95%	($73,933)	($52,759)	($31,585)	($10,412)	$10,762

The below table shows revenues and operating expenses with 15% of strand-miles leased at $20 per strand-mile. These figures do not include capital cost recovery.

Table 30 — Route 201 Build, First Five Years Projected Cash Flows

	1	2	3	4	5
Recurring Revenue	$15,621	$15,621	$15,621	$15,621	$15,621
Nonrecurring Revenue	$7,200	-	-	-	-
Operating Expenses	$101,530	$102,530	$103,558	$104,615	$105,701
EBITDA	**($78,709)**	**($86,909)**	**($87,937)**	**($88,994)**	**($90,080)**

Following are estimated operating costs for the network build. As with other builds, a scenario with only one tenant on the network would result in a significantly reduced need for the Management & Overhead and Marketing budgets. An alternative way to structure it considering the 1,094 addresses within one mile of the proposed build is that one third of the premises, or 365 premises, take service on the network, each premise's share of the operating costs would be $23 per month.

Table 31 — First Five Years Estimated Operating Expenses, Route 201 Build

	1	2	3	4	5
Dark or Underlying Network Opex Costs	**$101,530**	**$102,530**	**$103,558**	**$104,615**	**$105,701**
Management and Overhead	$30,000	$30,900	$31,827	$32,782	$33,765
Maintenance and Repair	$40,557	$40,557	$40,557	$40,557	$40,557
Pole Attachment Costs	$20,973	$20,973	$20,973	$20,973	$20,973
Marketing	$10,000	$10,100	$10,201	$10,303	$10,406

All Builds

Finally, we modeled the financial performance of all three options – towers, users, and Route 201 – as if they were all built and managed collectively.

Table 32 — All Builds, Second Year EBITDA Under Different Lease Scenarios

		Monthly Price per Strand Mile				
		$ 10.00	**$ 20.00**	**$ 30.00**	**$ 40.00**	**$ 50.00**
Percent of Strand-Miles Leased	**15%**	($230,620)	($214,002)	($197,383)	($180,765)	($164,147)
	25%	($219,541)	($191,844)	($164,147)	($136,450)	($108,752)
	35%	($208,462)	($169,686)	($130,910)	($92,134)	($53,358)
	45%	($197,383)	($147,528)	($97,673)	($47,818)	$2,037
	55%	($186,305)	($125,371)	($64,437)	($3,503)	$57,431
	65%	($175,226)	($103,213)	($31,200)	$40,813	$112,826
	75%	($164,147)	($81,055)	$2,037	$85,128	$168,220
	85%	($153,068)	($58,897)	$35,273	$129,444	$223,615
	95%	($141,989)	($36,739)	$68,510	$173,760	$279,009

As can be seen, this option is unlikely to be self-sustaining and will require significant subsidies at virtually any level of subscriptions. This is due to the higher fixed costs incurred with running three networks, as well as the generally low number of potential subscribers to connect. As mentioned above, it may be a worthwhile option to ask the "anchor tenant" on the network to pay at least a portion of the subsidy with the understanding that, as additional organizations lease network resources the costs will be spread among them as well. The below table shows revenues and operating expenses with 15% of strand-miles leased at $20 per strand-mile. These figures do not include capital cost recovery.

Table 33 — All Builds, First Five Years Projected Cash Flows

	1	2	3	4	5
Revenue	$59,187	$33,237	$33,237	$33,237	$33,237
Operating Expenses	$244,739	$247,239	$249,812	$252,460	$255,185
EBITDA	**($185,552)**	**($214,002)**	**($216,575)**	**($219,223)**	**($221,949)**

Finally, the below table shows the breakdown full anticipated operating costs for all three builds together with multiple ISPs or other tenants on the networks.

Table 34 — First Five Years Estimated Operating Expenses, All Builds

	1	2	3	4	5
Dark or Underlying Network Opex Costs	**$244,739**	**$247,239**	**$249,812**	**$252,460**	**$255,185**
Management and Overhead	$80,000	$82,400	$84,872	$87,418	$90,041
Maintenance and Repair	$100,741	$100,741	$100,741	$100,741	$100,741
Pole Attachment Costs	$53,998	$53,998	$53,998	$53,998	$53,998
Marketing	$10,000	$10,100	$10,201	$10,303	$10,406

Capital Costs

Total capital costs for the three build options are shown in the below table. This includes Tilson's estimate for detailed engineering and project management work, as well as a 10% contingency. The calculated price per mile of $50,000-55,000 reflects the contingency; typical per-mile pricing in rural Maine is in the $40,000-50,000 range including make-ready and capital cost.

Table 35 — Project Capital Costs

	All	Towers	End Users	Route 201
Miles	93.10	37.04	19.90	36.16
% underground	6.07%	5.00%	10.00%	5.00%
Maximum Passes	346	165	85	96
Fiber Network	$ 3,566,485	$1,334,355	$ 781,925	$1,450,205
Pole Applications and Make-Ready	*$1,219,900*	*$377,800*	*$285,600*	*$556,500*
Materials and Labor	*$2,346,585*	*$956,555*	*$496,325*	*$893,705*
Engineering and Project Management	$1,012,630	$ 402,877	$ 216,448	$ 393,305
Contingency	$457,912	$ 173,723	$ 99,837	$ 184,351
Total	**$ 5,037,027**	**$1,910,955**	**$1,098,211**	**$2,027,861**
$/Mile	*$54,103*	*$ 51,592*	*$ 55,186*	*$ 56,080*

Summary and Next Steps

The solutions outlined in this document can advance Somerset County's broadband goals, but they are not the entire picture. Each of the fiber builds outlined in this report essentially proposes extending the Three Ring Binder platform further into the County. This can be to enable provision of access to the fiber, wireless internet access, or future extensions of the fiber to reach more users but, no matter which options are built, will place "deep fiber"—a blend of middle mile and last mile fiber--closer to end users. This will make it more cost effective for communities to attract private investment or develop their own last-mile solutions. Having Axiom as a partner presents a convenient way to provide wireless services to relatively large areas. Significant work remains to be done, however, to make these projects a reality. Next steps for a given project would include:

- Validating and refining capital costs by choosing specific network build options, doing detailed engineering, and procuring a construction vendor. In a segmented project like this, which might get built in pieces over time, one option would be to bid for an initial project, but at the same time ask for unit cost pricing for engineering and construction that could be used to quickly extend the model as funding becomes available.
- Seeking funding sources. One possible solution is the federal Northern Border Regional Commission's (NBRC) development and infrastructure grants. Somerset County has been identified as an eligible county. The NBRC provides for a maximum grant of $500,000 for infrastructure projects.
- Identifying anchor tenants for proposed network builds. This could be Axiom or another company. Prospective anchor ISPs would be required to use network segments to expand service to retail users as the network is built.
- Arriving at a framework that communities can use to "buy in" to the program. This would provide them a one-stop-shop that can provide turnkey solutions once they have secured funding. This framework would be administered by a single fiber services organization organized through KVCOG or SEDC, who would be able to coordinate engineering work, permitting, project management, and dark fiber network management. Part of this framework should be the selection of a designated engineering firm to provide engineering, design, and construction management services.
- Creating outreach materials to local communities explaining how they can participate, thus extending Three Ring Binder's platform into or closer to them. Materials would show how participation would lead to improved broadband service and the benefits it brings.