City of Belfast
Community Technology Plan

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Background & Structure

The Belfast City Council, some time ago, formed a Broadband Committee that was charged with assessing the current status of internet connectivity in the City. Along the way, a ConnectME Authority grant was received for Community Broadband planning and Axiom was hired as a consultant to help guide and synthesize the Broadband Committee's recommendations.

Axiom goals for the City included:

- A strong articulation of goals from the Broadband Committee
- An understanding of the current coverage areas, and areas of need
- Technology recommendations and cost analysis

The report that Axiom has produced follows a Broadband Deployment Kit methodology that we use to help communities not only plan but proceed to implementation and beyond. This planning document takes the community through Steps 1-3 and makes recommendations on how to implement the planning (Step 4 Implementation).

Executive Summary

Several years ago, the City of Belfast authorized a citizen-led broadband working committee to investigate and report out on the feasibility of obtaining better broadband solutions for the City. To date, the committee has spoken to all of the current providers of internet service in Belfast has authored and distributed a broadband survey to both the business community and the homeowners in the community, has begun to investigate ownership options for a new system and has delivered, and received approval for, a committee report to the City Council that ratified the following five goals:

- **Ensure uniform service for all**

  The same service level options should be available at every location, and not dictated by the distance from the technology hub, or by being shared by many users and reducing the actual bandwidth delivered. This provides maximum flexibility and choice for each residence and business.

- **Ensure affordable service to all**

  The City should ensure a range of internet services are available at a range of costs. This should include low-cost options, such as life-line, and other options that would give eligible citizens an opportunity to obtain a broadband connection. A separate report on Digital Inclusion is included as an Appendix of this report.

- **Ensure speed and reliability to match customer needs**

  The minimum level of acceptable service has been increasing. Demand for better broadband will continue to increase. The City should ensure that infrastructure that is built matches the increasing needs of the future.

- **Ensure Broadband providers are accountable to the City for quality and cost of service**

  Consumers should not be left powerless in dealing with Internet Service Providers (ISPs) over service issues. The City should stay engaged to add its clout to ongoing issues that arise.

- **Ensure long term availability**

  Organizational structures are needed that will endure far beyond the limited life of private enterprises. Companies come and go. Broadband access is so important that the City should take steps to ensure the organizations that provide internet service are not subject to the whims of shareholders. "Promoting the public good" should be the prevailing ethic.

  In addition, any new investment in internet infrastructure should last not less than 30 years, ensuring that investments made are long term and hold their value.

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Current Broadband Connectivity

Through a survey that received 496 responses from residents and 108 responses from businesses, it was clear that the internet is a critical and important component of people's lives. All of the uses of the internet contribute to the quality of life in the Belfast community and it's important to understand what people and businesses currently can receive for service and what future demand might look like. The surveys highlighted several important points:

- Broadband service is less uniform and less available across the City than is commonly thought.
- Where there is service, the most common ISP is Spectrum, the cable TV provider.
- There is significant support from citizens for improving broadband service in Belfast.
- Symmetrical Service - the same upload and download speeds - is difficult or impossible to achieve with the majority of current technology being used in Belfast.
- The infrastructure of the current technologies is aging, and becoming more expensive and difficult to update.

Connectivity Plan

Axiom looked at a number of solutions and believes strongly that fiber optics is the only technology that will meet the goals of the Broadband Committee and the City. Fiber optics offers three important attributes:

- **Futureproof -** The system will be in place for decades, likely 40 years or more.
- **Growth -** The system we are recommending will accommodate years of future demand for increased speed, without costly additional investments.
- **Reliability -** Fiber is the most reliable technology to deliver consistent speeds even at peak usage times.

Currently the community is served by a number of providers, many of whom serve downtown businesses inside the bypass on a case-by-case basis with a variety of technology solutions including fiber connections. There is also a wireless service provider that has a limited customer base. The vast majority of residential connections in the community are with Spectrum or Consolidated Communications, the vendors with the largest operational footprint in Belfast.

Fiber recommendation

Axiom has developed a Fiber to the Premise (FTTP) plan that includes connecting every home and business in Belfast to a fiber connection that would deliver world-class speed and reliability across the city, make Belfast a Gigabit City, and create the conditions for citizens and businesses to prepare for an increasingly digital economy. In Maine, only the islands of Islesboro and the Town of Cranberry Isles, parts of Sanford, a very small area of Rockport, and several other communities in the planning phase of such a deployment would have this level of robust connectivity.

Initial high-level estimates project the cost of such a plan as between $5.5M and $6.1M. This estimate relies on a number of assumptions which are explained in the section of the report labeled "*Community Network Plan"* located on page 18.

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Other Options

One of the reasons the Broadband Committee has worked so diligently was to better understand current provider thinking about expansion or enhancements to their current infrastructure, especially the two largest providers of internet service in Belfast. Spectrum and Consolidated Communications were not interested in enhancing or expanding service to parts of the community that were not as well served without some level of public subsidy to help them make a return on their investment. City officials and the committee have concerns about investing public dollars into a private company. Just as important, because the current copper-based technologies of both companies are limiting, the Committee has not been in favor of expanding their service with taxpayer money as they would be investing in technology that will not meet the needs of consumers in the future.

In the discussions with providers who currently serve Belfast, there has always been a desire on the providers' part, *if a business case could be made*, to bring service to areas beyond their current operational footprint. The Committee is not particularly optimistic or enthusiastic that additional conversations with Spectrum, the provider with the largest coverage area in the community would make them suddenly become interested in expanding service. However, as part of its due diligence, the Broadband Committee will re-engage Spectrum to ensure that they are given the opportunity to help expand service to unserved and underserved areas of the City.

Current connectivity speeds, reliability, cost, customer service levels, and response times are all controlled by the private providers of service. This model (engaging private providers) might be a way to expand service, but it does not meet the goals of the Broadband Committee.

Survey Results

Community/Residential Survey

On the following page is a visual representation of where those who answered the survey are located and who provides their internet service. While a good number of providers are present in the community, most only serve a small fraction. The majority of residential internet uses in Belfast have either Spectrum or, to a lesser extent, Consolidated Communications.
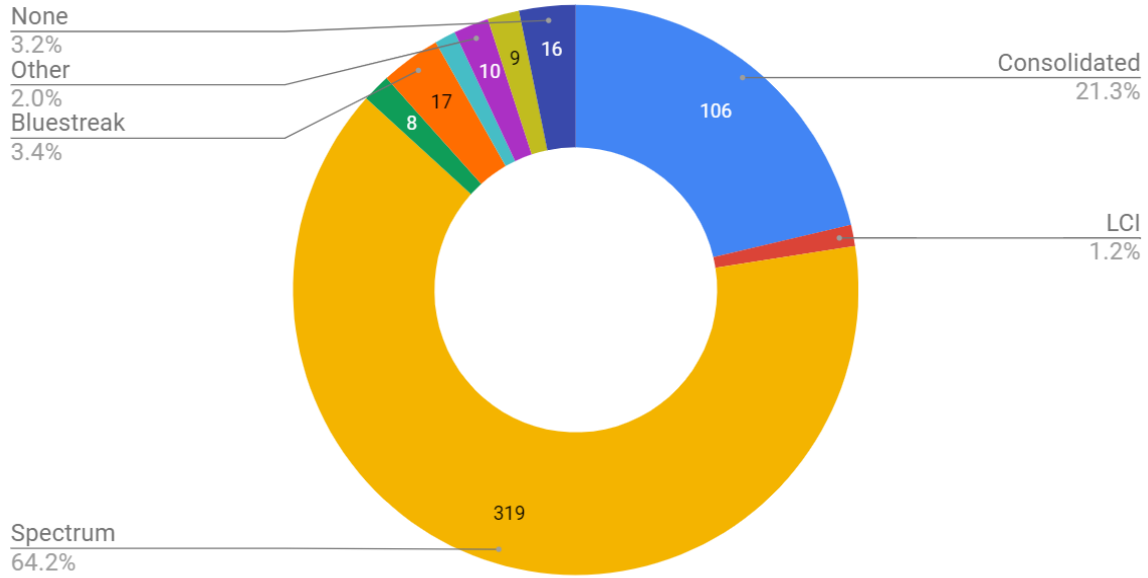
Color key to ISPs:

- CommunitySurvey - Spectrum
- CommunitySurvey - Other
- CommunitySurvey - LCI
- CommunitySurvey - Hughesnet
- CommunitySurvey - GWI
- CommunitySurvey - Consolidated
- CommunitySurvey - Cellular
- CommunitySurvey - Bluestreak

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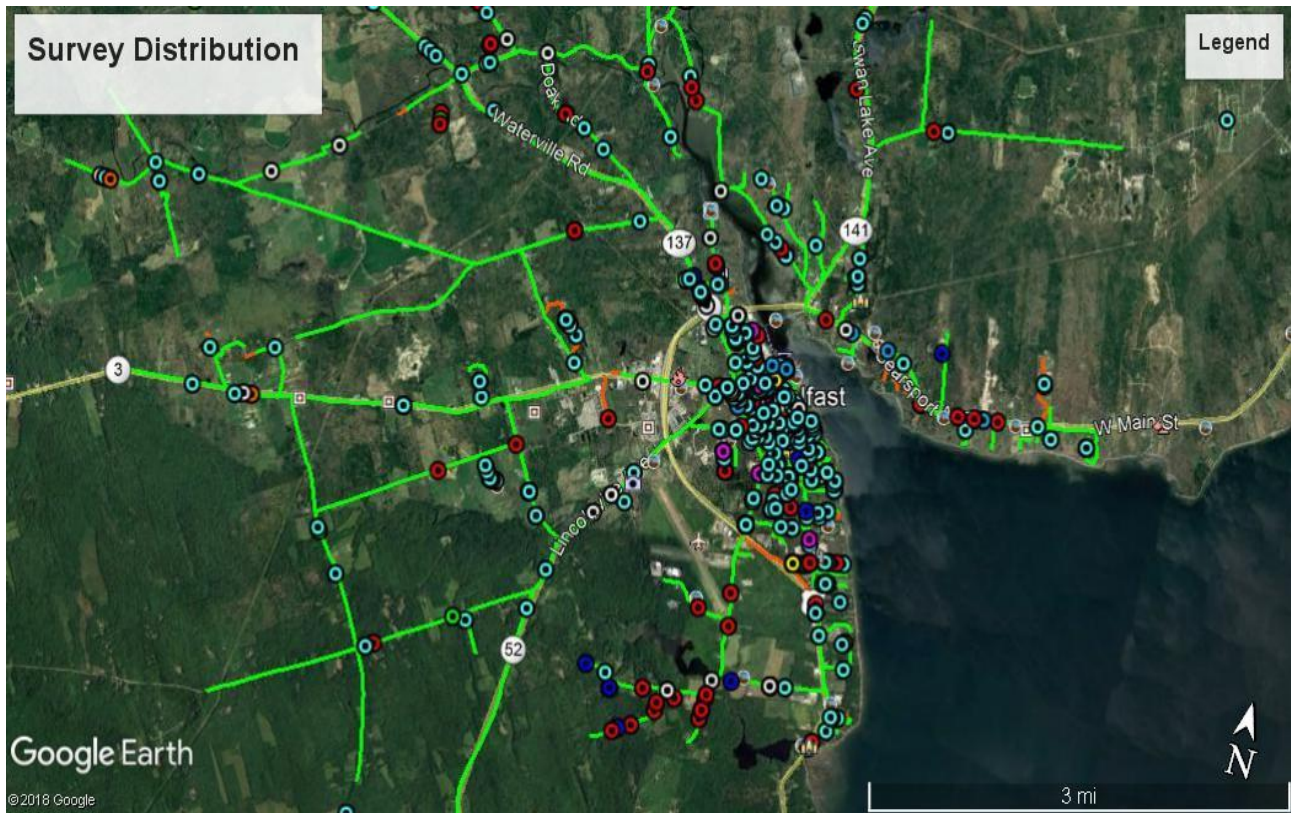
Survey Distribution by Internet Provider

Customers by ISP

A sizable number of respondents were concerned with the unaffordability of their current service and believed that the cost was only going to rise. The survey indicated that over 20% said they were paying $80.00 or more for service.

