PHASE ONE REPORT

The Corporation of the Municipality of Temagami and Temagami First Nation Broadband Assessment

FINAL VERSION

OCTOBER 1, 2019

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PLEASE NOTE THAT HYPERLINKS HAVE BEEN ACTIVATED IN THE DOCUMENT FOR EASE OF CROSS REFERENCING. SIMPLY "Ctrl-CLICK" TO BE TAKEN TO THE REFERENCED SECTION.

1.0 Introduction

The Municipality of Temagami and Temagami First Nation ("Temagami") seek to establish an affordable, ubiquitous, and scalable broadband network to enhance connectivity within the region and improve access to a wider global network. As part of this goal, Temagami commissioned this study as a first step to researching, defining and implementing a solution that will improve the availability of services to the communities and industries in the area so to tangibly increase economic diversity in the region.

The key to the success of this project is that it brings together several communities within Temagami that individually might not influence the significant investment required in their region. However, as a collective they have a critical mass that will drive creative solutions, economies of scale and return on investment that potential funders and vendors will take note of. A company might not be able to address a community of 40 homes but combining 400 may enable a sustainable model. However, refer to the section entitled "Recommendations" for additional commentary and suggested direction.

A study was recently published by the University of Tennessee at Chattanooga and Oklahoma State University that underscores the essence of the importance of broadband in rural areas. The researchers stated:

"We find that high speed broadband has significant effects on county-level unemployment rates… We also find measurable benefits to early adoption of high speed broadband. Compared to urban areas, the benefits of better quality broadband are disproportionately greater in rural areas."[1]

The study references the results of other research that suggest high-speed broadband:

- facilitates efficiency, heightens productivity and, likely, fosters innovation;
- positively impacts productivity, growth, employment and poverty levels;

[1] **Broadband Speed and Unemployment Rates: Data and Measurement Issues, April 22, 2019**

- where not available or is restricted, cuts off many families from e-commerce, banking, health care and other services;
- has impacts in applications to medicine, banking, education, and in the evolution of an entrepreneurial ecosystem; and
- has positive effects on disaster recovery services for businesses and benefits stemming from intelligent traffic systems (ie: smart grid technology).

The researchers take care to delineate broadband and speed, as the terms are now often used interchangeably. It is not enough to say a particular area has access to broadband internet – the speed and quality of that service is paramount. Please refer to the section entitled "High-Speed" that expands on this.

This report encapsulates the results of a desktop and a "ground truthing" (visual site inspection) analysis of the visible broadband infrastructure connecting the communities and the network within each. There is no question that a large broadband gap exists as highlighted in red in the chart[2].

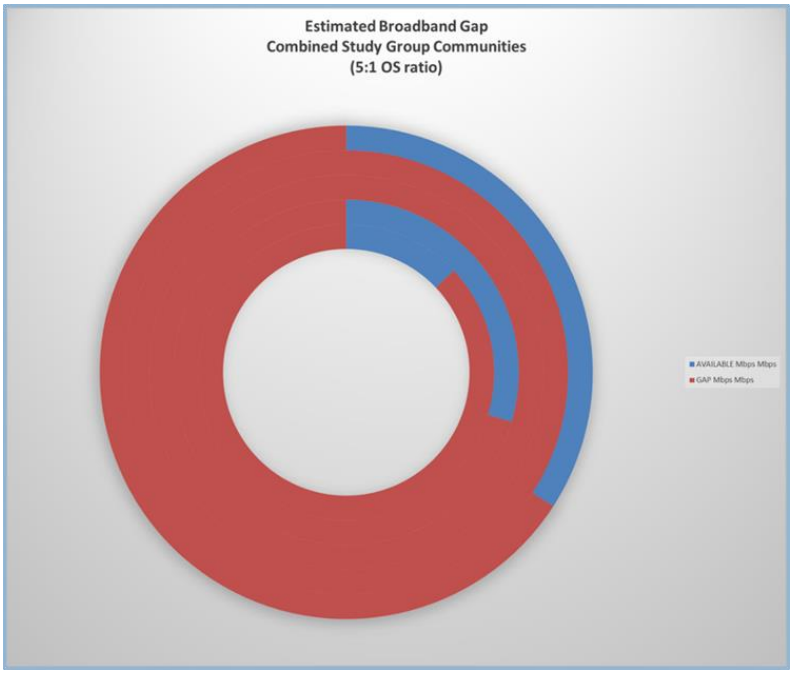


Figure 1: Estimated broadband gap (combined)

[2] Refer to Section 7.3 for details and assumptions contained in the chart.

To help areas such the Temagami region, the CRTC announced the "Closing the Broadband Gap" policy that sets out the target for all Canadians to have Internet access with speeds of at least 50 Mbps download, 10 Mbps upload and the option of unlimited data. The plan is to invest up to $750 million over five years to build or upgrade access and transport infrastructure in underserved areas. This report is the first step in aligning Temagami towards meeting the requirements of the funding whose parameters are expected to be announced imminently.

Ontera (owned by Bell Canada) dominates both the regional fibre transport system and the community last mile networks. With Bell having re-absorbed its regionally focused Bell Aliant subsidiary and with the purchase of Ontera, the region has become challenged to attract any of Bell's national near-term capital investment funding. Therefore, it is critical for Temagami to seek whatever possible funding available so that broadband infrastructure partnerships can be forged with other service providers in the region. One of the Temagami communities might also consider becoming its own regional ISP to ensure ongoing focus and participation in the keystone of the global economy – broadband Internet.

This report is organized into three general areas: the first provides a background on broadband Internet itself, the related Canadian regulatory environment and the basic infrastructure that underlies its delivery. The second area focuses on the regional and local infrastructure, the relative gaps and community recommendations. The last area summarizes the regional risks and respective recommendations, followed by various supporting exhibits.

2.0 Approach to the Study

The Project Lead, Amedeo Bernardi Consulting Inc. was responsible for the following deliverables, and to engage stakeholders as required in order to accomplish the deliverables ss per the Scope of Work document provided to Temagami:

2.1 Phase 1

Research and document the current broadband infrastructure in the region. Determine the state of terrestrial infrastructure, community needs and engage regional service providers.

Phase 1 – Deliverables:

- Perform a "desktop" gap and needs analysis using publicly available resources and data.
- Conduct site visits to identify visible telecommunications infrastructure in the communities (ground truthing). The study will focus on terrestrial-based services such as existing copper, coax and fibre plant. Buried services will be identified and/or assumed dependent on service markers and/or weather conditions. Mobile and fixed wireless services will be noted where feasible and to the extent service providers will supply information.
- To the extent feasible, engage regional telecommunications service providers as a source of information.
- Prepare, conduct and analyze community-based surveys with the assistance of the Prime Communities.
- Acquire data sets including Speed Test Data* and other statistical information as might be feasible with the assistance of the Prime Communities.
- Provide an overview of relevant regulatory matters that might have an impact on the project (ie: open access policy, basic service determination and potential access to new funding).
- Prepare a consolidated report outlining the current status of regional connectivity, needs, infrastructure gaps, risk matrix and recommendations.
- Prepare a high-level project budget based on the recommended methodologies.
- Provide status updates to the Prime Communities' project liaison.

***Note: While speed test data was collected as part of the project, the data was unusable due to inconsistencies including cellphone tests and testing from areas outside of Temagami (ie: USA). However, lack of this data has not impacted the exercise as the current network cannot support the CRTC's 50/10 aspirational goal.**

3.0 Participating Communities

This phase of the project included the Municipality of Temagami (including Temagami Core, Temagami North, Marten River, Lake Temagami) and Temagami First Nation's community of Bear Island (a portion of n'Daki-Menan[3]).

The Municipality of Temagami has been sub-divided to allow for a more granular review of the state of the broadband network and related gaps. Data for each area or "community" is furthered detailed in Section 7.4.

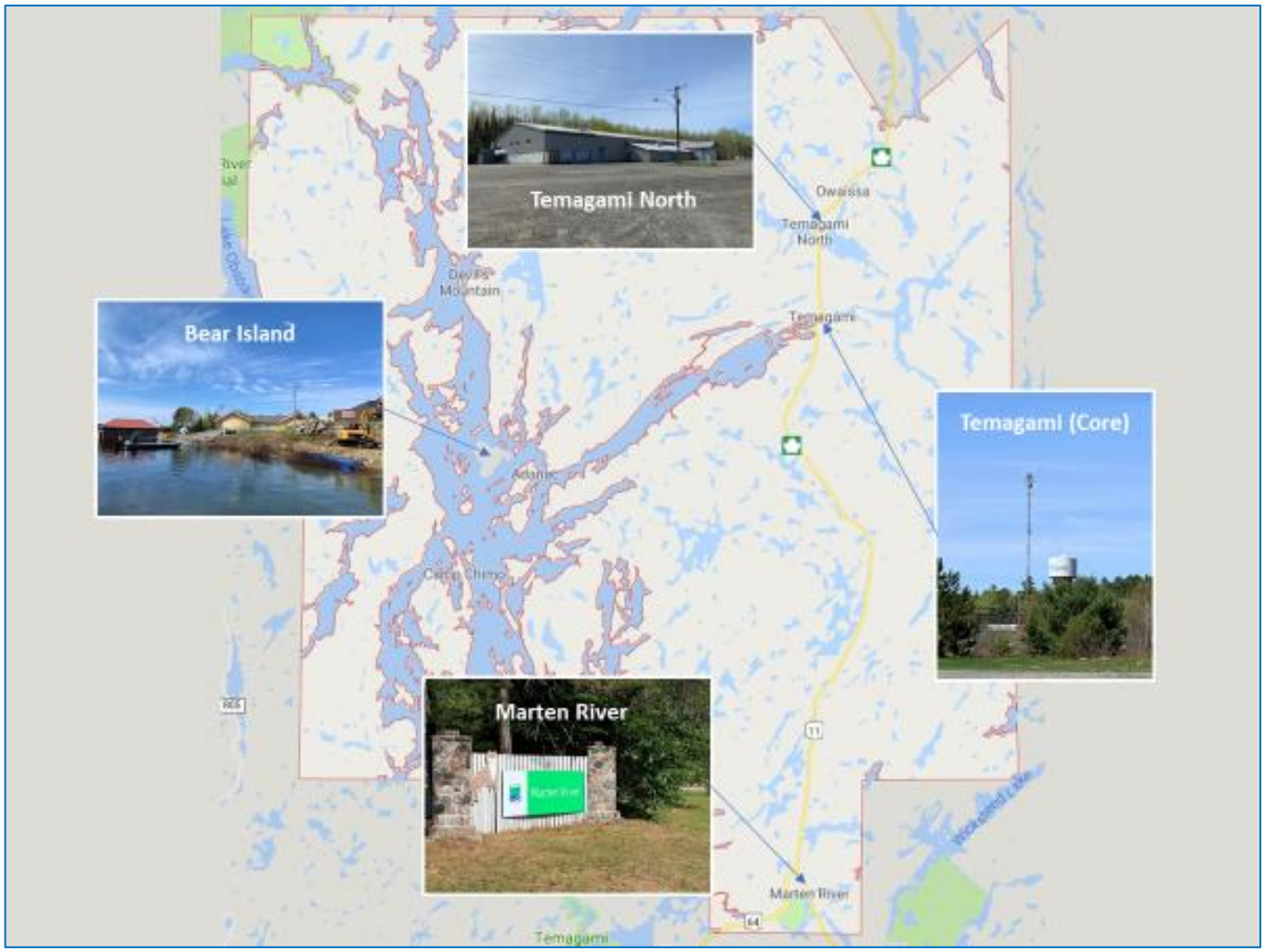


Figure 2: Study areas

[3] https://www.temagamifirstnation.ca/about-us/

4.0 Broadband Primer

Prior to reviewing the regional and community-specific broadband data, a review of what broadband itself is will be discussed. This section will step through the definition of "broadband" including relevant statistics. The global and Canadian backbones that enable the movement of data will be highlighted to provide insight on the highway system our information travels upon.

4.1 What is broadband?

The CRTC's 2017 Communications Monitoring Report defines broadband Internet as "high-speed Internet, with access of at least 1.5 Mbps". In 2016 the CRTC set the well-publicized goals of 50 Mbps download and 10 Mbps upload for broadband Internet by 2021[4]. While it might be possible that a large part of connected Canada can achieve these speeds - as many already do, there will be those areas that continue to languish as they do today. As such, the goal is to reduce from 18 per cent to 10 per cent, the number of homes in Canada that don't have access to those speeds or data by 2021, then down to zero over the subsequent 10 to 15 years.[5]

The Federal Communications Commission (FCC) in the United States changed their current definition of broadband to mean download speeds of at least 25 Mbps and upload speeds of at least 3 Mbps[6]. This has spurred its own debates and issues within the US with regards to funding mechanisms and an overall reset of expectations. It will be interesting to follow this topic and any potential spillover into the Canadian regulatory arena. Thankfully, Canada has not followed in the American regulator's footsteps with regards to Net Neutrality which will be further discussed in the Regulatory Matters section.

[4] The State of Broadband Connectivity in Canada's Rural and Remote Regions 2018 Internet Society isoc@isoc.org
[5] https://www.cbc.ca/news/canada/thunder-bay/tbaytel-waiting-crtc-decision-1.4564590
[6] The Verge

Broadband Internet can be delivered across a variety of mediums including fibre optics, coaxial cable, copper, fixed wireless, mobile wireless and satellite. Before diving into the details of each, it will help to review the following chart that provides a current snapshot as to the carriers active in the study region and the types of broadband technologies they use in the area. This graphic will be referenced again later in the report and the acronyms will be defined.

	FTTH	FTTN	DSL	Dial-up	HFC	Coax	4G/LTE	2G/3G	Fixed wireless	satellite
Ontera		X	X	X						
Xplornet									X	X
Galaxy Broadband										X
Bell Mobility							X	X		
Rogers							X	X		
Does not include cellular flanker brands (ie: Virgin, Koodo), satellite TV (ie: ExpressVu), telecom resellers (ie: Distributel)										

Figure 3: Study area broadband sources

This list does not represent all the services the companies provide in their telecommunications portfolio, only those specific to broadband in the study footprint. Also, there may be Internet Service Providers (ISPs) and Competitive Local Exchange Carriers (CLECs) in the footprint that are not reflected in the chart above. For the most part, these service providers use Ontera (Bell) or other wholesale services to provide their products in the study area; therefore, they have not been listed above.

Broadband Service Layers

Broadband Internet is delivered to the end-user through three main service layers: passive infrastructure, active network and service delivery. While there are many more detailed and technological models within these, the layers as presented are essentially universal.

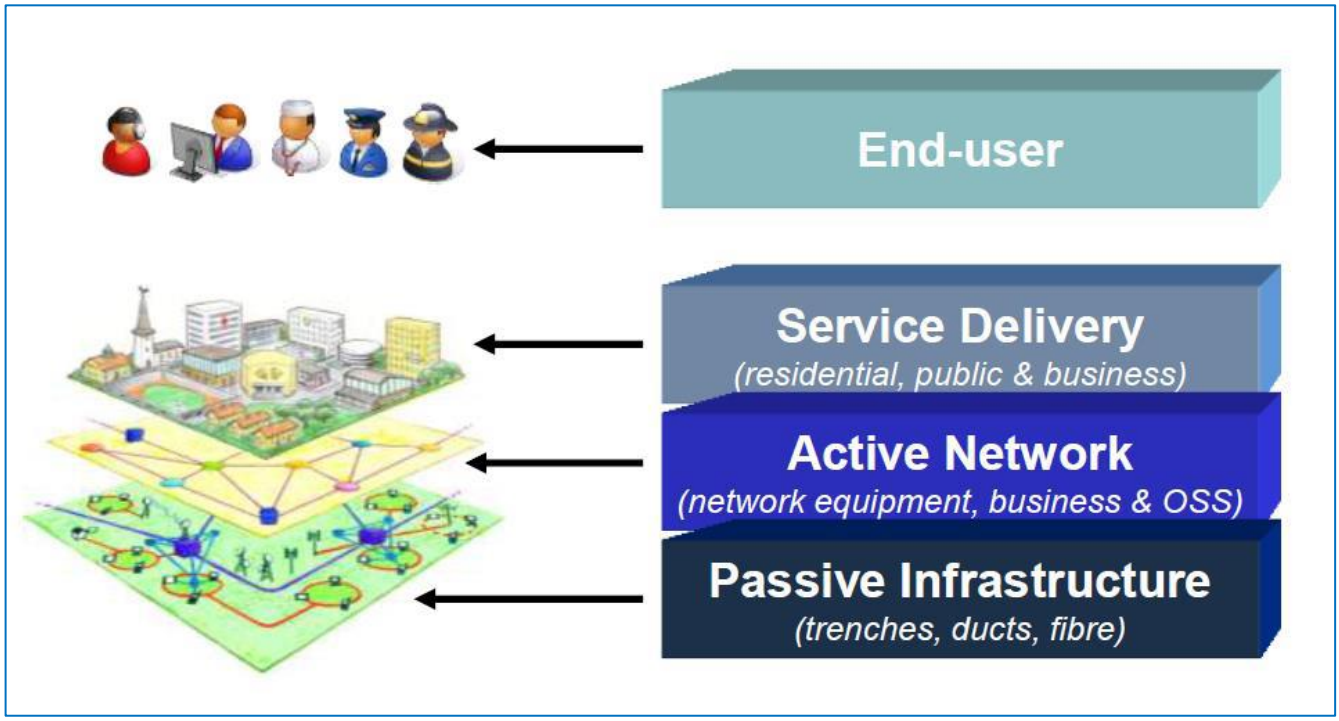


Figure 4: FTTH Handbook, D&O Committee, FTTH Council Europe 2014

The passive infrastructure layer comprises the physical items that are needed to construct the broadband network. Both visible and hidden elements include utility poles, underground ducts, fibre, cable, microwave dishes, towers, equipment racks and so forth.

The active network is made up of the electronics needed to "light up" the passive layer. There are also back office systems such as the operational and billing platforms included in this layer to enable the service provider to commercialize their services.

Finally, the retail services layer comes into play when the other two layers are set. Here the products and services such as Internet and Internet Protocol Television (IPTV)

are packaged and marketed to the consumer. Sales, marketing, and customer service are all part of this layer.
For illustrative purposes, a regional example of these layers could look like the following:

- Passive infrastructure regionally: Ontera's fibre attached to its own telephone poles entering and exiting its own equipment shelters along Highway 11 entering Temagami North.

- Active infrastructure: Ontera electronics housed within the roadside Ontera equipment shelters that repeat and boost the laser-produced light carrying data across the fibre to its Central Office (CO) in Temagami North. Within the CO, Ontera has additional electronics that parse the data into its respective service types for delivery on its copper plant outside of the CO to Ontera's customer base.

- Retail services: Ontera packages, markets and supports its telephone and Internet products for sale to consumers and businesses.

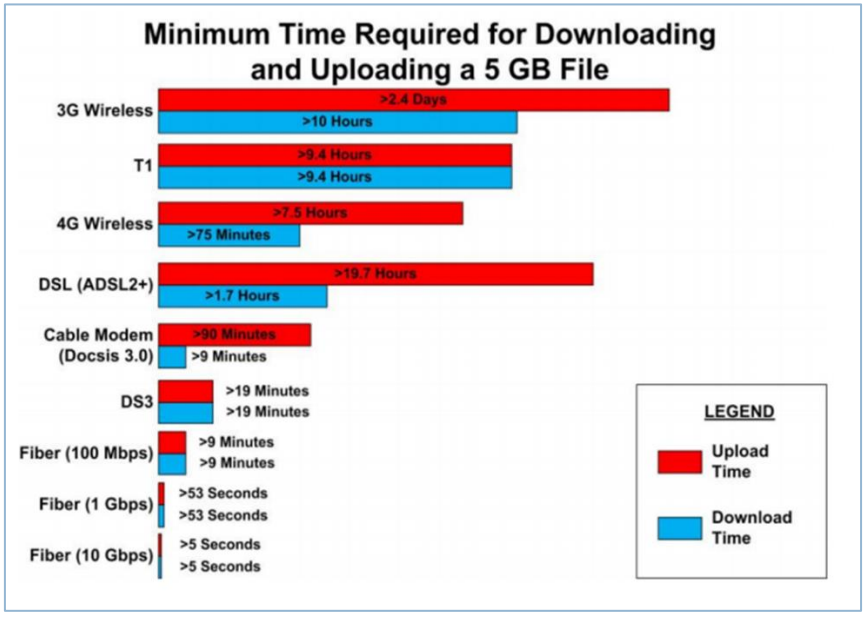
The above model can get somewhat confusing when another service provider either connects to Ontera within its CO to access services directly for distribution in a community on its own passive and active network layers OR if a reseller (usually an ISP) uses the entire Ontera network right to the customer premises and only provides its own retail services. These wholesale and reseller scenarios are typically invisible to the consumer as they receive a bill and service from the retail company.

4.2 High-Speed

While most people might be familiar with the terminology of “download” and “upload”, it is helpful to understand what “high-speed” really means with relation to the Internet. Speed is a combination of bandwidth and latency. For the purpose of illustration, bandwidth is how wide or narrow a pipe is and latency is how fast the material flows within the pipe.

Satellite internet subscribers will be familiar with latency. This is the time it takes for data to travel between points. For satellite services, it can take an appreciable amount of time for data to travel up to the satellite and then get bounced down to the recipient. Excessive latency levels can negatively impact any services that must have precision – ie: telerobotic surgery or even gamers at home.

Bandwidth is the rate at which data flows over the network. This is a measure of throughput (amount per second) rather than speed (distance traveled per second). The following chart illustrates how common network technologies compare in performance to one another.



[7]

Figure 5: Minimum time required for downloading and uploading a 5GB file

[7] **CTC Technology and Energy**

Oversubscription

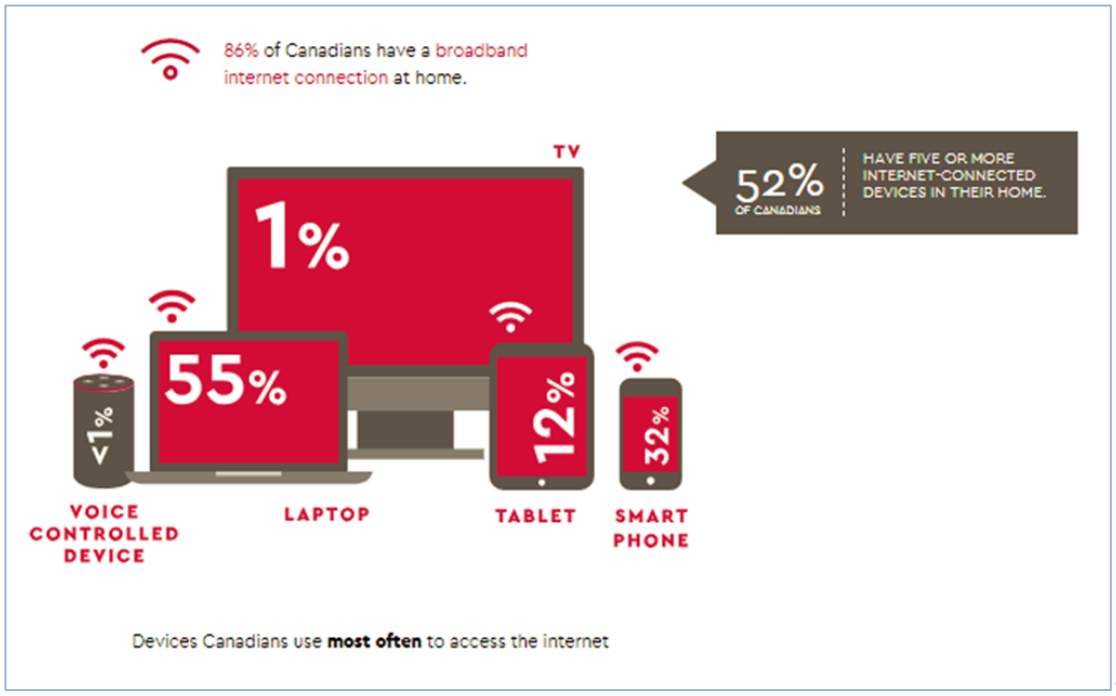
This is an underlying item that may also affect a customer's Internet performance and a critical component in analyzing system needs and gaps. Oversubscription is similar to the airlines' practice of over-selling seats on particular flight routes. Historical data and customer habits provide the companies with the ability to forecast how many passengers will show up for a flight. As airlines prefer full airplanes, they tend to sell more seats than are actually available in the aircraft. If everyone shows up, then there are issues. It is similar to what Internet Service Providers (ISPs) have to do when forecasting for data usage.

Service providers must employ various calculations when determining how much capacity they need to provide for a particular community or customer situation. As electronics and bandwidth are costly, service providers will typically build to a base forecast and allow for network growth as they monitor actual usage. Simply put, they logically assume that not everyone will be accessing a service at the exact same time and at the maximum capacity. The calculations to determine the needs and gaps in this study use the same logic (see Section 7.3).

4.3 Broadband Statistics

The Canadian Internet Registration Authority (CIRA) publishes an annual report on the state of Canada's Internet. Packed with good information and statistics, it provides a snapshot on several key metrics relevant to this regional study.

More than half of Canadians have at least 5 Internet-connected devices in their homes. As discussed in the preceding section, this not only drives the demand for greater Internet speeds, but also places challenges on the quality of the service due to those aforementioned factors.



[8]

Figure 6: Devices Canadians use most often to access the internet

Service providers constantly monitor their overall network quality and capacity. Key to them is that historically the aggregate cross-industry Internet growth has been consistent at 50% Compound Annual Growth Rate (CAGR). This means the total Internet transit traffic towards a network (or subscriber) from the Internet increases by 50% (ie: 1.5x) every year. This has been the trend since the mid-1990s for most high-

[8] CIRA - Canada's Internet Factbook 2018

speed Internet providers. Emphasis has been placed on traffic towards the network since the popularity of online video from the likes of YouTube and Netflix accounts for more than 50% of the network traffic as shown on the following chart[9].

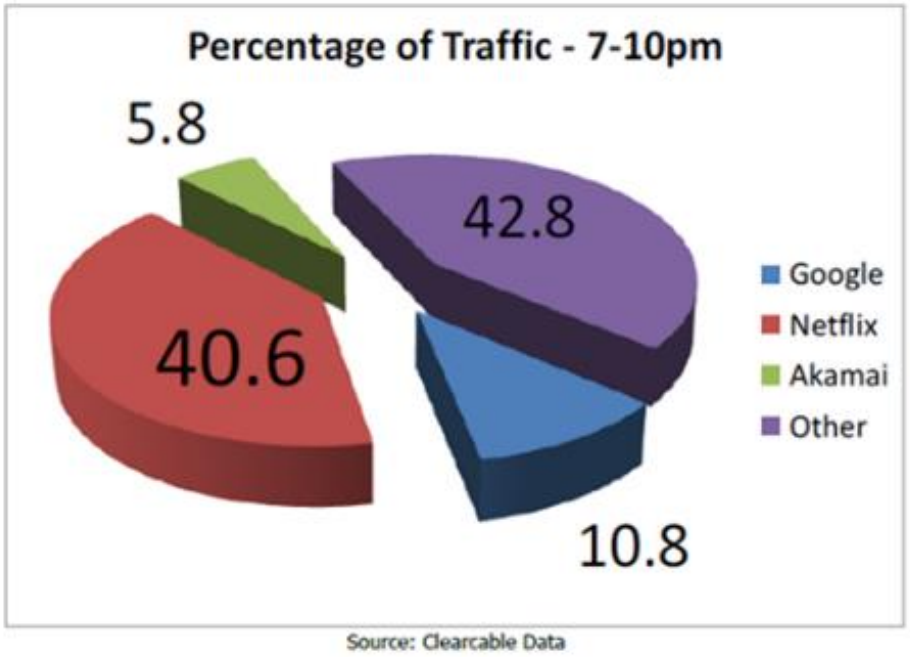


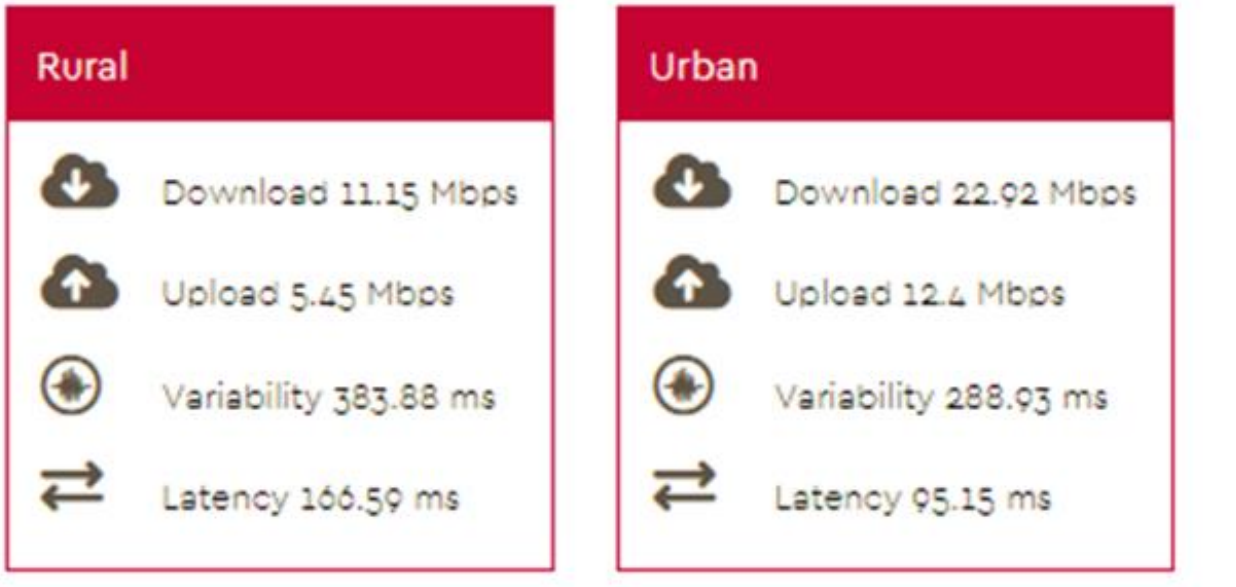
Figure 7: Percentage of network traffic – 7-10pm

Of note, the graphic is a sample snapshot of Internet traffic in the evening between 7pm and 10pm. With the onslaught of Netflix, Internet demand has shifted from predominantly daytime business usage to evening home demand. Add to this Google apps, including YouTube, and the consumer demand is creating inordinate pressure on data requirements for the carriers (the "active network"). Service providers also have to continuously forecast their network data traffic capacities to try to best meet the demands on the system at various times of day. Further, they must calculate the total usage at peak periods to meet the needs of their customers. Based on formulas, historical statistics and the cost of the bandwidth, the carriers will typically over-subscribe the network as discussed in the previous section. If there are 100 homes in a neighbourhood, and everyone purchased a 25Mbps Internet package, it is highly unlikely that every home will be using the maximum at the exact same time; therefore, they plan on a smaller percentage of usage at any one time.

[9] Clearcable Networks

From a community perspective, carriers need to forecast what they believe the total capacity requirement will be for all their current and potential customers. Homes will have one metric and larger enterprise customers that are contracted for high data requirements will have a different metric. Each carrier calculates their needs differently due to technologies and historical models. In some cases, an ISP might use a ratio of 10:1 or less. In another, a company might assess residential DSL customers at 100:1 and businesses at 50:1 ratio. For example, an ISP that has 1,000 subscribers with 10 Mbps service might contract for a 100 Mbps connection rather than the maximum 10,000 Mbps Internet connection its users might require.[10] As noted above, this is important in trying to determine a particular community's needs versus its apparent service gap. Invariably, the service provider will employ a more conservative model to control costs.

Not surprisingly, CIRA's analysis of Internet performance data concludes that rural Internet users generally experience lesser quality Internet service as noted in the graphic below.



[11]

Figure 8: Rural vs urban internet quality of service

[10] CTC Technology and Energy
[11] CIRA - Canada's Internet Factbook 2018

4.4 Global Network

Taking a few large steps back, it is helpful to understand the high-level interactions that illustrate how data traverses our planet and connects the North to the global ecosystem. The World Wide Web is an intricate and complex mesh of computing and storage devices interwoven across the world. It is also a somewhat recent phenomenon when compared to the lifecycle of plain old telephone service of the past century. This new evolution of communications has given rise to the infamous "Cloud" and "Internet-of-Things" (IoT) that many of us interact with while accessing online music or setting our new thermostats.

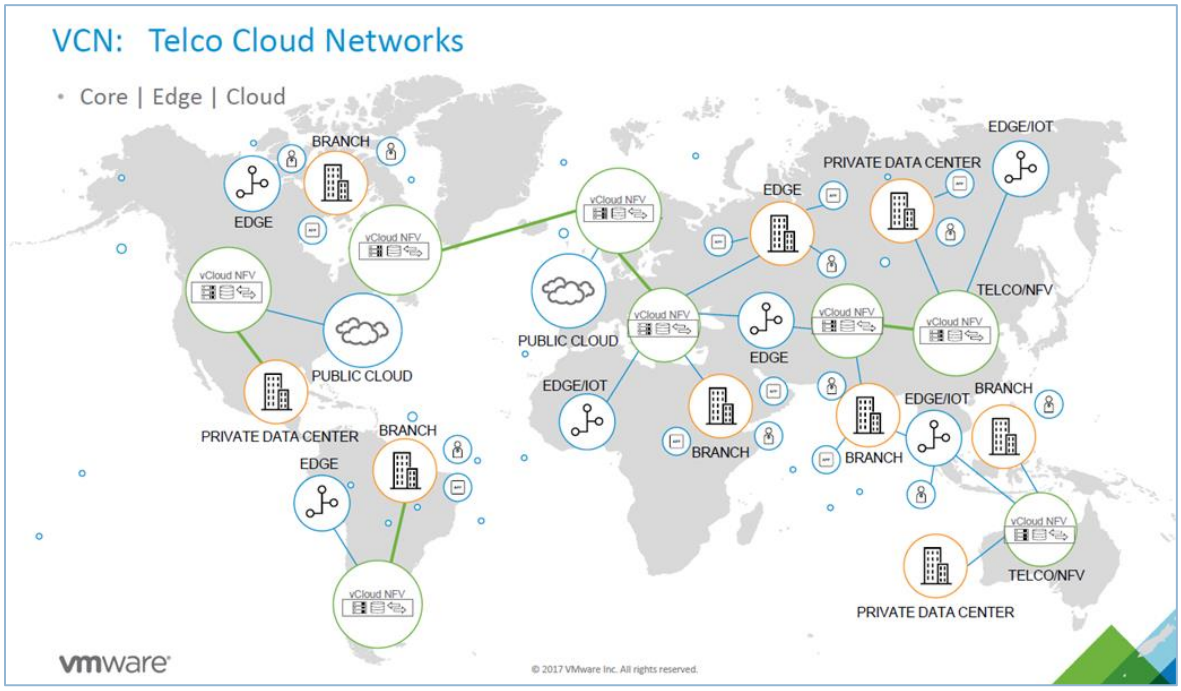


Figure 9: VmWare Inc. cloud networks

Not too long ago, the long-distance telephone network depended primarily on satellites to bounce voice signals across the globe. On the ground, large microwave installations relayed these signals between communities.

Today however, there is an impressive network of undersea fibre optic cables crisscrossing the ocean allowing data to travel at the speed of light from continent to continent. Gone (mostly) are the days of echoes on calls and that perceptible delay (latency) as you waited for your friend to reply to you. It will not be too long before the maps on the following page show the completed undersea fibre network across

Canada's Arctic Ocean – a huge boost for the Far North communities that get connected.

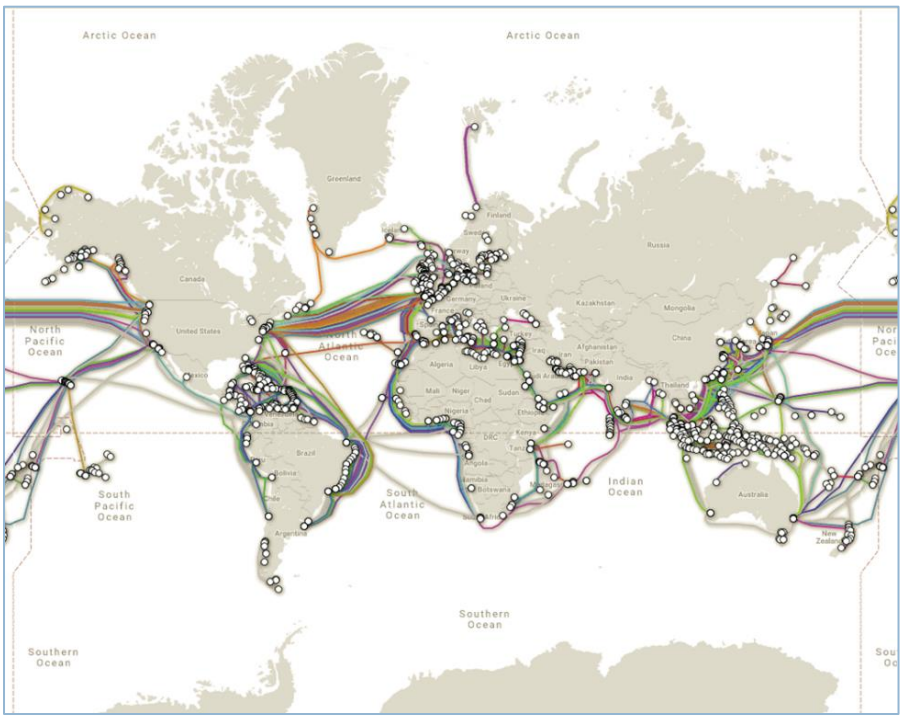


Figure 10: Fibre optics global undersea routes (Huawei Marine)

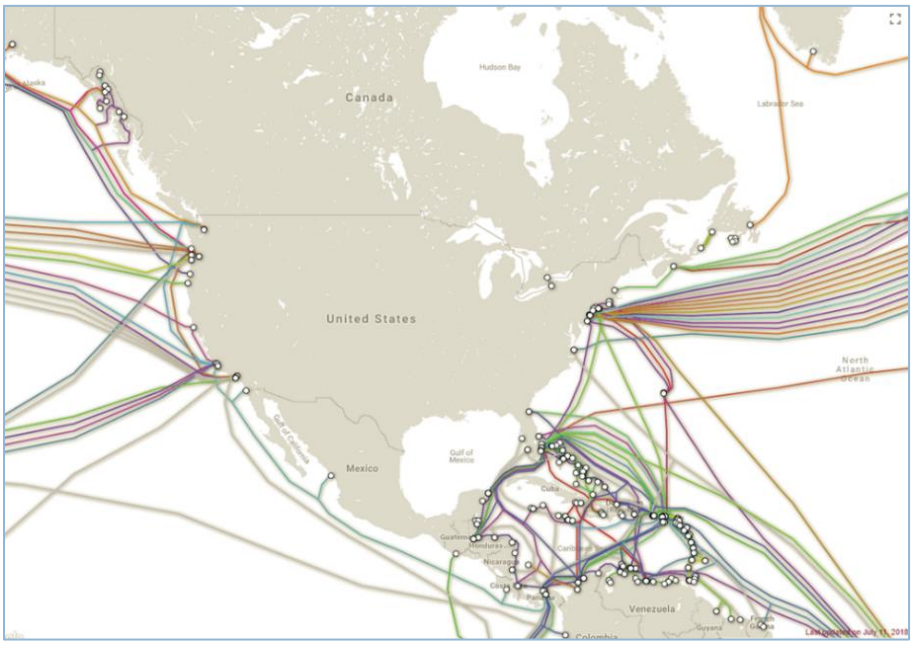


Figure 11: Fibre optics North American landing points (Huawei Marine)

These undersea cables make landfall at strategic locations along the shorelines of their destination countries. From there, ground-based fibre optic transmission routes bring the data in to central data centres, such as carrier hotels.

Canadian Network

All the major communication service providers meet at these data hubs and interconnect with each other so to facilitate the flow of data across their networks and across the country. Given the symbiotic nature of this data exchange, many of the smaller service providers also strive to interconnect at some of these centres to pick-up their traffic at greatly reduced costs and increased efficiencies. However, before discussing data centres, it is important to understand how data traffic gets to these centres and between each other across Canada.

The following map published by Shaw Business is a great example of the predominantly railway based fibre optic transport network across Canada and into key US locations. It also shows the major carrier hotels (indicated by the yellow stars) where Shaw is located so that their potential customers can interconnect with them to buy services. Further to the global fibre maps above, this map shows some of the key international peering locations in New York (to Europe), Seattle (to Asia) and San Jose (to Asia).

