Capital Regional District
Southern Gulf Islands
Regional Broadband Strategy

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TANEx Engineering Corporation
Phone: (250) 341-6118
www.tanexengineering.com

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Contents

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

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Phone: (250) 341-6118
Email: info@tanexengineering.com

1 EXECUTIVE SUMMARY

Recognizing the need for better connectivity for the islands of Galiano, Mayne, Saturna and Pender ("the SGI"), the Capital Regional District ("CRD" or the "Regional District") has engaged TANEx to develop a strategy to get broadband connectivity at 50 million bits per second download speed and 10 million bits per second upload speed ("50/10" or the "USO") for the SGI. Building on the CRD's prior work, Connecting SGI, this report provides a vision for the future of connectivity in the SGI along with a summary of the current level of connectivity. It illustrates the challenges and opportunities for improving broadband service for the SGI, describes alternatives and provides recommendations and cost estimates.

In short, while there are alternatives to improving connectivity in the SGI, the alternatives with the obvious potential in the SGI involve leveraging the Connected Coast project which has committed funding or by proceeding with construction of a sub-sea fibre optic cable between Salt Spring and Pender (the "Pender Link") outside of Connected Coast.

The SGI is generally served with connectivity at less than the USO despite having numerous service providers. In much of the SGI, internet service is already provided through coaxial cable which is highly capable of providing service in excess of the USO. Even in the areas that have that infrastructure, internet service performance is often not at the USO, and this is largely attributable to constrained backbone capacity coming into the islands. Constructing the Pender Link will alleviate this bottleneck, and while the Pender Link does not solve all areas of concerns, it can substantially improve service levels particularly for Shaw customers. CRD could partner with Shaw to construct the Pender Link.

The Connected Coast project is a fibre backbone project that will provide an opportunity for improved connectivity along the BC coast from north of Prince Rupert, to Haida Gwaii, south to Vancouver and around Vancouver Island. It includes construction of the Pender Link and connects Pender and Saturna to the Connected Coast backbone fibre. It does not currently include any local access (last mile) nor does it connect Galiano or Mayne to backbone fibre. Connecting all of the SGI to fibre backbone is the most important immediate issue to be resolved as proper, unconstrained, backbone connectivity is a prerequisite to high-quality internet and cellular connectivity. While Connected Coast is expected to eventually improve connectivity, the timeline is a challenge for the SGI as construction is not expected in the SGI until 2023 in the best case. CRD needs to lobby Connected Coast and senior government to escalate the schedule and facilitate speedy approvals for the Pender Link and add landing areas to Galiano and Mayne. Once the backbone issue is resolved, options will open for the SGI for improved last mile service that could be delivered by existing providers, third party or P3 partners or the CRD itself.

Finally, the CRD needs to determine its role in improving wired connectivity, ideally with fibre, to all homes on these islands and dedicate resources to do so. Not only does fibre provide unmatched reliability and scalability for ever increasing capacity requirements, it alleviates concerns from residents about the use of wireless infrastructure and towers necessary to deploy this technology.

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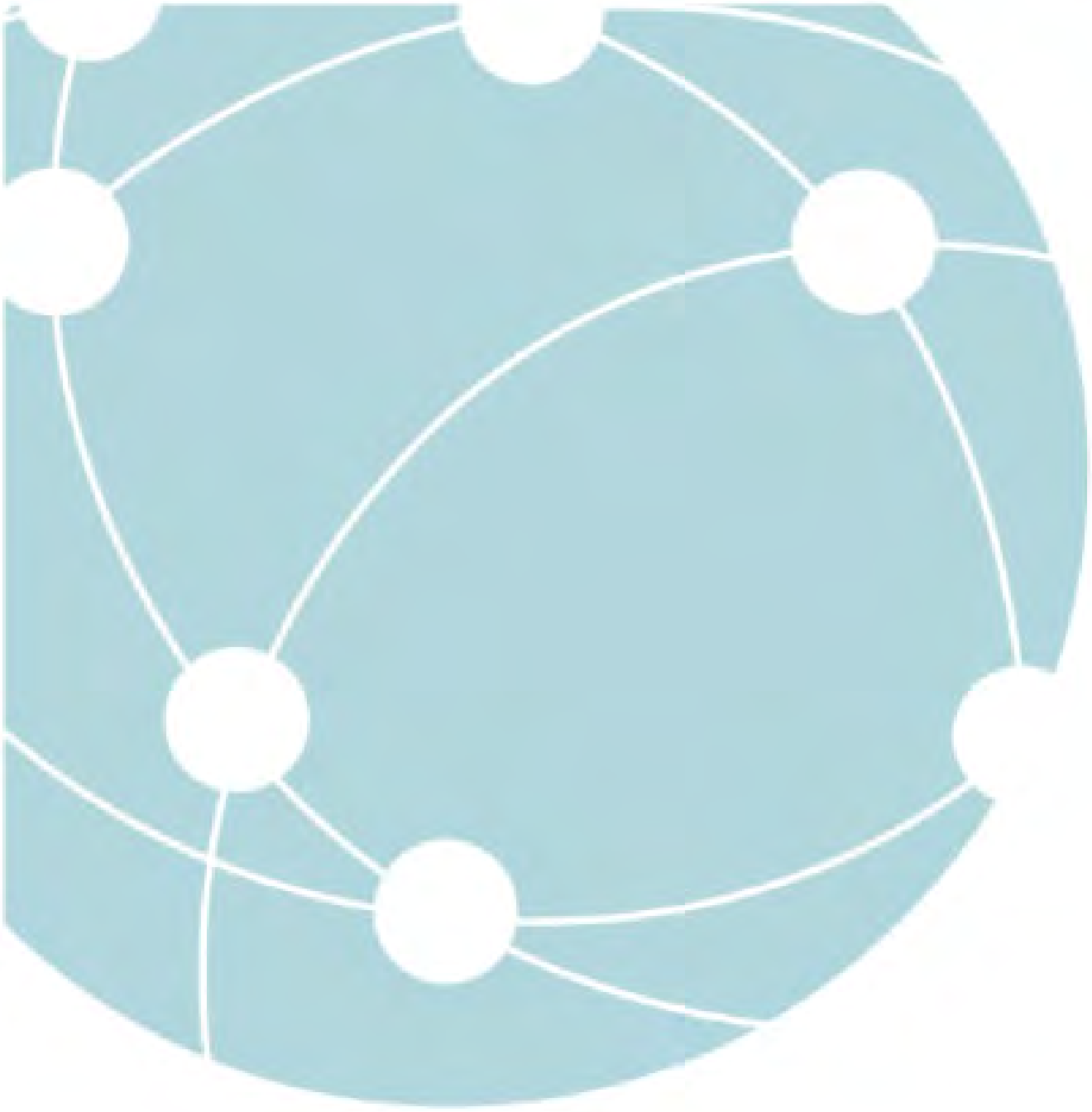
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com



2 INTRODUCTION

2.1 Purpose and Organization of Report

This report builds on the work done by the Capital Regional District culminating in the Connectivity Planning for the Southern Gulf Islands report dated January 2020 ("Phase 1 Report"). Building on the Phase 1 Report, TANEx has developed a strategy for the CRD to improve connectivity on Galiano, Mayne, Saturna and Pender Islands which are the main islands that comprise the Southern Gulf Islands Electoral Area (the "SGI"). The project assesses the existing state of connectivity within the SGI, identifies the service providers operating in the area, defines the gap between the current state and the Regional District's vision of the SGI as fully connected and then provides a path forward to improve connectivity on those islands along with high-level budgetary costs associated therewith.

The report has been organized in a manner that steps the reader through relevant background information, a vision for a connected future identifying benefits to the SGI, and a regional analysis including a current state assessment of connectivity in the region. It then goes on to identify gaps and strategies recommended to fill those gaps, with specific potential project areas identified and high level costs estimated. Finally, next steps were identified to advance connectivity in the SGI.

2.2 Summary of Prior Work

The Phase 1 Report began in Spring of 2019 and was completed in January of 2020. The scope of that work was to obtain information about the user experience with connectivity in the Southern Gulf Islands Electoral Area and to analyze how better access to high-speed broadband connectivity would advance existing priorities of the CRD and the SGI such as sustainable economic development, social and demographic diversity and community health and resilience. It confirmed the widely held view that high-speed connectivity is a fundamental necessity and that such connectivity must be advanced as a priority matter. This report is the second phase of this connectivity initiative which is intended to provide a technical analysis and connectivity design plan for serving the SGI at the USO.

2.3 Intended Audience

This report is intended to be utilized internally by CRD staff and its Board of Directors for education, guidance, and planning purposes to support decision making and advocacy efforts to improve access to, and availability of, high speed connectivity throughout the SGI. This connectivity strategy has been provided along with ancillary supporting information and documentation to the CRD for its sole benefit and reference. This work may not be relied upon by any third parties without completing their own independent due diligence.

2.4 Project Scope & Assumptions

The project focused on the islands of Mayne, Saturna, Galiano and Pender in the Southern Gulf Islands Electoral Area and included an assessment of the existing connectivity along with developing a strategy to improve internet connectivity. Creating a strategy specifically for increasing cellular coverage was not in the scope of this work although cellular coverage was considered as it pertains to internet connectivity.

2.5 General Approach

Resource staff from both TANEx and the CRD worked collaboratively to complete the strategy through various phases of the project. At a high level, developing this strategy included a series of activities including project kickoff, information gathering, presentation of draft strategy to the internal CRD

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connectivity team, receiving feedback, and report finalization and presentation to the Southern Gulf Islands Community Economic Sustainability Commission ("CESC").

The current state of internet connectivity in the SGI was assessed by undertaking public domain research and direct outreach to service providers.

An analysis of the difference between the current state of connectivity in the SGI and the future desired state identified by the SGI vision was completed. A technical analysis of alternatives to fill those gaps was completed and then a draft strategy was prepared and reviewed with the CRD staff team. The draft strategy incorporated feedback from the CRD project team and was then presented to CESC remotely.

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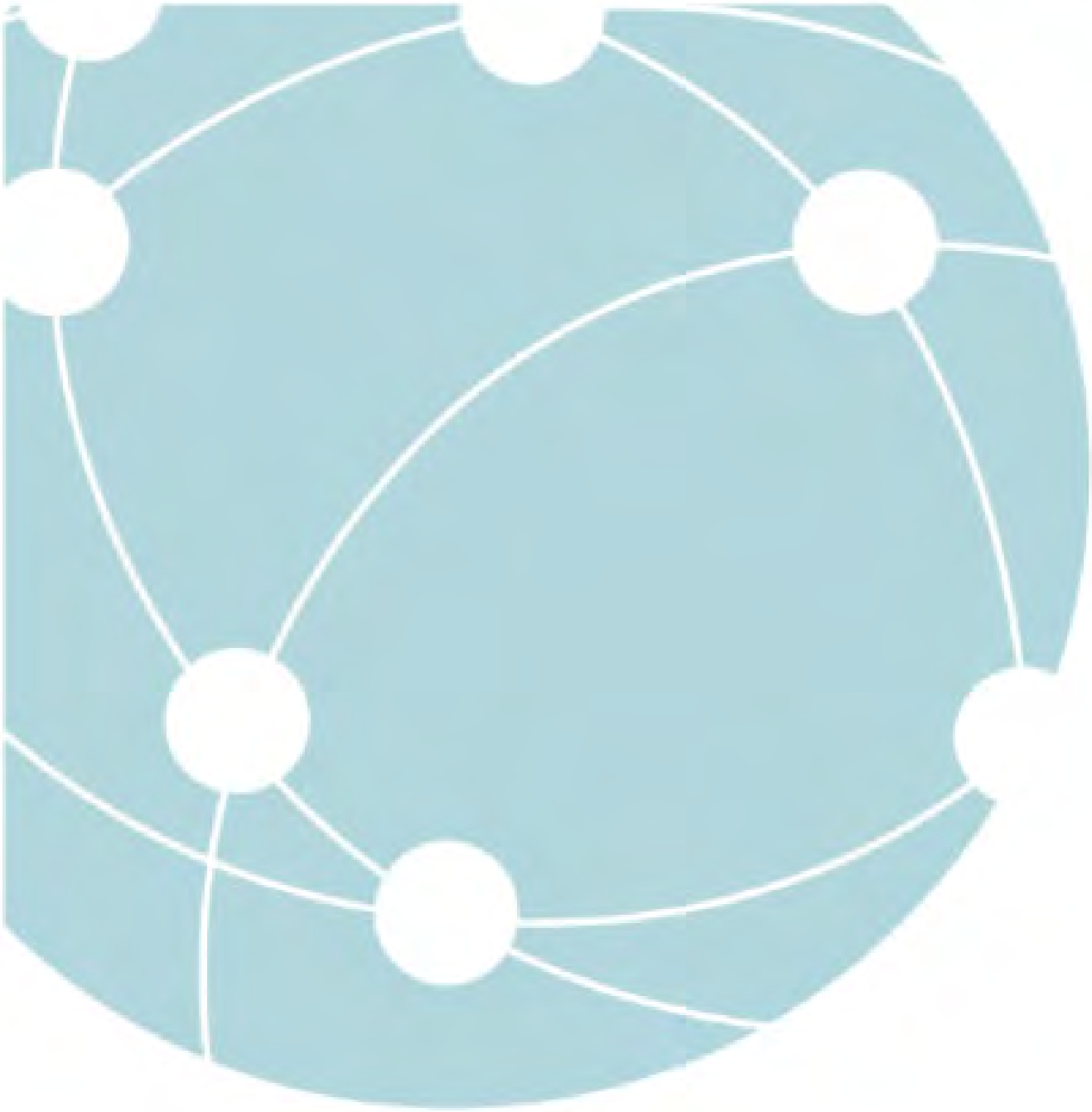
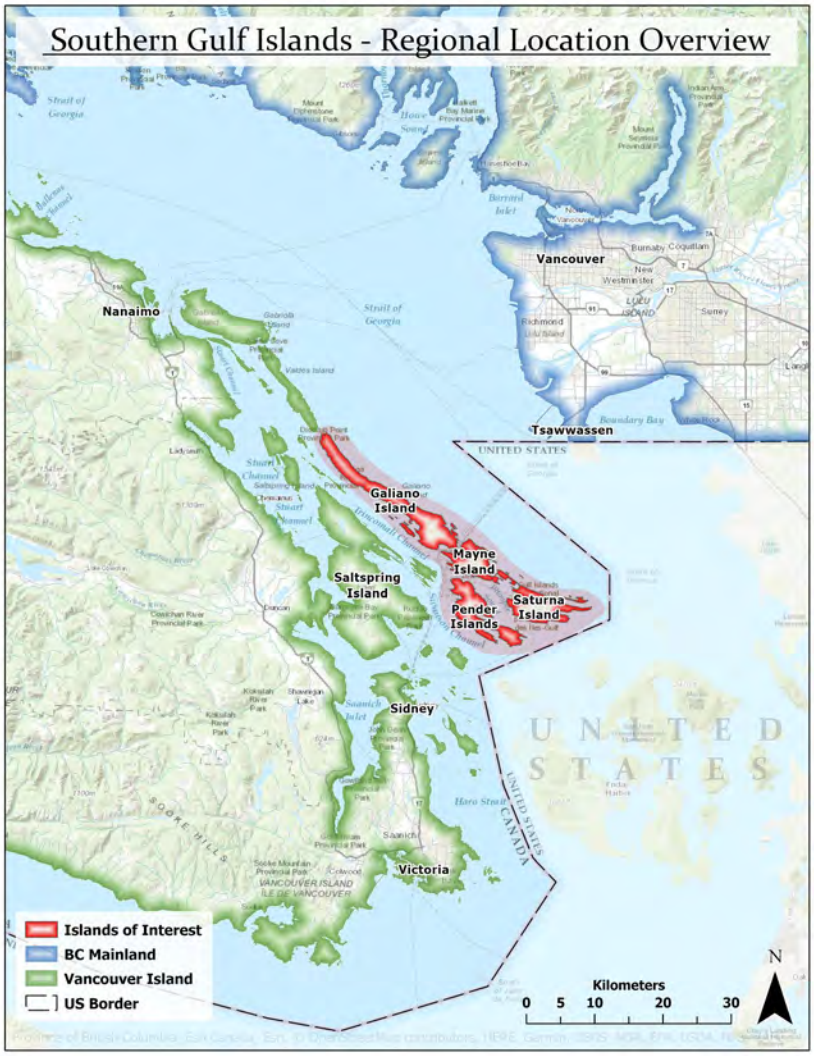


3 SGI SUMMARY

This section provides a short summary of the SGI and a lens through which to view this report, the strategy, and the recommendations.

3.1 Geographic Location

The Southern Gulf Islands are situated off the eastern coast of Vancouver Island in south western British Columbia. While geographically close to the urban centres of Victoria and Vancouver, the SGI remain remote given the logistical challenges of inter-island travel.



3.2 Population, Demographics and the Islands

Federal census population numbers at the time of writing are relatively out of date as the most recent census numbers are from the census of 2016. The SGI that are the focus of this project are characterized by higher-than-average percentage of non-permanent residents. Additionally, as pointed out in the Phase 1 Report, the demographic profile of the SGI is considerably older than the Capital Regional District as a whole, BC or Canada with an overall declining population over time. Finally, the

topography of the islands makes connectivity a challenge with dense forest and rocky make up creating issues for line-of-sight technologies as well as in ground deployment of wireline technology.

3.2.1 Galiano Island

Galiano Island is a long, narrow island that is 60.16 km^2. It is the northern most island in the SGI with a population of 1044[1]. It has 1170 private dwellings although only 564 of those are occupied by usual residents. The population is clustered on the island primarily centered in the communities of North Galiano, Retreat Cove, Montague Harbour, and Sturdies Bay.

[1] Statistics Canada – Census Profile – Galiano Island – Designated Place

3.2.2 Mayne Island

Just to the south of Galiano sits Mayne Island with its population of 949 people. It is s smaller island at 22.36 km^2. Mayne Island has 1211 total private dwellings with 517 of those occupied by usual residents. Mayne's population is clustered around the perimeter of the island in the communities of Miners Bay, Village Bay, Lighthouse Point, and Bennett Bay.

3.2.3 Saturna Island

Saturna Island is 35.75 km^2 and located to the south and east of Mayne Island. Its small population of 354 is one of the few Southern Gulf Islands to show an increase in population from 2011 to 2016. There are 464 private dwellings on Saturna with less than half of those occupied by usual residents.

3.2.4 Pender Island

Pender Island is 34 km^2 and is made up of North Pender and South Pender which are separated by a narrow canal but joined by a one lane bridge. It has the highest population in the SGI with over 2000 permanent residents who primarily reside on North Pender. The population concentrations are in Magic Lake Estates, Port Washington, Otter Bay, Hope Bay, Mouat Point, Hamilton Cove, and Bedwell Harbour with other smaller clusters located along the coastline of the island.

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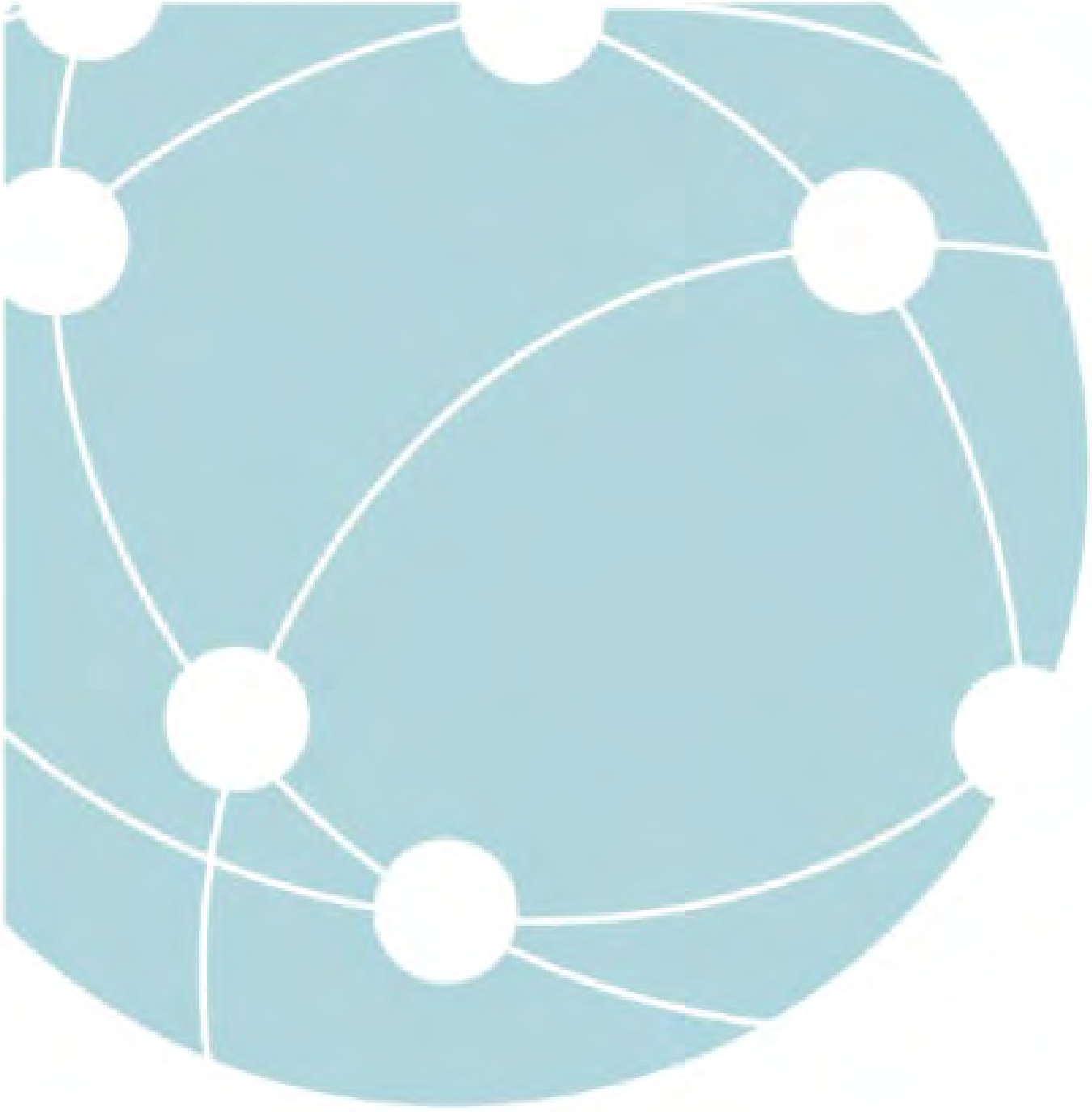

4 VISION AND GOALS

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4.1 Vision

TANEx facilitated a vision development session with the CRD project team which resulted in the following vision for the SGI:

"Southern Gulf Island communities, while remote by nature, are highly connected through a resilient, affordable high-speed network that supports services including telehealth, education, and emergency communications, and promotes lower carbon economic opportunities, social connection, and overall livability."

