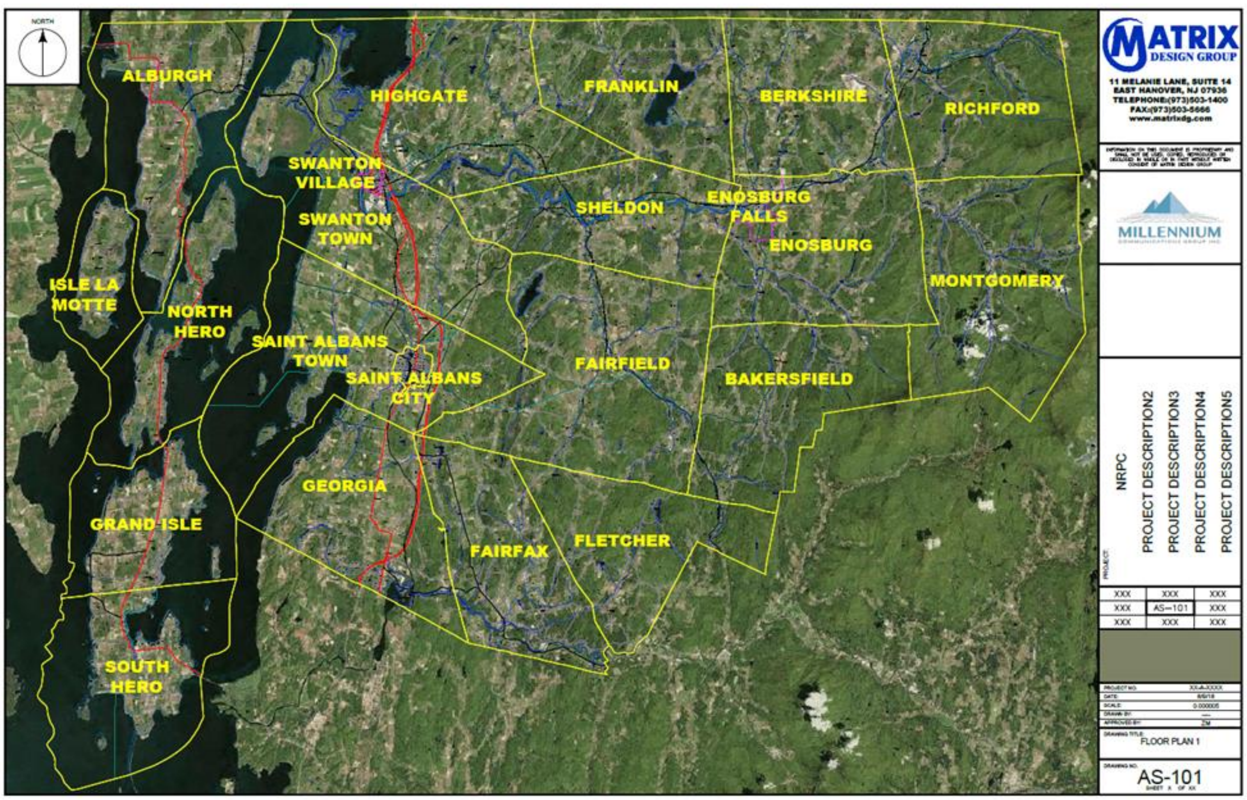
FOR PUBLIC RELEASE

Northwest Regional Planning Commission

Fiber Broadband Feasibility Study

Prepared For:
NRPC & Municipalities of Franklin & Grand Isle Counties



Prepared By

MATRIX DESIGN GROUP

Contents

Disclaimer

The information presented in this report has been based on Matrix Design Group's understanding of the site and project information obtained during our research. The information presented herein was obtained from sources that are believed to be reliable and has been accurately reported. This warranty is in lieu of all other warranties either expressed or implied. The Matrix Design Group is not responsible for the accuracy of this information or for the conclusions, opinions, or recommendations based on this information.