Monthly Cost

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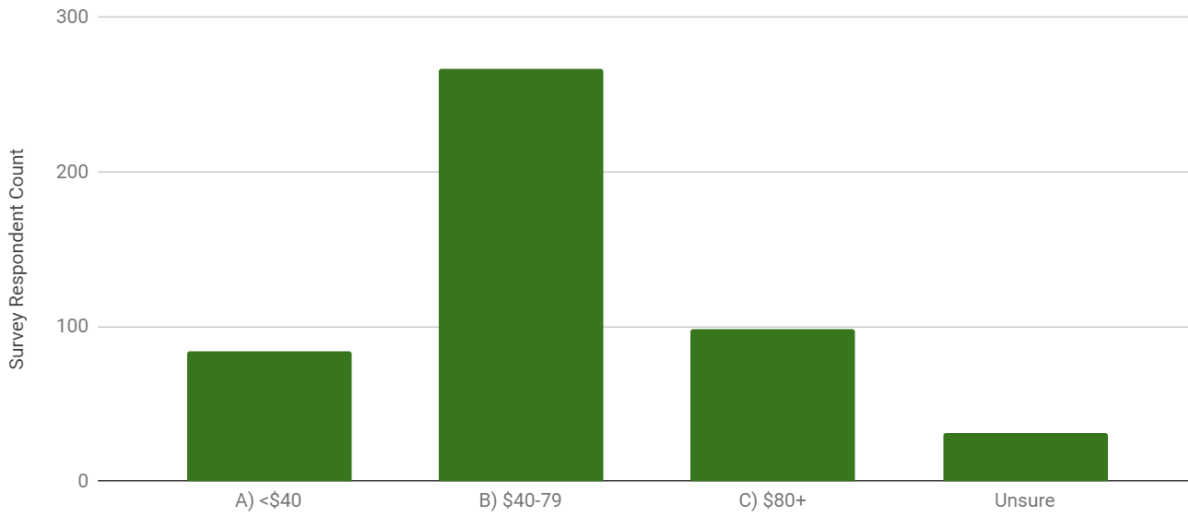
Customer Service Concerns

Other than cost, most concerns were centered on speed and reliability. Many of the respondents commented that either their speed levels were inadequate, and they were unable to do online tasks with the maximum speed packages available at their location, or that reliability was lacking and they were consistently receiving degraded or unusable service levels.

Cost concerns were centered on Spectrum, generally, and on HughesNet, a satellite internet provider that some commented was costing them up to $140 a month with data caps that were difficult to control.

Reliability concerns came mostly from customers of Consolidated Communications' DSL service, especially from those who were farthest away from Consolidated equipment where service tends to be significantly affected by the limits of DSL technology. Wireless customers also reported difficulty with service reliability, especially in times of inclement weather.

Generally, customer service was a special concern for many customers:

Customer Service Rankings
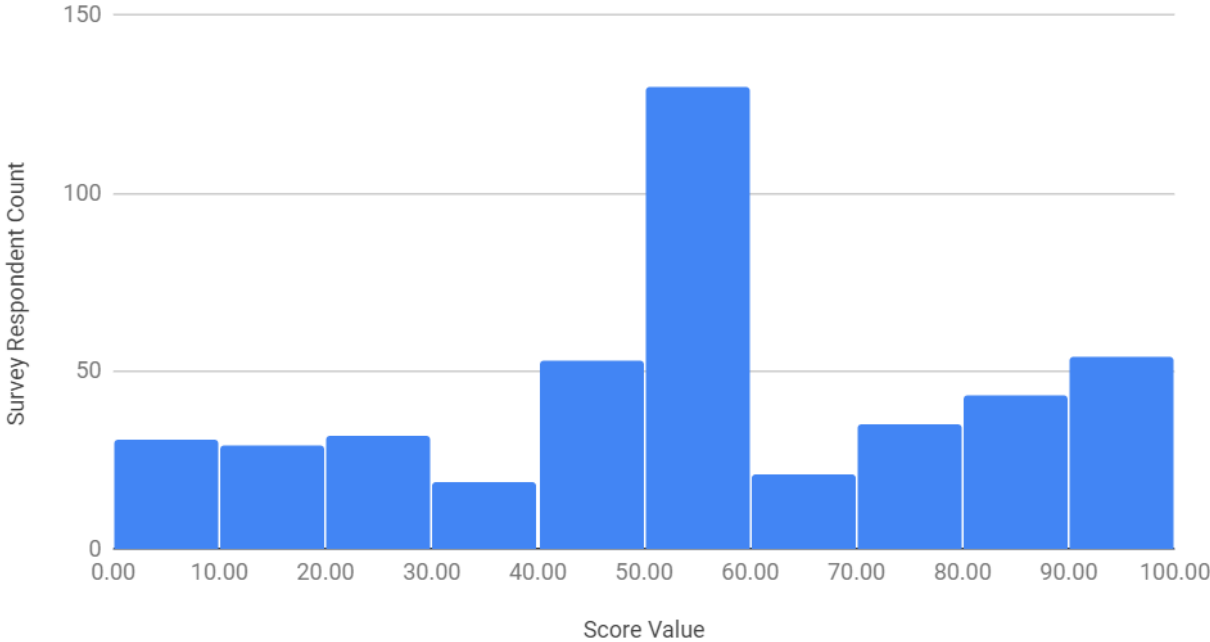
The survey received 464 responses to this question, but scrolling through the answers, over 57% scored their provider at or below 50 (average).

When asked directly about their satisfaction with their service answers were focused on:

Cost:
"Would like more choice. Cost has skyrocketed over 2 years from $120/month to $183/month."

Reliability:
"There are a number of brief, but annoying interruptions in service. Would like better reliability."

Speed:
"Slow! Sick and tired of calling to complain."

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Residential Telecommuters

We have found that many policy makers have an under appreciation for working from home and the need for high speed residential service. The surveys point to this issue and the need of home workers' dependence on a good internet connection. Almost 45% of the responses (222) indicated that they worked from home (65%), telecommuted (8%) or both (27%) and their frustration with trying to work on a substandard connection at their residence.

Frustrated Telecommuters

No 47.3% — 105
Yes 52.7% — 117
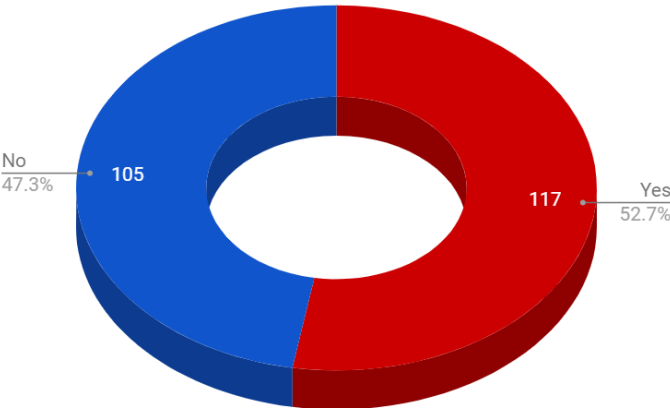
In addition to working from home, many are using the internet for education or homework. Out of the 197 who answered the question, 120 adults (61%) are using the internet for educational purposes. 14% indicated they had school age children who used the internet for homework.

Other highlights of the survey:

Do you think more people would move to Belfast if better internet service were available?

No
10.2%

49

175

Unsure
36.3%

258

Yes
53.5%
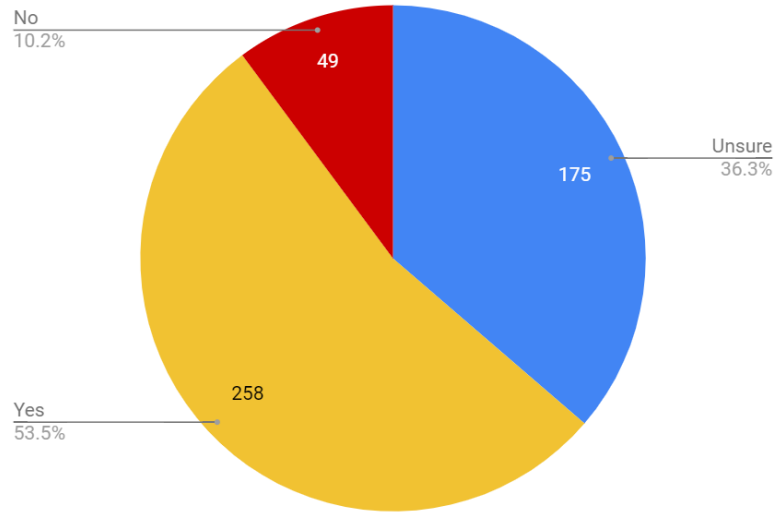
How much do you support City efforts to assist with internet service improvements?
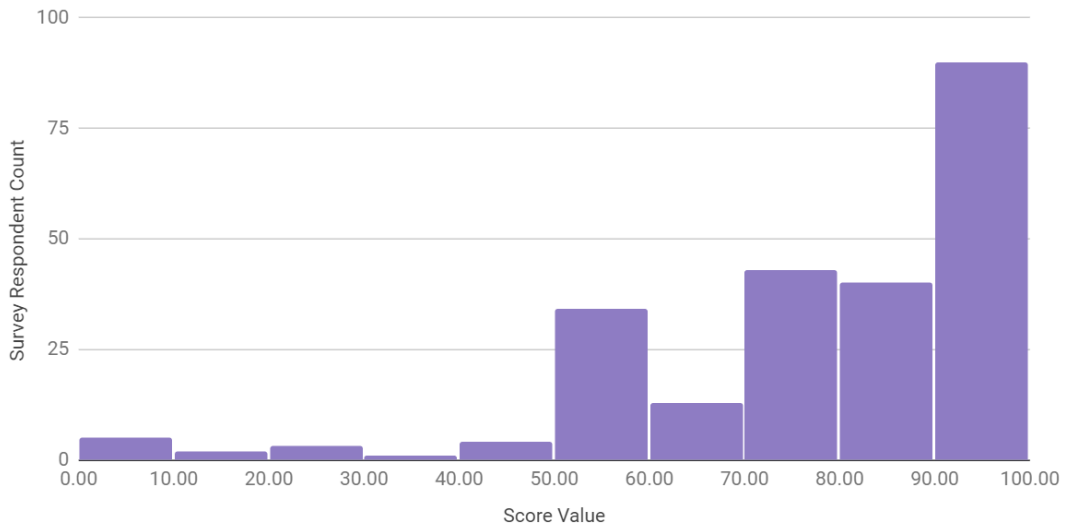
Community Survey summary:

- Strong belief in the City's efforts to support internet improvements
  - Little push back on the need for public intervention
- Across the board concerns with incumbent providers' service, reliability and cost
  - Responses for smaller provider were generally more positive
- Above average percentage of work-from-home adults
  - Points to the need for a focus on residential service

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Business Survey

The Broadband Committee collected 108 business surveys, which is a high level of participation in our experience. Likely because businesses rank the internet, as you would expect, as extremely important to their livelihood. These responses revealed that Belfast businesses are using the internet for a wide variety of applications.