4.2 Benefits

While the benefits of broadband connectivity are widely accepted, some specific ways that the SGI will benefit from better connectivity include:

- Greater efficiency in accessing services by reducing travel to access them. This includes decreased environmental impact, better use of time, greater convenience, and lower cost.
- Increased ability for the predominant demographic in the SGI (seniors) to remain in their homes for longer.
- Increased opportunities for economic and demographic diversification which is key in the SGI.
- Better access to essential services such as education and health care.
- Increased mental wellness arising from reduction in isolation and increased connection with off island friends, family and resources.
- More inclusive governance allowing widespread participation by SGI constituents.
- Enhanced public safety communication and services.

4.3 Connectivity Objectives

SGI Connectivity Objectives

- Remove the existing service bottleneck between Salt Spring and Pender Islands by escalating the build schedule of that link by the Connected Coast project or by partnering with the existing cable provider to construct the subsea cable connection between those islands. Resolving this backbone constraint will result in the immediate improvement for residents of the SGI that are impacted by this capacity restriction.
- Escalate the build schedule for Connected Coast as it pertains to the SGI.
- Negotiate landing areas for Connected Coast that support existing internet service providers' service provision
- Lobby for existing Internet Service Providers ("ISPs") to be included in service provision on island either directly or as contracted by existing service providers or Connected Coast.
- Connectivity to places such as community hubs, libraries, commercial centres and other public service buildings including first responders should be a priority in a phased approach to connectivity.
- Promote a solution that supports a true open access model that facilitates competition and choice for the consumer.

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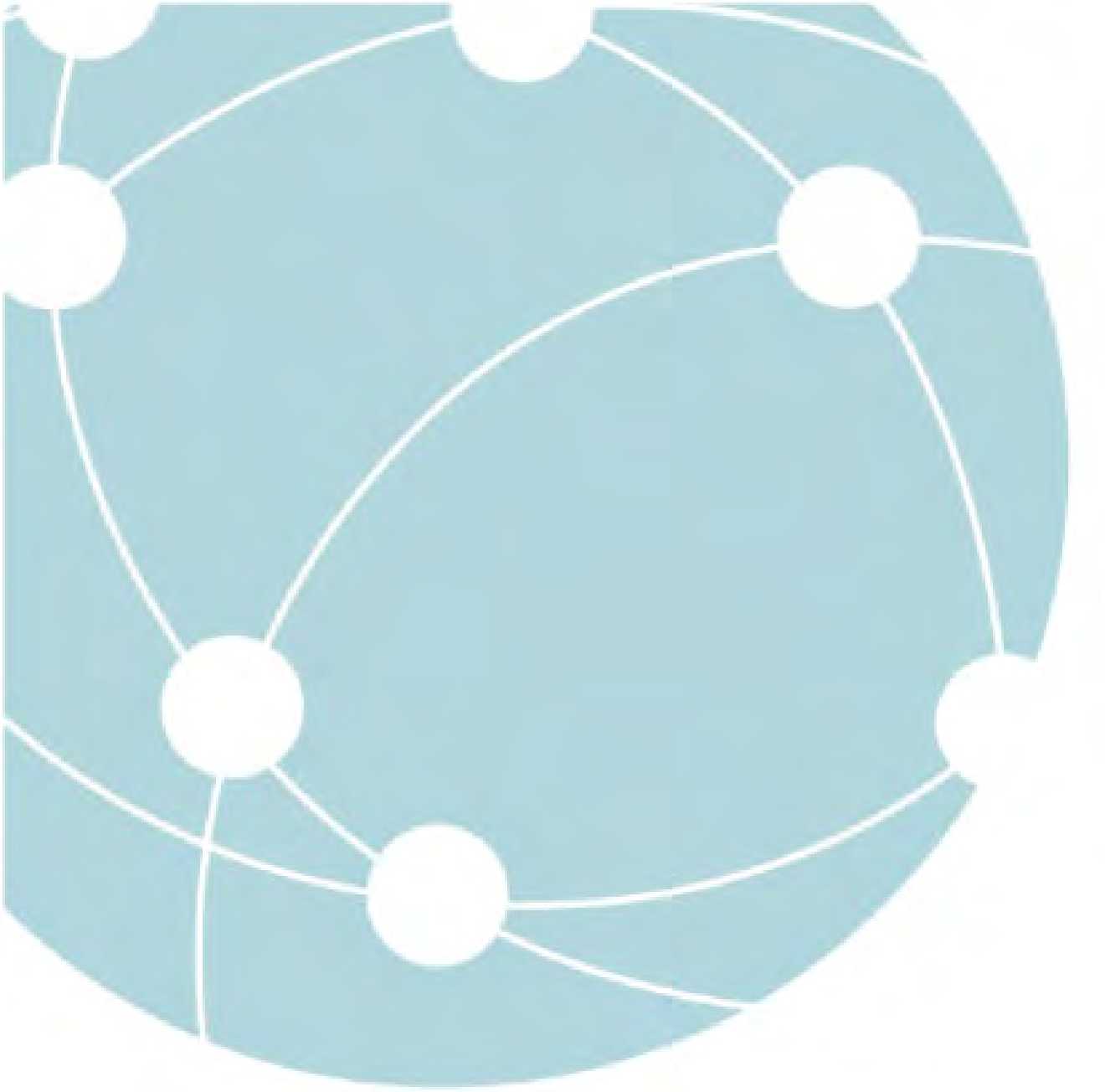

5 METHODOLOGY

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5.1 Methodology

This section describes the sources and methodology used for gathering the information used in the report for mapping and outreach. The information obtained will be summarized later in the document.

5.1.1 Mapping Methodology

Part of the information gathering process involved obtaining available geographic information system ("GIS") data from the CRD along with other sources and using it to create maps. The methodology and discussion of elements used for creating the important layers in these maps is generally laid out below.

Sources – The sources used in the analysis include the CRD, various stakeholders corresponding to the affected areas, the CRTC, Statistics Canada, Innovation, Science and Economic Development Canada ("ISED") and BC Open Data. The main dataset of analysis was sourced from the CRD and included the Points which are discussed in more detail below. The material sourced from the CRTC/ISED included the hexagons that indicate which type of service is available in a location and the National Broadband Internet Service Availability Map (the "ISED Map") to show the speeds available.[2]. Examples of the types of service include cable, fibre, DSL, and wireless, among others. Data from Statistics Canada included census data that determined the number of people and the number of dwellings in certain communities within the SGI. Another important layer sourced from the CRTC/ISED is the National Broadband Road Segments layer which is discussed in more detail below[3]. The existing infrastructure dataset that came from public sources that showed the location of existing cell towers[4]. Contextual information sourced from BC Open Data included anchor institutions such as schools, hospitals, and government buildings[5]. Road networks, administrative boundaries, and other layers were also sourced from BC Open Data and the CRD.

Potential Subscriber Points – Potential subscriber points ("Points"), are one of the most important datasets in the analysis. TANEx used CRD's GIS dataset of georeferenced Points as the main data upon which much of the analysis was based. This collection of Points approximates a potential subscriber location which may be a single dwelling or multiple dwellings within one geographic location. The Points were then assigned both density and available internet speed characteristics which are discussed in more detail below. The combination of Point characteristics created the foundation for delineating proposed project areas and the overall characteristics of those project areas as discussed in the project areas section below.

Density & Density Buffer Areas – In order to gauge the density of certain areas, six buffer zones around the Points were created. The six buffer distances used were 25m, 50m, 100m, 200m, 1km, and 2km. Individual buffer zones emanating from the Points were then dissolved into contiguous areas. If any of the buffer zones contained only one Point, they were erased. The results are contiguous areas that contain two or more Points. If a Point falls within a buffer zone, it is designated as Type 1 (25m), Type 2 (50m), Type 3 (100m), Type 4 (200m), Type 5 (1km), or Type 6 (2km) density, defaulting to the higher designation if it falls within two or more of the buffer zones. If a Point does not fall within the lowest density buffer zone designation (Type 6), it is designated as Type 7 which means it is outside the 2km buffer area. Such Points are fairly remote and rare.

[2] Government of Canada, *National Broadband Data Information,* Hexagonal Grid of Canada
[3] Government of Canada, *National Broadband Data Information,* National Broadband Data Road Segments
[4] Steven Nikkel, 2020, *Canadian Cell Towers Map*
[5] Government of British Columbia, BC Data Catalogue

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Speeds & Speed Buffer Areas – ISED maintains a dataset of national broadband road (NBD) segments which designate the internet speed a person could expect if they lived in the vicinity of that road. ISED notes that the data collected and used internally by ISED is, in most cases, accurate to within 250 metres[6]. This data is based on information provided annually by service providers[7].

If a Point fell within 250m of one of these NBD roads then it was designated with the speed available along that road, closest roads taking precedence. The range of speed combinations (download speed/upload speed in Mbps are as follows: 50/10, 25/5, 10/2, 5/1, Less than 5/1, or No Service. If a Point did not fall within 250m of a NBD road, its speed was uncertain and was designated "Unknown".

Project Areas – Project areas were created from the Points and the density buffers. Minor project areas were delineated 1km around the densest clusters of Points with a number of things in mind: Point characteristics for density, speed, topography, and distance between clusters. Large, consistent clusters of Points with speeds of 50/10 Mbps were also grouped into their own areas since they already have service at the USO. Points and clusters of Points separated by natural boundaries (e.g. cliffs, water bodies, etc.) were either omitted or split into different areas where necessary. Minor project areas were then grouped together into major project areas based on proximity to one another and connecting features such as fibre lines/highways. With SGI being a group of Islands this led to a logical grouping of project areas determined by which island they fall upon.

Fibre Lines – The routes of fibre lines were sourced from public domain or through consultation with service providers. Fibre lines and an understanding of where they are situated are important since they form a key element of the network infrastructure needed to serve potential customers.

Cell Towers – Cell tower locations and data were also sourced from public domain. Cell towers are another important element in providing existing and potential future internet service to underserved areas and their constituents.

Service Provider Coverage – Service provider coverage was sourced from ISED databases and where possible, verified with the service provider. The databases derive their information directly from individual service providers. Some of the information is older and may be out of date but nonetheless gives a sense of which service providers operate in which area and what types of technology they utilize in those areas. Examples of such technology include coaxial cable, DSL, fixed wireless, or Fiber-to-the-Premises/Home.

5.1.2 ISP Outreach Methodology

A list of Internet Service Providers was created from information provided by the CRD and research of publicly available sources identifying providers in the area. TANEx conducted at least one one-on-one telephone interview with each known area service providers and in some cases, more than one. The intent of these discussions was to gain a thorough understanding of each service providers connectivity and services within the SGI. This aids in providing realistic recommendations about the alternatives available to the CRD.

As part of the project scope, a meeting was held with the SGI Technical Collaboration Advisory Group ("TCAG"). This is a group of service providers that are actively offering services in the SGI. While input was obtained individually from each provider, a joint meeting of all providers making up the TCAG was held to review alternatives for the SGI.

[6] Innovation, Science, & Economic Development Canada
[7] Government of Canada, *National Broadband Data Information*, National Broadband Data Road Segments

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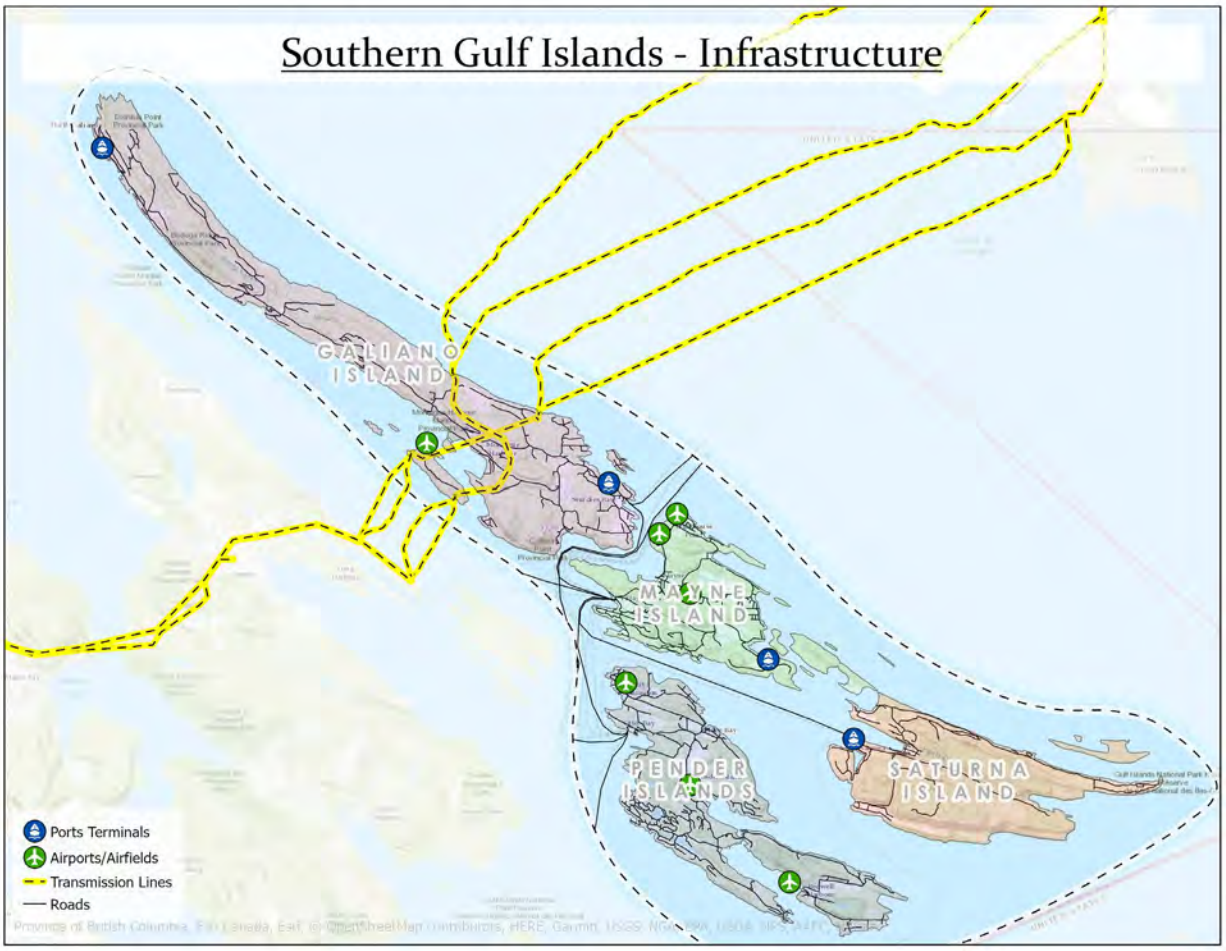
6 SGI CURRENT STATE

In order to formulate a strategy for the SGI, a thorough understanding of the current state of the region is necessary to form the basis of the analysis, identify the gaps and define the steps that must be taken to improve connectivity to underserved areas.

6.1 General Infrastructure

The following provides a brief overview of the major infrastructure into the SGI.



6.1.1 Health

The SGI is under the jurisdiction of Vancouver Island Health Authority. Health authorities govern, plan and deliver health-care services within their geographic areas and have responsibility for identifying health needs, planning programs and services, and overseeing program and service funding, management and performance[8].

[8] BC Provincial Health Authority

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Healthcare facilities in the SGI are set out in the table below.

Facility Name	Address	Type
Galiano Island Health Care Centre	908 Burrill Road, Galiano Island	Lab and Emergency services as well as Telehealth services.
Mayne Island Health Care Centre	535 Fernhill Road, Mayne Island	Telehealth services.
Pender Islands Bishop Coleman Memorial Health Centre	5715 Canal Road, Pender Island	Full-time primary health care, emergency services and telehealth services.
Saturna Island Medical Clinic	104 Harris Road, Saturna Island	Telehealth services part time in person care.

6.1.2 Educational Institutions

All schools in the SGI are in School District #64 - the Gulf Islands School District. SD#64 is home to five island communities including the SGI and Salt Spring Island. Schools in the SGI are laid out in the table below.

School name	Address	Type
Galiano Community	1290 Sturdies Bay Road, Galiano Island	K-12
Mayne Island	535 Fernhill Road, Mayne Island	K-12
Pender Islands	5714 Canal Road, Pender Island	K-12
Saturna Island	121 Sunset Boulevard, Saturna Island	K-12

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6.1.3 Service Provider Overview

Provider	Summary
Beacon Wireless	Beacon Wireless provides Internet connectivity using unlicensed wireless to all of the Southern Gulf Islands in the scope of this project. Service packages range from weekend only, to full business Internet services up to approximately 35Mbps.
City West / SRD (Connected Coast)	While not actively providing services in the CRD, City West is completing the BC Connected Coast project that may provide a potential for new services to the CRD through the Connected Coast backbone.
GAIA	GAIA is new to the SGI and recently began offering services on Galiano Island using unlicensed wireless technology. Services offered up to about 25Mbps.
Rogers	Primarily interested in cellular services. Rogers has recently announced the purchase of Shaw Communications, although at this time it is unknown how that may benefit / impact connectivity in the SGI.
Shaw	Provides wired internet connectivity and CATV using primarily coaxial cable infrastructure on the islands of Pender, Mayne and Galiano.
South Island	Based on Saturna Island, South Island Internet (SINet) provides Internet services to the SGI using unlicensed wireless technology. Services range from lower speeds of 5/1Mbps, up to 50/10Mbps in some locations.
Starlink	Currently (2021 March) provides pre-commercial beta-test internet service from a constellation of low earth orbit satellites. Later this year, full commercial service should be available. Starlink (and potentially other LEO solutions) present a promising alternative to remote residents in the CRD.
Telus	Provides services throughout the CRD using a mix of fixed wireless and DSL infrastructure and is considered the incumbent provider.
Xplornet	Provides direct to home internet service from a satellite in geostationary earth orbit. Before Starlink, Xplornet was the only viable satellite option for SGI residents that have no other wired or wireless options.

Detailed coverage information and technology is available in the Appendix of this report.

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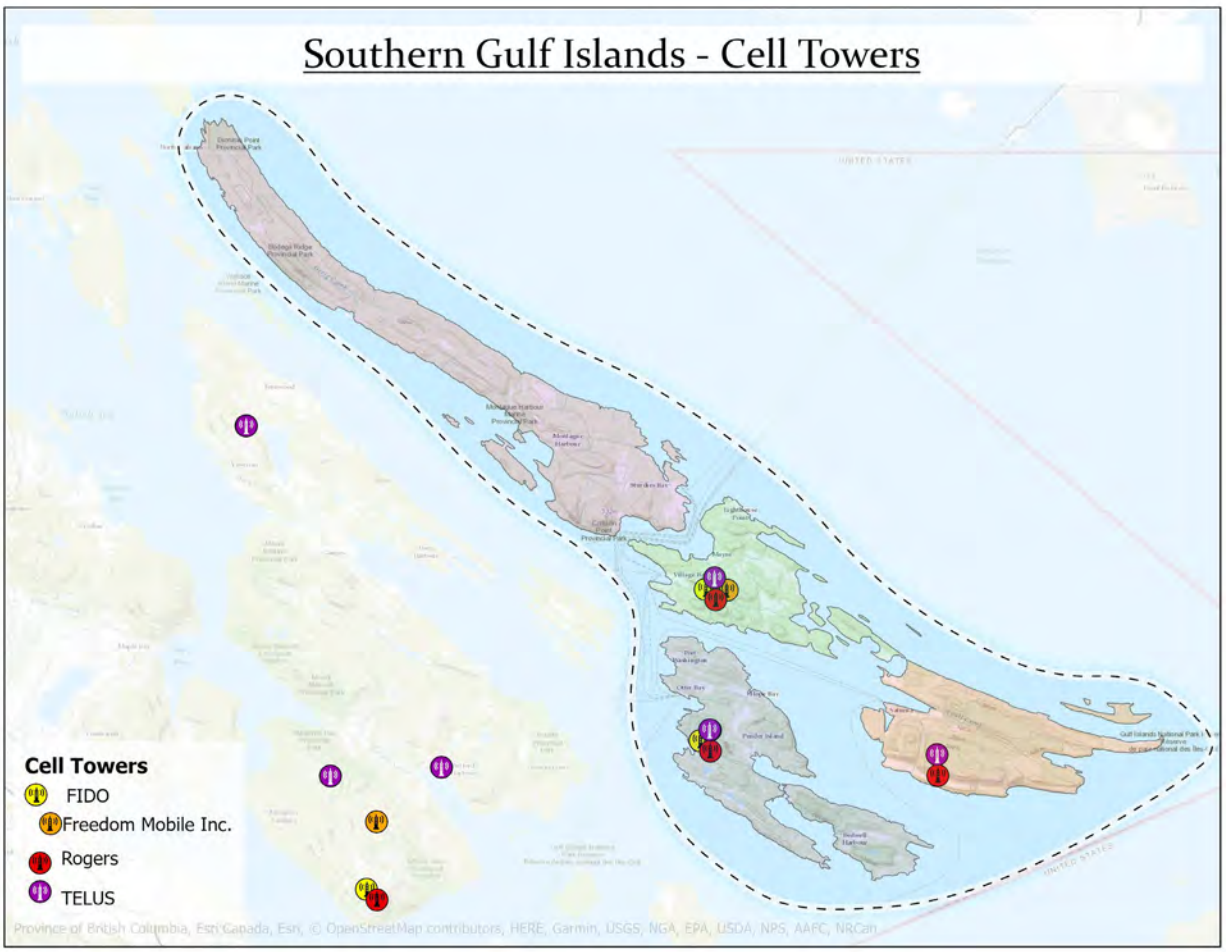
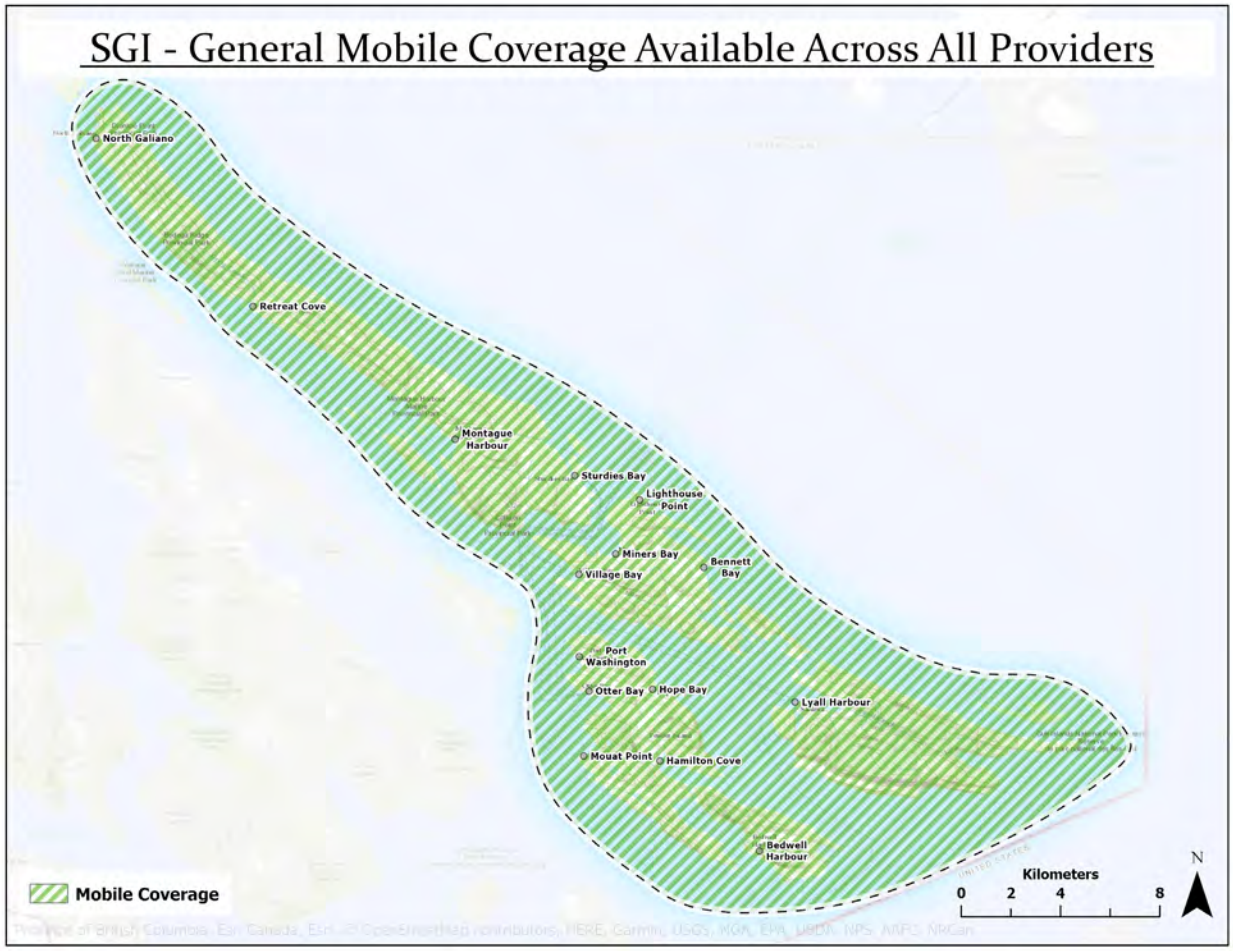
6.1.4 Cellular Services