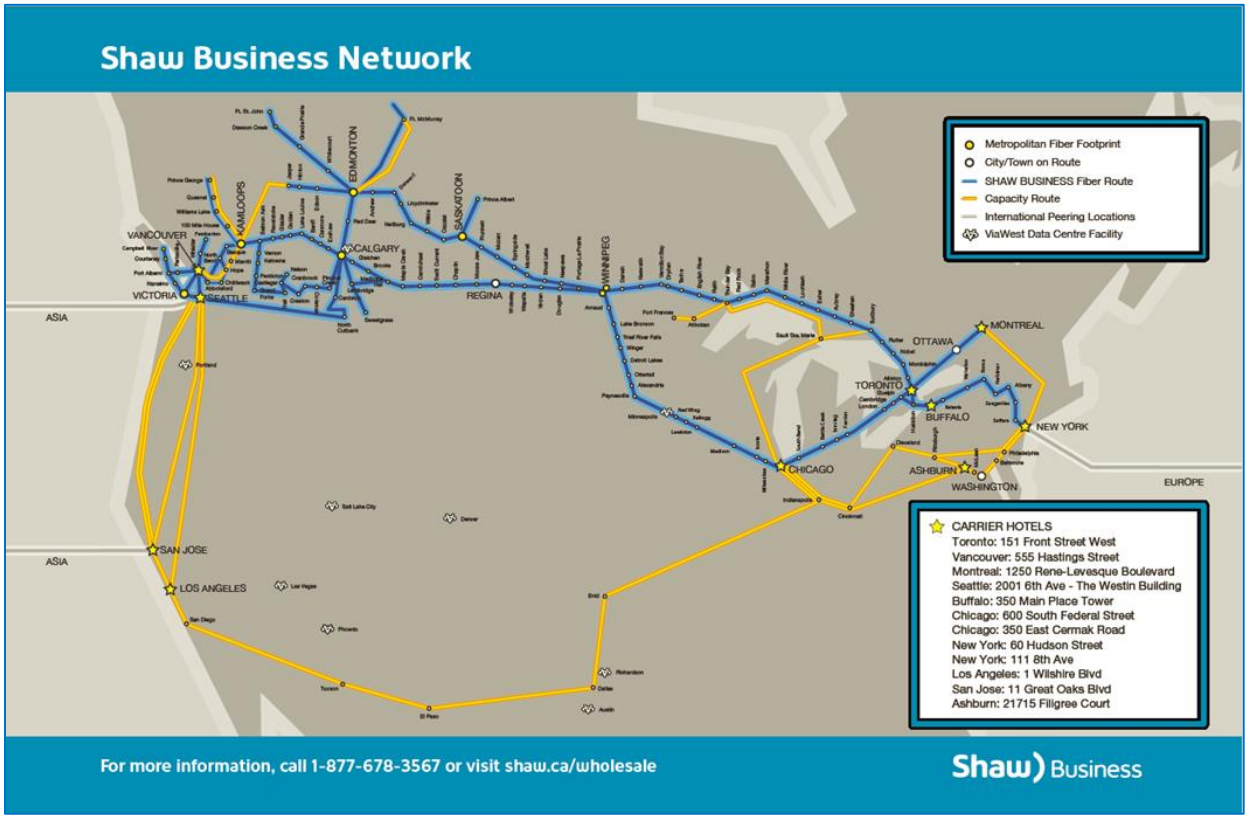


Figure 12: Shaw Business North American fibre routes

The routes shown in the map correspond (mostly) to rail routes. The rail network provides a natural pathway for fibre optic cable to traverse the country. Rail companies own significant Right of Ways (ROW) on either side of their track system and enjoy certain regulatory privileges as was set out in the Railway Act. In most places, rail tracks have priority access across all land ("Dominant Tenement") which simplifies matters for the carriers and why telecommunications companies negotiated directly with the railways to bury fibre within the rail ROW. It reduced the requirement for other complicated approvals, reduced the need to deal with a plethora of landowners and increased the speed by which they could roll out a cross country network.

While it would seem logical to simply access the national fibre that in many cases intersects a community within the rail ROW, it is typically unfeasible. Fibre equipment shelter spacing was based on the electronics of the time and on rail access. There is limited fibre within the older ROWs as dozens of strands may have been placed years ago which are now at full capacity versus the hundreds (sometimes thousands) that are typically installed now. Upgrades to the electronics to create additional capacity and/or gain access to the fibre are significant.

Data Centres

One of Canada's most important "carrier hotels" is located at 151 Front Street West in downtown Toronto. Situated alongside Canada's major railway corridor and in the shadow of the CN Tower, this facility has grown into a secure, hardened technology centre where a majority of Canada's service providers have either direct access to or connect to those that do.

Figure 13: 151 Front Street West, Toronto

Data centres are incredibly secure and they must have fully redundant systems. Only those with security clearance can access these facilities. The buildings will have at least two diverse fibre entry points, multiple generators and advanced fire suppression systems. Due to the volume of electronic equipment in the facility, cooling is a costly factor to deal with; therefore, electricity rates are a challenge for the operators.

The following graphic shows a typical floor in a centre such as 151 Front Street. On a much smaller scale, the Ontera or Bell central offices in communities have similar configurations as do the equipment shelters at the base of towers or alongside fibre facilities.

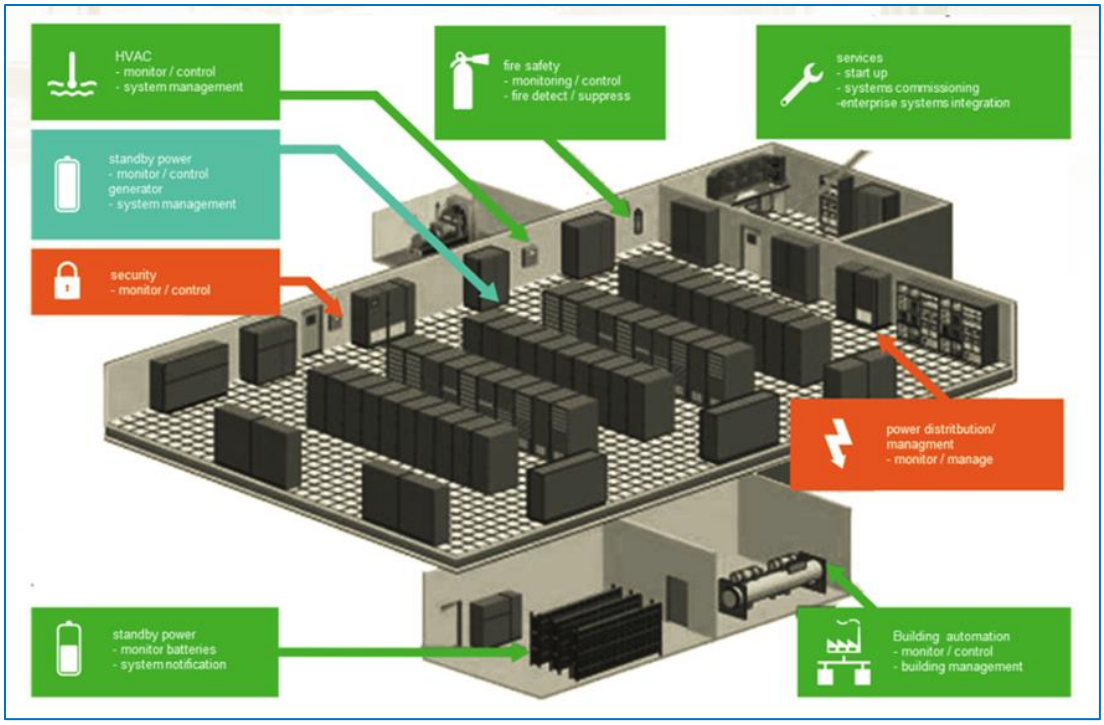


Figure 14: Rebel Networks data centre

The photo shows the rows of equipment cabinets that house the various electronics. Overhead there are cable trays that keep all the wiring organized and safe. Usually cooling is provided underneath the flooring if there are raised floors or ducted throughout the room.

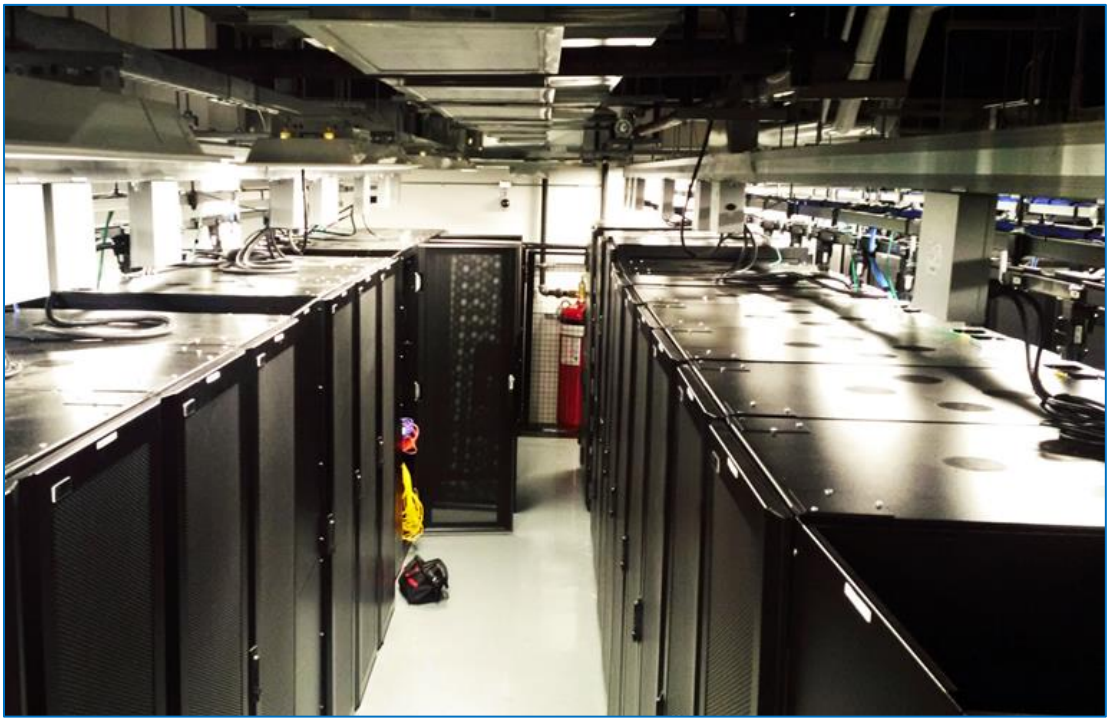


Figure 15: Rebel Networks data centre

Neighbour to 151 Front Street and straddling the other side of the rail corridor, the CN Tower itself is a major communications hub as it was built first and foremost as a large antenna tower. In the bubble beneath the rotating restaurant, there are several levels of massive microwave dishes broadcasting and receiving TV, radio and other data streams across the landscape.

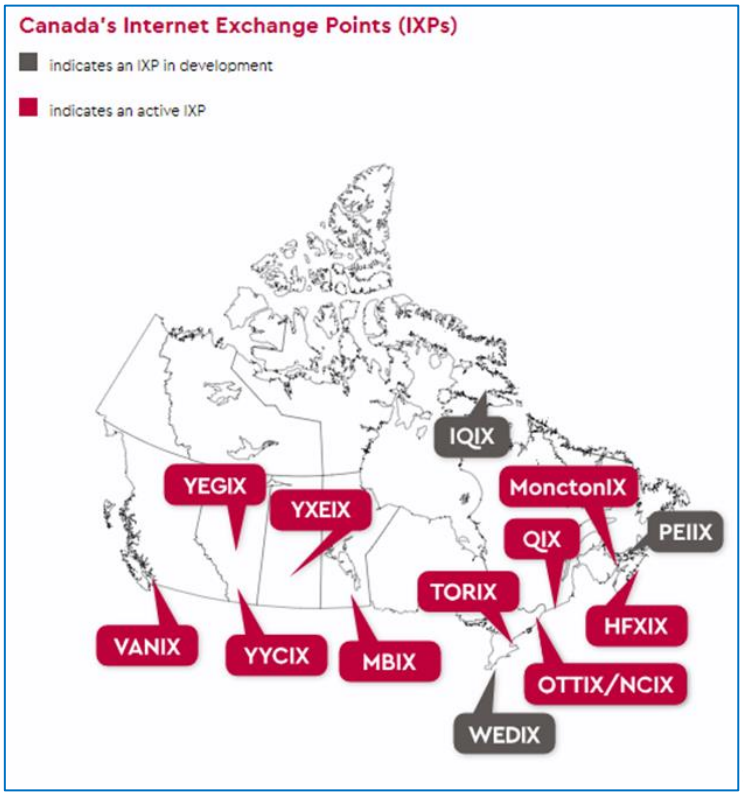
Figure 16: CN Tower, Toronto, ON

Figure 17: CN Tower, Toronto, ON

Internet Exchange Points (IXPs)

IXPs are data centres specific to the exchange of Internet traffic. CIRA points out that one of the benefits to such facilities is that while it brings key Internet suppliers together, it also serves as a way to keep Canadian data within Canada's borders. There are certain classes of data that cannot (or should not) cross into international territory especially due to privacy concerns.[12]

The primary purpose of an IXP is to allow networks to interconnect directly, via the exchange, rather than through one or more third-party networks. The primary advantages of direct interconnection are cost, latency, and bandwidth. It is much cheaper and quicker to exchange traffic directly with each other than to have to send data across distances through multiple carriers. Each step adds time (latency) and consequently costs.



[13]

Figure 18: Canada's Internet Exchange Points (IXPs)

[12] CIRA.ca
[13] CIRA.ca

5.0 Regulatory Overview

The Canadian telecom market is constantly transitioning – as are all technology-based sectors – from a once legacy era to new technologies able to deliver telephony services along with a plethora of other cutting-edge applications. Many of Canada's telecom service providers "TSPs" have existed for over a century established at the same time railways were being built and telegraph lines installed alongside them. However, while technology has been evolving rapidly, changes to Canada's telecommunications regulatory regime have been slow and deliberate. There are those that argue it has been far too slow and even question its relevance in a free market; however, there is no question as to its importance in trying to bring digital equity to the underserviced areas of Canada.

The telecommunications industry in Canada is governed by the federal Telecommunications Act. As such, any service provider in Canada must abide by the rules and regulations that are administered through the Canadian Radio-television and Telecommunications Commission (CRTC).

The Department of Innovation, Science and Economic Development Canada (ISED) plays a key role in the promotion of broadband in Canada and works closely with the CRTC to promote and drive the Federal Innovation Agenda. It has become increasingly apparent that both the CRTC and ISED are intrinsically linked in bringing about Canada's broadband growth. The CRTC recently announced "Connected – Closing the Broadband Gap", a $750 Million fund to be distributed over five years. Meanwhile, ISED rolled out the $500 Million "Connect to Innovate" fund.

With the advent of high-speed broadband and big data pipes, everything from voice services through to a wide array of media can stream across the Net. In the past it was easier to delineate between the infrastructure and technologies that delivered broadcast services such as television and radio versus that of telephone services. Now the Internet has brought about a ubiquitous pipe that is seemingly limitless in terms of the content and services it can serve up globally. More often than not, the telecommunications and broadcasting silos are being knocked down as carriers have

diversified their products and services. Both Bell and Telus have become two of Canada's largest television broadcasting companies with their IPTV deployments. Similarly, Shaw has expanded into telephony, including mobility with the recent purchase of Freedom Wireless.

Setting policies and rules to oversee these continuously interweaving areas and administering them continues to be a challenge. This section will focus on the CRTC and ISED, and some of the more important decisions and policies that they have introduced in relation to broadband. The section will close with an overview of the industry's telecommunications service provider framework.

5.1 Canadian Radio-television and Telecommunications Commission (CRTC)

The CRTC is an administrative tribunal within the Government of Canada that is responsible for regulating and supervising Canada's communication system in the public interest. The CRTC operates under a number of legislative authorities and Acts of Parliament. These include the following: the CRTC Act, the Bell Canada Act, the Broadcasting Act, the Telecommunications Act, Canada's Anti-Spam Legislation (CASL) and the Canada Elections Act, which includes provisions that established the Voter Contact Registry (VCR). [14]

The Commission, as it is otherwise referred to, reports to the Minister of Canadian Heritage. It is comprised of the Chairperson, Vice-Chairperson of Broadcasting and Vice-Chairperson of Telecommunications. There can be up to 13 Commissioners, all federal Cabinet appointees.[15] While the Commission is politically appointed, it acts at an arm's length from the government in more of a judicial-like manner whereby it tends to make decisions much in the same way a court would based on evidence and consultations.

[14] CRTC THREE YEAR PLAN 2017-2020
[15] https://crtc.gc.ca/eng/acrtc/organ.htm

The Telecommunications Act sets out what elements and services are to be regulated. Over the years, the CRTC has rendered many decisions and policies that have guided Canada's broadband industry. However, under certain conditions, the CRTC is able to "forbear" or "refrain" from regulating all or part of a service. This is the case with Internet services, allowing the industry to operate in a more market-based manner. It has refrained from the direct regulation of rates, enforcing quality of service issues, or overseeing the business practices of Internet service providers (ISPs) unlike its regulation of certain telephone voice services.

In 2006, the Government of Canada directed the CRTC to rely on market forces as much as possible. In some markets, several consumer choices are available, resulting in natural competition that brings better prices for consumers. In these cases, the CRTC limits regulations and allows competition to drive the market; in other markets, CRTC regulation is necessary.[16]

5.2 Innovation, Science and Economic Development

The Department of Innovation, Science and Economic Development (ISED) was previously known as Industry Canada. It is comprised of 17 federal departments and agencies, including the Federal Economic Development Initiative for Northern Ontario (FedNor). There are four Ministers that form the senior leadership of this portfolio. The Minister of Innovation, Science and Economic Development has purview over broadband technology matters and spectrum management.

The Minister of Innovation, Science and Economic Development, through the Department of Industry Act, the Radiocommunication Act and the Radiocommunication Regulations, with due regard to the objectives of the Telecommunications Act, is responsible for spectrum management in Canada. As such, the Minister is responsible for developing national goals and policies for spectrum utilization and for ensuring effective management of the radio frequency spectrum resource. [17]

[16] https://www.thecanadianencyclopedia.ca/en/article/canadian-radio-television-and-telecommunications-commission/
[17] https://www.ic.gc.ca/eic/site/icgc.nsf/eng/h_00022.html

While the CRTC "regulates and supervises" according to the Acts; ISED is responsible for the legislation of the Acts themselves, most relevant to this report being the Telecommunications Act. The ISED is also the driver behind the federal government's Innovation Agenda to bolster Canada's economic development and global competitiveness. It has introduced six areas for action of which the fifth, "Compete in a Digital World" links directly to broadband:

"Canada must also do more to give rural communities and low-income Canadians affordable access to high-speed Internet so that they can participate fully in a digital and global economy for a better quality of life."[18]

The Connect to Innovate (CTI) initiative was a direct output of this action area.

5.3 Regulatory Matters

There have been an innumerable amount of policy directives and decisions rendered by the Federal government with regards to the telecommunications industry over the years. The larger telecommunications companies have sizeable regulatory staffs and outsourced legal firms to try and keep up with the requirements as set forth by the government. Add in an ever-expanding service portfolio by the companies, and the task becomes more complex to ensure compliance in the eyes of the CRTC. There is also quarterly, semi-annual, and annual reporting that most carriers must comply with, except for the very smallest of them.

This section will highlight some of the more recent and relevant decisions and policy directives as they relate to broadband especially within the study region.

Open Access (Net Neutrality)

Unlike the ongoing battle in the US over Net Neutrality, Canada has not had the same level of concern in maintaining open access. Within the Telecommunications Act… "internet service providers are treated like utilities, and there are rules around how they can act. There are two key rules in particular: service providers can't give 'undue

[18] Positioning Canada to Lead: An Inclusive Innovation Agenda

or unreasonable preference' — say, to one application or online service over another — nor can they influence the content being transmitted over their networks. Those rules were put in place in 1993, and they pretty much form the bedrock for net neutrality in Canada today."[19]

The Federal Communications Commission (FCC) in the United States is a much more politically charged organization as was recently witnessed by the appointment of the Republican's choice for Commissioner. The CRTC Commissioners are also government appointees, but the Commission does operate more as a court as discussed above. There are several States that are trying to have the American Net Neutrality decision reversed and undoubtedly that fight will continue to wage on. The Canadian public and all of the lower tier telecommunications service providers continue to be very active and extremely vocal ensuring that open access remains as an indefeasible right – not to say there won't continue to be pressure by those that would like to see some relaxation of the policies in the future.

Broadband Internet Decision

Telecom Regulatory Policy CRTC 2016-496[20]

This Decision also is known as "Closing the Gap" or the "Faster Internet" decision. In it, the CRTC made several landmark announcements.

The Commission has recognized and declared that both (i) fixed and mobile wireless broadband Internet access services, and (ii) fixed and mobile wireless voice services are now considered basic telecommunications services. This marks a change from the long-held regulatory focus on wireline services, such as landline telephone, along with the subsidy mechanisms that supported those services.

With a focus on broadband Internet, the CRTC has now provided the industry the regulatory mandate to invest efforts in ensuring all Canadians, regardless of location, receive what it considers this revised universal service objective.

[19] "Why Canada's net neutrality fight hasn't been as fierce as the one in the U.S."
[20] Telecom Regulatory Policy CRTC 2016-496

As such, the CRTC Decision sets out the following objectives:

- Canadians in urban, rural, and remote areas can access affordable, high-quality telecommunications services;
- telecommunications companies continue to invest in, and various levels of government continue to fund robust infrastructure that can be upgraded in the future and that is capable of providing high-quality telecommunications services to Canadians across the country;
- Canadians can access innovative service offerings that enhance social and economic development; and
- Canadians can make informed decisions about their telecommunications services.[21]

To meet these objectives, the CRTC has set forth the target for all Canadians to have Internet access with speeds of at least 50 Mbps download, 10 Mbps upload and the option of unlimited data.

The Commission has announced that it will alter the way it will start to calculate and collect subsidies from the telecommunications service providers so to create a new funding mechanism. The plan is to invest up to $750 million over five years to build or upgrade access and transport infrastructure in underserved areas. For the first year of the fund, no more than $100 million will be distributed. This amount will increase by $25 million annually over the following four years to reach an annual cap of $200 million.

This initiative is meant to be in addition to other government programs and funding. Specifically, the CRTC points out that… “this decision complements the Government of Canada’s Innovation Agenda, notably the action area of competing in a digital world.” This in reference for example, to ISED’s Connect to Innovate fund (CTI).

The CRTC held public consultations on this Decision in 2017 and provided a skeleton outline of certain mechanisms it believes should be included as documented in Telecom Notice of Consultation CRTC 2017-112, which should bode well for the region.

[21] Telecom Regulatory Policy CRTC 2016-496

The Commission has just released in application process for Northern Canada including satellite dependent communities and will open applications for the remainder of Canada by Fall 2019.

Fibre Access Decision

Telecom Decision CRTC 2016-379 (Follow-up to Telecom Regulatory Policy 2015-326) Implementation of a disaggregated wholesale high-speed access service, including over fibre-to-the premises access facilities

Directly related to Telecom Regulatory Policy CRTC 2015-326, this Decision was rendered to set out and clarify the myriad of technical details and costing required for the large incumbent carriers to adhere to. This applies to both telecom and cable incumbents.

The intent is not to provide an analysis of the various architecture and interconnection details, but rather highlight that both this decision and the related Policy will enable competitive service providers in the region access to higher performing network elements and services of the incumbents. This can then translate into a greater choice of providers and competitive pricing once fully implemented.

5G and the 3500 MHz Band

Consultation on Revisions to the 3500 MHz Band to Accommodate Flexible Use and Preliminary Consultation on Changes to the 3800 MHz Band

The next generation of wireless technology is expected to offer faster speeds with less lag time and support many more connected devices. To build networks that offer broad coverage and also the high-speed transfers of large amounts of data, telecom providers will need to use a mix of different types of airwaves, known as spectrum. Lower-frequency airwaves can travel farther while high-band spectrum carries more data.[22]

The ISED had started a consultation process regarding revisions to the wireless spectrum 3500MHz and related bands. This consultation has driven increased media

[22] "Ottawa reveals plans for upcoming auctions for wireless spectrum" Christine Dobby, Globe and Mail, June 5, 2019

attention since it is linked to the eventual roll out of 5G and its possible negative impacts fixed wireless spectrum used in rural and remote settings.

ISED acknowledges that 5G is still a distance away from full commercialization, but it has to proactively study the 3500 MHz band to make sure Canada stays in step with the global market – especially that which will set the manufacturing standards for 5G enabled technology such as smartphones. It is also keenly aware of the importance of 3500 MHz in rural coverage.

"For example, given Canada's geography and widely dispersed population, it can be difficult to make a business case for the deployment of new innovative services in some rural and remote areas of the country. Consequently, some rural areas may continue to rely on fixed wireless access in the 3500 MHz band over a longer period of time than urban areas. As such, and in accordance with one of the objectives of the Telecommunications Act—to promote the availability of reliable and affordable services to all regions of Canada—ISED continues to consider options for promoting access in rural areas within the context of managing this spectrum resource, and within a broader policy context, noting that challenges may vary based on geography, population density and the state of the marketplace."[23]

The ISED's policy objectives for the 3500 MHz band are to:

- foster innovation, investment and the evolution of wireless networks by enabling the development and adoption of 5G technologies;
- support sustained competition, so that consumers and businesses benefit from greater choice; and
- facilitate the deployment and timely availability of services across the country, including rural areas.

As such, the ISED announced that it will initiate a claw back of a portion of 3500 MHz spectrum held by several service providers in preparation for a spectrum auction in 2020. Currently, spectrum in the 3,500-MHz band is designated only for "fixed-wireless" use, which means telecom operators use the airwaves to deliver internet

[23] https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11298.html

service using communications towers and wireless signals. However, in next year's auction they will be deemed as "flexible use", suitable for either fixed wireless or mobile service, key for larger service providers seeking to cover dense urban cellular footprints.

Xplornet, a national carrier that primarily serves customers just outside urban centres and remote areas through a combination of wireless, satellite and fibre optics, said earlier this year it planned to spend $500 million over five years to provide 5G wireless and faster internet in rural parts of Canada.[24] It is one of the companies, along with Bell and Rogers that will be impacted by the claw back. Refer to the section entitled "5G" for additional details.

Tower Sharing

CPC-2-0-17 — Conditions of Licence for Mandatory Roaming and Antenna Tower and Site Sharing and to Prohibit Exclusive Site Arrangements

The Canadian cellular industry has gone through several infrastructure build phases over the years as technologies have changed and coverage has increased. The wireless carriers have always considered their towers as strategic assets and have been hesitant to allow colocation, unless they could get a strategic location from the other carrier. There have been many attempts by cellular entrants to deploy their own network services. Increased tower requests were being made at municipalities and the residents began to push back with NIMBY – Not In My Back Yard. All levels of government were demanding that cellular companies cooperate to allow colocation and therefore reduce the number of towers appearing next to each other.

Finally ISED released revised conditions of licencing for wireless carriers stating that… "the Licensee must facilitate sharing of antenna towers and sites, including rooftops, supporting structures and access to ancillary equipment and services ("Sites") and not cause or contribute to the exclusion of other telecommunications common carriers from gaining access to Sites."[25]

[24] "Ottawa looking to balance tensions between telecom carriers, consumers" David Paddon, The Canadian Press, June 5, 2019

[25] https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09081.html

Unfortunately, even with this condition, there are still enough exclusions that colocation requests are often prevented or greatly impeded. The lack of willing colocation can impact the region as wireless ISPs (WISPs) or other cellular companies look to cover communities and/or existing transportation corridors as effectively as possible.

Pole Attachment Fees Increase

The OEB's New Wireline Pole Attachment Framework: Updated Single Provincial Pole Attachment Charge

The Ontario Energy Board is the provincial body that regulates, amongst other things, electricity rates and utility pole access fees. Their recent decision to almost double the per pole rental fee from $22.35 to $43.63 has sparked an uproar amongst all the companies that have to attach to utility poles to carry their facilities.

In the view of the OEB… "Elements of the underlying methodology as well as certain costs were updated in favour of electricity ratepayers, while other elements were updated in favour of carriers. In the OEB's view, the increase in the charge is reasonable given the benefit that carriers have received over the last 13 years. Unlike the majority of electricity distribution customers, carriers enjoyed the benefit of what was essentially a rate freeze."[26]

The Ontario Broadband Coalition was formed by a large cross-section of service providers and special interest groups. It points out that the new rates make Ontario's pole fees the most expensive on the continent and almost double that of the rest of Canada.[27]

Rock is prevalent in Northern Ontario which makes burying fibre optic cable untenable for any business case. For smaller providers, installing their own poles can also negatively impact any decision to bring new service to a community. The increased fee also jeopardizes those providers that currently use these poles and will in turn affect customers as prices may have to rise.

[26] EB-2015-0304 Report of the Ontario Energy Board Wireline Pole Attachment Charges March 22, 2018
[27] http://ontariobroadbandcoalition.ca/

Recently, the Doug Ford government committed to reviewing these fees, among other policy items, in a bid to encourage additional broadband deployment.

Final rates for aggregated wholesale high-speed access services

Telecom Order CRTC 2019-288

On August 15, 2019, the CRTC issued Telecom Order CRTC 2019-288 that set off a media barrage by the large incumbents, blasting the Commission for setting low wholesale rates for access to their networks by other service providers. Bell Canada led the offensive declaring that they would stop investing in the roll-out of their Fixed Wireless broadband internet network. They stated that they would no longer deploy the last 200,000 households in their rural internet expansion program and will reassess all of their other broadband projects. Many of the other larger telecom and cableco's also stated they would adjust their broadband projects, particularly impacting rural and remote regions across Canada.

As stated in a release by the CRTC:
"To foster competition at the wholesale level, the CRTC requires that large companies sell access to their networks under specific terms and conditions. Service providers use this access, with their own networks, to offer Internet and other services to their own retail customers. In other words, independent service providers are wholesale customers of large cable and telephone companies. The CRTC sets the rates at which telephone and cable companies may charge their wholesale clients. The rates are based on the costs that the large cable and telephone companies incur to provide the wholesale service, and include a reasonable markup."[28]

While this is a significant decision by the CRTC, it does not necessarily impact the Study Region as Ontera is the registered service provider. Even though it is part of Bell, Ontera operates within its own tariffs thus the effects will need to be analyzed further. However, in larger centres where companies such as TekSavvy make heavy use of the underlying Bell network to access its clients, this outcome will provide a marked cost

[28] https://crtc.gc.ca/eng/internet/facbill.htm

savings to their operations that, one assumes, will provide the capacity for increased competition in pricing.

At time of writing, the large cable companies have filed a notice of motion with the Federal Court of Appeal to appeal the CRTC's ruling on wholesale internet rates.

M-208, Rural Digital Infrastructure

Rural Wireless Digital Infrastructure: A Critical Role

"On 8 May 2019, the House of Commons unanimously adopted Private Member's Motion M-208, calling on the House of Commons Standing Committee on Industry, Science and Technology (the Committee) to study approaches to encourage wireless infrastructure deployment in rural Canada, given that this infrastructure is critical, particularly during a crisis. The Committee acknowledges that considerable effort has been made in recent years to improve connectivity in Canada, particularly in rural and remote areas. However, it is worth conducting a more in-depth study of how these initiatives can further wireless infrastructure deployment in rural and remote areas, as well as a more in-depth review of available, reliable, and authoritative data and analysis on connectivity in these areas. This infrastructure is critical for rural Canadians, not only during emergencies or natural disaster, but also in their daily lives. The Committee expresses concerns regarding the appropriateness of the CRTC's stewardship of the deployment of wireless infrastructure in rural and remote areas, and the amount of time it is taking to provide solutions."[29]

The Committee has made the following recommendations:

- Consider prospective solutions to address gaps in wireless infrastructure deployment in rural Canada.
- Study ways to improve wireless infrastructure availability and reliability to ensure optimal performance in all circumstances and particularly, in an emergency.
- Ensure that when allocating spectrum licenses, the interests of rural areas are considered.

[29] https://www.ourcommons.ca/DocumentViewer/en/42-1/INDU/report-18/page-ToC

- Support and encourage the development of innovative ways to provide digital wireless services in rural areas to improve connectivity in areas where deploying wireless and/or wired infrastructure is physically and economically challenging.
- Treat mobile services as essential to both the safety of the public and participation in the modern economy, particularly in rural areas that are currently unserved or underserved.

Connect to Innovate (CTI)

The Connect to Innovate program was the outcome of the ISED's Innovation Agenda action area "Compete in a Digital World". CTI was introduced as part of federal Budget 2016 as a five-year initiative committing $500 million to extend and improve broadband service in rural and remote communities. The intake for applications closed in 2017; however, this summary was included as the CTI process might serve as a window to the CRTC "Closing the Broadband Gap" fund.

The ISED stated that there is… "a focus on supporting new backbone infrastructure projects that connect public institutions like schools, hospitals and First Nation band offices. A portion of funding is also available for backbone infrastructure upgrades and last-mile projects connecting underserved households and businesses currently lacking service at speeds of 5 Megabits per second (Mbps).[30]

The most recent Federal Budget allotted additional funds to the CTI program to surpass the original $500M. At the time of writing, there has been $517.6M awarded with additional projects being announced.

[30] https://www.canada.ca/en/innovation-science-economic-development/programs/computer-internet-access/connect-to-innovate/announced-projects.html

5.4 Telecom Service Provider Categories

The CRTC defines a Telecommunications Service as "any service involving the use of telecommunications in whole or in part and which is provided by any person, organization, unit, or legal entity to any other private person, organization, unit, or legal entity. Telecommunications services include both regulated and unregulated services, such as the provision of Internet access".[31] It further defines telecommunications as "any emission, transmission, or reception of intelligence by any wire, cable, radio, optical, or other electromagnetic systems."[32]

A Telecommunications Service Provider (TSP), otherwise referred to as a "service provider" or "carrier" in this report, must register with the CRTC – regardless of size. This includes Voice over IP (VoIP) services, wireless services and Internet services to name a few. It does not mean that the CRTC directly regulates the actual business operation, but it must be registered, nonetheless.

The CRTC subdivides the different types of TSPs into two major categories, namely "facilities-based" or "non-facilities-based". As the terms imply, the first group provides services over transmission facilities that they either own or operate, the second essentially re-sell services over another provider's network facilities.

Facilities-Based-Providers

These types of telecommunications entities own or operate transmission facilities as defined in the Telecommunications Act, such as:

- Incumbent Local Exchange Carriers (ILECs) - facilities-based incumbent provider of local voice services. These are the large telephone companies, such as Bell and Telus. There is also a sub-classification known as Small Incumbent Local Exchange Carriers (SILECS). These include companies like Cochrane Telecom (and formerly Ontera) that have operated in their communities for over 100 years in most cases.

[31] https://crtc.gc.ca/eng/dcs/glossaryt.htm#w
[32] https://crtc.gc.ca/eng/dcs/glossaryt.htm#t

- Competitive Local Exchange Carriers (CLECs) - a telecommunications entities that own and/or operate transmission facilities, as per the Telecommunications Act, and is in competition with the ILECs. Companies such as Vianet (Exatel) operate as CLECs in some of the region. Many of the ILECs and SILECs also compete in each other's territories.

- Wireless Carriers – in this case, those wireless carriers that own and/or operate transmission facilities. Examples would include Bell Mobility, Rogers Wireless and Telus Mobility. Many of these companies also have flanker brands, such as Koodo, Fido and Virgin Mobile.

- Other Carriers – somewhat of a catch basin for carriers such as Xplornet and Galaxy Broadband that have their own facilities but provide satellite and fixed wireless.

Non-Facilities-Based Providers

These are telecommunications entities that do not own or operate transmission facilities. These companies purchase all their services from a facilities-based company such as those noted above, to resell to retail customers. In the case of broadband Internet services, companies might fall into one of these two categories:

- Resellers of High Speed Retail Internet Service (RHSRIS) - entities engaged in the resale of Internet services to retail customers. Examples in the region might include Teksavvy and Distributel.
- Digital Subscriber Line (DSL) Providers - This type of provider provides DSL service. They do not provide the telephone line over which the service is delivered. Digital subscriber line (DSL) service provides high-speed access to digital networks via the same copper telephone lines that are used for common voice telephone services.

An Internet service provider (ISP) is an organization that provides services for accessing, using, or participating in the Internet. Internet service providers may be

organized in various forms, such as commercial, community-owned, non-profit, or otherwise privately owned.[33]

An ISP can be a provider within any of the above defined categories (ILEC, CLEC, Resellers). In other words, an ISP can provide Internet services using its own network, parts of another provider's network or completely wholesale other network providers' systems.

A wireless Internet service provider (WISP) is an Internet service provider with a network based on wireless networking. Technology may include commonplace Wi-Fi wireless mesh networking, or proprietary equipment designed to operate over open 900 MHz, 2.4 GHz, 4.9, 5.2, 5.4, 5.7, and 5.8 GHz bands or licensed frequencies such as 2.5 GHz (EBS/BRS), 3.65 GHz (NN) and in the UHF band (including the MMDS frequency band) and LMDS.

A WISP is distinct from other wireless services we currently use. Most cell-phone service providers offer wireless Internet service—with 4G LTE being the fastest current technology—but that doesn't make them WISPs.[34]

[33] **https://en.wikipedia.org/wiki/Internet_service_provider**
[34] **https://www.pcworld.com/article/2067283/meet-wisp-the-wireless-future-of-internet-service.html**

6.0 Local Access Distribution Network

There are many delivery methodologies for broadband Internet services depending on the location and availability of service providers. This section will highlight the most popular types and provide a description of the technology, including:

Terrestrial:

- Fibre-to-the-Home (FTTH). This is also referred to as Fibre-to-the Premised (FTTP) to include businesses and other non-residential premises.
- Fibre-to-the-Node (FTTN)
- Digital Subscriber Line (DSL)
- Coax Cable
- Hybrid Fibre Coax (HFC)

Wireless:

- Fixed Wireless
- Mobile Wireless (not typically considered a broadband access technology; however, in the region there are many that use data hubs and turbo sticks from carriers such as Bell Mobility and Rogers so it will be referenced herein.)
- Satellite

The graphic that follows does a very good job at illustrating the relative performance metrics between wireless and wireline technologies. Essentially, FTTP is a far better architecture than DSL and older cable technologies. 5G has been announced as the next evolution of high capacity wireless technology, but its full implementation is several years away, at least in the study region. It is not shown on the graphic below but certainly would rank higher in the matrix than the other noted wireless technologies once it becomes commercialized and depending on which version of 5G is referenced. See the section entitled “5G” for additional information.

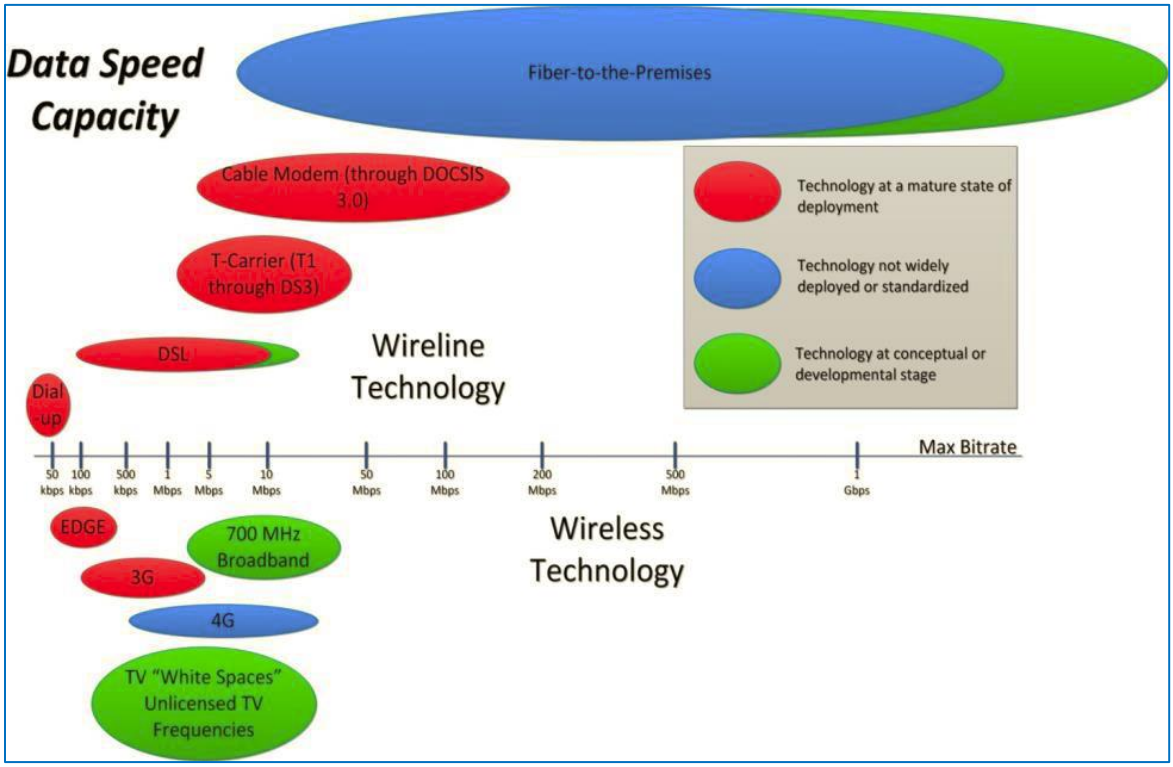


Figure 19: Data speed capacity (CTC Technology and Energy)

As previously noted, the following chart highlights the local service providers and a cross-section of their access technologies in use within the study area. Resellers that may be using wholesale access from carriers such as Ontera, are not shown on this chart.

	FTTH	FTTN	DSL	Dial-up	HFC	Coax	4G/LTE	2G/3G	Fixed wireless	satellite
Ontera		X	X	X						
Xplornet									X	X
Galaxy Broadband										X
Bell Mobility							X	X		
Rogers							X	X		
Does not include cellular flanker brands (ie: Virgin, Koodo), satellite TV (ie: ExpressVu), telecom resellers (ie: Distributel)										

Figure 20: Study area broadband sources

Of course, several of these service providers are capable of carrying more than Internet services. With the expansion of competitive telephone companies (CLECs) and quickly evolving technology, providers can deliver Internet, telephone and television; however, to what effectiveness depends on location factors as noted throughout this report.

