Broadband Strategy

Findings & Recommendations

District of Muskoka

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Version 3.2

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1. Executive Summary

1.1 Context

This Report represents a high-level plan and set of recommendations developed by Clearcable Networks and Rothschild & Co. as a tool for stakeholders to understand the overall technology, design, requirements, and costs of potential projects to improve broadband service and eliminate coverage gaps in the District of Muskoka. This Report provides our findings and recommendations for accelerating the deployment of better broadband to the entire District.

1.2 Findings

Our research confirmed there are extensive broadband coverage gaps resulting in many underserved areas scattered throughout the District of Muskoka.

Fixed Wireless is the predominant technology currently in use to provide broadband connectivity in the rural areas of Muskoka. In towns along Highway 11, broadband connectivity for the most part is provided using fibre optic or hybrid fibre/coaxial cable.

Broadband connectivity in many areas of the District is quite poor except for those towns located, for the most part, on fibre routes along Highway 11 (Bracebridge, Gravenhurst & Huntsville).

The models included in this Report detail a range of possible policies and approaches for the District and Area Municipalities to encourage broadband expansion and eliminate broadband coverage gaps.

Our Report outlines strengths and weaknesses of different technologies.

The preferred technology, Fibre-to-the-Premises (“FTTP”) - also known as Fibre-to-the-Home, would require the greatest investment and provide the greatest long-term scalability. However, due in great measure to Muskoka’s unique, challenging, topography, our research confirms that fibre alone is not a practicable solution to eliminate coverage gaps. Muskoka requires a hybrid solution using several technologies. And potentially several service providers, to eliminate or minimize coverage gaps.

In our opinion the District, Area Municipalities, and First Nations should focus on three distinct options:

1. Consult with providers to confirm the actions, outlined herein, to be taken at the District and municipal levels to encourage the private sector to increase its investment in infrastructure across the District and eliminate coverage gaps; or
2. Create a form of Public Private Partnership (“PPP”) to “take the lead” to directly eliminate coverage gaps; or

3. Both encourage providers to eliminate gaps while working to create a form of PPP to "take the lead" to eliminate any coverage gaps that remain.

The District, Area Municipalities, and First Nations first need to adopt common policies and procedures for the installation of fibre, the installation of towers, the documentation of deployments, and the process by which service providers deal with the District and Area Municipalities. We believe that this is achievable and have built our recommendations around how to foster the environment that will meet the goal of reliable and affordable broadband throughout the District.

1.3 Recommendations

The recommendations included in this Report are consistent with the comments of providers in response to the Spring 2021 Request For Information as to how the District (and Area Municipalities) could better directly support expansion of broadband infrastructure and service. Providers summarized steps that could be taken to encourage them to expand in Muskoka.

- "Expediting and streamlining approval processes for build and expansion plans";
- Facilitating "the use of District physical assets and infrastructure (buildings, towers, etc)"; and
- "Coordination with municipal operational teams to utilize best practices and identify opportunities to expand service infrastructure as part of municipal improvement projects (laying fibre/conduits during road reconstruction)".

We recommend the District create a full-time Broadband Coordinator position to serve as a single point of contact for providers proposing to build or expand in Muskoka.

Our research revealed that a single point of contact for providers serving, or looking to serve, the District is essential to facilitate, encourage, and expedite broadband expansion. This resource can be implemented at the District level and shared amongst the stakeholders.

The person filling this role would be responsible for:

- Keeping in regular contact with providers to understand their needs, provide support, promote successes, and encourage expansion;
- Dealing with residents looking for information on broadband and broadband builds;
- Coordinating broadband build proposals with other projects and build activities;
- Assisting businesses in the District to ensure their needs are considered and met;
- Dealing with the different departments in each municipality to keep them apprised of broadband projects being proposed and coordinating activities; and
- Coordinating communications and Letters of Support for broadband initiatives.

We recommend the District, Area Municipalities, and First Nations formalize an agreement to collaborate and work together on a District-wide basis with a consistent, unified approach and consistent, aligned policies at the District and municipal levels.

We recommend that work commence immediately with a meeting between the Chief Administrative Officers of the Area Municipalities and the Chiefs of the First Nations to coordinate and align on common policies, initiate broad communication to the service provider community, and begin collaborative efforts. Then the participants should assign the appropriate resource(s) in each of their jurisdictions to work with the District's Broadband Coordinator to build alignment in a timely fashion.

We recommend against the District or Area Municipalities creating an entirely new broadband utility to compete with the wide range of existing public and private players in the District.

At an estimated cost in excess of $240 million, we recommend against the District and Area Municipalities building their own broadband fibre network. Beyond the cost implications, given the number of existing providers serving the District, we see no need to create a new competitor and we recommend against it. Given the investments the incumbent providers have already made in the District, and their plans to invest further to expand coverage, we anticipate both an opportunity to encourage continued investment, and potential resistance to the District and Area Municipalities launching their own additional broadband service in competition with the private sector.

We recommend that the District, Area Municipalities, and First Nations support and encourage installation of fibre backhaul and Fibre-to-the-Premises wherever practical.

The technology that offers the greatest speeds today and for the foreseeable future is fibre optic cable. Unlike wireless and other technologies, fibre is scalable and "future ready". Fibre is easily upgradable from today's Universal Service Objective of 50/10Mbps to 1Gbps and up to 10Gbps and beyond. Fibre-to-the-Premises (also known as Fibre-to-the-Home) is the most expensive technology for an initial build yet fibre backhaul and FTTP is often referred to as the "gold standard" solution.

We recommend that the District, Area Municipalities, and First Nations support and encourage a hybrid approach to fill any coverage gaps.

Our research revealed that no single technology or service provider will be practical to cover the entire District.

We recommend that the District, Area Municipalities, and First Nations await the impending funding announcements from the current federal and provincial programs.

While the recommendations in this Report are being considered and codified, the District can defer finalizing its plans to directly invest in the infrastructure needed to eliminate coverage gaps until various government funding programs, including Improving Connectivity for Ontario Now ("ICON"), Universal Broadband Fund ("UBF"), Infrastructure Ontario ("IO") and the Canadian Radio-television and Telecommunications Commission ("CRTC") have announced which infrastructure projects in the District have been approved.

Once the District knows which broadband infrastructure projects have been funded, it will be better positioned to predict what coverage gaps will remain and make informed decisions as to how to proceed.

We recommend that the District consider filling remaining gaps by "taking the lead" in a potential public private partnership (PPP) initiative.

Should the funding and current service providers fail to eliminate the coverage gaps, with the information contained in this Report the District and Area Municipalities should be positioned to act promptly to "take the lead" to eliminate any gaps by considering a form of public private partnership with a viable private sector partner.

We recommend that the District and Area Municipalities approve plowing in the shoulder of the road as an alternative low-cost fibre installation method.

Service providers resoundingly indicated that without lower cost installation methods, they simply would not be able to make the business case to significantly expand broadband in Muskoka. Specifically, they indicated that the pole remediation costs are insurmountable for aerial installations and the challenges of drilling fibre at the back of the ditch from both cost and geography perspective was uneconomical. Plowing in the shoulder of the road presents risk to future road expansion and/or fibre damage, but the fibre is easily repaired and cost saving far outweigh the risks.

We recommend that the District and Area Municipalities implement a Broadband Levy.

Given that broadband is now widely considered essential infrastructure akin to roads, bridges, or power, we recommend that the District and Area Municipalities consider introducing a Municipal Broadband Levy like that introduced in the Town of Caledon, ON. The Broadband Levy could be used to recover the costs of creating the position of Broadband Coordinator or to provide additional municipal subsidies directly to residents or providers.

We recommend Municipal Funding Supports

Where possible and potentially afforded by the Broadband Levy, the District and Area Municipalities should consider additional municipal funding supports. Specifically demonstrating a local interest in investing in broadband to help de-risk existing service providers will attract the attention of service providers and will improve the odds for approval

of applications by providers to government funding programs that support and promote the stacking other forms of funding (eg UBF).

1.4 Summary of Recommendations

Recommendation	Timeframe
Agree to Collaborate and Convene Collaboration Meeting	Short-term
Implement a Broadband Coordinator	Short-term
Establish Consistent Policies for Tower and Fibre Installation	Short-term
Complete a Standard and Unified Municipal Access Agreement	Short-term
Create a Process for Express Approval in High Priority Areas	Short-term
Consider and Approve Lower-Cost Broadband Installation Policies	Medium-term
Explore Possible Public Private Partnerships	Medium-term
Create Telecom Infrastructure Mapping Requirements	Long-term
Establish Open Access Tower Requirements	Long-term
Create a Broadband Levy and Associated Subsidy Programs	Long-term
Consider Additional Financial Supports to Priority Areas that Remain	Long-term

Figure 1 – Action Plan

2. Scope

2.1 Overview and Purpose

Clearcable, in partnership with Rothschild & Co, was engaged by the District of Muskoka to develop a broadband strategy to improve connectivity throughout the District and eliminate coverage gaps. The broadband strategy was expected to include unbiased, objective technical expertise to address which technology solutions are most cost effective and might work best to reach unserved/underserved areas of Muskoka. The objective was to analyze Muskoka's current broadband connectivity, propose solutions to eliminate coverage gaps, and develop a broadband strategy to improve Internet connectivity throughout Muskoka. In this Report we provide our findings and recommendations.

2.1.1 Engagement

The scope of this engagement was to develop a documented high-level technical plan and business model in order to help key stakeholders and Council members understand the overall technology, design, requirements, and costs and to make decisions as to the most appropriate strategy for bringing reliable, affordable broadband service to underserved homes and businesses in Muskoka. Specifically, this document:

- Provides Muskoka with a broadband roadmap with short, medium, and long-term actions that have measurable implementation timelines;
- Outlines business models detailing the investment, operating costs, and risks associated with different broadband technologies available;
- Recommends policies and approaches for adoption by the District and area municipalities to encourage broadband expansion and eliminate current gaps in broadband coverage;
- Outlines the cost/benefits of the various potential models for broadband expansion including direct investment in a Public Utility, investment in an Open Access Network, P3 Public Private Partnerships, encouragement of existing service providers, broadband-friendly municipal policies, and emerging technologies such as low-earth orbit satellites (eg. Telesat, Starlink).
- Outlines possible implementation scenarios with high-level budgetary numbers and sample service coverage overlaid onto the District map;
- Outlines the pros and cons of the resulting scenarios and provides recommendations.

2.1.2 Limitations

The viable technology options for servicing the identified network routes and services areas are presented as design concepts with budgetary numbers for assessing the options and potential business case. Sufficient care is taken to assess the viability and high-level design requirements of the various options to produce rational budgetary expectations but, if any project outlined

herein were to be undertaken, a detailed engineering exercise would need to be conducted before commencement. The budgets provided do not include pole attachments, make-ready pole remediation, or cost to acquire or lease space for the towers.

2.2 Defining Broadband

This analysis adopts the CRTC established Universal Service Objective ("USO") for broadband Internet access services on fixed networks of 50 Mbps download/10 Mbps upload with an unlimited data option. It specifically focuses on the delivery of fixed broadband (as opposed to mobile) services to the residents of Muskoka. This analysis identifies technologies that can meet or can exceed the CRTC's USO of 50/10Mbps.

2.3 Exclusion of Mobile, Wi-Fi, and Legacy Satellite Technologies

This analysis specifically considered the availability of fixed broadband services to the residential household and therefore excluded consideration of the mobile, Wi-Fi, and legacy GEO stationary orbit satellite options that may be available in various parts of the District. (At an average orbit height of 22,000km, compared to an average height of 600km for LEOs, GEO satellites do not lend themselves to high-speed data transmission because they experience significant signal loss, lag, and jitter).

2.4 Project Approach

The project gathered data from various sources and then assessed and validated the data. The project team engaged with District staff members, Area Municipality staff members, government organizations, First Nations, interested community members, and service providers. The complete list of consultations is provided in Appendix B. Finally, the analysis contemplated the unique environmental and geological features of the District in developing the potential options and strategies that make up the recommendations.

2.4.1 Previous Study

In September of 2020, in collaboration with Blue Sky Net, the District undertook a review of fixed broadband access to produce a Muskoka Community Broadband Summary. The information in the Summary was used as input to this engagement and compared to the Background Data Sources described in the following sections.

Overall, the previous study concluded that:

- Fixed Broadband networks that serve Townships/Municipalities areas that are less densely populated are not able to deliver speeds equivalent to their more urban neighbours.
- Only 22.4% of the land parcels in the District are able to access networks that deliver the Universal Service Objective of 50/10Mbps while 76% can access only 5/1Mbps.

- Over 50% of residential properties can receive 50/10Mbps service in Muskoka while approximately 200 (less than 1%) cannot access fixed broadband services at all.

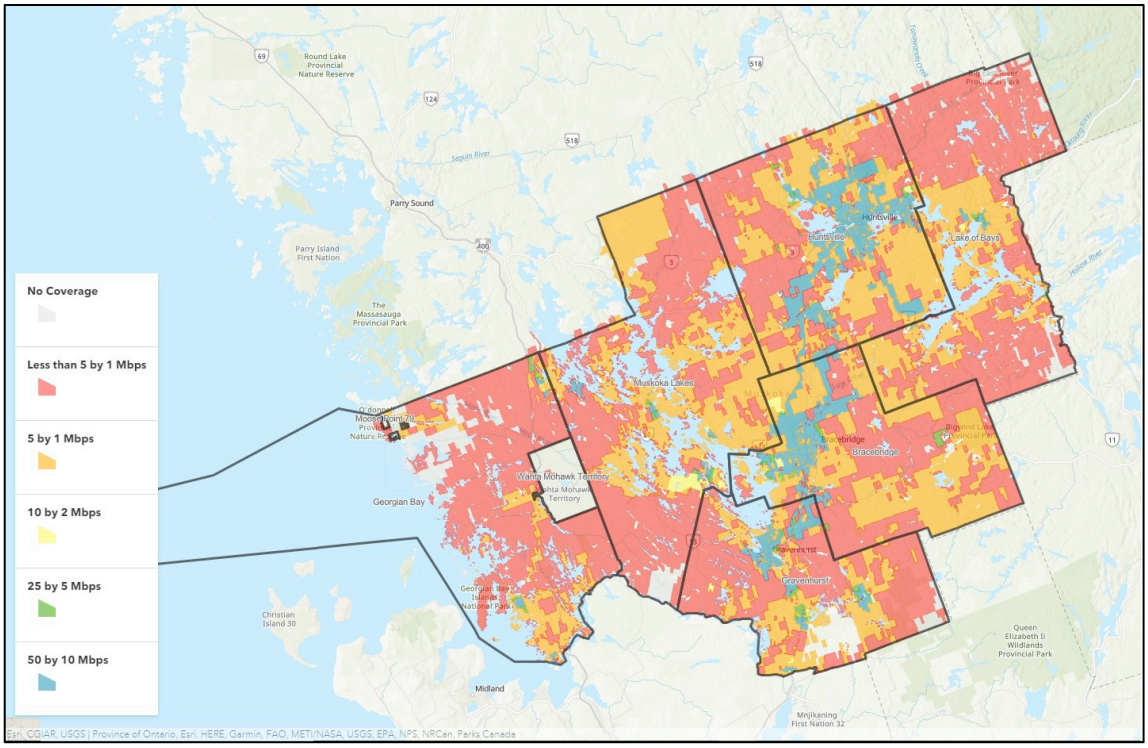

Figure 2 – Blue Sky Net Broadband Findings[1]

2.4.2 Background Data Sources

Publicly available background data sources provided context on overall geography and scope of existing services. Primary sources of background data include the Muskoka District Geohub and Blue Sky Net's mapping, Building Density as provided by the District, the Canadian Internet Registration Authority (CIRA) Performance Data, and CRTC's Telecommunication Service Provider Registration List and National Broadband Data.

District of Muskoka Map

The official Map published by District of Muskoka was used to establish the boundaries of the District and set any potential service areas. Specifically, the analysis used the November 18, 2020 District boundary maps published on the Muskoka Geohub[2].

[1] Buell, Jeff, Blue Sky Net, Muskoka Community Broadband Summary, September 15, 2020
[2] https://map.muskoka.on.ca/

Building Density

Building density was important to understand the distribution of households throughout the District, the number of homes per km, and the average setbacks of residential buildings from the roadways. The analysis used the December 1, 2020 Building Footprint map on the Muskoka Geohub[3].

Broadband and Associated Infrastructure Mapping and Analysis Project

Since 2012 Blue Sky Net has been collecting and analyzing fixed broadband coverage and usage statistics as part of its Broadband and Associated Infrastructure Mapping and Analysis Project (BAIMAP). BAIMAP data was one of the sources used to assess tower locations in coordination with backhaul links, available fibre routes, and underserved roads.