6.1.5 Announced Projects

While not necessarily a complete list, there are publicly announced telecommunications related projects that can benefit the SGI, including:

- The Connected Coast project is a fibre backbone project that was announced by the Strathcona Regional District ("SRD") and CityWest Cable and Telephone Corporation ("CityWest") in 2018 with the promise to bring high-capacity connectivity to 139 rural and remote coastal communities, including 44 Indigenous communities along the BC coast from north of Prince Rupert to Haida Gwaii, south to Victoria and around Vancouver Island. This represents approximately 3,400 km of subsea fibre optic cable that will be constructed including to the islands of Saturna and Pender[9]. Connected Coast and the SGI will be discussed in more detail later in this document.
- Shaw has recently been awarded $341,000 through the Economic Recovery Intake to address improved performance and reliability on Mayne, Pender and Galiano.
- At the time of completing this report, the Universal Broadband Fund recently closed. While it is believed that some providers made applications to the UBF, nothing is available for public announcement at this time.

[9] ConnectedCoast.ca

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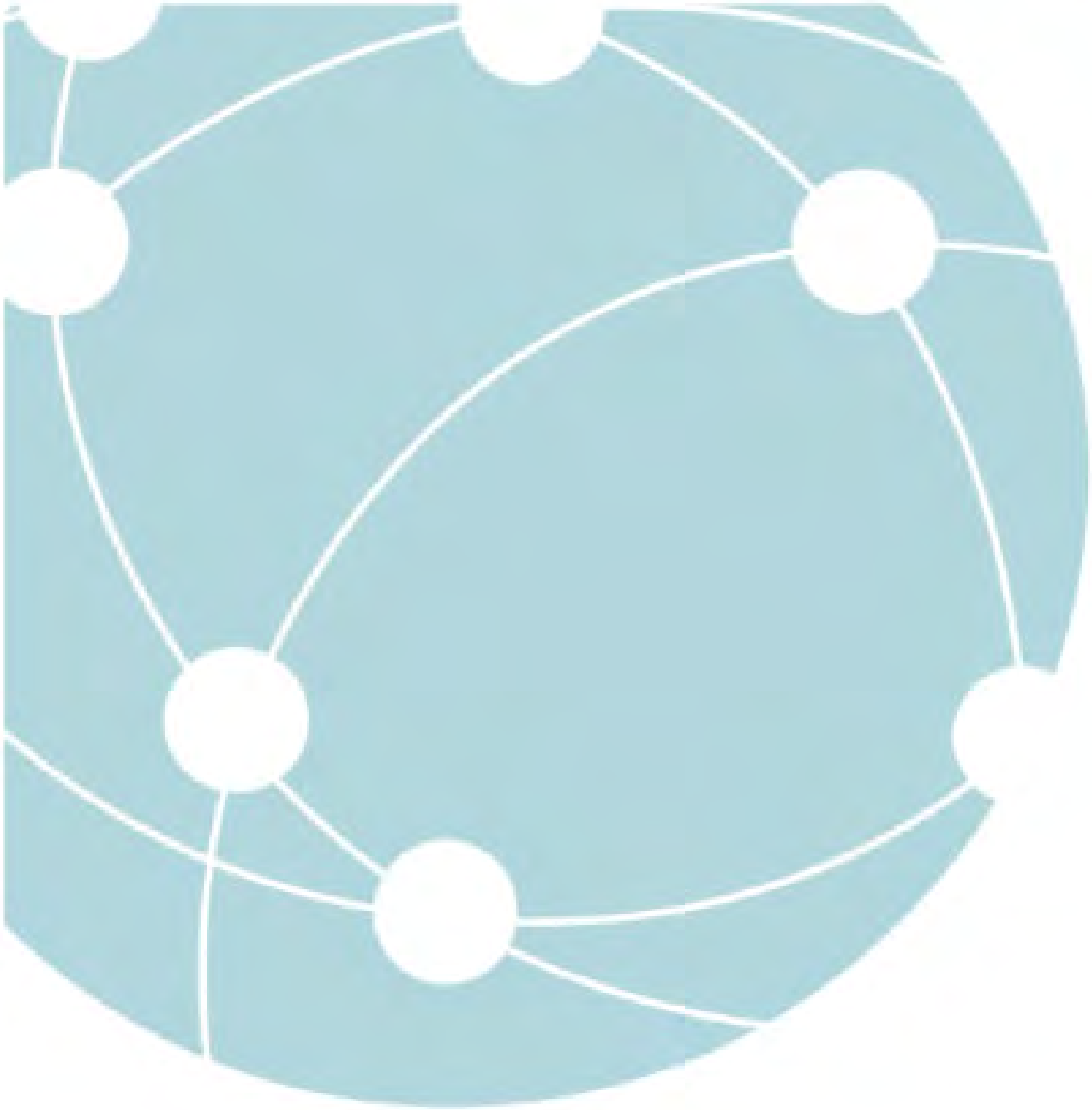

7 SITUATIONAL ANALYSIS

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7.1 Moving from Current State to Vision

Earlier in the report, the CRD vision of the SGI as a highly connected region was articulated followed by the analysis of its current state. To achieve the vision, a number of steps must be completed from documenting the current state through to achieving the vision as shown below.

7.2 Understanding the Gap

7.2.1 SGI Connectivity Factors

Understanding the SGI connectivity situation requires identifying the characteristics of the region from a connectivity perspective. The SGI strengths, weakness, opportunities, and threats have been summarized in the table below:

STRENGTHS
• Close proximity to Regional Districts that have similar connectivity concerns who are actively pursuing connectivity strategies. • There is existing presence by a number of providers given the size of the area. • Geographically, small defined area. • There is a passion within the Regional District organization and the SGI to solve the connectivity challenge as evidenced by the phase 1 work. • Significant co-axial infrastructure is widely implemented. Shaw infrastructure has already been widely deployed and merely suffers for lack of backbone capacity. • Clearly identified community goals and good understanding of how connectivity supports those. • Supported by a number of smaller local providers that want to help provide service. • Strong tourism sector. • Linear distribution of points facilitating an easier build for a wired solution. • Fairly high density of rural clusters with 73% of Points within 25 m of another Point. • Independent culture that is accustomed to being self-sufficient. • Existing fibre that connects the islands of Pender, Mayne and Galliano. • Regional District has facilitated a Technical Collaboration Advisory Group and island-based liaisons. • Strong CRD human capital with priority given to solving the connectivity issue.
WEAKNESSES
• Only 10% of SGI Points have service at 50/10. • Lack of fibre inter-connect to the mainland and Saturna. • Terrain and topography challenges. • Need for sub-sea cable to connect to the outer world. • Foreshore rights must be obtained for landing areas. • Absence of large industry needing high-capacity connectivity. • The ISED map shows certain portions of the SGI as already served at the USO so additional capital may be required to improve connectivity in those areas.

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- Geological make up of islands. Rocky, heavy trees, limited accessibility so may be required to work with incumbent to get pole access.
- Physical access is difficult (ie. It's an island)
- Significantly older average age than CRD, BC or Canada. There are fewer children which threatens schools and fewer students creating demand.
- Over ½ population not in labour force creating an absence of demand for connectivity arising from WFH and HBB.
- Half of residents are seasonal.
- Regional District is not structured to operate an ISP.
- Declining population.
- Lower median income than BC average.
- Some aversion to increased cellular towers and wireless technology may make deployment of those technologies more challenging.

OPPORTUNITIES

- A huge difference in service level to Shaw served areas of Pender, Mayne and Galiano is possible by simply building the sub-sea cable between Pender and Salt Spring Island.
- ISPs generally express willingness to cooperate and partner to improve service in under-served areas. Greater success can be achieved by leveraging resources and government subsidies to solve a bigger problem for more people.
- A variety of subsidy funding sources are available.
- The COVID-19 pandemic reinforces the important need for improved connectivity to rural and remote communities for services like education and medical care.
- Expression of interest by external providers to deliver services with a more desirable business model.
- People wanting to relocate to smaller centres, thus creating higher demand.
- Attraction of professionals and remote workers.
- Areas that do not have 50/10 are severely underserved which may make a more compelling case for funding applications.
- Earthquake zone location may drive needs for a safety warning system which requires robust communications. This represents a specific characteristic of the SGI which helps to justify higher needs for connectivity and may allow access to multiple funding sources.
- Connected Coast initiative promises to bring backbone connectivity so there is an opportunity to serve the last mile.

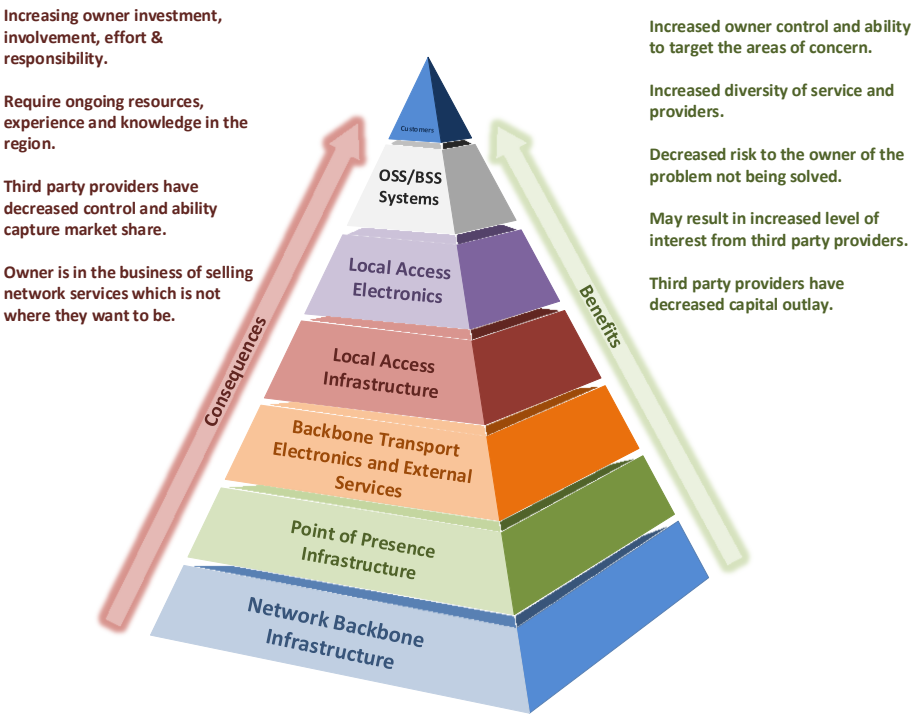
THREATS

- The COVID-19 pandemic may have significant near-term impact on travel and tourism.
- Applications for subsidy funding are complex and involve significant effort. Further, applications to different funding sources often need to be combined in order to create a viable business case; increasing the complexity and effort required.
- Access to funding programs may be hampered by the need to partner with other entities to meet the eligibility characteristics.
- Earthquake zone and potentially tsunami.
- Unknown impact to local ISPs with the introduction of Connected Coast and City West.
- If Connected Coast is not open access on last mile, it may displace local providers.
- Local ISPs may not have uniform views on opportunity presented by Connected Coast.
- Connected Coast timeline is long, and promises may not become reality. Other providers are not investing because of Connected Coast. Putting all eggs in one basket.
- Lack of connectivity means people must invest in a major effort to get access to services (ie. Have to leave island on ferry or plane and losing days of productivity).
- Less desirable for full time residency because of lack of services.

7.2.2 Technology

7.2.2.1 Broadband Service Delivery Pyramid

From a technical perspective, solving the connectivity challenge for rural and remote areas is the same as an urban environment and requires a service delivery model that encompasses a number of layers that all need to be provided. The following Service Delivery Pyramid ("SDP") provides a visual depiction of the layers of infrastructure that must be present to solve the connectivity issue:



The diagram above outlines the SDP and delineates the individual layers that must be provided and the relative levels of responsibility the network owner must address to satisfy the goal of improved services to the residents and businesses. Solving the connectivity problem requires that all layers of the SDP be provided, either by one entity or by the collaborative efforts of numerous parties.

As the network owner commits to, and moves up the layers of the pyramid, increasing levels of complexity and involvement are required. Although this may seem intimidating, the benefit of increased control and influence on improvement of services may outweigh the hurdles.

The layers of the SDP are as follows:

Backbone Infrastructure: This is the physical infrastructure required to bring long distance connectivity to a community. For high-capacity modern networks, this would typically be fibre optic cable but in some cases, high-capacity microwave may also be suitable. The term backbone is also synonymous with "transport infrastructure".

Points of Presence: POPs are the infrastructure required in each community (or along the backbone route) used to locate the electronic components required to enable connectivity as well as act as a

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

termination point for the backbone infrastructure. For example, in the case of a fibre optic backbone, the physical cable would be installed inside the POP and the cable connected to the electronic components within the POP. A POP houses sensitive electronic components requiring suitable environmental controls including, but not limited to, air conditioning, battery, backup power, and security.

Backbone Transport Electronics and External Services: This layer represents the electronic components and services required for the POP to enable connectivity outside of the local area to other POPs and ultimately, the global internet. Although the term "backhaul" may have different meanings when referring to the network, it often refers to these external services.

Local Access Infrastructure: This includes the physical assets required to connect the local POP to the subscriber's home or business. There are numerous choices for technology, but for modern, high capacity, scalable networks, fibre optic connectivity is the preferred option. Different options for local access technology are more detailed in supplementary documentation.

Local Access Electronics: This layer of the SDP represents the electronic components required in the POP and in the subscriber's home or business that enable connectivity to underlying layers of the SDP. This is the final physical component required to enable connectivity.

OSS/BSS Systems: All the lower levels of the SDP, require management to ensure they are operating correctly and to provide the business operations of the network. These operations include, but are not limited to, network monitoring and management systems, billing, provisioning, technical support, customer service support, maintenance, among others.

Customers: The final layer to a successful broadband network is the existence of customers subscribing and paying for services on the network. In the case of rural and remote networks, anchor tenants or institutional customers can be particularly beneficial in supporting the sustainability of the network.

Greater detail on the technical aspects of the Service Delivery Pyramid and a comparison of technology can be found in Appendix D.

7.2.2.2 Technology Overview

Broadband connectivity can be provided using a number of different technologies each having various advantages and disadvantages. While a more thorough comparison of different technologies is contained in the Appendix of this document, it is important to understand a few key technologies for delivering high quality connectivity in rural areas.

7.2.2.2.1 Fibre Optic Technology

For delivering high capacity, scalable and very reliable connectivity over long distances, fibre optic technology is the only viable technology available. Long distance fibre optic backbone networks are critical to enabling almost all other technologies to deliver services in a manner that provides the high capacity needed to deliver the USO now and in the future. Fibre-optic backbones combined with local access delivery using Fibre to the Premise ("FTTP") provides the best possible fixed service currently available with virtually unlimited ability to offer a variety of services in the most reliable fashion and lowest ongoing operational costs. While disadvantages include high up front capital costs and the fact that it cannot be moved, it is the preferred alternative for all fixed broadband connectivity. However, when considering the lifetime of fibre optic infrastructure is 25+ years, the capital cost over the lifetime of the asset makes the cost of fibre comparable to other technologies.

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

7.2.2.2.2 Cellular Technology

Cellular networks began as a means of delivering mobile telephone service but have evolved to include text messaging and access to most of the communications, information, and other services available over the Internet. Cellular phones have displaced fixed line telephone service as the preferred way to communicate with individuals. The smart phone has become an essential personal appliance, providing communication, access to information and many other services and applications for personal convenience, productivity, safety, and entertainment. Safety and security are often cited as a primary use for cell phones. In many areas, over 80% of emergency calls to 911 are from cell phones[10].

The cellular mobile system uses a separate network from broadband internet, with cell sites that connect to user terminals, typically smartphones, over a licensed radio channel (radio frequency or spectrum). The cell sites are connected back to a core backbone network, typically over fiber. The core network has gateways into other networks including the public switched telephone network and the global internet, and in many instances, secure gateways to specific enterprises and private networks. The technology is governed by open global standards, enabling cell phones to generally "roam" world-wide. Access to radio frequencies requires licencing, and is regulated by national governments. These frequencies are usually secured through an auction format which tends to favour mobile network operators who have the financial backing to afford the licensed spectrum.

The current generation of cellular network in Canada is the fourth generation or 4G - commonly referred to as Long-Term Evolution (“LTE”). The LTE network was designed from the ground up to support high data rates and using the Internet Protocol suite (“IP”). IP is a global standard for enabling internet connectivity and is the foundation of the global internet. Although not designed to compete with FTTP data speeds and monthly usage levels, where several user devices, including big screen TVs are accessing the internet, the cell network provides good internet access given the small form factor of most mobile devices. In the home, Wi-Fi is used to connect mobile devices to the internet, offloading usage from the cellular system.

Next generation cell, is known as 5G, and has rolled out to urban centres across Canada. It is expected to gradually extend to smaller centres and rural areas over the next few years. The 5G network features improved efficiency, capacity and capabilities that are intended to support additional use cases, including fixed wireless broadband access. The new frequencies to support fixed broadband will only be released in Canada through government auction processes over the next few years.

7.2.2.2.3 Low Earth Satellite Technology

While the appendix of this document provides additional detail on different technologies, LEO technology has been specifically addressed because of its emergence in the market and because it provides a viable alternative to remote connectivity.

Satellite based communications have been characterized as "distance-insensitive" because there is no linear chain of terrestrial cables or radio links between the end points, only the radio link through the satellite network. Satellite networks designed to serve directly to the customer's premise combine the transport and access (last mile) network functions into a single network. Xplornet is an example of such a network, based on geostationary earth orbit satellites. Unfortunately, transmission delay and the relatively high cost for normal consumer broadband usage levels are significant limitations for these satellite networks.

[10] Local21News – *“How accurate is your cell phone location data in an emergency?”*

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

A new generation of satellite networks are being planned and deployed into low earth orbit (LEO) that vastly improve the delay (latency) performance and may address the data usage affordability issue. The Starlink system being launched by Spacex is the first-to-market. As of the writing of this report (March 2021), beta test service is available from Starlink in northern US and southern Canada including the SGI. The beta service is proving popular for isolated customers. So far, the beta test results support Starlink claims of 50 - 150 Mbps download speeds and 10 - 30 Mbps upload speeds with round trip delay in the 20 - 40 msec range. Whether the system will retain this level of performance, as the system and subscriber base scales up, is unknown at this time. Other broadband LEO systems are also planned, but service is at least one or two years out, and these may not be marketed directly to residential customers (e.g. other LEO systems may be marketed to existing service providers and used to connect access networks such as cell sites, remote camps and remote communities).

7.2.3 Potential Project Areas

In order to achieve CRD's vision for the SGI, it is necessary to break down the connectivity gap into smaller components so that projects can be prioritized, funded and constructed as time, priorities and budget allow. All projects in the table below are assumed to be fibre as a base case. The following table provides a summary of projects identified as a result of this study. An ancillary document outlining additional detail for each of the identified project areas will be provided.