Executive Summary

This study was compiled to assess the feasibility of a fiber optic broadband network within Franklin and Grand Isle County County's with special consideration for the Un/Underserved communities located within its borders. The Covid-19 pandemic along with other influencing socio-economic factors has drastically increased consumer demand and access to additional funds through private, local, state and federal grants supporting these higher bandwidth services throughout the country. The feasibility objectives and estimates outlined below will serve as baselines for comparison to those Un/Underserved communities intended to assist in the development of a business plan to best support those communities based on those findings.

To achieve a level of scale whereas a fiber broadband network is considered viable within the parameters of this study the most densely populated unserved areas must be financially stable starting in year three following the onset of the first Capital Expense of any such network. Cash flow positive EBITDA (Earnings before Interest, Taxes, Depreciation, and Amortization) returns will be analyzed in outlined geographic areas targeting the most densely populated Un/Underserved communities. This approach is ideal to achieve the greatest impact with regards to the network construction costs, community benefit, revenue collection, funding resources and speed to market.

Project viability objectives:

- Provide Broadband services greater than 25/3 Mbps (Megabits per second) to the Unserved Communities
- Provide Broadband services greater than 25/3 Mbps to the Underserved Communities
- Identify Network deployment costs Per Subscriber within Un/Underserved Communities
- Identify Potential Funding Sources for Capital Expenditure flexibility & offset
- Identify Network Operational & Maintenance Costs
- Estimate Subscriber Demand "take rate" within the targeted areas

Background Information

The economies of Franklin and Grand Isle County contain a mix of tourism, recreation, professional services, agriculture, retail, and more. There are a sizeable number of second homes in the area mostly in closer proximity to seasonal tourism locations and are well distributed throughout the region. Geographical accessibility is somewhat limited in some areas due to changes in geological, ecological, and elevation within the region along with close proximity to an international border. The rural nature of these areas may have an effect on construction costs due to special equipment and additional skilled labor requirements along the routes into and out of the towns. These special accessibility considerations will also have an adverse effect on maintenance and repair costs during seasonal changes and other operational considerations. The sparseness of the population density would also make it difficult to build and operate a universal wireless network in these same areas making distribution network redundancy design absolutely necessary to provide reliable service.

The FCC defines “Broadband” as having access to speeds of 25 Megabits per second (Mbps) download, and 3 Megabits per second (Mbps) upload (known as 25/3Mbps). According to this definition, areas considered served have 25/3Mbps or better, and areas considered unserved have less than 25/3Mbps. This standard was adopted by the FCC in 2015. Due to the exponential growth of technology in everyday life and especially so now with a large portion of the population working and learning, via video services, from home due to COVID-19 speeds much higher than the 25/3 baseline are required to effectively provide these simultaneous services.

As stated in 30 V.S.A. § 202c the Vermont Legislature voted to “support measures designed to ensure that by the end of the year 2024 every E-911 business and residential location in Vermont has infrastructure capable of delivering Internet access with service that has a minimum download speed of 100 Mbps and is symmetrical.” To meet this goal the only realistic technology that can achieve this level of service would be via fiber optic cabling considering fiber optic cable is only limited by the speed at which the network equipment can relay data packets. As both demand and technology improves a Fiber Optic Network can be upgraded by simply switching out or adding additional equipment at the signal Distribution facility.

Source:https://www.fcc.gov/reports-research/reports/measuring-broadband-america/measuring-fixed-broadband-eighth-report#_Toc464398833

Currently commercially available technology makes it possible to replace electronics at each central distribution facility (hub site, roughly one per town) and in the home of each customer for a cost of $500-$700/customer to allow 10Gbps symmetrical connections. 100G technology is being tested, and 1 Terabyte speeds will be possible when demand exists.

This report represents information based on fieldwork, research and analysis completed by Matrix Design Group. This report contains projections and costs based on readily available data.