What does your business use the internet for?
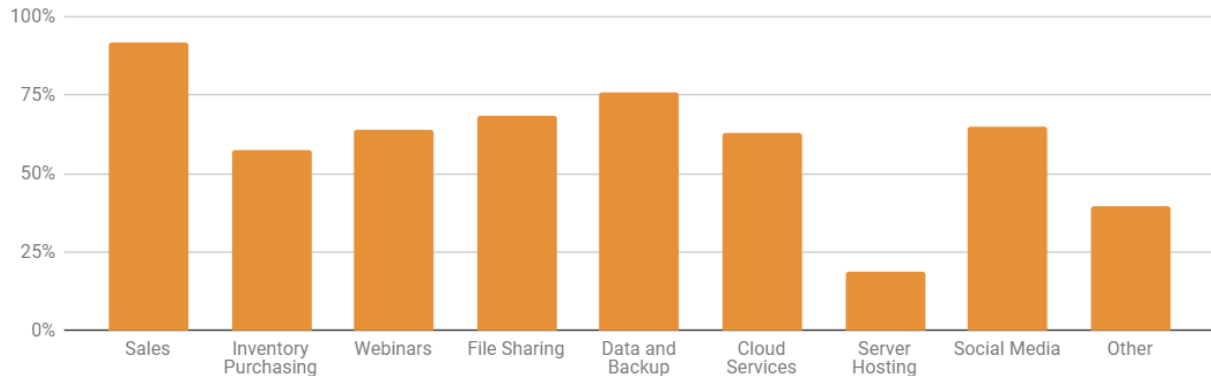
In addition, close to one-half of businesses answered no or not sure to internet speeds keeping up with their needs. As demand increases for better broadband, we would expect this level of dissatisfaction to increase. It is also clear that multiple providers are providing service in the downtown area but do not necessarily offer ubiquitous service, instead providing connectivity solutions to individual businesses on a case-by-case basis.

Have internet speeds kept pace with your business needs?
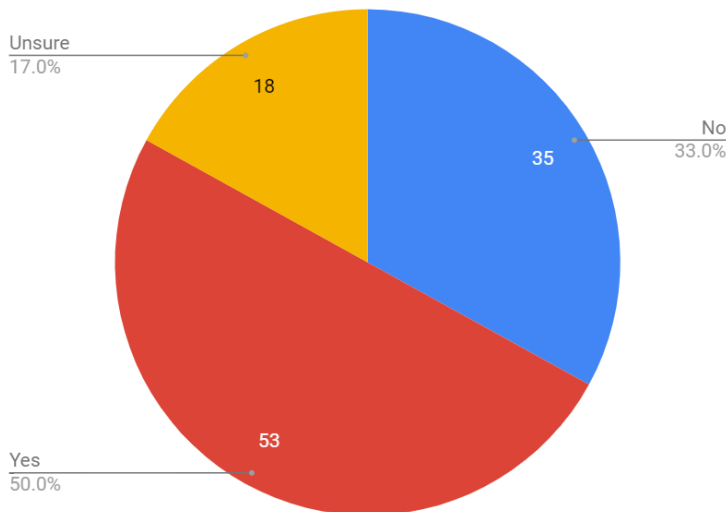
When asked to provide the speeds available, many had download speeds of 50 Mbps or more with a few having connectivity well over 100 Mbps. Reported speeds for upload were typically well below the reported download speeds with many reporting upload speeds of less than 5 Mbps and some less than 1 Mbps.

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Unlike the Community survey, there was a much wider number of providers for businesses, and while Consolidated and Spectrum were still dominating, there were a number of other providers with some market share.

Business Internet Service Providers
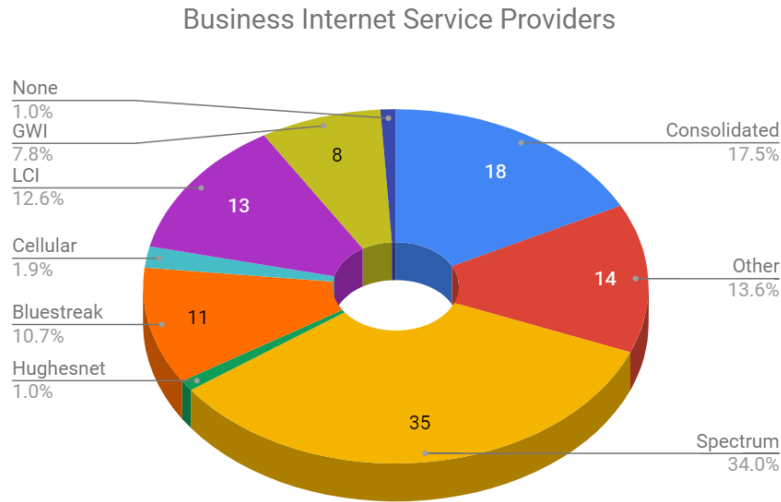
23% (24 respondents) indicated they had a fiber connection and monthly cost varied, but the majority of business connections were over $80.00 per month. Over 60% of the businesses had employees who worked from home either part or full time.

There were a series of questions that pointed to a need for digital training on a variety of topics which indicates a need to implement a Digital Literacy project in the community. Please see Digital Inclusion Plan attached for more information.

The survey captured a variety of business sizes:

Total Employees
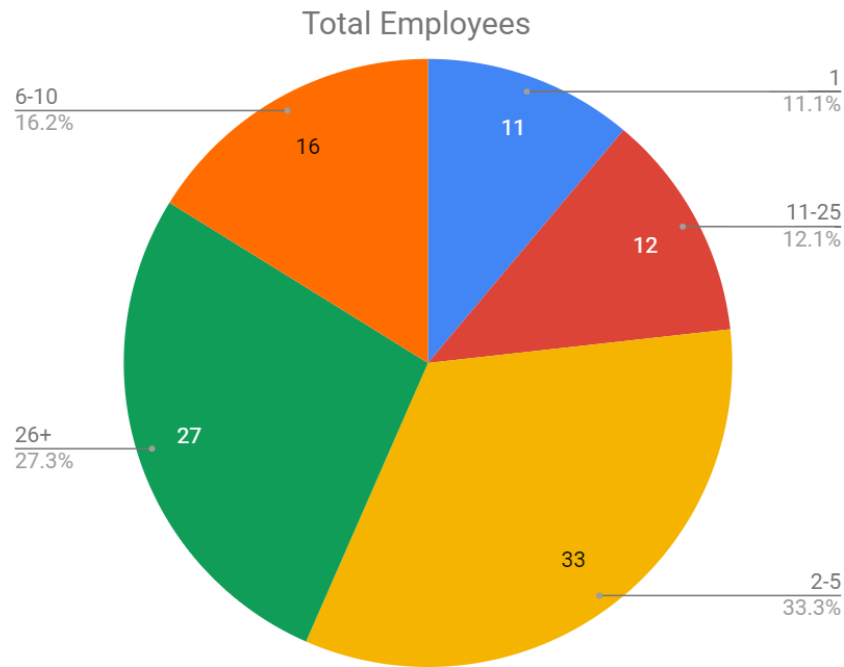
Here are some comments:

"While the business is able to have multiple vendors for their internet, personally living in the heart of Belfast on Cedar Street only FairPoint and Spectrum are available, and both are expensive options"

"It took 2 years to get fiber and only fiber is sufficiently fast and reliable for our needs"

"Access to faster internet, Consolidated is our only choice"

"As a design biz and manufacturing we load up and download large files with high resolution. Streaming content for displays of catalog, DEMO videos and marketing materials require ample bandwidth"

Business Survey summary:

- Increased fiber build-out would give more businesses access to higher speeds and symmetrical service, an increasingly important aspect of internet connectivity
- While the downtown is better served with more providers, there remain gaps and uneven service that is out of reach to small business, across the downtown and other parts of the City
- Additional business engagement is important to understand their training needs especially around increasingly important online business applications

Benefits of Fiber Optics

Copper is 19th Century technology, coax Cable is 20th Century technology and Fiber is 21st Century technology. Fiber optic internet systems are the future and Broadband Committees often get questions about the technology choice or the need for such systems. This section will help community members understand the benefits of fiber optics and its superiority over other technologies, including DSL and coax cable. Both DSL and cable are serving the majority of the community now.

- Fiber is a long-term investment in a community's future with a life expectancy of up to 40 years.
- Fiber supports 21st century Digital economy.
- Fiber leapfrogs communities that are left behind.
- Fiber, over the long run, is a less expensive technology.

Total Cost of Ownership

One of the major concerns with fiber systems is the up-front cost. However, over time, other technologies would need to be replaced, upgraded or will be deemed obsolete. On the other hand, fiber will allow you to scale the bandwidth delivered as needed, using the same fiber distribution network over a period of decades.
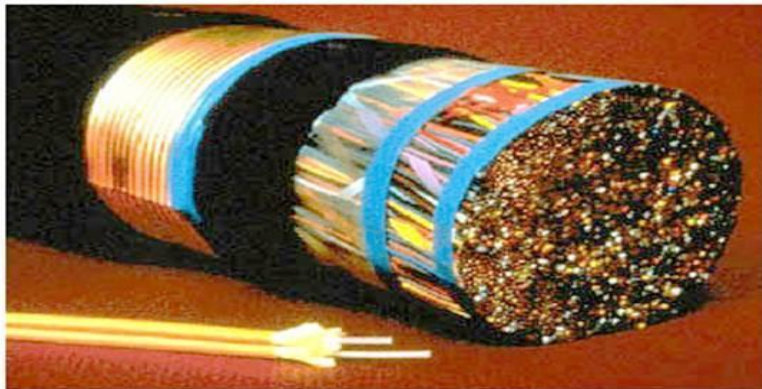
The optical fiber cable in the foreground has the equivalent capacity of the copper cable in the background.

This visual example underscores the capabilities of a fiber connection (the **yellow cable** at the left bottom of the picture) versus a legacy copper (the large **black cable** containing hundreds of wires) network connection. With today's technology, one fiber the thickness of a human hair can carry more data than 4,000 top-speed DSL lines.

Limits of DSL and Cable

Homes that are being served by copper, either through DSL (Digital Subscriber Line) from the phone company, or with coaxial cable from the cable company have significant limitations in service because of how each technology works.

In the case of **DSL**, not only is the driving technology outdated, but the old copper lines are susceptible to corrosion that can severely impact the reliability of a subscriber connection.
Furthermore, DSL is severely limited in the distance it can push a signal (3-mile maximum), meaning homes that are furthest from the telco equipment are faced with connections that often cannot reach 3Mbps download speed.