While the ISED maps purport to have some small areas of 50/10Mbps service available on the islands of Mayne, Pender and Galiano, it is believed that services throughout all islands are considered poor. The following map provides an overview of the areas in the region that have been identified based on available data,

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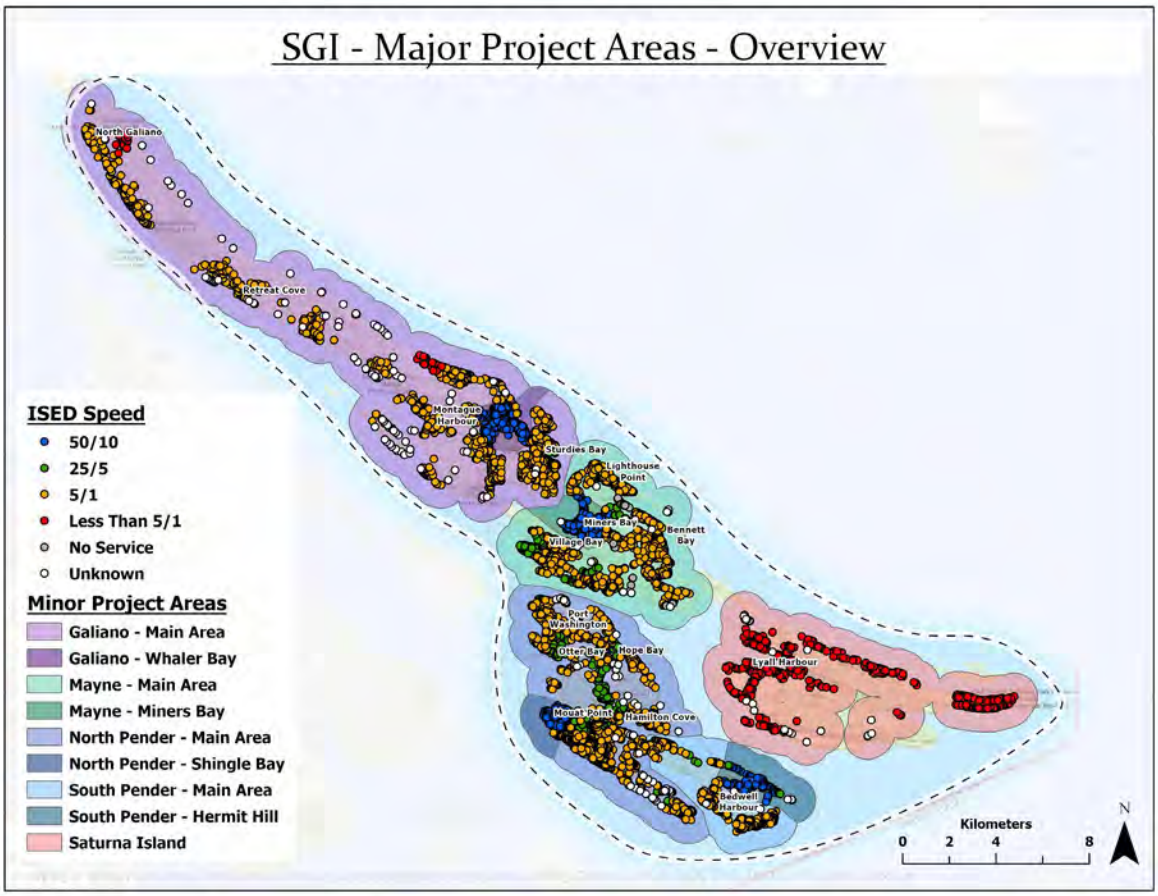
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com



TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

8 STRATEGY IMPLEMENTATION

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

8.1 Capital Regional District Areas of Focus

The analysis of the data provided by the CRD overlaid with the service levels from the ISED Map results in an understanding of the number of Points in the SGI, served at various service levels, according to the ISED Map. The following table provides a breakdown of the major project areas identified in the SGI and provides a total of the Points as well as the Points per project area.

Project Area Summary

Apr 05, 2021

		Project Definition						Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Galiano Island	Galiano - Whaler Bay	Galia	Yes	Yes	204	3.42%	50/10	66	0	4	134
Galiano Island	Galiano Island - Main	Galia	Yes	Yes	1178	19.73%	5/1	1176	0	2	0
	Area Galiano SubTotal				**1382**	**23%**		**1,242**	**0**	**6**	**134**
Mayne Island	Mayne Community	May	Yes	Yes	224	3.75%	50/10	22	0	0	202
Mayne Island	Mayne Island - Main	May	Yes	Yes	1416	23.71%		1288	0	128	0
	Area Mayne SubTotal				**1640**	**27%**		**1,310**	**0**	**128**	**202**
Pender Island	North Pender - Shingle	Pend	Yes	Yes	305	5.11%	50/10	74	0	16	215
Pender Island	North Pender - Main	Pend	Yes	Yes	1710	28.63%	5/1	1582	0	128	0
Pender Island	South Pender - Hermit Hill	Pend	Yes	Yes	98	1.64%	50/10	17	0	16	65
Pender Island	South Pender - Main	Pend	Yes	Yes	239	4.00%	5/1	237	0	2	0
	Area Pender SubTotal				**2352**	**39%**		**1,910**	**0**	**162**	**280**
Saturna Island	Saturna Island	Satu	Yes	Yes	598	10.01%	5/1	598	0	0	0
	Area Saturna SubTotal				**598**	**10%**		**598**	**0**	**0**	**0**
	Totals				**5,972**	**100%**		**5,060**	**0**	**296**	**616**
								85%	**0%**	**5%**	**10%**

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e: info@tanexengineering.com
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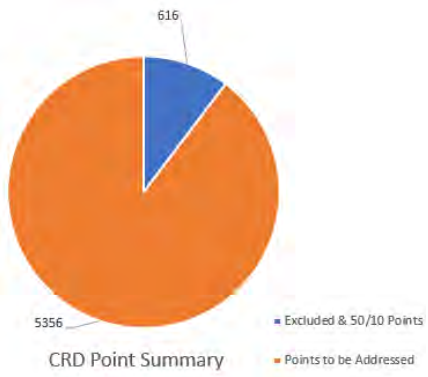
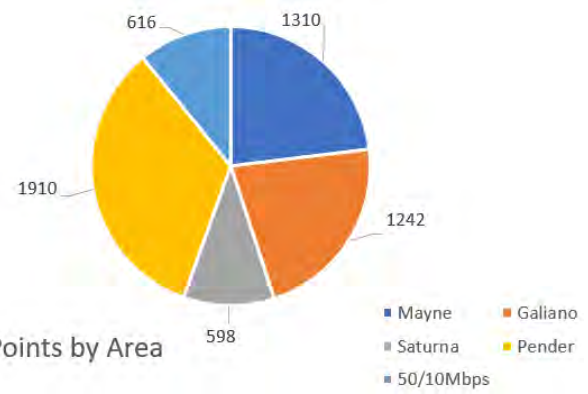
Areas identified in the table as “Points (potential subscriber location) at the USO (CRTC’s Universal Service Objective)” are those that are reported to be already served at 50/10Mbps. Points identified as “Remote Points” are points that are very sparse and not easily combined into a suitable project area or Points that may not be a potential subscriber location.





The above tables support the following conclusions:

- There are just shy of 6,000 Points in the SGI.
- Only 10% (approximately 600) of these Points show as served at 50/10Mbps but speed test results shown by the Canadian Internet Registry Authority (“CIRA”) performance test indicate it may not be even this high.
- The vast majority of Points, 85%, are served well below the USO at just 5/1Mbps.

8.2 Strategic Direction

The strategy is driven by CRD’s vision for the SGI as well as the role it is prepared to play to advance the connectivity initiative.

The CRD’s strategic direction includes a number of alternatives which have been detailed below. The CRD will need to establish the role that it is prepared to play in advancing rural connectivity for each project area in the SGI. The CRD’s role may vary depending on the project area that is being considered. In some cases, the path forward will depend heavily on the CRD’s appetite for increased involvement, and this may also have impacts on its ability to access federal and provincial funding. One possibility is for the CRD to establish a service area and provide the mechanism for residents and businesses to contribute to the capital funding through taxation. Establisihing a service area will require a central authority such as the Regional District to implement this structure and coordinate the effort between the residents and providers.

The range of roles is depicted in the following diagram in an escalating level of involvement.

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Given the topography of the SGI and the simple fact that they are islands, a unique set of technological challenges and considerations in delivering connectivity presents itself such as:

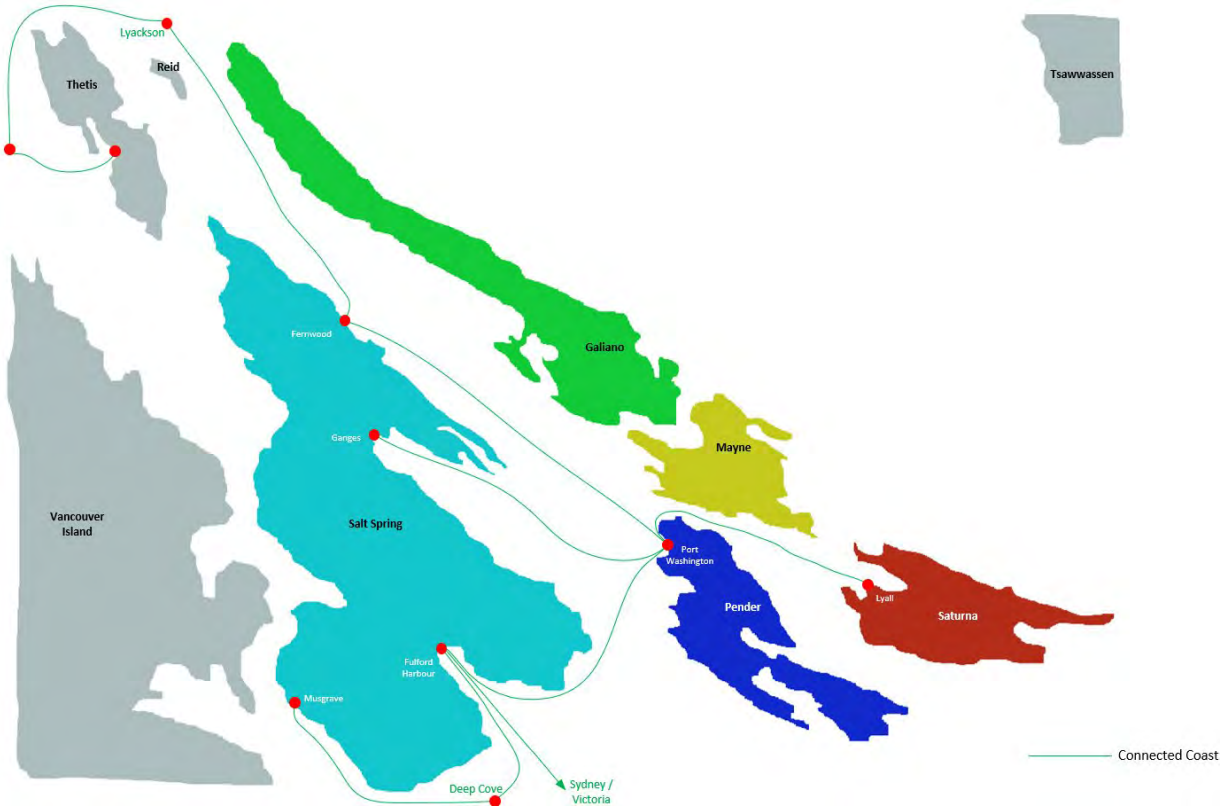
- Wireless technology can be challenging for island topologies due to the difficulty in locating wireless hub radios in a location that provides Line of Sight ("LOS") coverage for the coastline.
- It is often more desirable to serve Points along the coast from a neighbouring island to capture as many Points as possible from a tower location.
- Cellular and microwave radio towers may be viewed as undesirable making it difficult and more costly to provide these services.
- The SGI tend to be heavily treed which contributes to the LOS issues.
- Bringing high-capacity fibre optic connectivity to an island can be more challenging given the need for under-sea cables and various approvals required.
- Providing for a wired solution (eg. FTTP), may be more costly due to the difficulty in constructing underground infrastructure. Underground construction is desirable because it is less vulnerable to fibre breaks making it more reliable. Additionally, it avoids the extensive delays and cost in obtaining the approvals to use existing aerial infrastructure. In the case of the SGI, it may be cost prohibitive or very difficult to construct because of the terrain. The characteristics of the SGI may push the design to aerial construction. While aerial construction would seem an obvious choice for the SGI, it is also not without its challenges as access to poles requires incumbent approval and the process of obtaining that consent can be protracted. In addition, aerial construction has the additional vulnerability of aerial fibre to the elements such as falling trees and fire. The design decision to use underground or aerial fibre will need to be considered on a case by case basis.

Quite simply, while the long-term strategic goal is a fibre-based solution, this will take time given the physical and other challenges of existing projects and approvals. Short term improvements and certain critical infrastructure can be completed to provide more immediate relief before a long-term fibre solution can be realized.

8.2.1 Strategic Alternatives

8.2.1.1 Connected Coast - Backbone

Unfortunately, as of the time of completing this report, the islands of Galiano and Mayne are not slated for a Connected Coast landing site for the fibre optic cable even though construction of the fibre backbone will go right by these islands. The following provides an overview of the Connected Coast project as it relates to the SGI.



Backbone, particularly the capacity available with fibre, is critical for broadband and cellular connectivity. Solving the connectivity challenge requires two main components those being:

a) access to the reliable high-capacity fibre backbone
b) local access technology suitable for delivering the desired service levels.

Fibre backbone is almost mandatory in most situations and fibre local access is highly desirable for services levels at the USO or above.

Without a high-capacity fibre backbone to these islands, the capacity available to the residents will always be constrained. As such, the main recommendation for this alternative is to ensure timely connectivity of ALL islands in the SGI to Connected Coast.

Scope:

CRD needs to work with Connected Coast to secure landing areas on Galiano and Mayne. Further considerations should include augmenting the design of Connected Coast to increase backbone redundancy by creating alternate fibre paths between the SGI.

Positives:

[+] Connected Coast provides open access to a high-capacity fibre backbone for all service providers to use that does not currently exist.

[+] Creates opportunity for increased services for multiple providers.
[+] Potentially lowers the cost of Internet backhaul (connectivity from the island to the Internet).
[+] Potentially brings additional providers to the SGI.

Negatives:

[-] Connected Coast schedule does not meet expectations for delivery of services to SGI. Currently scheduled into 2023 as a high-level timeline. It is unclear when construction will begin or end.
[-] Does not provide for open access fibre for local access (last mile) alternatives as part of the current scope.
[-] Does not currently include the islands of Galiano and Mayne.
[-] No available information on services available or costs at this time.
[-] Current understanding is that construction plan is from North to South and the SGI is essentially last on the construction list.

Immediate CRD Actions:

- Work with SRD and CityWest to address the build schedule.
- Lobby more senior levels of government for additional construction details and concerns over schedule and lack of landing areas.
- Seek funding to address the missing landing areas if required.
- Lobby and seek a path to have critical priority fibre links that can address immediate capacity bottlenecks to be built more quickly.

High Level Cost Considerations:

At this time, there is no indication of what co-location (ability to locate equipment in the Connected Coast POP) infrastructure may be available, the cost to co-locate equipment or the cost of capacity on the Connected Coast backbone. While there is no cost to the CRD to construct Connected Coast, there are no landing areas on Galiano and Mayne. Connected Coast did indicate that landing areas for Galiano and Mayne could be addressed for approximately $100k each if they were included into the existing scope of work and completed as part of the construction.

8.2.1.2 Shaw

Shaw currently provides Internet and cable television services to the islands of Pender, Mayne and Galiano via a wired coaxial cable infrastructure. Coaxial cable is a good alternative to local access fibre and provides capability for service at the USO and above, in addition to entertainment services such as cable television. Shaw currently does not provide service to the island of Saturna and is constrained in backbone capacity due to the missing Pender Link. While constructing the Pender Link is included in the Connected Coast project, the unknown services and timeline for Connected Coast to be available for service provision does not provide an immediate solution for Shaw connected customers.

Scope:

The CRD should consider a joint effort with Shaw to complete the missing Pender Link to alleviate the current capacity issues as well as to complete a connection to Saturna. Addressing the backbone capacity would provide a very short term solution for customers of Shaw on the 3 islands that already have Shaw services.

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Estimates based on publicly available data shows that if the backbone constraint was removed, an estimated 4,660 Points could benefit from the increased capacity and may have services at level much closer to, or in excess of the USO.

Positives:

[+] Shaw already has cable infrastructure, is an existing provider and delivers services to the SGI other than Saturna.
[+] Coaxial cable can provide high-capacity connectivity and while not as scalable as fibre, it is probably the next best choice to fibre.
[+] By addressing the fibre backbone in a timely fashion, immediate relief could be realized for Shaw customers.

Negatives:

[-] There are no plans to address the backbone constraint and Shaw is likely not motivated to invest in the fibre backbone given the Connected Coast project.
[-] Without addressing the backbone constraint, there is little that can be done for Shaw customers to address capacity.
[-] Rogers has announced an intended purchase of Shaw. The outcome of this and how it might impact CRD is unknown.
[-] Information received is that obtaining government approvals for a new sub-sea fibre cable can be extensive.
[-] Alleviating the backbone constraint for Shaw may negatively impact existing providers in the SGI.

Immediate CRD Actions:

- Initiate detailed discussions with Shaw and Rogers to understand longer term plans for the combined company and strategic play for the SGI.
- Lobby more senior levels of government to address more timely process in gaining the necessary approvals to constructing the required fibre backbone.
- Seek efficiencies between the required fibre backbone and the Connected Coast construction to improve the timeline on this critical link in a way that aligns with existing Connected Coast plans.

High Level Cost Considerations:

The ability or appetite of the CRD to assist in addressing the two main factors for this alternative (backbone capacity and lack of service on Saturna) is unknown at this time. If the CRD were interested in exploring this alternative, it is expected that the Pender Link would cost approximately $1.5M to $2.5M with an additional equivalent cost to connect Saturna with backbone.

8.2.1.3 Existing Wireless Service Providers

There are a number of existing wireless providers that are offering competitive services on the SGI. These providers are using unlicensed wireless technology to offer improved services as a local solution to the connectivity problem. These providers struggle with many of the issues facing other providers like them such as:

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

- Obtaining timely approvals to place the required infrastructure
- Public concerns with wireless towers. Some segments of the population have health and safety concerns with wireless technology.
- Interference in the unlicensed wireless space between competitive providers and other sources.
- Lack of resources and time to complete grant applications, construction and installations.
- Competitive disadvantage arising out of lack of capital.
- Costly access to external services that are required to deliver services.

Scope:

Existing wireless providers have a passion to improve services for the SGI and in some cases, perform these services in a not-for-profit business model. The CRD has made efforts to support existing providers and has attempted to address their concerns in delivering services. The CRD should continue to work with and support the initiatives of the existing wireless providers as in the short term, this is the most effective alternative to obtain improved service. Every effort to remove the practical barriers to improvements should be considered.

Positives:

[+] Local solution by companies with a passion to provide connectivity in the SGI.
[+] Practical solution to provide timely connectivity without the need for expensive wired solutions.
[+] More than one provider is available to maintain consumer choice and competitive service.
[+] Existing providers are delivering services where other providers are not willing to.
[+] On island support for customers.

Negatives:

[-] Unlicensed wireless will always lag the capability and ability to provide higher capacity services than other technologies.
[-] Unlicensed wireless suffers from the inherent concerns with interference and ability to scale.
[-] Wireless service requires LOS and can be difficult to achieve for homes along the coast, in challenging terrain and in heavy tree cover all of which apply to the SGI.
[-] Concerns from the public about unsightly or harmful wireless towers in the area (Not in my Backyard).
[-] Backbone capacity is still a concern even with wireless local access.
[-] Future capability to meet long term expectations. Services are often not at current USO and the capacity required will only increase.

Immediate CRD Actions:

- Support the existing wireless providers requests for infrastructure where possible.
- Work with Connected Coast to address the long timeline to bring higher capacity backbone services to the SGI.

High Level Cost Considerations:

At this time, there is no known cost impact to the CRD to address this alternative.

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Phone: (250) 341-6118
Email: info@tanexengineering.com

8.2.1.4 Telus PureFibre

Throughout BC, Telus is considered the incumbent provider and enjoys the advantage of many years of infrastructure that has been constructed. Telus typically provides services to rural areas of the province in one of two ways, 1) via existing copper phone lines using DSL technology 2) via cellular technology in a mobile or fixed wireless model. In either case, Telus often has a large advantage over other providers with access to a vast amount of infrastructure including existing wired infrastructure, aerial pole lines and underground conduits, large number of business resources and ability to leverage funding opportunities and access to licensed wireless spectrum not available to other providers.

Telus does have a FTTP solution, branded Telus Purefibre, and has deployed this solution to other rural areas of the province. Like any for-profit provider, the business case for investment must make financial sense and where public funds are not available, Telus has completed projects that are subsidized by the local governments or residents to bring a more advanced solution like PureFibre to the community.

Scope:

While it is not confirmed whether Telus has any plans to bring PureFibre to the SGI, they are likely best positioned to bring a fibre optic local access solution to the SGI. Any other provider wanting to bring a wired solution like fibre, will be faced with the need to either place infrastructure underground or obtain approvals from Telus to use existing aerial and/or underground conduits. While there is a defined process to obtain this approval, in practice, it is protracted, painful and expensive. It often requires a dedicated effort and patience and will more than likely involve substantial make ready costs (ie. costs to upgrade aerial infrastructure where it is deemed required) and an ongoing annual fee for pole attachment fees.

Positives:

[+] Best positioned to bring a competitive wired fibre solution to the SGI.
[+] Large company with an established record of completing similar projects.
[+] Ability to access public funding.
[+] PureFibre offers a scalable, reliable, high-capacity solution.

Negatives:

[-] Telus has not indicated any plans or desire to provide PureFibre to the SGI.
[-] A capital contribution to Telus to complete a PureFibre solution will very likely be significant.
[-] Although this has not been confirmed, Telus may also be constrained in backbone capacity to the SGI.
[-] Focus for an SGI solution appears to be cellular rather than a wired solution.[-] Completion of the Telus PureFibre solution does not promote a competitive landscape for consumers.

Immediate CRD Actions:

- Solicit a proposal from Telus to bring Telus PureFibre to the SGI.
- Use the information in this strategy to focus Telus on the priorities of the CRD.

High Level Cost Considerations:

The potential cost for a Telus PureFibre solution is unknown but is expected to be significant as Telus will have a maximum investment level that it is willing to contribute based on its business profit model and the difference between that and the quote provided by Telus to bring the service will need to be made up by the local government or by some other means.

8.2.1.5 CRD Service Delivery

The final alternative discussed in this report is the possibility of a CRD solution in which the Regional District owns some or all of the infrastructure required for a fibre solution. Fibre optic backbone and local access networks is the preferred option for a high capacity, reliable wired solution. No other technology currently available can match the reliability and scalability of fibre.

While other for-profit providers will always seek a suitable business case to ensure a profitable network, the CRD may be a motivated by a self-sustaining model rather than a profit driven model. With the introduction of Connected Coast to the SGI, the existing backbone capacity constraint will likely be resolved. However, the existing plan does not provide local access service and as a result, service to residents and businesses may still not meet the USO. Further, the introduction of fibre services by any other provider will likely displace the existing wireless providers that have focused their efforts on providing improved services for the SGI.

A CRD delivered solution can be constructed in a manner that promotes competition and consumer choice in the form of an open access solution. An open access solution is one where the CRD (or another entity motivated in the public interest) provides the infrastructure and allows other external providers to use the infrastructure to offer competitive services over that common infrastructure. This alleviates the need for every provider to construct its own network to offer competitive services.