Survey Overview

The Un/Underserved geographic target areas were used to develop a 10,000' view of potential network design. Presented materials are substantiated by data and metrics collected by Matrix Design Group of the service area(s) using online mapping software, satellite imagery, available road mile data, and street view cataloged photographic images.

This process is used developed a conceptual FTTH (Fiber to the Home) architecture reflective of the necessary requirements of a Calix GPON architecture, OSP (Outside Plant) utilizing existing public right-of-ways. Logical and physical maps are "high level" in concept, as included in this report, for the purpose depiction of solutions and best practices that are intended to meet the needs of this study. The network design is intended to allow for flexibility, scalability, and resiliency.

Technical Feasibility

A review of the existing infrastructure in Franklin and Grand Isle County area has determined that there are no notable issues that would make a multi-town fiber network unfeasible to build in the deployment of known construction methods. Nor any additional restrictions prohibitive in nature to the design and engineering required for such a network. With that being said, designing a fiber network of this size and scale may require creativity, additional and unconventional construction methods, along with advanced management oversight in the areas requiring special access considerations mentioned in background section of this study.

Backhaul Availability

A fiber to the premise network is useless without a connection to the global internet network itself and this is why determining backhaul availability is one of the most important steps in the process. Fortunately, there are backhaul carriers in the region along with others planning on expanding their presence in rural areas throughout the northeast as demand continues to grow. This report contains vendor pricing for an appropriate and sufficient backhaul to the network distribution locations identified. As previously mentioned, due to the geographic isolation of these areas redundant and diverse circuits were requested. Backhaul pricing came out at approximately $2,400-$4,300 and one time access connection charge of $1,500-$3,000. Pricing ranges were for 1G to 10G DIA connections.

MOMENTUM TELECOM

QUOTE

Website: www.momentumtelecom.com

Requested by:

Matrix Design Group

Location	Service	Bandwidth	MRC	NRC	Term
44°46'55"N 72°48'05"W 44.781944, -72.801389 Nearby location 54 E Bakersfield Rd, Bakersfield, VT 05441, United States	Internet	10G	$4,345.00	$1,000.00	36 months
44°56'06.0"N 72°42'35.0"W 44.935000, -72.709722 Nearby location 2861 VT 105, EAST BERKSHIRE, VT, 05447	Internet	10G	$4,060.00	$1,000.00	36 months

*All orders come with 1 free static IP (/30 SUBNET)
*Prices are expressed in US Dollar
*Prices do not include applicable taxes
*Prices do not include cross-connection costs
*Prices are subject to a feasibility study
*The offer is valid for 30 days
*Typical install time is 60-90 days from receipt of all required paperwork.
*We supply an Ethernet handoff, we do not supply a router. If you need extra services like a router and such, please let us know as we will require more information to provide services.
*Momentum will make a best effort to install the service at the desired location/suite. If the service is installed in the MPOE the Customer will be responsible for the extension of the demarcation from the MPOE to the Customer premises.

*This quote may be based on the service location being Near Net. There will be construction required in some cases in order to service this location. If the project is more complex than anticipated and costs exceed what is expected, we may be required to adjust the pricing accordingly. If there is a price adjustment, it will be the client's discretion if they want to proceed with the order.

Ready to experience Momentum Telecom?

New Customer please submit your information in the link below:

https://metroopticalforms.wufoo.com/forms/z1y2aqf70fzwx1n/

Current Customer please email orders@momentumtelecom.com

If you have any questions about this price quote, please contact qr@momentumtelecom.com

Pole replacements can be expected to cost $3,000 and will be required where the existing poles do not provide the adequate structural integrity and/or clearance (height) required for the pole to remain compliant with the NESC (National Electrical Safety Code), OSHA 1910.268 & 1910.269 Standards, and any other local compliance orders.