In the case of **coaxial cable** (coax), used by TV cable providers, capacity is still an issue, but for different reasons than with DSL. Compared to a fiber-optic system, cable is not nearly so scalable – and requires more frequent and expensive equipment upgrades for every step up in speeds. Furthermore, cable systems were designed primarily to push data down to the customer, a significantly different model than

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the emerging needs for a variety of applications and growing needs for telecommuting and interactive video, which require high bandwidth in both directions.

Finally, there is a major concern that cable is a shared system, meaning that the signal strength you receive is dependent on how much bandwidth is being drawn by other users that are also connected to the line of cable. Cable companies commonly oversaturate their subscriber networks by a ratio of up to 100:1, leading to inconsistent speeds for the end user.

How fiber works is the secret to higher speeds
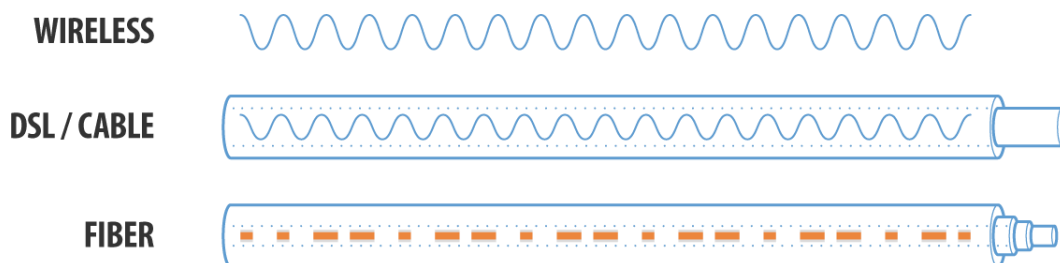
"Broadband" describes the fastest method of delivering high-speed internet to subscribers. While DSL and cable utilize existing phone and TV infrastructure to transmit data as frequency "vibrations" over copper wires, fiber networks transmit data using light over specialized cables that contain glass fiber strands. Light moves at 186,000 miles per second, and this is what enables speeds of 1 Gig (1000 Mbps) or much more per connection- 100 times faster than a 10Mbps DSL connection and 10 times faster than a 100Mbps cable connection. In addition, both DSL and cable suffer from the limits of their own technology, making them less than ideal choices into the future.

Wireless is an interesting choice and is certainly being considered in major urban markets where the density of buildings makes fiber optic cabling expensive and complicated. Wireless service, while reliable, is not as reliable as fiber optics and can be susceptible to weather conditions and movement of outdoor equipment due to wind. Wireless also requires a direct line of sight; obstructions are not a friend of a wireless signal. While it has the capability to be as fast as fiber, reliability concerns and reliance on line of sight make wireless installations best suited to very dense urban, or certain rural situations where the physical environment allows for reliable, high speed wireless systems, where lower costs make wireless a serious consideration.

All of us have been hearing about **5G**, the new cellular service that is going to begin replacing 4G on our cellular phones. Will this be something that could replace our current internet systems in the future? The answer is unlikely, and while you can find differing opinions about the promise of 5G technology, we do not believe 5G will ever replace a fiber connection, and we believe that the technology is many years away from replacing even a traditional DSL or cable connection.

The technology being developed for the 5G network does not translate well outside of very dense urban areas. First, the technology requires what is referred to as "deep fiber", meaning that the fiber required to power a 5G network needs to be brought essentially to the curb, where the last few hundred feet would be served wirelessly with 5G technology. If you are going to deploy fiber that close to the end user why not just go all the way to the premise? Second, the frequency that 5G is going to be broadcast suffers from

line of sight concerns, just like most of the other wireless technologies, making it less than ideal in rural settings where lots of obstructions can severely impact wireless signals. There are other issues, but Axiom believes 5G is not a solution worth waiting for.

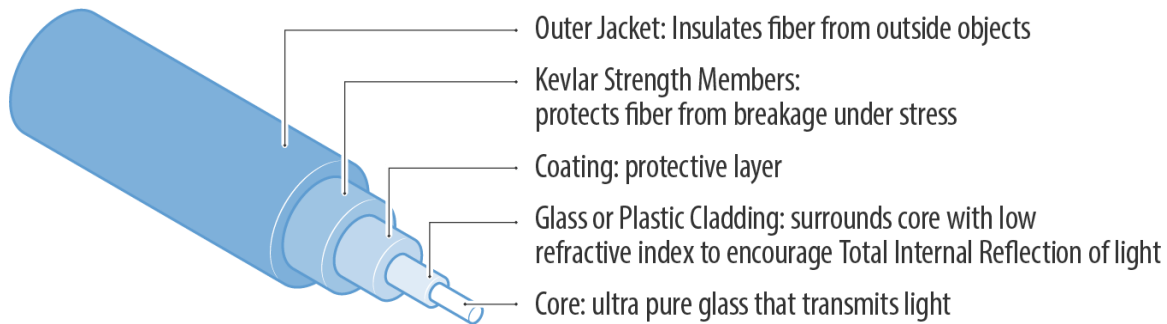## Will Fiber Become Obsolete Like other Technologies?
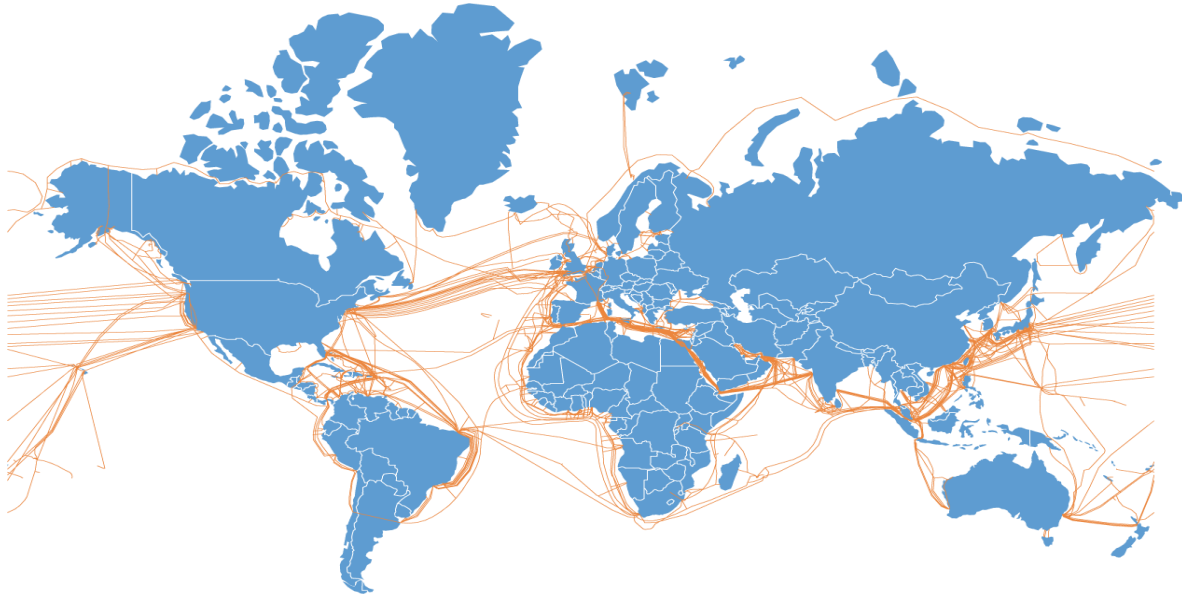
While we cannot predict the future, all indications are that fiber optics technology is here to stay for a very long time. Frankly, it has already been used for many, many years, which means that there are trillions of dollars of fiber installed globally. A whole industry has grown up around how to utilize fiber to its fullest capacity to make all of our lives better. This industry has proven very good at developing new electronics to push more and more data through existing fiber lines.

Most people think of fiber as a new technology, but in reality, it has been used for "backbone" connectivity as far back as the 1980s, with hundreds of fiber optic cables running across the sea floor all around the world.

What is new is that fiber is starting to be used to serve homes in places like Austin and Chattanooga and right here in Maine on the islands of Islesboro and the Town of Cranberry Isles, where FTTH (Fiber-to-the Home) networks are being deployed. Because of the extensive network of fiber already deployed and continuing to be deployed, it is very unlikely that we would see any major shift in market forces that would make fiber optics obsolete.

What is in a fiber-optic cable?

An individual optical fiber (the size of a human hair) is surrounded by several layers of material that strengthen and protect the fiber. A fiber-optic cable can have any number of "fibers" ranging from 1 to several 100s.

Outer Jacket: Insulates fiber from outside objects

Kevlar Strength Members:
protects fiber from breakage under stress

Coating: protective layer

Glass or Plastic Cladding: surrounds core with low
refractive index to encourage Total Internal Reflection of light

Core: ultra pure glass that transmits light

Benefits of Fiber Technology

Speed and Capacity. Experts at the FTTH Council say fiber-to-the-home connections are the only technology with enough bandwidth to support the projected consumer demands over the next decade.

Future proof. The ICT Regulation Toolkit states that because of fiber's capabilities, new technological innovations are being invented every day to utilize fiber's superior ability to transport tremendous amounts of data at blazingly fast speeds. Technologies such as 3D holographic high definition television and gaming will someday be everyday items in households around the world. FTTH will be able handle the estimated 30 gigabit-per-second needs of such equipment… and this is just one technology. Think about the new ways that you use the internet that seem commonplace now which had not even been conceived of 10 years ago.

One delivery system. Right now, a consumer can receive telephone, video, audio, television and almost any type of data transmission using a single seamless FTTH connection. That trend will continue as consumers are given an increasing array of a la carte choices for how they receive their various communication and data and streaming content. Subscribers are also realizing that receiving bundled services through a fiber connection can save money.

Reliability. Fiber is the most reliable connection you can have. In surveys across the state of Maine, the #1 complaint is reliability. An internet connection is becoming a necessity, not a luxury. When connectivity is interrupted or slowed down unexpectedly or inexplicably, consumers are furious that they cannot accomplish the online task, leading to a significant loss of productivity or time.

Community Benefits

Job Creation **-** There are many examples of new fiber networks creating jobs by either supporting existing businesses or attracting new ones.

Business Attraction **-** When we say business attraction, we really mean businesses that are looking for the kinds of connections that can move large amounts of data, quickly - architects, designers, banks and other heavy users.

Entrepreneurship **-** Fiber helps induce young people to locate and work from anywhere.

Telemedicine **-** The medical field and how patients and providers interact is undergoing seismic changes. One of those changes is the way patients are able to be seen, treated, monitored and are increasingly being given tools to manage their own health care, right from their home. A fiber connection has the capacity to manage these data transmission uses, which in turn facilitates our elders aging in place.

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Education - Creating equal access for all eliminates "the homework gap" for those students that are increasingly required to complete assignments online but are unable to do so from their home because of a lack of an adequate internet connection. Adult learners also benefit from online learning options that utilize interactive video or other tools that those with better connections can access.

Increased Home Values - A *Broadband Communities* study indicated that FTTH networks increase the value of a $300,000 home by an average of $5,000-$6,000. This is reinforced by another study by the FTTH Council in conjunction with the University of Colorado showed that homes with a FTTH connection are worth on average 3.1% more than homes that do not have a fiber connection.

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Community Network Plan

The Community Network Plan would bring a fiber connection to every home in Belfast that wants it while accomplishing several other goals important to the City.