CIRA Performance Data

The CIRA Performance Data confirmed at a high-level, based on available data, that service levels fall below the CRTC universal service objective particularly in the most rural areas. White markers indicate ~25Mbps download of service, various shades of red indicate less than 25Mbps (with dark red the slowest), and various shades of blue indicate greater than 25Mbps (with darkest blue being above 50Mbps)

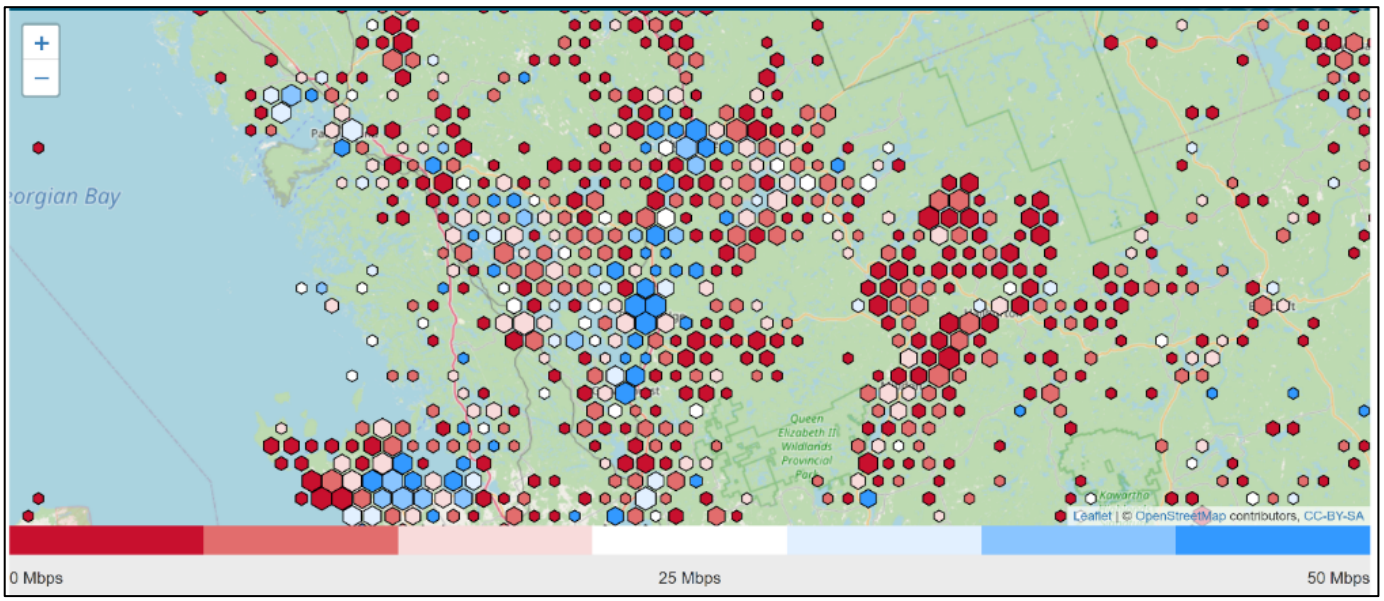

Figure 3 – Sample CIRA Performance Data[4]

[3] https://map.muskoka.on.ca/
[4] http://performance.cira.ca August 29, 2021

CRTC Data

The CRTC's National Broadband Data included a Pseudo-Household level assessment of the percentage of homes within an area that received defined thresholds of service. This data also confirmed lack of service and provides insight into the areas of the District recorded as underserved. The map in Figure 4 includes the Pseudo-Household level and the previous hexagon model. This map combines the previous 2017 National Broadband Internet Service Availability dataset (which was based on large hexagons of service) with the 2021 National Broadband Data v7.2 which is based on small, 250m road segments derived from annual CRTC reporting obligations. The map's red lines indicate the District roads currently defined as underserved (defined as having less than 50/10Mbps service) and golden colour hexagon signifies households in 2017 that between 0-25% of households had 50/10Mbps service, orange signifies 25-50%Mbps, dark orange 50-75%Mbps, brown 100%. The areas with no colouring indicates households that had 5/1Mbps available. The CRTC and Innovation, Science and Economic Development ("ISED") mapping data, which is the only officially accepted data, indicates that 2,712km of roads across Muskoka are considered underserved.

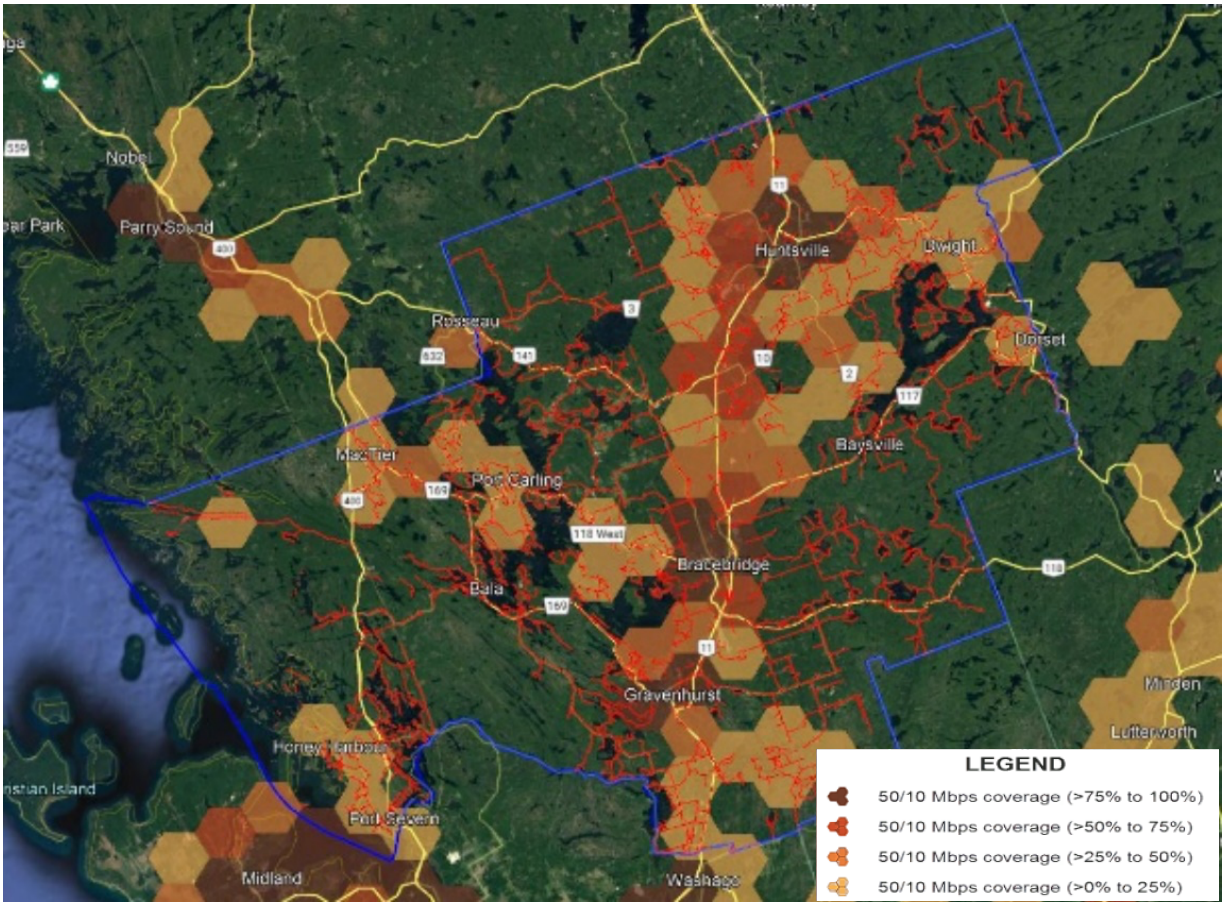

Figure 4 – CRTC National Broadband Data

2.4.3 Service Provider Identification

The background data from ISED, the CRTC, information from the District's Spring 2021 Request For Information, and local intelligence provided sufficient information to identify existing providers and understand current available capacity. For each service provider, public-facing information was used to determine available network coverage and pricing. The list of broadband providers currently servicing the District include:

- Algonquin Fibre
- 4Pairless Communications
- Bell Canada
- CHB Highspeed
- Cogeco Connexion
- Cottage Country Internet
- Indigiinet
- Lakeland Networks
- Muskoka WiFi
- Rogers Communications
- Starlink
- Xplornet
- Zayo (wholesale)

While best efforts were made to identify every service provider currently operating in Muskoka, the market is constantly changing and there may be additional small providers or recent startup operations which we did not identify. These smaller providers are essential to the hybrid approach and key to filling localized service gaps, but given their size and scope, their presence or emergence would not considerably or materially influence the outcome of this report or our recommendations.

2.4.4 Assessment, Verification, and Engagement

The maps, housing density, key site data, and previous study data provided the input for assessment of the potential options. Additional details from consultations with a broad range of key stakeholders (listed in Appendix E) with respect to economic conditions, needs, and gaps and with municipal staff members as to the processes and requirements for access to rights-of-way provided insight into the service providers requirements for building in various Area Municipalities. The identified gaps drove the suggested technical reference designs, projected budgets, recommended policies, and new strategies detailed in this Report.

2.4.5 Design and Documentation

The findings of the assessment, verification, and engagement phases were used to finalize the network options, maps, and potential technologies that ultimately make up the proposed design and the complete package with are presented here as findings and recommendations to the District Council and Broadband Sub-committee.

3. Current Landscape

3.1 Demographics

The District of Muskoka includes the towns of Bracebridge, Huntsville, and Gravenhurst, the townships of Lake of Bays, Muskoka Lakes, and Georgian Bay, and the Wahta and Moose Deer Point First Nations.

In 2019 the permanent, year-round population of the District was estimated at 66,268. In the District's 2017 Second Home Study the seasonal population was estimated at 81,000[5]. The Covid-19 pandemic has dramatically increased the number of people who now work remotely and that may result in an increase in Muskoka's permanent resident population with Muskoka's traditional seasonal residents relocating year-round to the region.

According to Statistics Canada[6], the median age in Muskoka is 51.3, which is significantly older than Ontario's median age of 41.3. The data lists that 35.51% of the total Muskoka population is aged 60+. At just 38.5% the "core" 25-54-year-old labour force, according to Statistics Canada, is well below the provincial average. The youth population. aged 0-14, totals just 11.99% of the population. Muskoka has an aging population which, given the District's low youth population, is in danger of not being able to sustain itself.

3.1.1 Employment

Almost 50% of total employment in Muskoka is in the retail trade, accommodations, food services, health care and social assistance[7].

Construction and manufacturing accounts for just over 16% of total employment.

Manufacturing jobs in Muskoka have decreased by 50% since 2005.

A large percentage of employment in Muskoka is either seasonal, part-time, or contract. This sector has been especially hard hit during the pandemic. According to the most recent Labour Force Survey data, the unemployment rate in Muskoka was 12.0%[8].

As to where the jobs are located, Bracebridge and Huntsville account for 66.28% of employment in Muskoka.

While the unemployment rate is high, without exception providers and Economic Development Officers spoke about the difficulty employers have filling jobs. Providers specifically spoke of their challenges in finding staff for crews or support. They explained that potential employees can get higher paying jobs outside the District where the cost of living and transportation costs

[5] See The District Municipality of Muskoka, Second Home Study, 2017.
[6] Statistics Canada, Census 2016, District of Muskoka
[7] Ibid.
[8] Statistics Canada, Labour Force Survey, 2020

are more reasonable. More than one commented that the cost of living in Muskoka was higher than living in Toronto.

3.1.2 Attainable Housing

Again, almost without exception, those we met with spoke of the high cost of housing in Muskoka. Housing has become less and less affordable – assuming it can be found at all. The influx of residents during the pandemic has only exacerbated this problem.

The high cost of housing forces local workers to live outside the District's municipalities. With little public transit within Muskoka, workers are forced to own vehicles to get to and from work. The high cost of housing and the need for personal transportation are major factors in the high cost of living in the District.

3.1.3 Affordability of Broadband

Affordability of broadband is an issue given lower-than-average income levels of Muskoka. Many residents cannot afford the cost of 50/10Mbps broadband (typically $80/month and as high as $199/month). Further, many residents do not require 50/10Mbps broadband. There is a real need for low-cost plans for "light" users.

3.1.4 Seasonality

According to providers, seasonal customers use at least 1/3 of their backbone Internet bandwidth. These customers, primarily cottagers, don't want to pay for service out-of-season. However, providers must buy bandwidth on 12-month (or longer) contracts. While this is not an issue for large providers, this cost for excess bandwidth which for the most part is only needed during the summer, represents a significant, unrecoverable cost for smaller providers.

3.1.5 Funding Programs

Until recently there were three (3) primary government funding programs available to providers serving Muskoka, namely Ontario's Improving Connectivity for Ontario Now ("ICON"), Innovation Science and Economic Development's Universal Broadband Fund ("UBF") and the Canadian Radio-television and Telecommunications Commission Broadband Fund.

ICON would fund up to 25% of the cost of a project while the UBF would fund up to 75% of the project cost. The CRTC does not have a specific limit as to the percentage it would fund.

We are aware of at least two Muskoka projects that have received ICON and/or UBF funding. One grant is for a project in the Baysville area and another in the Bala, Port Carling, and MacTier areas. We are also aware of other funding applications that have been filed for which funding decisions have not yet been announced.

Originally UBF had two funding streams – "shovel ready" and "longer term". UBF "shovel ready" projects were to be completed by the end of 2021. UBF allocated $150M for "shovel ready"

projects. UBF allocated an additional $1.75B to “longer term” projects that must be completed within five years of being awarded funding. At the time of writing, additional funding announcements from the UBF fund are imminent.

To date the CRTC Broadband Fund has issued two Calls for Applications. It is not currently accepting additional applications but, given it has an annual budget for the funding program, we anticipate it will issue another call later this year or early in 2022. We are not aware of any grants for the area having been awarded by the CRTC Broadband Fund.

Funding allocations from the ICON and UBF programs in Ontario were recently combined with a new Infrastructure Ontario (“IO”) created program. This new program combines funding originally allocated by ICON and UBF for Ontario projects into a new $4B Infrastructure Ontario managed grant program.

Under this new combined program Infrastructure Ontario has allocated up to $44.6 million to subsidize a fibre build in eastern sections of Muskoka and up to $34.9 million to subsidize a fibre build in western sections of Muskoka. Each subsidy will be awarded to a single provider based on a reverse auction with the monies being awarded to the company requesting the smallest subsidy. Infrastructure Ontario has also allocated up to $7.3 million to subsidize a wireless build in southern Muskoka including Bracebridge and Gravenhurst. In total Infrastructure Ontario has allocated almost $87m in fibre and wireless subsidies for Muskoka.

Unfortunately, based on our estimates of costs exceeding $240 million, and estimates prepared previously by Blue Sky, we are skeptical that the proposed $80m+ in fibre subsidies is sufficient to achieve the nearly 100% fibre coverage that Infrastructure Ontario expects.

Details as to Infrastructure Ontario’s funding are not transparent or publicly available. What has been announced is that the monies will be awarded through a “reverse auction” and that the lowest bids will prevail. It has also been announced that the IO program favours fibre solutions over all others.

Concerns have been raised by many stakeholders that the Infrastructure Ontario funding program will favour larger telecom players over smaller, independent providers and that this will not fare well for communities like Muskoka.

3.2 Service Providers

Internet Service Providers use a variety of technologies to deliver or distribute broadband across Muskoka.

- Fibre-to-the-Premises (FTTP), Wireless Home Internet (WHI), Fibre to the Node (FTTN), Digital Subscriber Line (DSL) (NOTE: FTTP is also known as Fibre-to-the-Home or FTTH)
- Hybrid Fibre-Coaxial (HFC) cable modem service
- LTE & Line-of-Sight Wireless (LOS)
- Point to Point microwave links (P2Ps)
- Geostationary Earth Orbit Satellites (GEOs)
- Low Earth Orbit Satellites (LEOs)

For reference, these technologies are outlined in Appendix A.

3.2.1 Algonquin Fibre

Algonquin Fibre is a new service provider, installing fibre in and around the Township of Lake of Bays. It began installations in 2021 and to date Algonquin has installed FTTP fibre in some parts of Dwight. Algonquin has plans to extend its fibre service over time east toward South Portage and Huntsville. Algonquin is committed to using exclusively fibre optic technology in its backbone, distribution, and last mile. They plow fibre wherever possible to optimize installation costs and see opportunity for further growth in Muskoka if there is sufficient support in the Area Municipalities in the form of favourable technical approvals and consistent policies.

3.2.2 4Pairless

4Pairless is a small, locally owned, and operated, provider based in Huntsville. 4Pairless resells Bell DSL and Cogeco HFC cable modem service. According to its website, 4Pairless offers wireless and owns towers but provides no details. 4Pairless primarily serves Lake of Bays and the Huntsville area.

3.2.3 Bell

Bell is a national provider that uses Fibre to the Home (FTTP), Wireless Home Internet (WHI), Fibre to the Node (FTTN), Digital Subscriber Line (DSL) and Bell Mobility cellular. In the Town of Huntsville Bell has overlaid approximately 4,000 locations in its existing copper network with fibre optics to provide FTTP services. Most new developments (residential or commercial) across Muskoka are being served with fibre, including the new Arena/Sports Complex in Bracebridge, the professional buildings surrounding Fairvern Nursing Home in Huntsville and the Loon's Call development in Gravenhurst and Legacy Cottages in Minett. Individuals or groups (i.e. cottage associations, First Nations, municipalities, etc.) can request that Bell provision fibre to a specific area currently fed with copper that is not on Bell's immediate FTTP overlay plans. Projects in their beginning stages include the Port Carling/Minett area, as well as one at Bigwin Island in Lake of Bays. Bell also offers LOS wireless service across Muskoka.

3.2.4 Cogeco Connexion

Cogeco serves communities in Quebec and Ontario. Cogeco currently provides broadband service to approximately 21,000 homes and businesses in Muskoka. These clients are serviced primarily using a Hybrid Fibre-Coaxial (HFC) network and cable modem technology that is capable of gigabit level services. Cogeco currently provides broadband service in Gravenhurst, Bracebridge, and Huntsville. Cogeco also has coaxial cable in Muskoka communities which, when upgraded, could also provide broadband connectivity to Bala, Port Carling, MacTier, and Baysville.

3.2.5 Cottage Country Internet (CCI)

CCI is a small, Muskoka-based ISP that provides LOS wireless internet and DSL and coaxial cable internet in Muskoka. CCI owns several towers to which it provides wholesale access to other providers. CCI wireless uses approximately 75 towers throughout Muskoka. Towers are located on private properties and typically range from 100 to 130feet (30 to 40m) in height.

3.2.6 Cottage, Home & Business Highspeed (CHB Highspeed)

CHB Highspeed is a small, locally owned, Bala-based provider. CHB Highspeed uses Indigiinet's fibre backbone and wireless infrastructure to offer wireless Internet.

3.2.7 Indigiinet

Indigiinet is a small, local First Nation-owned provider based in Bala. Indigiinet currently purports to offer services to the Moose Deer Point and Wahta First Nations, Bala, Georgian Bay, Tiny, and Tay Townships and along the 400 corridor. Indigiinet is an ISP with both fibre and wireless infrastructure. Fibre backbone delivers to a tower in Midland. Indigiinet also offers other services like computer sales, network design, custom connectivity, and consulting. It hopes to serve other customers in Muskoka as well as other First Nation communities across Canada.

3.2.8 Lakeland Networks

Lakeland Energy (Lakeland) is a private company owned by the Municipalities of Bracebridge, Huntsville, Parry Sound, Burk's Falls, Sundridge, and Magnetawan. Lakeland Energy in turn owns Lakeland Networks, an ISP with both a fibre network and an extensive wireless network. Lakeland offers internet services, is a CLEC registered VoIP provider, offers GIS services, electrical consulting, and construction services. Lakeland Networks has offered broadband since 2005. It has over 500km of fibre serving over 6,200 residential and business customers.

Lakeland Networks provides fibre and wireless internet service to communities, from Sundridge south to Port Severn, Lake of Bays west to Parry Sound. Lakeland Networks has fibre in communities along the Highway 11 corridor from Sundridge to Gravenhurst, provides service to Wasausksing First Nation and service to Parry Sound.

Lakeland Networks has wireless infrastructure throughout Parry Sound–Muskoka delivering broadband using over 120 towers.

Lakeland Networks is:

- Locally owned and operated;
- Creates local employment;
- Is the dominant ISP serving Muskoka;
- Uses 120+ wireless towers across the District of various ownership; and
- Operates 500km+ of fibre.

In 2020, Lakeland began upgrading its existing towers to offer 50/10 Mbps service and developing new tower sites. In addition, Lakeland is expanding coverage using new fixed wireless solutions along shorelines utilizing existing structures like boathouses, streetlight poles, etc.