Scope:

Consider the possibility of how the CRD might participate more fully in the solution and what assets it has that it could contribute to an open access solution and the Regional District's ability and desire to participate in full or partial ownership of some or all the required infrastructure.

Positives:

[+] Services are delivered that address CRD priorities rather than those of profit driven provider.
[+] Multiple providers have access to the infrastructure to offer competitive services in an open access environment.
[+] Consumer choice, increased customer service and competitive consumer costs.
[+] Results in a high-capacity network that is developed and maintained and continues to keep pace with technology, all in public interest.
[+] Recent changes to the Local Government Act enable Regional Districts to form partnerships with ISPs.

Negatives:

[-] This is an innovative step for a Regional District and the CRD does not currently have the organizational structure to support it.
[-] Regional District concerns with getting involved as an owner/operator of technology.
[-] Requires Service Establishment by voter assent.
[-] Requires contracting with the necessary technical and business skills.

[-] Risk and public perception.

Immediate CRD Actions:

- Consider establishing a service to enable funding or owning infrastructure.
- Consider the possibility of a fully or partially owned Regional District network that is in the public interest.
- Seek technical and operational expertise to contract in connection with the network.
- Seek P3 partners that may be able to assist in deploying this business model.

High Level Cost Considerations:

A high-level cost estimate was prepared for the SGI and can be used as an estimate for this alternative. The cost estimate assumes access to the backbone fibre capacity from Connected Coast, or another equivalent solution. The cost estimate is provided in the ancillary document to this report.

Whether this is a CRD provided solution, a partnership between the CRD and another third party, or a third party only solution, the cost estimate provided should be considered a high-level estimate to bring a wired FTTP solution to the SGI.

8.2.2 Other CRD Initiatives

8.2.2.1 Establish CRD Resourcing

Like most initiatives, making tangible progress towards a goal requires dedicated effort by the stakeholders. Like many organizations, Regional Districts suffer from the problem of more regional needs than time and resources to complete them. In order to effectively move the connectivity challenge forward however, the CRD needs to consider a dedicated resource that can manage the CRD priorities and ensure progress towards its objectives. Among others, some of the tasks for this resource may be as follows:

- Facilitating internal CRD decision making about its role and establish working parameters to guide the effort.
- Establishing CRD priorities.
- Communicating the priorities to external providers, partners and other stakeholders.
- Creating a method to measure and ensure progress.
- Participate in existing connectivity working groups.
- Researching, gathering information and obtaining access to funding.
- Resolving discrepancies in the ISED map to maximize the number of eligible areas for funding.
- Working with other experts to create solutions.
- Gaining community support for initiatives.
- Focusing and responding to letters of support by providers to ensure the proposed solutions meets to the goals of the CRD.
- Potentially advancing the creation of service areas depending on the CRD direction.

8.2.2.2 Present Priorities to Providers

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Regardless of the role of the CRD, the Regional District must communicate its priorities to potential providers in a cooperative fashion. Providers such as Telus, are applying for funding subsidies based on their defined areas of interest and choice of technologies and may not be considering all the priorities of the Regional District. Using the information outlined in this report, the CRD is better positioned to understand these areas and communicate its priorities to external third parties.

An advocacy role makes cooperative participation with providers a key action for the CRD.

Letters of support are often requested by providers and these letters need to be considered carefully to ensure the proposed project aligns with the goals and priorities of the Regional District. Further, funding programs often have eligibility criteria and care needs to be taken to ensure that projects are positioned for future scalability and do not provide marginal improvement which has the result of disqualifying the area from future funding by establishing an improved service but not consistently throughout the community at the USO.

Investments in infrastructure should be scalable to meet the current USO and position appropriate technology for current and future requirements particularly if public funding is deployed.

Considerations for the letter of support should include:

- Definition on the specific projects area(s).
- Inclusion of other surrounding project areas and priorities that may not be the intended focus but could be addressed more efficiently by inclusion in the requested scope.
- Defined project timelines.
- Defined levels of service and technology. Ideally projects that are requesting funding should be completed with technology that meets or exceeds the current USO as while this may be considered sufficient for today's needs, technology continues to evolve and requirements for connectivity are likely always increase.
- Definition of the services desired. This is discussed more in the next section.
- Support for infrastructure to be constructed in a manner that promotes competitive services and provides where the providers is seeking public funds.

In addition to communicating project priorities and support for third party initiatives, the CRD may be able to contribute Regional District owned assets that can be leveraged by providers to reduce the barrier to entry in the priority areas. The Regional District may have access to buildings, locations, rights of way, etc that may be available to contribute to a project. Firehalls provide a good example of a Regional District asset that could be used as a Point of Presence ("POP") required in delivery improved connectivity.

The Regional District should inventory its available assets in an effort to make them available where required to reduce the barrier to entry for a provider.

8.2.2.3 Establish a Timeline

The CRD should establish a timeline for noticeable action and improvement. Federal and provincial funding programs have an inherent problem of slow response. Often, funding programs are announced, time is given to obtain funding applications, time is allotted for evaluation, announcements are made, clarifications and questions are required, funding is deployed, detailed construction plans are drafted, approvals are required for access to existing infrastructure and finally construction begins. The

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

problem is that the time to complete this is measured in years rather than months. Further contributing to this problem is that federal, provincial and local government changes in leadership may stop advancing the solution due to differing priorities.

The CRD must establish milestones which provide a checkpoint for completion with a predefined action and escalation plan if the milestone is not reached when expected. Once project priority has been established, clear established milestones for engaging service providers, assessment of options, decision on the path forward, etc have been developed. For example, a timeline may be established that if provider engagement has not been achieved within 3 months of initial engagement, the CRD has a plan to escalate the initiative to what might eventually be a more active role for the CRD is obtaining the solution.

8.2.2.4 Seek P3 Partners

One of the evolving options for solving the connectivity challenge is the development of Public Private Partnerships ("P3'). While the CRD may not have explored these opportunities to date in this space, there are some options worth considering. These may include a range from established providers developing more creative models to involving private funding in a variety of forms. This may also include a simple financial contribution with no established method for sharing of revenue, control or ownership, to a more active role of participating in the ownership and sharing of the revenue to make the investment sustainable.

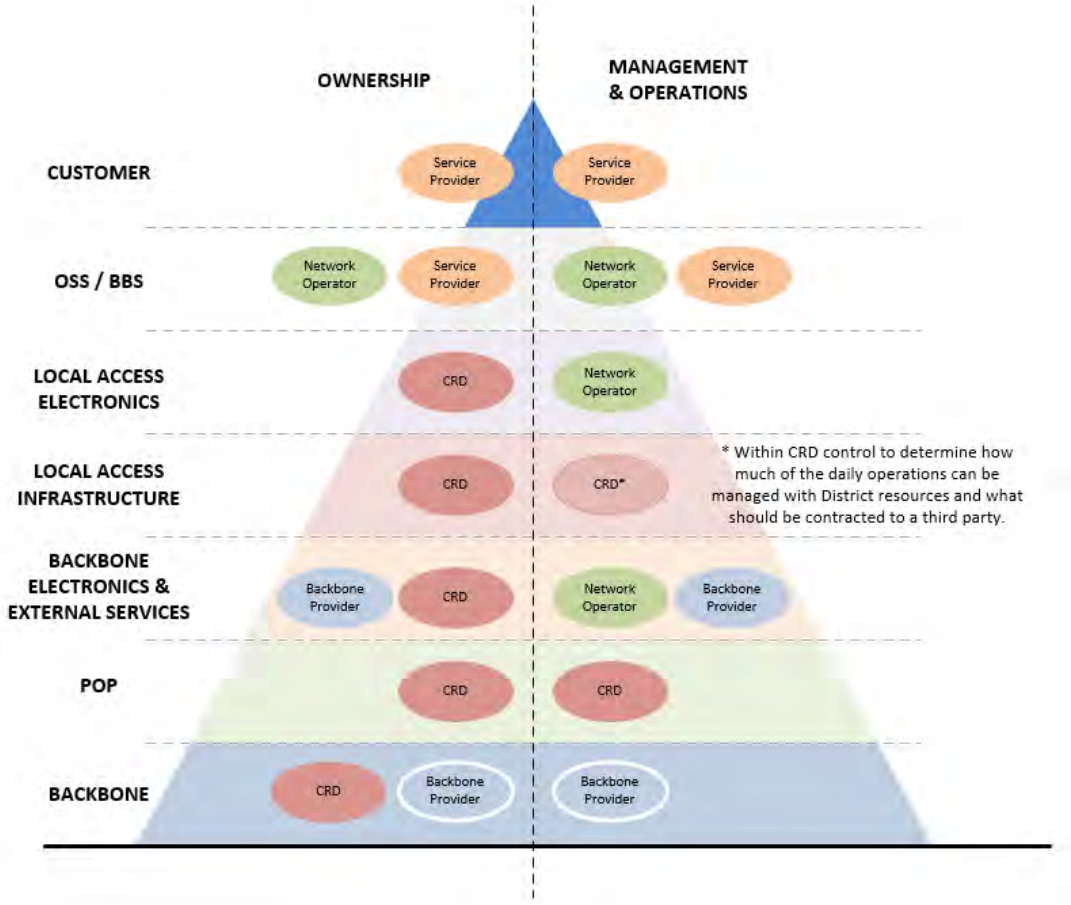
8.2.2.5 CRD Business Model

As discussed earlier, providing connectivity requires that all layers of the SDP be solved. This does not mean that the CRD must own and manage every layer of the pyramid or have a detailed understanding of telecommunications and network troubleshooting, but rather that it actively participates in a model in which multiple parties collaborate to resolve the pyramid each bringing a set of skills and resources.

To solve the pyramid, there are four main parties involved each with a discrete role and responsibility. A single organization may fill multiple roles or, different aspects may be fulfilled by more than one party. The business model may vary but assuming the CRD decides to take a more active role in the solution, the main parties to consider are:

- The CRD – Owns (either by itself or together with others) the network and has ultimate control over it. To provide service, the CRD contracts with the parties below to provide the specified parts of the network.
- Backbone Provider – Third party that provides the backbone and global connectivity to the network.
- Network Operator – Third party that manages, operates, and maintains the network on behalf of the CRD and can provide technical escalation path to Service Provider.
- Service Provider(s) – Third party that provides the customer facing services, operations, billing, collections, and technical and customer support.

This structure is overlaid on top of the SDP that was introduced earlier in this report and provides one conceptual view of a business model, but there are several variations that can be considered depending on the desired role of the CRD.



8.2.3 Conceptual Network Architecture

The cost estimate provided is based on the following conceptual design that would utilize Connected Coast to bring high-capacity fibre optic connectivity to each island. Fibre connectivity would be distributed throughout the islands approximately as shown. All connectivity to the homes would be completed using FTTP technology.

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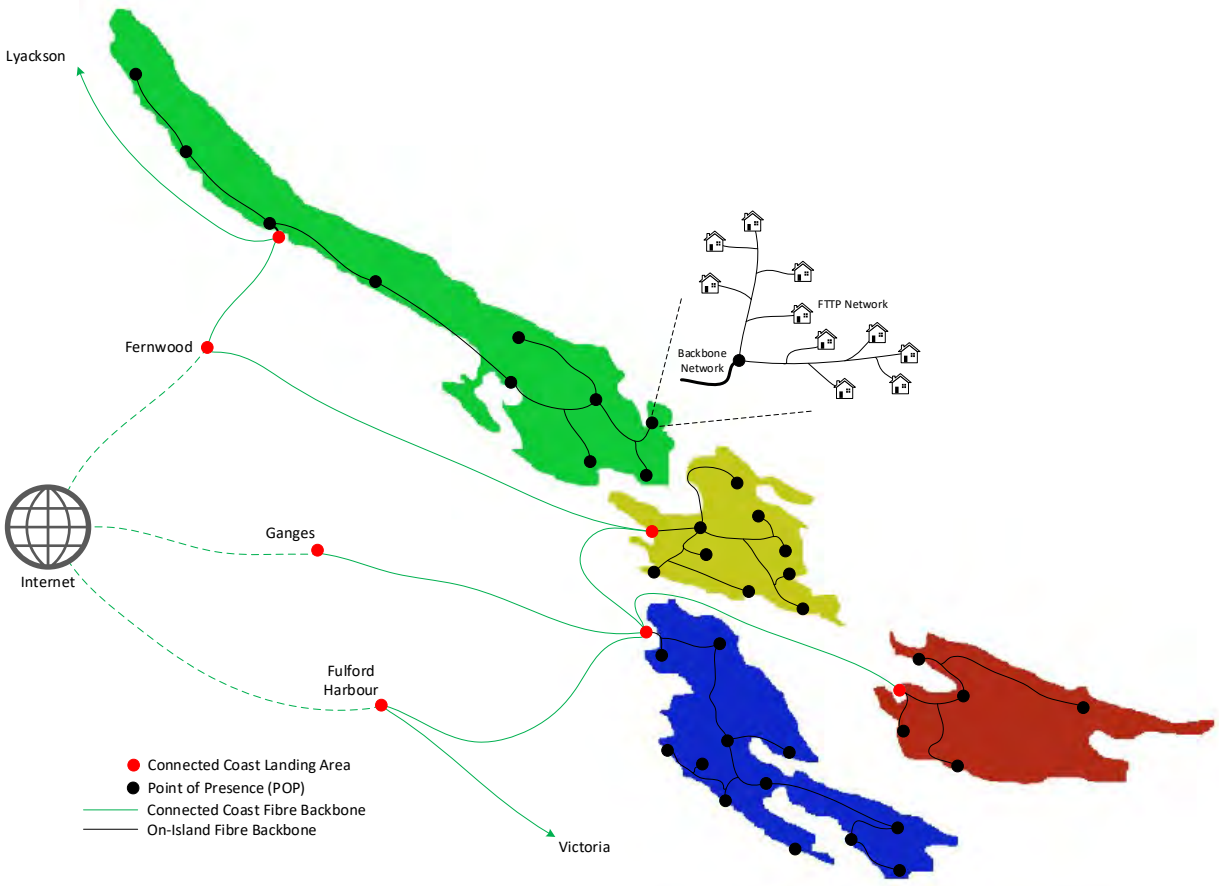
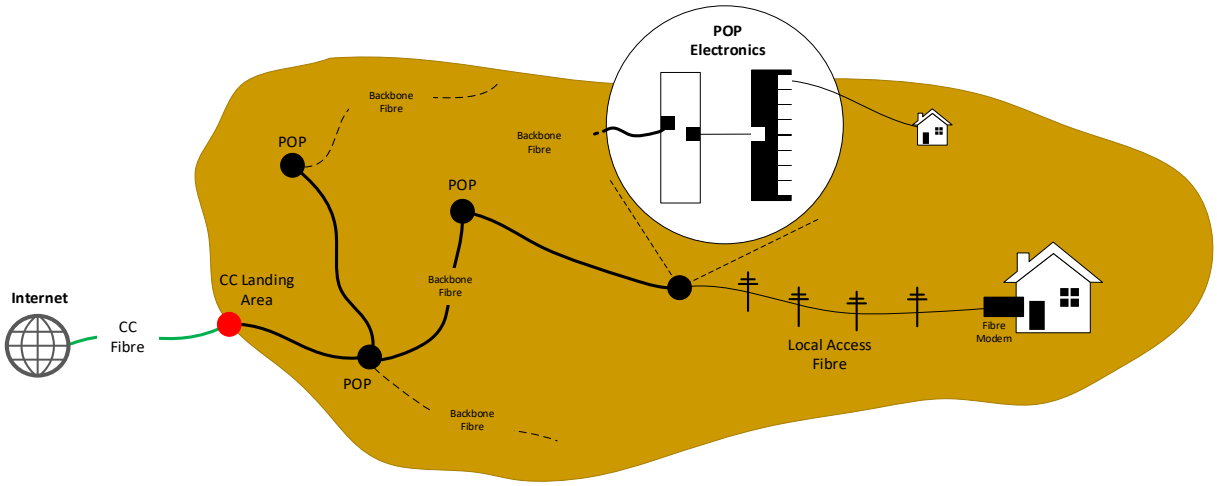
Email: info@tanexengineering.com



Within each island a series of POPs are established to connect different areas and clusters of homes. These may have different types of equipment depending on the requirements ranging from small passive POPs (ie. POP that require no power) to large cabinets or shelters that may contain 100s, or 1,000s of fibre optic connections to connect homes in the immediate vicinity. Within each POP location, appropriate electronic components are required to connect a single fibre strand from each home back to the POP. These connections to the homes are aggregated in a POP and then connected back to other POPs and eventually to the Connected Coast (or another backbone provider) and the global Internet.

While the cost estimate takes into consideration the location and clustering of homes with an approximation of where POPs might be located, a more accurate estimate and detailed design will be required if warranted.

The following provides a conceptual view of how connectivity is provided within an island.



8.3 Cost Estimate

The scope of this project is to provide the Regional District a strategy outlining the recommended actions to be completed by the Regional District and an order of magnitude cost to complete the strategy.

Cost estimates for identified projects are found in the project summary ancillary document and are intended for internal CRD staff and not intended for sharing with third parties including service providers.

8.4 Options for Sourcing Capital

Funding for rural broadband is a priority item for government, particularly considering the on-going COVID-19 pandemic. Remote and rural broadband projects are unlikely to be implemented by service providers without financial support as those service providers have business requirements that drive where and when they will invest their own funds to construct additional network capacity. Rural and remote capacity simply does not meet those requirements so there will be a financial gap between what a provider is willing to invest and what it costs to provide the service. This financial gap will need to be filled if service is to be provided in those areas.

Sources of funding in place at the time of writing for projects of this nature have been identified below. Funding programs have been included even if there is no currently open intake to identify places to look for funding options once a project is moving forward. **A detailed review of the application guide materials will be necessary to identify the specifics of the proposed project and the requirements for applying.** That detailed review should be a priority item so that appropriate work is commissioned in time to be "shovel ready," if, and when, a decision is made to proceed with a project either through the Regional District itself or through a third-party provider or some combination of the

two. It should be noted that as program intakes close, there are sometimes iterations of the funding requirements that apply in subsequent intakes so each phase or intake should be reviewed closely.

- Universal Broadband Fund (the "UBF") is a $1.75 billion fund through ISED (2021 budget adds $1.00 billion to this fund) for the expansion of affordable, reliable, high-speed internet service in areas of Canada that have been identified by ISED as not having access to service at the USO or for mobile projects primarily benefitting Indigenous peoples. Funding is available until March 31, 2027. Applicants can request funding for up to 75% (or 90% in the case of highly remote areas or mobile projects primarily benefiting Indigenous peoples) of total eligible costs as defined in the program. The first intake just closed on March 15, 2021.

- Connecting British Columbia is a BC government funding program administered by the Northern Development Initiative Trust which is open to local, regional, or national service providers, local governments; First Nations or BC not-for-profits. The program has a number of focus points described below.

    - Last-Mile, Transport Infrastructure:

        - This program is in its third phase and has, as its objective, the acceleration of the delivery of internet connectivity at the USO to homes and businesses in rural and Indigenous BC communities. The program will accept applications through successive intakes until funds are exhausted. The fifth intake just closed on March 15, 2021. Projects that are already ready to go will rank more favourably than ones which rely on other steps to be taken first. A pre-screening process is required which ensures that an applicant either has the experience requirement (3 years' experience deploying and operating the proposed broadband infrastructure in Canada) for an application or will work with an ISP that does. In addition, the applicant must agree to own, operate, and maintain the resulting network for 3 years after the project is complete otherwise some repayment of the funds will be required.

            - Transport Infrastructure – 50% of eligible costs for transport infrastructure. Fibre project are highly preferred over other transport technologies such as microwave. In some cases, project will require a partnership with a facilities-based provider that provides confirmation that the proposed network design meets their standards for future expansion of cellular coverage along the route. Transport projects should achieve at least one of the following:
                - new or upgraded transport infrastructure that provides open-access for transport and internet gateways at affordable wholesale rates to last-mile service providers in those underserved regions;
                - improve network resiliency and provide redundancy;
                - provide future services such as cellular, public Wi-Fi or future technology;
                - increase competition in areas with high prices and low capacity;
                - enable government services in rural areas.

            - Last-Mile Project - 50% of eligible costs to improve last mile connectivity in underserved rural and Indigenous areas in BC but follows a baseline funding level of $250,000 per community. Last mile infrastructure is to provide potential for long-term usage and expansion through technologies such as fibre, coaxial cable and fixed-wireless LTE. The project is to align with the

region's plans to show that the project is a priority for the communities it serves. It should be noted that the application documentation provides a list of BC rural and Indigenous communities along with whether that community does or does not have connectivity at the USO. The application guide states however, that if a project is also seeking funding from a federal connectivity fund, then the federal program will dictate whether the project is qualified. This is important to note as there are examples where the Connecting BC list includes a community, but the federal map shows it as served in some fashion.

- Economic Recovery:
  - A one-time $90 million infusion to encourage rapid expansion of connectivity to "drive regional economic development in rural areas, Indigenous communities and along BC highways." Funds were to be fully allocated by March 31, 2021 for connectivity infrastructure projects that would be completed by October 31, 2021. This funding stream prefers projects that deliver 50/10 but considers projects that provide 25/5 as eligible. Compared to the regular Connecting BC program above, it has increased funding ratios (90% rather than the 50% through the regular Connecting BC program) and supports a wider range of technologies as well as highway connectivity projects.

- Core UBF:
  - An intake intended to leverage the main federal Universal Broadband Fund. Now closed to intake.

- Rapid Response UBF:
  - An intake intended to leverage the Rapid Response Universal Broadband Fund. Now closed to intake.

- The Broadband Fund (the "BBF"). – In connection with upgrading infrastructure to meet the USO, the BBF was established by the CRTC to provide funding of $750 Million over five years. The second call for applications closed on June 1, 2020 so this fund is not currently open for applications at the time of writing. This fund provides funding for backbone projects, local access projects and mobile wireless projects. The Broadband Fund has committed up to $156.5 million of the fund to date[11].

  CRD can apply to the BBF directly or as a member of a joint venture, partnership, or consortium with other eligible entities – eligible entities include other regional districts, first nations, municipal governments and private for-profit or not for profit service providers. BBF requires that "**the applicant, or at least one member of a partnership, joint venture, or consortium must have at least three years of experience in deploying and operating broadband infrastructure and must be eligible to operate as a Canadian carrier**." If this criterion is not met by the applicant or a member of the consortium, the applicant must enter contract with an entity that does.

- Gas Tax Fund – permanent funding normally provided twice a year by Infrastructure Canada. In BC, there is a tri-partite agreement between Canada, BC and the Union of British Columbia Municipalities ("UBCM"). Infrastructure Canada flows the funds to UBCM who then flows them to local governments for investment in local infrastructure priorities, specifically including use for broadband and connectivity.