6.1 Terrestrial

Overview

In all instances, data is delivered to each community to a service provider's point of presence (POP). There are several examples of POPs depending on the location being served and the service provider. The traditional telephone companies, Ontera in this case, have Central Offices (CO). These are buildings that house all the telecommunications equipment required to operate and deliver the services in the community. They are either backed up by generators and/or large battery banks (refer to the section entitled "
Data Centres" for additional information). The size of COs used to be predominantly dictated by the quantity of copper wires that needed to be connected into the community. These copper plants and related switching gear took up a lot of space and in many of the study communities, this is still the case. However, with the advent of fibre networks, these facilities are beginning to shrink in size.

While there are no cable TV operators in the study, it is useful to understand the concept. Cable TV providers also have a similar infrastructure as noted above but as they dealt with television broadcasting exclusively until more recent times, these buildings are known as Head Ends. Prior to fibre optic transport, most TV channels were delivered over satellite to very large satellite dishes next to the building. This is still the case in a majority of locations, including large urban centres such as Toronto. However, companies such as Cogeco or Eastlink can now aggregate most of their channel delivery at key facilities and then distribute their line up across other means, preferably across their fibre backbone networks to their local distribution hubs. Most local content is still received via regional and local satellite dishes.

These companies along with smaller providers do not always need COs or Head Ends in communities and can place equipment in much smaller environmentally secure shelters or cabinets. These are still considered POPs for the purposes of this report. A POP houses the relevant type of equipment specifically suited to the service that needs to be delivered. Each technology has a different set of equipment, but for the purposes of this report the focus will be on the access and distribution methods from the POP to the premises, not on the electronics themselves.

The following graphic illustrates a POP in relation to a fibre-based local network.

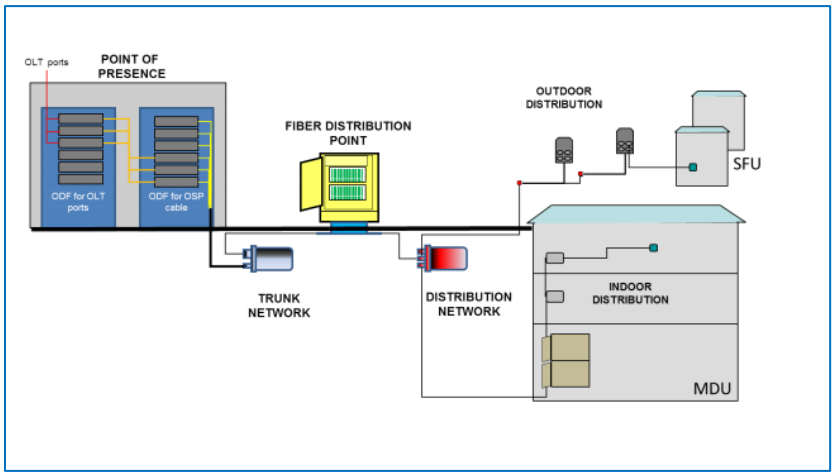


Figure 21: SFU=Single Family Unit, MDU=Multi Dwelling Unit

The following graphic shows the various iterations of fibre towards the home or premises (FTTP). In the following sections both Fibre-to-the-Home (FTTH) and Fibre-to-the-Node (FTTN) will be highlighted. Fibre-to-the-Curb (FTTC) is closely related to FTTN; similarly, Fibre-to-the-Building (FTTB) is interchangeable with FTTP in this case.

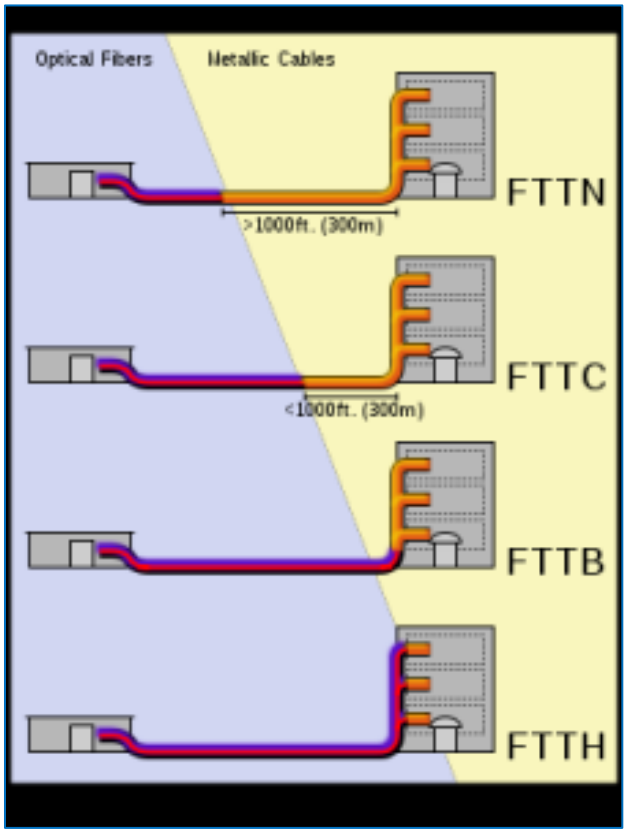


Figure 22: Types of Fibre-to-the-X (Attinternetservice.com)

Fibre-to-the-Home (FTTH)

FTTH is a fibre optic communications path that connects the service providers electronics directly to the customers premises. Also called Fibre-to-the-Premises (FTTP).[35]

There are two prevalent forms of FTTH topology – point to multi-point (P2MP) and point to point (P2P).

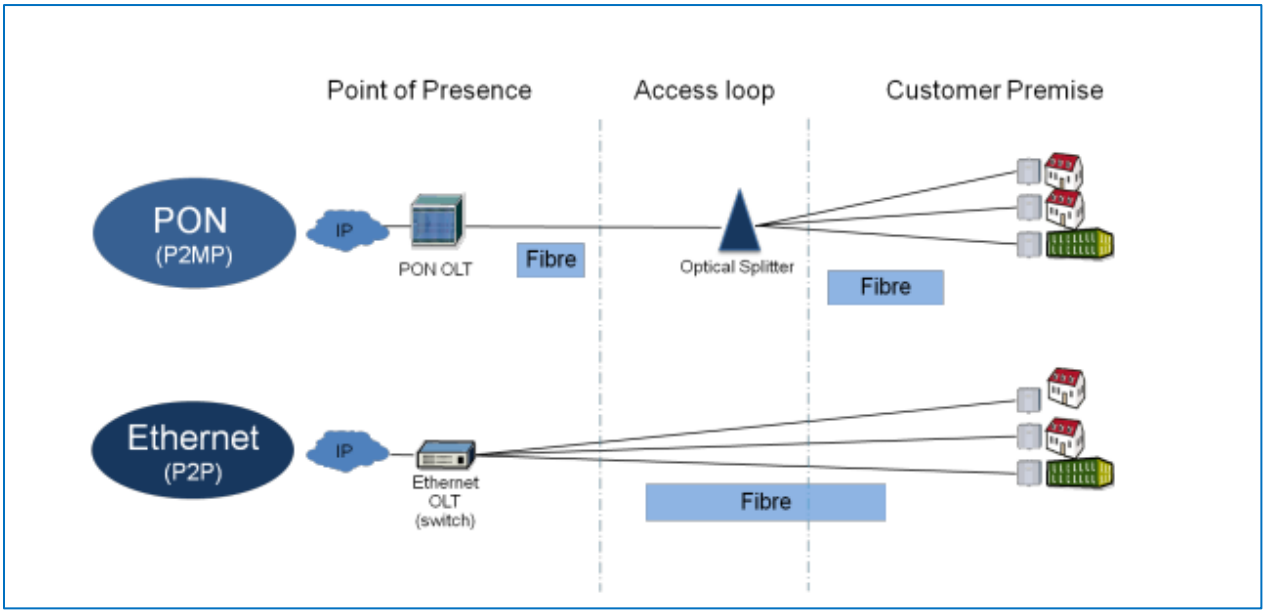


Figure 23: Types of FTTH topology (FTTH Council Europe)

As illustrated above, P2MP begins with one fibre that is then split to multiple fibres closer to the target neighbourhood. The technology that combines with this distribution is known as passive optical network (PON); whereby, the light waves travelling through the fibres are split into channels to carry data to and from the customer. This is quickly becoming the favoured deployment strategy of carriers as it can take advantage of existing and potentially constrained fibre assets already in the market to extend direct fibre links to customer premises.

[35] What Fiber Broadband Can Do For Your Community, BROADBAND COMMUNITIES, www.bbcmag.com, FALL 2016

The second topology is P2P which means a dedicated fibre link directly between the service provider's POP and the end user. This topology uses an ethernet transmission technology, also known as Active E. The advantages include a dedicated connection and a more future-proof ability to transmit greater amounts of data over the fibre since the waves are not split towards the user. However, one can argue that the pace of electronics development and its ability to carry greater amounts of data through the spectrum of light waves, is increasing rapidly. This is likely to reduce the risk of bandwidth constraint with PON architecture, especially on residential applications.

Figure 24: Ontera fibre (orange/red tags)

Fibre-to-the-Node (FTTN)

In a FTTN network, fibre is extended to a street cabinet or an on-pole cabinet an average of 1,000 to 5,000 feet from users. From there, copper connects users, typically through a variant of digital subscriber lines (DSL). Cable companies, such as Cogeco also use the FTTN topology in their hybrid fibre coax (HFC) local networks as will be described below. In this case, coaxial cable extends from the node to the premises.

The following example shows FTTN deployed in a telephone company network. The node houses the digital subscriber line access multiplexer (DSLAM), a network device that aggregates the data from individual DSL delivered to end users.

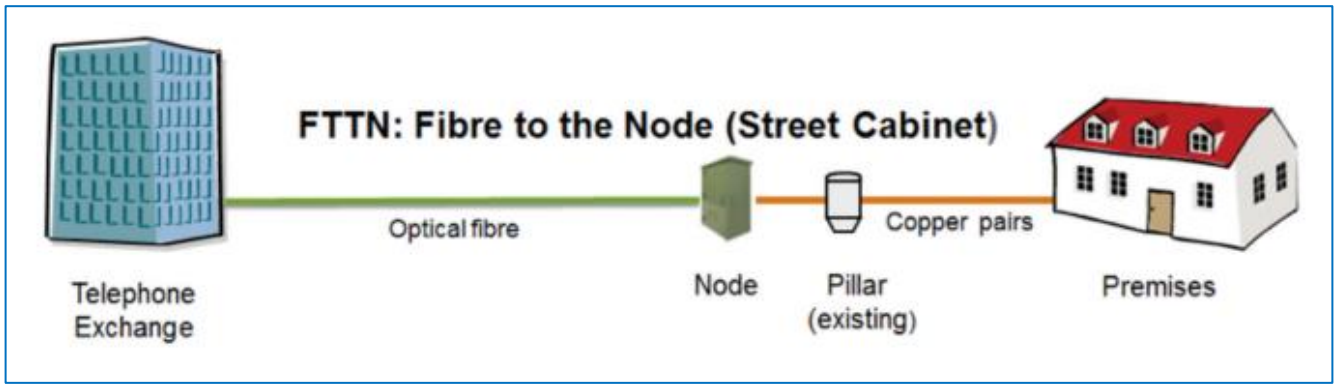


Figure 25: FTTN example (www.nbnco.com.au/.../fttn-construction-fact-sheet.pdf)

FTTN is a preferred way for service providers with existing local copper and coax distribution to increase the amount of data capacity it can bring to neighbourhoods without having to replace all the copper to each premises. Distance greatly affects the amount of data copper can carry between the service provider's POP and a customer's location as shown in the graph below. By using fibre to between the POP and neighbourhood node, the service provider can eliminate extremely long copper runs and increase capacity. As noted in a previous section, the elimination of the copper entering the Central Office also has its benefits for the carriers.

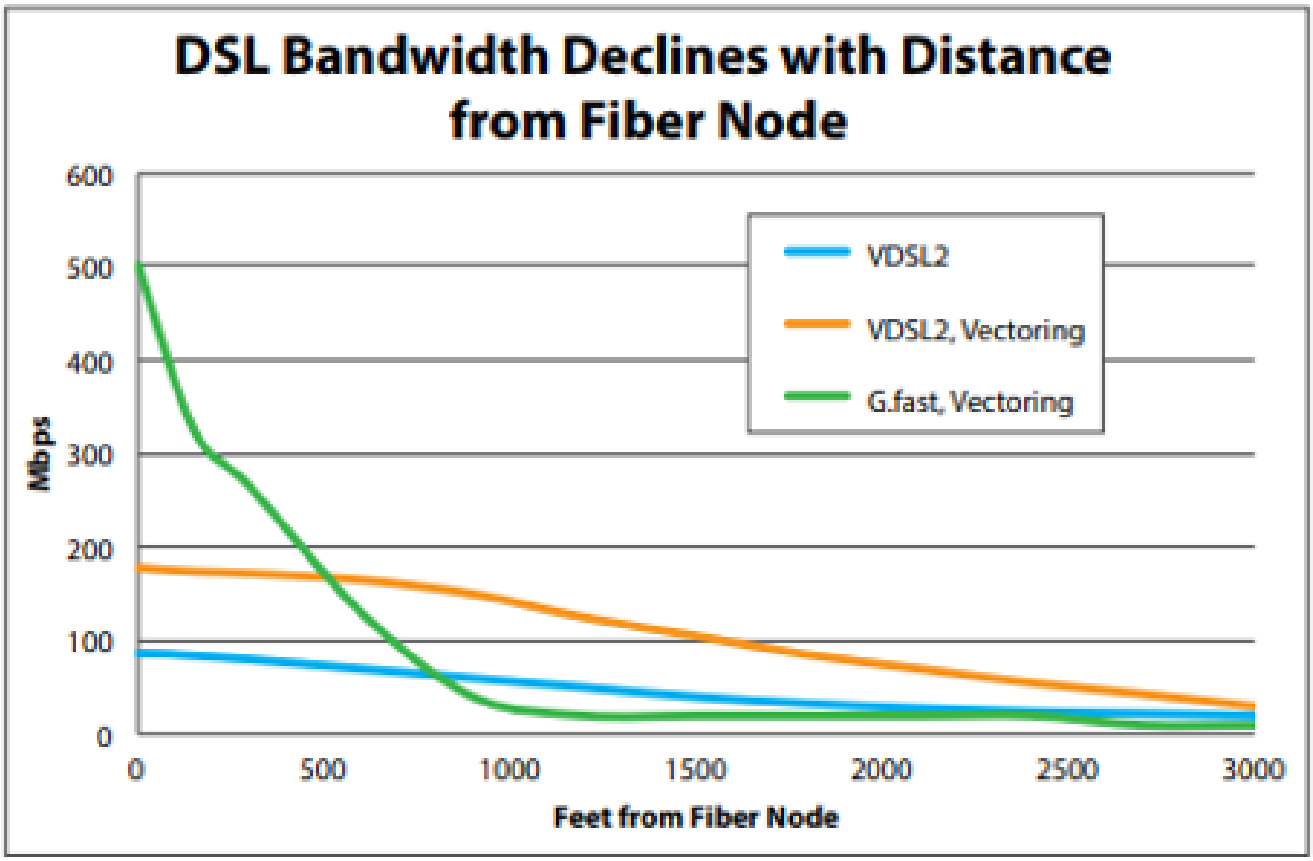


Figure 26: Broadband Communities - What Fiber Broadband Can Do For Your Community

Digital Subscriber Line (DSL)

DSL is a technology for Internet access over voice lines. There are various types of DSL, including asymmetric DSL (ADSL – used in the study area), high-bit-rate DSL (HDSL), symmetric DSL (SDSL) and very-high-bit-rate DSL (VDSL). The whole group is sometimes referred to as "xDSL."[36] VDSL is super-fast DSL service. This type of DSL Internet is the fastest: providing speeds of up to 50 Mbps in certain areas.[37] The study area only has the slower, older ADSL technology.

The following chart provides an overview of various DSL technology speeds versus FTTH. (Only ADSL is present in the region).

[36] **https://www.gartner.com/it-glossary**
[37] **The Internet Experts℠ Blog**

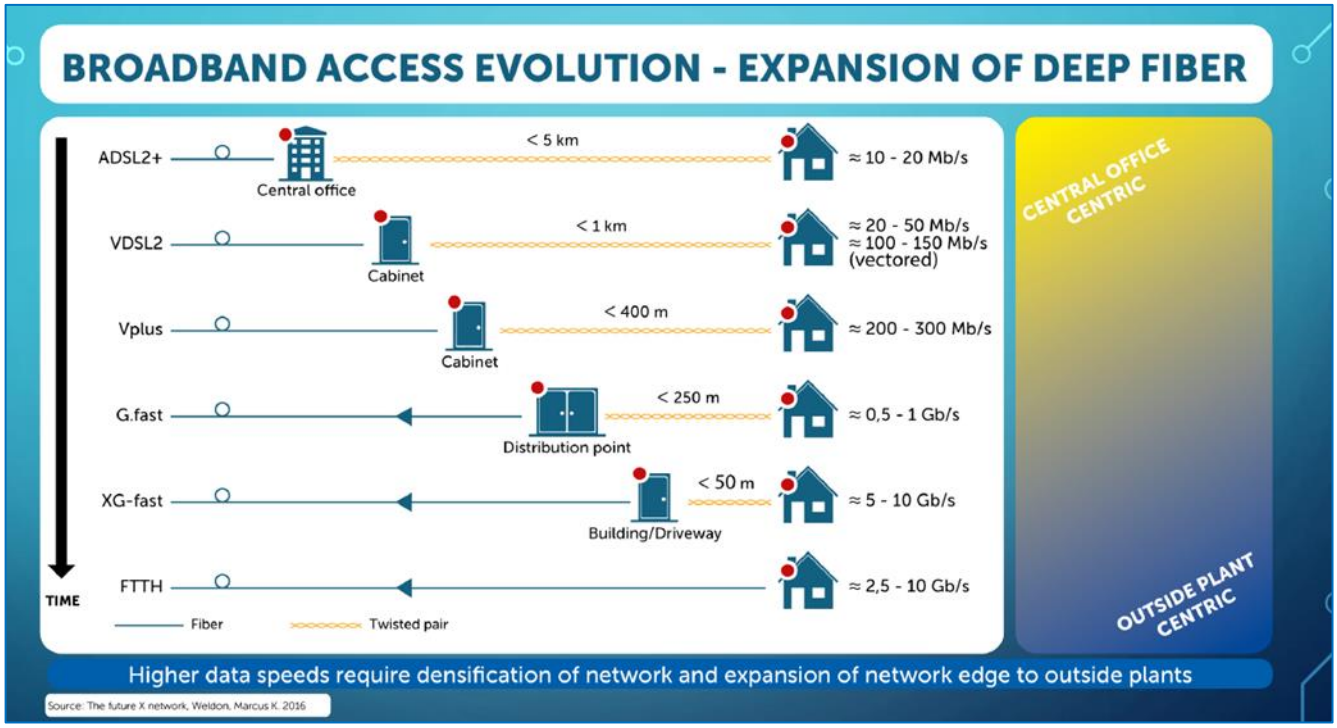


Figure 27: Fibre-based network options (The Future X Network)

Traditional telephone service and dial-up Internet only use a very small portion of the available frequency ranges which could pass over a copper telephone wire. DSL uses a portion of the remaining frequency ranges. This allows DSL to attain high speeds over the same wires without interfering with the phone service.

As noted in the FTTN section above, the quality of a DSL line depends on the distance from the CO (or remote cabinet) that a customer is connected to. As the data travels along the telephone line, increased interference and electrical resistance causes the signals to degrade. This degradation directly affects the advertised Internet speeds an end user might be expecting. In some communities, the distance is so great between the telephone company's equipment that the Internet speeds are terribly low.

Coax Cable

Cable Internet uses the same infrastructure as a cable television. It provides an Internet signal over the coaxial cable lines which run to a customer's premises. Similar to DSL, cable Internet makes use of unused channels (predefined frequency ranges) to pass data without interfering with television programming.

Cable is a shared connection. The line that runs to a house is a branch of a larger trunk which also feeds the neighbours' homes. This means that if that trunk is not wide enough to feed the neighbourhood it may become congested causing decreased speeds. On the plus side, cable uses coaxial cables which are very heavily shielded. This means that unlike DSL, distance is of very little concern to a cable connection. [38]

Hybrid Fibre Coax (HFC)

This architecture is used by cable television companies. In a typical HFC system, fibre runs to an optical node in each neighborhood, and coaxial cable running from the node serves between 100 and 500 users as shown below.

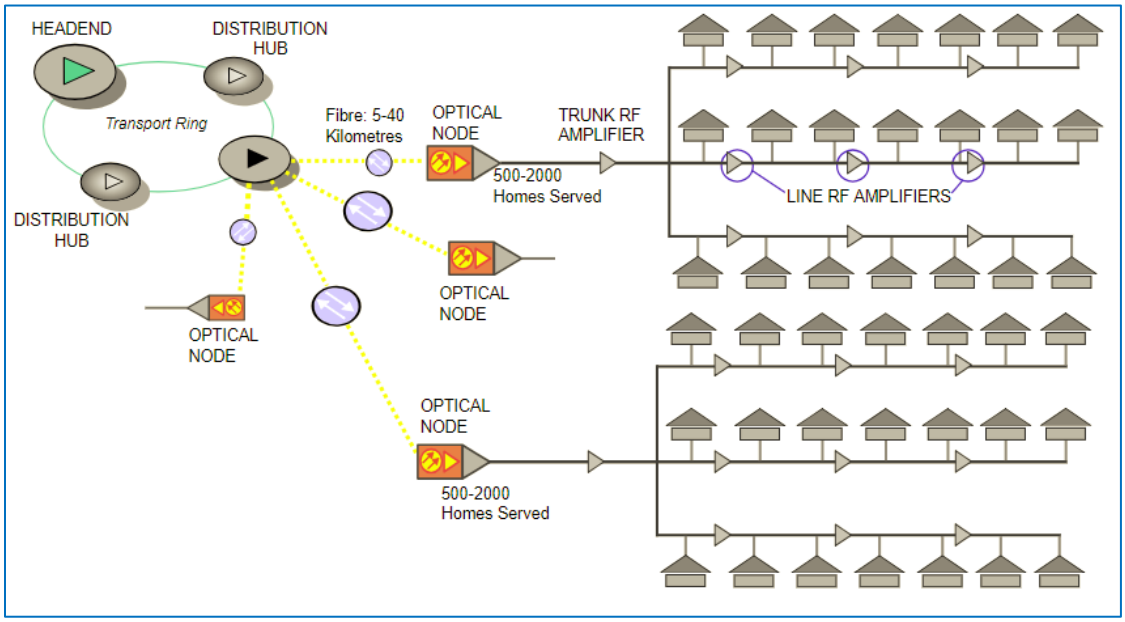


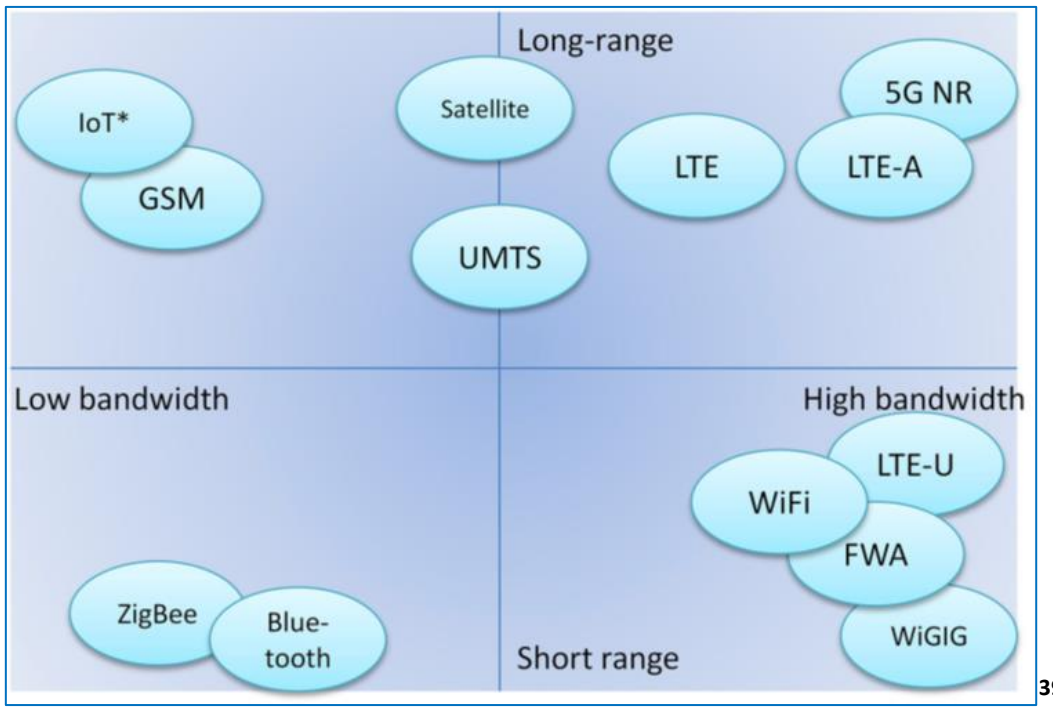
Figure 28: Wikipedia Hybrid Fibre-Coaxial

[38] TekSavvy Solutions Inc.

6.2 Wireless

Overview

As noted in the section entitled "5G and the 3500 MHz Band", 5G has drawn enormous attention based on what it is anticipated to provide once fully deployed, but there are proven alternatives with suitable characteristics, equipment availability and a long evolution path, such as LTE (refer to "LTE" below for additional details).



[39]

Figure 29: Wireless technologies and their characteristics

While there are many wireless technologies deployed throughout the world, this study will predominantly focus on those in the long-range, high bandwidth quadrant given the challenges of local terrain. There are both licensed and unlicensed wireless technologies that can be deployed in a variety of situations. In general, the technologies in the upper quadrants are licensed (except IoT) and those in the lower quadrants are unlicensed (except fixed wireless access "FWA").

[39] Connected Train and Customer Communications: Rail and Digital Industry Roadmap

Innovation, Science and Economic Development (ISED) manages the radio spectrum in Canada as per internationally recognized standards set by the ITU (International Telecommunication Union, a specialized agency of the United Nations). ISED provides licenses to companies for specific frequency bands, and only those companies are allowed to use them (ie: cellular companies). Unlicensed bands can be used by anyone as long as they use industry compliant devices. However, there is the potential for interference between users in unlicensed bands (ie: Wi-Fi, cordless phones). Also, there are still regulations pertaining to unlicensed bands. In Canada, ISED regulates all the electromagnetic spectrum, but it has set aside several ranges for public use. The Radio Spectrum Allocation chart below details all the frequencies and their allowable uses.

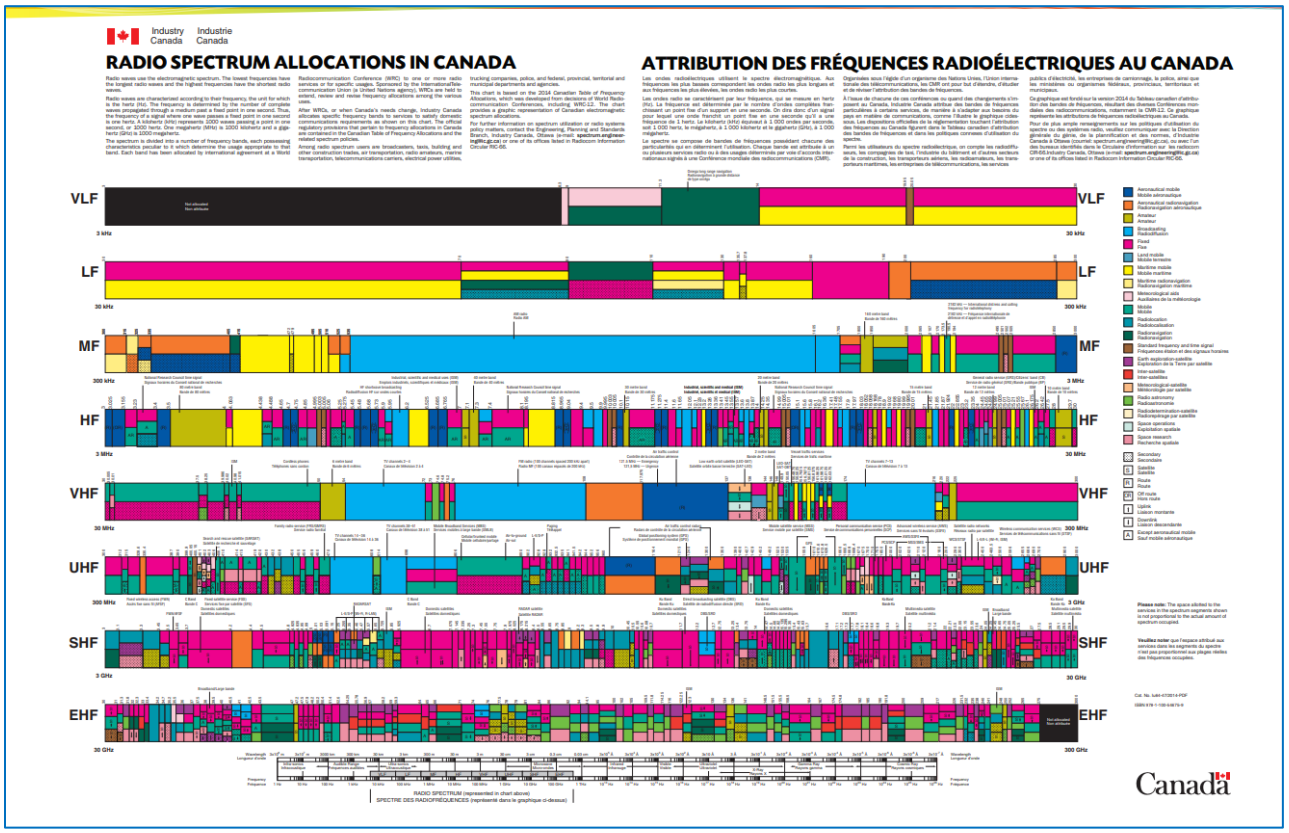
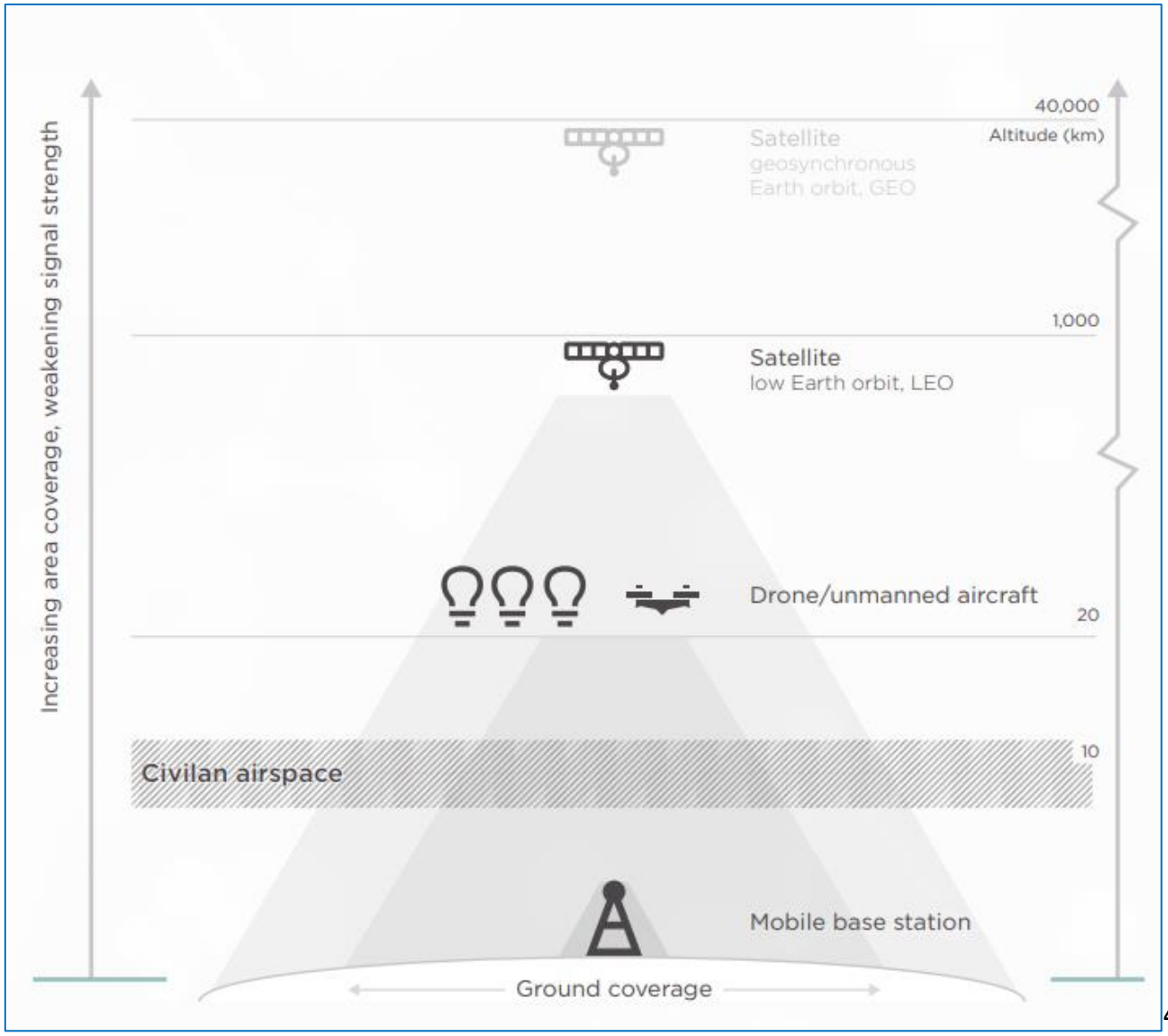


Figure 30: ISED Canadian Radio Spectrum Chart

The graphic below provides a good representation of the coverage range characteristics of the levels of wireless signals. Particularly, the difference between satellite (GEO, LEO) technologies and earthbound towers.



[40]

Figure 31: Types of wireless technologies and related coverage ranges

[40] GSMA Intelligence, Global Mobile Trends 2017

Fixed Wireless

Fixed wireless allows for broadband connectivity to a premises that may not have access to reliable wireline services or has poor dial-up speeds. This technology requires the installation of a small panel antenna at the premises which is aimed towards a nearby tower as shown in the graphic below. Depending on the technology deployed by the service provider, users can experience in the range of 1.5Mbps up to 25Mbps as advertised by Xplornet.

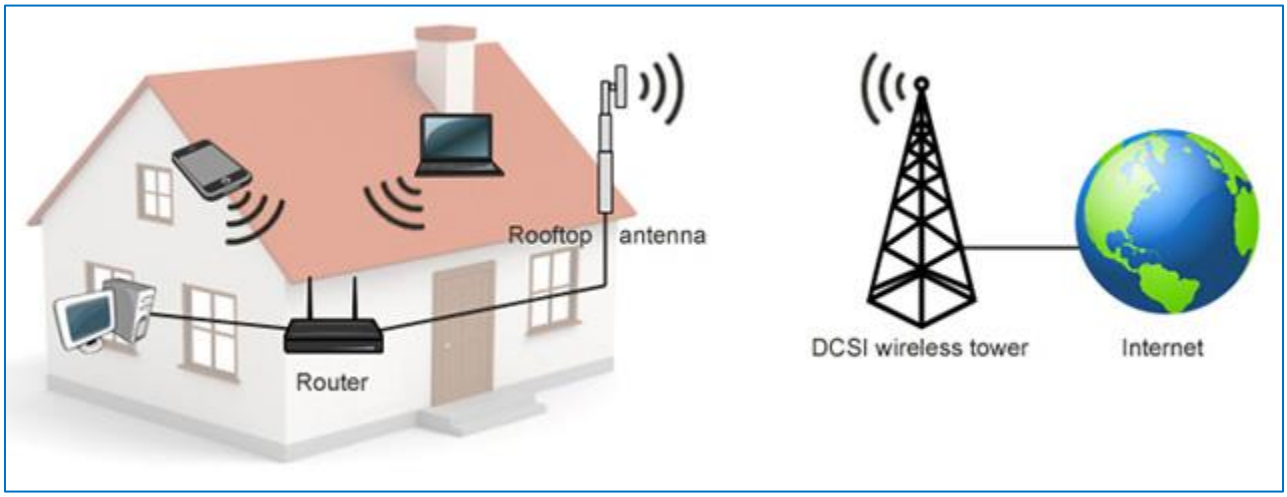


Figure 32: Typical FWA network (www.androidauthority.com/what-is-fixed-wireless-internet)

There are a few challenges with receiving quality fixed wireless service, namely weather and location. Similar to satellite, there can be signal degradation due to weather conditions. However, location proves to be a bigger challenge in that the system needs to have line of site between the user's panel and the tower's antennas for the best experience. Trees and elevation are factors if there's either blockage or perhaps the premises is located at a lower elevation along a river bank or shore of a lake.

Fixed wireless can be a more cost-effective way for service providers to cover a rural area over the cost of bringing fibre to a community. A service provider might be able to use existing structures such as microwave towers and water towers to create a microwave (wireless) backbone connecting its facilities to the target area. Service providers might also build new towers along the path to fill in missing areas. As with

cellular mobile wireless, tower locating can be challenging due to the lack of accessible power, suitable ground conditions and distances.

Another consideration is what kind of bandwidth or data capacity can be delivered to the transmission site at the community. In rare cases there might be a fibre feed to the tower which greatly increases the amount of capacity the site can deliver. However, in rural settings fibre is not usually an option and the service provider is restricted by the carrying capacity of its backbone microwave system, at least for part of the route, to deliver services. Also, given the shared nature of the bandwidth at the transmission site, there is the chance the users will experience variable speeds depending on the number of concurrent users connected to the site.

Ultimately, fixed wireless technology continues to improve as the global service providers are committing more resources to the sector as a viable rural broadband solution.

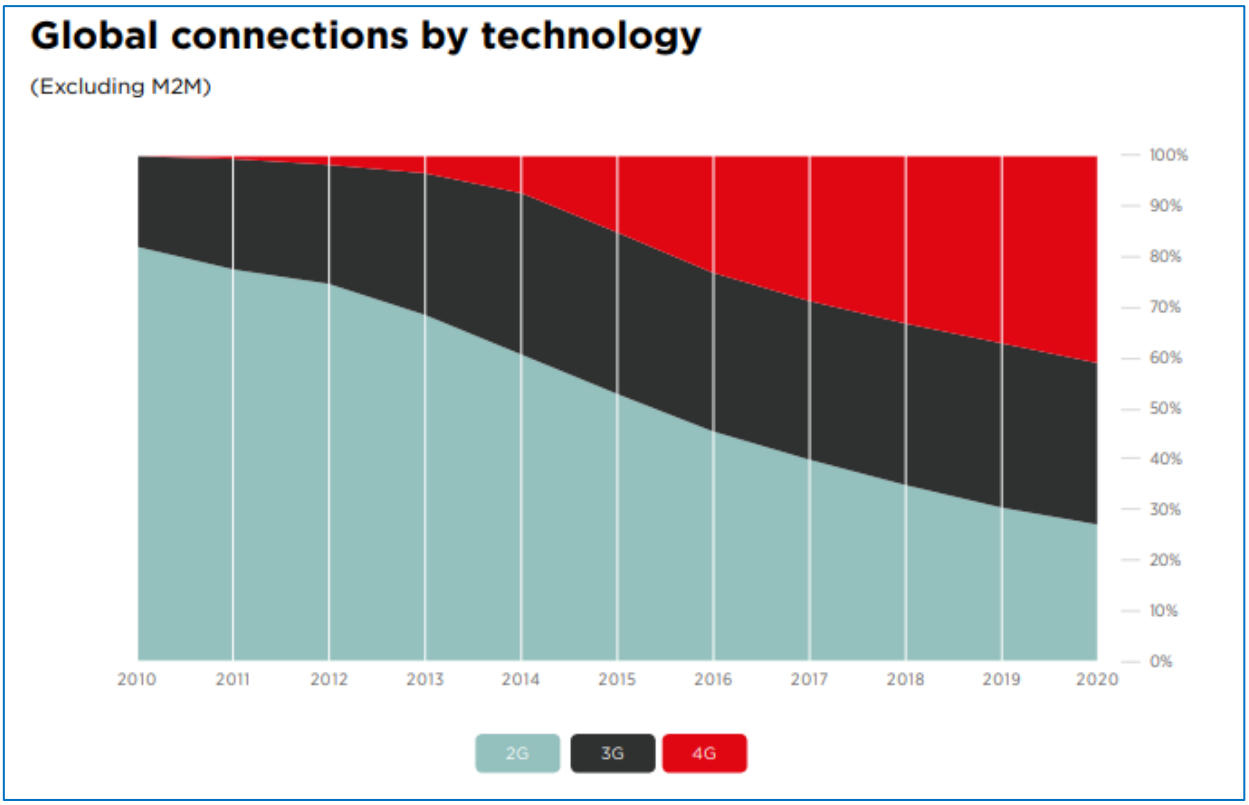
LTE

Most people in Canada are well acquainted with cellular service given the penetration of the technology across the country. Over the years there have been many terms used such as GSM, CDMA, HSPA+, 2G, 3G and the more recent 4G/LTE.