3.2.9 Muskoka WiFi

Muskoka WiFi is a small Muskoka-based, locally owned provider based in Gravenhurst. It has approximately 200 subscribers. It currently has seven towers installed on leased, private land serving in and around Sparrow Lake and Kilworthy. Its towers are typically between 100 and 120 feet tall and are installed in more remote areas.

3.2.10 Rogers Communications

Rogers is a national service provider with some 48 towers located throughout the District. These towers are primarily located along major roads and larger lakes. Rogers Wireless has indicated that its service could be upgraded to serve between 2,000-3,000 underserved households. While it does not currently offer FTTP service in Muskoka, Rogers has transport fibre across the District roughly from Washago into Bala, north connecting Parry Sound and Huntsville and beyond. In October 2020, Rogers introduced wireless home internet service, also known as fixed wireless access (FWA), across more than 100 communities in in Southwestern and Eastern Ontario.

3.2.11 Xplornet

Xplornet is a national provider. Xplornet uses a combination of fixed wireless and GEO satellite technologies to provider broadband throughout Muskoka. Speeds vary significantly depending on the technology used and the level of traffic across the Xplornet system.

3.2.12 Zayo/Allstream

Allstream was the enterprise telecom services subsidiary of Manitoba Telecom Services (“MTS”) outside the province of Manitoba and is now a wholly owned subsidiary of the privately held Zayo Group. The company provides wholesale communications infrastructure services, including fibre and bandwidth connectivity, colocation, and cloud infrastructure.

As opposed to retail consumers, Zayo would provide backbone Internet options in Muskoka to service providers offering an alternative to leasing fibre backhaul from Bell, Cogeco or Rogers.

3.2.13 Low Earth Orbit Satellites - Starlink

Starlink is a US-based Low Earth Orbit satellite ("LEO") global provider owned by Space Exploration (SpaceX). Starlink currently offers beta service to 100,000 beta customers in 14 countries including a limited number of Canadians in remote areas like Muskoka. Currently, Starlink charges $649CDN for its receiver and dish while the cost of service begins at $129CDN per month. Starlink is perhaps the best-known LEO satellite project. Starlink had launched 1,800 satellites by August 2021 and plans to have 4,425 satellites in orbit by 2024 with its ultimate goal to launch as many as 12,000.

Starlink targets the consumer – as opposed to wholesale - market. According to SpaceX, Starlink already meets the Universal Service Objective of 50/10Mbps and tests in the US have delivered speeds of up to 100Mbps. SpaceX claims that Starlink will be able to simultaneously support as many as 2.76M users and process 276,00Gbps of traffic.

Several organizations in the US, including the Fibre Broadband Association, position that Starlink (and LEO constellations in general) will be unable to deliver consistent service that meets the CRTC and US Federal Communications Commission (FCC) service objectives at the scale and density proposed to the FCC Rural Digital Opportunity Fund (RDOF). The RDOF has a minimum speed requirement of 20/3Mbps which is significantly lower than the CRTC's Universal Service Objective of 50/10Mbps. The lobbyists' model predicts that "Starlink would face a capacity shortfall by 2028 and over 56% of Starlink's RDOF subscribers would not be fully served."[9] Given that Starlink has received RDOF funding and currently does not have facilities in Canada, we believe that Starlink's immediate near-term focus will continue to be the US market.

3.2.14 Other LEO Providers

Blue Origin-Kuiper

A competitor to Elon Musk and SpaceX will be Amazon-owner Jeff Bezos and his LEO service, Blue Origin (Amazon's official LEO corporate name is Kuiper though it is more commonly known as Blue Origin). Blue Origin plans to launch 3,236 satellites and install as many as one million earth stations to provide unimpeded reception anywhere on the planet. Amazon has committed to invest as much as $10B in Blue Origin/Kuiper. Like Starlink, Blue Origin/Kuiper will target the consumer market.

[9] NTCA, Fibre Broadband Association Equip FCC with Model to Evaluate LEO Satellite RDOF Applications, Feb 8, 2021. https://www.ntca.org/ruraliscool/newsroom/press-releases/2021/8/ntca-fibre-broadband-association-equip-fcc-model

Telesat Canada

The major Canadian entry in LEO satellites is Telesat Canada. Known as Lightspeed, Telesat's LEO constellation will include 298 satellites.

The Federal government has committed $1.4-billion to the Telesat project. Telesat has also attracted $400-million from the Quebec government and $109-million from the government of Ontario. According to Telesat, Lightspeed is a $5B project. Telesat will target the wholesale market and offer its service to Internet Service Providers as a backbone alternative to areas where fibre backbone is not available. The ISPs, in turn, will market directly to consumers.

Telesat expects to have its full constellation of almost 300 LEO satellites launched within two years with beta testing beginning in 2023

OneWeb

The original LEO satellite system, launched many years ago using quite different technology, was Iridium, now known as OneWeb. Iridium struggled for many years, was unsuccessful and went bankrupt. Its assets were purchased last year by the governments of India and the United Kingdom. It is believed the two countries to date have invested $1.4B in the new venture. OneWeb currently has 110 satellites in orbit and plans to have a total of 648 satellites when its constellation is complete. OneWeb targets the wholesale market and ISPs as opposed to the consumer market.

3.3 Coverage Gaps

The Report confirms there are extensive broadband coverage gaps resulting in many underserved areas scattered throughout Muskoka. The National Broadband Data identifies more than 29,000 households and more than 2,700 kilometers of roads that are underserviced.

Importantly, providing Internet services in Canada requires registration with the CRTC and annual reporting. These reports are used to collect data about services to roads and households. This is used by both levels of government to determine eligibility for funding. It is widely accepted that the data is not perfect but it is the best approximation for analysis. Our report relies on the National Broadband Data v7.2[10] to derived conclusions on coverage.

While best efforts were made to identify service providers in Muskoka, the market is constantly changing and some providers may be brand new or others may not be reporting in compliance with the obligations. Regardless, the data provides key insight into the coverage gaps where business and residents do not receive the mandated Universal Service Objective. Those gaps are highlighted in the two maps. Figure 5 outlines the specific 250m road segments upon which residents do not receive the USO. Figure 6 combines the December 1, 2020 Building Footprint

[10] https://open.canada.ca/data/en/dataset/00a331db-121b-445d-b119-35dbbe3eedd9

map on the Muskoka Geohub, the National Broadband Data v2.7 and the StatCan Pseudo-Household data to show areas where residents and businesses are considered underserviced.

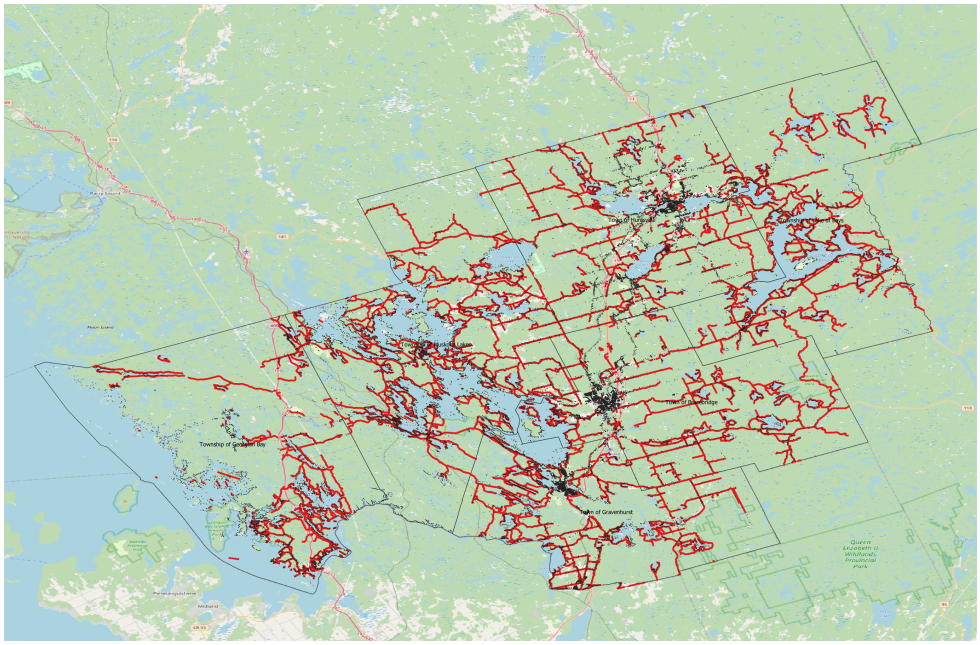

Figure 5 – Underserviced Roads

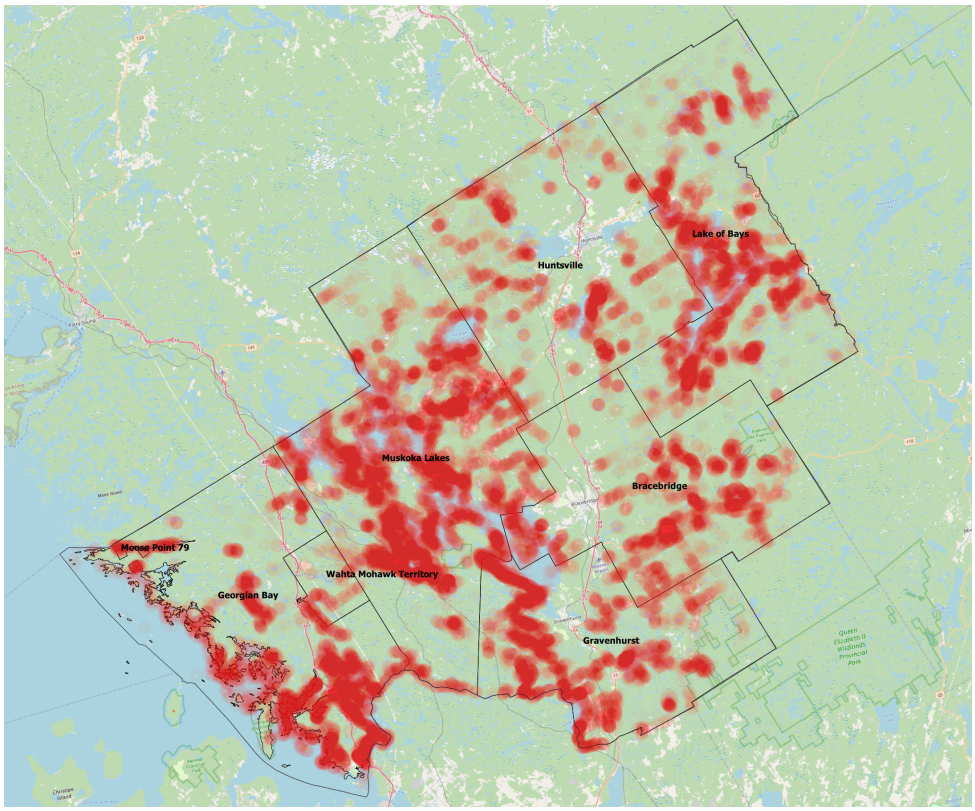

Figure 6 – Heatmap of Underserved Residents and Businesses

Fixed Wireless is the predominant technology currently in use to provide broadband connectivity in the rural areas of Muskoka. In towns along Highway 11, broadband connectivity for the most part is provided using fibre optic or hybrid fibre/coaxial cable. Broadband connectivity in most areas is quite poor except for those towns located, for the most part, along Highway 11 (Bracebridge, Gravenhurst & Huntsville).

3.3.1 Towers

Wireless broadband requires tall towers from which to broadcast to customers. Wireless often also requires the construction of a tower at the customer's location to receive the broadband signal. As with most rural communities, the issue of towers is volatile and controversial across Muskoka. Tall "broadcast" towers are especially controversial. But many residents also oppose towers erected at the customer's premises.

In discussions with each of the municipal Economic Development Officers they emphasized the importance of respecting the environmental concerns of residents. These concerns have resulted in at least one municipality adopting a policy requiring customer towers be camouflaged to resemble trees.

A key issue/concern raised by each provider was the lack of consistent policies on towers and fibre installations across the District's lower tier municipalities. The providers also raised the issue/concern that it can take months to get a tower build application processed and approved.

Previous research confirmed there are literally hundreds of towers of varying heights installed across Muskoka. Lakeland Networks alone uses more than 120 towers. Rogers, Bell, CCi, Galaxy, Muskoka WiFi, and 4Pairless each has installed towers in different parts of Muskoka. And, of course, there are many more "receiving" towers at the homes of residents. The cost to residents of towers for receiving broadband can be a significant obstacle.

3.3.2 Fibre

Fibre optic cable is considered by many to be the "gold standard" for broadband. The Infrastructure Ontario program has indicated that fibre is its preferred broadband technology. Fibre can deliver higher speeds than other technologies and is readily scalable for future upgrades.

In a report prepared for the District by Blue Sky Net in Spring 2021, the cost of universal deployment of fibre, to all roads in the District, was estimated at between $288 million and $344 million. We found the Blue Sky Net estimates to be reasonable, conservative budgets and we discuss further in subsequent sections our own similar estimates.

As with the erection of towers, the installation of fibre along roadways is also almost always controversial. Roads departments typically prefer the aerial installation of fibre (on hydro or telephone poles) to fibre being buried in trenches or conduit along roadways.

As with towers, there is no consistency in Muskoka municipalities on fibre policy or even which department is responsible for in-ground installations. For example, one municipality planning department made it clear that, while in-ground installations are not prohibited, it is opposed to any in-ground installation of fibre. To that end, it has adopted criteria that discourage in-ground and favour aerial builds. Yet in another Muskoka municipality the manager responsible for roadways had no issues with in-ground fibre installations if the installation adhered to clear municipal installation policies.

This lack of consistency in policies amongst the six main Muskoka municipalities discourages providers from wanting to invest and build.

3.3.3 Pricing

In preparing this Report we reviewed the pricing of providers currently serving Muskoka. Our review confirmed that prices in Muskoka are significantly higher than the cost of similar services in urban markets like Barrie or Toronto. Our review also confirmed the pricing data in the table below that was gathered earlier this year in response to the District-issued RFI. We have added one additional provider that offers 50/10Mbps service for $199/month. The data is summarized in Figure 6.

ISP	Service Type	Service Cost	Speed (download/upload)	Monthly usage Limits
A	Fibre	$50-$130	10Mbps-1.5Gbps	100Gb – Unlimited
	Wireless	$50-$150	25-50Mbps, 5-10Mbps	100Gb – Unlimited
B	Fibre	$89-$150	90-120Mbps, 10-20Mbps	Unlimited
C	DSL	$60-$130	10-25Mbps-3Mbps	400Gb-Unlimited
	Cable	$50-$90	15-250Mbps. 2-20Mbps	400Gb
	Wireless	$60-$130	15-25Mbps. 3Mbps	500Gb-Unlimited
D	Fibre	$80-$100	1-1Gbps	Unlimited
	Wireless	$60-$190	8-40Mbps, 2-20Mbps	Unlimited
E	Cable	$50-$110	10-500Mbps, 1-20Mbps	10Gb-Unlimited
	Wireless	$60-$120	200Mbps-0.25Mbps	5-50Gb
	Fibre	$100-$120	150-1,000Mbps, 15-30Mbps	Unlimited
F	Wireless	$50-$199	50/10Mbps	Unlimited

Figure 7 – Market Pricing Table

3.4 Processes and Policies

3.4.1 Competition For Investment

Given the large number of underserved Ontario rural and remote areas and the various funding programs offered, rural communities are essentially competing with one another to entice providers to deploy and invest in the local area. This gives providers the freedom to choose which communities with which to work. Even in cases where the business case is good, in our experience, service providers choose to work with communities that adopt collaborative development policies and make deployment easy to manage.

In developing this Report, we contacted both small and large providers. Some were out of market providers (Rogers, Cogeco Connexion, Xplornet) while others were Muskoka-based (Lakeland, Cottage Country Internet, Muskoka WiFi, 4Pairless, Algonquin Fibre). We also spoke with former providers (eg. CORE Network) about their experiences. Across the board, their comments were consistent. In large measure, inconsistent municipal policies, make it very difficult, time consuming, and expensive to expand in Muskoka.

The concerns raised in our meetings with providers were consistent with issues raised by providers in responding to the District's Request For Information ("RFI") issued in Spring 2021.

3.4.2 Complexity

In each of our interviews, service providers cited their frustration with the lack of consistent policies in each of the seven municipalities and at the District level. They also noted that it is often unclear who to deal with at the municipal level. For instance, in some communities the responsibility for tower permits falls under Planning, in others under Infrastructure and, in one case, the Fire Chief. Consistent and approved tower policies would serve to encourage providers to increase their investment throughout Muskoka.

Depending on the municipality, the department or person responsible for approval of tower applications can be different from the department or person responsible for permits to install fibre along roadways. The adoption of consistent approval processes at the District and municipal levels would serve to encourage infrastructure investment by providers.

Our findings, and the comments of providers, are consistent with the replies to the Spring 2021 RFI as to how the District (and other municipalities) could better directly support expansion of broadband infrastructure and service.

- "Expediting and streamlining approval processes for build and expansion plans";
- Facilitating "the use of District physical assets and infrastructure (buildings, towers, etc)"; and
- "Coordination with municipal operational teams to utilize best practices and identify opportunities to expand service infrastructure as part of municipal improvement projects. (laying fibre/conduits during road reconstruction)".

4. Solutions

4.1 Policy Options

This section describes some of the municipal policies that influence decisions by providers to invest or expand in an area like Muskoka.

4.1.1 Municipal Access Agreements

Municipalities have an obligation to protect public infrastructure. Constituents do not like communications pedestals, towers, road construction, or traffic disruption. Moreover, installation of communications infrastructure must maintain the integrity and serviceability of roads. To support this level of protection, Muskoka's individual municipalities control rights-of-way and issue permits for construction and other utility activities within these rights-of-way. Policies vary from municipality to municipality. It is up to each provider to negotiate terms with a municipality for access to its right-of-way. To build and maintain subsurface copper, fibre or wireless infrastructure, service providers must navigate each municipality's application process or negotiate access to the owners of passive infrastructure (eg. poles). Any single project may require involvement of multiple Area Municipalities, the District, and even private roads.

The municipalities set the requirements on any telecommunications companies proposing to install equipment within its jurisdiction. The standard approach is to enter into a formal Municipal Access Agreement ("MAA").

Complex and demanding Municipal Access Agreements are a deterrent to investment for service providers. The MAA should be crafted to protect both parties to the agreement. To be effective, a MAA should not be one-sided. The MAA should incorporate what could be termed "carrier friendly" provisions as well as protections for Muskoka with a view towards simplifying mandatory requirements and contributing towards a more reasonable share of capital risk.