[11] CRTC – Broadband Fund – *Projects selected for funding*

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

- Trusts or non-profits that have support for CRD as part of their mandate.
- Private industry partners that may support a public/private partnership infrastructure project.
- Lenders such as the Canada Infrastructure Bank which has $2 billion in loans and equity for new broadband infrastructure projects.
- Local government taxation where possible.

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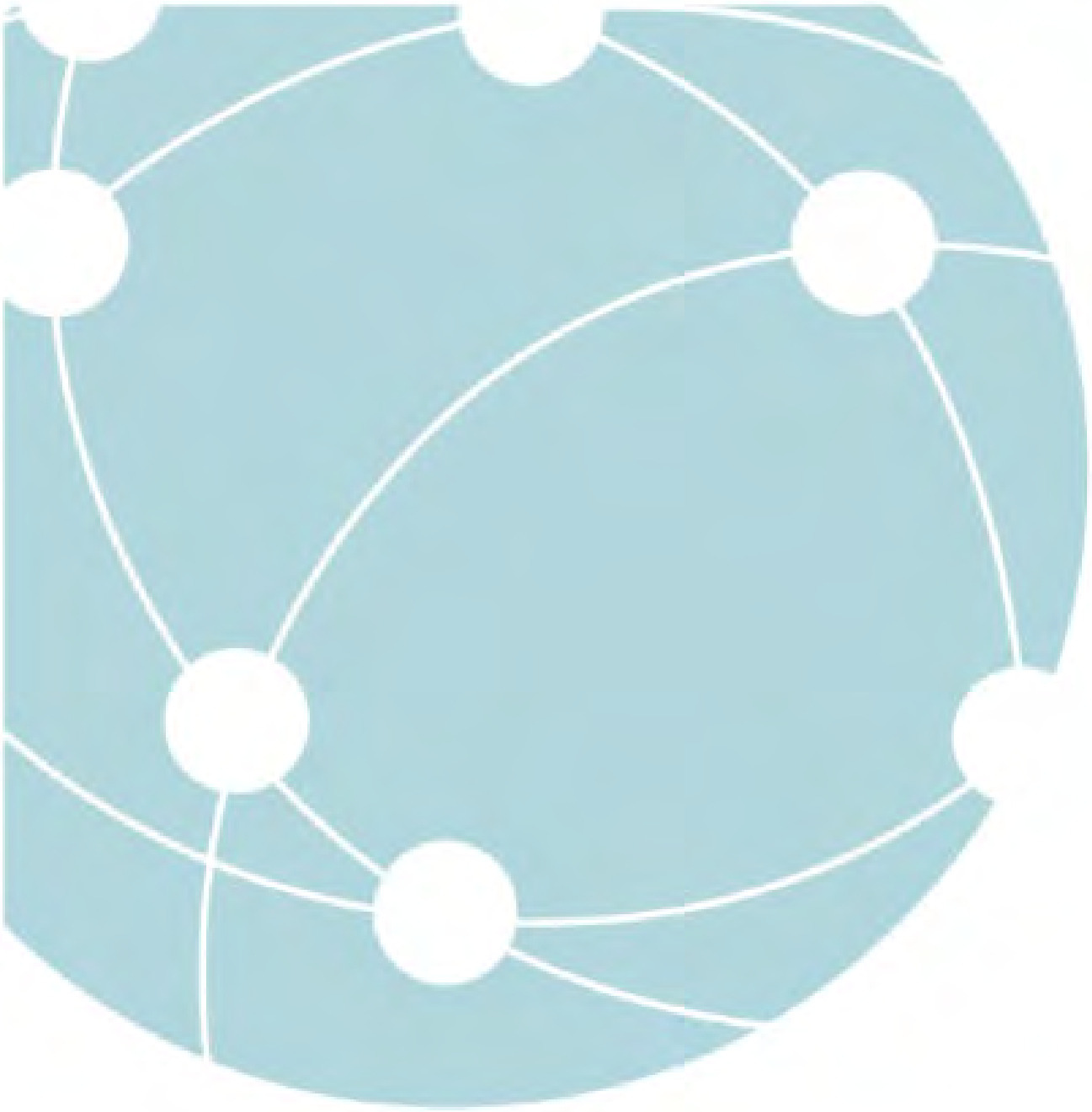
Phone: (250) 341-6118
Email: info@tanexengineering.com



9 NEXT STEPS

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

9.1 Next Steps and Recommendations

Based on the information gathered during the course of this project, the following provides a summary of the recommended next steps for the Regional District.

Recommendation Summary

The following are the main recommendations on how to proceed to improve connectivity for the SGI:

- Access to high capacity fibre backbone is mandatory for all services to be scalable and meet future requirements. The CRD needs to work with Connected Coast to establish landing areas on Galiano and Mayne.
- Immediately improve the connectivity for many of the SGI residents on Pender, Mayne and Galiano by accelerating the construction of the Pender Link to remove the existing bottleneck restricting connectivity. Many of the homes on all islands except for Saturna have access to coaxial cable infrastructure which provides access to good quality connectivity. Once the bottleneck is removed, there should be a dramatic improvement in capacity available.
- Consider alternatives to bring improved wired access to Saturna. Options include working with Shaw to extend coverage the last remaining island or a third party provider.
- Consider long term connectivity requirements and options available such as P3 and/or third party providers. Fibre connectivity is the most reliable and scalable and conforms with local concerns around cellular/wireless concerns around tower infrastructure that is required to deliver these services.
- Homes that are difficult to reach via a wired solution are good candidates for emerging LEO technology.

Fundamental Tasks

- Identify a lead internal staff resource to manage and advance connectivity initiatives.
- Inventory CRD assets that may lower barriers to service delivery in the SGI.
- Align with other infrastructure type Regional District initiatives that may be ongoing.
- Actively provide intervenor feedback to the CRTC in collaboration with other local governments.
- If not already, become a member of the BC Broadband Association.
- Participate in broadband conferences, especially those focused on rural and remote communities.
- Review schedule and scope with Connected Coast for landing areas. Work with Connected Coast and / or senior government to get these included in the Connected Coast scope.

Prioritize the Project Areas

- Create criterion for prioritizing the potential projects identified in this report
    - A list of criteria that identify how each potential project will be assessed which should include identification of projects where collaboration with First Nations or neighbouring Regional Districts is available
- Complete the prioritization of the potential projects.

Determine the Role of the Regional District

- Identify what contribution the Regional District will make to solving the connectivity challenge.
    - Advocate/facilitate/lobby
    - Contribute capital to third party
    - Partnership with a service provider

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Phone: (250) 341-6118
Email: info@tanexengineering.com

  - Construct and own infrastructure
- Determine specifics of how that role will be fulfilled
  - If, for example, CRD decides that its role is to contribute capital, what are the mechanics of that

Create an Action Plan

- Identify project specific steps to address each priority area
- Communicate priorities to service providers
- Provide specific information about SGI's priority areas to providers for both internet and cellular
- Develop a process and minimum service levels for responding to requests for letters of support to ensure that SGI's priorities are being addressed
- Identify the specific barriers to service delivery in each priority area and determine whether the SGI can do anything to lower or remove them
- Obtain proposals with pricing for priority project areas.

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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

9.2 About TANEx Engineering

TANEx is a professional engineering firm located in British Columbia, Canada focused on providing engineering consulting services specializing in telecommunications and networking. TANEx provides design, commissioning and operational services to its clients from varied industries and has a wide variety of expertise in connectivity technologies, infrastructure and services. For more information, please refer to our website at www.tanexengineering.com.

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

10 APPENDICES

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Appendix A - Terminology

The following provides a table of acronyms and terminology of often used in the telecommunications and networking industry.

50/10 – 50Mbps Download / 10Mbps Upload
BSS – Business Support Systems
CAPEX – Capital Expense
CATV – Cable Television
CO – Central Office
CPE – Customer Premise Equipment
CRTC – Canadian Radio-television and Telecommunications Commission
DHCP – Dynamic Host Configuration Protocol
DNS – Domain Name Service
DWDM – Dense Wave Division Multiplexer
FDH – Fibre Distribution Hub
FO – Fibre Optic
FOC – Fibre Optic Cable
FOSC – Fibre Optic Splice Case
FPP – Fibre Optic Patch Panel
FTTH – Fibre to the Home
FTTP – Fibre to the Premise
GEO – Geo-Stationary Orbit
GPON – Gigabit Passive Optical Network
IP – Internet Protocol
IRU – Indefeasible Right of Use
ISED – Innovation, Science and Economic Division
ISP – Internet Service Providers
LEO – Low Earth Orbit
LTE – Long-Term Evolution
OLT – Optical Line Terminal
ONT – Optical Network Terminal
OPEX – Operating Expense
OSS – Operations Support Systems
PON – Passive Optical Network
POP – Point of Presence
POS – Passive Optical Splitter
PSTN – Public Switched Telephone Network
ROW – Right of Way
RX – Receive
SDP – Service Delivery Pyramid
SUB – Subscriber or customer receiving service from the network
TX – Transmit
UBF – Universal Broadband Fund
USO – Universal Service Objective

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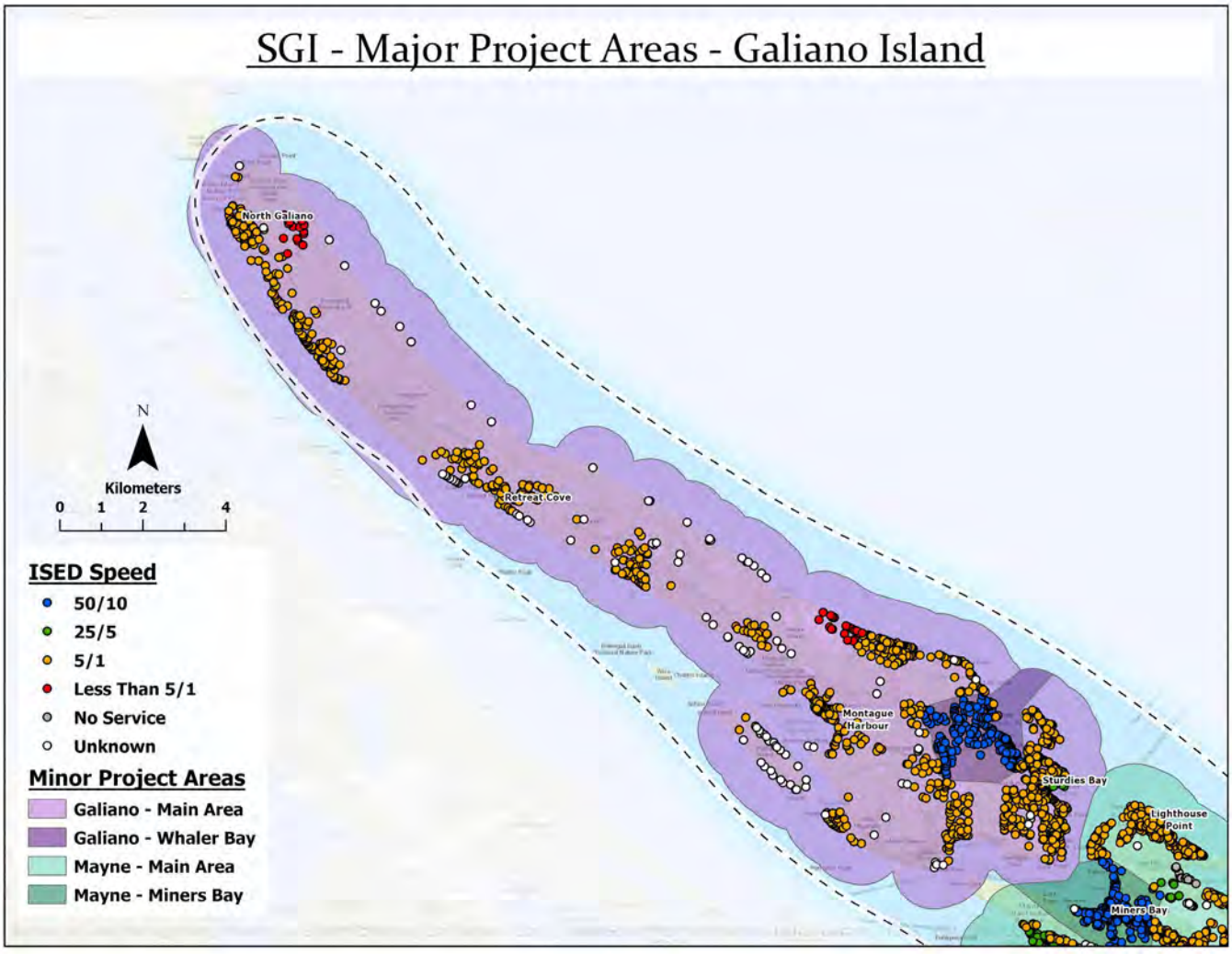
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Appendix B - Mapping - Internet Speeds Available

As part of the development of this report, a number of maps were created to provide a visual depiction of various aspects of the SGI. The island maps produced below draw data from the ISED Map to show the speeds available on the island according to ISED. In some cases, the ISED Map does not reflect the user experience but the process to correct it is difficult.

Detailed Project Area Maps



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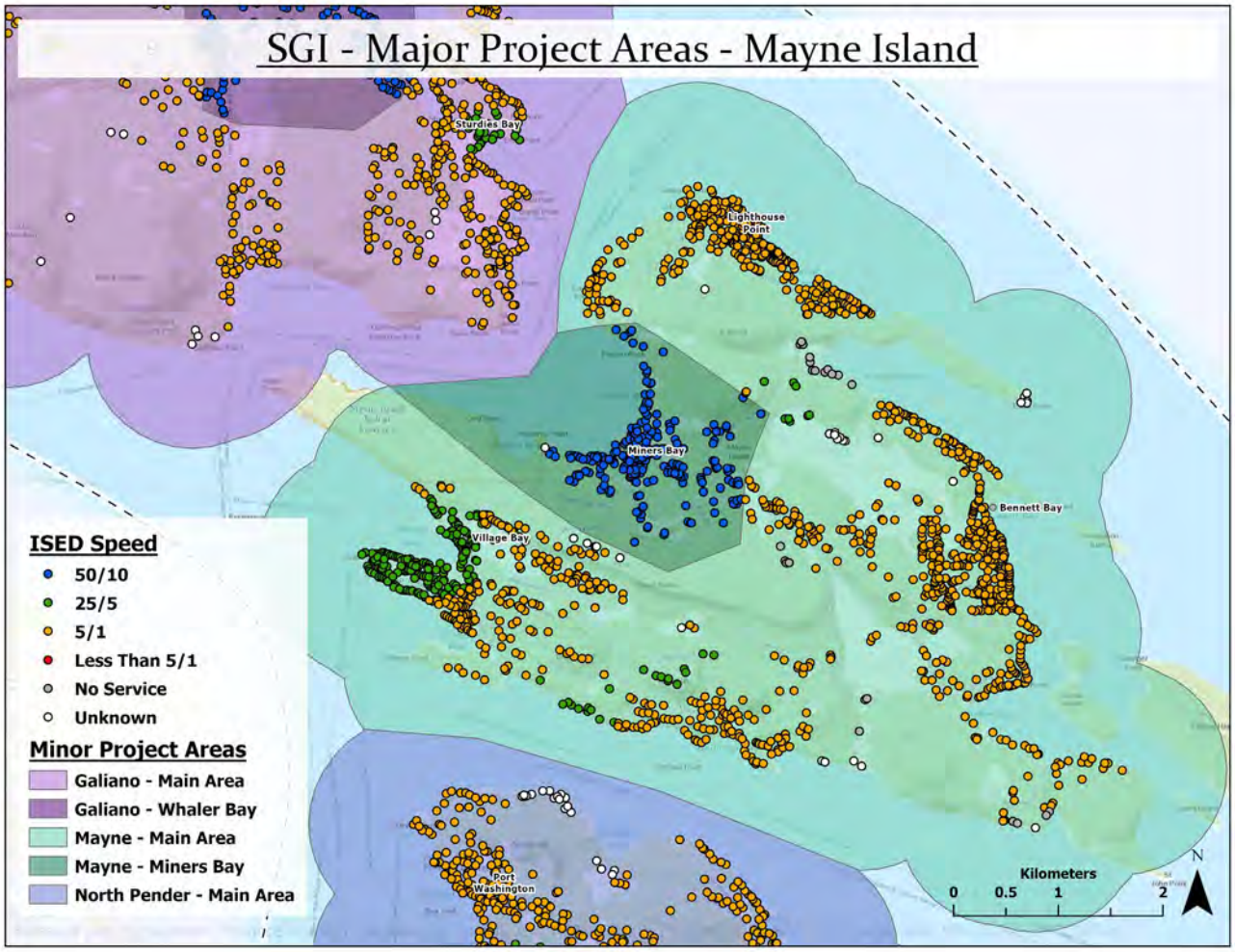

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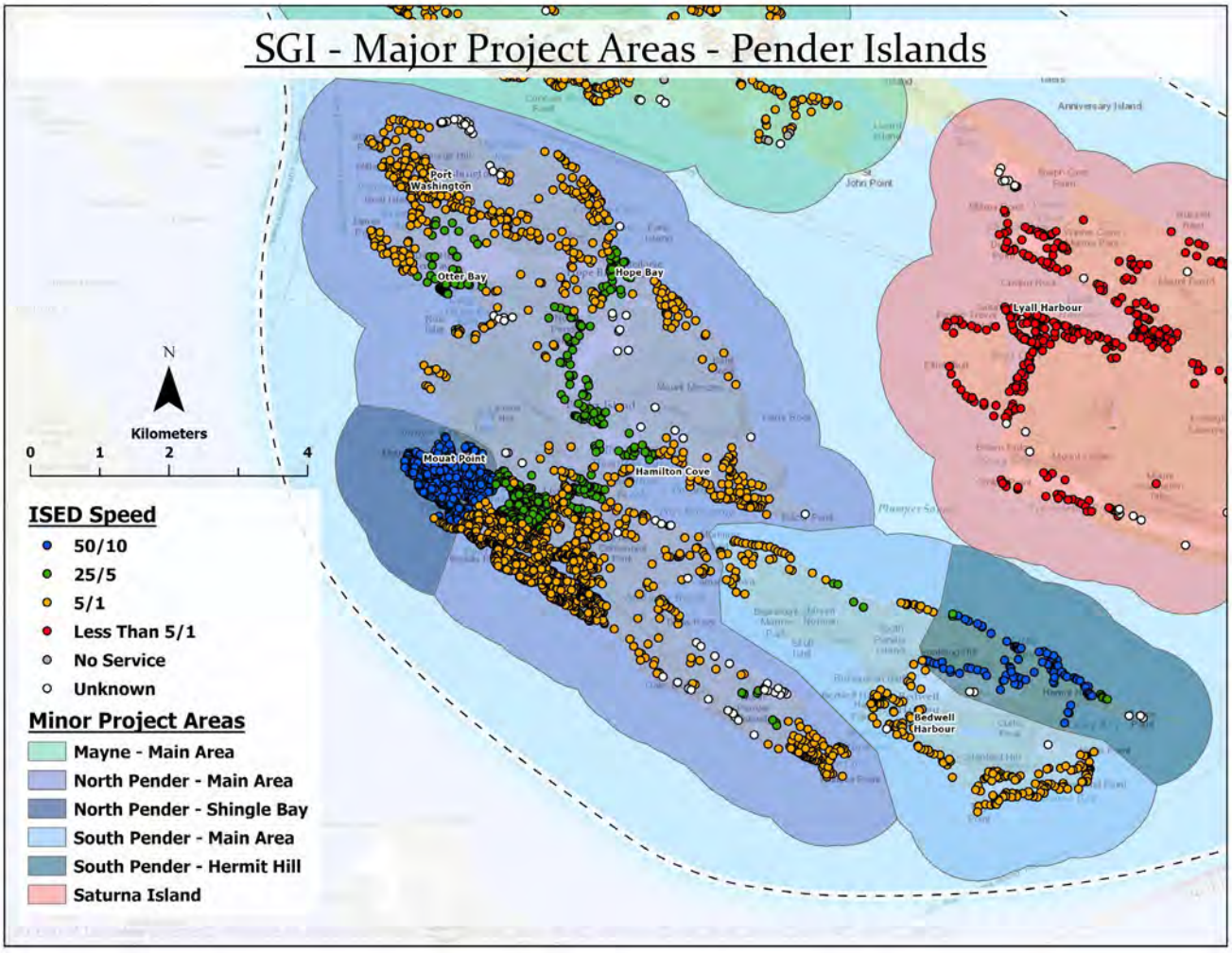

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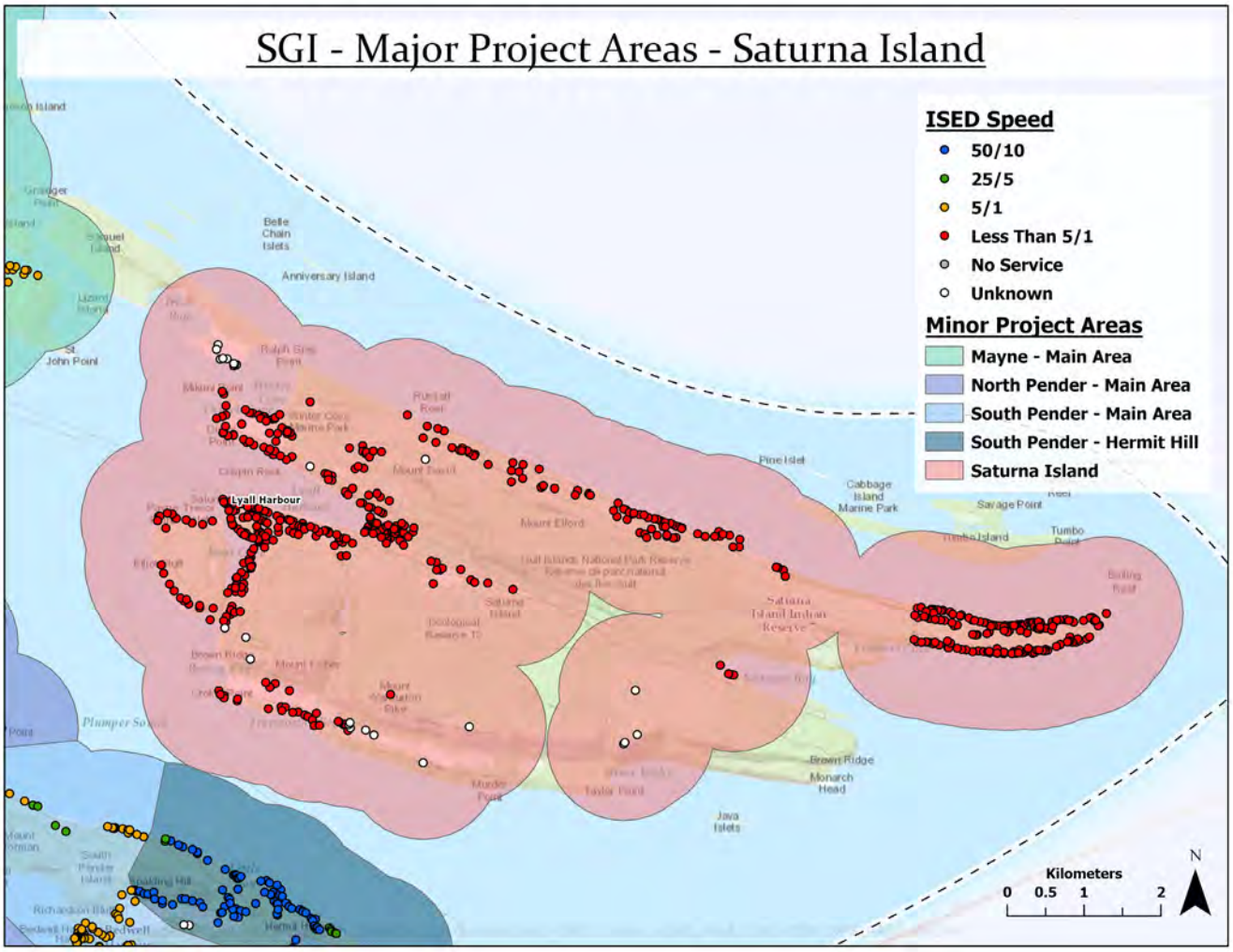