Second generation (2G) technology was rolled out globally as GSM (Global System for Mobile Communications) ie: Rogers. CDMA (Code-division multiple access) was a 2G technology more prevalent in North America ie: Bell and Telus, but also used in other countries. Most 2G networks handled phone calls, basic text messaging, and small amounts of data.

Third generation (3G) technology was an upgrade on 2G over both GSM and CDMA technologies. 3G allows for larger data formats, including standard HTML pages, videos, and music. UMTS (Universal Mobile Telecommunications System) in Figure 29 refers generally to the GSM evolution to HSPA+ (Evolved High Speed Packet Access). CDMA also evolved to W-CDMA (“wideband” CDMA). Canadian cellular companies still have 3G technology deployed in their networks but are steadily phasing it out in favour of 4G/LTE.

The following chart (Figure 33) shows the global proportion of these technologies as 4G/LTE continues to grow.



[41]

Figure 33: Global wireless (mobile) connections by technology

LTE (Long-Term Evolution) is synonymous with 4G networks, albeit there is a substantial underlying level of detail that will not be covered here – and some marketing spin. Essentially LTE is the path towards achieving the 4G standard.
The goal of LTE was to increase the capacity and speed of wireless data networks. A further goal was the redesign and simplification of the network architecture to an IP-based system with significantly reduced transfer latency compared to the 3G architecture. The LTE wireless interface is incompatible with 2G and 3G networks, so that it must be operated on a separate radio spectrum.[42]

[41] **GSMA Intelligence, Global Mobile Trends 2017**
[42] https://en.wikipedia.org/wiki/LTE_(telecommunication)

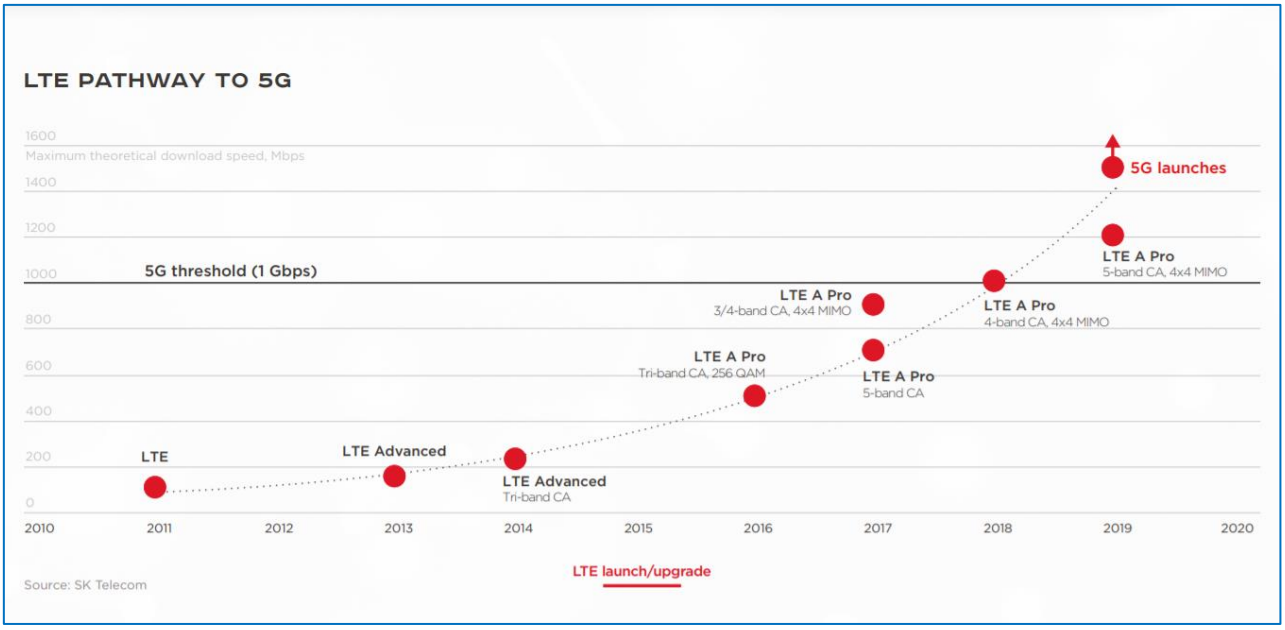
LTE-A (Long-term Evolution Advanced) is a further upgrade to LTE and closer to the 4G standard. Bell Mobility's Moosonee cell site is advertised as LTE-A.
Some advantages of LTE technology as it pertains to broadband:

- Peak download rates up to 300Mbps and upload rates up to 75Mbps
- Low data transfer latencies
- Improved support for mobility, performing at up to 350 km/h or 500 km/h (depending on the frequency band
- Increased spectrum flexibility
- Support for cell sizes from tens of metres radius (femto and picocells) up to 100 km radius macrocells. In the lower frequency bands to be used in rural areas, 5 km is the optimal cell size, 30 km having reasonable performance, and up to 100 km cell sizes supported with acceptable performance.[43]

600MHz

As part of LTE, 600MHz was the most recently auctioned spectrum in Canada. In March 2019, ISED held a spectrum auction of the 600MHz band. According to ISED, "the low-frequency 600 MHz spectrum carries signals well over long distances and penetrates structures better than higher frequency bands. This makes it well suited to deliver next-generation wireless services in both urban and rural settings."[44] The higher the frequency of the radio signal, the less distance it can travel through the air. Conversely, the lower the frequency, the further it goes. This also applies to buildings, windows, and trees - lower frequency signals go through more stuff.[45]
This makes the 600Mhz band important to potential rural broadband deployments. Some of the bidders in the 600 MHz auction included Bragg Communications, the private owner of Eastlink, TBayTel of Thunder Bay, Ont., the Saskatchewan government's SaskTel, and Xplornet Communications Inc.[46]

[43] https://en.wikipedia.org/wiki/LTE_(telecommunication)#Features
[44] https://www.canada.ca/en/innovation-science-economic-development/news/2019/04/600-mhz-spectrum-auction--process-and-results.html
[45] "Analyst Angle: What 600 MHz spectrum will be good for … and what it will not." Iain Gillott, April 6, 2016
[46] "Ottawa looking to balance tensions between telecom carriers, consumers" David Paddon, The Canadian Press, June 5, 2019



[47]

Figure 34: LTE pathway to 5G

5G

5G technology is based on a New Radio (NR) platform and is subdivided into two frequency bands, FR1 (below 6GHz) and FR2 (mmWave). The most common frequency band for FR1 is 3500Mhz and for FR2 is greater than 24Ghz.

It is important to note some of the differences between the 5G bands and their applications. One should not confuse the performance of millimeter wave 5G deployments in fixed wireless networks to that of 5G at the 3500MHz level. In the lower frequency band, 5G and LTE can perform similarly depending on the type of LTE, spectrum allotment and number of antennas (see Figure 34Figure 34). However, speeds in the FR2 range will be much greater, but cell sites much closer together. In this case, 5G base stations may be only 100 metres apart but capable of connecting 1000 more devices than 4G/LTE.

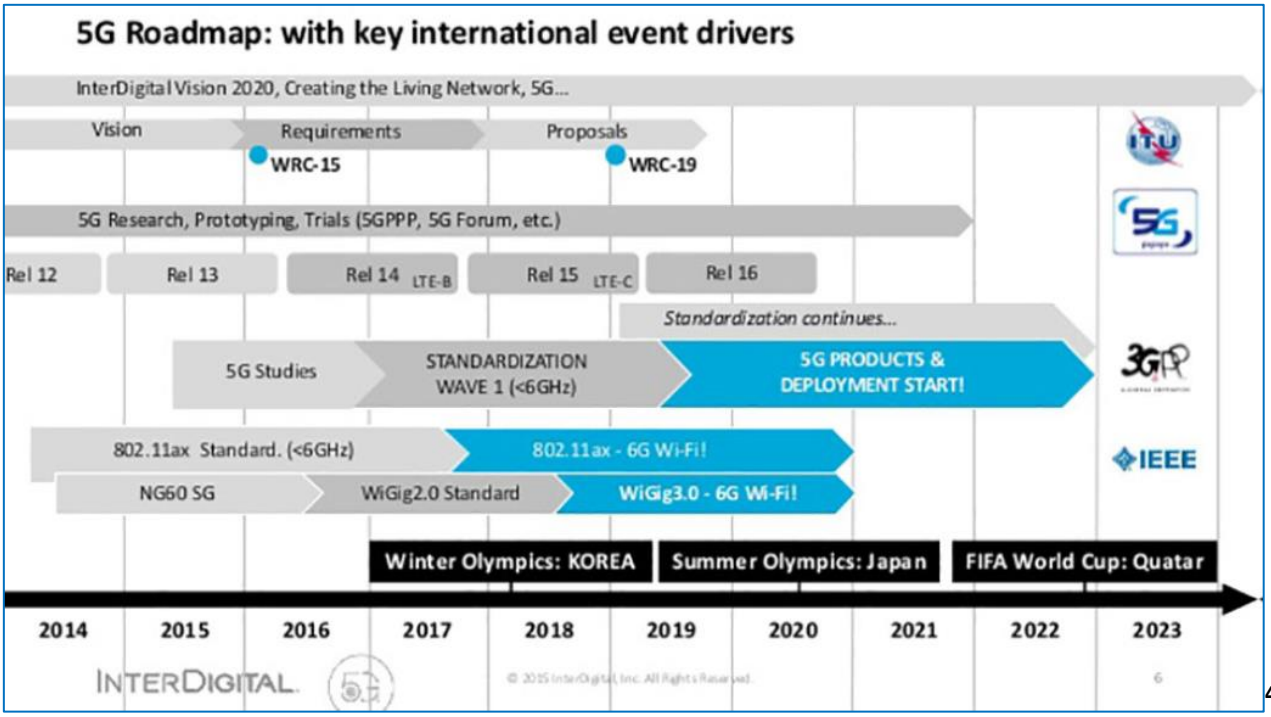
The following is an excellent overview of the advantages of 5G taken from “Eight Reasons Why 5G Is Better Than 4G”, March 16, 2018 by Shatrughan Singh:

[47] GSMA Intelligence, Global Mobile Trends 2017

- Peak data rate. Reaching up to 1 gigabit per second (Gbps), 4G's peak data rate is satisfactory for most of today's apps. But 4G won't be sufficient to support the growing number of wireless devices being introduced into wireless networks every day—thanks in large part to the growth of Internet of Things (IoT)—and the number of applications requiring real-time high-throughput data. With a peak data rate of up to 20 Gbps, 5G will be able to handle these new apps without breaking a sweat.
- User-experienced data rate. The data rate that the end user experiences in 4G can be up to 10 Megabits per second (Mbps), which is sufficient for most of today's applications. But as IoT and mobile devices advance, users will require faster throughput. With speeds of up to 100 Mbps, 5G will give them the boost they need.
- Spectrum efficiency. If you want to optimize a system, you need to utilize its available resources as efficiently as possible. Keeping that in mind, 5G cells will be able to utilize the available spectrum three times more efficiently than 4G cells.
- Mobility. Today, 4G can support mobility of up to 350 kilometres per hour (kph). As the technology advances and magnetic levitation high-speed trains become more common, 5G will break through this speed barrier by supporting mobile devices traveling up to 500 kph.
- Latency. Autonomous vehicles and vehicle-to-vehicle (V2V) communication in a vehicular ad hoc network (VANET) are still a few years from commercialization, despite many of the foundational technologies being well developed and tested. One major part of it is data latency. The latency for VANET needs to be less than 100 milliseconds. Today, latency in 4G cells is up to 100 milliseconds for the control plane and 10 milliseconds for the data plane. Combined, this is too slow to support VANET as any small delay in V2V communication could cause a traffic incident or worse. 5G solves the latency issue by decreasing control-plane latency by 50% and data-plane latency by 90%, which is 50 milliseconds and 1 millisecond, respectively.
- Connection density. As the IoT market accelerates, many more devices will be connected to cells. 5G allows up to 900,000 more devices to be connected per square kilometre than 4G, which supports the connection of at most 100,000 devices per square kilometre.

- Network energy efficiency. The 5G network will be 100 times more energy efficient than 4G. So even as the number of wireless devices increases, the energy required to power them will decline. This means the carbon footprint of wireless communication networks globally will also decline or at least not increase proportionate to the number of devices increases.
- Area traffic capacity. As the number of networked devices increases, 5G will have the capacity to manage the increase in network throughput. That's because the expected area traffic capacity—defined as the end user data rate measured in megabits per second per square meter—of 5G networks will be 100 times higher than existing 4G networks.

5G still has a long path ahead of it – especially in the study region. It is widely debated as to how effective 5G will be in a rural setting given its limited propagation characteristics, regardless of the frequency range. At best, 5G in the FR1 band might be utilized, notwithstanding deployments in higher density locations (ie: along the main street). The following chart (Figure 35) highlights some of the key milestones vis-à-vis world events and in relation to other wireless technologies.



[48]

Figure 35: 5G roadmap with key international drivers

[48] www.interdigital.com

Satellite

Satellite Internet has been a viable, if not sole option for many rural customers. It does not require access to land-based telephone or cable TV lines as the link is between the satellite and the dish located at the premises. Current systems perform well beyond dial-up telephone capabilities.

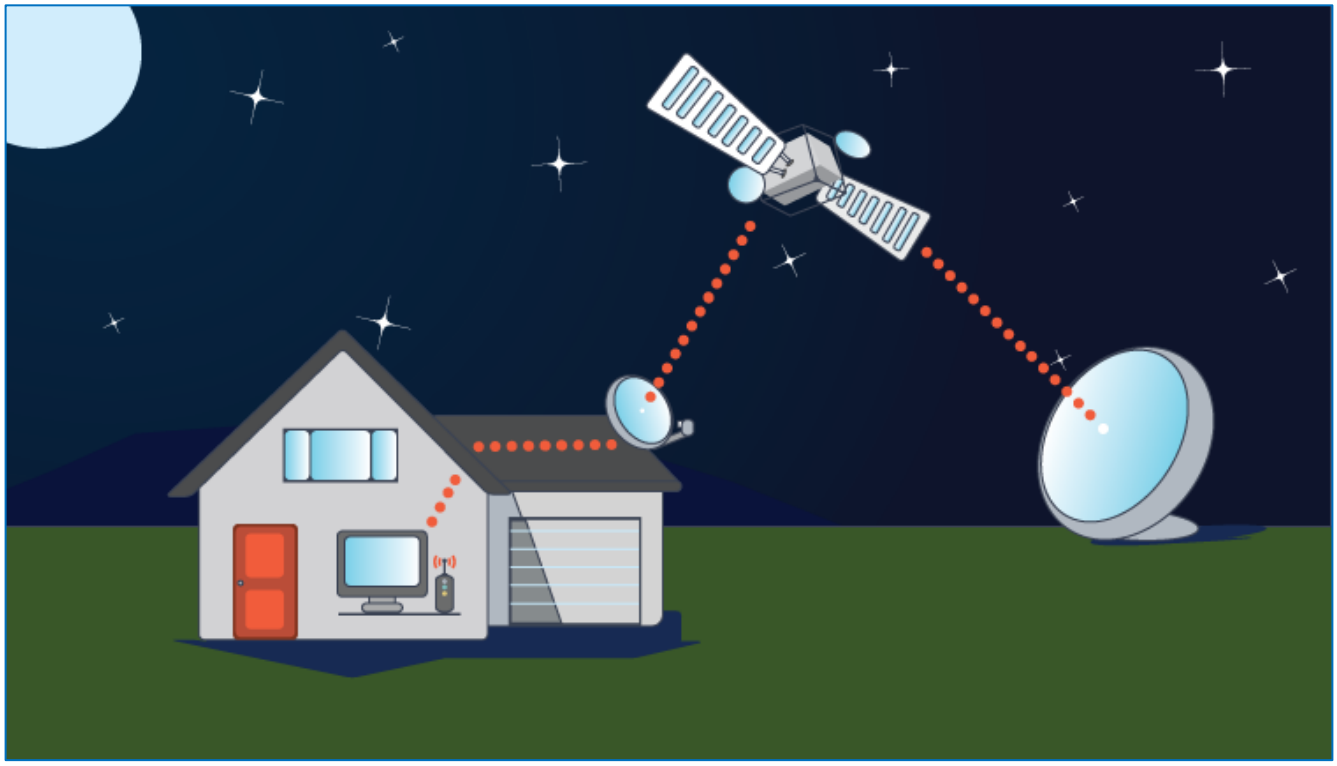


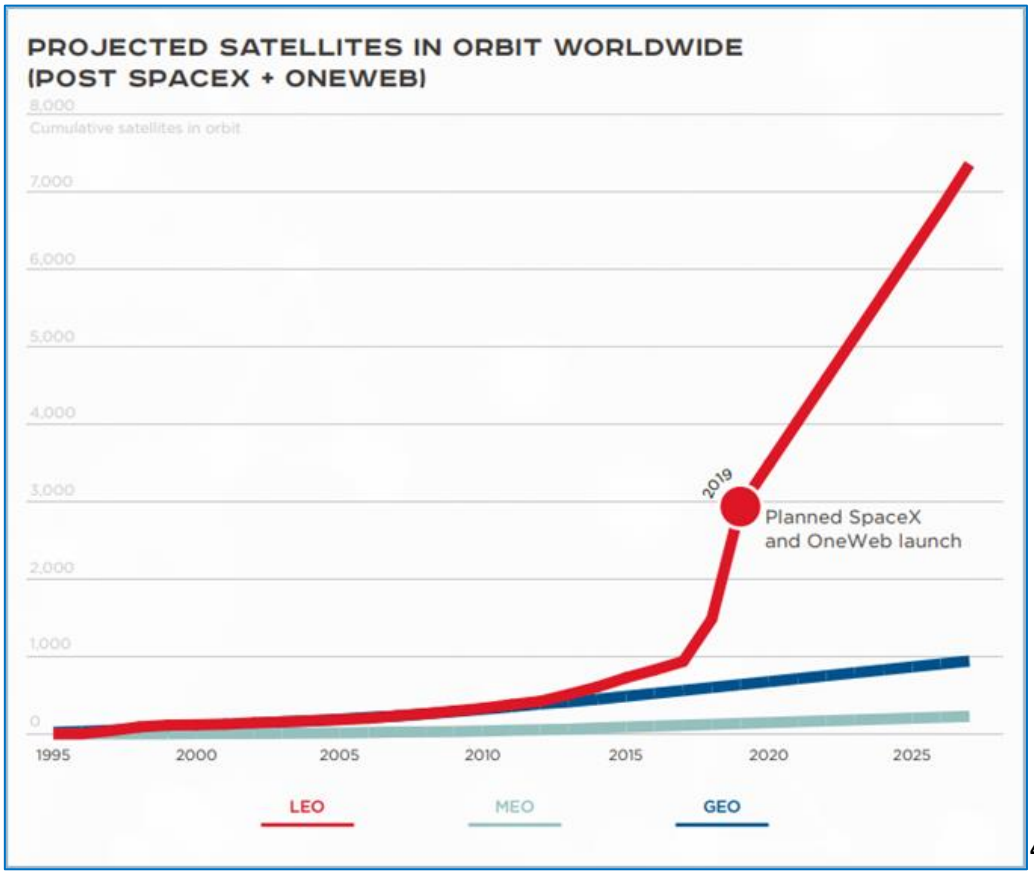
Figure 36: How satellite works (www.reivew.org/interent-service/best-satellite-internet-providers)

In the study region, Xplornet and Galaxy Broadband are the prime satellite providers for consumer broadband communications. Shaw Direct advertises that it is bundling Xplornet's Internet service with its TV product. These satellites use a geostationary orbit, often referred to as a geosynchronous equatorial orbit (GEO); whereby, the satellite orbits the earth at a very high altitude above the equator and follows the earth's orbit. To an earthbound observer, the satellite appears fixed in the sky and therefore the dish at the premises can stay aimed in the same southerly position.

Satellite broadband has advanced over the past years with new, high capacity equipment employing the latest technology. However, satellite communications are affected by heavy rain or snow (rain fade). They also are affected by a signal delay (latency) because of the distance data must travel from the user to the satellite back

down to an earth station and then along the path again to the user. This latency is a factor in services that cannot tolerate perceptible delays, such as tele-robotic medicine.

However, satellite broadband has advanced over the past few years with new, high capacity equipment employing the latest technology. The industry has been getting a lot of mainstream attention recently with the well-publicized race by many companies such as SpaceX and OneWeb to develop and launch low earth orbit (LEO) systems. These constellations of satellites will number in the thousands with the promise of lower latency and higher throughput. While not usually publicized, satellite networks also require a substantial terrestrial network that provides the linkages to the equipment and the global network. Eventually, the technology can be a major benefit to rural coverage as networks are completed and pricing drops.

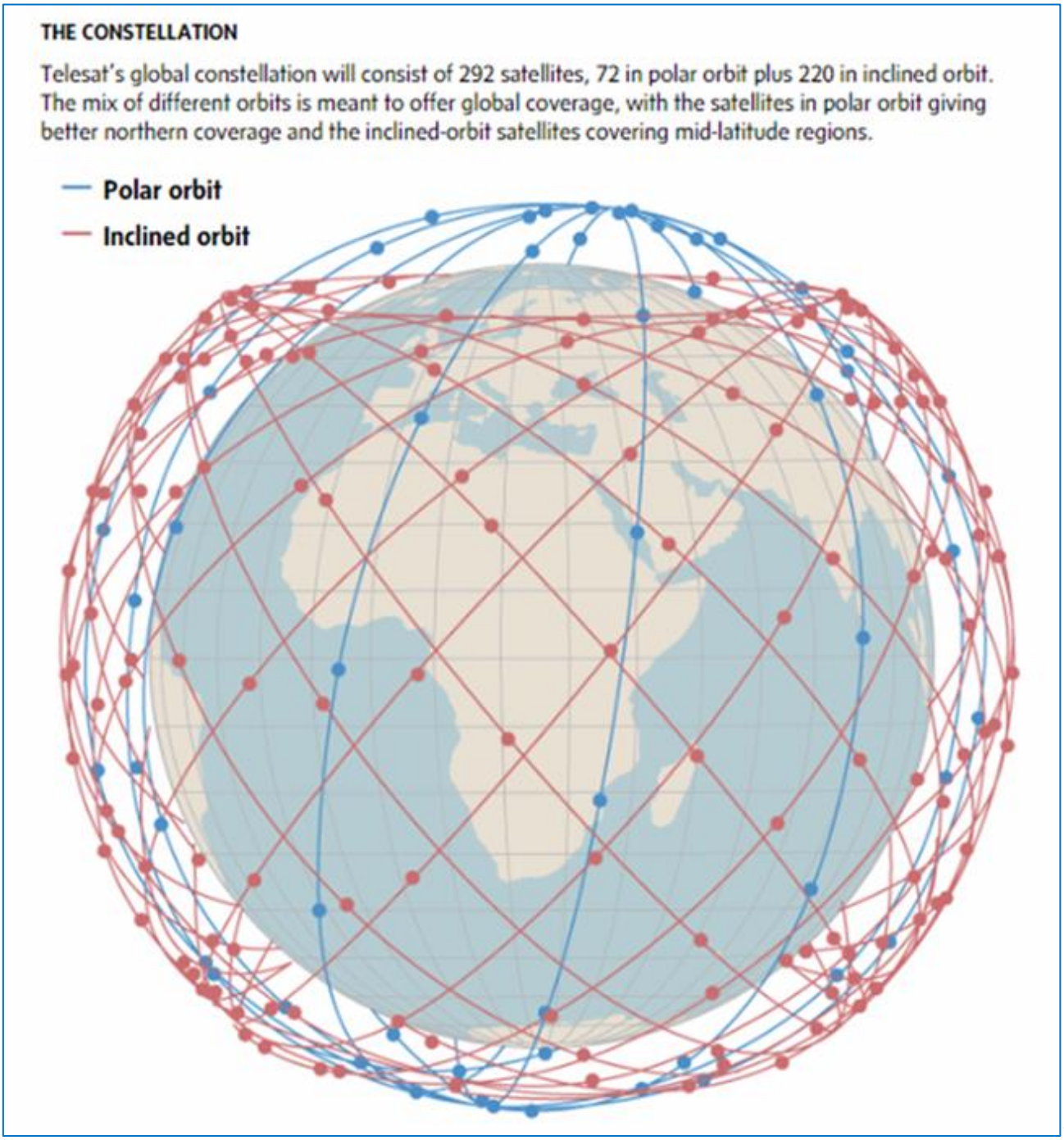


[49]

Figure 37: Projected satellites in orbit worldwide (post SpaceX + OneWeb)

[49] GSMA Intelligence, Global Mobile Trends 2017

Canada's Kepler Communications has already launched its first bread loaf sized satellite, initially for commercial use in the resources sector. Telesat has outlined its coverage plans as illustrated in the graphic below (Figure 38).



[50]

Figure 38: Telesat future global satellite constellation

[50] "Canada's Telesat takes on U.S. giants in 'low-Earth orbit' internet space race" Globe and Mail, January 31, 2019

Mobile Wireless

Mobility (cellular) was not in scope for this study; however, with the advent of 4G/LTE technology as deployed by the wireless service providers, broadband access across large swaths of Canada's cellular corridors has increased.

As a function of the increase in mobile data, cellular companies are moving rapidly to try and bring direct fibre connectivity to their cell sites. Where that isn't possible, they bring fibre to a key site which then reduces the number of wireless/microwave hops to other sites.

Given the amount of regional fibre Bell and Ontera have in the study area, a number of their cellular towers have been directly connected to their fibre network. Adjacent tower sites without fibre are more easily reached due to shorter microwave hops and can therefore access additional bandwidth. Bell Mobility customers in the core of downtown Temagami should experience very good cellular data speeds from the tower at the community.

Figure 39: Bell Mobility cellular tower Temagami

7.0 Study Area Analysis

Site visits were conducted during May 27th and August 2nd, 2019. The site visits were limited to visual, non-destructive investigation of facilities-based telecommunications infrastructure, specifically the visible "passive network". This included copper telephone routes, coaxial cable (none were noted) and fibre optic systems. While outside the scope of this study, cellular sites were noted to the extent possible, particularly as they could serve as potential fixed wireless sites for any future projects. The field visit information was further enhanced by a desktop analysis of publicly available network information.

Several meetings were held with Ontera representatives so to attempt confirmation of visual networking as noted above. Typically, these carriers consider their network information as confidential as they protect against competitive strategies. However, they were co-operative in confirming visual items.

7.1 Regional Transport Network

The transport network is the connectivity provided between communities or other long distances on a point to point basis. Last mile that will be discussed next, are those connections from a service provider's CO or Head End (if cable) to the end-user. Within the study region footprint, the broadband passive transport layer is predominantly Ontera-owned pole mounted fibre optics.

There are several fibre optic routes that travel through the area. Ontera has fibre buried within the Ontario Northland Rail's right-of-way (ROW). There is a Bell Canada national fibre route located within the TransCanada pipeline.

Visual confirmation of a particular carrier's fibre cable is possible via recognizable markers on the cable. In the case of aerial (pole mounted) cable, Ontera uses small rectangular orange tags that indicate the fibre optics, ownership and contact information. Similarly, (in other markets) Shaw uses a light blue tag and ribbon; whereas, Vianet uses a yellow tag. This is common practice with all companies as routes can be congested with various suppliers, whether fibre, traditional copper

telephone lines or cable especially when cables need to be repaired. These aerial facilities are always located well below any power lines for safety reasons (telecom space vs power space). Buried cable also carries warnings as shown in the figures below.

Figure 40: Ontera aerial fibre tag

Figure 41: Ontera buried fibre marker

The following map traces Ontera's visible regional aerial fibre route crossing through the footprint on Highway 11 and towards Bear Island. Other than certain road, rail and water crossings, most of the regional fibre is aerial along the highways due to the prevalence of rock that makes burial very expensive.

Figure 42: Regional fibre routes

Ontera Fibre and Equipment POP

One Ontera's points of presence (POPs) is located in downtown Temagami adjacent to the ONR tracks. The next photo shows a close up of Ontera's buried fibre orange warning post. Fibre enters and exits the POP from underground in this location.

Figure 43: Ontera equipment shelter (POP)

Figure 44: Ontera buried fibre marker

However, it does not always work out that accessible fibre equipment repeater shelters are located within community boundaries. National shelter spacing was based on the electronics of the time and on rail access. There are many such shelters that can only be accessed by rail equipment. Therefore, it can be prohibitively expensive for the telephone companies to access these locations to bring fibre to adjacent communities. Also, there is limited fibre within the older ROWs as dozens of strands may have been placed years ago versus the hundreds that are typically installed now.

Bell Canada Fibre Access Point

As noted previously, there is a Bell Canada fibre access point located at the TransCanada pipeline compressor facility on Tonomo Lake Road. Similar to national fibre routes within rail ROWs, Bell also had constructed a route along the pipeline.

Figure 45: Bell Canada fibre equipment shelter

Figure 46: TransCanada compressor station

Figure 47: Bell buried fibre marker

7.2 Community Last Mile Networks

Last mile is a term given to the local connectivity between a service provider's POP and the customer premises. It can also be known as the distribution layer. The term can technically apply in fixed wireless applications – the wireless "shot" from the tower to the customer's panel antenna.

Within the communities, Ontera is the only facilities based, terrestrial last mile carrier based on its copper distribution. Ontera's equipment provides ADSL level electronics that supplies internet to premises. There is very limited point to point fibre last mile from Ontera to locations such as the school and medical centre. Xplornet does provide fixed wireless last mile connectivity in the area; however, the extent of coverage and their customer base was not determined.

Several survey respondents noted that they have a variety of Internet service providers, but all except Ontera are non-facilities based, meaning they access customers over Ontera's network.

Cellular data was provided as a reference point; however, it was not a part of the scope of the study. Cellular data has been sourced from publicly available information as noted on the maps and whose accuracy could not be verified, linked to the ISED database.

7.3 Needs and Gap Overview

An oversubscription ratio was used in this study to calculate a reasonable expectation for a community's particular broadband requirements. For the study, a 5:1 oversubscription ratio has been used to determine a reasonable initial local POP size. Ratios and capacity calculations will vary depending on the actual service provider based on their business metrics and network capacity.

The "available" broadband capacity was based on information derived from the service providers where available and network assumptions based on local visible infrastructure. Wireless broadband capacity was not included unless otherwise noted.

Each community's broadband "need" was calculated based on the following metrics:

Premises Type	Mbps
Dwellings	25
Businesses	100
Hospitals/Clinics	100
Schools	100
Student	1

Figure 48: Broadband metrics

The full "need" would be the result of the above-noted metrics multiplied by each of the community's data sets (# of dwellings + # of students, etc.). The "adjusted need" was calculated by applying the ratio of 5:1 to the total community need (total divided by 5).

The "gap" was determined by subtracting the "available" broadband capacity from the "adjusted need". The table below details the data sets used to estimate the gaps per location.

Community Broadband Gap Analysis	STATISTICS						DATA (Mbps)					NEED	OS ratio 5:1	AVAILABLE Mbps	GAP Mbps
	POP	Dwellings	Businesses	Hospital/ Clinics	Schools	Students	Dwellings	Businesses	Hospital/ Clinics	Schools	Students				
							25	100	100	100	1	Mbps		Mbps	Mbps
Temagami (core)	520	220	20	1	1	24	5500	2000	100	100	24	**7724**	**1545**	200	**1344.8**
Temagami North	242	115	5	0	0	0	2875	500	0	0	0	**3375**	**675**	200	**475.0**
Lake Temagami	2100	908	5	0	0	0	22700	500	0	0	0	**23200**	**4640**	0	**4640.0**
Marten River	40	20	5	0	0	0	500	500	0	0	0	**1000**	**200**	0	**200.0**
Bear Island	244	110	14	1	1	44	2750	1400	100	100	44	**4394**	**879**	300	**578.8**

Figure 49: Community broadband gap analysis calculations

The breakdown of data for the Municipality of Temagami "communities" is based on estimates of premises contained within the general boundaries of each location using Stats Can 2016 Census information and a variety of Temagami related information sources that will be detailed further in the report in Section 7.4.

The following map illustrates the relative gap (red) versus the estimated available broadband (blue) per study group community[51].

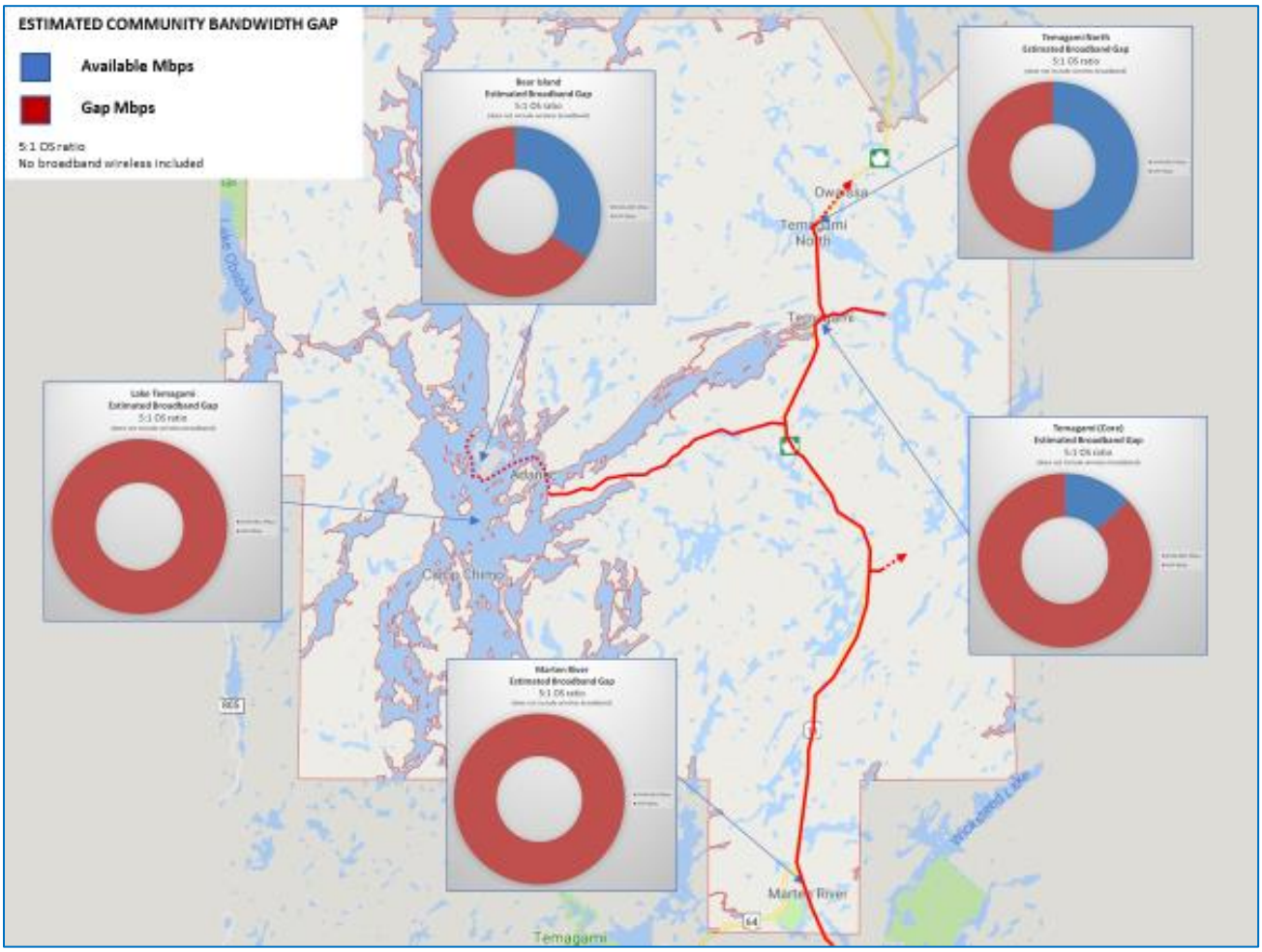


Figure 50: Study area gap analysis

There is a visibly definitive broadband gap in the study group communities. These will be discussed in greater detail in each respective section below.

[51]**Calculations based on facilities-based fixed (non-wireless/mobile) data available**

The community aggregated analysis, the gap (red) comprises a significant portion of the chart below versus the estimated available capacity (blue).

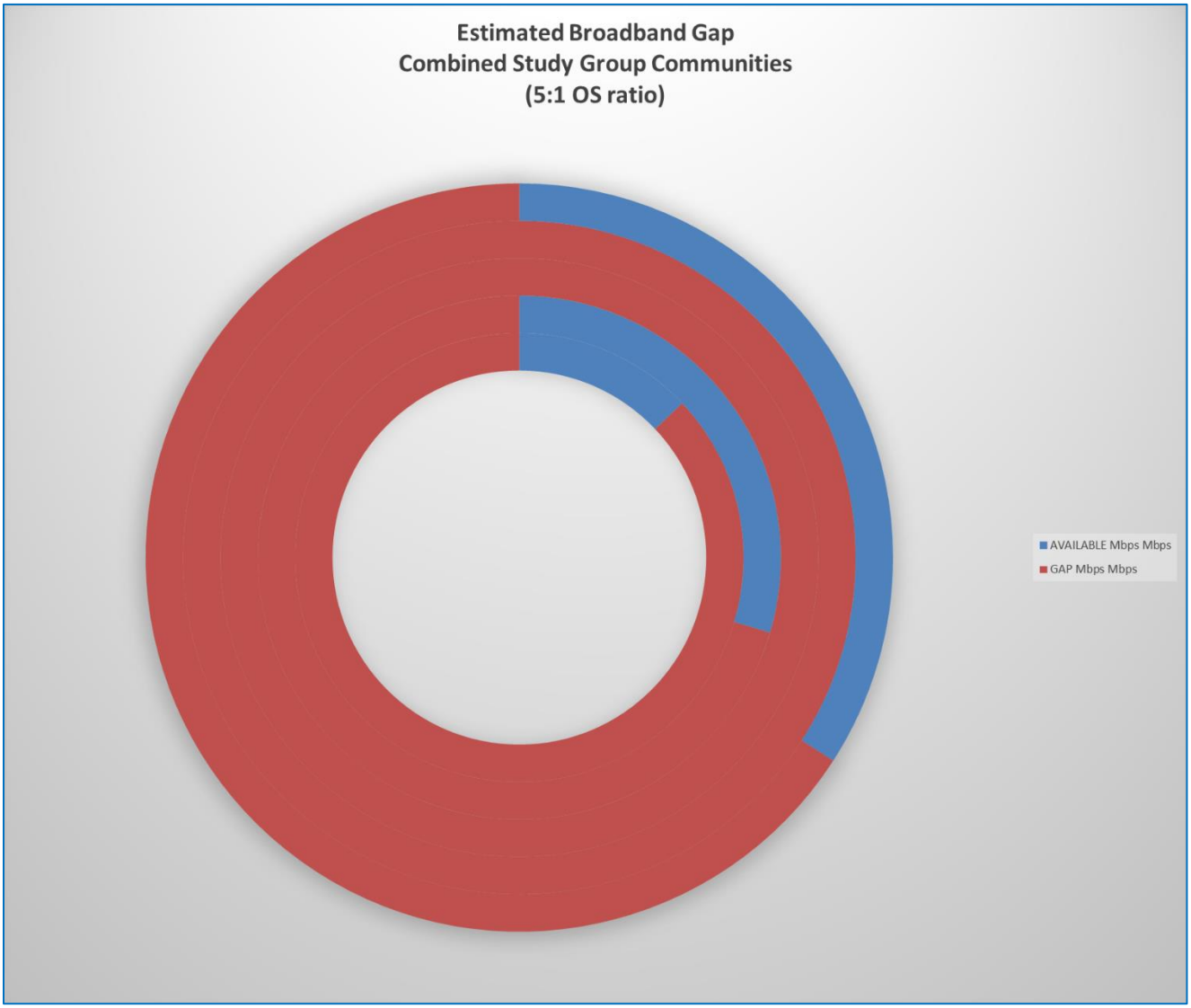


Figure 51: Combined study area gap analysis

7.4 Community Analysis Introduction

This section is divided into 5 parts, one for each general area within the Municipality of Temagami plus Temagami First Nation. Specifically, the Municipality of Temagami has been broken down into the following four "communities":

- Temagami Core
- Temagami North
- Lake Temagami
- Marten River

The breakdown allows for a more granular analysis of each location versus lumping all the area into one general catchment. It is meant to align with the ground-truthing exercise that attempted to document all the visible fibre optic networking upon which a more fruitful estimation of budgetary costs and targeted broadband gaps could be ascertained for future planning.

The population, dwelling and business data contained in the following sections are estimates based on an analysis of StatsCan 2016 census data, local economic development documents and a visual estimation of structures derived from Google Earth data. In discussion with municipal representatives, the breakdowns provided herein are a fair representation of the disbursement of locations. However, when combined, the data for Temagami Core, Temagami North, Marten River and Lake Temagami reflects StatsCan information.