The successful MAA focuses less on monitoring and enforcement of permit conditions, and more towards developing collaborative working relationships with service providers that facilitate the deployment of next-generation infrastructure critical to economic futures.

Further, the successful MAA is consistent with the CRTC-approved Model MAA[11] that is intended to serve as a model for use by municipalities and carriers and with the recommendations of the Federation of Canadian Municipalities "Telecommunications and rights-of-way: A handbook for Municipalities"[12]. A unified, consistent, District-wide MAA would simplify deployment for service providers.

[11] https://crtc.gc.ca/public/cisc/m-docs/MAA1311eng.docx
[12] https://data.fcm.ca/documents/resources/guide/handbook-telecommunications-row.pdf

4.1.2 Conduit and Dig Once Policies

In recent years, in many regions municipalities have worked toward Dig Once policies to minimize road disruption from the placement of utilities. These policies can be as simple as coordinating all utilities for common placement of infrastructure during construction or can be the default placement by the municipality of conduit for future use during road reconstruction. Some jurisdictions, particularly in urban centers where real estate is limited, have had success with this approach.

The challenges with the Dig Once approach however is that it attempts to anticipate a service provider's needs but may fall short of service provider requirements and potentially add cost to the service provider.

The cost of installing conduit depends largely on the installation method, size of the conduit, type of soil, location, and depth. Simple advanced placement of conduit without coordination with a future tenant offers no certainty that the design of the conduit placement will meet the needs of the service provider's network design. In this case, the conduit would need to terminate in strategic locations so the service provider can access it, but without service provider input the municipality does not know where the future service providers will want to break out connections. Retrofitting installed conduit can be complicated. Moreover, a single conduit will be unlikely to be serviceable for more than one provider, so the practice requires anticipating the needs of additional service providers and multiple conduits.

Dig Once policies are attractive in theory, but in practice they often force service providers to use a common approved contractor which ultimately increases the costs to the service providers. Also, service providers often operate with their own qualified installation crews to minimize cost. For these reasons, neither proactive conduit placement nor Dig Once policies are expected to yield positive benefits for the District or the lower-tier municipalities.

4.1.3 Service Provider Encouragement

A clear road map, clear local development policies and clear direction can encourage service providers to invest and develop in a region. In this Report we emphasize the need for consistent policies across the District and detail suggested policies that should be adopted at the District and Municipal level to encourage providers to expand in the District.

In deciding where to expand, service providers look for communities that actively support their expansion efforts by eliminating or minimizing barriers. Encouragement by local government through clear communication can help to stimulate that investment.

Incentives

Without exception service providers raised the issue of local subsidies to help finance their projects. Whether it is cash or access to municipal facilities, providers look at it as the municipalities having "skin in the game". Naturally providers look for local subsidies to reduce their need for provincial or federal funding. However, what many emphasized was that local

investment – in the form of grants or access to municipal infrastructure – amplifies the commitment of a local government and underscores the importance a municipality places on broadband expansion. They emphasized that even small contributions would serve to encourage investment on their part.

In addition to clear policies and the minimizing of roadblocks, a small investment on the part of Muskoka, at the District and/or lower-tier level, would help to show service providers that Muskoka is an engaged partner in broadband expansion and encourage them to invest.

4.2 Deployment Models

The District and the municipalities need to reach a consensus on whether they want to work together to eliminate broadband coverage gaps. Assuming they elect to work together, in our opinion they should consider several different approaches contained in this section.

4.2.1 Open Access Network

In most countries an Open Access Network ("OAN") means multiple ISPs use the same telecom network infrastructure to distribute their services without each of them having to build their own infrastructure. A true OAN separates ownership of the network infrastructure from the provision of telecom services. The owner of a true OAN is not an ISP and does not compete with network users. Its business is to build and maintain the network. Service providers focus on their business of providing quality services at competitive prices.

Conceptually a true OAN is like a street or a highway. Cars and trucks all share the same streets and highways. We don't build one highway for Fords, another for Chryslers, and another for GM. Yet in Canada, and many other countries, the major players each build their own network infrastructure and promote it as a competitive advantage. Building separate networks contributes to high costs, high prices, and lessens competition by creating a barrier to entry into the market. A true OAN would seem to make economic sense in a low-density rural area like Muskoka.

An OAN can come in the form of a fully-managed access network, that is one that includes the activation of the connection to the subscriber's home, or as a passive fibre network that simply makes the physical infrastructure available for other service providers. Unfortunately, in Canada we have not seen wide scale adoption of open access and the models for Canada are not fully developed. Hence, this approach may not garner the interest necessary to be successful.

While government funding programs like ICON or the Universal Broadband Fund require applicants to commit to providing open access, in practice open access has not been widely adopted in Canada. Muskoka-based ISP CORE Networks, recently acquired by Lakeland Networks, was a rare example of a provider offering true open access.

A key reason open access has not been widely implemented, in spite it being a requirement of funding programs, is that the funding programs fail to define open access or detail any obligations for providing open access. The only specific obligation is that there must be a common rate card for anyone seeking access. In our experience the lack of detailed obligations makes it difficult, and often impossible, to successfully negotiate access to network infrastructure.

Moreover, in an open access network it takes great effort to balance the cost and revenue in such a way that all parties can be successful and in complex environments like Muskoka it can be very difficult to keep everyone profitable.

4.2.2 Municipal Public Utility

In the Municipal Public Utility model, the District, Area Municipalities, or First Nations would decide to operate a network directly or contract a private sector player to construct and operate the network. The network may include fibre, tower, or hybrid fibre-tower infrastructure.

The parties could choose to establish an ISP to offer services to homes and businesses or operate the physical assets as an Open Access Network (OAN). In both cases, the municipalities would retain ownership of the infrastructure and be responsible for raising the capital needed to build the infrastructure.

To be eligible to receive government funding to build the network, the broadband infrastructure would have to be "open" meaning other ISPs would be permitted to pay to use the infrastructure to reach their customers. This would create an additional source of revenue for the Public Utility.

What is unknown currently is whether the major ISPs would be receptive to using infrastructure that they do not own or control. To date they have used claims about the quality of their infrastructure as a competitive advantage and they may be reluctant to change.

Given the considerable public and private investment already committed to the District, a new municipal public utility that would compete with existing investment is unnecessary and impractical.

4.2.3 Public-Private Partnerships

A public-private partnership ("PPP") is defined as a long-term contract between a private party and a government agency for providing a public asset or service, in which the private party bears significant risk and management responsibility. (World Bank, 2012). PPPs often involve ongoing, long-term relationships because private sector partners are assumed to bring efficiencies and higher quality outcomes than the public sector could achieve on its own.

PPPs are based in the belief that the private and public sectors have different but complementary skills, needs and experiences that in combination can better serve the public interest than working separately. This is especially true in the case of public infrastructure projects.

The PPP model has been used for years in the construction of roads, bridges, and public transport systems. More recently it has also been used for other infrastructure projects ranging from schools to prisons and hospitals. Today the PPP model is being used for the building of broadband infrastructure with SWIFT and EORN as notable facilitators of the PPP model.

The PPP model could prove a viable approach for developing broadband infrastructure in Muskoka. There is a range of approaches to the PPP that could be considered.

- A PPP could be created where a private sector partner would be chosen by the District and municipalities to build, operate, and maintain the broadband infrastructure; or
- A PPP could see a private sector partner contracted to operate and maintain the broadband infrastructure on behalf of the owners; or
- A PPP could see the District and municipalities create their own ISP and contract a private sector partner to operate the business.

There could be separate PPPs for each approach, or a single, all-encompassing PPP to deliver the entire suite of services.

A variation on the PPP model is known as the Wholesale Model. In the Wholesale Model, the District or Area Municipalities would partner with a private sector partner (or partners) to construct, maintain, and operate the broadband infrastructure. However, in this variation of the PPP model, the private sector partner would not only build and maintain the infrastructure. The private sector partner would own the infrastructure.

The partner would generate revenue by charging ISPs wholesale fees to use the infrastructure to reach their customers. Any ISP could contract to use the network. This would allow multiple ISPs to deliver services to residents of the common infrastructure. It would eliminate the quality of the network as a competitive advantage or issue and prompt ISPs to compete on customer service and price.

In the Wholesale Model the private sector partner, as the owner, would be responsible for raising the money needed to build the infrastructure. The District would not be expected to finance the building or maintenance of the infrastructure.

The only currently identified player promoting the PPP Wholesale Model approach is Toronto-based development company, BAI Communications but some others such as the Digital Infrastructure Group, Crown Capital Partners, and American Tower are emerging entrants in Canada. There may be others as this is an area that continues to be of interest to investment firms and private equity. The District should continue to monitor the emergence of new players.

Locally, Lakeland Networks may be a potential easy entry into a PPP if this approach is deemed necessary to eliminate any remaining service gaps.

4.3 Build Option Cost Estimates

To accurately assess and validate the anticipated costs to build in Muskoka, we developed budget models for three areas of the District as representative samples. We chose the areas of Lake of Bays, Walker Lake, and the Moose Deer Point First Nation.

The sample builds drive assumptions about deployment across the District and project overall costs to potential approaches for expanding broadband.

Note that this section only considers the infrastructure build cost and does not consider the additional costs to establish or operate an independent ISP. The cost to develop an ISP are added in subsequent sections.

4.3.1 Fibre to the Premises

Moose Deer Point First Nation FTTP

The Moose Deer Point First Nation is located on the eastern shore of Georgian Bay with approximately 200 full-time residents and 78 households. The Nation includes two large marinas, a manufacturing facility, a nursing station, and a water treatment plant. The Moose Deer Point First Nation is a member of the Anishinabek Nation (formerly Union of Ontario Indians) that delivers a variety of programs and services and provides the necessary forum for collective First Nation action on individual and collective issues.

As one of the eight First Nations that have a traditional tie or ongoing interest in the lands that now encompass Muskoka, and despite being serviced by both Indigiinet and Xplornet, Moose Deer Point First Nation residents frequently experience slow speeds and frequent outages. Yet they pay comparatively high prices for Internet services.

The District has a history of engagement with Indigenous Peoples and in June 18, 2019 the first Muskoka Area Indigenous Leadership Table (MAILT) was held at Moose Deer Point First Nation to strengthen relationships, review best practices, better understand legal obligations, and propose new solutions, including the development of a modern Indigenous-Municipal Consultation Protocol. In support of the District's commitment, and the geographic characteristics of the territory, Moose Deer Point First Nation was chosen as one representative sample area for build cost estimates. Moose Deer Point First Nation is an example of a representative low household density area where entire underground construction is possible.

Figure 8 – Moose Deer Point First Nation

Our model assumes the Pottawatomi of Moose Deer Point Government Services office at 3720 Twelve Mile Bay Road would serve as the network hub. This is an excellent location for the hub because of its central location. For this analysis, we assume that a small space inside the office can be made available to accommodate a hub. The proposed fibre route extends from the office west along Twelve Mile Bay Road through to its termination at the Chippewa Island First Nations reserve, from the office south along Ogemawahj Road, and around King Bay. The total route is 9.9 kilometres with an average estimated drop length of 80m.

The proposed route considers that roads are all soft surfaced with no pole infrastructure and assumes the ability to cost-effectively plow fibre in the side road with minimal environmental disruption (drilling only where necessary). The design will require roughly 18 fibre optic splice closures (FOSC) and 18 ground-level boxes (GLB) or pedestals. The total number of premises to be serviced is 93 and fits easily into one GPON OLT.

Construction for this project is expected to take approximately 10 weeks with a single crew. It could be completed more quickly using additional crews but growing provincial demand for fibre crews may potentially increase prices.

For our model we contemplate using a single crew with an estimated construction cost of $841,232.06 or $84.97 per metre. The access layer equipment necessary to connect the network at the PoP and customer premises totals $136,568.37 and the overall cost of the project is estimated at $977,800.43 or $10,513.98 per home passed.

The costs are broken down as follows.

Description	Cost	Per Home Passed
Labour*	$684,941.50	$7,364.96
Materials	$73,310.56	$788.29
Engineering/Permitting	$26,901.00	$289.26
Drop Costs	$56,079.00	$603.00
Construction Total	**$841,232.06**	**$9,045.51**
Cost Per Metre	$84.97	
POP/Access Layer	$109,970.37	$1,182.48
CPE/Access Layer	$26,598.00	$286.00
Total	**$977,800.43**	**$10,513.98**

Figure 9 – MDPFN FTTP Estimated Costs

Baysville FTTP

Baysville is one of the four major communities in the Township of Lake of Bays. Located at the southern end of Lake of Bays, Baysville is a tourist destination and home to a vibrant community and local commerce. Despite a recent Bell Canada project slated for Baysville, the most recent ISED National Broadband Data (v7.2) lists the core area of Baysville as underserviced. Baysville was chosen as a sample area for cost estimates because it has medium household density which requires a mix of underground, aerial, and complex (bridge) construction.

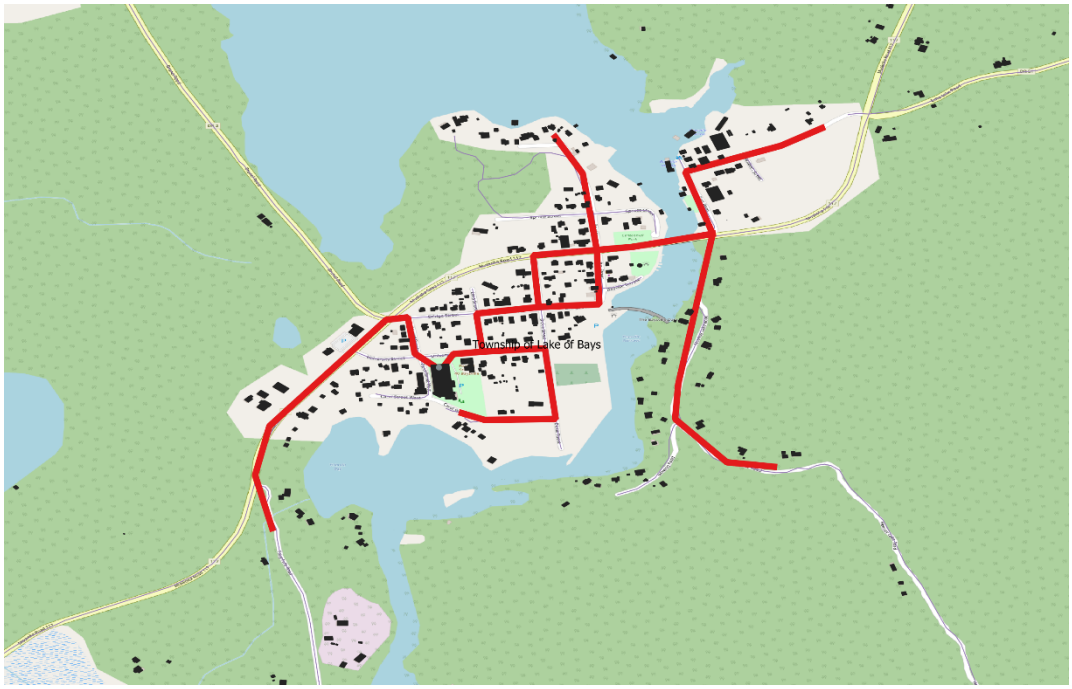

Figure 10 – Baysville FTTP Map

Our model assumes locating the hub at the Lake of Bays Community Centre Arena. There may be existing network access at the Arena but to serve as the hub it would require an upgrade of

the existing Internet backhaul. The proposed backbone fibre route runs along the primary roads within the settlement boundaries and extending southwest onto Fairy Falls Road and east until it heads north through and past the marina and south along Heney Lake Road. The proposed route covers 102 premises over the approximate 4km of roads. Some areas have significant pole infrastructure, but key areas are congested, and other areas have only minor underground complications. Roads outside the densest settlement area are open and accessible with soft shoulders and typical rural pole distribution. Roads in the settlement will require underground installation as the terrain allows. In this area we assume an average fibre drop length of 50m.

Overall, the route is targeted for approximately 50% underground installation and the remaining 50% would be aerial. The design will require approximately 20 fibre optic splice closures (FOSC) and 18 ground-level boxes (GLB) or pedestals and one GPON OLT.

Physical construction for a project of this scale is expected to take 2-3 weeks with a single crew. Delays could be encountered on the bridge crossing and complications may arise with the plowing efforts.

Our model budgets an estimated construction cost of $338,524.40 or $84.63 per metre. The access layer equipment necessary to connect the network at the PoP and customer premises totals $139,142.37 and the overall cost of the project is estimated at $477,666.77 or $4,683.01.43 per home passed. The *significant risk* here is that the estimate does not include pole remediation and our assumption is that as many as 20 poles may need to be replaced or remedied which could add as much as $250,000.00 to the build cost. The only way to mitigate or confirm this risk is to undertake the complete pole engineering effort.

The costs are broken down as follows.

Description	Cost	Per Home Passed
Labour*	$217,380.00	$2,131.18
Materials	$37,164.40	$364.36
Engineering/Permitting	$24,310.00	$238.33
Drop Costs	$59,670.00	$585.00
Construction Total	**$338,524.40**	**$3,318.87**
Cost Per Metre	$84.63	
POP/Access Layer	$109,970.37	$1,078.14
CPE/Access Layer	$29,172.00	$286.00
Total	**$477,666.77**	**$4,683.01**

Figure 11 – Baysville FTTP Estimated Costs

Walker Lake FTTP

The Walker Lake community is built around the 6.5-kilometre perimeter of Walker Lake in the Township of Lake of Bays. With homes mostly along the waterfront, including a small resort, the community is one that prefers the natural environment and includes approximately 89

premises. This area is representative of the typical lower density areas across the District where exclusively aerial infrastructure is most likely.