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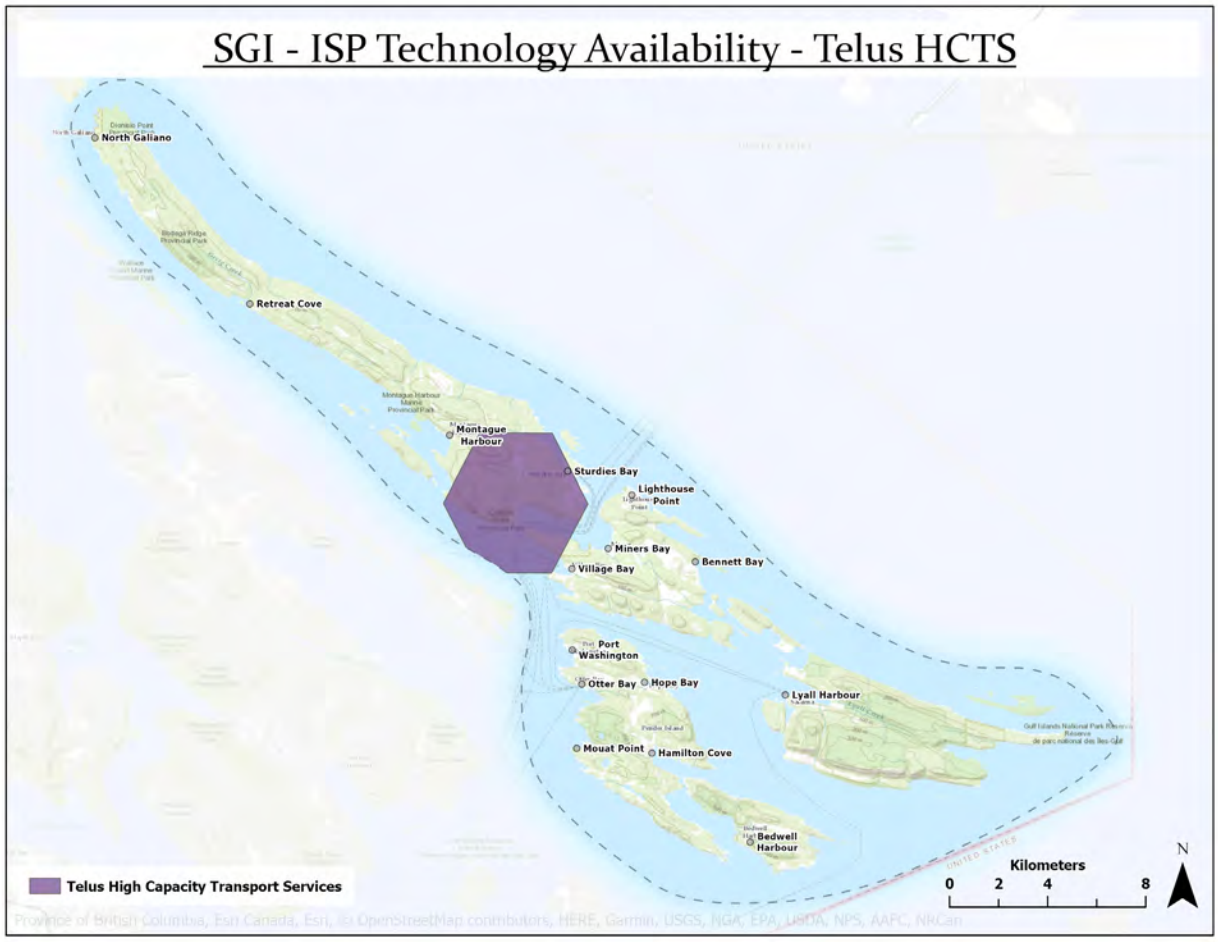
Phone: (250) 341-6118
Email: info@tanexengineering.com

Appendix C – Service Provider Service Areas

These maps show the areas served by each of the service providers in the SGI.

Note: The main source of these maps is the ISED Map and given the recent addition of a new provider on the Island of Galiano (GAIA), coverage maps for this new provider are not available from ISED.



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PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

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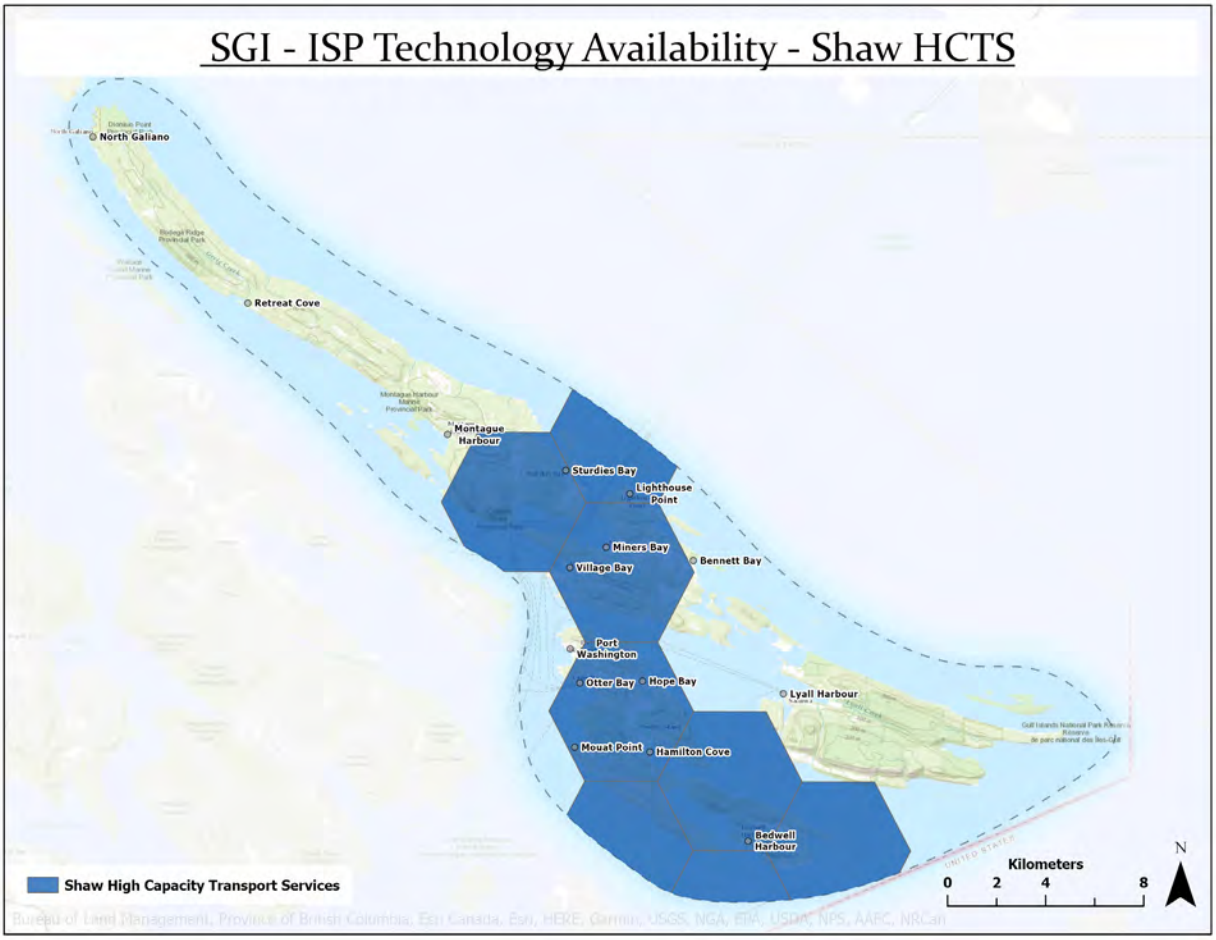
Phone: (250) 341-6118
Email: info@tanexengineering.com



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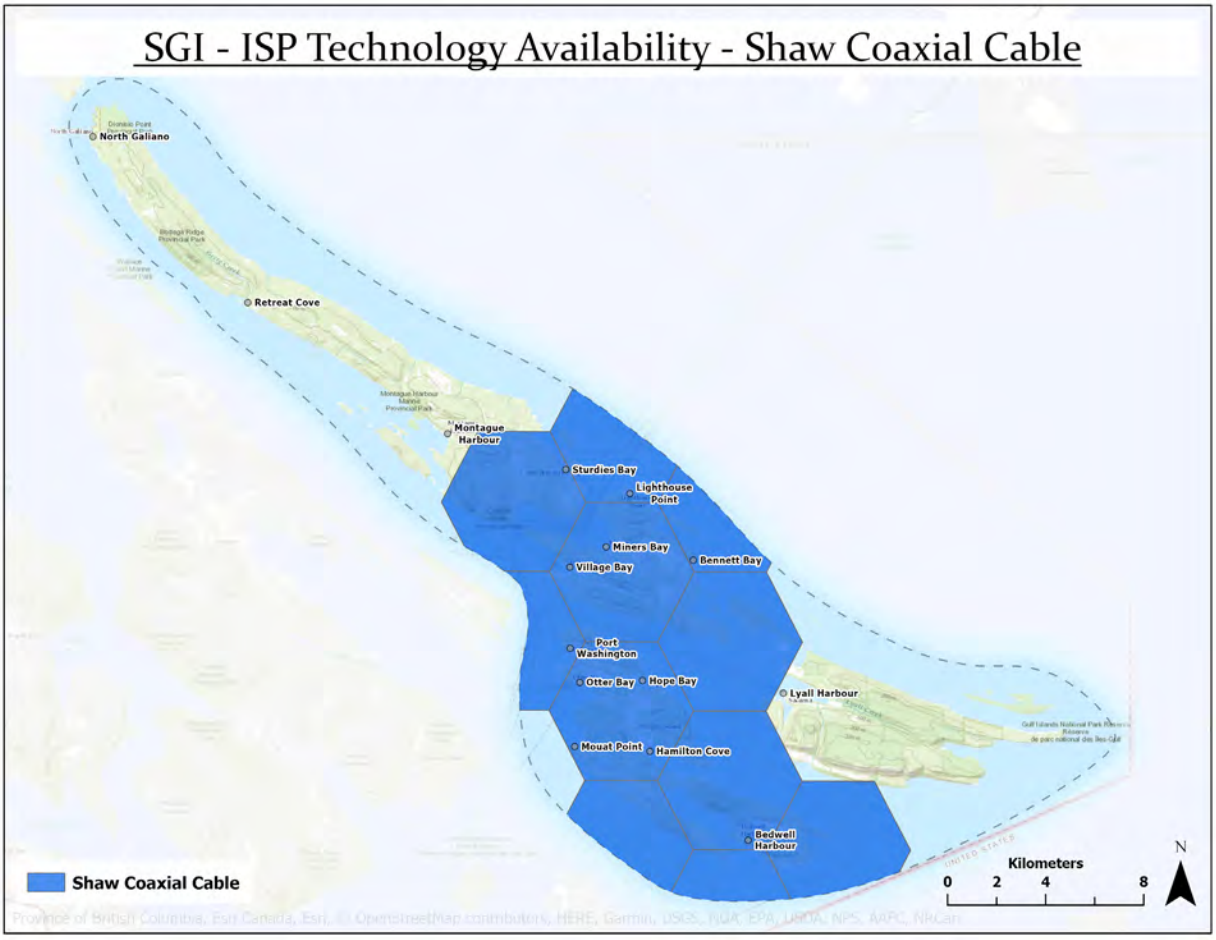

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PO Box 1016, Invermere, BC, V0A 1K0
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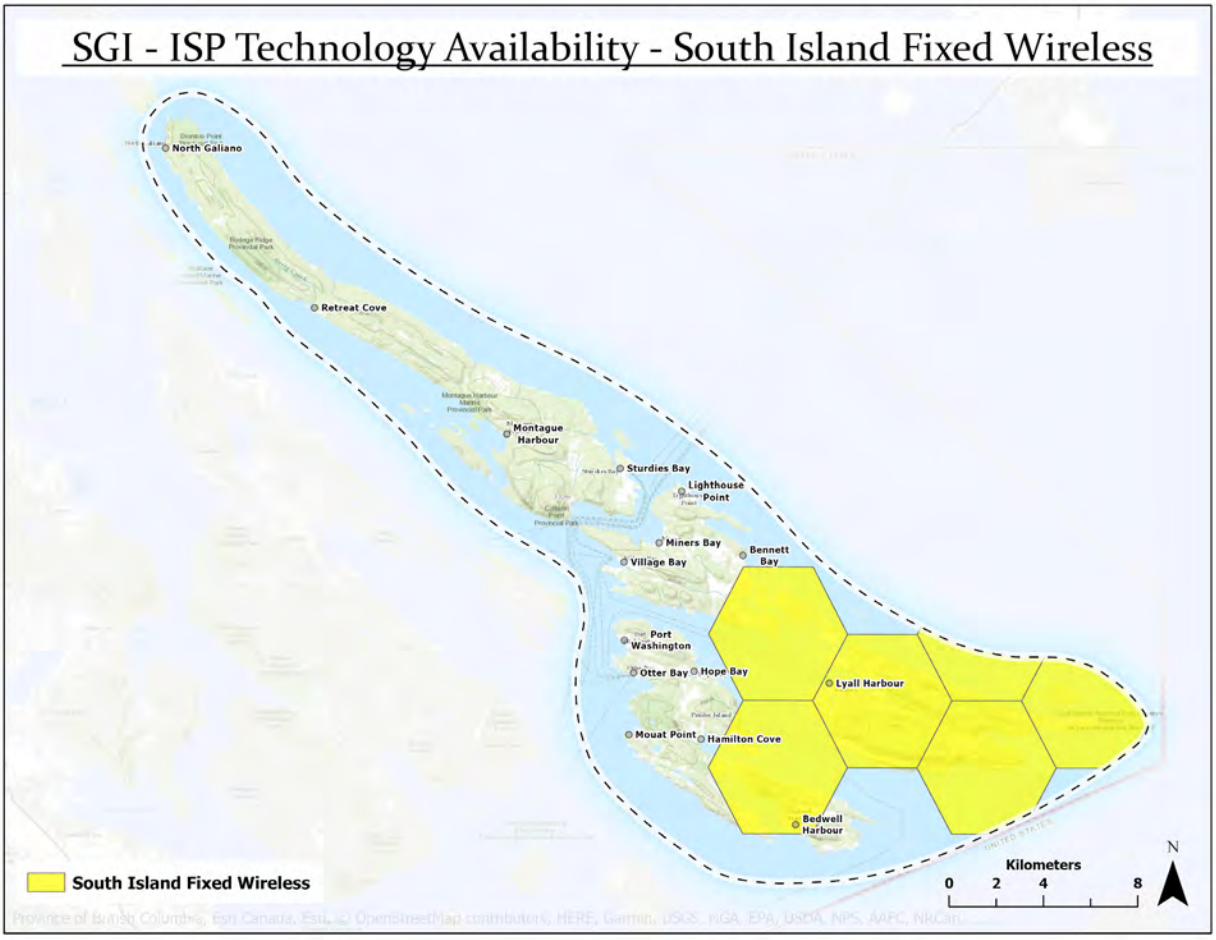
Email: info@tanexengineering.com



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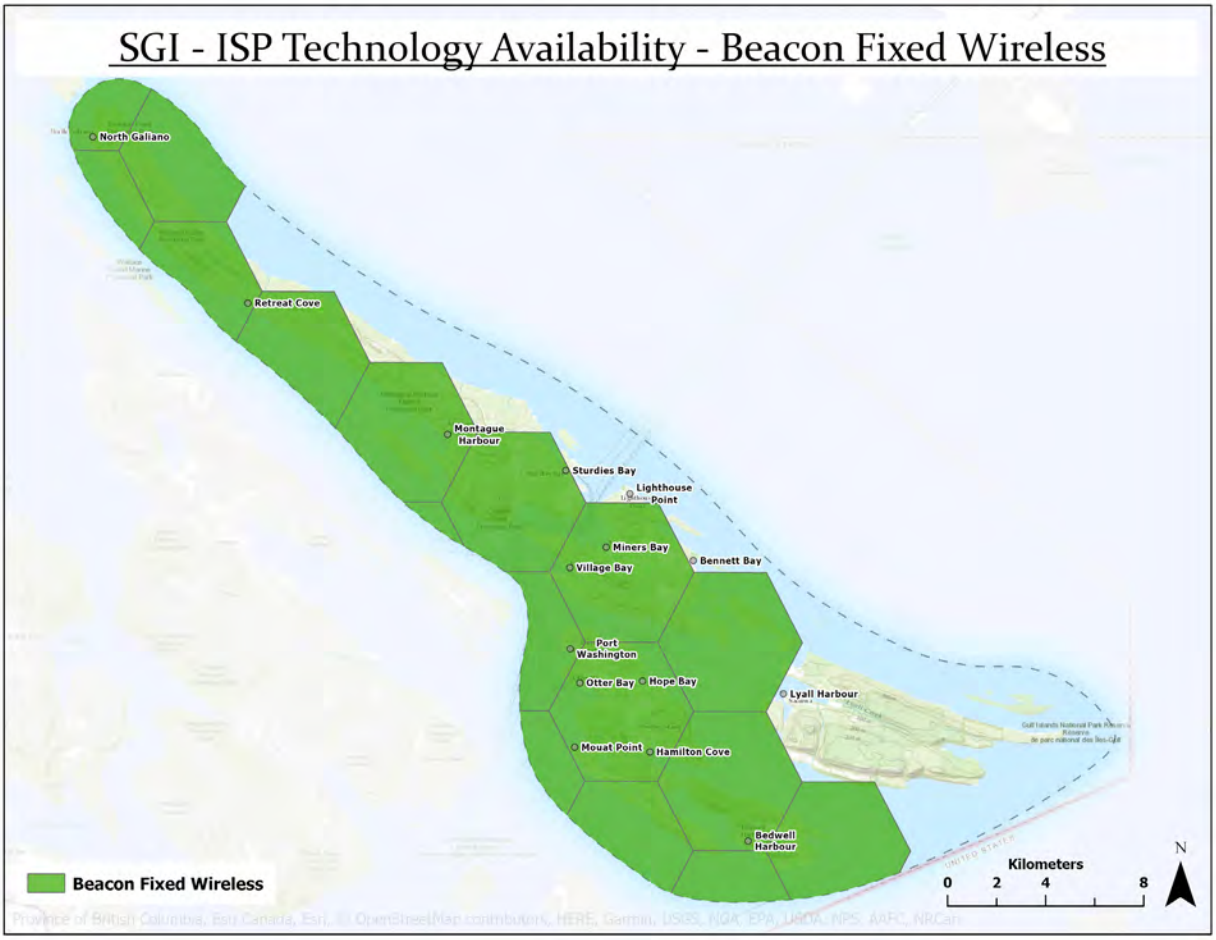
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com



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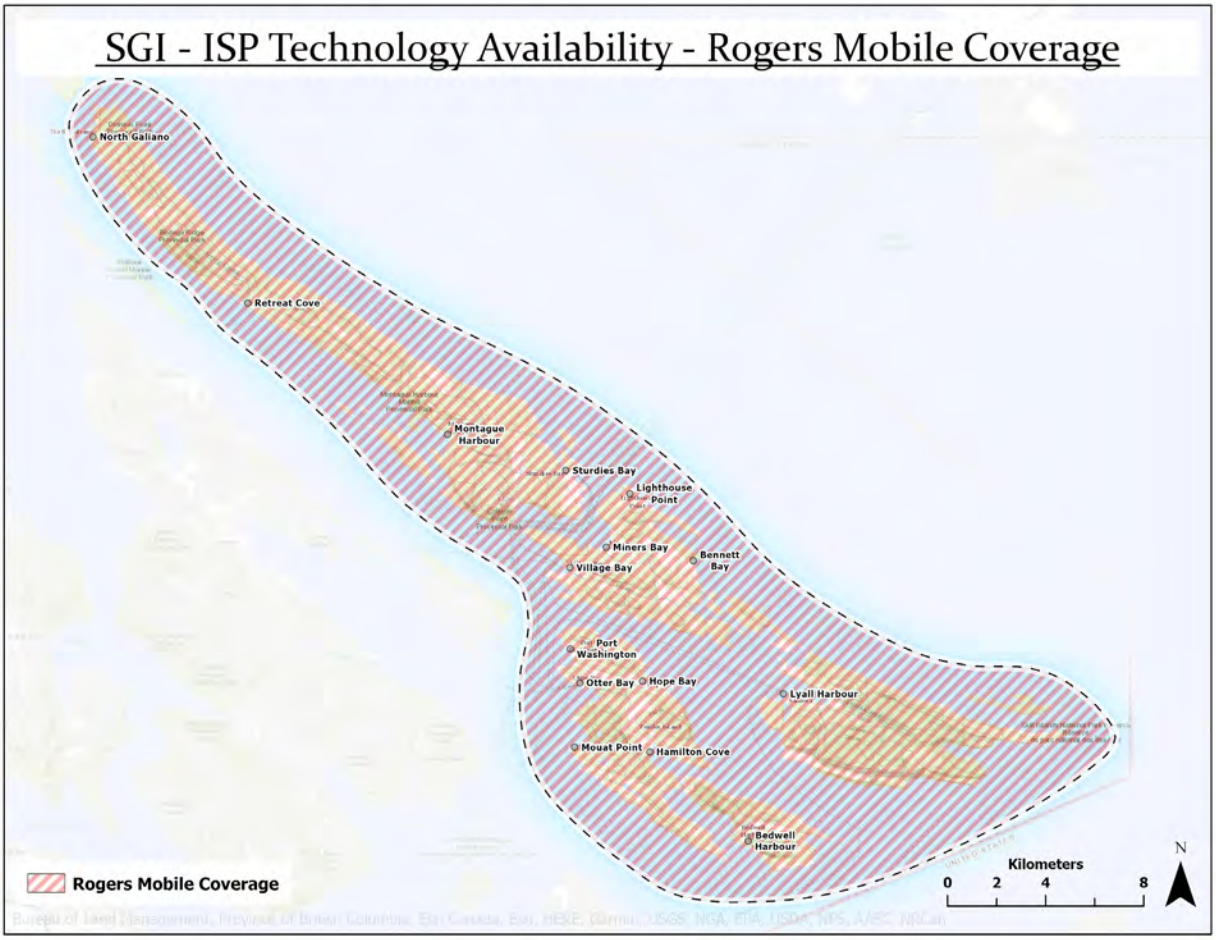