For each of the communities, local statistics and observations are provided. Market overview maps indicate visible aerial fibre optic broadband. In the case of Ontera's underwater fibre at Bear Island, local knowledge of the network was relied on. Ontera copper telephone infrastructure was not mapped given its ubiquitous coverage and the inability to ascertain underwater routing to the various islands on Lake Temagami. As there is no terrestrial cable TV provider, there were no coax cable facilities to document. As previously noted, cellular towers are indicated where visible and with corresponding publicly available transmission data. Xplornet is collocated on the tower in downtown Temagami (Temagami Core) near the school. Xplornet's fixed wireless capacity is not included in the gap calculations as noted below or in Exhibit B – Gap Analysis.

The needs and gap analysis data is presented followed by summary recommendations. A high-level budget range is provided for broadband upgrades per area for future planning.

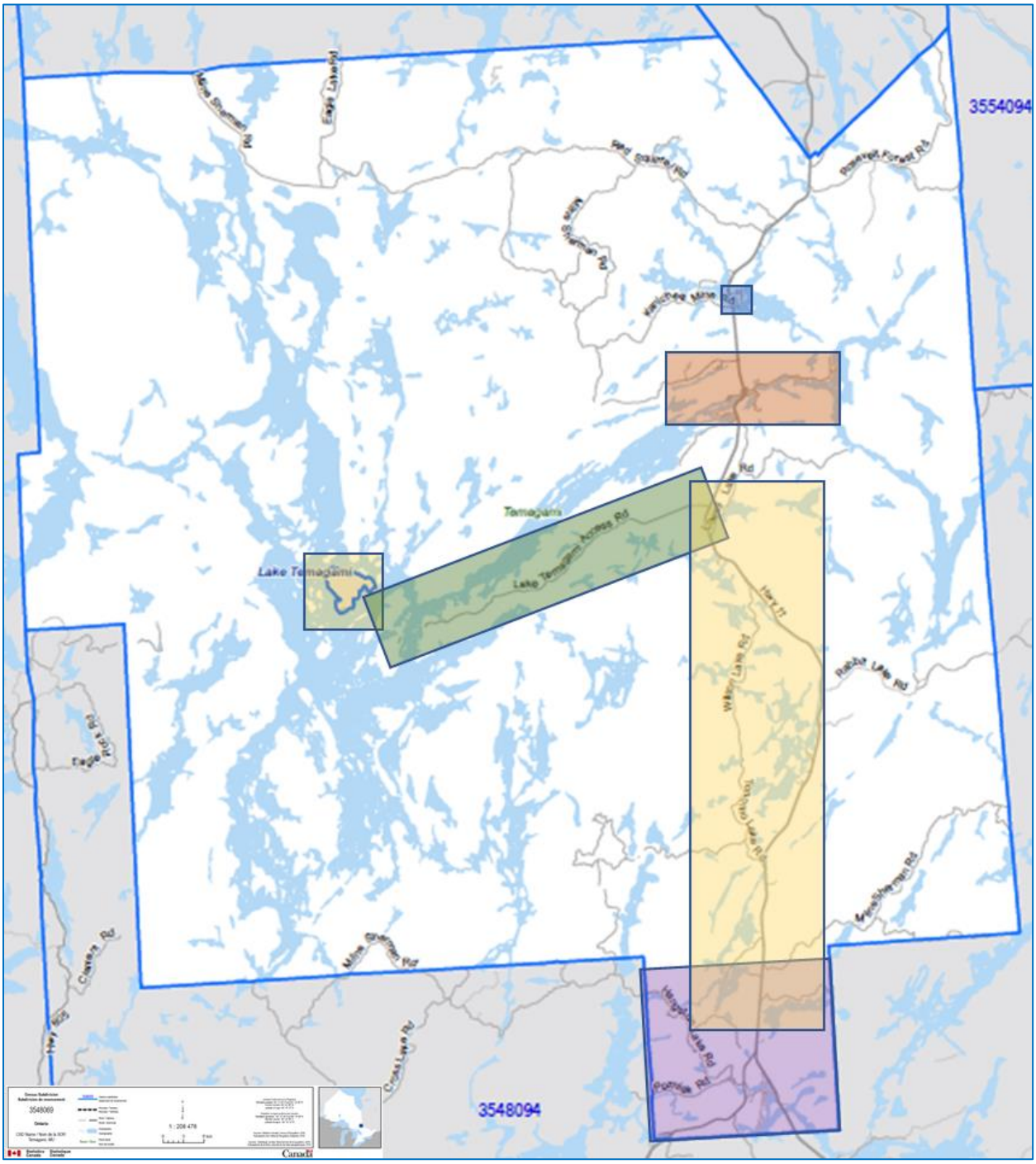


Figure 52: Community analysis areas

7.5 Temagami (Core)

Quick View

Site Visit: May 27th and August 2nd, 2019
Population: 520
# of homes: 220
# of businesses: 20
# of students: 24
# of schools: 1
# of hospitals/clinics: 1

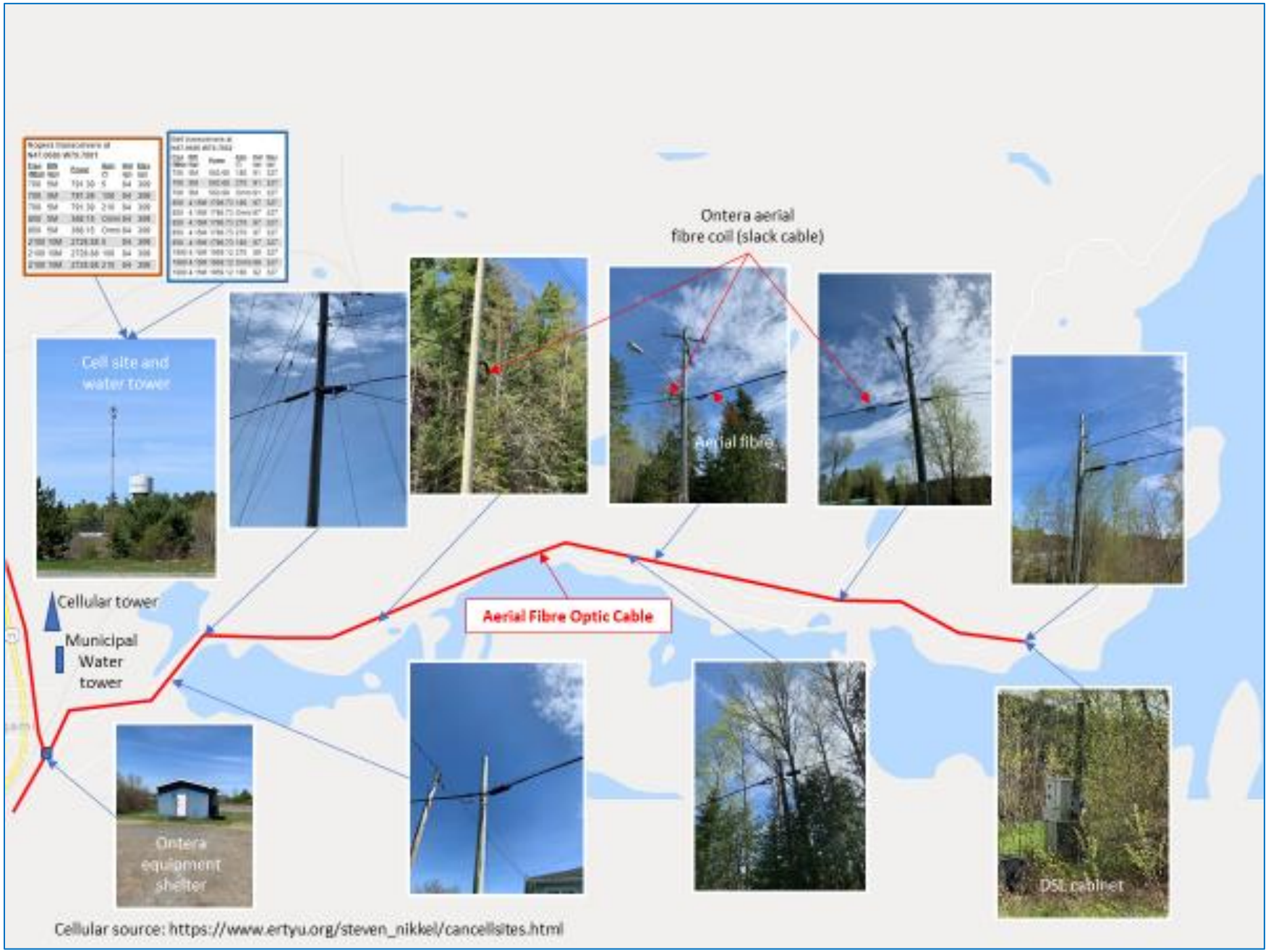
Telecommunications Observations

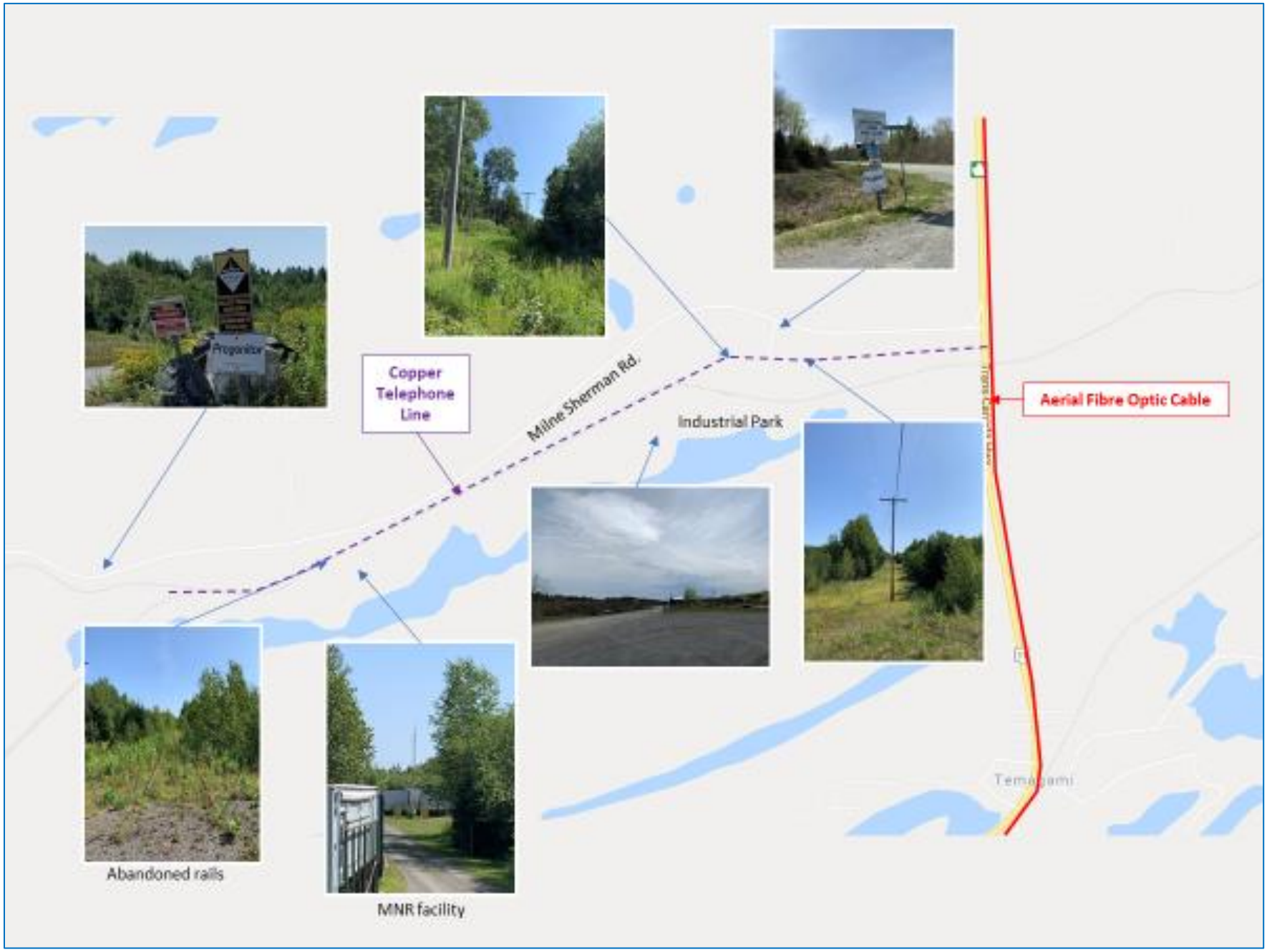
The core of Temagami is serviced by Ontera's copper ADSL plant, which is older technology with limited capacity.

As shown on the diagrams that follow, Ontera does have aerial fibre optic assets that pass through the footprint with a breakout to the clinic and school, likely due to previous service contracts. However, additional point to point fibre connections could not be determined visually. Ontera also has an equipment POP near the railway lines as their fibre also is located within the ONR right-of-way. Ontera does service some of its distribution nodes with fibre so to extend their reach, such as Fox Road as shown below. There is an Ontera pole line that delivers copper-based services down Milne Sherman Rd. to the industrial park area and beyond.

There is also a Bell Mobility 4G/LTE tower site near the school with both Rogers and Xplornet collocate don the same structure. Xplornet recently collocated on the tower located; however, their operating capacity is not known nor their market penetration. Both Xplornet and Galaxy Broadband are reported to provide satellite data services; however, few premises mounted dishes were visible. Television satellite dishes were not covered in this scope (ie: ExpressVu).

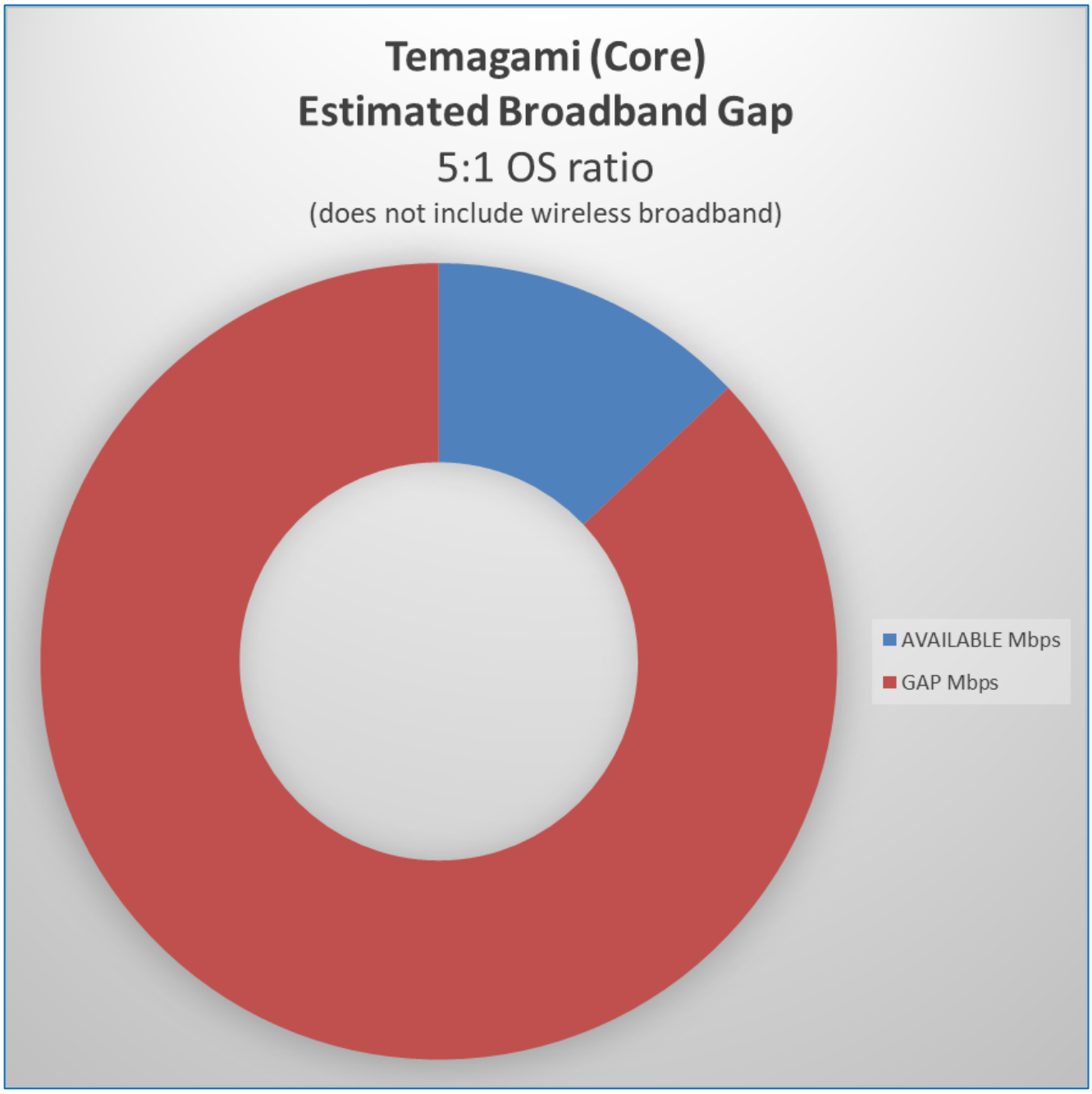

Ontera aerial fibre
Aerial fibre
Buried fibre marker
Ontera copper
Ontera distribution cabinet
Ontera fibre & Equipment POP
Temagami Medical Centre
Fibre aerial enclosure
Leisure Island Houseboat Rentals
Orient Garden


Ontera aerial
fibre coil (slack cable)
Cell site and
water tower
Aerial fibre
Cellular tower
Municipal
Water
tower
Aerial Fibre Optic Cable
Ontera
equipment
shelter
DSL cabinet
Cellular source: https://www.ertyu.org/steven_nikkel/cancellsites.html


Copper Telephone Line
Milne Sherman Rd.
Industrial Park
Aerial Fibre Optic Cable
Abandoned rails
MNR facility

The core of Temagami has a sizeable broadband gap as illustrated below in red. However, there is the potential to increase capacity as recommended herein.

Community Broadband Gap Analysis	STATISTICS						DATA (Mbps)					NEED	OS ratio 5:1	AVAILABLE Mbps	GAP Mbps
	POP	Dwellings	Businesses	Hospital/ Clinics	Schools	Students	Dwellings	Businesses	Hospital/ Clinics	Schools	Students				
							25	100	100	100	1	Mbps		Mbps	Mbps
Temagami (core)	520	220	20	1	1	24	5500	2000	100	100	24	7724	1545	200	1344.8



Recommendations

- Given the level of fibre connectivity through Temagami's core, Ontera should be contacted to discuss the potential to upgrade the community's local access and distribution. For instance, discuss whether Ontera will install a FTTN/DSLAM within the community and deploy VDSL. While that would not meet the CRTC's aspirational goals of 50/10, it would at least improve user experience in the interim.
- Ontera will also need to confirm the transport capacity of its current fibre into the community should it require additional equipment to be sized properly for local distribution.
- The presence of fibre does provide the opportunity for an alternate service provider to access Ontera wholesale services and deploy either as a WISP and/or a FTTP deployment, depending on a sustainable business case.

Estimated Capital Ranges

[refer to Exhibit A – Estimated Capital Ranges for full project view]

		MARKET PROJECTION		CONNECTED PREMS		
Communities	Prems Passed	Target Market Penetration	Target Prem Project Total	Year One Connected Prems	Year Two Connected Prems	Year Three Connected Prems
Temagami (Core)	240	80%	192	77	58	58

TRANSPORT	DISTRIBUTION	DROPS	YEAR TWO & THREE		TOTAL FTTP COSTS		
Transport + electronics	Distribution + Electronics	FTTP Drop + Prem Total Cost	Year Two PREM Capital	Year Three PREM Capital	Total Project Cost	Total Cost Per Prem PASSED	Total Cost Per CONNECTED Prem
$ 111,948	$ 560,000	**$ 89,088**	$ 66,816	$ 66,816	$ 894,668	$ 3,500	$ 4,660

Prems Passed = # of premises that distribution cabling passes along a street, but not connecting to the premises (drop)
Target Market Penetration = estimate of how many customers would use the new service
Transport + Electronics = cost of construction backbone fibre to community + electronics, or electronics if transport fibre in place
Distribution + Electronics = cost of constructing last mile distribution fibre + electronics within the community
VDSL Per Connected Prem = cost of installing the node divided by the number of total subscribers
LOW (VDSL) = estimated lower end of providing a degree of broadband in the community
HIGH (FTTP) = estimated upper end of providing a degree of broadband in the community

Overall Assumptions:
pole make ready costs not included
% of prems connected varies, max 80% where no competitor to Ontera/Bell, max 60% where a facilities based competitor exists
VDSL will not require distribution copper upgrades
all values are estimates, additional accuracy requires market design and pricing exercise
WIRELESS AND FIXED WIRELESS SOLUTIONS NOT INCLUDED EXCEPT FOR LAKE TEMAGAMI

7.6 Temagami North

Quick View

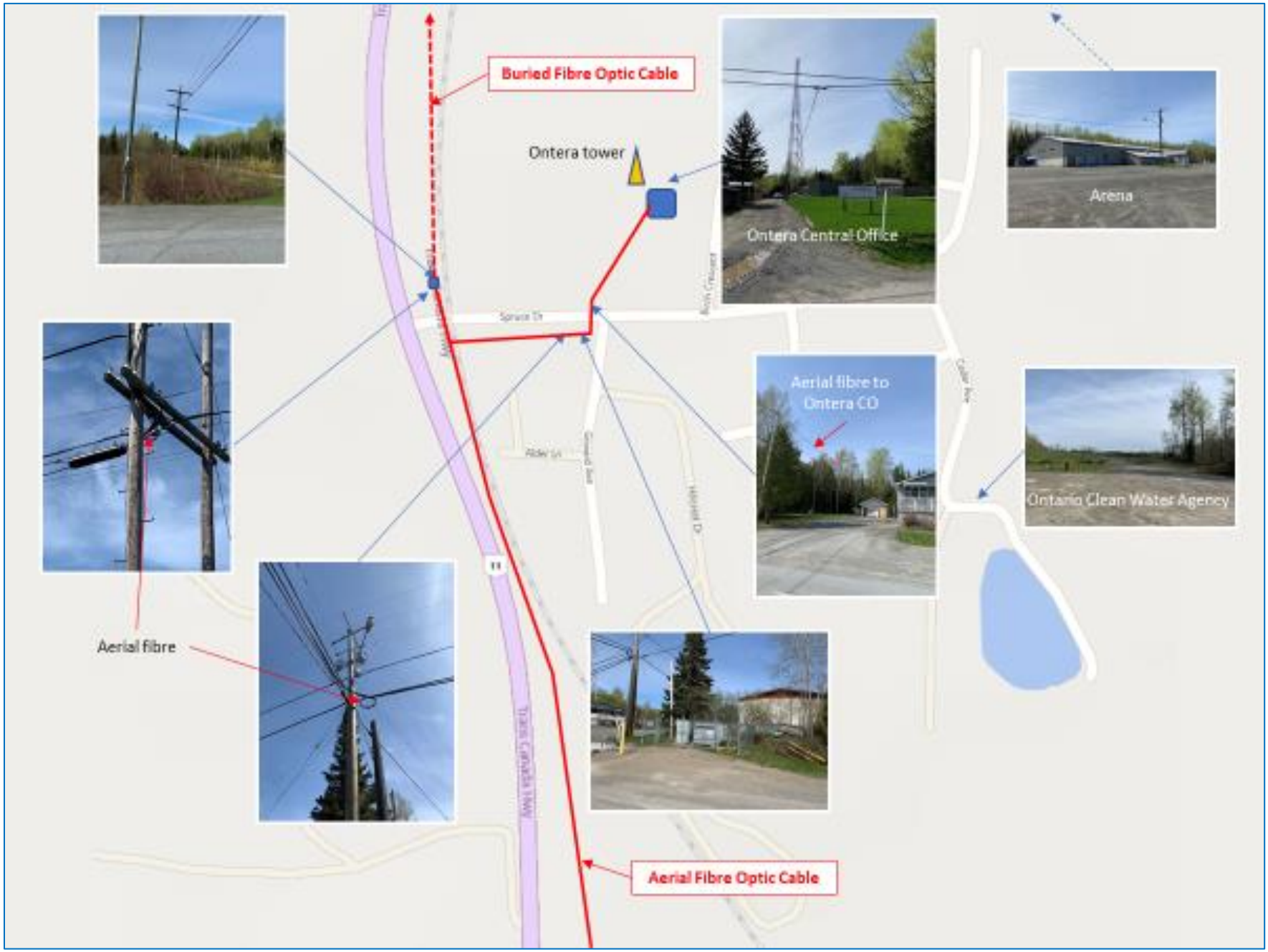
Site Visit: May 27th and August 2nd, 2019
Population: 242
# of homes: 115
# of businesses: 5
# of students: 0
# of schools: 0
# of hospitals/clinics: 1

Telecommunications Observations

Ontera's central office (CO) is located in Temagami North. As such, Ontera has aerial fibre assets that come into the community from the highway and rail systems. There is a now abandoned microwave tower at Ontera's property.

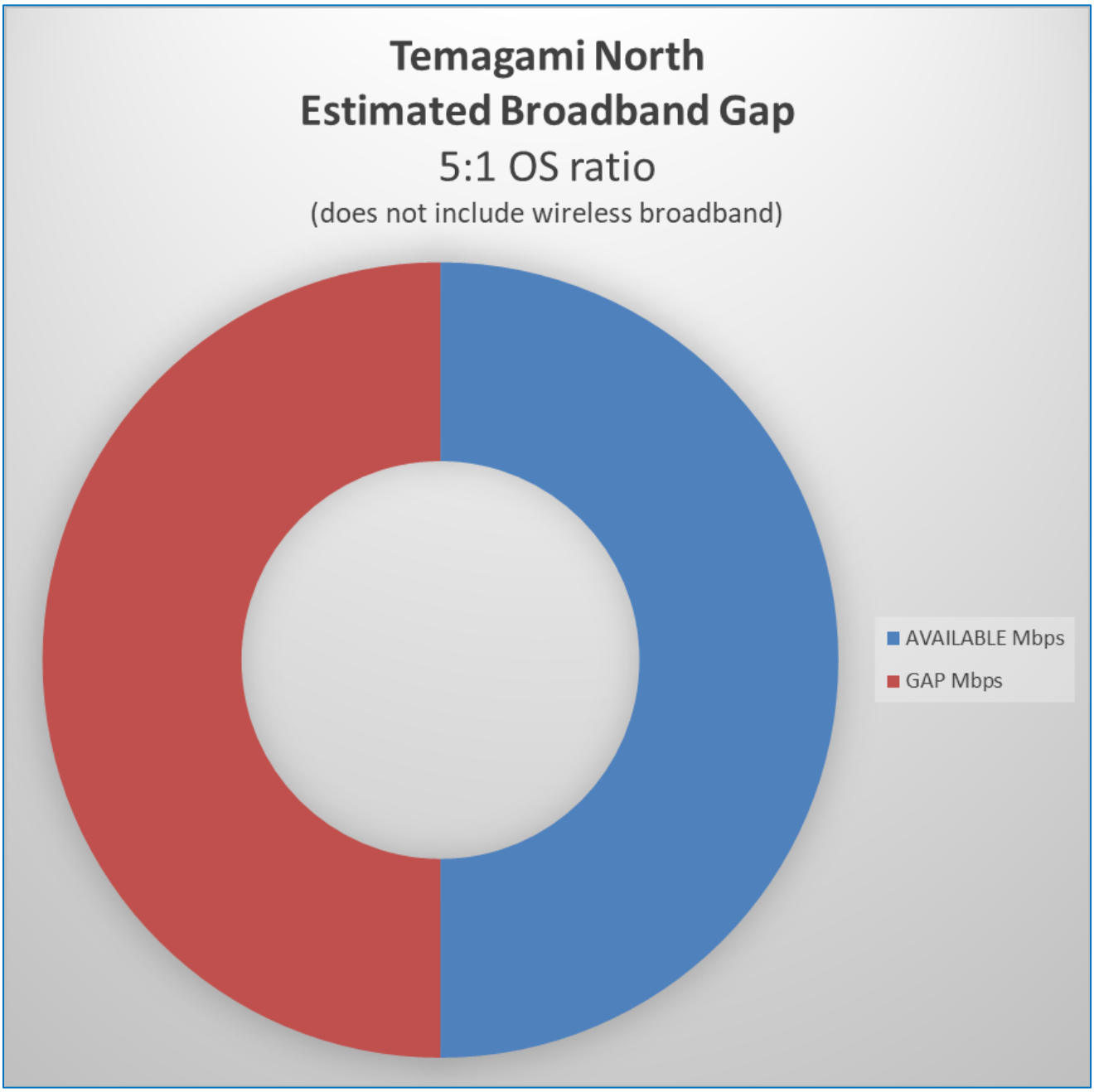
However, the community itself is serviced by aged ADSL technology with limited capacity, which greatly drops the further a dwelling is located from the CO. Ontera's plant is aerial copper throughout the community. There is likely some Xplornet service available as a small Xplornet panel antenna was noted on a dwelling pointed southward towards Temagami Core. However, the total capacity of the facility is unknown.

Mobility coverage appears to come from the cellular tower site near the school in Temagami. Both Xplornet and Galaxy Broadband are reported to provide satellite data services; however, no premises mounted dishes were visible. Television satellite dishes were not covered in this scope (ie: ExpressVu).


Buried Fibre Optic Cable
Ontera tower
Ontera Central Office
Arena
Aerial fibre to Ontera CO
Ontario Clean Water Agency
Aerial fibre
Aerial Fibre Optic Cable

Temagami North does have a relatively sizeable gap as noted below in red. However, there is the potential to increase capacity as recommended herein.

Community Broadband Gap Analysis	STATISTICS						DATA (Mbps)					NEED	OS ratio 5:1	AVAILABLE Mbps	GAP Mbps
	POP	Dwellings	Businesses	Hospital/ Clinics	Schools	Students	Dwellings	Businesses	Hospital/ Clinics	Schools	Students				
							25	100	100	100	1	Mbps		Mbps	Mbps
Temagami North	242	115	5	0	0	0	2875	500	0	0	0	3375	675	200	475.0



Recommendations

- Given the level of fibre connectivity into Temagami North given Ontera's central office location, they should be contacted to discuss the potential to upgrade the community's local access and distribution. For instance, discuss whether Ontera will install an upgraded DSLAM within their CO and deploy VDSL. While that would not meet the CRTC's aspirational goals of 50/10, it would at least improve user experience in the interim.
- Ontera will also need to confirm the transport capacity of its current fibre into the community should it require additional equipment to be sized properly for local distribution.
- The presence of fibre does provide the opportunity for an alternate service provider to access Ontera wholesale services and deploy either as a WISP and/or a FTTP deployment, depending on a sustainable business case.

Estimated Capital Ranges

[refer to Exhibit A – Estimated Capital Ranges for full project view]

		MARKET PROJECTION		CONNECTED PREMS		
Communities	Prems Passed	Target Market Penetration	Target Prem Project Total	Year One Connected Prems	Year Two Connected Prems	Year Three Connected Prems
Temagami North	120	80%	96	38	29	29

TRANSPORT	DISTRIBUTION	DROPS	YEAR TWO & THREE		TOTAL FTTP COSTS		
Transport + electronics	Distribution + Electronics	FTTP Drop + Prem Total Cost	Year Two PREM Capital	Year Three PREM Capital	Total Project Cost	Total Cost Per Prem PASSED	Total Cost Per CONNECTED Prem
$ 111,948	$ 280,000	**$ 44,544**	$ 33,408	$ 33,408	$ 503,308	$ 4,083	$ 5,243

Prems Passed = # of premises that distribution cabling passes along a street, but not connecting to the premises (drop)
Target Market Penetration = estimate of how many customers would use the new service
Transport + Electronics = cost of construction backbone fibre to community + electronics, or electronics if transport fibre in place
Distribution + Electronics = cost of constructing last mile distribution fibre + electronics within the community
VDSL Per Connected Prem = cost of installing the node divided by the number of total subscribers
LOW (VDSL) = estimated lower end of providing a degree of broadband in the community
HIGH (FTTP) = estimated upper end of providing a degree of broadband in the community

Overall Assumptions:
pole make ready costs not included
% of prems connected varies, max 80% where no competitor to Ontera/Bell, max 60% where a facilities based competitor exists
VDSL will not require distribution copper upgrades
all values are estimates, additional accuracy requires market design and pricing exercise
WIRELESS AND FIXED WIRELESS SOLUTIONS NOT INCLUDED EXCEPT FOR LAKE TEMAGAMI

7.7 Marten River

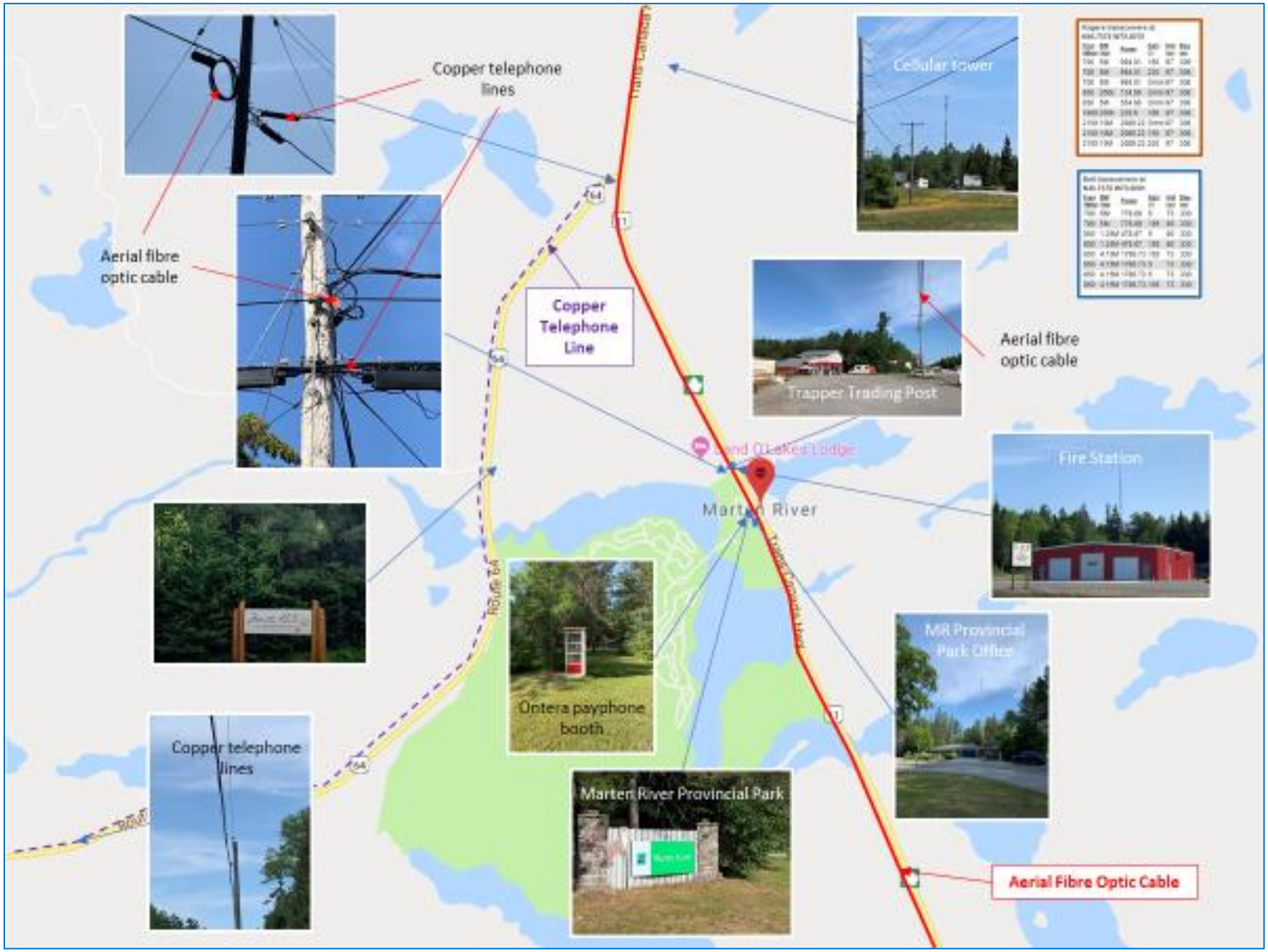
Quick View

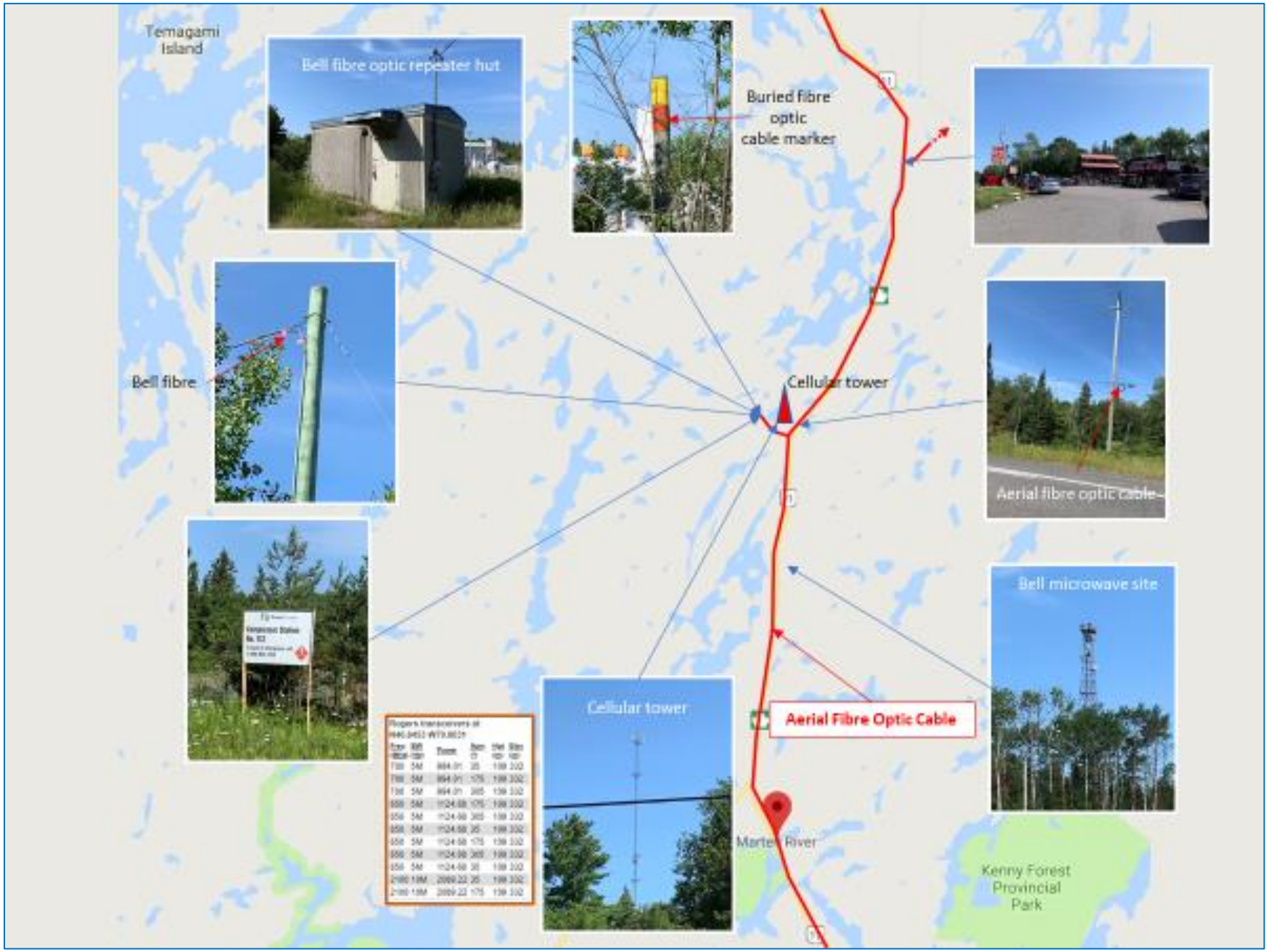
Site Visit: August 2nd, 2019
Population: 40
# of homes: 20
# of businesses: 5
# of students: 0
# of schools: 0
# of hospitals/clinics: 0

Telecommunications Observations

The community has aerial Ontera fibre facility that passes through along Highway 11. There is only aerial copper plant installed along Highway 64. Local distribution is limited to copper with aged ADSL technology at low speeds.