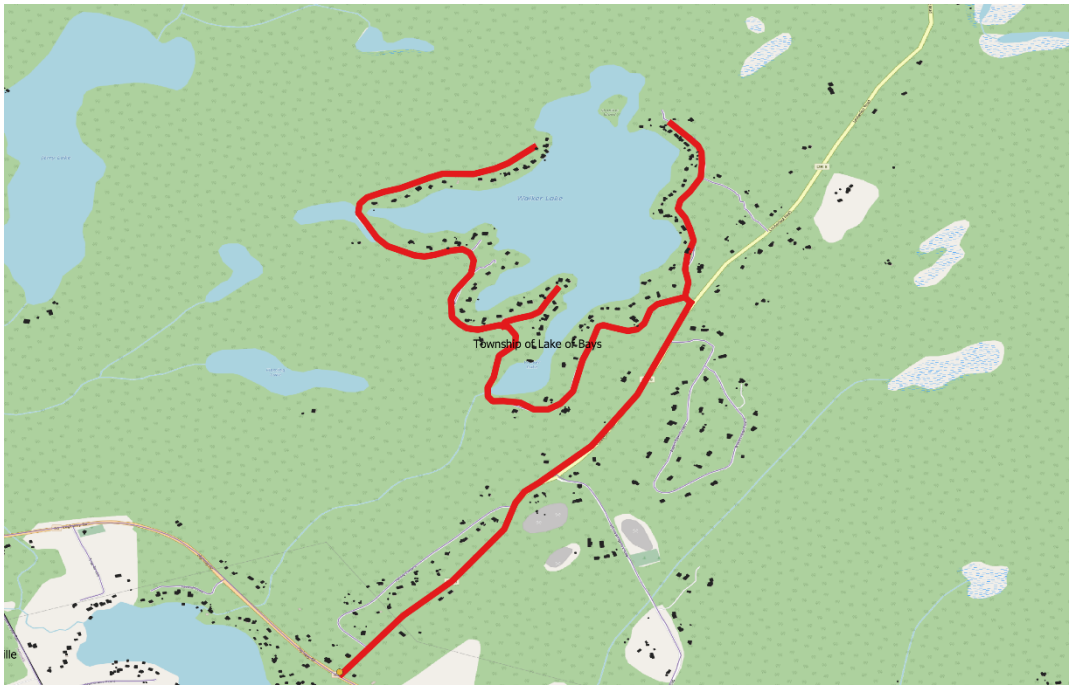

Figure 12 – Walker Lake FTTP

Our model assumes a network hub near the intersection of Limberlost Road and Highway 60 possibly at the Lake of Bays Fire Station 30. This is an excellent location for the hub because it is at a central location. For this analysis, we assume that a small space inside the office can be made available to accommodate a hub. The proposed fibre route extends from the office east along Limberlost Road through to the perimeter of the lake itself. The total route is 7.2 kilometres with an average estimated drop length of 80m.

The proposed route considers that roads and pole conditions are substantially unknown and that the ability to cost-effectively plow fibre in the side road with minimal environmental disruption is unlikely. The proposed build is representative of an entirely aerial build and the design will require approximately 15 fibre optic splice closures (FOSC) and 14 ground-level boxes (GLB) or pedestals. The total number of premises to be serviced is 89 and fits easily into one GPON OLT. Construction for this project is expected to take approximately 2 weeks with a single crew.

For our model we contemplate using a single crew with an estimated construction cost of $357,268.40 or $49.63 per metre. The access layer equipment necessary to connect the network at the PoP and customer premises totals $136,924.37 and the overall cost of the project is estimated at $494,192.77 or $5,552.73 per home passed. The *significant risk* here is that the estimate does not include pole remediation and our assumption is that as many as 75 poles may need to be replaced or remedied which could add as much as $1,000,000.00 to the

build cost. The only way to mitigate or confirm this risk is to undertake the complete pole engineering effort.

The costs are broken down as follows.

Description	Cost	Per Home Passed
Labour*	$198,912.00	$2,234.97
Materials	$40,951.40	$460.13
Engineering/Permitting	$63,738.00	$716.16
Drop Costs	$53,667.00	$603.00
Construction Total	**$357,268.40**	**$4,014.25**
Cost Per Metre	$49.62	
POP/Access Layer	$111,470.37	$1,252.48
CPE/Access Layer	$25,454.00	$286.00
Total	**$494,192.77**	**$5,552.73**

Figure 13 – Walk Lake FTTP Estimated Costs

4.3.2 Wireless

Upgrading Wireless Infrastructure

In developing this Report we assessed what fibre, hybrid fibre-coaxial cable and wireless infrastructure already exist across Muskoka.

Wireless currently has the greatest deployment across Muskoka with hundreds of towers already in place. Given the number of towers already installed, we considered the potential coverage that could be achieved if equipment on the towers were upgraded to more current and efficient technology and the towers were supplemented with neighbourhood hubs. The potential improvement is significant.

Our models indicate that the improvement in wireless coverage as a result of technology upgrades could significantly reduce the need for additional towers. Furthermore, if all towers were subject to “open access” obligations wherein tower owners would be required to make access to tower space under safe engineering practices to other providers, this could significantly reduce the need to build additional towers. Further, upgrading existing towers with an “open access” requirement would prove much less expensive than replacement.

Tower hardware upgrades are already being considered or implemented by some providers. For example, Lakeland Networks and Centre for Excellence in Next Generation Networks (“CENGN”) recently announced an innovative pilot project using new tower technology in the Lake of Bays area to improve coverage and speeds.

Walker Lake Sample

To support our review of wireless alternatives we evaluated the costs of covering the residents of Walker Lake with a wireless alternative. This section sets out the comparative costs for the conceptual wireless deployment. The equivalent coverage for Walker Lake would require an approximately 40m tower placed roughly at the intersection of Limberlost Road and Walker Lake Drive. The tower would need to be outfitted with two 90-degree sectors. Residents would require antenna mounting to heights as much as 12m which is consider and would carry substantial cost to the resident.

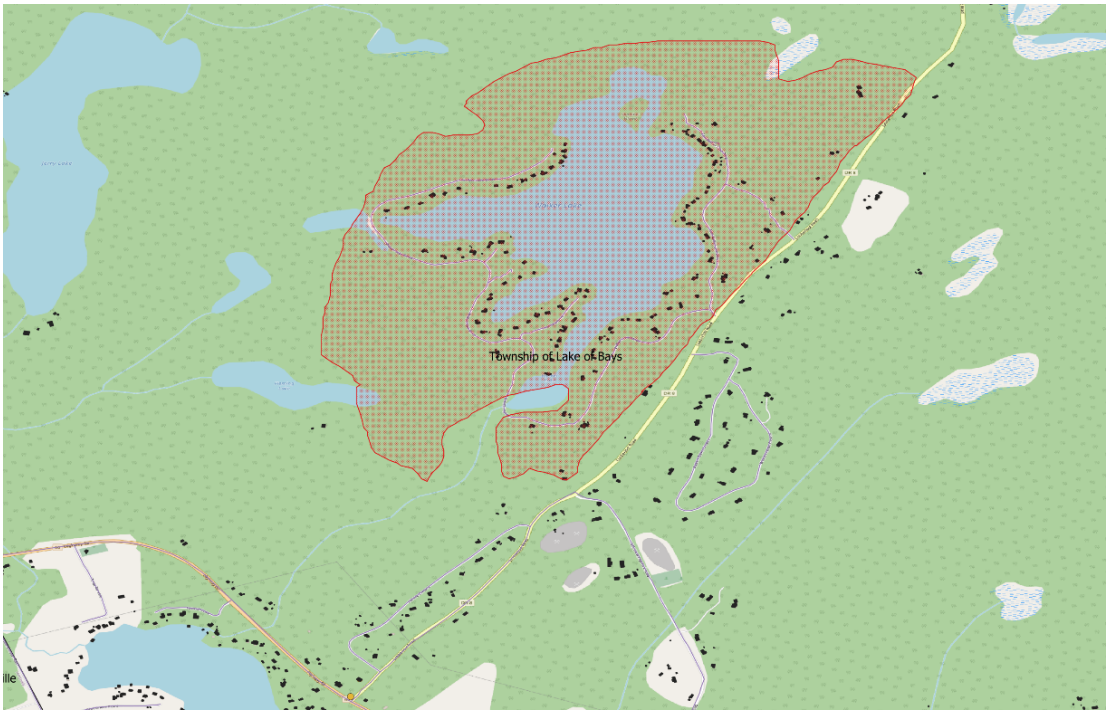

Figure 14 – Conceptual Walker Lake Wireless Network

The cost to construct the wireless infrastructure is $151,373.31 and the access equipment necessary to connected subscribers is $105,929.59 for a total cost of $257,302.90 or $2,891.01 per home.

Description	Cost	Per Home Passed
Labor	$73,600.00	$826.97
Materials	$57,773.31	$649.14
Engineering/Permitting	$20,000.00	$224.72
Construction Cost	**$151,373.31**	**$1,700.82**
POP/Access Layer	$42,109.01	$473.13
CPE/Access Layer	$63,820.58	$717.09
Total	**$257,302.90**	**$2,891.04**

Figure 15 – Walker Lake Wireless Estimated Costs

Despite the attractiveness of the dramatically reduced cost of wireless compared to fibre, the challenge is that wireless service will, in practice, never reliably exceed the basic service objective of 50/10Mbps. Under load at peak usage times it will likely be difficult, if not impossible, to sustain a consistent 50/10Mbps. Further, this type of wireless is a "line of sight" technology and can have difficulty with obstructions such as trees, hills, and buildings.

However, this approach does demonstrate that wireless technology could cut costs in half and moreover offer the ability to deliver to more homes. For example, our conceptual design used two 90-degree sectors from a proposed tower at the entry point of the Walker Lake settlement, but a relative minor incremental investment in additional 90-degree sectors would reach a relatively comparable number of buildings on the other side.

Given the large number of existing and potential towers, along routes with fibre, and covering different geographies, it is very challenging to predict the overall cost of servicing the entire District with wireless and the terrain makes it impossible to discern the exact service level to a given home. We estimate that implementations such as this conceptual tower for Walker Lake would service up to 200 homes and building with this precision for all the 29,176 underserviced homes could require 150 – 200 towers. Therefore, while wireless certainly has a role to play, it is not a ubiquitous and reliable option so it should be used sparingly where necessary to fill precise gaps.

4.3.3 Hybrid Approach

In our opinion no single technology can be deployed to eliminate Muskoka's coverage gaps or to meet the Universal Standard objective of 50/10Mbps. Muskoka requires what can be described as a "hybrid approach" which means the technology deployed, and the service levels achieved, will differ depending on the locale.

Fibre alone is simply not economically viable given the topography, the small, widespread population, and the relatively low average income level of the population. In many parts of Muskoka there is no reasonable return on a fibre investment for providers or municipalities. This is true regardless of the availability of government grants to subsidize the build.

Muskoka's goal should be to deploy fibre wherever practical and use a combination of HFC cable, wireless, and LEO satellites to service those areas which fibre cannot reach.

Moreover, no single service provider is likely to address all the gaps and all the requisite technologies, therefore the hybrid approach would also need to support and encourage development of broadband by a wide range of both large and small, local and national carriers.

4.4 Developing an ISP Costs

Developing an ISP requires a broad range of expertise and significant investment in technology. This section describes the primary elements of an ISP and provides the cost estimates used in our modelling.

4.4.1 Core Network

The core network hardware includes the switching and routing capacity to connect the broadband network to the Internet and the required IP addresses and services related to Internet access. The core network is located at a primary PoP site and consists of routers, switches, servers, and powering. Equipment is generally deployed in a redundant fashion for reliability and the network may consist of several PoP as required for the geography. PoP sites are connected with backbone fibre. Our model contemplated one primary PoP site with two service provider grade routers, two switches, an uninterruptable power support, backup natural gas generator, out-of-band management devices, and all related vendor maintenance programs for five years. We budgeted for building a PoP site and provisioning it with the appropriate power, air conditioning, and security (see Figure 16)

Item	Description	Cost
	Capital	
PoP Site	Physical space for core network	$155,000.00
Internet Transit	Installation of two carrier connections	$30,000.00
Core Network Routers	Core Routing Pair	$54,681.60
Server Switches	Server Switching Pair	$3,194.88
Standby Power	Generators, engineering, and UPSs	$60,750.00
Out-of-Band Access Devices	Out-of-Band Access Devices	$3,054.00
Optics	Optics	$12,121.00
Vendor Maintenance	Initial 5 years core hardware	$95,136.92
Implementation	Install, Configure, Core Services	$75,000.00
	Total Capital	$488,938.40

Figure 16 – Core ISP Network Costs

4.4.2 Operational Support Systems

In order to provide a consistent level of service, subscriber management, service monitoring, provisioning, and billing tools are essential. As with the network components the operational support system (OSS) should also be high availability and built-in redundancy (see Figure 17).

Item	Description	Cost
	Capital	
OSS and Billing	Servers and OSS Software	$132,500.00
	Total Capital	$132,500.00

Figure 17 – Operational Support System Costs

4.4.3 Human Resources

Management

A new ISP would require a general, technical operations, and customer service management team to oversee operations. A budget of $20,000.00 per month is used as a placeholder for hiring staff.

Technical Support

Technical support guidelines will need to be developed. This includes support documentation for customers, operating hours for technical support, clearly defined escalation procedures and service call requirements. Technical support can be classified into three Tiers with Tier 1 being the front line taking direct phone calls and/or answering electronic communications from customers. Tier 1 provides basic assistance answering questions, providing service details, and basic troubleshooting of network related issues. Tier 2 is escalated to for more complex issues and ultimately major network related issues are passed to Tier 3. Our modelling contemplates Tier 1 customer support outsourced to third parties in the range of $7 per subscriber per month and Tier2/3 technical support outsourced at $15,000.00 per month.

Field Services and Installations

Most field services and installation can be contracted out and initial installations costs are noted in the customer premises equipment (CPE) costs. There may however be a requirement for field services vehicles and staff training to support the ongoing operations. An additional budget of $10,000 per month is included to account for a field technician and vehicle (See Figure 18).

Item	Description	Cost
Monthly Operating		
Management	Management Team	$20,000.00
Tier 1 Support	Outsourced Tier 1 Support @ $7/sub	$204,232.84
Tier 2/3 Support	Outsourced Tier 2/3 Suport	$15,000.00
Field Technician	Field operations, installations, repairs	$40,000.00
Fibre/Plant Maintenance	Budget for maintenance and repairs	$56,510.08
	Monthly Operating	$335,742.92

Figure 18 – Human Resources Costs

4.4.4 Internet Access

The network will require connections to the Internet. With existing telecom providers in the District, it would be practical to acquire wholesale Internet access. Our budget model estimates from our experience that at full capacity of 29,176 subscribers, the District's underserved households would require approximately 80Gb of Internet access and we have budgeted $30,000 for installation and $40,000 per month (See Figure 19).

Item	Description	Cost
	Capital	
Internet Transit	Installation of two carrier connections	$30,000.00
	Total Capital	$30,000.00
	Monthly Operating	
Internet Transit	Ongoing transit costs to two providers	$40,000.00
	Monthly Operating	$40,000.00

Figure 19 – Internet Access Costs

4.4.5 Sales and Marketing

A new ISP would require a budget for sales and marketing efforts as well as other miscellaneous expenses such as legal, regulatory, and office expenses. Our budget includes an initial $135,000.00 for a) development of standardized marketing services description and sale processes, and b) branding, website, marketing launch, and related legal/admin fees. Thereafter we use a model budget of $5,000.00 per month (See Figure 20).

Item	Description	Cost
	Capital	
Marketing	Initial Market Launch and Sales Processes	$135,000.00
	Total Capital	$135,000.00
	Monthly Operating	
Sales/Marketing/Misc	Miscellaneous budget	$5,000.00
	Monthly Operating	$5,000.00

Figure 20 – Sales and Marketing Costs

4.5 Overall Cost Models

The high-level business case is built around delivering broadband to all the underserved roads in the District as identified by the Innovation, Science, and Economic Development Canada (ISED) National Broadband Availability Mapping Data version 7.2. Underserved roads are those segments identified by ISED as having less than 50/10 Mbps service. The data represents available broadband services down to the 250-metre road segment level using demographics and road file information from Statistics Canada, combined with information from Internet service providers. According to this data, the District of Muskoka has 2,712 km of roads and 29,176 households that are currently considered underserved.

We used the sample build options in previous sections to estimate the average cost to build in the District and project that across all the underserved roads and households. We reviewed the resulting average cost to build and considered any potential impacts of other unique characteristics of the District such as larger lakes and more rugged terrain and determined that the resulting average was sufficient as an approximation of the overall cost not including pole remediation. Note the pole remediation in the District may present a ***significant cost risk*** and the only way to truly assess is to undertake pole engineering in the region. The result provides a reasonable estimate of the cost build various fibre-based solutions for the District.

4.5.1 Municipal ISP

This model assumes that the District goes into direct competition with existing providers and becomes a municipal ISP. This has been a common approach across Canada and the United States for a very long time. Building on the fibre costs and adding the costs to develop an ISP, overall the estimated costs are $240,737,897.29 with a monthly operating budget of $459,689.77. The estimated cost of the project is detailed in the following table.

Item	Description	Cost
	Capital	
PoP Site	Physical space for core network	$155,000.00
Internet Transit	Installation of two carrier connections	$30,000.00
Physical Network (FTTx)	FTTx: Engineering, labour, materials (no pole remediation)	$197,590,291.07
Pole Remediation	To be determined after engineering	
Access Network (XGS-PON)	Remote XGS-PON Cabinets	$34,046,797.50
Core Network Routers	Core Routing Pair	$54,681.60
Server Switches	Server Switching Pair	$3,194.88
Standby Power	Generators, engineering, and UPSs	$60,750.00
Out-of-Band Access Devices	Out-of-Band Access Devices	$3,054.00
Optics	Optics	$12,121.00
OSS and Billing	Servers and OSS Software	$132,500.00
Vendor Maintenance	Initial 5 years core hardware	$95,136.92
Implementation	Install, Configure, Core Services	$75,000.00
CPE	Optical Network Terminals installed susbcribers	$8,344,370.32
Marketing	Initial Market Launch and Sales Processes	$135,000.00
	Total Capital	$240,737,897.29
	Monthly Operating	
Internet Transit	Ongoing transit costs to two providers	$40,000.00
Pole Attachment Costs	Cost of $44.50 per pole per year for attachment	$78,944.85
Management	Management Team	$20,000.00
Tier 1 Support	Outsourced Tier 1 Support @ $7/sub	$204,232.84
Tier 2/3 Support	Outsourced Tier 2/3 Suport	$15,000.00
Field Technician	Field operations, installations, repairs	$40,000.00
Fibre/Plant Maintenance	Budget for maintenance and repairs	$56,510.08
Sales/Marketing/Misc	Miscellaneous budget	$5,000.00
	Monthly Operating	$459,687.77

Figure 21 – Complete Municipal ISP

4.5.2 Open Access Network

This model assumes the District would choose to build and “light” a fibre network by both designing/implementing both the passive fibre and active access equipment. This approach would allow the District to provide access for potential service providers across the fibre to the underserved subscribers. In this model the District would not build a core network and would not become an ISP but would offer third party ISPs a high-quality connection on an open access basis. The estimated costs are provided in Figure 22.