- Equal Access to All - no matter where you live or work, your home or business would have access to the same speeds and reliability as any other resident or business.
- The system would be built to withstand large fluctuations in demand that occur in the summer months when seasonal residents and tourist arrive, and at other peak usage times.
- The provider, on behalf of the town, would undertake a pole licensing and Make-Ready process that would allow for the fiber to be strung on the utility poles (explained below).
- Our recommendation for the system technology is often referred to as "active Ethernet" - more details of the technology are located on page 29.

Cost

Fiber Materials		$1,214,535
Fiber Labor		$1,362,174
Licensing and Make-Ready		$592,300
Replacement Poles (10%)		$633,000
Regen Hardware		$674,388
Backhaul/bandwidth installation		$15,000
Customer Premise Hardware & Installation		$1,553,000
Total estimated budget		$6,044,397

The budget contains several line items that may change and lower the cost of the project overall. A lot of additional costing information will be learned by proceeding with the pole licensing process, for example. We have made some assumptions based on past experience, but the true understanding of the costs associated with pole attachments and "Make-Ready" (the cost of other users of the utility poles moving their lines to *make* a space *ready* for a new cable) will be certain once the licensing process is completed.

Components of Cost of Project

Fiber Materials
Fiber Materials refers to the cost of the trunk cable and associated equipment to hang the cable and the equipment needed to power the internet system.

Fiber Labor
Fiber Labor refers to the cost of manpower needed to string the fiber along the utility poles.

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Licensing and Make-Ready
Licensing and Make-Ready refers to the cost of applying for utility pole rights and the associated cost of making the poles ready to accept a new fiber cable. In order to install new fiber optics cable on utility poles, a licensing process is in place that evaluates each pole for readiness to accept a new cable. Each provider (other than the electrical) would move the current lines to accommodate a space for a new cable. The cost of this process is estimated in our calculations and can change depending on the application process costs associated with each pole.

Replacement Poles