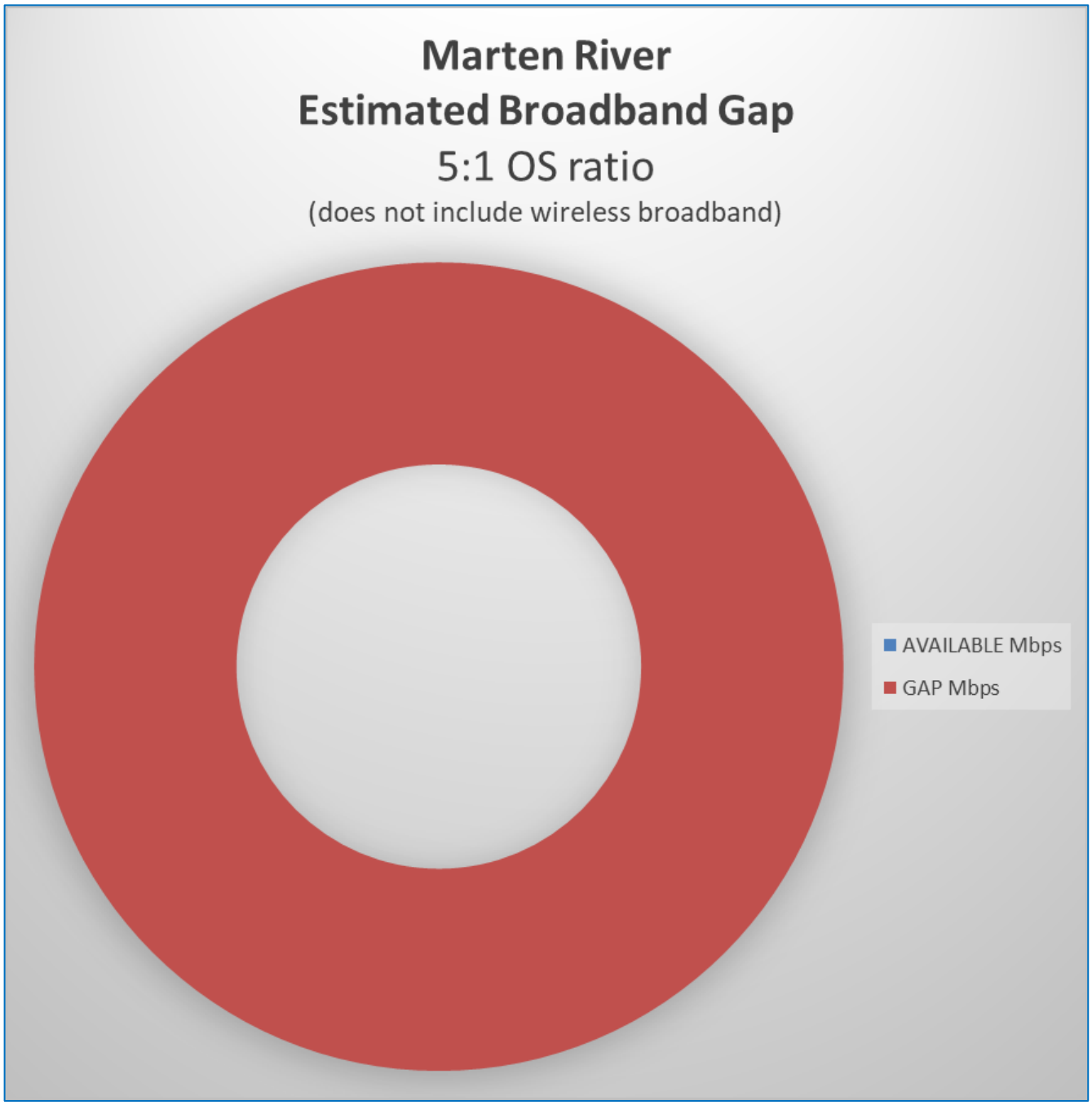
Mobility coverage comes from towers in the vicinity as noted in the mapping below. Both Xplornet and Galaxy Broadband are reported to provide satellite data services; however, no premises mounted dishes were visible. Television satellite dishes were not covered in this scope (ie: ExpressVu).


Copper telephone lines
Aerial fibre optic cable
Cellular tower
Copper Telephone Line
Trapper Trading Post
Aerial fibre optic cable
Fire Station
Marten River
Ontera payphone booth
MR Provincial Park Office
Copper telephone lines
Marten River Provincial Park
Aerial Fibre Optic Cable


Temagami Island
Bell fibre optic repeater hut
Buried fibre optic cable marker
Bell fibre
Cellular tower
Aerial fibre optic cable
Bell microwave site
Cellular tower
Aerial Fibre Optic Cable
Marten River
Kenny Forest Provincial Park

Marten River has a complete broadband gap as illustrated below in red. However, there is the potential to increase capacity as recommended herein.

Community Broadband Gap Analysis	STATISTICS						DATA (Mbps)					NEED	OS ratio 5:1	AVAILABLE Mbps	GAP Mbps
	POP	Dwellings	Businesses	Hospital/ Clinics	Schools	Students	Dwellings	Businesses	Hospital/ Clinics	Schools	Students				
							25	100	100	100	1	Mbps		Mbps	Mbps
Marten River	40	20	5	0	0	0	500	500	0	0	0	1000	200	0	200.0



Recommendations

- Given the level of fibre connectivity passing through a portion of Marten River along Highway 11, Ontera should be contacted to discuss the potential to upgrade the community's local access and distribution. For instance, discuss whether Ontera will install a FTTN/DSLAM within the community and deploy VDSL. While that would not meet the CRTC's aspirational goals of 50/10, it would at least improve user experience in the interim.
- Ontera will also need to confirm the transport capacity of its current fibre into the community should it require additional equipment to be sized properly for local distribution.
- The presence of fibre does provide the opportunity for an alternate service provider to access Ontera wholesale services and deploy either as a WISP and/or a FTTP deployment, depending on a sustainable business case.

Estimated Capital Ranges

[refer to Exhibit A – Estimated Capital Ranges for full project view]

		MARKET PROJECTION		CONNECTED PREMS		
Communities	Prems Passed	Target Market Penetration	Target Prem Project Total	Year One Connected Prems	Year Two Connected Prems	Year Three Connected Prems
Marten River	25	80%	20	8	6	6

TRANSPORT	DISTRIBUTION	DROPS	YEAR TWO & THREE		TOTAL FTTP COSTS		
Transport + electronics	Distribution + Electronics	FTTP Drop + Prem Total Cost	Year Two PREM Capital	Year Three PREM Capital	Total Project Cost	Total Cost Per Prem PASSED	Total Cost Per CONNECTED Prem
$ 559,741	$ 237,500	**$ 9,280**	$ 6,960	$ 6,960	$ 820,441	$ 39,862	$ 41,022

Prems Passed = # of premises that distribution cabling passes along a street, but not connecting to the premises (drop)
Target Market Penetration = estimate of how many customers would use the new service
Transport + Electronics = cost of construction backbone fibre to community + electronics, or electronics if transport fibre in place
Distribution + Electronics = cost of constructing last mile distribution fibre + electronics within the community
VDSL Per Connected Prem = cost of installing the node divided by the number of total subscribers
LOW (VDSL) = estimated lower end of providing a degree of broadband in the community
HIGH (FTTP) = estimated upper end of providing a degree of broadband in the community

Overall Assumptions:
pole make ready costs not included
% of prems connected varies, max 80% where no competitor to Ontera/Bell, max 60% where a facilities based competitor exists
VDSL will not require distribution copper upgrades
all values are estimates, additional accuracy requires market design and pricing exercise
WIRELESS AND FIXED WIRELESS SOLUTIONS NOT INCLUDED EXCEPT FOR LAKE TEMAGAMI

7.8 Bear Island

Quick View

Site Visit: May 27th, 2019
Population: 244
# of homes: 110
# of businesses: 14
# of students: 44
# of schools: 1
# of hospitals/clinics: 1

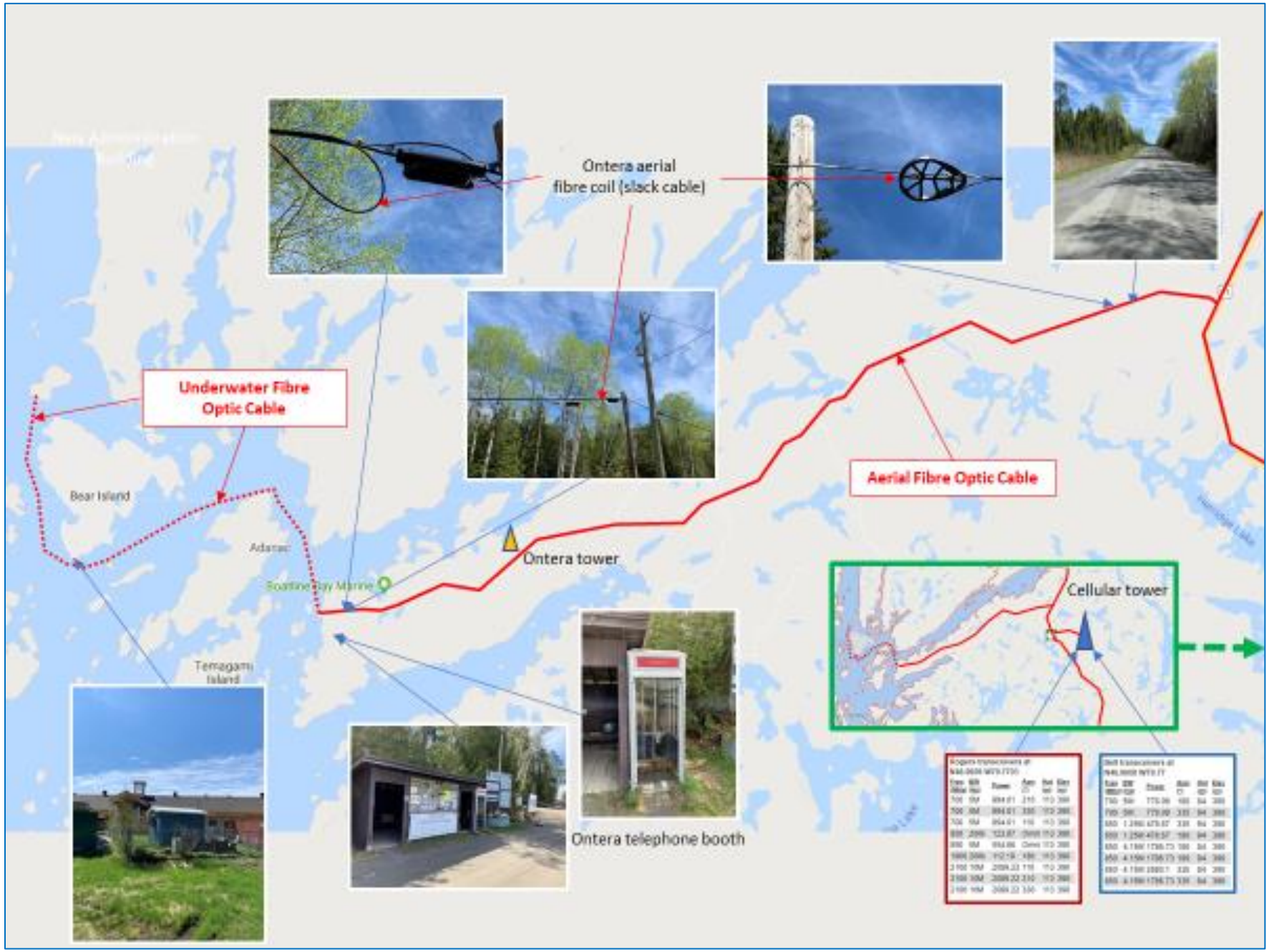
Telecommunications Observations

Bear Island is served by Ontera's fibre optic cable that comes ashore and into their POP as shown below. The community itself has an Ontera aerial copper distribution network. Some of the copper plant has been upgrade in the past few years; however, it is still an aged ADSL system with limited capacity. There is a single point to point fibre from the Ontera POP to the Doreen Potts Health Centre that was likely installed as part of KNET's service contract with eHealth (Provincial program to connect medical facilities). It was observed that attempts have been made to access the bandwidth to create wireless connections to points in the community. Inherently, such a system would not be optimal as the original circuit was not intended to support the additional traffic, nor was it a carrier-grade installation.

There are a few locations that are served by Xplornet satellite services, especially at the construction trailer site. That particular installation is temporary.

Cellular coverage is spotty at best to non-existent given the topography of Bear Island and that of the surrounding territory.

Television satellite dishes were not covered in this scope (ie: ExpressVu).

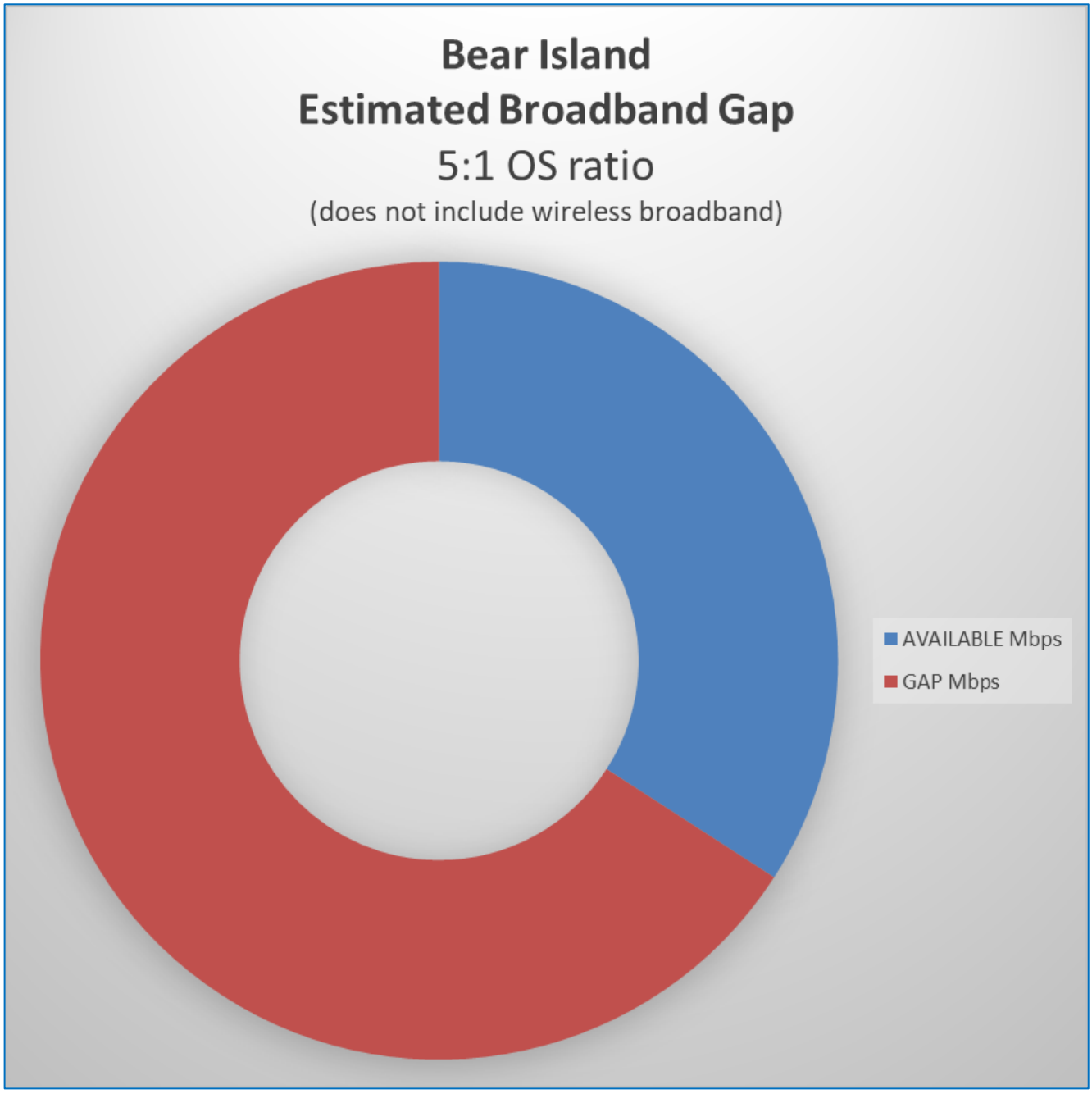

Ontera aerial
fibre coil (slack cable)
Underwater Fibre
Optic Cable
Aerial Fibre Optic Cable
Bear Island
Adanac
Ontera tower
Cellular tower
Temagami
Island
Ontera telephone booth


Thunder Pipe Lodge
Elders Building
Laura Mackenzie Learning Centre
Water Treatment Plant
Bear Island
Doreen Potts Health Centre
Police Station
Aerial Fibre Optic Cable
New Administration Building
Underwater Fibre Optic Cable


Construction trailers c/w Xplornet Internet dishes
Outdoor rink
Wireless Internet mast
Ontera payphone
Buried Fibre Optic Cable
Security camera
Aerial Fibre Optic Cable
Underwater Fibre Optic Cable
Aerial fibre optic cable
Ontera patch panel inside health centre
Ontera POP building
Buried Fibre Optic Cable

Bear Island does have a relatively sizeable gap as noted below in red. However, there is the potential to increase capacity as recommended herein.

Community Broadband Gap Analysis	STATISTICS						DATA (Mbps)					NEED	OS ratio 5:1	AVAILABLE Mbps	GAP Mbps
	POP	Dwellings	Businesses	Hospital/ Clinics	Schools	Students	Dwellings	Businesses	Hospital/ Clinics	Schools	Students				
							25	100	100	100	1	Mbps		Mbps	Mbps
Bear Island	244	110	14	1	1	44	2750	1400	100	100	44	4394	879	300	578.8
STUDY AREA TOTALS	3146	1373	49	2	2	68	34325	4900	200	200	68	39693	7938.6	700	7238.6



Recommendations

- Given the level of fibre connectivity onto Bear Island, Temagami First Nation has contracted Amedeo Bernardi Consulting Inc. to investigate if additional capacity can be provisioned for Bear Island. Ontera is currently assessing its network and determining whether its equipment is sized properly for the increased request.
- A consideration in the interim is to have Ontera upgrade the community's local copper access and distribution. Ontera has upgraded much of its copper plant in the main section of the Island. At a minimum, Ontera could install an upgraded DSLAM within the community and deploy VDSL. While that would not meet the CRTC's aspirational goals of 50/10, it would at least improve user experience in the interim. However, until Ontera confirms its overall network capacity on to Bear Island, the discussion is premature.
- The presence of fibre does provide the eventual opportunity for an alternate service provider to access Ontera wholesale services and deploy either as a WISP and/or a FTTP deployment, depending on a sustainable business case.

Estimated Capital Ranges

[refer to Exhibit A – Estimated Capital Ranges for full project view]

		MARKET PROJECTION		CONNECTED PREMS		
Communities	Prems Passed	Target Market Penetration	Target Prem Project Total	Year One Connected Prems	Year Two Connected Prems	Year Three Connected Prems
Bear Island	125	90%	113	45	34	34

TRANSPORT	DISTRIBUTION	DROPS	YEAR TWO & THREE		TOTAL FTTP COSTS		
Transport + electronics	Distribution + Electronics	FTTP Drop + Prem Total Cost	Year Two PREM Capital	Year Three PREM Capital	Total Project Cost	Total Cost Per Prem PASSED	Total Cost Per CONNECTED Prem
$ 55,974	$ 287,500	**$ 52,200**	$ 39,150	$ 39,150	$ 473,974	$ 3,053	$ 4,213

Prems Passed = # of premises that distribution cabling passes along a street, but not connecting to the premises (drop)
Target Market Penetration = estimate of how many customers would use the new service
Transport + Electronics = cost of construction backbone fibre to community + electronics, or electronics if transport fibre in place
Distribution + Electronics = cost of constructing last mile distribution fibre + electronics within the community
VDSL Per Connected Prem = cost of installing the node divided by the number of total subscribers
LOW (VDSL) = estimated lower end of providing a degree of broadband in the community
HIGH (FTTP) = estimated upper end of providing a degree of broadband in the community

Overall Assumptions:
pole make ready costs not included
% of prems connected varies, max 80% where no competitor to Ontera/Bell, max 60% where a facilities based competitor exists
VDSL will not require distribution copper upgrades
all values are estimates, additional accuracy requires market design and pricing exercise
WIRELESS AND FIXED WIRELESS SOLUTIONS NOT INCLUDED EXCEPT FOR LAKE TEMAGAMI

7.9 Temagami (Lake)

Quick View

Site Visit: May 27th, 2019
Population: 2100 (predominantly seasonal)
# of homes: 908
# of businesses: 5
# of students: 0
# of schools: 0
# of hospitals/clinics: 0

Telecommunications Observations

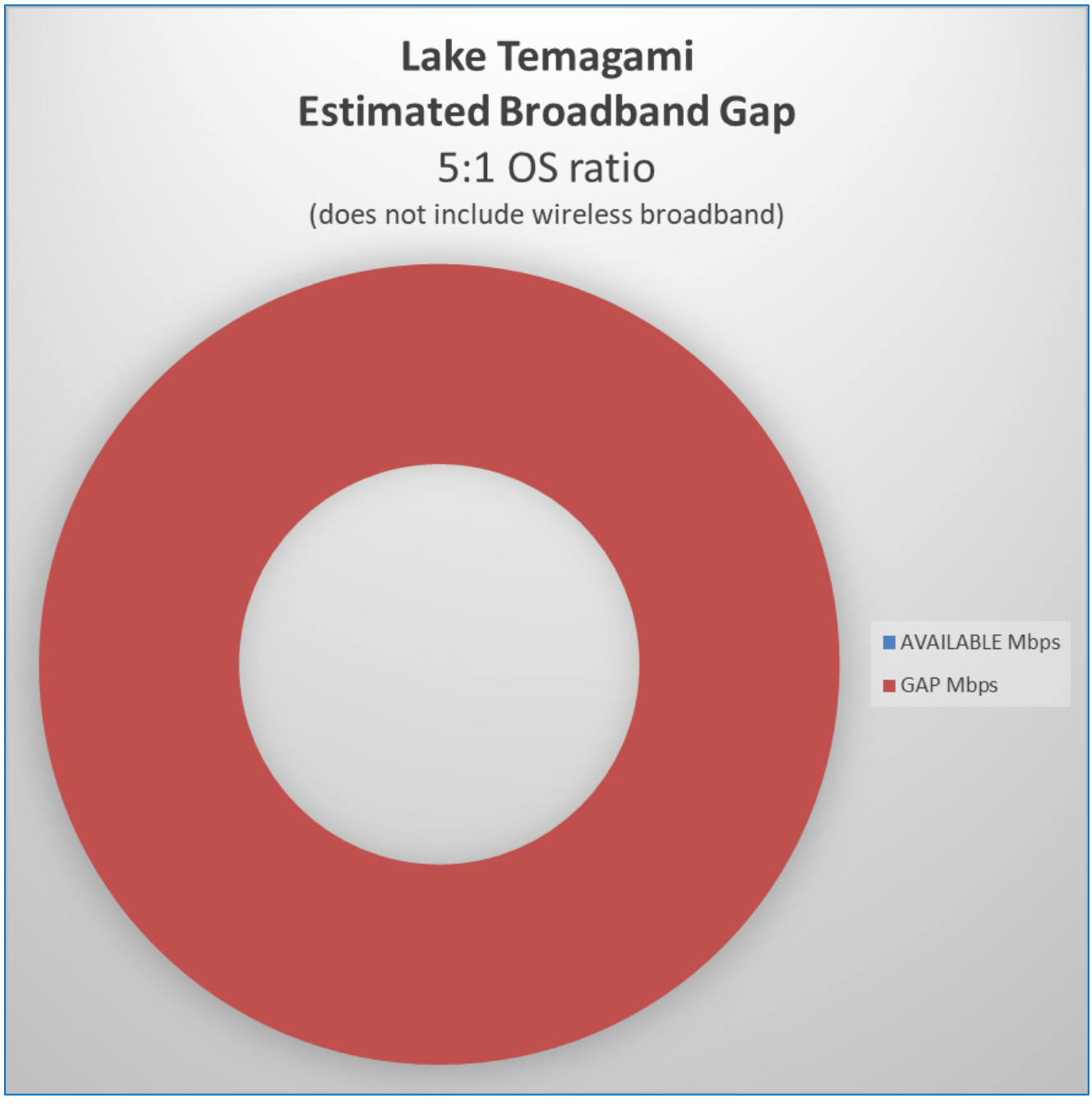
The dwellings on Lake Temagami are predominantly seasonal, recreational cottages that peak during the summer months. Given the extensive shoreline and number of islands on the Lake, wired connectivity has always been a challenge. Most locations are serviced by Ontera's network of underwater copper plant. Distribution points are fed by fibre (ie: from Bear Island and Wabun/Garden Island), copper and microwave (ie: from Ontera tower on Lake Temagami Access Rd to other lake towers).

Based on survey responses, it was observed that some seasonal residents rely on cellular based data services, where there is coverage. However, cellular coverage is spotty at best to non-existent given the topography of the surrounding territory.

Both Xplornet and Galaxy Broadband are reported to provide satellite data services. Television satellite dishes were not covered in this scope (ie: ExpressVu).

Lake Temagami has a complete broadband gap as illustrated below in red. However, there is the potential to increase capacity as recommended herein.

Community Broadband Gap Analysis	STATISTICS						DATA (Mbps)					NEED	OS ratio 5:1	AVAILABLE Mbps	GAP Mbps
	POP	Dwellings	Businesses	Hospital/ Clinics	Schools	Students	Dwellings	Businesses	Hospital/ Clinics	Schools	Students				
							25	100	100	100	1	Mbps		Mbps	Mbps
Lake Temagami	2100	908	5	0	0	0	22700	500	0	0	0	23200	4640	0	4640.0



Recommendations

- It would be cost prohibitive to replace the existing Ontera underwater copper network based on the low density and seasonal population. Over time, Ontera might replace key segments with fibre based on costing, but that does not ensure that the underlying network capacity would be increased in step.
- This report is not intended to review or analyze wireless-based coverage; nor make any related recommendations. However, so to provide a potential scope of the potential effort to provide additional capacity to portions of Lake Temagami, some high-level suggestions follow. Note that a radio-frequency engineering analysis was not commissioned, and this is merely based on observations.
- As noted in the report, LEO (low earth orbit) satellite network constellations are starting to be launched. Should one or more of the providers commercialize their offerings successfully, the potential for coverage in the region is greatly increased.
- A potential option to consider is the installation of at least one tower on Bear Island at the height of land. A second tower could be considered on another sector of the lake (or more).
- A Bear Island tower of 100’ – 200’ in height may provide a sizeable coverage footprint for fixed wireless services to adjacent locations. Capacity is predicated on accessing sufficient services from the Ontera network (see Bear Island section).
- A proxy of the possible costs to implement one to two towers is estimated in the table below.
- A benefit to a tower on Bear Island is that cellular companies such as Bell Mobility and Rogers might be attracted to collocate on the facility (for a recurring fee). One or more of the companies should be approached to even consider partially funding the structure, as long as there is a business case for the tower owners.
- The diagrams that follow are included for illustration purposes only and are not meant to represent an actual design.

Estimated Capital Ranges

[refer to Exhibit A – Estimated Capital Ranges for full project view]

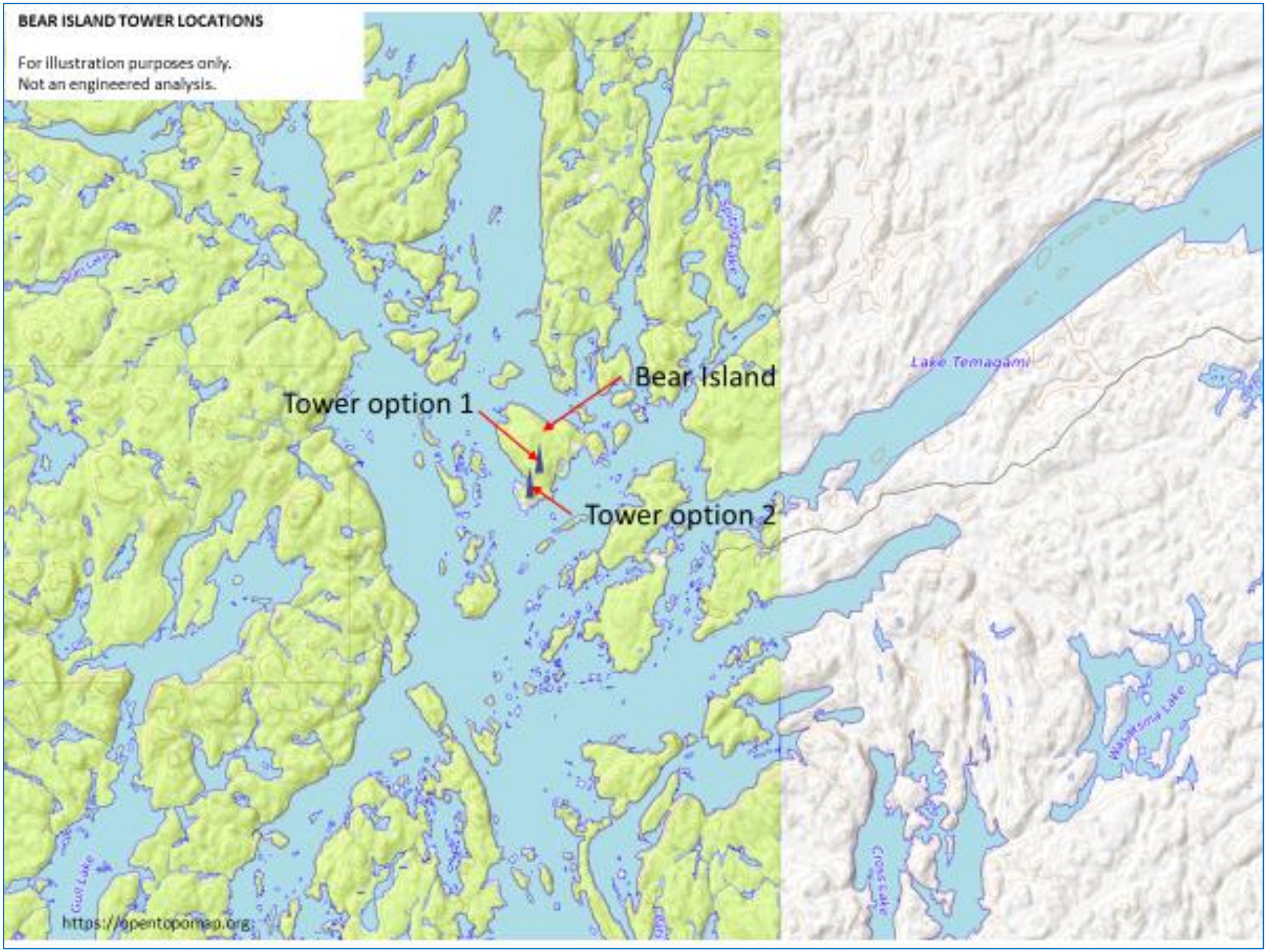
		MARKET PROJECTION		CONNECTED PREMS		
Communities	Prems Passed	Target Market Penetration	Target Prem Project Total	Year One Connected Prems	Year Two Connected Prems	Year Three Connected Prems
Lake Temagami	913	30%	274	110	82	82

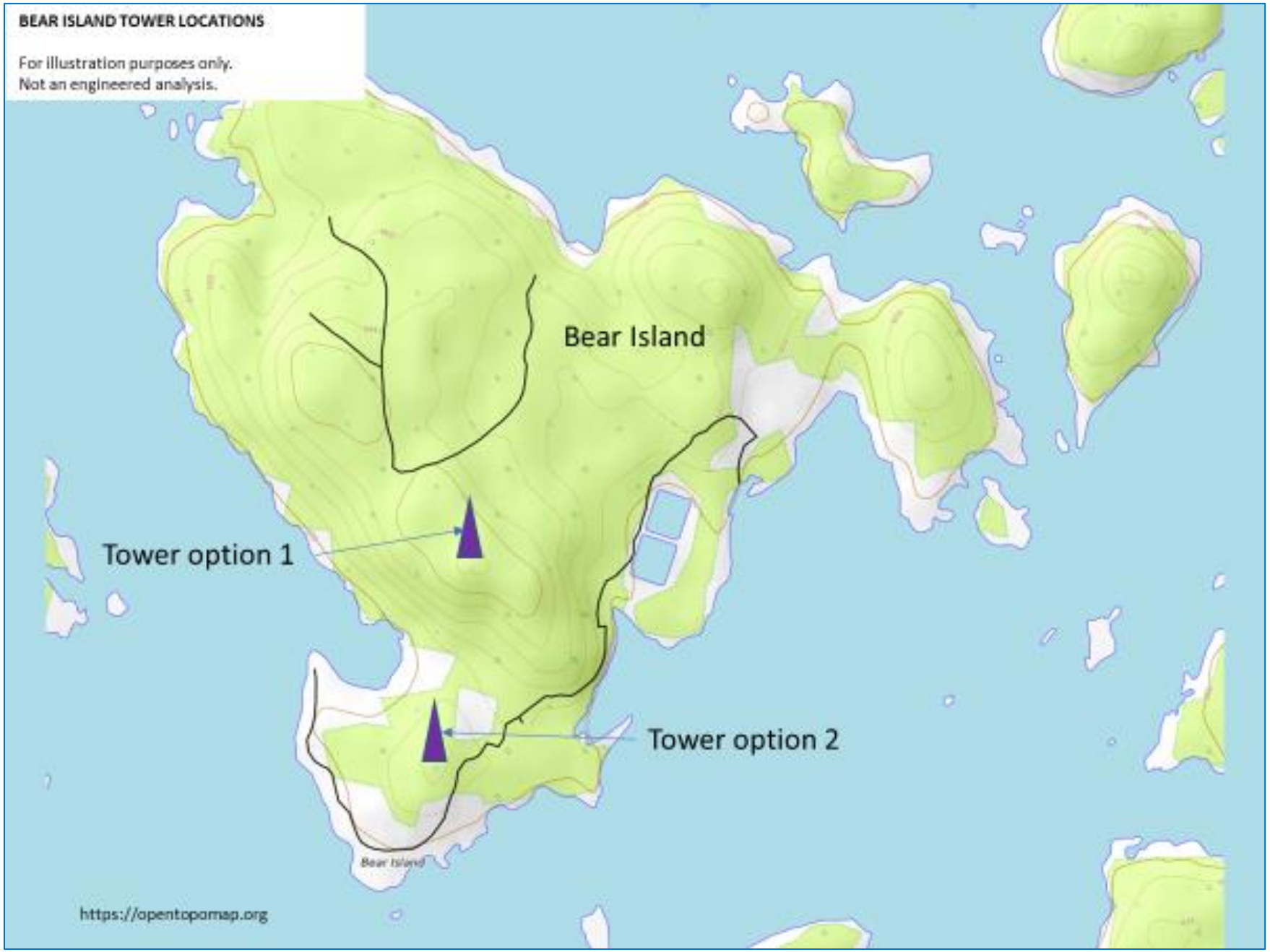
TRANSPORT	DISTRIBUTION	DROPS	YEAR TWO & THREE		TOTAL FTTP COSTS		
Transport + electronics	Distribution + Electronics	FTTP Drop + Prem Total Cost	Year Two PREM Capital	Year Three PREM Capital	Total Project Cost	Total Cost Per Prem PASSED	Total Cost Per CONNECTED Prem
$ 559,741	$ 1,569,500	**$ 127,090**	$ 95,317	$ 95,317	$ 2,446,965	$ 7,774	$ 8,934

NOTE: The values as presented are only a proxy for the estimated costs of two towers, do not reference fibre-related terminology.

Prems Passed = # of premises that distribution cabling passes along a street, but not connecting to the premises (drop)
Target Market Penetration = estimate of how many customers would use the new service
Transport + Electronics = cost of construction backbone fibre to community + electronics, or electronics if transport fibre in place
Distribution + Electronics = cost of constructing last mile distribution fibre + electronics within the community
VDSL Per Connected Prem = cost of installing the node divided by the number of total subscribers
LOW (VDSL) = estimated lower end of providing a degree of broadband in the community
HIGH (FTTP) = estimated upper end of providing a degree of broadband in the community

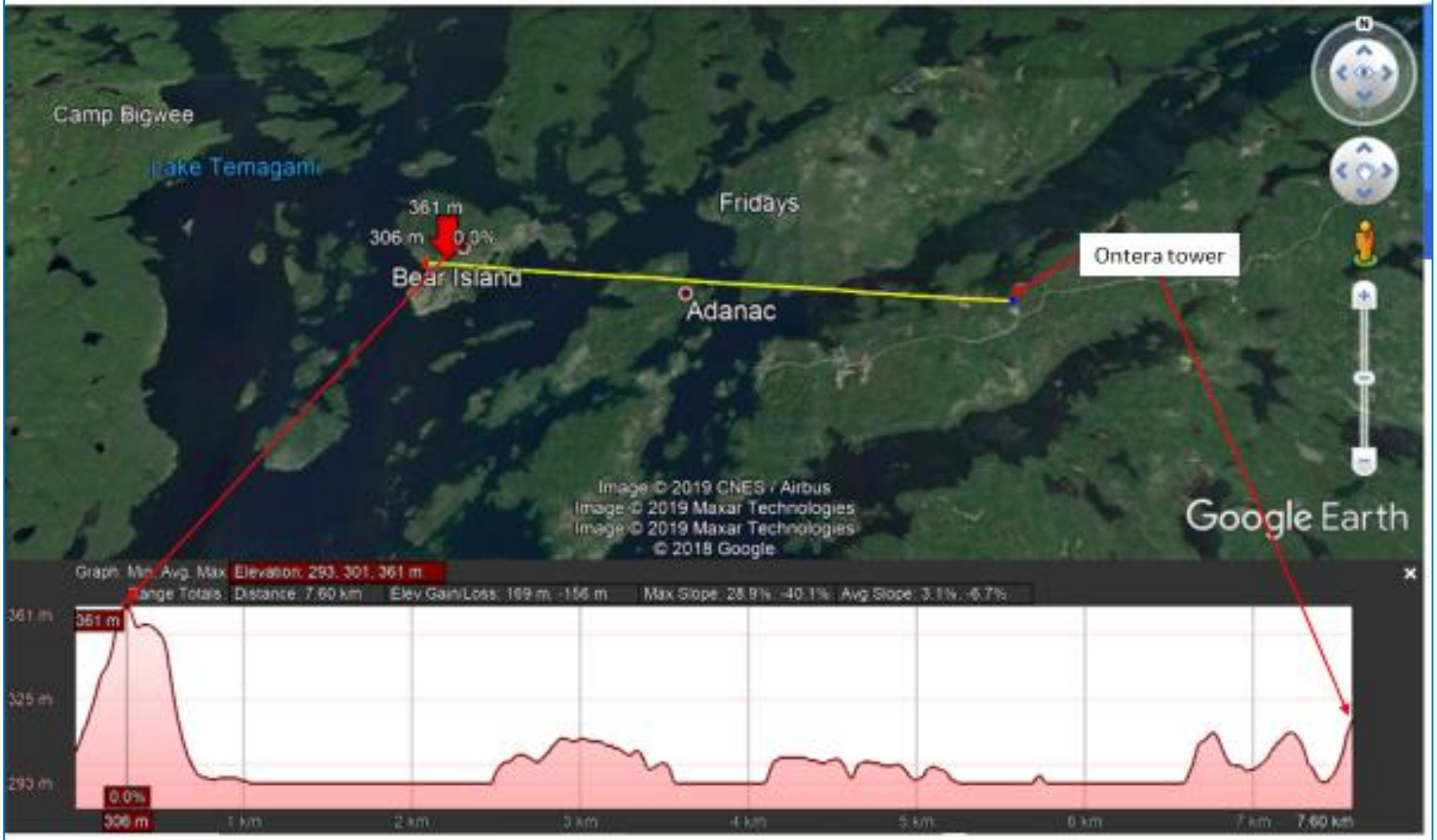
Overall Assumptions:
pole make ready costs not included
% of prems connected varies, max 80% where no competitor to Ontera/Bell, max 60% where a facilities based competitor exists
VDSL will not require distribution copper upgrades
all values are estimates, additional accuracy requires market design and pricing exercise
WIRELESS AND FIXED WIRELESS SOLUTIONS NOT INCLUDED EXCEPT FOR LAKE TEMAGAMI


BEAR ISLAND TOWER LOCATIONS
For illustration purposes only.
Not an engineered analysis.
Bear Island
Tower option 1
Tower option 2
Lake Temagami
https://opentopomap.org


BEAR ISLAND TOWER LOCATIONS
For illustration purposes only.
Not an engineered analysis.
Bear Island
Tower option 1
Tower option 2
Bear Island
https://opentopomap.org

ELEVATIONS

For illustration purposes only.
Not an engineered analysis.