Item	Description	Cost
	Capital	
PoP Site	Physical space for core network	$155,000.00
Physical Network (FTTx)	FTTx: Engineering, labour, materials (no pole remediation)	$197,590,291.07
Pole Remediation	To be determined after engineering	
Access Network (XGS-PON)	Remote XGS-PON Cabinets	$34,046,797.50
Core Network Routers	Core Routing Pair	$54,681.60
Server Switches	Server Switching Pair	$3,194.88
Standby Power	Generators, engineering, and UPSs	$60,750.00
Out-of-Band Access Devices	Out-of-Band Access Devices	$3,054.00
Optics	Optics	$12,121.00
OSS and Billing	Servers and OSS Software	$132,500.00
Vendor Maintenance	Initial 5 years core hardware	$95,136.92
Implementation	Install, Configure, Core Services	$75,000.00
CPE	Optical Network Terminals installed susbcribers	$8,344,370.32
	Total Capital	$240,572,897.29
	Monthly Operating	
Pole Attachment Costs	Cost of $44.50 per pole per year for attachment	$78,944.85
Management	Management Team	$20,000.00
Tier 2/3 Support	Outsourced Tier 2/3 Suport	$15,000.00
Field Technician	Field operations, installations, repairs	$40,000.00
Fibre/Plant Maintenance	Budget for maintenance and repairs	$56,510.08
	Monthly Operating	$210,454.93

Figure 22 – Open Access Network

4.5.3 Passive Fibre Network

The District could construct an entirely passive fibre network, meaning one with no electronics in which the fibre is said to be “dark” and that provides no access or ISP services to residents. The network would reach all underserved residents but then the District would make that passive fibre network available to third party ISPs who would use it to provide the actual services. Essentially, the District would be shouldering the physical construction cost to de-risk potential service providers. The estimated costs for this option are summarized in Figure 23.

Item	Description	Cost
	Capital	
PoP Site	Physical space for core network	$155,000.00
Physical Network (FTTx)	FTTx: Engineering, labour, materials (no pole remediation)	$197,590,291.07
Pole Remediation	To be determined after engineering	
	Total Capital	$197,745,291.07
	Monthly Operating	
Pole Attachment Costs	Cost of $44.50 per pole per year for attachment	$78,944.85
Management	Management Team	$20,000.00
Field Technician	Field operations, installations, repairs	$20,000.00
Fibre/Plant Maintenance	Budget for maintenance and repairs	$56,510.08
	Monthly Operating	$175,454.93

Figure 23 – Passive Fibre Network

5. Recommendations

In our view, the level of investment required coupled with the District's unique topography, make a fibre-only solution impractical.

The cost estimates developed by both Blue Sky Net and our own independent analysis produced similarly aligned costs and clearly show that Muskoka does not lend itself to universal deployment of fibre. It is simply too expensive and not economically viable given the topography, the small, widespread population, and the relatively low average income level of the population. This is true regardless of the availability of government grants to subsidize the build.

Given the topography of Muskoka, with its many lakes, extensive granite, and low density, in our opinion no single technology can be deployed to eliminate coverage gaps or to meet the Universal Standard objective of 50/10Mbps

We believe Muskoka requires a hybrid approach that includes multiple service providers and several different technologies including fibre, wireless, and LEO satellite.

In its recent report to the District, Blue Sky Net estimated the cost of installing fibre throughout Muskoka at almost $300M. "In looking at the Road Network File used for the coverage study above, there are a total of 4,297.45 kms of road in the District Municipality of Muskoka. In using an $80,000/km cost estimate, it would cost $343,795,845.04 to install fibre on every road in the District. The Road Network File also indicated that there was approx. 690.8 kms of road that has broadband capacity of 50/10 Mbps, so perhaps these roads can be subtracted from the overall project cost making it approximately a $288,528,869.52 million dollar project."

Our evaluation, looking only at the 2,712 km of roads and 29,176 households identified by ISED and the CRTC as underserved, as projected from the three defined model cases, yielded an investment requirement more than $240M to deliver the 50/10Mbps service objective to those households.

By either account, the level of investment to deploy fibre across the District is at least three times the maximum amount allocated to the District by Infrastructure Ontario for fibre and wireless ($86.8M).

Given the number of active service providers and the level of public and private investment in the District, we recommend against the development of a new municipal public broadband utility.

For the most part, the recommendations included in this Report are consistent with the comments of providers in response to the Spring 2021 RFI as to how the District and Area Municipalities could better directly support expansion of broadband infrastructure and service. Providers summarized steps that could be taken to encourage them to expand in Muskoka.

- "Expediting and streamlining approval processes for build and expansion plans";
- Facilitate "the use of District physical assets and infrastructure (buildings, towers, etc)"; and
- "Coordination with municipal operational teams to utilize best practices and identify opportunities to expand service infrastructure as part of municipal improvement projects. (laying fibre/conduits during road reconstruction)".

These are recurring concerns we encounter in most, if not all, rural communities.

In our opinion the District, Area Municipalities, and First Nations should focus on three distinct options:

1. Consult with providers and encourage the private sector to invest in infrastructure and eliminate coverage gaps; or
2. Create a form of Public Private Partnership to "take the lead" to eliminate coverage gaps; or
3. Both encourage providers to eliminate gaps and create a form of PPP to "take the lead" to eliminate any coverage gaps that remain.

In our recommendations we set out a short, medium, and long-term action plan designed to encourage existing players to invest in infrastructure upgrades while concurrently investigating the possibility of "taking the lead" to eliminate broadband gaps in the District of Muskoka.

5.1.1 Broadband Coordinator

Our research revealed that a single point of contact for providers serving, or looking to serve, the District is essential to facilitate, encourage and expedite broadband expansion.

We recommend the District create a full-time Broadband Coordinator position to serve as a single point of contact for providers proposing to build or expand in Muskoka. The key is to have a single point of contact for providers, businesses, and residents.

The person filling this role would be responsible for:

- Keeping in regular contact with providers to understand their needs, provide support, promote successes, and encourage expansion;
- Dealing with residents looking for information on broadband and broadband builds;
- Coordinating broadband build proposals with other projects and build activities;
- Assisting businesses in the District to ensure their needs are considered and met; and
- Dealing with the different departments in each municipality to keep them apprised of broadband projects being proposed and coordinating activities; and
- Coordinating communications and Letters of Support for broadband initiatives.

The Broadband Coordinator would be Muskoka's broadband cheerleader giving encouragement to providers and ensuring their concerns reach appropriate decision-makers.

Through the Broadband Coordinator the District and Area Municipalities can become proactive in "taking the lead" for broadband expansion.

5.2 Recommended Technologies

The CRTC has established the Universal Service Objective (USO) for broadband networks as 50/10 Mbps. Many broadband access technologies are capable of delivering these speeds but not all are suitable for deployment in Muskoka District. Other older legacy technologies cannot reliably deliver these speeds. Additional information on each technology can be found in Appendix A – Technology Primer.

We recommend and rank the following technologies to deliver broadband services in the District:

- FTTP/FTTH (Fibre-to-the-Premises/Fibre-to-the-Home)
    - Fibre directly to the subscriber offers the greatest level of future proofing and the greatest speeds. These technologies are cable of delivering 1 to 10 Gbps of downstream speeds today but the base technology will be upgradeable to offer much higher speeds in the near future. This is also the preferred technology for most government funding.
- HFC (Hybrid Fibre Coax)
    - Hybrid Fibre Coax uses fibre optics to deliver signals close to the subscriber with the "last mile" delivery over coaxial cable. This is the core technology for traditional Cable TV providers. It is capable today of subscriber packages of up to 1 Gbps/50 Mbps depending on the age and condition of the coaxial plant.
- Fixed Wireless/Fibre Wireless
    - Fixed wireless technology uses wireless as the "last mile" and can deliver speeds today of over 100 Mbps downstream and is capable of meeting the CRTC's USO. Fixed wireless is already deployed throughout Muskoka but upgrades will be required to meet the USO.
- Low Earth Orbit Satellite (LEO)
    - Low earth orbit satellite service is a newer technology that may be a viable option for the most remote areas. While LEO can achieve the USO today there are scaling concerns for the future. As subscriber counts increase the number of satellites will also need to increase to continue to meet the subscriber demand.

The following access network technologies are not recommended:

- Digital Subscriber Line (DSL)
    - Digital subscriber line includes many sub technologies and specifications including G.fast, ADSL, VDSL2, etc. All of these technologies use copper as the "last mile". The length of the copper loop will determine the maximum capability with longer copper loops resulting in lower overall speeds. The

topography and distances within the District are generally beyond the capability of the technology.

- WiFi
  - WiFi is not intended as a "last mile" delivery technology. There are limitations with respect to distance and interference that prevents the solution from being viable for the District.

5.3 Recommended Municipal Policies

Consistent development policies and clear direction are vitally important if the District, Area Municipalities, and First Nations want to encourage service providers to invest and develop in Muskoka.

5.3.1 Consistent Policies

We recommend the District and Area Municipalities that make-up the District should adopt consistent, aligned policies at the District and municipal levels. The adoption of consistent, aligned policies at the District and municipal levels will encourage providers to expand.

5.3.2 Municipal Access Agreement (MAA)

We recommend Muskoka and the municipalities should adopt a standard MAA which should incorporate what could be termed "carrier friendly" provisions as well as protections for the District and municipalities with a view towards simplifying mandatory requirements and contributing towards a more reasonable share of capital risk. The most preferred approach would be one MAA for the entire District but at the very least if one is required for each Area Municipality, they should be the same.

We recommend that the Muskoka-MAA should be consistent with the CRTC-approved model MAA[13] and the recommendations of the Federation of Canadian Municipalities[14].

5.3.3 Expedite Approvals

We recommend that Muskoka should draft uniform guidelines or criteria which, if met and consistent with the standard MAA, would allow for the expedited processing of a build proposal. These would clarify or identify circumstances that would allow exceptions to standard processing procedures.

5.3.4 Dig Once Policies

We recommend against Muskoka adopting either a proactive conduit placement policy and/or a Dig Once policy. In our experience Dig Once policies add costs and delay construction.

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[13] https://crtc.gc.ca/public/cisc/m-docs/MAA1311eng.docx
[14] https://data.fcm.ca/documents/resources/guide/handbook-telecommunications-row.pdf

5.3.5 Tower Policies

We recommend that the District and Area Municipalities should investigate the possibility of imposing open access requirements on tower owners to ensure the optimization of tower sharing and reduce the need for new towers.

5.3.6 Wireless Upgrades

There are hundreds of towers of varying heights installed across Muskoka to deliver and receive wireless broadband. With so many towers already in place, we modelled the potential coverage that could be achieved if the equipment currently on the existing towers were upgraded to more efficient and advanced technology and the towers were supplemented with neighbourhood hubs.

Our modelling shows the potential improvement in broadband coverage is significant and that the improvement in wireless coverage as a result of technology upgrades would prove much less expensive than replacement.

Tower hardware upgrades are already being considered or implemented by some providers. For example, Lakeland Networks and Centre for Excellence in Next Generation Networks ("CENGN") recently announced an innovative pilot project using new tower technology in the Lake of Bays area to improve coverage and speeds.

We recommend the District and Area Municipalities consult with current providers to investigate the possibility of upgrades to towers and/or the technology installed on existing towers to reduce the need to build additional towers.

5.3.7 Promotion

The Broadband Coordinator should be tasked with ensuring the efforts and investments of providers are recognized in local media and through local events. Celebration of community investments is key to public awareness, citizen sentiment, and investment attraction.

We recommend promotion of companies that invest in Muskoka in the form of ribbon cutting, Mayor's welcome, or local media availabilities to promote each step of progress the ISPs make as they complete sections of the network, add to their facilities, or launch new services. Muskoka has an opportunity to be a cheerleader for private sector efforts and in doing so encourage additional investment.

5.3.8 In-ground Fibre Installations

New technologies have emerged for fibre installation such as micro-trenching whereby a thin ribbon of fibre is placed in a shallow saw cut or plowing fibre into the road shoulder. In micro-trenching, a groove between 70-300mm deep is sawn into the pavement and special cables or ducts are placed in the groove. The groove is refilled with special non-contracting filing agents

making for a simple, neat installation. In plowing, the fibre cable is put directly in the ground by specialized machinery. It is faster and more cost-effective than trenching or directional boring.

Both options allow for less streetscape disruption and lower costs to service providers. Most municipalities do not permit these technologies because micro-trenching may compromise the long-term maintenance of the pavement and plowing may interfere with road maintenance and future road widening projects, but they should be considerations for specific applications and hard to service areas.

The techniques for deployment of digital infrastructure will continue to evolve and Muskoka will always need to consider new alternatives as such advancements will lead to lower disruption of residents and public space, lower cost to deploy, and restore.

Moreover, service providers resoundingly indicated that without lower cost installation methods, they simply would not be able to make the business case to significantly expand broadband in Muskoka. Specifically, they indicated that the pole remediation costs are insurmountable for aerial installations and the challenges of drilling fibre at the back of the ditch from both cost and geography perspective was uneconomical. Plowing in the shoulder of the road presents risk to future road expansion and/or fibre damage, but the fibre is easily repaired and cost saving far outweigh the risks.

We recommend allowing fibre to be installed in the road shoulder using micro-trenching or plowing. This would greatly reduce the cost to build on the most rural roads and should be permitted to encourage further fibre deployment and infrastructure upgrades.

5.3.9 Mapping Data

One of the surprisingly difficult challenges in preparing our Report was the lack of comprehensive and current mapping to indicate the location of towers and fibre through Muskoka. We recommend that the District and Area Municipalities should require tower owners to advise the District of the height and GPS coordinates for any existing towers and be required to provide updated mapping within 30 days of the erection of any towers built in the future. We would further recommend a similar policy for the location of existing fibre or future fibre installations.

5.4 “Taking the Lead”

We recommend against creating a Municipal Public Utility which would compete with the existing providers. Given the number of providers already operating in Muskoka, and the investments they have already made in the District, we can see no economic benefit to establishing another competitor. Further, building its own new infrastructure would be very expensive for the District and Area Municipalities. We estimate costs more than $240 million.

That said, a variation on the PPP model would put the District and Area Municipalities in a position to “take the lead” to eliminate coverage gaps.

In our view "taking the lead" will provide an efficient approach to fill the remaining gaps and guarantee consistent service throughout the District. Knowing the District and Area Municipalities have entered into a PPP to invest in broadband infrastructure may encourage providers to increase and accelerate their builds in the areas they serve to retain their market share.

5.4.1 Private Public Partnership Option

Lakeland Energy (Lakeland) is a private company owned by the Municipalities of Bracebridge, Huntsville, Parry Sound, Burk's Falls, Sundridge, and Magnetawan. Lakeland Energy in turn owns Lakeland Networks, an ISP with both a fibre network and an extensive wireless network.

Lakeland Networks has fibre in communities along the Highway 11 corridor from Sundridge to Gravenhurst, provides service to Wasausksing First Nation and service to Parry Sound.

Lakeland Networks has wireless infrastructure throughout Parry Sound–Muskoka delivering broadband using over 120 towers. As mentioned previously, Lakeland Networks and CENGN recently announced a pilot wireless upgrade project in the Lake of Bays area to improve coverage and speeds.

Lakeland is locally owned, creates local jobs and, while many national and local providers operate in the District, Lakeland Networks is the dominant provider across Muskoka.

Given its extensive infrastructure, client base and existing municipal investments, Lakeland Networks is an obvious (but not the only) candidate, for a PPP partnership.

We recommend the District consult with Lakeland Networks as well as with other providers to determine interest in developing a form of PPP.

5.4.2 Funding – Wait and See

Infrastructure Ontario has allocated up to almost $80 million to subsidize fibre builds and almost $8 million for wireless builds in sections of Muskoka.

Unfortunately, based on our experience, the models and cost estimates developed for this Report and the estimates of Blue Sky Net, we do not believe the allocation of $88 million is nearly sufficient to cover the costs of building the fibre and wireless infrastructure required to service the areas contemplated by Infrastructure Ontario. We estimate the costs of fibre alone to be more than $240m or three times the maximum Infrastructure Ontario grant allocation. Recent announcements by Infrastructure Ontario seem to open the possibility for partnerships and hybrid technology solutions. But details of this change have yet to be announced.

We recommend the District, Area Municipalities, and First Nations pay close attention to the process and likely await the outcome of Infrastructure Ontario's reverse auction, review the proposals that are approved by Infrastructure Ontario and meet with the successful

proponent(s) to determine how these actions influence the District's decisions on how to proceed.

5.4.3 Broadband Subsidies

Funding of municipal broadband projects can be challenging.

The Town of Caledon in 2016 introduced a Municipal Broadband Levy of roughly $11 per household per year to support development of broadband initiatives. In this model, all households, regardless of current connectivity, contribute to the overall strategy in the interests of economic development of the entire region.

According to the Town of Caledon, the levy was expected to generate $300,000 per year and $1.2 to $1.5 million over four and five years. The levy began with the 2016 final property tax bills and will continue until the Caledon fibre build, being managed by SWIFT, is complete.

https://www.caledon.ca/en/town-services/internet-levy.aspx?hdncontent=#Background

https://www.caledon.ca/en/town-services/internet-levy.aspx?hdncontent=

We recommend that District and Area Municipalities consider introducing a Municipal Broadband Levy to help offset the costs associated with expanding broadband throughout the District.

Revenues generated by a Broadband Levy could be used to recover the costs of creating the position of Broadband Coordinator or to provide subsidies to residents or providers.

5.5 Short, Medium & Long-Term Action Plan

The District and Area Municipalities should move immediately to implement the Short, Medium and Long-Term Action Plan of organizational recommendations included in this Report.

Recommendation	Timeframe
Agree to Collaborate	Short-term
Implement a Broadband	Short-term
Establish Consistent Policies for Tower and Fibre Installation	Short-term
Complete a Standardized and Unified Municipal Access Agreement	Short-term
Create a Process for Express Approval in High Priority Areas	Short-term
Consider and Approve Lower-Cost Broadband Installation Policies	Medium-term
Explore Possible Public Private Partnerships	Medium-term
Create Telecom Infrastructure Mapping Requirements	Long-term
Establish Open Access Tower Requirements	Long-term
Create a Broadband Levy and Associated Subsidy Programs	Long-term
Consider Additional Financial Supports to Priority Areas that Remain Unfunded	Long-term

Figure 24 – Action Plan

5.5.1 Short-term Actions

Broadband Coordinator
The District should create a full-time Broadband Coordinator position to both serve as a single point of contact for providers proposing to build or expand in Muskoka and oversee deployment and policy initiatives. This role should not be attached to the duties of existing staff members and for a District the size and acute lack of broadband of Muskoka making broadband a priority requires a full-time dedicated resource.

Agree to Collaborate
The District and Area Municipalities should agree to collaborate and work together to develop consistent, uniform policies throughout Muskoka. The District should convene a meeting of the CAOs of the Area Municipalities and Chiefs of the First Nations to coordinate and align on a) common policies, b) broad communication, and c) collaborative efforts on the file. Then the Broadband Coordinator should follow up to have the participants assign the appropriate resource(s) in their jurisdiction and build the policy alignment in a timely fashion.

Consistent Policies
The District and Area Municipalities should adopt consistent, aligned policies across the District and all municipalities. The adoption of consistent policies at the District and municipal levels will encourage providers to expand.