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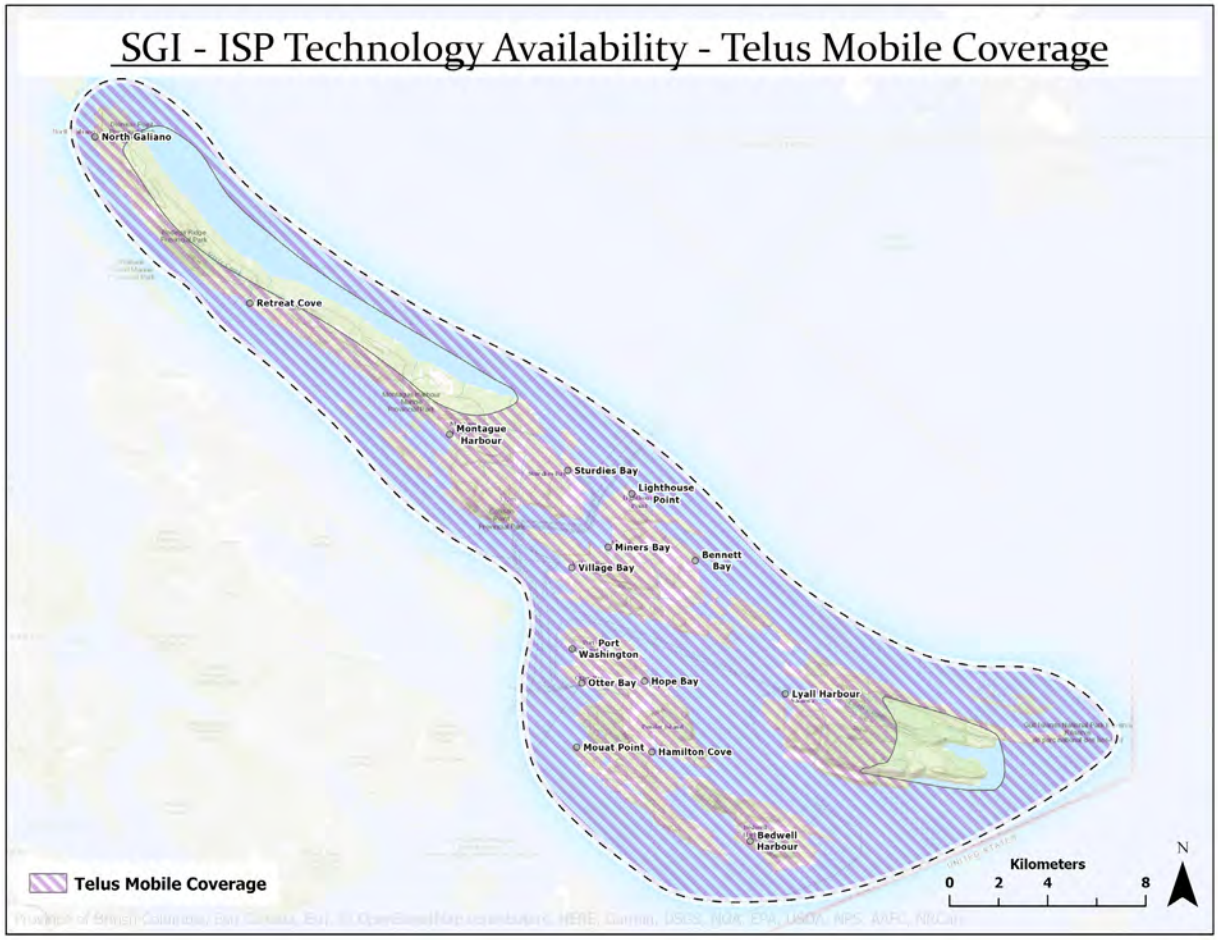

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Appendix D – Technology Overview

Technology Alternatives

In terms of technology, the primary obstacle for rural broadband is cost. Depending on the most suitable technology, the primary cost consideration may be associated with either the backbone or local access networks. A wide range of options are available and broadband services can be provided through a variety of technologies each with advantage and disadvantages. These technologies trade off high capital and operating costs with capacity, scalability and the ability to support the desired applications. The choice of technology needs to be assessed against the requirements for the particular situation and the cost of providing the services. While some technologies represent higher capital costs, the life expectancy may be factored over a long period of time (ie. 20 – 30 years) so capital costs need to be amortized over the lifetime of the asset when comparing technologies. This section of the document is a high-level introduction to these technologies.

Alternative technologies used to connect locations together are outlined below. Technology choice is dictated by the needs and circumstances of the service area. The challenge is to select technologies and configure them into systems that meet those requirements while minimizing life cycle cost.

As summarized above, **backbone or transport infrastructure** is the technology used to transmit and receive data over long distance to connect towns, cities, provinces and countries. Fibre optic cable (optical fibre), microwave radio, and satellite are the three principal transmission medias but fibre is, by far, the most desirable with very high scalable capacity, long life cycle and low operating cost. The challenge with fibre is the high initial cost and as such high capacity terrestrial microwave radio solutions, or even satellite, may be considered depending on the requirements.

Local access networks connect users to the backbone network in order to reach distant locations and applications. In broadband, the term applications, refers the services that people (subscribers) use including things such as the internet, video streaming or broadcast, voice communications, email, access to business services such as Microsoft Office 365, security services, business to business communications. These applications require high capacity, reliable connectivity.

Fibre to the Premise (FTTP, FTTH, FTTx) is the gold standard for broadband service to fixed locations such as homes, businesses and institutions, providing very high capacity, reliability and support for almost any application. As with backbone fibre, FTTP can be expensive to deploy as it requires a physical cable (or optical strand) to be connected from a local POP to every subscriber location.

Like fibre, **coaxial cable** service (typically used for Cable TV broadcast) and **Digital Subscriber Line (DSL)** service (over phone lines), share the requirement of installation of a physical cable from a local POP to the subscriber's premises. These technologies would typically be deployed in locations where this cable infrastructure already exists, thus avoiding the cost of construction. It would now be considered uncommon for a provider to construct new DSL or coaxial cable infrastructure rather than a fibre deployment. While coaxial cable can deliver capacity meeting, and exceeding, the CRTC Service Objective, DSL technology is limited in its ability to scale to these capacities. That said, neither technology can approach the capacity of fibre

and as such, will likely not scale to meet the capacity requirements in the long term. Coaxial cable is also a shared technology as described below in Fixed Wireless.

The alternative to wired technology like optical fibre, coaxial cable or DSL is a radio-based "wireless" technology. **Fixed wireless** technology and unlicensed radio spectrum has been used as a low cost means of kick-starting internet service in low density rural markets. Fixed wireless is considered to be infrastructure that is fixed to a specific location, unlike technology used for mobile wireless described later. While no physical connection is required between the local POP and the subscriber's premises, high capacity wireless services typically requires "line of sight" to deliver reliable, high speed services. Any obstructions, including buildings, trees, or hills impair the signal resulting in no or poor service. Wireless technology, like coaxial cable, is a shared technology meaning that all subscribers using the wireless network are "sharing" the available capacity. The more subscribers using the service at one time, the less capacity each gets. The requirements to scale wireless service to high numbers of subscribers and capacities must be considered during the deployment of the network.

Cellular mobile technology, a variation of wireless, has become the de facto standard for voice and internet service direct to individual mobile devices. The data communication capability of current 4G (4th generation or LTE for Long-Term Evolution) cellular systems make this a viable broadband technology in appropriate circumstances. The emergence of 5G (5th generation) cellular over the next 5 to 10 years is expected to reinforce this trend (see emerging technologies below). While 5G technology is promising, it will require heavy investment in fibre to connect the local, high density of antennas to the backbone and ultimately globally provided services.

Finally, to reach isolated premises that are beyond terrestrial transport networks, fixed, or mobile wireless, direct to home **satellite** is the only viable choice. Xplornet's geostationary earth orbit satellite service is available across the region. Unfortunately, it suffers from high latency (the time it takes to send or receive information) resulting in some applications not functioning optimally and speeds can slow during periods of high usage. **Low earth orbit (LEO)** technology is emerging. The first to market with a direct to consumer play is Starlink. Starlink is currently (2021-02-19) in paid beta testing in northern US and southern Canada. As the satellite constellation fills in with more launches over the next few months to maintain continuous service, the service will become commercial. Beta test results support Starlink claims of 50 to 150 Mbps downlink speeds and 10 to 30 Mbps uplink speeds with round trip delay in the 20 to 40 ms range. Other broadband LEO systems are planned, but service is at least one or two years out and these may not be consumer service plays.

The following summarizes the key characteristics, advantages and disadvantages of the technologies used for broadband service delivery.

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Phone: (250) 341-6118
Email: info@tanexengineering.com

Backbone and Local Access Technologies

Fibre optic cable - Backbone & Local Access

Extremely high capacity that is scalable for backbone / transport and local access. 10 Gbps already very common and 100 Gbps emerging.
[+] Long life cycle: 20 - 30+ years. Cost can be amortized over a long period of time.
[+] Low operating cost.
[+] High capacity, low latency, high subscriber counts.
[+] Very reliable.
[+] Very scalable. Upgrades to high capacity for relatively low cost.
[+] Supports a wide variety of applications.
[-] High initial (capital) cost.
[-] Acquiring right of way permits can be challenging
[-] Accessing existing underground and aerial infrastructure can be time consuming and expensive.
[-] Repair time can be long when cables break impacting network if redundant routes are not available.
[-] Not cost effective where low long-term capacity needs and long distances.
[-] Fixed to a specific location.

High capacity microwave - Backbone

High capacity microwave provides capacity up to approximately 1Gbps.
[+] Long hop distance is possible under optimal conditions (30 - 50 km). Higher distances may require multiple hops.
[+] Can be engineered for high reliability.
[+] Can be cost effective for one or two hops.
[+] Supports a wide variety of applications.
[-] Issues accessing or permitting to construct towers in some locations.
[-] High initial cost if tall tower required.
[-] High initial and recurring cost if remote tower sites are required.
[-] Can be support and power challenges for remote areas such as accessing mountain tops.
[-] Relatively low capacity: scales from under 100 Mbps to over 1 Gbps.
[-] Appropriate spectrum scarcity an increasing issue.
[-] Fixed to a specific location.

High-throughput satellite (Geostationary) - Backbone & Local Access

Well established technology with a competitive marketplace.
[+] Can be used direct to home (DTH).
[+] Cost does not vary with distance within the coverage footprint.
[+] Good capacity.
[+] Relatively low initial capital costs.
[-] High cost for usage (bytes per month).
[-] Can be susceptible to service impacts with severe weather.
[-] Larger antenna sizes needed at high latitude sites.
[-] Fixed to a specific location.
[-] May not be well suited to some applications.

Cellular mobile – Local Access

Open standards allowing mobility and connectivity anywhere, anytime.
[+] Huge global market and competitive ecosystem with ongoing evolution.
[+] Low cost for user equipment (competitive market).
[+] Versatile user equipment.
[+] Mobile services.
[-] Relatively high usage costs compared to fixed services (bytes per month).
[-] High initial costs for network build (poor return in low density markets).
[-] Relatively high operating cost (management and evolution).
[-] Limited competition in lower density markets.
[-] Shared technology. Additional subscribers degrade overall performance.
[-] Performance can be inconsistent. Latency can be high.
[-] Higher capacity usually requires significant investment in network upgrades to new technology.
[-] May not be well suited to some applications.

Fixed wireless– Local Access

Different technology with different coverage and capacity characteristics. A range of proprietary and semi-proprietary products are available.
[+] Can be fast to deploy (if antenna tower permitting is not an issue).
[+] Can have high capacity if high frequency (trade-off with coverage).
[-] Limited spectrum and licensed spectrum can be expensive.
[-] Unlicensed spectrum: performance may degrade from interference.
[-] Susceptible to weather and local weather can cause service issues.
[-] Usually needs fibre for sufficiently high capacity backhaul.
[-] Requires line of sight for high capacity and reliability.
[-] Shared technology. Additional subscribers degrade overall performance.
[-] Fixed to a specific location.
[-] May not be well suited to some applications.

Emerging Technologies

Low earth orbit satellite (LEO)

Only Starlink service is available for beta testing in Canada as of 2021-02-21.
[+] User speeds 50-150 Mbps downlink and 10-30 Mbps uplink.
[+] Delay in the 20 to 40 msec range.
[+] Potential to lower the cost of usage to isolated customer locations (beta service in Canada is $130 per month for unlimited usage).
[-] A competitive market may not emerge if other initiatives fail (OneWeb, Telesat LEO, etc).
[-] High inclined and polar orbits required for high latitude coverage.
[-] Long-term costs and performance are still uncertain.
[-] Current costs are not competitive for communities that are large enough to economically support fiber transport and fiber access networks (FTTH).

Cellular 5G – Local Access

Next generation 5G cellular
[+] Potential for low usage costs with 5G and mmWave frequencies.
[+] Mobile and fixed services.
[-] Requires a heavy investment in fibre to connect numerous 5G antennas..
[-] Emerging now in Canada but mmWave frequencies have yet to be auctioned.

Summary of Technology Alternatives

In summary, rural and remote areas are low density, meaning network links are required over long distance and all else being equal, rural telecom service costs per subscriber will always be higher than urban.

- Fibre optic infrastructure for both transport and access is the long-term end game for fixed broadband. No other currently available technology can match the speed and reliability of fibre connectivity or scalability for the future.
- Cellular mobile to open global standards is, and will remain, the delivery mechanism of choice for mobile voice and data communications direct to individuals.
- Proprietary radio access systems in license-exempt and licensed bands can have a role to play if they are sufficiently inexpensive that payback is within their expected service life.
- Satellite remains the service of last resort for isolated customer locations. Current services that are based on long-delay geostationary arc satellites can be expected to yield market share to low earth orbit broadband satellite service as or if cost-performance proves-in.

Business and Operational Considerations

Infrastructure enables services to subscribers, but it does not provide the resources required to effectively manage, monitor and obtain revenue from the network. When referring to the SDP introduced earlier in this report, the OSS/BSS layer provides all the infrastructure required to perform the operational and business functions required for the network to operate successfully.

The OSS/BSS layer of the SDP includes many components that enable and support service to the customer. In summary:

- Personnel with appropriate knowledge and experience with operating a network.
- Customer support to effectively support subscribers of the network such as technical support and customer service support.
- The infrastructure and software applications required to effectively monitor, manage and operate the network.
- Business operations for the business such as customer service and billing.
- Equipment, tools and assets required to complete onsite activities.

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

The OSS/BSS layer must include, but is not necessarily limited to:

Resources:

- The personnel required to:
  - support and provision network services.
  - provide maintenance activities on the network electronics and other infrastructure.
  - manage subscriber requests for adding, removing and changing existing services.
  - Provide the expertise required to enhance services on the network.
- The support system, which includes the personnel, required to effectively support subscribers of the network such as technical support and customer service support.
- The processes and procedures related to the operation of the business.
- The equipment and tools required to complete onsite activities such as vehicles, tools, fibre splicing and testing equipment, network testing equipment, etc.

The personnel required to operate the network need the following skill sets:

- Overall management resources that are familiar with the operation of a network and can provide the overall guidance for the network operations.
- Technical resources that can effectively design, commission and support the electronic components of the network.
- Technical resources that can effectively design, commission and support the infrastructure components of the network such as POPs, power systems, environmental systems, outside plant, fibre, etc.
- Installation and maintenance skills that can provide the onsite support for the infrastructure, electronic components and subscribers.
- Customer service resources that can provide effective assistance to subscribers of the network.
- Sales resources that can manage new opportunities.

Business Systems:

- Customer database containing customer information.
- Billing systems to issue invoices and accept payments.
- Documentation storage.
- Reporting systems to gather, consolidate and report on customer usage that may be used for customer billing.
- Scheduling systems to book and schedule customer site visits and technician tracking that may be required.
- Remote access systems used to provide key support and business technicians access to the systems 7x24x365.

Operational Systems:

- Monitoring systems to monitor the network, locate problems, send alerts to support technicians, gather statistics, report on trends, etc.
- Trouble reporting systems to gather and maintain information on problems reported by customers for timely resolution.
- Provisioning systems to add, change and remove services to customers.

- Logging systems to log network and customer events.
- Documentation storage.
- Manufacturer specific software required to operate and maintain network equipment.
- Backup and restore systems to maintain configuration backups and restore when required.
- Network maintenance software.
- Network operation systems that are required to make Internet services function. Eg. Domain Name Service (DNS)
- Network authentication and registration systems such as RADIUS and DHCP that are required to activate subscribers on the network.

The hardware and software systems are typically located in one or more datacenters (or POPs) on the network. The intent is to have a location suitable for the equipment required to run the software applications required to effectively operate the network. As these systems will contain sensitive operational and subscriber information, they would typically be implemented in a manner that provides security from external sources such as the internet. These systems contain the infrastructure that provide the daily operational functions for the network.

Along with appropriate resources and software applications the OSS/BSS systems include all the processes and procedures and physical equipment required to perform these functions. An example of a process would include the step-by-step procedure to install and activate a new subscriber on the network as a number of components need to be considered including the physical installation of the fibre drop, the equipment at the subscriber premises, connection of the subscriber in the POP, the activation of the service on the network, etc. Each of these functions needs to be completed in order for the service to be ready for the subscriber.

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Technology	FTTP/FTTH	Fixed Wireless	LTE 4/5G	DSL	Coaxial Cable	GEO Satellite	LEO Satellite
[+]	Unlimited capacity Easily scaled Very reliable Multiple services Low OPEX	Low capital cost Fast to deploy Big bang for your buck Common for regional ISPs	Good capacity Mobile services No wires Low cost for user Versatility in services	Cost effective if cable exists Supports multiple services Leverages existing phone lines	Cost effective if cable exists High capacity Supports multiple services	Available anywhere Can be moved easily	Available in remote locations Can be moved easily Good performance
[-]	High capital cost Requires permitting & approvals Fixed a specific location	Limited scalability Technology lifecycle Requires line of site Unreliable if designed wrong Interference concerns for unlicensed	Limited scalability Technology lifecycle Poorly suited to some services High usage costs to subscriber Limited ability for competition	Cable has high capital cost Scalability is limited Subject to reliability issues Subject to quality & distance Limited ability for competition	Cable has high capital cost Scalability is limited Unreliable if designed wrong Limited ability for competition	Lower capacity High latency Costly bandwidth Problems in extreme weather	New technology Not available eveywhere Will take time to build out Long term is unknown Only one provider at this time
Characteristics	Dedicated	Shared	Shared	Dedicated	Shared	Shared	Shared
	A/Symmetrical	Asymmetrical	A/Symmetrical	Asymmetrical	Asymmetrical	Asymmetrical	Asymmetrical
	Very Low Latency	Low latency	Medium Latency	Low latency	Low latency	High Latency	Low latency

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

Appendix E – Open Access Overview

British Columbia and Canada face a problem with connectivity in remote and rural communities of Canada. Many of these communities are faced with absolutely no connectivity or connectivity that is poor or unreliable. The primary challenge is that rural connectivity lacks a business case to invest capital and operational funds. Private enterprises do not provide services in these areas because it simply does not make business sense to do so. As a result, providers position requests for funding to build transport where it creates opportunities for them and local access in areas that may already be served leaving rural areas untouched as a lower priority.

Government funding programs often require that infrastructure constructed using funds from these programs be available for other providers to use at pre-determined rates ("quasi open-access"). The challenge with this approach is that the lack of a business case makes it nearly impossible for one provider to provide services in these areas, let alone more than one. While it may be physically possible for more than one provider to service these areas, the business case dictates that it will likely be a single provider thus excluding any form of competitive services or pricing.

Government support to address the connectivity problem is appropriate but the distribution of funds is typically in the form of grants of funds to an existing (often for-profit incumbents) provider on the basis that it will provide new or enhanced services. Funds are granted to the provider on the basis that they use them to solve connectivity issues in these un/underserved regions. While quasi open-access is a step in the right direction, it doesn't go far enough.

The connectivity problem in rural BC is not going to fix itself and using public funds to benefit private enterprise that are not motivated to solve the rural challenge is not the right approach. We need to think bigger. We need to think differently. Rural funding programs should support government priorities not the priorities of the service providers. Rural funding should be done as part of much larger vision with affordable choice for consumers.

In the traditional model, for a service provider to service a customer, they must construct all levels of the Service Delivery Pyramid ("SDP"). While this model may be acceptable in larger centers where there are enough subscribers to make a suitable business case for providers to essentially overbuild each other with different types of technology, in remote and rural communities, there is not enough subscribers to justify one provider building this infrastructure let alone more than one. Once a provider has built the infrastructure, there is virtually no chance that a second provider will provide any competitive services. In the short term, the funding can be considered a success and area residents do get improved services. In the long term though, as service requirements change due to progression in technology and connectivity requirements, these areas will lag behind once again and the problem of second-class connectivity will again be reality. Then government must, again, incent the provider to upgrade the service.

True Open Access ("TOA") networks alleviate the above problem by architecting the solution in a way that addresses the problem at a broader regional level and encourages competition, provides support for government initiatives, choice of services and providers for the consumer. A TOA network leverages technology and a business model to allow multiple providers to share the network and deliver a variety of services to the consumer. In the end, the consumer is the winner with a choice of providers and services in a competitive market forcing providers to deliver innovative services at improved price points and high levels of customer service. In the case of rural connectivity, using this model over a larger number of communities, aggregating the costs under a single entity provides the opportunity to make more attractive business case with the benefit of choice to the consumer.

TANEx Engineering Corporation
PO Box 1016, Invermere, BC, V0A 1K0
Phone: (250) 341-6118
Email: info@tanexengineering.com

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