We estimate that 10% of the poles, through the licensing process might need replacement. There are two major reasons for pole replacements. First, the amount of equipment or utility lines on a pole may make it necessary to increase the height of the current pole to allow for an additional line to be placed on it. Or the current pole is aged to the point where it would be unsafe to place the additional line strain on it without a replacement pole. We make an estimate, but these issues get addressed through the application and Make-Ready process.

Regen Hardware
Regeneration (Regen) hardware is the equipment that would be used to power the internet system and control each individual connection through this central system. These costs also include a heated and cooled utility shack that would house the equipment.

Bandwidth Installation
Bandwidth installation refers to the one-time cost of creating a hookup from the Regen hardware that would distribute the bulk internet connection.

Project Management
Refers to the day-to-day management of the installation of the equipment, equipment sourcing and purchasing, the overall troubleshooting and time and percentage of completion management, the attachment details for each subscriber and the details around the connectivity choices of each subscriber.

Cost Breakdown by Street or Road Segment

Axiom has a cost breakdown by street for this fiber plan. Because of the number of street/road segments, we have not included them individually in this report but they will be provided to the Broadband Committee as part of the project.

The fiber maps included in the next section are a good representation of the roads that the fiber will be located. The entire town would have fiber placed on the current utility pole structure. These recommendations should be considered preliminary and could be adjusted as the constructor of the network does additional due diligence or if the town has input into a final design.

Additionally, the map does not depict each connection from the trunk fiber to the individual homes, it would make the maps unreadable. However, we have built into our pricing model connections to every home or business that wants service. If an individual home looks like it may be unserved by the new system, this mapping was not meant to depict that information. Again, any premise is capable of receiving a connection from this construction design.
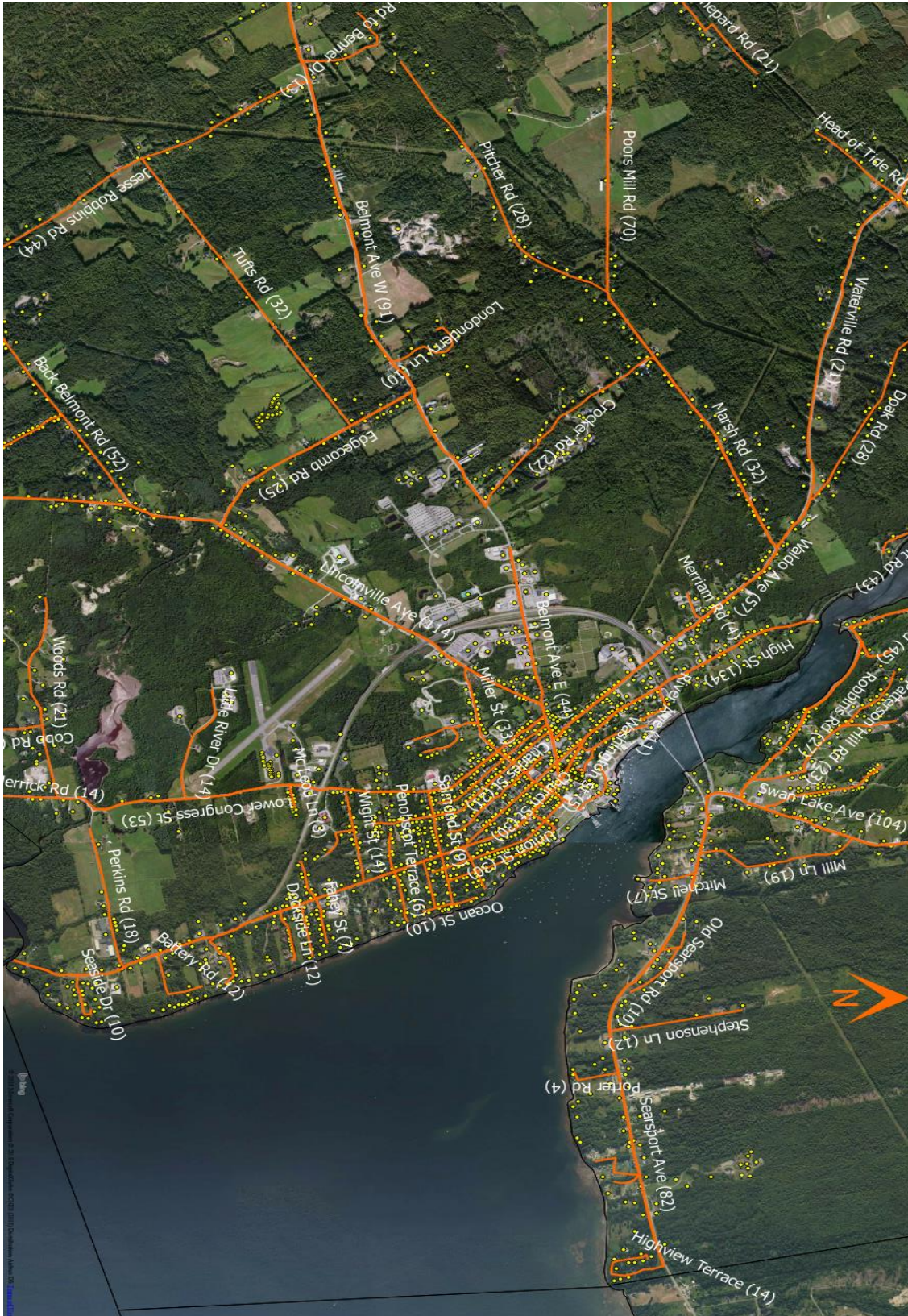
The white dots represent homes, businesses and structures that have been registered with the E911 system. The orange lines represent the fiber that would be installed throughout the city.
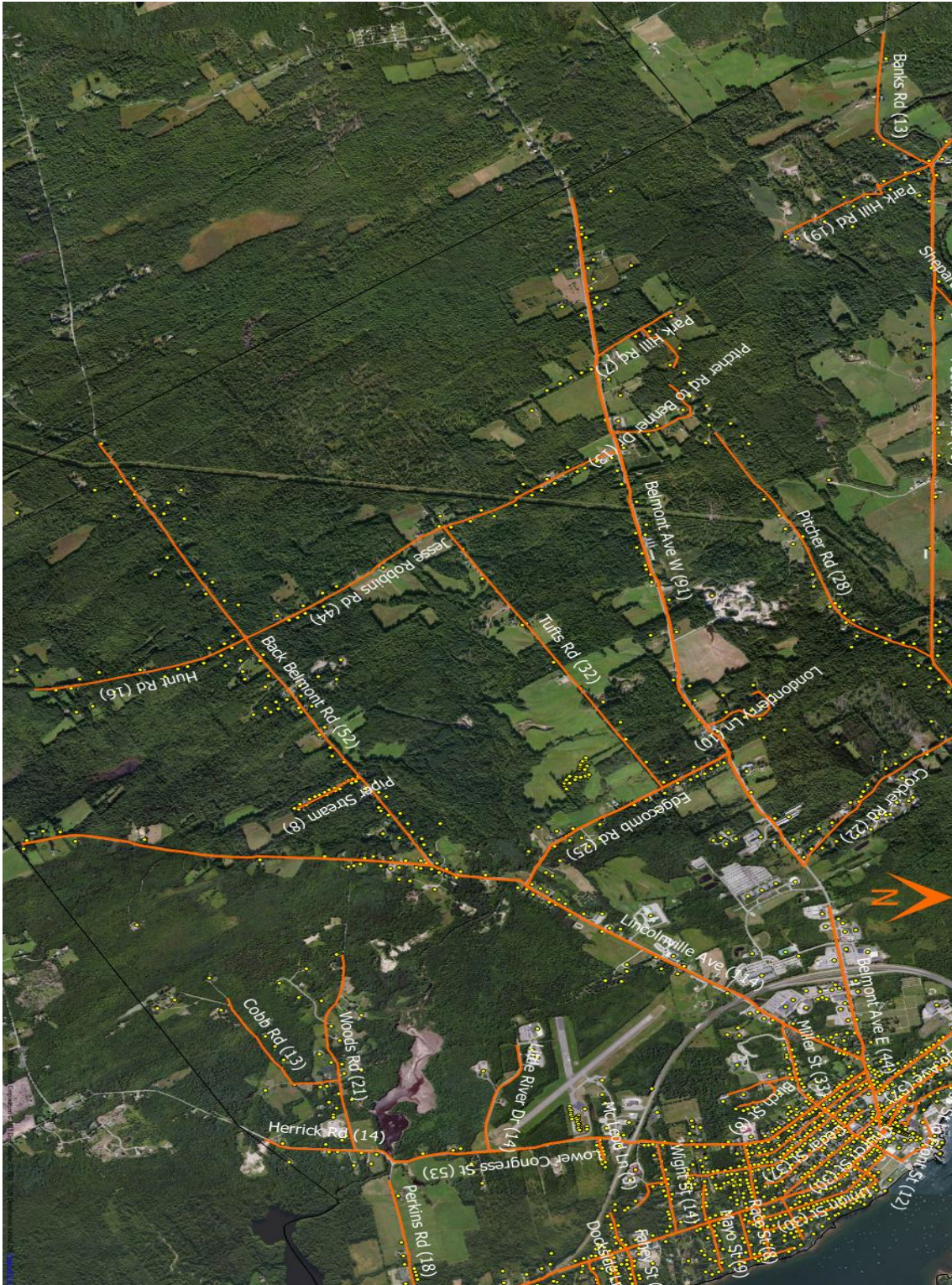
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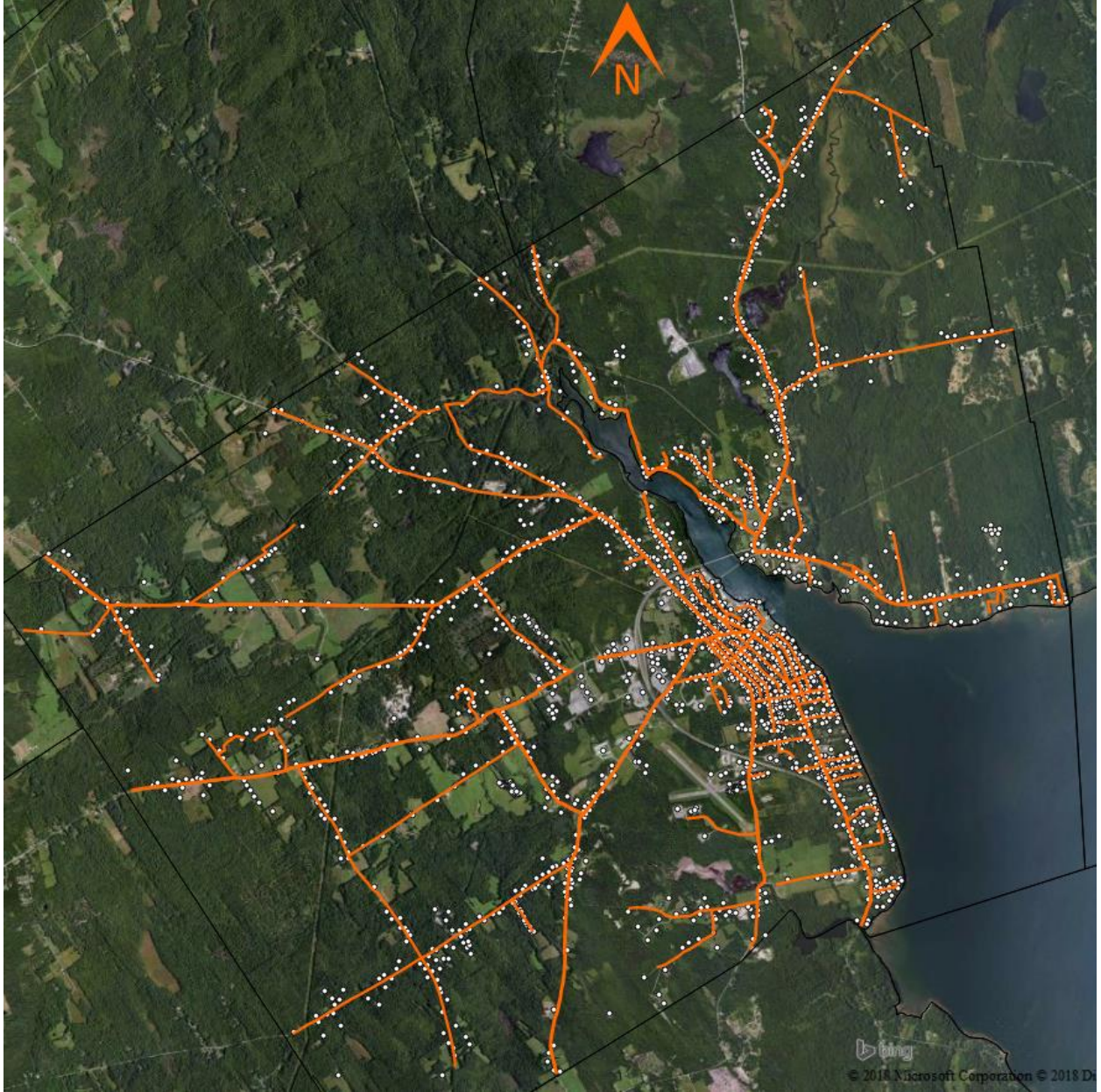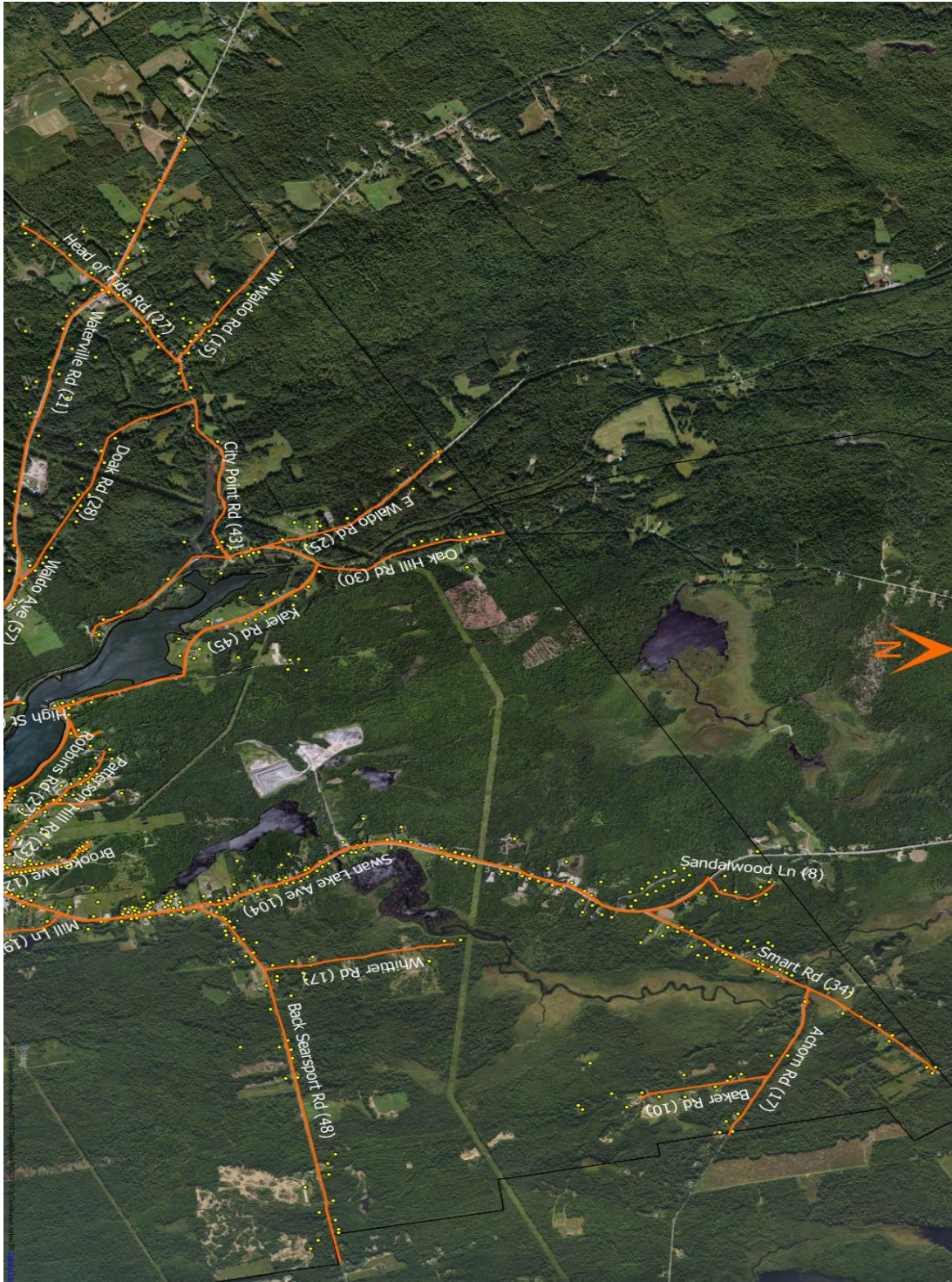
Belfast - North East