Municipal Access Agreement
The District and Area Municipalities should adopt a standard and unified MAA which should incorporate what could be termed “carrier friendly” provisions consistent with the CRTC-approved model MAA and the recommendations of the Federation of Canadian Municipalities

Expedited Approval Process
The District and Area Municipalities should draft uniform guidelines or criteria which, if met and are consistent with the standard MAA, would allow for the expedited processing of a build proposal.

5.5.2 Medium-term Actions

Lower-Cost Installation Technology Approvals
We recommend adoption of a policy that allow both micro-trenching and plowing fibre in road shoulders for use in specific applications and hard to service areas. Both options allow for less streetscape disruption and lower costs to service providers thereby promoting further broadband deployment.

Explore Structure of Possible PPP
Our Report details the cost of building a FTTH or fixed wireless network to eliminate coverage gaps and deliver 50/10Mbps service to the 75% of Muskoka households that ISED and the CRTC have identified as being unserved or underserved.

Our Report also details the cost of establishing a Municipal Public Utility to serve District residents and businesses. The costs and risks are high. We estimate the costs to be more than $240 million dollars.

The risks of going alone are compounded by the number of providers that already operate in Muskoka. Given the investments they have made in infrastructure and their plans to invest further to expand coverage, we anticipate significant opposition to the District deciding to go into competition with the private sector.

We recommend the District, through the Broadband Coordinator or whatever single-point-of-contact is created (or perhaps the Broadband Sub-committee), consult with existing providers to determine their interest in working together and the possible structure of a PPP. Any of the larger providers (Bell, Rogers, Cogeco Connexion, and Lakeland) would be viable partners.

5.5.3 Long-term Actions

Infrastructure Mapping

Currently the District and Area Municipalities do not track the locations of fibre builds or tower installations. Creating and maintaining a comprehensive map of broadband infrastructure, including fibre runs and tower installations, would allow the District to better manage future growth and build applications.

We recommend the District and Area Municipalities should require providers to supply them with mapping and GPS locations of their existing towers and fibre. We further recommend providers should be required to provide updates to the District and municipalities within 30 days of commencing any future builds.

These updates should be added to the District's Geohub site as public information available to all residents and service providers. When coupled with an open access policy for tower infrastructure, this mapping will provide insight to service providers looking for locations to place equipment.

Tower Open Access Requirements

Wherever feasible with sound engineering practices, we recommend that the District enforce or at least encourage open access requirements with every tower build. Ensuring that multiple providers have access to tower infrastructure will minimize the number of towers required and promote more broad coverage and consumer choice.

Broadband Levy & Subsidies

We recommend that District and Area Municipalities consider introducing a levy similar to Caledon's Broadband Levy.

https://www.caledon.ca/en/town-services/internet-levy.aspx?hdncontent=#Background

https://www.caledon.ca/en/town-services/internet-levy.aspx?hdncontent=

Revenues generated by a Broadband Levy could be used to recover the costs of creating the position of Broadband Coordinator. If revenues were sufficient, they could also be used to provide subsidies to residents (for install costs or receive towers) or providers (to offset network build costs).

Broadband Levy revenues could be used to provide some level of financial support to residents that need help to subsidize the cost of installing equipment like towers to receive wireless service.

Levy revenues could also be used to provide financial support to providers that invest in broadband infrastructure upgrades.

We also recommend that, if a Broadband Levy is introduced, that it should apply to both permanent and seasonal residents.

5.5.4 Beyond

Additional Municipal Funding Supports

Where possible and potentially afforded by the Broadband Levy, the District and Area Municipalities should consider additional municipal funding supports. Specifically demonstrating a local interest in investing in broadband to help de-risk existing service providers will attract the attention of service providers and will improve the odds for approval of applications by providers to government funding programs that support and promote the stacking other forms of funding (eg UBF).

5.6 Summary

The District of Muskoka has a wide range of engaged large and small service providers who are both interested and making investments in expanded service coverage. The business case is not good given the unique challenges in the District, but it isn't practical for the District to enter into direct competition given the vibrant market. Government funding options are offsetting some of the costs to encourage further deployment by service providers, but the District is in competition with other rural markets and a simplified, unified approach with clear and consistent communications across the entire District, Area Municipalities, and First Nations will better foster the environment for additional investment. Where gaps remain, a public private partnership is a viable option but the District can take immediate steps to actively engage existing service providers and implement policies that simplify future deployments.

6. Appendix A – Technology Primer

6.1 Digital Subscriber Line (DSL)

Copper twisted pair and DSL are the common technology used by legacy telephone service providers like Bell. There are multiple ITU specifications for DSL, these include ADSL, VDSL, and G.Fast. The maximum Internet speeds that can be achieved with copper twisted pair and DSL decreases as the distance between the Digital Subscriber Line Access Multiplexer (DSLAM) and the DSL modem increases. The relationship between loop length and performance (speed) is a major limiting factor for DSL deployments, and it becomes a bigger challenge in rural areas where it is not practical to move the DSLAM close enough to the subscribers to achieve competitive speeds.

6.2 Hybrid-Fibre Coaxial (HFC Cable)

Hybrid Fibre Coax (HFC) networks are commonly deployed by legacy cable companies. The capabilities of these networks will depend on the bandwidth (number of RF channels) and how the channels are allocated (how much is given to each service). Unlike DSL, distance is not a significant consideration, full capabilities can be achieved at distances of up to 160 km. Typical node sizes are in the range or 100 to 400 homes passed, the service and bandwidth is shared by all the subscribers in the serving area or node. Cable companies drive node sizes smaller to reduce the amount of bandwidth sharing (reduce oversubscription) in the access network to improve speeds and customer experience. The latest deployed generation of technology allows for reliable speeds exceeding 1 Gbps downstream and 60 Mbps upstream and beyond. A cable operator with a modern HFC plant could in theory create an 8 to 10 Gbps pipe toward the subscribers (downstream) and a 300 Mbps+ upstream pipe. In common practice, the downstream pip is between 1.5 and 5 Gbps and the upstream pipe is limited to under 200 Mbps as the system must also support legacy video and other services.

Even with the current technologies, upstream speeds are a slight disadvantage for HFC cable as it cannot meet the capabilities of FTTP technologies. HFC upstream speeds will be limited in the long term to 100 to 200 Mbps compared to the option to upgrade to a Gbps or better using FTTH.

6.3 Fibre-to-the-Premises/Fibre-to-the-Home

Fibre-to-the-Premises (FTTP) is quickly becoming the main wired access network technology. Most operators are deploying FTTP in green field (new) deployments. Service providers are upgrading brown field plant in areas with very old copper plant or in areas where the competition is expected to be significant. For example, Bell is currently overbuilding its copper with fibre for customers in Huntsville. (Note: FTTP and FTTH refer to the same technology and are interchangeable)

Fibre-to-the-Premises (FTTP) has many advantages over legacy copper and HFC network technologies. There are four main FTTP technologies being deployed today. These are Active Ethernet, Gigabit Passive Optical Network ("GPON"), Ethernet Passive Optical Network ("EPON"), and XGS Passive Optical Network ("XGS-PON"). Active Ethernet provides a direct fibre link from the central location to the customer.

GPON, EPON, and XGS-PON are shared fibre technologies where one fibre is used to deliver the service to an area, this fibre is then split to feed the pocket of subscribers. Although there is a distance limitation (about 20 to 30 km depending on the deployment and technology chosen) this is significantly higher than DSL. The distance limitation can also be stretched further by installing a remote Optical Line Terminal (OLT) closer to the subscribers.

For GPON, EPON, and XGS-PON one fibre leaves the central location, and it is split in the field between 16 and 64 times (32 being the most common deployment) to feed individual subscribers. Depending on the technology the group of homes shares either 1, 2.5, or 10 Gbps of capacity on the FTTH network. Unlike other technologies, PON be upgraded to provide up to 10 Gbps service.

6.4 Wireless

Although wireless technologies have progressed to provide some very high speeds, they cannot compete with the current capabilities of HFC Cable and FTTP. Wireless technologies do have some advantages as there is no need to provide a wire or fibre to each customer. Further, our modelling and research confirms that wireless may be the most practicable technological solution in more remote, lightly populated areas of Muskoka.

6.4.1 Fixed Wireless Point-to-Point/Multipoint RF and Microwave

These technologies "broadcast" wireless signals from a tower located at a central location via either RF or microwave to a receiver at the customer's "receiver" location (usually located on a rooftop or on a small tower). The RF or microwave spectrum can be licensed or unlicensed. These technologies have been deployed by many operators to reach rural customer that could not be practically reached by landlines.

Point to multipoint implementations use a "broadcast" tower location within the service area (typically at the central location) with multiple multipoint sectors (each feeding in a different direction). The bandwidth in each sector will be shared between all the subscribers in that sector. Due to the shared bandwidth, most of these systems are usually limited to 10 Mbps to 25 Mbps service packages but service providers are beginning to launch technology that can deliver the universal basic service of 50 Mbps by 10 Mbps.

Fixed wireless speeds are influenced by distance from a "broadcast" tower. The technology can typically reach many kilometres, depending on design, but longer distances from the tower yield lower speeds.

Systems with lower frequencies will typically have a longer reach. These systems operate in either licensed or unlicensed spectrum in the range of 700 MHz to 5 GHz.

These systems will require Line of Site (LoS) between the "broadcast" tower and each subscriber's receiver. The implementation often requires small towers at the subscriber home. A site survey is usually required for each subscriber as part of the sales cycle to verify LoS and to also check for terrestrial interference. Rogue carriers are often found operating using unlicensed spectrum in licensed spectrum areas, but unlicensed spectrum can be crowded by multiple uncoordinated providers and deliver unreliable, unacceptable download/upload speeds.

LTE/4G

Long Term Evolution/Fourth Generation (LTE/4G) wireless technology is currently being used in some areas of Muskoka by several large service providers including Lakeland, Rogers, Bell, and XplorNet. These systems are also point-to-multipoint technologies and can operate in licensed and unlicensed spectrum. Depending on the operating frequency a reach of 5 km is possible with optimum performance. These distances can be stretched to 30 km with some performance degradation.

Speeds of 100Mbps are possible with smaller cell sizes but as with any point-to-multipoint system the bandwidth is shared, and speeds may be significantly lower due to congestion. Longer distances can typically provide a 10 Mbps service.

5G

Fifth Generation or 5G is the next generation of advanced wireless systems. Globally 5G deployments have started to ramp up. The deployment of 5G is broken down into two frequency ranges. The first range (Frequency Range 1/FR1) operates below 6 GHz. The second frequency range (Frequency Range 2/FR2) operates in the mm wave band above 20 GHz. In comparison, 4G operates in the 700 MHz to 2.6 GHz range depending on the operator. In the FR1 bands 5G can provide internet speeds that are slightly better than what is possible with the older 4G technology (10 to 100 Mbps depending on distance and congestion levels), in FR2 range significantly higher speeds are theoretically possible, conceivably up to 1 Gbps.

The new 5G deployments will require smaller cell sizes than 4G required. With the older 4G technology macrocells could be as large as 30 km but the larger cells came at the expense of performance, optimal cell sizes of 5 km or less (picocells) maximized the performance. The spectrum used by 5G is operating at a higher frequency requiring much smaller cell sizes, FR1 is expected to be in the 2 km range, FR2 in the sub-100m range. In general, for all wireless technology, as the frequency increases the distance decreases. There are also expected to be significant real-world deployment challenges in the FR2 spectrum as these radio waves will also be absorbed and interfered with by trees and building construction (use of metal or brick). The smaller cell sizes will provide a capacity advantage for 5G as smaller cell sizes have fewer customers competing for bandwidth (less congestion).

It is anticipated the required range will be 500-1000m meaning FWA 5G radios will need to be densely installed and require fibre backhaul. There is debate in the industry in regard to the economics of FWA 5G vs FTTP in rural markets.

6.5 Backbone Internet

Lakeland, Bell, Cogeco, Rogers, and Zayo have backbone fibre running through and in some cases terminating in the District. These services are not typically available to residential subscribers but often are delivered for commercial application or as connections to other ISPs. These backbone connections can be leveraged for connections to towers for expansion of wireless services or for the construction of a new ISP.

6.6 Low Earth Orbit Satellite

Traditional communications satellites, known as Geostationary Earth Orbit satellites (GEOs), are large (often the size of a school bus), on average take 5 years to design and build, are expensive to build averaging $500m and expensive to launch, again averaging $500m. GEO satellites typically orbit the earth at an average height of 36,000km. As the GEO satellite is in a stationary orbit above the equator it does not move in comparison the ground station.

Low Earth Orbit satellites (LEOs) are quite different from GEOs. LEOs are small (typically less than 100Kg), can be designed, built, and launched in months as opposed to years, and are relatively inexpensive to build and launch, typically less than $1m in total. LEOs orbit relatively close to Earth's surface at altitudes ranging from as low as 160Km above the earth to 1000Km above Earth.

The fact that LEO satellites orbit quite close to Earth means they are well suited for high-speed data transmission. It takes far less time to transmit and receive data from a LEO satellite orbiting at less than 1,000Km than from a GEO satellite orbiting at 36,000Km. In other words, LEOs are well suited for broadband transmission while GEOs are not.

LEO satellites typically work as part of a combination of multiple satellites, known as a constellation, to allow them to provide unimpeded coverage to the ground. The low orbit means the satellites are not stationary, they are in constant motion. The earthbound receive stations must switch between satellites as they move in and out of range. A constellation of LEO satellites essentially creates a 'net' around the earth, and this allows them to cover large areas by working together with one or multiple satellites within range to ensure full coverage. Currently there are several competitors using LEO satellites. Starlink recently launched beta services and has accepted beta-subscribers in Muskoka.

As the demand per subscriber and/or the number of subscribers increases the number of satellites must also increase to maintain the same oversubscription ratio. This is not unlike HFC or wireless networks where the number of nodes or serving groups increase to meet increased

subscriber demand. This is expected to be a challenge with LEO deployments if large scale adoption occurs.

7. Appendix B – RFI Summary

7.1 Background

To assist in the development of a Regional Broadband Strategy, in Spring 2021 the Muskoka Broadband Subcommittee issued an RFI to obtain information from ISP's to identify networks coverages, infrastructure, and current/future plans. The RFI was intended to seek feedback from ISP's as to how the District could assist in supporting the expansion of private internet broadband service delivery for the region.

7.2 Submission Overviews

Deadline for submissions was April 23, 2021. Six submissions from ISP's Submissions included service options, pricing information, service area and infrastructure mapping and other relevant information, including current and proposed projects and funding applications of various ISPs.

The RFI Summary summarized the responses to the RFI as follows:

Does your organization currently provide broadband services within Muskoka?

- ISP's are offering a variety of service options throughout Muskoka including;
- Fibre-to-the-Premises (FTTP), Wire Home Internet (WHI), Fibre to the Node (FTTN), Digital Subscriber Line (DSL)
- Broadband services (Hybrid Fibre-Coaxial (HFC) capable of download speeds of up to 180mbps) to communities within the District (Gravenhurst, Bracebridge, Huntsville), approximately 21,000 homes and businesses.
- Broadband wireless internet, DSL and Cable internet throughout areas in Muskoka
- P2P microwave links, large satellite (VSAT) community aggregation connections, direct to home satellite (VSAT) connections and community distribution models.
- Fibre to the Premise (FTTP), Wire Home Internet (WHI)
- Transport fibre that transects the District of Muskoka (roughly from Washago into Bala, north connecting Parry Sound and Huntsville and beyond). Additionally, owns, operates and maintains a mobility network that's comprised of 48 towers throughout the District primarily located along major roads and larger lakes. Fixed Wireless and Fibre-to-the-Home.

What obstacles or challenges do you currently see that may hinder your expansion plans in Muskoka?

- Financial viability (economic conditions in the Muskoka including supply and demand)
- Project feasibility as it relates to current network infrastructure.
- Human Resources and Contractor availability
- Equipment and Material availability and costs
- Geographic landscape and terrain

- Project timelines
- Funding available

How could the District (and other municipalities) directly support expansion of broadband infrastructure and service?

- Expediting and streamlining approval processes for build and expansion plans.
- The use of District physical assets and infrastructure (buildings, towers, etc.)
- Access to hydro or having hydro provided; solar power is problematic.
- Support of current and future projects and funding applications
- Coordination with municipal operational teams to utilize best practices and identify opportunities to expand service infrastructure as part of municipal improvement projects. (laying fibre/conduits during road reconstruction)

Seasonality Impacts

- Seasonality does not pose significant impacts for most ISP's. Some do currently offer "seasonal rates and packages" to provide cost savings to those customers. Smaller ISP's cite that bandwidth is purchased in multi-year terms so it is difficult to plan for expansion and expensive to maintain the excess capacity required to meet the jumps in service needs of seasonal customers.

8. Appendix C – Summary of Blue Sky Net Findings

8.1 Costing considerations

Blue Sky Net consulted with many stakeholders within the telecom industry to estimate an "average" cost of building a Fibre-to-the-Premises (FTTP) network. FTTP Networks represent both the best quality and performance on internet speed and capacity to subscribers bosting a variety of IP services, however, they are extremely costly to deploy. When building the outside-plant components of a new FTTP network there are three main "options" to deploy. In many cases network deployment combines two or more of these options;

1. Aerial build on existing utility poles: The first scenario is installing the fibre cable on existing hydro poles. Assuming the poles were deemed adequate to support the new cable, the cost would come out to approximately $40,000/km. However, Utility poles are frequently inadequate as deemed by Hydro One or other pole owner standards. The cost to replace deficient poles is born solely by the new lessee, and this replacement can easily double the per-km cost. There is also an annual per pole rental cost to add to operating expenses. If the builder/operator of the new FTTH network either owns the utility poles or has a support strand attached on the poles for existing cable, these costs would remain lower than for a new entrant.
2. Aerial build on new utility poles: This method would make sense in areas where there are no existing poles, or it is difficult or expensive to enter into pole usage agreement for existing poles. Building a new pole line would require enough space to accommodate on right of ways. Although a more expensive base cost for a new build, this method is easier to budget (no unknown make-ready costs) and there is no ongoing operational expense and possibly a small revenue source if these poles are used by another user. Base cost $76,000/km
3. Buried fibre cable: This technique is commonly used in new builds. It involves either directionally drilling and installing fibre duct (conduit) or trenching and installing the duct. Armoured fibre can also be buried directly in the ground. In many areas this method has its limitations due to obstacles in ground either natural or by way of other infrastructure. Base cost $58,000/km. There are also "inside plant" costs (central office/network electronics, switches, IP equipment, racks, cabling, batteries, etc.) to be added. These costs are more dependant on subscriber capacity vs cost per km. In denser areas more cabiNet, central offices would need to be installed to meet capacity demands, driving up a higher over cost per km.