ELEVATIONS

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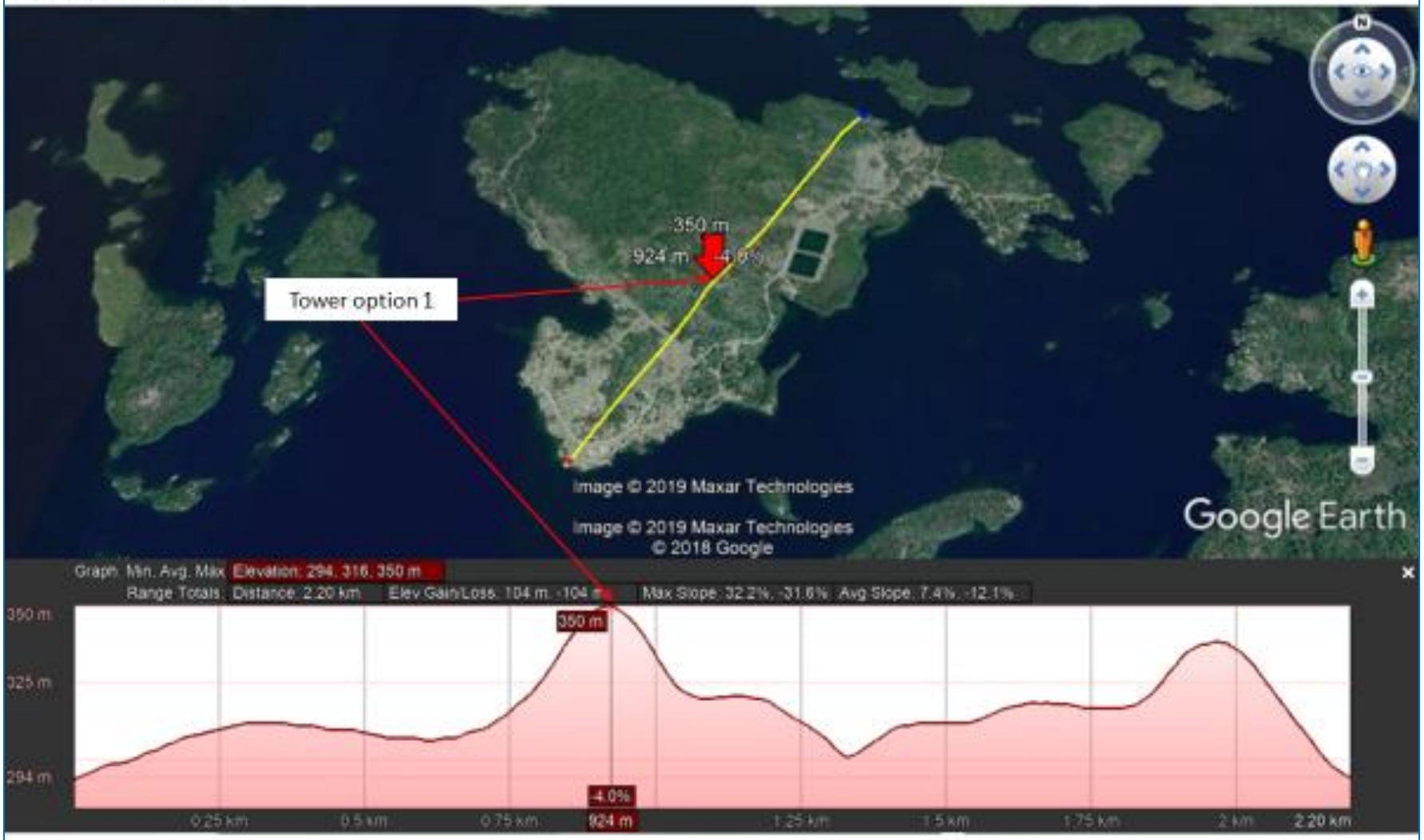


8.0 Survey

8.1 Overview

The survey was administered from July 29th to August 16th, 2019. It was provided in both online and paper formats. Representatives of the participating communities employed a variety of communications methods to drive participation in the survey.

The following table is a summary of the survey engagement.

Surveys Completed	385
Total Dwellings*	1408
Percentage Completed	**27%**
*Total Dwellings based on 2016 Stats Can census, TFN Community Profile Feb 2019 (110), Connected North parcel 2019 information (1298)	

The survey was premises-based versus individual responses so to reduce multiple results from the same home or business. There was an overall 27% participation rate across the communities with 37% representing residences and 55% seasonal respondents. This aligns closely with the data that follows the table below.

Participation by Premises Type	#	%
Home or primary residence	144	37%
Seasonal residence/cottage	213	55%
Business (not including tourist camp)	10	3%
Tourist camp/resort	11	3%
Other	7	2%
Total	**385**	**100%**

Responses were tabulated relative to their communities as noted in the table below with 58% of input received from Lake Temagami.

Participation by Community (Cumulative)	#	%
Bear Island	49	13%
Temagami North	35	9%
Temagami	63	16%
Lake Temagami	223	58%
Marten River	15	4%
Total	**385**	**100%**

Grouping the areas by their census areas, the results indicate that Bear Island had a 45% participation rate and Municipality of Temagami a rate of 26% based on respondents versus total number of dwellings and parcels.

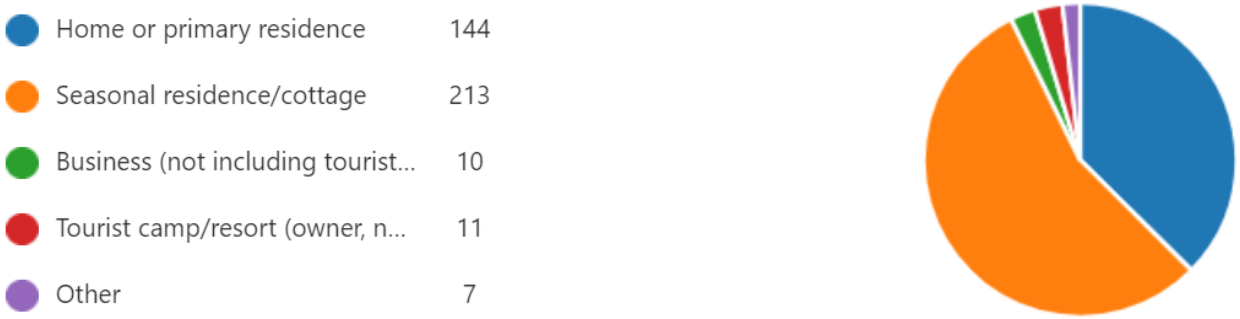
Participation by Community	#	%
Bear Island	49	45%
Municipality of Temagami	336	26%

8.2 Survey Details

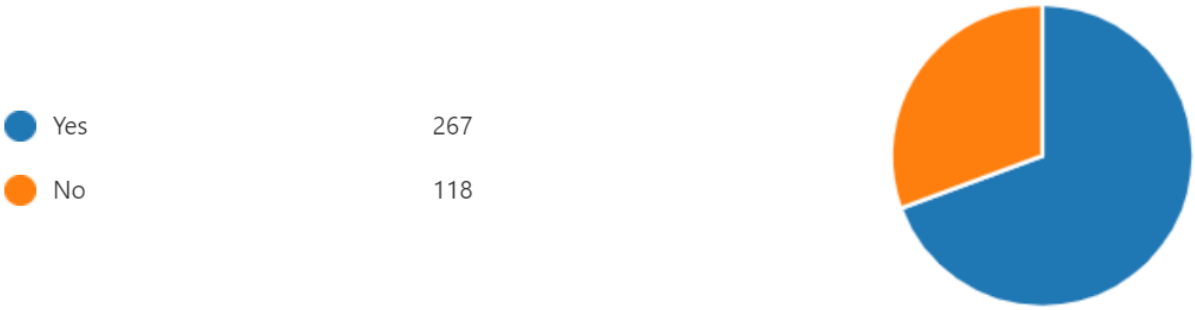
The following information was derived from the survey and has been arranged into three general categories: i) current broadband status, ii) desired connectivity and iii) cellular. The full survey results can be referenced in the Exhibits section.

Current Broadband Status

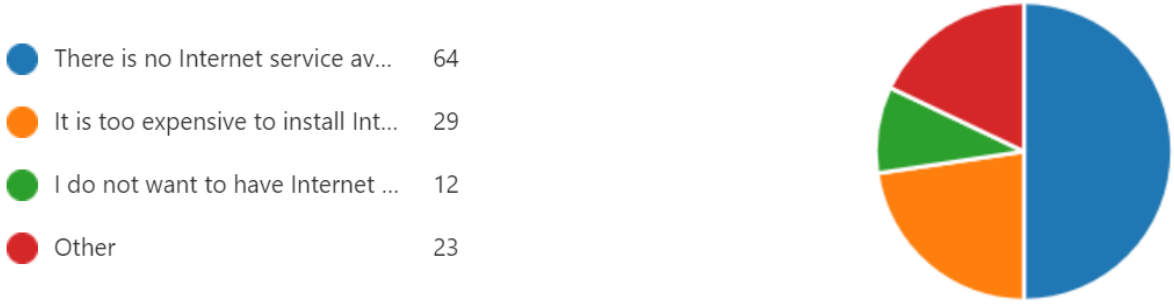
- 92% of the respondents were residential/seasonal.



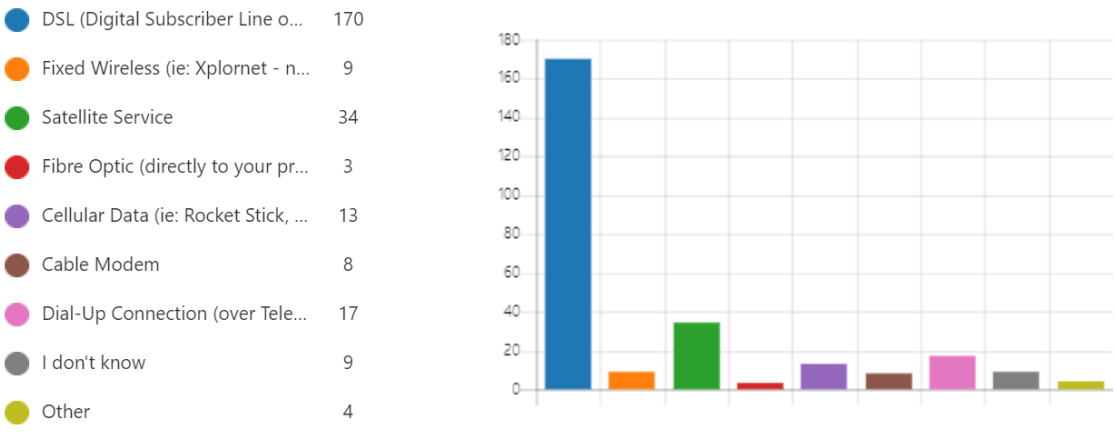
- 69% of all respondents have Internet access from their location.



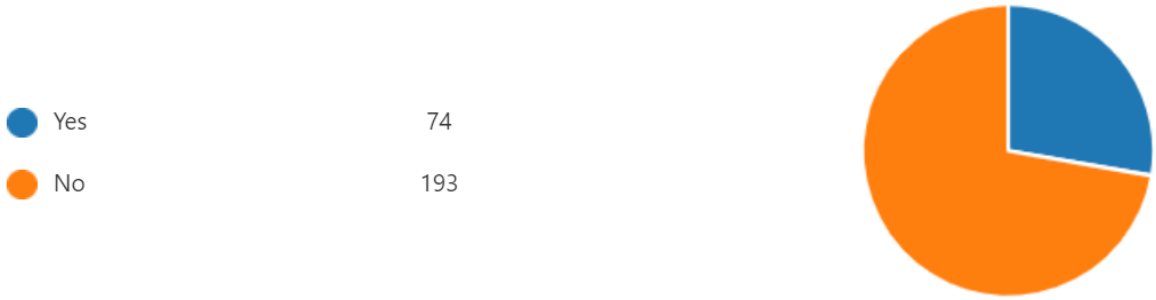
- Of those that do not, 50% said it was due to lack of service.



- The predominant connection type is DSL (44%) followed by satellite (9%)



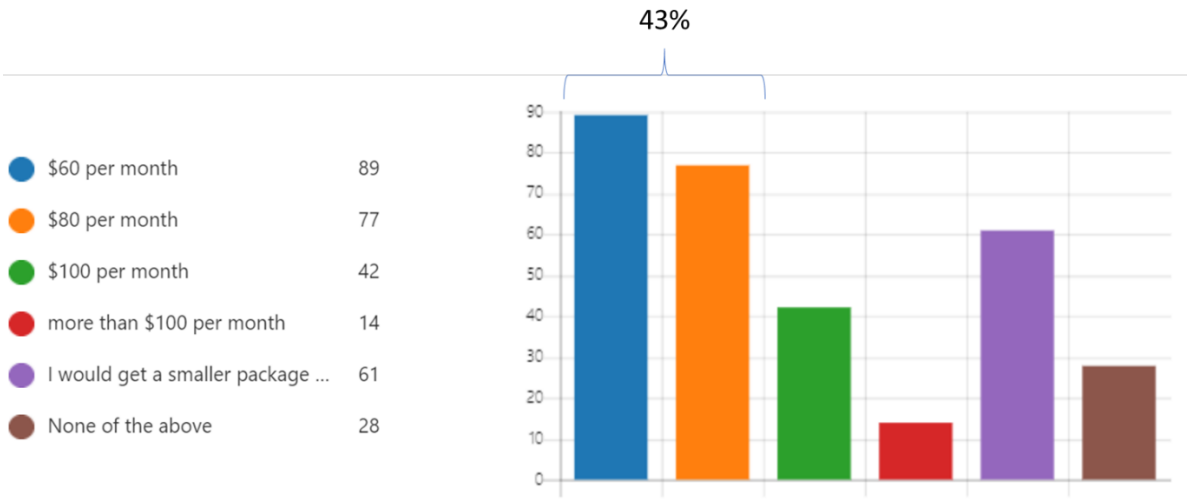
- 72% of respondents are dissatisfied with their current services.



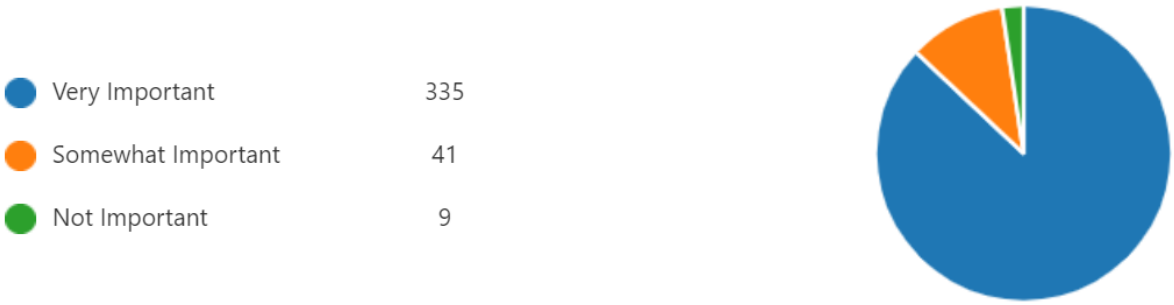
The responses in this category align with the findings of this report. Ontera does have the most widespread broadband network in the region with 77% of the respondents subscribed to Ontera.

Desired Connectivity

- 43% of respondents would subscribe to packages that cost $60-$80 per month to achieve the Federal goal of 50/10. That increases to 54% for those willing to spend between $60-$100 per month.



- 87% of respondents believe that advanced communications are very important for the community, inhabitants and businesses.



There is a strong demand of improved speeds in the region with the willingness to subscribe to fair priced packages if they were available. This suggests that there is a definite opportunity for service providers willing to invest and communities seeking partners in developing broadband for their residents and businesses.

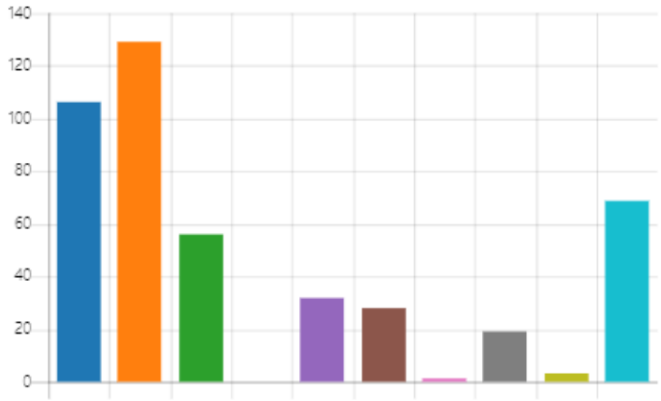
Cellular

- 95% of households own at least one cellphone.

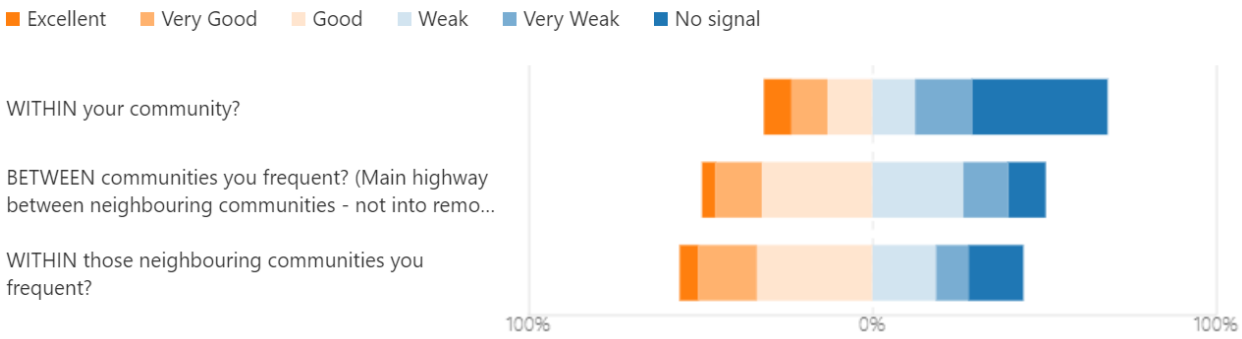
Yes	365
No	20

- While most respondents have Rogers as their provider (30%), when the respective flanker brands and roaming partners (ie; Bell and Telus) are accounted for, Rogers et al account for 34% of cellular users and Bell/Telus total 51%.

Bell Mobility	106
Rogers	129
TELUS Mobility	56
Tbaytel Mobility	0
Koodo Mobile	32
Virgin Mobile	28
Chartr Mobile	1
Fido Mobile	19
NorthernTel Mobility	3
Other	69



- Approximately one-third of respondents rate cellular coverage within their community as good to excellent. Almost 60% consider coverage within neighbouring communities to be good to excellent. However, approximately 50% indicate that the coverage between communities is weak to no coverage at all.



Cellphones have become an indispensable tool, not only for communications but assisting with many everyday tasks. Given the topology of the region combined with severe winter weather patterns, deficiencies in cellular coverage present challenges in emergency planning and safety concerns for residents. This issue was outside of the original scope of this study, but it is recommended that it be investigated further.

9.0 Risk Matrix

The potential regional risks that could influence the impact of broadband Internet improvement plans are captured over the coming pages. The assessed likelihood coupled with the estimated impact results in a rating of the potential risk using the scales in the two charts below.

LIKELIHOOD = Probability of the risk event actually occurring.	
Score:	Description:
1	Improbable; Rare
2	Unlikely
3	Possible
4	Likely
5	Certain

IMPACT = Degree of severity of the consequence.	
Score:	Description:
1	Insignificant - negligible effects.
2	Minor - normal administrative difficulties;
3	Significant - delay in accomplishing program or project objectives;
4	Major - program or project re-design, re-approval and re-do
5	Catastrophic - project or program irrevocably finished; objective will not be met.

The risks are grouped for ease of reference: Economy, Environment, Political, Regulatory, Safety, Strategic, and Technology. Suggested mitigation strategies that accompany each risk will also serve to inform of overall recommendations for the communities to consider.

CATEGORY	RISK	LIKELIHOOD (1-5 low-high)	IMPACT (1-5 low-high)	SCORE TOTAL	RANK	BACKGROUND	MITIGATION
Economy	Regional economy impacts - expansion or contraction of projects (natural resources valuations ie gold, forestry, etc)	1	4	**4**	***LOW***	Expansion or contraction of existing industries, effects of national and international trade, and financial stability of those operating in the Region can impact demand on Broadband.	Industry can be a major partner in furthering the communities' Broadband goals, whether as investors and/or their own lobbying efforts. They also benefit highly with a solid Broadband underpinning in the web-based and global economy. Continuous efforts to monitor their progress and solicit their help is key.
Environment	Natural disasters such as forest fires, ice rain, landslides, flooding, windstorms and lightning have impaired telecommunications network connectivity.	3	4	**12**	***HIGH***	The region is susceptible to many types of natural disasters, especially forest fires. With a predominantly aerial fibre and copper infrastructure, communities can risk isolation.	Communities must continue their vigilance and press their service providers on network redundancy strategies.
Political	Upcoming Federal elections (October 21, 2019) potential to change governing party and/or remove majority. Can result in discontinuation of funding priorities such as rural broadband and wireless expansion, delay budgetary approvals, and/or contribute to increased regulation (Internet traffic management).	3	5	**15**	***HIGH***	The success of the region's Broadband development is intrinsically linked to Federal policies and directions given the low population densities and challenging terrains.	Contact and dialogue with Federal politicians and bureaucrats must be maintained. Regional and local needs must continue to be addressed and impacts highlighted.
Political	New provincial government. Still unclear on broadband direction and funding priorities as MOI plans are scheduled for Spring 2020.	3	4	**12**	***HIGH***	The success of the region's Broadband development is intrinsically linked to Provincial policies and directions given the low population densities and challenging terrains.	Contact and dialogue with Provincial politicians and bureaucrats must be maintained. Regional and local needs must continue to be addressed and impacts highlighted.
Political	Closing the Broadband Gap - what will be the Federal government's funding priorities in the coming year(s).	2	4	**8**	***MEDIUM***	The new fund will be a key funding mechanism to enable the Region's and communities' Broaband objectives. Where and when the fund become available could be significant for the area.	Contact and dialogue with Federal politicians and bureaucrats must be maintained. Regional and local needs must continue to be addressed and impacts highlighted. Importantly, the communities should participate as jointly as possible in applications and support for local initiatives. While being the lead applicant, partnerships with service providers and private enterprises can increase likelihood of funding. Parallel applications to other funds, especially Provincial, are crucial.
Political	Indigenous Funders	3	4	**12**	***HIGH***	Based on the possible participation of stakeholders such as Temagami First Nation, the contribution of the various federal Indigenous funding programs is essential.	The communities should seek ways to work together as soon as possible. Bear Island can serve as a key network location (tower, fibre access) to the mutual benefit of the area.

Political	FedNor - what will funding priority role be in upcoming year(s)	2	4	**8**	***MEDIUM***	FedNor is an important support vehicle for the Region's needs. Their prominence and influence of government policies will remain key to the Region's Broadband initiatives.	Contact and dialogue with Federal politicians and bureaucrats must be maintained. Regional and local needs must continue to be addressed and impacts highlighted. Importantly, the Region should participate as jointly as possible in applications and support for local initiatives. While being the lead applicant, partnerships with service providers and private enterprises can increase likelihood of funding. Parallel applications to other funds, especially Provincial, are crucial.
Political	MENDM - what will funding priority role be in upcoming year(s)	2	4	**8**	***MEDIUM***	MENDM is an important support vehicle for the Region's needs. Their prominence and influence of government policies will remain key to the Region's Broadband initiatives.	Contact and dialogue with Provincial politicians and bureaucrats must be maintained. Regional and local needs must continue to be addressed and impacts highlighted. Importantly, the Region should participate as jointly as possible in applications and support for local initiatives. While being the lead applicant, partnerships with service providers and private enterprises can increase likelihood of funding. Parallel applications to other funds are crucial.
Political	NOHFC - what will funding priority role be in upcoming year(s)	2	4	**8**	***MEDIUM***	NOHFC is an important support vehicle for the Region's needs. Their prominence and influence of government policies will remain key to the Region's Broadband initiatives.	Contact and dialogue with Provincial politicians and bureaucrats must be maintained. Regional and local needs must continue to be addressed and impacts highlighted. Importantly, the Region should participate as jointly as possible in applications and support for local initiatives. While being the lead applicant, partnerships with service providers and private enterprises can increase likelihood of funding. Parallel applications to other funds are crucial.
Regulatory	CRTC - Open Access (Net Neutrality)	1	5	**5**	***LOW***	Should Canada decide to abandon its Open Access platform, smaller operators will be unable to consider competing and servicing customers in remote/rural areas.	Participate as a regional group to actively monitor and contribute to Regulatory proceedings. Consider participation in existing industry groups with similar causes and concerns as required. Maintain active contact with local Federal MPs.
Regulatory	CRTC - Faster Internet and Basic Service Offering, $750M broadband fund - how will the fund be administered?	4	5	**20**	***EXTREME***	The CRTC's direction on the establishment of its broadband objectives and funding mechanisms will have a significant bearing on the overall improvements to Broadband in the region.	Participate as a regional group to actively monitor and contribute to Regulatory proceedings. Consider participation in existing industry groups with similar causes and concerns as required. Maintain active contact with local Federal MPs.

Regulatory	CRTC - Implementation of a disaggregated wholesale high-speed access service	2	2	**4**	***LOW***	The CRTC's implementation of high-speed access will begin to have appreciable impacts only once Ontera has a FTTP network within participating communities.	Participate as a regional group to actively monitor and contribute to Regulatory proceedings. Consider participation in existing industry groups with similar causes and concerns as required. Maintain active contact with local Federal MPs.
Regulatory	ISED - Revisions to the 3500 MHz Band	2	4	**8**	***MEDIUM***	The ISED's direction on the upcoming auction must be monitored as it can have impacts on those regional providers that rely on licenced spectrum to deliver fixed wireless broadband or other WISPs.	Participate as a regional group to actively monitor and contribute to Regulatory proceedings. Consider participation in existing industry groups with similar causes and concerns as required. Maintain active contact with local Federal MPs.
Regulatory	ISED - Antenna Tower and Site Sharing	3	3	**9**	***MEDIUM***	Cellular coverage is an important for regional safety and commerce. Enforcing tower sharing will enable service providers to extend and enhance their wireless networks to a greater extent if they can colocate on existing towers, putting capital towards added transmission equipment versus tower construction.	Participate as a regional group to actively monitor and contribute to Regulatory proceedings. Consider participation in existing industry groups with similar causes and concerns as required. Maintain active contact with local Federal MPs.
Regulatory	Ontario Energy Board's New Wireline Pole Attachment Framework	4	4	**16**	***HIGH***	The region is located on the Canadian Shield; therefore, the majority of fibre optic network expansion, at least between communities, will likely be pole mounted. The historical rates per pole have doubled with increases contemplated thus jeopardizing sustainable business cases for service providers. The potential of increased retail pricing is a consideration impacting consumers.	Participate as a regional group to actively monitor and contribute to OEB/Provincial proceedings. Consider participation in existing industry groups with similar causes and concerns as required. Maintain active contact with local Provincial MPPs.
Safety	Cellular corridor coverage between the communities.	4	5	**20**	***EXTREME***	Deficiencies in cellular coverage present challenges in emergency planning and safety concerns for residents living in rural and remote areas. This issue was outside of the original scope of this study, but it is recommended that it be investigated further.	The Province has indicated that a study was commissioned earlier this year and is awaiting review post-election. Community members should continue to liaise with the Provincial representatives to ensure the matter remains at the forefront of government policy. Additionally, consider expanding the scope of future phases to include cellular wireless in as much as it may qualify for the CRTC fund for the data component to assist communities that may not get access to upgrades for FTTH or DSL.

Strategic	Stakeholders - clear definition of requirements and delineation of responsibilities	2	4	**8**	***MEDIUM***	Stakeholders include the Community and Band administration, Economic Development representatives, local politicians, residents, businesses and the service providers. Each has a different role, set of responsibilities and degrees of accountability.	Each Stakeholder must be listed with clearly delineated roles, responsibilities, and accountabilities. A communications plan must be tailored to address these elements. Care must be taken to ensure controls and management of efforts.
Strategic	Ontera - what investment directions will it have beginning in 2020? Where will it focus its broadband?	3	4	**12**	***HIGH***	Ontera is the major regional service provider in the Study Area. Its corporate fiscal goals can have direct impact on the region's connectivity and participating community's level of upgrades.	Establish contacts within Ontera and maintain dialogue underscoring importance of improvements and positive impact to both the communities and the service provider.
Strategic	Xplornet - what investment directions will it have beginning in 2020? Where will it focus its broadband?	3	4	**12**	***HIGH***	Xplornet is the major fixed wireless regional service provider in the Study Area. Its corporate fiscal goals can have direct impact on the region's connectivity and participating community's level of upgrades.	Establish contacts within Xplornet and maintain dialogue underscoring importance of improvements and positive impact to both the communities and the service provider.
Technology	Developments in 5G deployments and funding impacts	1	1	**1**	***LOW***	5G is garnering significant technology media coverage with the promise of facilitating data communications. Also concerns with access to 3500Mhz spectrum and the negative impact to rural fixed wireless.	5G should not play a significant role in the early stages of the project given the rural and low density parameters.
Technology	Sparse mobile cellular coverage on Lake Temagami	2	5	**10**	***MEDIUM***	Deficiencies in cellular coverage on the lake present challenges in emergency planning and safety concerns for residents.	Consider expanding the scope of future phases to include cellular wireless in as much as it may qualify for the CRTC fund for the data component to assist communities that may not get access to upgrades for FTTH or DSL.
Technology	Developments in LEO deployments and funding impacts	2	5	**10**	***MEDIUM***	Low earth orbit (LEO) satellite systems are starting to be deployed around the globe with the promise of high capacity, ubiquitous broadband coverage.	The proliferation of LEO systems is a positive "risk" for the sustainability of a future project as it could be the answer to coverage gaps along the PBX route. However, trends in costing and coverage will need to be monitored.
Technology	Propagation assumptions	4	4	**16**	***HIGH***	Project network coverage was based on a single RFI respondent's estimations.	A Radio Frequency (RF) study should be commissioned as an initial step in any future project to assess optimal design.

Technology	600MHz licenced spectrum	4	3	**12**	***HIGH***	Similar to the propagation estimates, access to cost effective 600MHz spectrum can be a factor in the future project.	A Radio Frequency (RF) study should be commissioned as an initial step in any future project to assess optimal design. Furthermore, initiating discussions with spectrum licencees early in the future project will be beneficial. However, there are alternate frequency ranges available.
Technology	Fibre optic availability and pricing	3	3	**9**	***MEDIUM***	The global demand for fibre optics continues to grow and timely availability is always tenuous.	It is key to identify projects as soon as possible, especially if significant fibre optic lengths are required. Communities must be mindful of the lead times for contractors to source such critical materials when approving timelines.

10.0 Recommendations

In anticipation of the upcoming CRTC's "Closing the Broadband Gap" funding that will total $750 Million over the first five years and potential Provincial programs by the Ministry of Infrastructure (MOI), the communities have taken the first step in preparing for their imminent release by undertaking this report. The communities are underserved for the most part based on the findings of this study. Community-specific infrastructure recommendations were summarized at the end of each respective community section. The following serves to provide items to consider for the communities as a whole.

The recommendations are not presented in any particular order of importance or rank as they may not all apply to the individual communities to the same extent, with the exception of the first two bullets:

- The communities should seek to add adjacent communities to this effort, especially if the intent is to seek future funding. Current indications of funding programs underscore the importance of multiple communities (multi-region) and First Nation partnerships. The Northeast Superior Regional Broadband Network currently totals ten communities (5 First Nation and 5 municipal members) that have grown organically into a regional body seeking future funding. Other examples include SWIFT and EORN.

- The communities should undertake a feasibility study to assess the benefits of creating a regional ISP tailored to meet the needs of the participating communities and general area. The individual communities themselves might consider investing in their own ISP as other locations have been doing successfully in recent years such as: Stratford, Ontario; Olds, Alberta; and Hearst, Ontario. However, a joint effort would provide greater benefits to the region given a larger base to leverage, economies of scale, and reduction in overhead – both from a systems perspective and management oversight.

- As a joint entity, the communities should take the lead in the upcoming Federal "Closing the Broadband Gap" funding application and bring the service providers

on board as partners as opposed to the service providers leading the applications. This will allow the communities to create the mandate, drive the project(s), and maintain priority. The carriers must balance between other areas in the province (or Canada) where they might get funding which jeopardizes the focus the region requires. Future broadband projects can be further advanced through the tangible cooperation of private partners. These can be anchor industries within the community and smaller service providers that are seeking a new market or foothold in an area.

- Consider supporting the efforts of the Ontario Broadband Coalition in actively monitoring and contributing to Ontario Energy Board (OEB) pole attachment proceedings. Consider participation in existing industry groups with similar causes and concerns as required. Maintain active contact with local MPPs on this provincial matter.

- Secure the expertise of a Regulatory resource that can monitor and advise on current and upcoming proceedings that could have an impact on the region and the communities with regards to broadband Internet. It will become increasingly important to have a unified voice and to actively contribute to government actions. Join available industry groups to stay informed and prepared.

- Appoint a resource to liaise directly with the regional service providers including Ontera and Xplornet. It will be crucial to stay informed of their network planning as it relates to the area and to offer input and support where applicable.

- Undertake a review of the Smart Cities and Intelligent Communities movements. These global initiatives are not just about the quality of broadband Internet but can underpin the efforts of the communities to improve their overall prosperity and quality of life. Smart City projects make cities work better; whereas, Intelligent Communities seek to make better cities.[52]

[52] https://www.intelligentcommunity.org/from_smart_cities_to_intelligent_communities

11.0 Funding Options

Broadband Internet funding options have become limited as there is now a waiting period between ISED announcing the last of the CTI funding, the CRTC unveiling how and when they will open access to the anticipated $750 Million Closing the Broadband Gap fund, and any provincial programs.

The table on the following page is a summary of the current and traditionally available funding sources that could apply to broadband infrastructure or a derivative of broadband services.

Table 1: Potential funding programs

Funding Program	Owner	Funding	Description
Closing the Broadband Gap	Canadian Radio-television and Telecommunications (CRTC)	$750M fund over 5 years	To build or upgrade access and transport infrastructure in underserved areas. **https://crtc.gc.ca/eng/internet/internet.htm**
Strategic Economic Infrastructure Program	Northern Ontario Heritage Fund Corporation (NOHFC)	The lesser of 50% or $1 million	Municipalities, municipal organizations, First Nations, Community Based Networks or ICT community champions (non-profit economic development / innovation centres) in Northern Ontario. **https://nohfc.ca/en/pages/programs/strategic-economic-infrastructure-program**
Rural Economic Development Program (RED)	Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)	Up to 50% of the project costs or a maximum $100,000	Funding . Activities that grow the local economy and remove barriers to economic development. **www.ontario.ca/page/rural-economic-development-program**
Indigenous Economic Development Fund (IEDF)	Ontario Ministry of Indigenous Affairs (OMIA)	$70 million over the next seven years to extend the fund, originally launched in 2014, for a total combined investment of $95 million over 10 years.	The IEDF has 3 funding programs: The Business and Community Fund Program, Economic Diversification Grants Program, Regional Partnership Grants Program. **www.grants.gov.on.ca/GrantsPortal/en/OntarioGrants/GrantOpportunities/PRDR012765**
First Nation Infrastructure Fund	Indigenous Services Canada (ISC)	The amount of money planned under FNIIP varies from year-to-year because of time-limited, targeted funding programs.	The FNIF was created as a complementary source of funding to the Capital Facilities and Maintenance Program and includes eight categories of eligible infrastructure projects including connectivity. **www.sac-isc.gc.ca/eng/1100100010656/1533645154710**
Community Investment Program	Canadian Internet Registration Authority (CIRA)	To date CIRA has contributed $6.7 million in Community Investment Program grants.	CIRA funds innovative community projects to build a stronger, safer and more accessible internet for all Canadians - improving digital literacy, internet infrastructure, access and online services. **www.cengn.ca/ontario-broadband-program**
Next Generation Network Program (NGNP)	Centre of Excellence in Next Generation Networks (CENGN)	This intake has already passed; however CENGN noted that there will be future applications. In this previous intake, CENGN contributed 50 percent of eligible project costs for an approved project to a maximum contribution of $500,000 per project.	Their mission is to accelerate the growth of the Canadian Information and Communications Technology (ICT) sector, enabling economic strength and prosperity, as well as innovation and competitiveness. **www.cengn.ca/ontario-broadband-program**
Rural and Northern Communities Infrastructure	Infrastructure Canada	The Government will invest $2 billion over the next decade to support a broad range of infrastructure projects.	Investments in rural and northern infrastructure will help grow local economies, build stronger, more inclusive communities, and help safeguard the environment and the health of Canadians. Because rural and northern communities have unique infrastructure needs that require a more targeted approach. **www.infrastructure.gc.ca/plan/rnc-crn-eng.html**

Exhibit A – Estimated Capital Ranges

Temagami Community Capital Projections

		MARKET PROJECTION		CONNECTED PREMS			TRANSPORT	DISTRIBUTION	DROPS	YEAR TWO & THREE		TOTAL FTTP COSTS			
Communities	Prems Passed	Target Market Penetration	Target Prem Project Total	Year One Connected Prems	Year Two Connected Prems	Year Three Connected Prems	Transport + electronics	Distribution + Electronics	FTTP Drop + Prem Total Cost	Year Two PREM Capital	Year Three PREM Capital	Total Project Cost	Total Cost Per Prem PASSED	Total Cost Per CONNECTED Prem	Notes
Temagami (Core)	240	80%	192	77	58	58	$ 111,948	$ 560,000	**$ 89,088**	$ 66,816	$ 66,816	$ 894,668	$ 3,500	$ 4,660	access at Ontera POP c/w upgrades
Temagami North	120	80%	96	38	29	29	$ 111,948	$ 280,000	**$ 44,544**	$ 33,408	$ 33,408	$ 503,308	$ 4,083	$ 5,243	access at Ontera CO c/w upgrades
Lake Temagami	913	30%	274	110	82	82	$ 559,741	$ 1,569,500	**$ 127,090**	$ 95,317	$ 95,317	$ 2,446,965	$ 7,774	$ 8,934	proxy for two towers on Lake (Bear Island + TBD)
Marten River	25	80%	20	8	6	6	$ 559,741	$ 237,500	**$ 9,280**	$ 6,960	$ 6,960	$ 820,441	$ 39,862	$ 41,022	POP undetermined, distances estimated
Bear Island	125	90%	113	45	34	34	$ 55,974	$ 287,500	**$ 52,200**	$ 39,150	$ 39,150	$ 473,974	$ 3,053	$ 4,213	fibre available (nodes and transport)
Total Prems	**1423**		**694**	278	208	208	**$ 1,399,353**	**$ 2,934,500**	**$ 322,202**	**$ 241,651**	**$ 241,651**	**$ 5,139,357**			

	AVG	AVG
$ 3,740,004 *includes Years 1-3 (if applicable)*	$ 11,654	$ 12,814

Prems Passed = # of premises that distribution cabling passes along a street, but not connecting to the premises (drop)
Target Market Penetration = estimate of how many customers would use the new service
Transport + Electronics = cost of construction backbone fibre to community + electronics, or electronics if transport fibre in place
Distribution + Electronics = cost of constructing last mile distribution fibre + electronics within the community
VDSL Per Connected Prem = cost of installing the node divided by the number of total subscribers
LOW (VDSL) = estimated lower end of providing a degree of broadband in the community
HIGH (FTTP) = estimated upper end of providing a degree of broadband in the community

Overall Assumptions:
pole make ready costs not included
% of prems connected varies, max 80% where no competitor to Ontera/Bell, max 60% where a facilities based competitor exists
VDSL will not require distribution copper upgrades
all values are estimates, additional accuracy requires market design and pricing exercise
WIRELESS AND FIXED WIRELESS SOLUTIONS NOT INCLUDED EXCEPT FOR LAKE TEMAGAMI

Temagami Community Capital Projections - Estimated High - Low Ranges

	Transport		Distribution		Total Deployment	
	Low	High (+30%)	Low	High	Low	High
Temagami (Core)	$ 111,948	$ 145,533	$ 351,948	$ 894,668	$ 463,896	$ 1,040,201
Temagami North	$ 111,948	$ 145,533	$ 351,948	$ 503,308	$ 463,896	$ 648,841
Lake Temagami	$ 559,741	$ 727,663	$ 799,741	$ 2,446,965	$ 1,359,482	$ 3,174,628
Marten River	$ 559,741	$ 727,663	$ 799,741	$ 820,441	$ 1,359,482	$ 1,548,104
Bear Island	$ 55,974	$ 72,766	$ 295,974	$ 473,974	$ 351,948	$ 546,740
Community Totals	**$ 1,399,353**	**$ 1,819,158**	**$ 2,599,353**	**$ 5,139,357**	**$ 3,998,705**	**$ 6,958,515**

Deployment "Low" includes only 1 DSLAM c/w cabinet, power, installation allowance
Deployment "High" includes full FTTP system and fibre transport (where needed)
These estimated ranges are provided solely for planning and require detailed analysis if used for other uses.