Belfast - South West

Belfast - West

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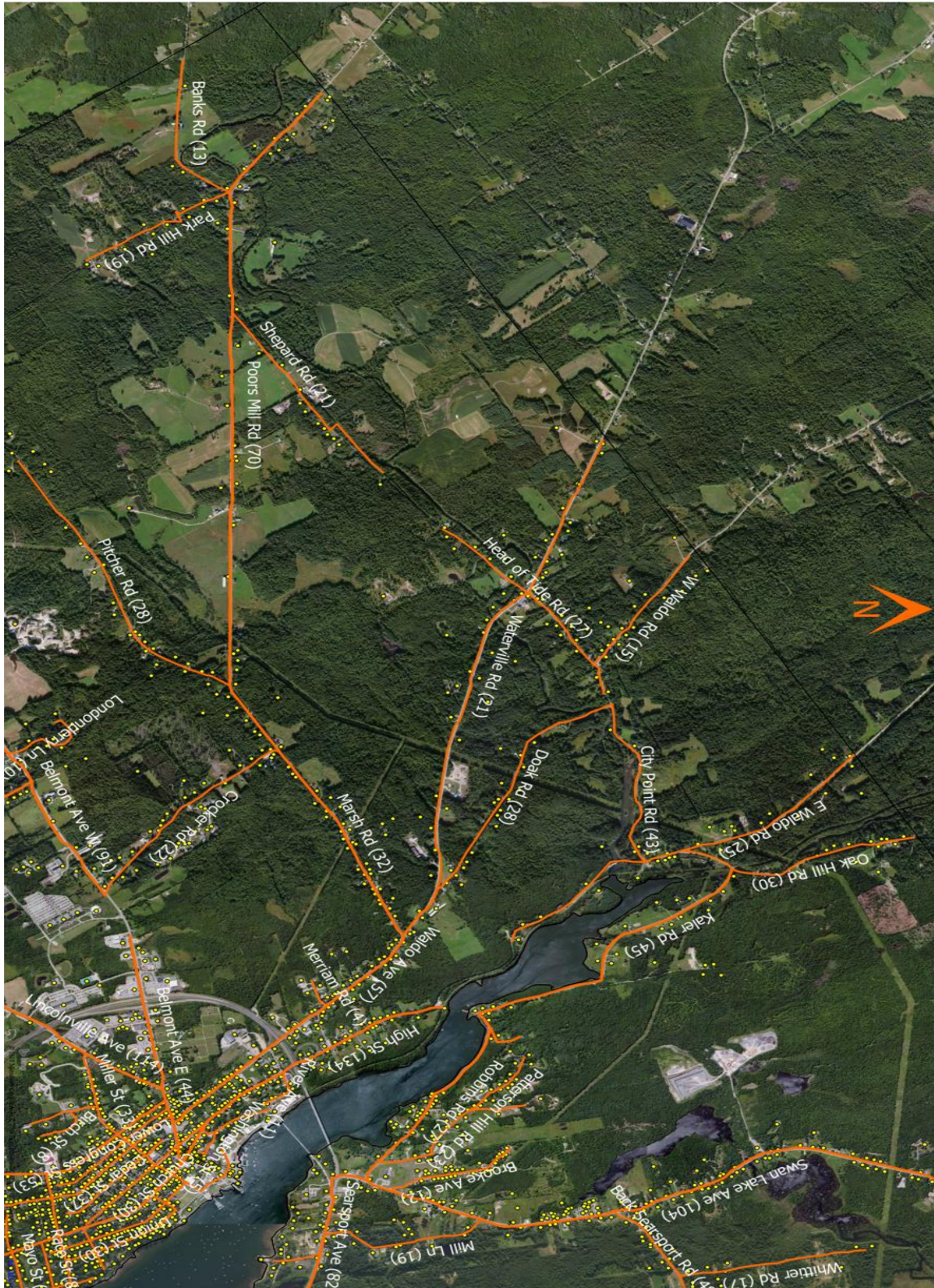
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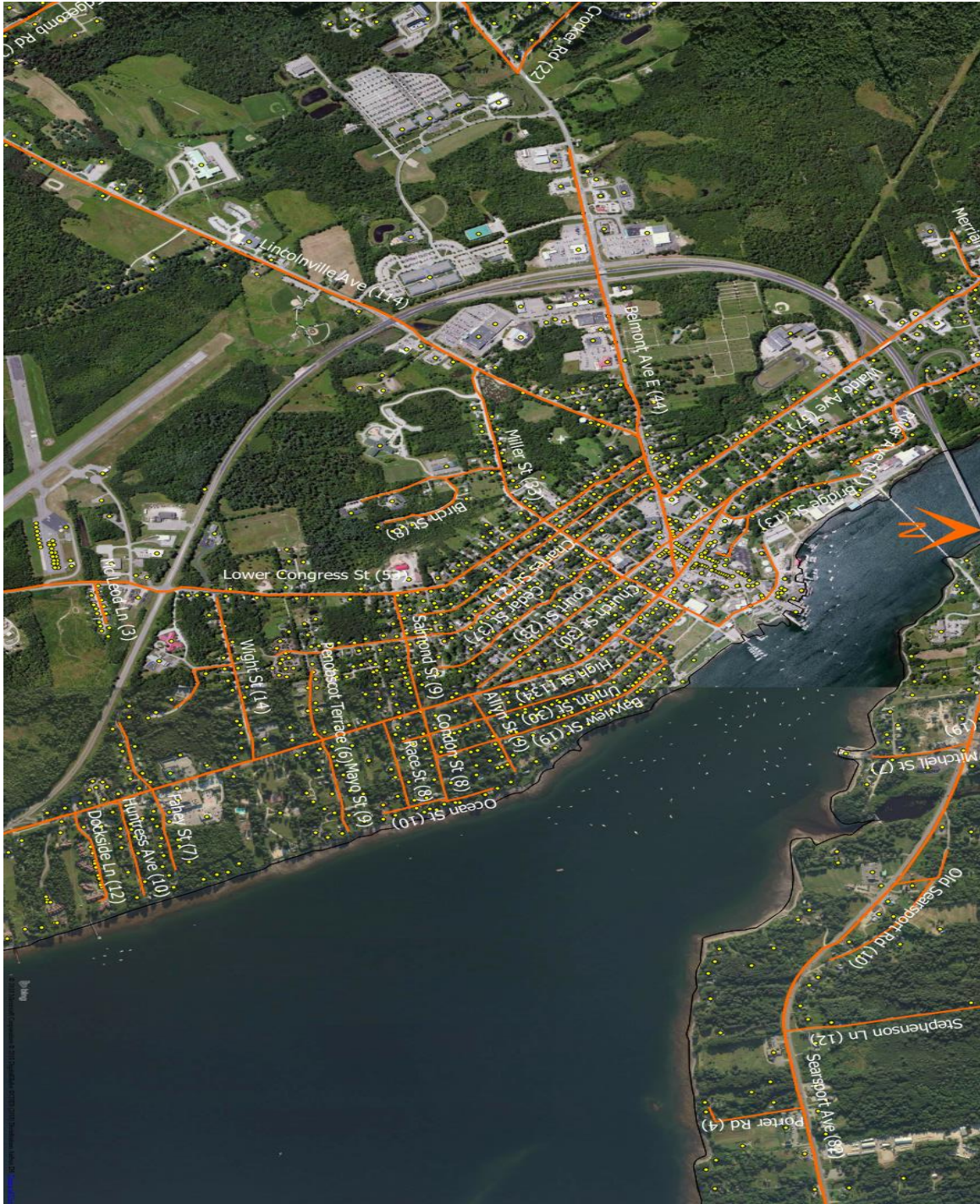
Proposed Fiber Equipment

Coarse Wavelength Division Multiplexing (CWDM)

Key Takeaways from this section of the report:

➢ Fiber is expensive, but will cost less than other technologies over the life of the fiber- likely several decades
➢ The technology proposed is future-proof: as demand grows for faster and increasing capacity, this fiber solution can easily be scaled
➢ This technology allows for true symmetrical service (equal upload and download speeds) a key feature that is becoming increasingly important

Our cost estimates use a fiber technology hardware called Coarse Wavelength Division Multiplexing (CWDM). This equipment allows up to 18 connections over a single fiber pair by having each connection operate on a separate light wave. This allows individual premise connections over that fiber that can carry up to 10 Gbps (10,000 Mbps), depending on the hardware used.
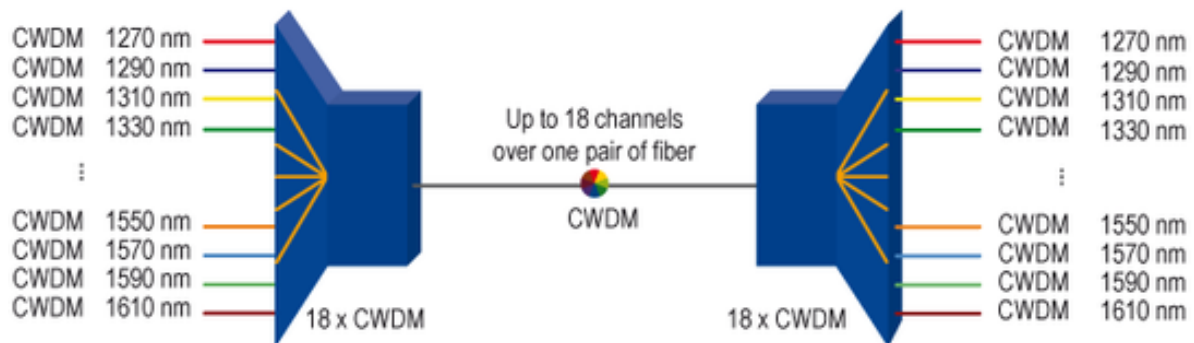
What does this mean for communities deploying this technology?

➢ Saves cost, because size of trunk cable has potential to be sized differently (smaller)
➢ Allows for inexpensive connections up to a Gigabit to each business or home and can increase to 10 Gbps (10,000 Mbps) with off-the-shelf hardware upgrades. Even 10 Gbps CWDM transceivers are relatively inexpensive today at about $100/each
➢ Scalable and futureproof, can easily accommodate 1 Gbps to each home today and can scale easily to 10 Gbps per home in the future

The CDWM solution saves cost, but not at the sacrifice of performance. First, the trunk line that will serve as the main line of fiber that is used to create "drops" (fiber connections) to each premise does not need to be as large, saving space, reducing tension and weight on the existing utility pole infrastructure that the trunk line would be hung. Using CDWM allows the trunk line size and weight and cost to be reduced, while still offering excellent scalability.

Weight and tension matter when you consider poles can cost up to $3,000 a piece to replace. The size and weight of the fiber cable can have a direct relationship to potential pole replacements.

With inexpensive optics, up to 1 Gbps (1,000 Mbps) could be offered to each home today. Unlike with cable, or even other fiber technologies (xPON), this is not a shared connection – the network truly

supports a full Gig to each home. As time passes, we imagine a day when more than a Gig of service would be needed at each premise. At that time, optical equipment can easily be switched out to offer up to 10 Gbps (10,000 Mbps) of service for a robust upgrade that is both easy and inexpensive.

When looking at future proofing a network, this design allows for almost unlimited speed and capacity increases without changing the actual fiber deployment methodology on the street. As fiber has become the chosen technology for connectivity, equipment providers continue to innovate by changing the hardware on each end of the fiber to increase capability, without having to reinvest in a whole new system. We are comfortable recommending a system that will easily last 20 years or more with relatively small, if any, equipment upgrades over the life of the fiber.

Potential Revenue for Internet Service Provider

As part of our commitment to our mission to help rural communities more fully understand what ISPs are facing serving a small community, we have created a revenue and operational expense budget that helps the community and the ISP better negotiate an operating agreement through the Public-Private Partnership or through a Public Utility that could manage the fiber network.

For the provider, understanding that some form of revenue return to the community is achievable and important to show good faith in a long-term agreement. For Belfast, understanding the costs associated with running such a system helps to better understand what the ISP is reasonably contribute, while still making a profit. The estimates are Axiom derived, each provider has their own operational cost decisions and revenues are based on pricing and the number of subscribers who take service. All of this pricing and speeds are subjective and act as an illustration of service level take rates and annual revenue projections. The City, or a public utility would be in a strong position to dictate the terms of service they would like to see providers offer the citizens of Belfast.

** Preliminary pricing and take rates- ONLY for illustrative purposes**

Potential Annual Revenue	Number of Subscribers	Monthly rate	Revenue per month	Revenue per year
10M	172	$39.99	$6,878	$82,539
25M	829	$59.99	$49,732	$596,781
50M	414	$79.99	$33,116	$397,390
100M	138	$109.99	$15,179	$182,143
(all speed symmetrical)	**Total Monthly Gross Revenue**		**$104,904**	
	Total Annual Revenue			**$1,258,854**

- Each rate of service category are approximate estimates of what we estimate each category will attract for subscribers.
- We did not create an estimated number of seasonal customers, but we would expect a provider to offer seasonal rates

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● The number of customers is determined as a 50% take rate (one of two homes passed would take service) for 1,553 total customers that would take service.

Operating expenses are estimated at $70,000 a month and can vary widely by provider. The operational expenses are listed below.

- ● Backhaul/bulk bandwidth
- ● Maintenance and break/fix
- ● Onsite support
- ● Technical support and overhead
- ● Yearly utility pole fee

If the system is owned by a utility or the City, some expenses might be part of the utility's responsibility to upkeep the system. A revenue sharing or a leasing model would have ISPs contributing to the utility on a monthly basis and are unknown at this time. Initial revenue and operating expense calculations indicate that there would be room for an ISP, or multiple ISPs, to make a profit, but also pay a fee to operate on a publicly owned system. This "open-access" model has proven successful in promoting competition in communities such as Ammon, Idaho.

Important takeaways to consider:

- ➢ Take rate is highly important to the overall profitability of the project (fewer subscribers = less viability).
- ➢ Monthly operating expenses are generally fixed, no matter the number of subscribers (there is not a linear relationship between subscriber counts and expenses).
- ➢ A publicly owned entity has been proven feasible and should be strongly considered.

The next section explores the basic choices of how the City might engage with ISPs and what kinds of ownership structures are possible.

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Ownership Models

Internet service is an unregulated, market-driven utility. Internet service providers are not subject to federal or state oversight. As frustration has grown in communities across Maine and the United States with the current internet options available and providers not being willing to build into areas that are marginally or unlikely to be profitable, many communities are looking to create better relationships with ISPs to get what their constituents are demanding - better broadband.

As the Broadband Committee and the City explore how they might proceed, we suggest three basic models for you to consider. Each model can take multiple forms and included are some basic questions that City officials and the Broadband Committee can investigate to help determine the best fit. There are good national resources that will explain and give examples of projects across the United States that could be models to consider.