Each scenario may be used to some degree, when building a FTTH network and all three have costing variability. While considering this variability and adding inside plant costs, a comfortable estimate to deploy a new FTTH network would be about $80,000/km or $80/m.

In looking at the Road Network File used for the coverage study above, there are a total of 4,297.45 kms of road in the District Municipality of Muskoka. In using an $80,000/km cost

estimate, it would cost $343,795,845.04 to install fibre on every road in the District. The Road Network File also indicated that there was approx. 690.8 kms of road that has broadband capacity of 50/10 Mbps, so perhaps these roads can be subtracted from the overall project cost making it approximately a $288,528,869.52 million dollar project.

To break the numbers down further, the above illustrates the estimated cost to build a FTTH network separated by road segments and property parcels within each speed class of existing broadband service. Costs per road segment were worked out by multiplying the length of road segment within each speed class by $80/m (length(m)x80).

Costs per property were determined by dividing the overall cost for the FTTH network within the speed class by how many property parcels are contained within 30m of road segments (see Table 2 in the Muskoka Community Broadband Summary). Costs per non-vacant property is the same as Cost per property, only removing vacant, agricultural and unclassified properties.

Further study is needed to determine a realistic approach to identifying what technology is appropriate for different population densities within the District Municipality of Muskoka. Recognizing that running Fibre to every home is likely not realistic, then thought must be given to alternative technologies that are more economical but can deliver adequate throughput. Additional thought also must be given to if these technologies can be scaled up or replaced economically to meet future demand. It is advisable for communities to seek this information directly from Telecom Service Providers as only they can identify the true cost associated with achieving ubiquitous broadband service delivery.

9. Appendix D – Physical Network Cost Assumptions

This appendix outlines the underlying cost assumptions used in the project networks costs.

9.1 Fibre Build – Fibre Placement

9.1.1 Fibre Distribution

The cost to install fibre distribution varies widely between providers, local geographies, and installation methods. It is not uncommon to hear ranges from $30 per metre or less in ideal conditions with low-cost methods to hundreds of dollars per metre in challenging terrain or urban settings with more complex methods. In our experience, any reliable estimate must consider the full costs of installation and must be field tested. For instance, aerial fibre might be estimated at $18-20 per metre to install, plowing in the side of the road is considered a low-cost installation method that is often estimated around $30 per meter, and buried fibre in conduit could be installed in the range of $60-$90 per metre depending on conditions. Our analysis assumes a build out will include portions of aerial installation and burial installation depending on the area. Buried fibre is assumed to be installed using plowing everywhere possible and directional boring where necessary. This analysis does not consider trenching in any of the desired areas and assumes that there are no remediation costs to make the poles ready for attachments (this could be an important factor in the final engineering, design, and costing).

Engineering costs in our modeling are estimated at $2 per metre for underground and $6.50 per metre for aerial. For the analysis we used $60/m to place duct (conduit), $18/m to install aerial strand (including ancillary hardware like bolts and anchors), and $3.50/m to install fibre on either infrastructure. The model designs contemplate 72-count fibre.

Official quotes from fibre contractors would be required to confirm the estimates included in this Report should any project proceed but in our experience these estimates are conservative. Moreover, there may be additional costs to engineering and ancillary hardware installations.

9.1.2 Fibre Build - Fibre Drops

Fibre Drops are the segments of fibre cable installed between the pole or the roadway and the subscriber's home. The fibre drop can be buried directly in a trench or run through a buried duct/conduit or installed above ground aerially. The way the fibre drop is installed, and the distance between the road and house, will greatly affect costs. For example, homes on large rural lots are often located at considerable distance from the roadway and, as a result, have expensive drop costs.

For our models we assume average fibre drop lengths for each target area using 2-count fibre drop cable, a consistent total cost of $500 for drop installation, $45 for drop hardware, plus the cost of the actual drop fibre based on the average length of the drop.

9.1.3 Fibre Build – Infrastructure Maintenance

When operating the physical fibre infrastructure regular maintenance of the outside (fibre, duct, strand) and inside (batteries, connections, etc) plant is required. For budgetary purposes, we estimate annual costs of $250 per km for fibre/plant maintenance in all scenarios.

9.1.4 Fibre Build - Pole Attachments

Wireline pole attachment charges are what telephone companies and electricity distributors charge carriers to install anything on their network of poles. In the case of electrical companies, rates are governed by the Ontario Energy Board and are currently set at $44.50 per year per pole. This analysis does not factor in the pole attachment charges but assuming 16-20 poles per km would yield an additional cost of more than $800 per km per year. The rates charged in Ontario are currently under review with the government's stated objective of lowering costs and facilitating access.

9.1.5 Fibre Build - Pole Remediation

When a company proposes to install equipment on a hydro or telephone pole, the pole owner conducts an engineering study to determine what remedial work might be required for the installation. The cost of the engineering study typically ranges between $250 and $325 per pole and is borne by the company proposing to install equipment.

The costs associated with pole remediation are extremely difficult to predict. Many factors influence the potential costs. These factors range from the number of existing attachments on the pole to the age of the pole to the amount of foliage surrounding the pole. Each of these factors as well as others impact the costs associated with being able to attach to the pole at all. In extreme cases the pole must be replaced at costs between $6,000-$20,000.

Pole remediation is the norm and can be required for as much as 20% or more of poles needed to deploy the fibre depending on the specific region. It is important to recognize that the models developed for this Report do not include the cost of pole remediation. We cannot over emphasize that pole remediation represents a ***significant cost risk*** that would need to be validated during detailed engineering before making deployment decisions. To underscore the potential high costs associated with pole remediation, be aware that the cost of pole remediation often offsets the cost savings of aerial installations over underground installations.

9.2 Wireless Build - Tower Infrastructure

Depending on the approach for moving forward, reusing, or upgrading existing towers may be an option where wireless services are to be used to fill gaps. For purposes of this analysis, we assume 40m freestanding towers can be supplied and properly installed for roughly $100,000.00.

9.2.1 Tower Maintenance

Each tower can be expected to require regular annual maintenance. For simplicity we budget $1,000 per year per tower.

9.3 Fibre Build - Access Network Hardware

9.3.1 Fibre Access Network ("PON")

Providing Internet services through a Passive Optical Network ("PON") requires access network hardware. While other varieties of technology are possibilities, XGS-PON was used to develop our budget models. XGS-PON can provide up to 10 Gbps service.

In our model the XGS-PON platform consists of Optical Line Terminators (OLTs) at deployed in remote environment cabinets with backup power. For budget purposes, each OLT is designed for 256 individual GPON subscribers based on a 16-way split in the field over 16 GPON ports. Each port initially supports 2.5 Gbps in the downstream direction toward the subscriber and 1.25 Gbps in the upstream with 10G uplinks to the core network and an upgrade path to 10G.

We have developed our models using this approach because it assures that all subscribers can receive a consistent 150Mbps service with no oversubscription. It is common in the industry to oversubscribe the services based on the assumption that not everyone will use the network at the same time. It would be cheaper to build if the network were built using a 32-way or 64-way split, rather than the 16-way split we assume for our model, but the level of service to customers would not be assured under load, meaning when there is heavy use of the network, and future scalability would be limited.

Common XGS-PON vendors to be considered consist of Calix, Adtran, Nokia (Alcatel) and Huawei. Nokia and Huawei have large market shares globally while Calix and Adtran are strong in North America. Both Calix and Adtran have suitable options to meet the needs of an XGS-PON deployment in Muskoka. Both also have strong comparable systems within Ontario to use as reference accounts. Comparable Calix and Adtran GPON systems were used to build the budget model reference costs.

Our budget includes an XGS-PON configuration with a single OLT at a cost of $103,470.37 and Customer Premises Equipment at $186 per subscriber plus $100 for contract installation.

9.3.2 Wireless Build - Wireless Access Network

Providing Internet services over a wireless network, as opposed to a PON, will require access network hardware at each tower site. Specifically, each tower requires a base station and sectorized antennae along with appropriate cabling and installation. In the case of wireless, licensed spectrum would be preferred over unlicensed spectrum. Licensed spectrum is protected and thereby avoids interference from other users, unlike unlicensed spectrum.

Licensed spectrum is in great demand and extremely difficult to acquire. Obtaining licensed spectrum would require a detailed engineering study and submission of a license application to ISED. Given the lack of certainty that licensed spectrum could be acquired, for our model and budget we assume deploying unlicensed Cambium equipment with each tower having four 90-degree sectors.

10. Appendix E – Stakeholders Consulted

10.1 People/Organizations Consulted

10.1.1 Providers

- Algonquin Fibre Inc.: Ron Huinink, Vice-President of Operations
- 4Pairless: Michel Potvin, Founder
- Cogeco Connexion: Michael Hennessy, Director Sales, Network Expansion
- Cottage Country Internet ("CCi"): Mike Stephens, President
- Galaxy: Lindsay Hodgkinson, VP Customer Service
- Lakeland Networks: David Keith, Director Business Development & CEO Chris LItschko
- Muskoka WiFi: William Holmes, Founder
- Roger Communications: Marnie Miron, Director, Service Expansion
- Xplornet: Bill MacDonald, VP Business Development

10.1.2 Officials

- Muskoka Broadband Sub-Committee
- Bracebridge EDO: Randy Mattice
- Georgian Bay EDO: Jennifer Schnier
- Gravenhurst EDO: Jeff Loney
- Gravenhurst Infrastructure Services Andrew Stacey
- Huntsville EDO: Scott Ovell
- Lake of Bays EDO: Leanne Fetterley
- Lake of Bays Planning:Melissa Markham
- Muskoka Lakes EDO: Corey Moore
- Muskoka Lakes Planning: David Pink, Ken Becking
- District Planning: Summer Valentine & Elizabeth Reimer
- District Tourism: James Murphy (Explorer's Edge) & Janet O'Connell (Muskoka)
- District Maintenance & Ops: Ryan Elbe
- Moose Deer Point First Nation: Colette Isaac

10.1.3 Resources

- Blue Sky Net: Jeff Buell, Project Manager
- Blue Sky Net: Susan Church, Executive Director
- Independent: Neil Smellie
- Parry Sound Muskoka Network: Stuart Morley, Executive Director

11. Appendix F – Broadband Coordinator Job Description

The Broadband Coordinator is responsible for supporting the ongoing development of the District by coordinating with internal and external stakeholders to promote and expand the availability of reliable telecommunications service throughout the District. Specifically, the Broadband Coordinator will:

- Gather input from and provide communications to residents, business, the local Broadband Committee, and local service providers in support of an ongoing and evolving Broadband Strategy.
- Facilitate execution of broadband expansion planning projects, including acting as the primary point of contact for collocation applications and processes, right-of-way agreements and utility feasibility reviews, review of suitability of proposed network routes, and assisting local service providers and new entrants with navigating District and Area Municipalities processes and approvals.
- Track and respond to broadband-related inquiries from service providers, investors, local businesses, industry, community groups and the general public; address all concerns from residents and business owners related to broadband availability.
- Pursue and coordinate local, provincial, and federal funding opportunities that may further support the development of broadband in the Districts's underserved areas.
- Work with various departments to ensure timely and consistent feedback or approvals throughout the implementation process.
- Conduct independent research and make recommendations on opportunities that may advance the achievement of the broadband priorities, including policy recommendations.
- Prepare and deliver regular updates to senior management, Committees, and Council.

The successful applicant will hold the following qualifications:

- Successful completion of university or college program in information systems, technology, or business management.
- Previous experience with a telecommunications company in a business development capacity or a system expansion planning or infrastructure project management capacity
- Knowledge of broadband network expansion projects, real estate development, communications and business development, and urban/rural utility and infrastructure construction projects.
- Proven proficiency with various computer software applications, including Microsoft Office (Word, Excel, PowerPoint), web technologies, and desktop publishing
- Project management skills
- Excellent interpersonal, verbal and written communication and customer service skills.

The Broadband Coordinator must maintain a valid Ontario drivers license and have access to a vehicle for business purposes.

Glossary

ADSL2: Asymmetrical Digital Subscriber Line Version 2.

ARIN: American Registry for Internet Numbers, is the Regional Internet Registry (RIR) for North America and some islands in the Caribbean.

ASN: An autonomous system number is a unique number that's available globally to identify a network connected to the Internet.

Billing System: A business support system responsible for rendering invoices, tracking services and hardware, and managing payments.

Broadband: An always-on, high-speed connection to the Internet through the facilities of an ISP that provide[s] download throughput of greater than 1 Mbps (2009). In this Report, broadband is defined as 50 Mbps download, 10 Mbps upload, as per the CRTC's universal service objective (2016).

Cable: Refers to Internet Service Providers or other services provided via coaxial cable.

CIDR: Classless Inter-Domain Routing, is a way of interpreting IP addresses which allow increased flexibility when dividing ranges of IP addresses into separate networks promoting more efficient use of IP addresses.

CIRA: The he Canadian Internet Registration Authority is a member-based not-for-profit organization, best known for managing the .CA internet domain on behalf of all Canadians, developing and implementing policies that support Canada's internet community.

Core Network Hardware: Includes the switching and routing capacity to connect the access network to the Internet.

CPE: Customer premises devices are the equipment placed in a household to deliver services.

CRTC: The Canadian Radio-television and Telecommunications Commission is an independent public authority in charge of regulating and supervising Canadian broadcasting and telecommunications.

DSL Digital Subscriber Line: Copper, phone-line-based internet services.

DSLAM: Digital Subscriber Line Access Multiplexer (used in DSL deployments).

DNS: Domain Name System, stores and associates many types of information with domain names, but most importantly, it translates domain names to IP addresses.

DOCSIS: Data over Cable Service Interface Specification

Dark Fibre: Optical fibre infrastructure that is in place but is not connected to in-service transmission equipment.

EPON: Ethernet Passive Optical Network

Fibre Drop: A fibre drop is the segment of fibre cable installed between the pole or the roadway and the subscriber's home. The fibre drop can be buried directly in a trench or run through a buried duct/conduit or installed above ground aerially.

Fibre Optic Splice Closures ("FOSC"): Fibre optic splice closures are used to protect stripped fibre optic cable and fibre optic splices from the environment. Outdoor fibre optic enclosures are usually weatherproof with watertight seals.

Fibre (shorthand for "optical fibre"): The medium and technology associated with the transmission of information as light pulses guided over a filament of transparent dielectric material, usually glass or plastic.

FTTP/FTTH Fibre-to-the-Premises/Fibre-to-the-Home: Describes a fibre optic line being delivered directly to a household or business. The terms FTTP and FTTH refer to the same technology and are interchangeable.

FTTN Fibre-to-the-Node/Neighbourhood: Describes a fibre optic line being delivered to a local "central office" or another neighbourhood node.

Gbps / Gigabits-per-second: a measure of internet speed. One gigabit is equal to one thousand megabits.

GPON: Gigabit Passive Optical Network

Ground-level Boxes ("GLB"): A pedestal or vault that is installed along the network route for the purposes of distributing the physical connections and holding equipment.

Internet Backhaul: The connection of individual hub or PoP sites back to a primary Internet connection.

Internet Transit: The connection of a local network to the outside Internet.

Internet Transport: The connections that carry network traffic between Internet network access points and link last mile connections to a local for Internet Transit.

ISED: Innovation, Science and Economic Development Canada, is the department of the Government of Canada with a mandate of fostering a growing, competitive, and knowledge-based Canadian economy.

ISP: An Internet Service Provider connects subscribers over an access network technology to the backbone Internet.

Lit Fibre: Optical fibre infrastructure attached to in-service transmission equipment. (See also "Dark Fibre").

LOS: Line of sight is the level of obstruction on the path between two points determining visibility from one point to another and the quality of signal reception for wireless transmissions.

Low Earth Orbit Satellites ("LEOs": LEOs orbit relatively close to Earth's surface at altitudes ranging from as low as 160Km above the earth to 1000Km above Earth.

LTE "Long Term Evolution": A standard for mobile broadband communications, part of the fourth generation of mobile telecommunications technology (4G).

Mbps: Megabits per second. A standard measure of internet speed. One megabyte is equivalent to 1,024 Kilobytes.

Multi-homed: Connecting a local network to multiple upstream Internet Transit connections.

Municipal Access Agreement ("MAA"): A MAA details the requirements on any telecommunications companies proposing to install equipment within a municipality's jurisdiction.

Network Access Point ("NAP"): An interconnection point where an Internet service provider (ISP) establishes peering arrangements to provide Internet connectivity to customers.

Open Access Network ("OAN"): A network that allows all ISPs and competitors to pay to use a common infrastructure to reach subscribers.

Operational Support System ("OSS"): Software component that enables a service provider to monitor, control, analyze, and manage services on its network.

Optical Line Terminator ("OLT"): Aggregation device used in passive optical networks services on the service provider side.

Optical Network Terminal ("ONT"): Subscriber device used in passive optical networks service on the customer end.

OSS: An operational support system is a software component that enables a service provider to monitor, control, analyze, and manage services on its network.

Passive optical network ("PON"): A PON uses fibre optic cable to deliver broadband to users. An optical fibre uses unpowered (passive) fibre optic splitters to divide the fibre bandwidth among customers. Passive optical networks are often referred to as the last mile between an ISP and its customers. A GPON refers to a PON capable of delivering gigabit service to customers.

Peering: A process by which two Internet networks connect at a NAP and exchange traffic. It allows the ISPs to directly hand off traffic between each other's customers, without having to pay a third party to carry that traffic across the Internet for them.

Pole Attachment Charges: Wireline pole attachment charges are what telephone companies and electricity distributors charge carriers to install anything on their network of poles.

Point of Presence ("PoP"): A Point of presence site is the aggregation point of an access network where equipment resides and connects to the Internet backbone.

Pole Remediation Charges: When a company proposes to install equipment on a hydro or telephone pole, the pole owner conducts an engineering study to determine what remedial work might be required for the pole to support the installation.

Public-private partnership ("PPP"): Defined as a long-term contract between a private party and a government agency for providing a public asset or service, in which the private party bears significant risk and management responsibility.

Subscriber Management System: This software is responsible for activating and supporting customers including provisioning protocols, DNS, and tracking

SWIFT: A regional broadband project Southwestern Integrated Fibre Technology (SWIFT) is a non-profit municipally led broadband expansion project created to improve internet connectivity in underserved communities and rural areas across Southwestern Ontario.

Universal Broadband Fund ("UBF"): Federal broadband funding program. Administered through department of Industry Science and Economic Development. Funds up to 75% of eligible expenses in broadband projects.

Universal Service Objective ("USO"): The CRTC's Universal Service Objective for fixed Internet access service is that all Canadians have access to speeds of at least 50 megabits per second (Mbps) download and 10 Mbps upload, with the option of an unlimited data allowance.

VDSL2: Very-High-Bit-Rate Digital Subscriber Line Version 2