Exhibit B – Gap Analysis

TEMAGAMI MASTER DATA - NEEDS ANALYSIS

Community Broadband Gap Analysis	STATISTICS						DATA (Mbps)					NEED	OS ratio 5:1	AVAILABLE Mbps	GAP Mbps
	POP	Dwellings	Businesses	Hospital/ Clinics	Schools	Students	Dwellings	Businesses	Hospital/ Clinics	Schools	Students				
							25	100	100	100	1	Mbps		Mbps	Mbps
Temagami (core)	520	220	20	1	1	24	5500	2000	100	100	24	**7724**	**1545**	200	**1344.8**
Temagami North	242	115	5	0	0	0	2875	500	0	0	0	**3375**	**675**	200	**475.0**
Lake Temagami	2100	908	5	0	0	0	22700	500	0	0	0	**23200**	**4640**	0	**4640.0**
Marten River	40	20	5	0	0	0	500	500	0	0	0	**1000**	**200**	0	**200.0**
Bear Island	244	110	14	1	1	44	2750	1400	100	100	44	**4394**	**879**	300	**578.8**
STUDY AREA TOTALS	**3146**	**1373**	**49**	**2**	**2**	**68**	**34325**	**4900**	**200**	**200**	**68**	**39693**	**7938.6**	**700**	**7238.6**
	0	0													

Assumptions

Temagami (core)	base population of 802 taken from 2016 stats can census, then adjusted by approx 2 people per dwelling
Temagami North	counted visible dwellings on Google Map - subtracted this from the Tem total and adjusted Temagami core (along with MR estimate)
Lake Temagami	population taken from statement in Temagami 2011 EcDev document
Marten River	counted visible dwellings on Google Map - subtracted this from the Tem total and adjusted Temagami core (along with MR estimate)
Bear Island	taken from 2019 ecdev document
	Business counts are estimates

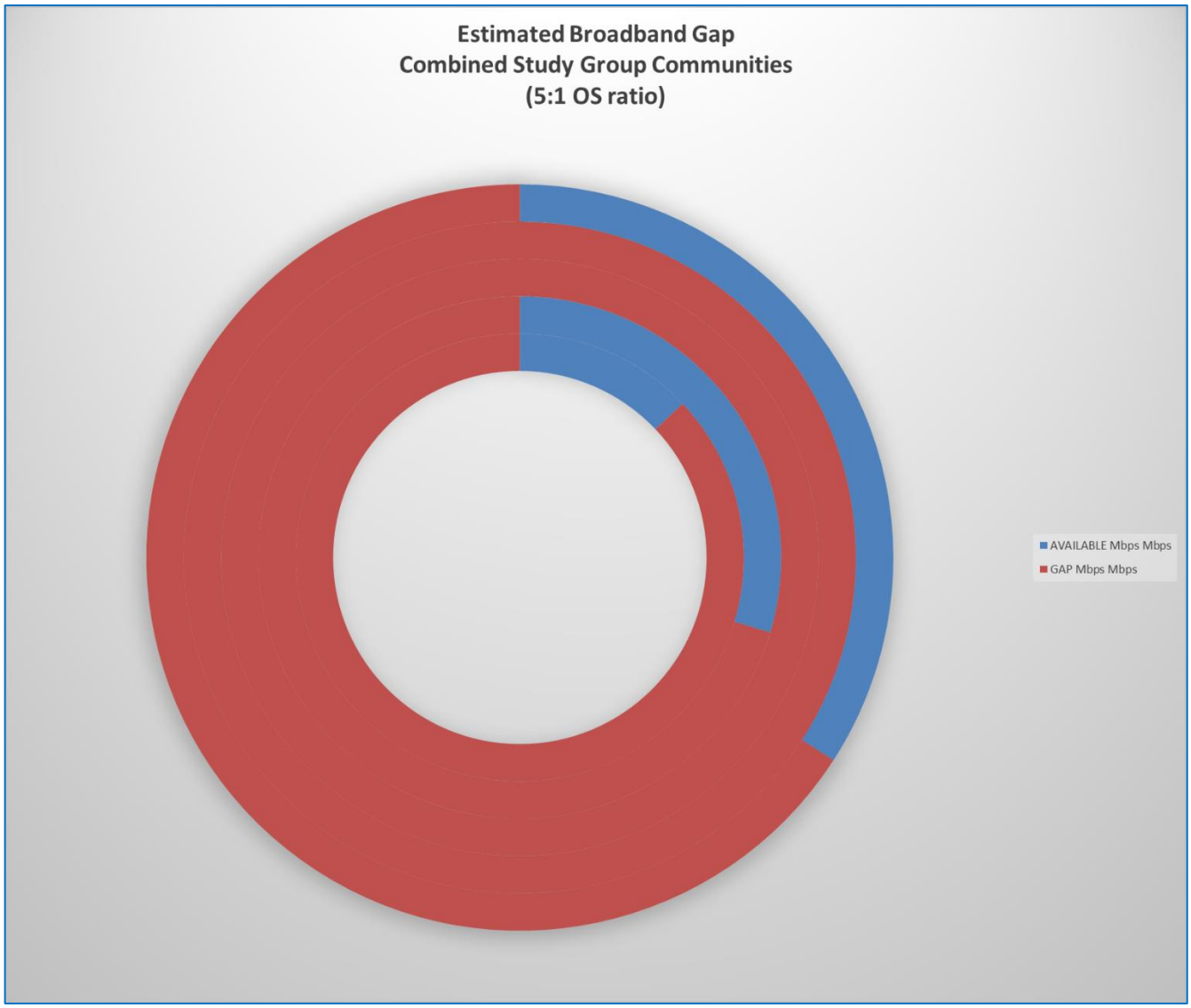
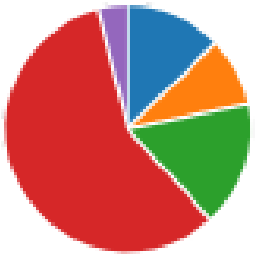


Exhibit C – Survey Results

385	13:55	Closed	
Responses	Average time to complete	Status	Ideas

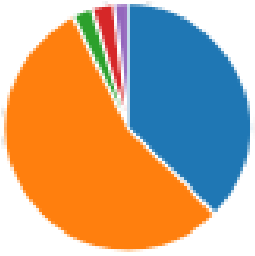
1. Which of the participating communities do you reside in?

Bear Island	49
Temagami North	35
Temagami	63
Lake Temagami	223
Marten River	15



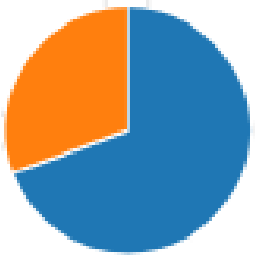
2. Describe your premises (home, cottage, business) within one of the participating communities noted above. If you have more than one premises within the community (ie: a home and a separate business location), please complete a separate survey for EACH location and corresponding speed test.

Home or primary residence	144
Seasonal residence/cottage	213
Business (not including tourist...	10
Tourist camp/resort (owner, n...	11
Other	7



3. Do you have Internet service at this premises?

Yes	267
No	118

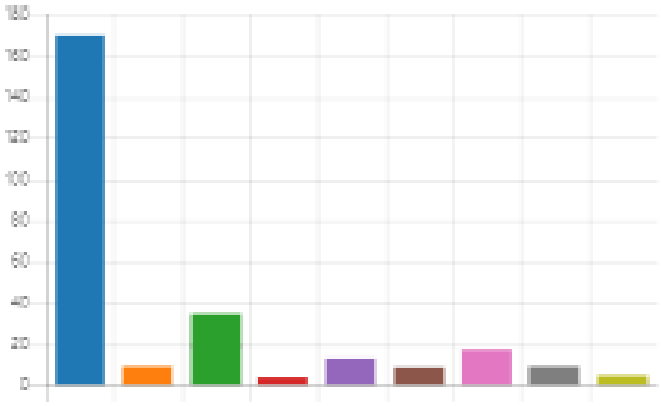


4. If "NO", why do you not have Internet service at this premises?

There is no Internet service av...	64
It is too expensive to install Int...	29
I do not want to have Internet ...	12
Other	23

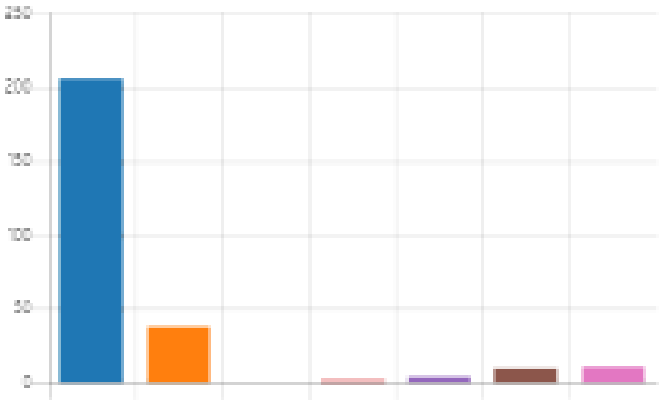
5. If you do have Internet service, what type of connection do you have at your premises?

DSL (Digital Subscriber Line o...	170
Fixed Wireless (ie: Xplornet - n...	9
Satellite Service	34
Fibre Optic (directly to your pr...	3
Cellular Data (ie: Rocket Stick, ...	13
Cable Modem	8
Dial-Up Connection (over Tele...	17
I don't know	9
Other	4



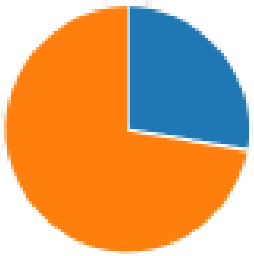
6. Who do you purchase your Internet services from?

Ontera	206
Xplornet	38
KNET	0
NorthernTel	1
Bell Mobility hub or "stick" (no...	3
Rogers Mobility hub or "stick" ...	9
Other	10



7. If you have Internet services at your premises, are you satisfied with the level of service?

Yes	74
No	193



8. If you are NOT satisfied with the level of Internet services, please describe your reason:

192
Responses

Latest Responses
"too slow and too expensive"
"outages, slow speeds"
"very slow - cut out often, cannot upgrade to high speed, or time will not ..."

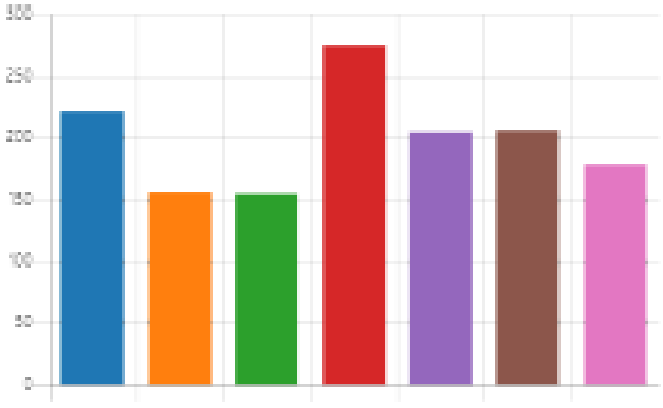
9. If you do have Internet, what kind of package do you have and how much does it cost per month? (Do not include other charges if you purchase bundled services ie: phone, tv, internet, cellular)

193
Responses

Latest Responses
"..."
"approx $60/month"
"medium high"

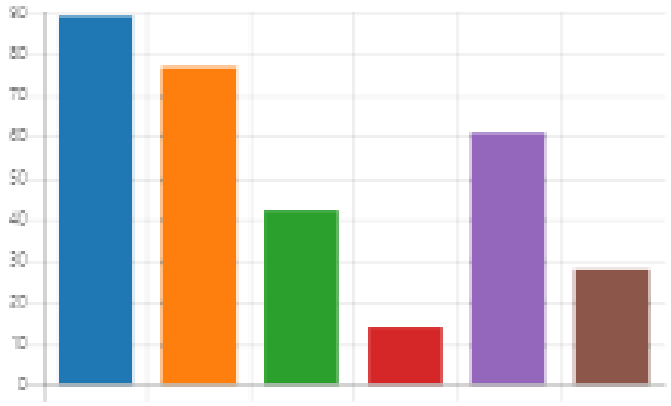
10. Whether or not you have Internet access, what would you use the internet for? (Select all that are applicable to you.)

Work (business, home office, r...	222
Education (distance learning, ...	155
Tourism Information (events, s...	154
Staying informed (news, medi...	276
Social Media (Facebook, Insta...	205
Entertainment (videos, movies...	206
Online shopping (Amazon, eB...	179



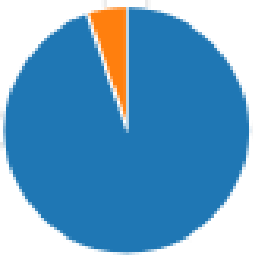
11. If you were able to subscribe to the Federal and Provincial goal of 50Mbps download and 10Mbps upload speeds with no data caps, how much would you be willing to spend each month?

$60 per month	89
$80 per month	77
$100 per month	42
more than $100 per month	14
I would get a smaller package ...	61
None of the above	28



12. Do you or someone at your premises own a cellphone?

Yes	365
No	20



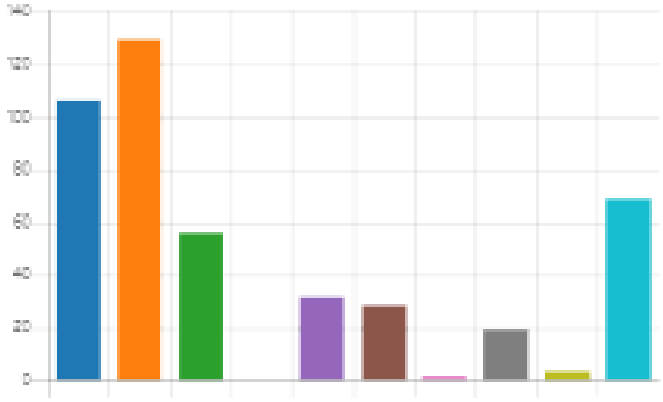
13. If YES, how many cellphones do you own? (This may vary on the number of users you have or are billed for.)

365
Responses

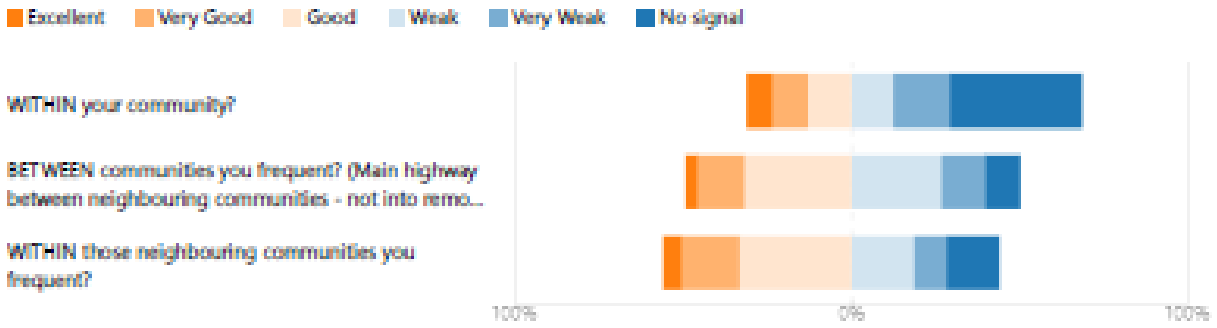
Latest Responses
"2"
"3"
"2"

14. If YES, who is your cellular provider? (Check all that apply if you receive multiple bills)

Bell Mobility	106
Rogers	129
TELUS Mobility	56
Tbaytel Mobility	0
Koodo Mobile	32
Virgin Mobile	28
Chartr Mobile	1
Fido Mobile	19
NorthernTel Mobility	3
Other	69



15. If YES, how would you rate the quality of your cellphone service?



16. Do you believe advanced communications services to be important for the community, residents and businesses?

Very Important	335
Somewhat Important	41
Not Important	9

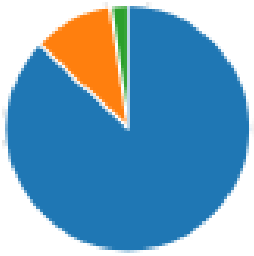


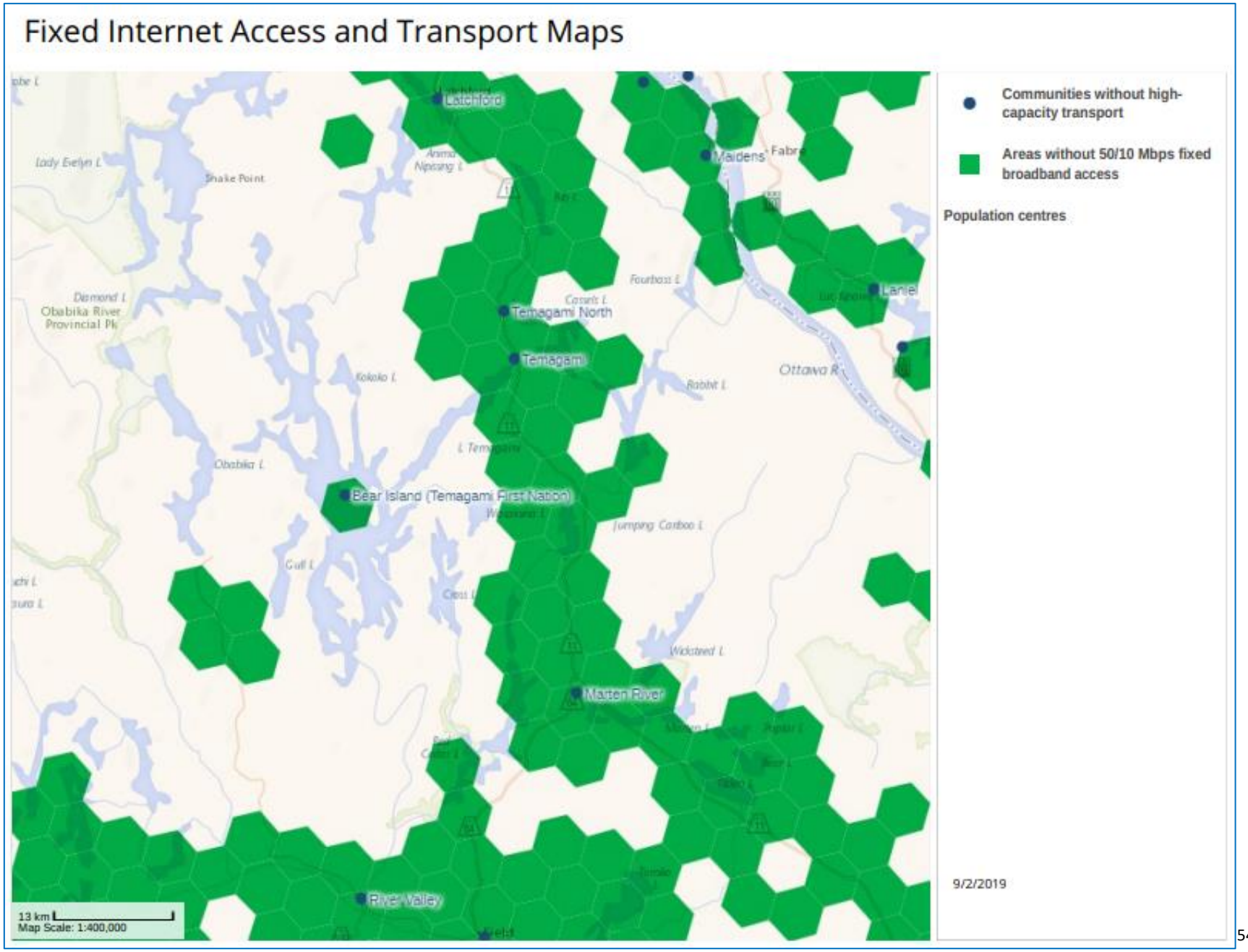
Exhibit D - Coverage Analytics

As per the CRTC's recent "Broadband Fund Application Guide for the 3 June 2019 Call for Applications", the definition of the eligible hexagon areas is noted below (highlighting added for emphasis):

> *6.1.3(d) Access project eligibility criteria – Geographic eligibility (1-G2)*
> *Access project proposals must involve building or upgrading infrastructure in an eligible geographic area, defined as a 25 km^2 hexagon where there is at least one household (as defined in Appendix 1), as per Statistics Canada's latest census data, but where no household has access to broadband Internet access service at universal service objective-level download and upload speeds (i.e. 50/10 Mbps). The maps displaying potentially eligible geographic areas based on 2017 information have been made available. As described above, applicants should conduct their own due diligence to ensure that their projects meet the geographic eligibility criterion. The CRTC has provided information on geographic eligibility based on the information that was available as of the launch date of this call for applications. It may also rely on more up-to-date information, whether public or confidential, as it is received and verified. Updated information on geographic eligibility may therefore be made available during the period following the launch date of this call for applications until the submission deadline.*[53]

The map below illustrates the community areas that are currently noted as eligible (green hexagons) should the upcoming Federal funding process follow the same eligibility criteria as noted above. Specifically, these hexagons do not have services capable of delivering 50/10 broadband speeds.

[53] https://crtc.gc.ca/eng/internet/guid.htm


Fixed Internet Access and Transport Maps
Latchford
Maidens
Lady Evelyn L.
Shake Point
Desmond L.
Obabika River Provincial Pk
Temagami North
Temagami
Fourbass L.
Cassels L.
Lariel
Ottawa R.
Kokoko L.
Rabbit L.
Obabika L.
Bear Island (Temagami First Nation)
Jumping Caribou L.
Gull L.
Wicksteed L.
Marten River
River Valley
13 km
Map Scale: 1:400,000
Communities without high-capacity transport
Areas without 50/10 Mbps fixed broadband access
Population centres
9/2/2019

The Municipality of Temagami requested broadband data from Blue Sky Net on behalf of this study. The information contained in the mapping that follows illustrates the minimum broadband speeds in the communities as pulled from data supplied by service providers (ie: Ontera, Xplornet). This is a good tool to assess those areas tabulated in their Connected North database.

As supplied by Blue Sky Net:

- *Analysis compares spatial broadband coverage files submitted by ISPs and the best possible base map available. In most cases this is the MPAC Digital Parcel. Failing that, Census Dissemination Blocks.*
- *The performance classification for fixed broadband is separated into three classes= 1) Better that 5Mbps-describes high speed services that constantly deliver 5 Mbps down and 1 Mbps up. These networks likely deliver better service and different packages/rates. These networks are shown in green shading. 2) Less than 5Mbps-These networks deliver high speed, but cannot consistently deliver 5Mbps down and 1 up. These networks are depicted in red shading. 3) Finally areas left unshaded do not have fixed broadband coverage and would likely have to rely on mobile data (depicted on separate map) or satellite internet services.*
- *Parcel Property classifications are based on MPAC property codes and are grouped into the categories of: Commercial, Government Owned, Industrial, Institutional, Residential, Seasonal, Special Purpose and Vacant.*
- *Accuracy of the analysis is dependent on the accuracy of the ISP submitted coverage files and the accuracy of the MPAC base map.*

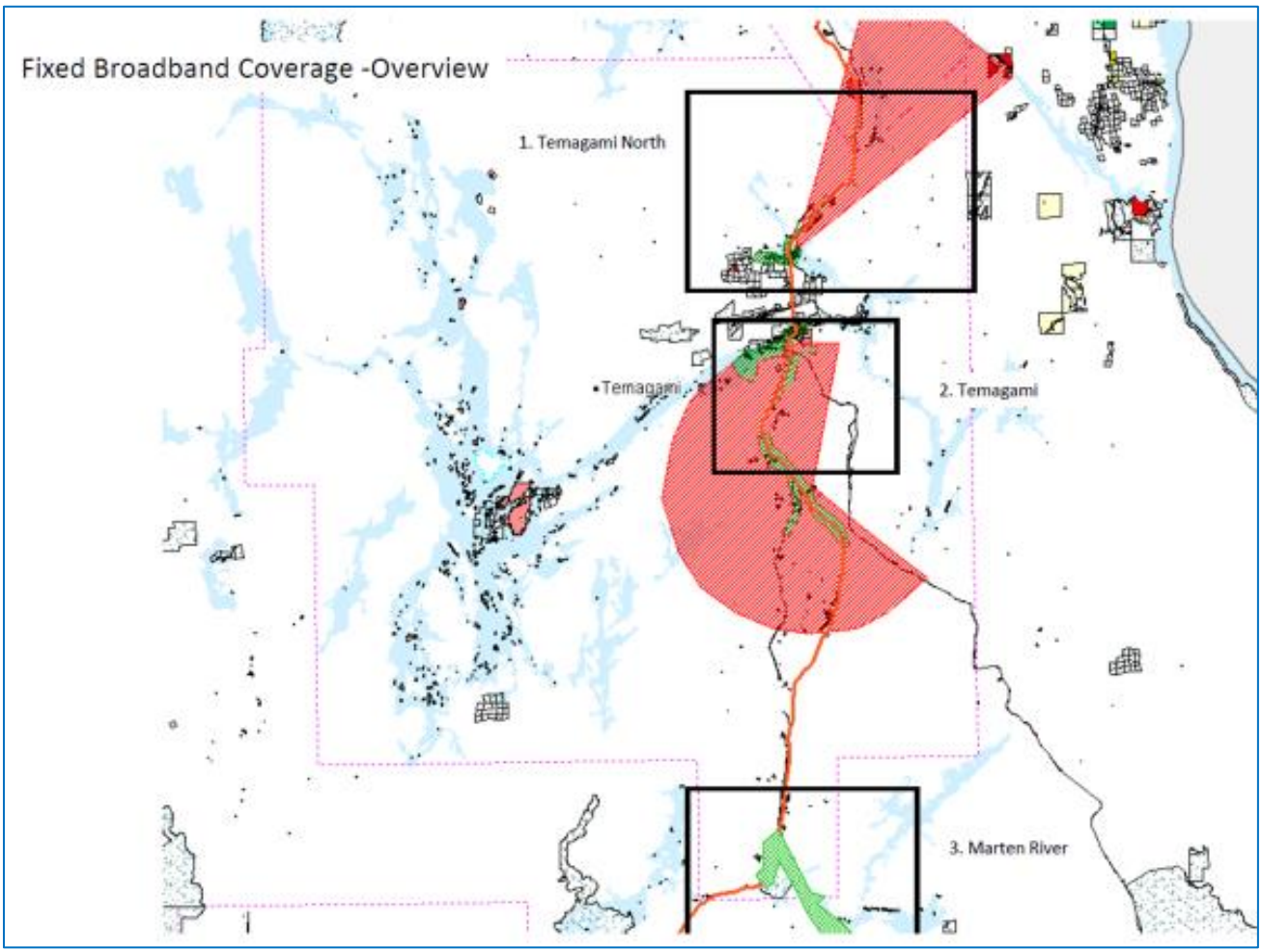
It is critical however to “ground truth” any such data as was done in this study since carriers may not provide fully accurate information (competitive information, errors) and it is a prerequisite of most current funding bodies such as the recently published SWIFT call for funding (Southwestern Ontario only) and Broadband Gap Far North applications. The community gap analysis performed as part of this study (Needs and Gap Overview) addresses this requirement confirming that there are no apparent terrestrially capable 50/10 service locations in the footprint. It is important to note that the Xplornet mapping data shown below provides their planned wireless

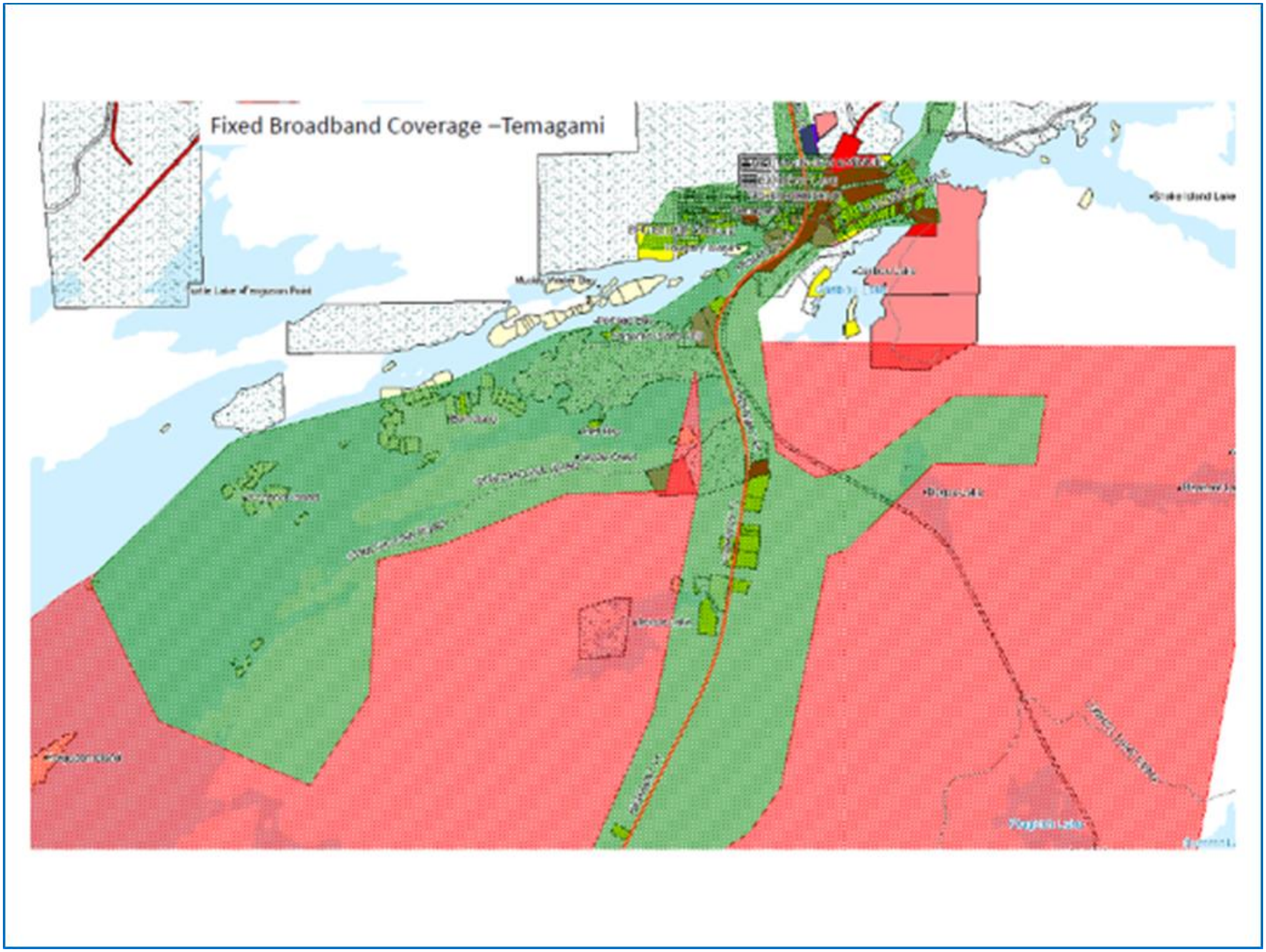
propagation which was not confirmed as part of this study. It is possible that Xplornet can report speeds that meet or exceed 50/10 in the future which could nullify certain hexagons within Temagami's eligibility areas.

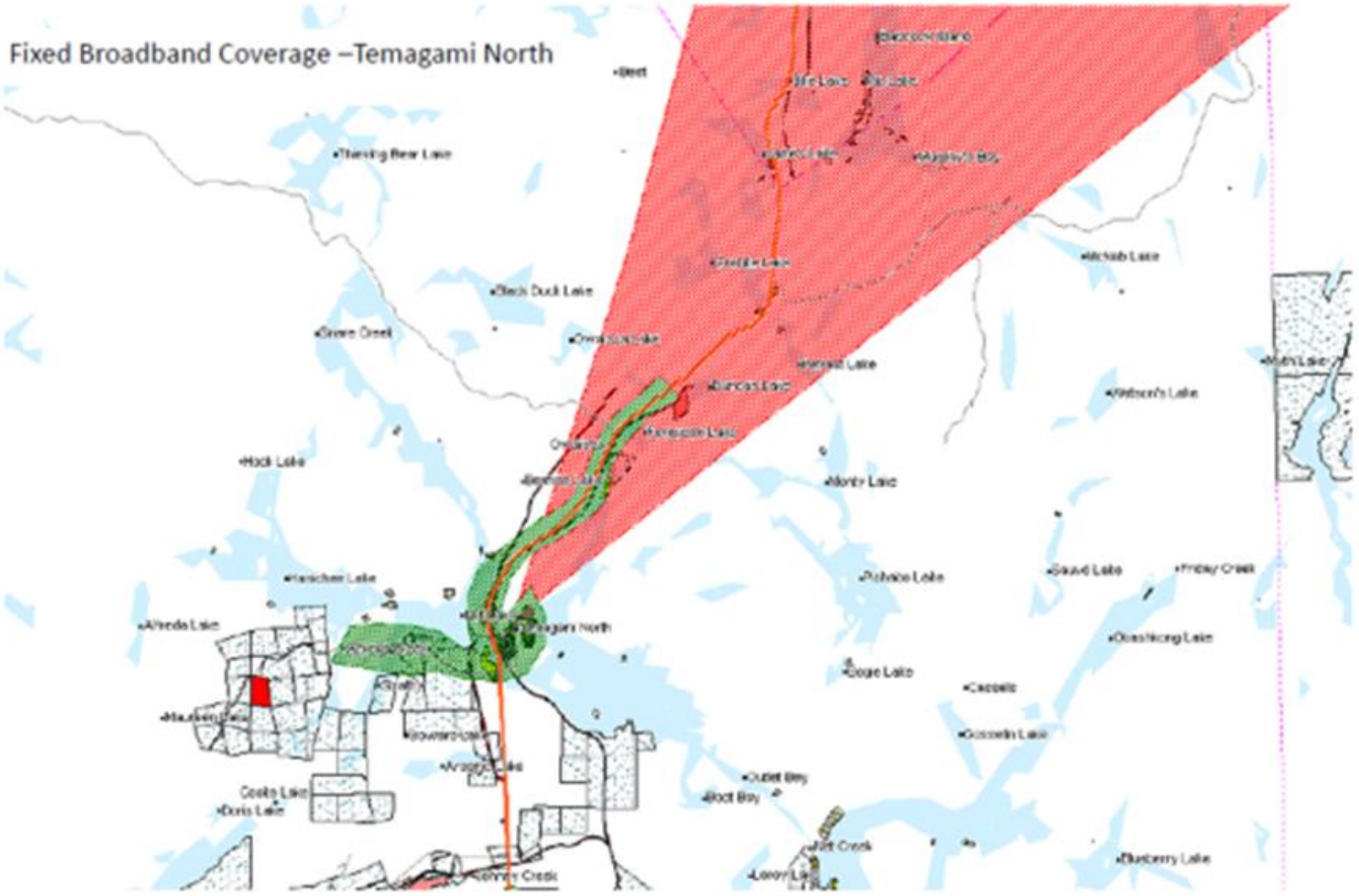
Legend:

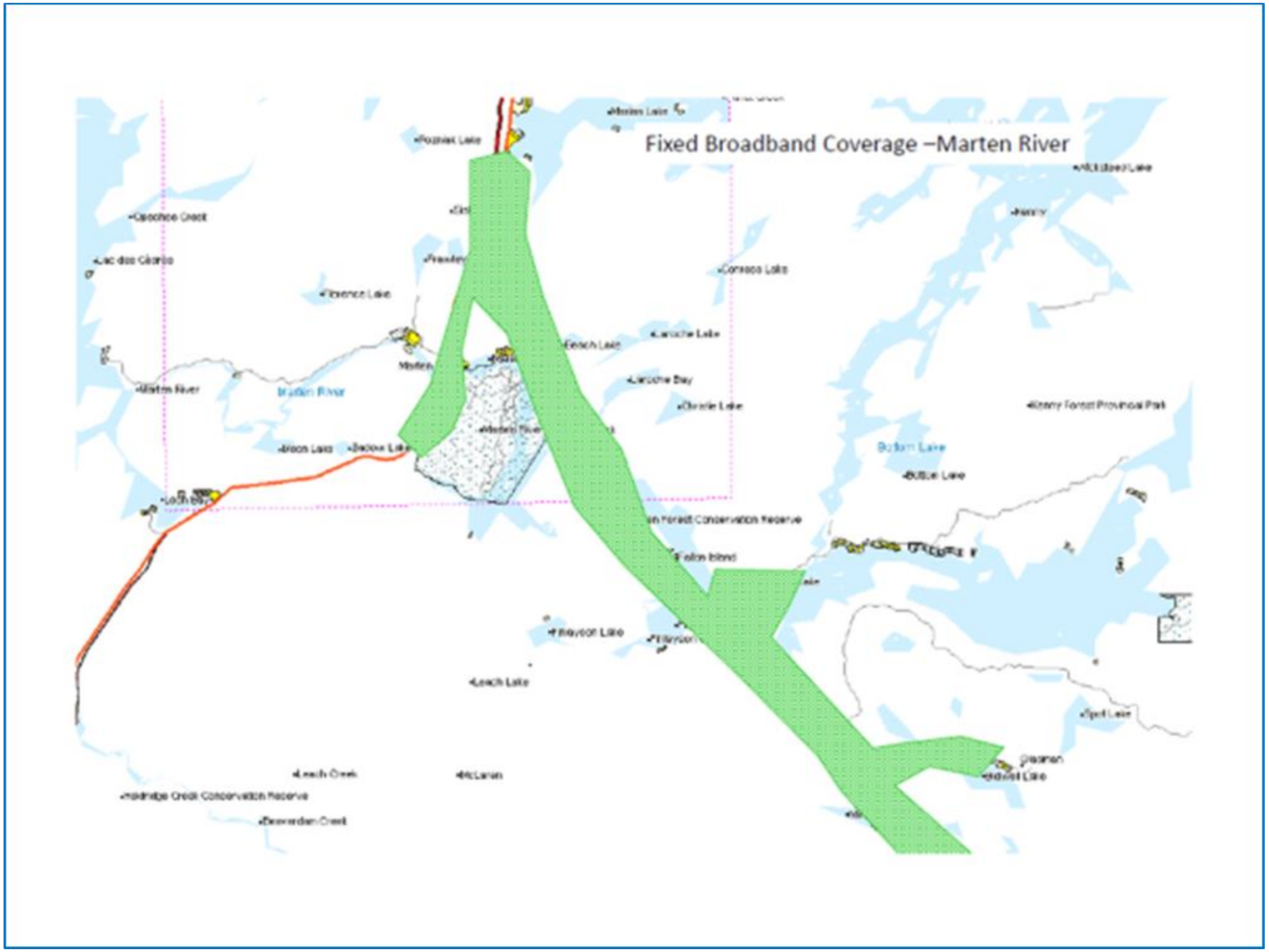
RED = *Less than 5Mbps - These networks deliver high speed, but cannot consistently deliver 5Mbps down and 1 up.*

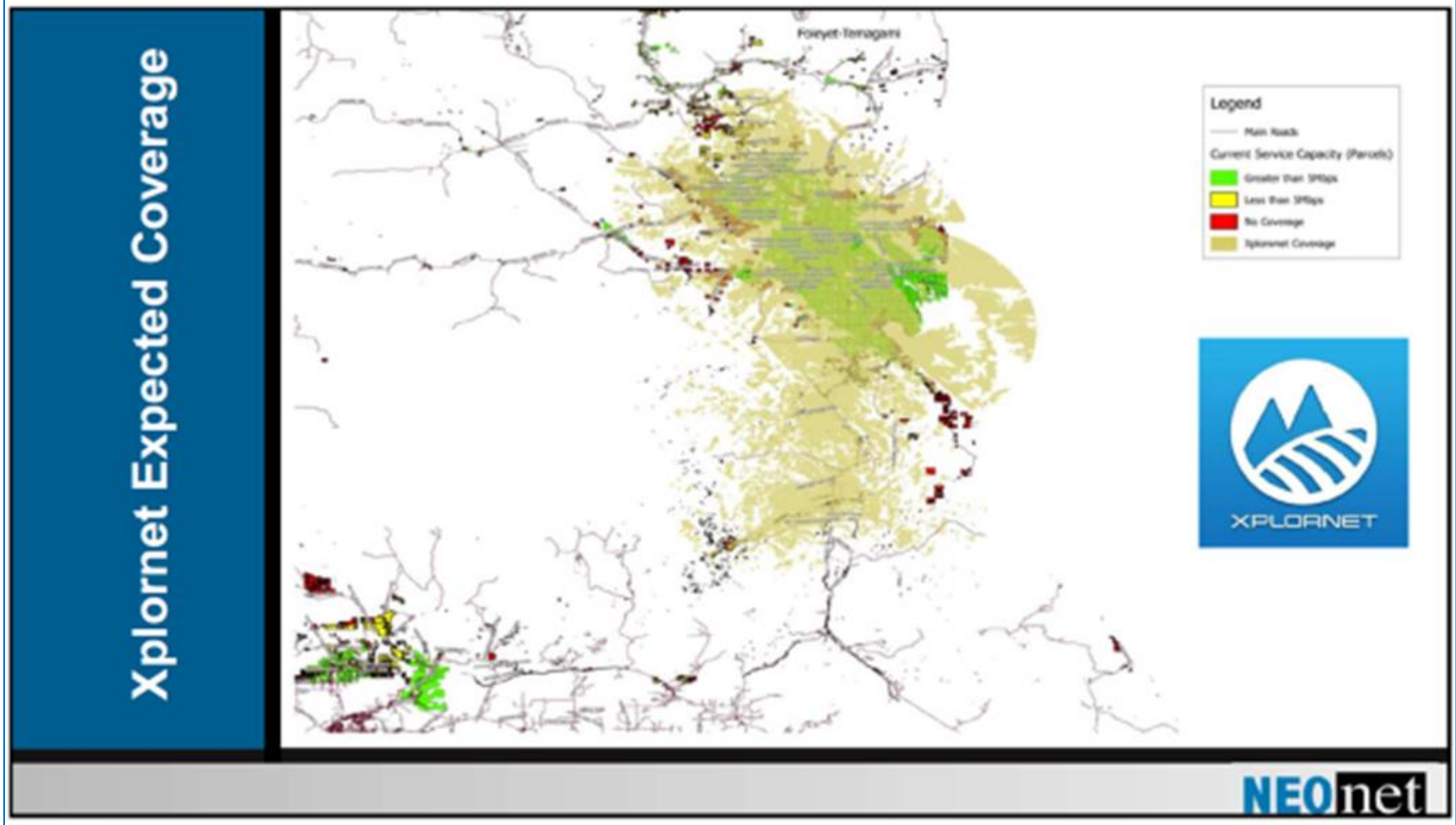
GREEN = *Better that 5Mbps - Describes high speed services that constantly deliver 5 Mbps down and 1 Mbps up. These networks likely deliver better service and different packages/rates.*




Fixed Broadband Coverage –Temagami


Fixed Broadband Coverage –Temagami North
Black Duck Lake
Rock Lake
Cooks Lake
Doris Lake
Outlet Bay
Rock Bay
Blueberry Lake


Fixed Broadband Coverage –Marten River



NEOnet presentation March 7, 2019

Exhibit E - Table of Figures

Exhibit F – Reference Material

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Richard Bennett 2 February 11, 2016

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Exhibit G – Revision Check Page

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