Private
This is what you essentially have now, a series of operator-providers (ISPs) who deliver service based on market profitability and customer demand, with pricing and service levels entirely dictated by the ISP. Given their interest and the fiber network already in town, LCI would be a good candidate for this type of relationship. They are local, just recently won a contract with the City to deploy fiber to municipal buildings and have planned and developed at least a partial fiber buildout in your community. LCI, as well as others (GWI, Spectrum) have fiber networks in the downtown area and might be interested in expanding fiber, if they could do so with a reduced risk in the form of a public subsidy or some level of customer take-rate guarantee.

This is the least risky to the City, but it also offers little to no control once the system is in place and handed over to the ISP for operation.

Belfast's only cable provider has service across a good part of your community. Our understanding is the Spectrum is getting ready to offer "Gigabit" (960 Mbps) service to all of its subscribers across Maine - as a shared connection, subject to peak time slowdowns. While this will not be fiber, one option under this section of ownership would be to work directly with Spectrum to expand their service to serve the whole community.

This approach leaves the community where it started, does not meet many of the goals of the committee and City, but potentially gets service to some problem areas with little risk to the City.

Questions to be considered:

> ➢ Do we want to leave the system in private hands with no opportunity to discuss service levels and pricing?
> ➢ Can we legally hand over an infrastructure project to a private entity after using public dollars to build it?
> ➢ Would a private entity contribute to the cost of the construction with the promise to own and operate exclusively on the network?

The following map is not exact, but it will give you an idea of where Spectrum does not currently have service. Because the City has a Franchise Agreement with Spectrum, perhaps the City could use that as leverage to explore the cost of build out.

Areas not currently covered by Spectrum:

Public-Private

This model can have several options, but in general as the project finds potential funding, an RFP (Request for Proposals) would be issued for contractor services to build the network and/or operate it once it was built. In this scenario, a public-private partnership agreement (franchise) would be negotiated with a private operator who would take responsibility for the network maintenance and upkeep in exchange for operating and serving customers on the network exclusively.

A Service Level Agreement (SLA) would be part of the negotiated Public-Private Partnership Agreement and would spell out potential service speeds and cost tiers to the subscribers, as well as other details, such as response times for break/fix. There is less risk to the community, but the public-private partnership contract becomes critical to spelling out who is responsible for what. This is the model being used in the Town of Cranberry Isles and Cliff Island. This model is best in smaller communities where there are not enough customers to promote competition. This model gives the community control over the network, and therefore, its operations. Retaining ownership or control of the network gives the community leverage on a host of issues, but most importantly allows the community to switch operators if agreements are not kept.

Questions in this model include:

➢ Is there a revenue model that can help pay for the initial capital cost of the network build?
➢ Does the public entity retain some level of the maintenance of the system, to reduce cost and risk to the operator? Or vice-versa, is the maintenance fully the responsibility of the ISP which in turn could raise prices or not make the operation of the system attractive enough for potential operators?
➢ Would this be a long-term contract (10 years or more)?

Public

If the project, is in whole or in part, built with public money, either state, federal or local, the issue of who would own the network is a question that will need to be answered. There are examples nationally of networks that were poorly managed by either a public entity or a licensed private operator that the public entity contracted with to provide the services and maintenance on the network. There are also many success stories. You can access these success stories at www.muninetworks.org/communitymap. The map includes Islesboro, ME, a recently completed publically owned municipal network.

There was a law change in Maine that allows a region or band of communities to come together to form a Broadband utility. It is based on regional cooperatives with a local Board of Directors who would manage the system and contract out various aspects of the network operation. Recently, the communities of Calais and Baileyville, and Our Katahdin (Millinocket, East Millinocket and Medway), have formed this type of Broadband utility to manage the construction and operation of a new FTTH project in each community that they hope to build. This is a model that is being utilized in Islesboro, where the town maintains ownership, and has hired a network operator (GWI) for a fixed yearly fee to operate the network.

There are various resources to help communities explore this option. Broadband Magazine offers an online resource section for municipalities looking to explore this option. They have a tab that is labeled "Municipal" that has a host or resources for communities to explore. That website is located at www.bbpmag.com.

If the community were to create a publicly driven entity, there are several questions that would need to be answered including:

➢ What would the financial oversight look like?
➢ Would the entity be incorporated separately from the City?
➢ How will the system built be maintained and operated?
➢ Is the City willing to consider operating such a system?
➢ Would the operations and oversight be handled by an experienced operator?

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Final Thoughts

Clearly, there is a lot to absorb. Given the ongoing commitment the City has already expressed to continue this work, we offer several suggestions for what the next steps might be:

Information campaign
Now that the committee's work has been endorsed by the City Council, the committee's work, including this report should be made more public to increase the dialog, transparency and community understanding of why better broadband is important.

- Information distribution (City Website, develop a Constant Contact list with survey responders)
- Have a community meeting(s) to present the findings of this report and other materials
- Council Workshop

Further develop operational network plan
There are several options for a future network operation. Axiom believes that there is an operational model that would support multiple providers operating on a City owned network. A number of questions need to be explored to determine the best structure and to determine if this is a feasible option for the Council. Member of the Broadband Committee have begun outreach with other communities who have implemented either a Broadband Utility District or some other form of community ownership.

- Explore resources suggested in *Operational Model* section of the report
- Engage with Baileyville-Calais (ongoing) and Our Katahdin (newly formed) utility districts to explore possible models for Belfast

Re-engage ISPs currently serving the City
As part of the Broadband Committee's due diligence, Axiom would recommend engaging the current providers in the community to discuss the Committee's goals and the opportunities to partner.

- Would ISPs be interested in operating on a publicly owned network?
- Do the current ISPs have plans to expand their operational footprint?
- What would it cost for Spectrum to offer service to every home?

Refinement of fiber plan cost
As described, the cost of a new system relies on better understanding of the pole attachment cost and several other variables built into our model. While the modeling gives a good estimation of build cost, additional engineering would be required to determine a more concrete number. As the process unfolds it may make sense to get further refinement of the construction cost of the system.

- Potentially undertake the pole licensing process to refine construction cost
- Create an RFP to attract Broadband Network Providers to bid on the project construction

Axiom will remain a resource to Belfast long after this report and is happy to answer questions or attend meetings. Contact: Mark Ouellette, mark@connectwithaxiom.com or (207)272-5617(m).

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Grant Funding Resources

Broadband Planning

The ConnectME Authority provides funds for broadband planning grants to municipalities, groups of municipalities or nonprofit local or regional community organizations that are providing local or regional economic development programs to develop plans to expand the availability of broadband services in unserved and underserved areas.

Typically, ConnectME grants open for applications in the March- April timeframe, but have not been announced for 2019. Information about this program can be found here:
https://www.maine.gov/connectme/grants/planning-grants

The Maine Community Foundation recently opened a new grant opportunity for municipal and town planning. The Community Broadband Grant Program has a maximum request of $15,000, the application deadline just passed, but this program is expected to continue. Information on eligible activities and other details can be found here:
http://mainecf.org/GrantsNonprofits/AvailableGrantsDeadlines/CommunityBroadbandGrants.aspx

The Island Institute is a technical assistance partner and has a planning grant opportunity available to coastal and island communities in Maine. Typical grants are $10,000 and accepted on a rolling basis as funding is available. For more information and eligibility, please contact Stephanie MacLagan, Senior Community Development Officer at: smaclagan@islandinstitute.org

Infrastructure Funding

The ConnectME Authority offers two types of grants - Infrastructure and Community Broadband Planning Grants. When communities are ready to construct a Broadband system, the authority has a funding resource available to help, details can be found here: http://maine.gov/connectme/grants/

Axiom has extensive knowledge of these grants and has received over $1 Million in funding.

- Grant proposals must meet the state standard of 10 Mbps symmetrical.
- Grant limits are suggested, but typically $100,000- $150,000 maximum, which must be matched 1-to-1 with a combination of cash and in-kind services
- Area targeted must be unserved or severely underserved (service that is less than 1.5 Mbps download)

Typically, ConnectME grants open for applications in the March- April timeframe, but have not been announced for 2019. **This program is being reevaluated and new criteria are being developed for 2019.** The criteria for this program may change as soon as the next funding cycle.

The Maine Community Foundation has regional grants that can support initiatives up to $10,000.
http://www.mainecf.org/GrantsNonprofits/AvailableGrantsDeadlines/CommunityBuildingGrantProgram.aspx

- Grants available up to $10,000

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- Local decision makers by county
- Various criteria that need review, depending on county
- Deadline February 15th of each new year

Northern Border Regional Commission Grants (http://www.nbrc.gov). The Commission accepts grant applications from across the northern border regions of Maine, New Hampshire, Vermont and New York.

- Requires at least a 1-to-1 cash match
- Must be tied to quantifiable job creation
- Very competitive
- Millinocket and Rumford have been awarded broadband deployment projects through this program

Contact: Andrea Smith at (207) 624-9813 or andrea.smith@maine.gov for information on deadlines and program parameters.

U.S. Department of Commerce: Economic Development Administration (EDA) provides funding for economic development projects across the state of Maine. Maine projects are reviewed and administered by EDA's local representative, Alan Brigham at (215) 316-2965 or abrigham@eda.gov. Programs and eligibility can be found at www.eda.gov

- Various funding programs
- Guidelines encourage regions to incorporate BB investments in their regional economic development strategies (CEDS)
- Funding requires match

This program is funding a Sanford FTTP project. SanfordNet Fiber is a 45-mile fiber optic network designed to serve the city's municipal buildings, its downtown mill complex, its 600 acres of industrial parks, and more than 80 other locations, including Southern Maine Health Care's campus on June Street and the new high school and technical center that is expected to open for students and staff this October.

U.S Department of Agriculture: Rural Development has a number of grant programs. The local office is located in Bangor, and the contact is Tommy Higgins, State Director, (207) 990-9161. More information on programs in Maine can be found here: www.rd.usda/me

- Rural Broadband Access Loans and Loan Guarantees Program
  - 2019 program has not been announced
- Several other competitive grant programs to explore eligibility and criteria including a new $600M pilot program aimed at assisting rural American get connected.
  - Details of program are still being developed
  - Application window expected early in 2019

The Town of Cranberry Isles was awarded a $1.3M grant for their FTTH project.

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U.S. Department of Treasury: New Markets Tax Credits (NMTC) has recently clarified the eligibility of broadband infrastructure and related activities are eligible for NMTC provided they meet certain criteria located here:
https://www.cdfifund.gov/Documents/2015%20NMTC%20Application%20QA%20FINAL.pdf

- Axiom is exploring the potential of NMTC funding
- Belfast is in an eligible census tract
- Difficult to qualify projects

Technical Assistance

U.S. Department of Commerce- Broadband USA is helping communities nationwide ensure they have the broadband infrastructure, digitally literate workforce and engaged citizens to thrive in the Digital Economy. Details can be found here: https://www2.ntia.doc.gov/

- Provides direct (one-to-one) assistance to communities
- Resource rich website- no direct grants
- Building a self-assessment tool for communities

The Island Institute offers technical assistance to coastal and island communities across Maine and has developed a resource page for communities interested in best practices, resources and examples of projects. That information can be found here: http://www.islandinstitute.org/resource/broadband-island-and-coastal-sustainability