Vermont instituted new pole attachment regulations in 2019, including one-touch make-ready in the communication space. This new rule option allows for (1) Utility company to execute the movement of existing attachments for all licensees' at any one location. This progressive process will drastically reduce logistical coordination, scheduling and make-ready costs overall than the previously implemented process. Prior to submitting Pole licensing applications a broad scale survey should be completed to provide additional information to determine the "ideal network path" with special targeted insight in the best interest of to the overall project goals and budgetary restrictions. Accurately collected cable route data will show the number and type of pole attachments and should be incorporated into the construction estimates during the design phase of a FTTH project. Additionally any poles located in the right-of-way will require Certificate of Public Good to use space on the poles. This certificate can be obtained from the Vermont Public Utility Commission and authorizes a body to provide telecommunications services.

Underground Construction

The vast majority of the Franklin and Grand Isle County Outside Plant (OSP) network will be aerial construction; however, there may be small areas that fiber pathways will need to be routed underground. Underground construction is significantly more expensive than aerial and can be difficult to estimate costs as they are mostly dependent upon on localized ground conditions and methods of construction. Without a final detailed fiber route design, it is difficult to estimate how much of the network would need to be located underground. With that being said, generally the average of underground construction in rural areas is usually less than 5% of the total network miles.

Type of Broadband Connections

Digital Subscriber Line (DSL):

DSL is a wireline transmission technology that transmits data faster over traditional copper telephone lines already installed to homes and businesses. DSL-based broadband provides transmission speeds ranging from several hundred Kbps to millions of bits per second

(Mbps). The availability and speed of your DSL service may depend on the distance from your home or business to the closest telephone company facility.

The following are types of DSL transmission technologies:

- **Asymmetrical Digital Subscriber Line (ADSL)** – Used primarily by residential customers, such as Internet surfers, who receive a lot of data but do not send much. ADSL typically provides faster speed in the downstream direction than the upstream direction. ADSL allows faster downstreamdata transmission over the same line used to provide voice service, without disrupting regular telephone calls on that line.

- **Symmetrical Digital Subscriber Line (SDSL)** – Used typically by businesses for services such as video conferencing, which need significant bandwidth both upstream and downstream.

Faster forms of DSL typically available to businesses include:

- High data rate Digital Subscriber Line (HDSL); and

- Very High data rate Digital Subscriber Line (VDSL).

Cable Modem

Cable modem service enables cable operators to provide broadband using the same coaxial cables thatdeliver pictures and sound to your TV set.

Most cable modems are external devices that have two connections: one to the cable wall outlet, the other to a computer. They provide transmission speeds of 1.5 Mbps or more.

Subscribers can access their cable modem service by simply turning on their computers, without dialing-up an ISP. You can still watch cable TV while using it. Transmission speeds vary depending on the type of cable modem, cable network, and traffic load. Speeds are comparable to DSL.

Wireless

- Wireless broadband connects a home or business to the Internet using a radio link between the customer’s location and the service provider’s facility. Wireless broadband can be mobile or fixed.

- Wireless technologies using longer-range directional equipment provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly to provide. Speeds are generally comparable to DSL and cable modem. An external antenna is usually required.

- Wireless broadband Internet access services offered over fixed networks allow consumers to access the Internet from a fixed point while stationary and often require a direct line-of-sight between the wireless transmitter and receiver. These services have been offered using both licensed spectrum and unlicensed devices. For example, thousands of small Wireless Internet Services Providers (WISPs) provide such wireless broadband at speeds of around one Mbpsusing unlicensed devices, often in rural areas not served by cable or wireline broadband networks.

- Wireless Local Area Networks (WLANs) provide wireless broadband access over shorter distances and are often used to extend the reach of a "last-mile" wireline or fixed wireless broadband connection within a home, building, or campus environment. Wi-Fi networks use unlicensed devices and can be designed for private access within a home or business, or be used for public Internet access at "hot spots" such as restaurants, coffee shops, hotels, airports, convention centers, and city parks.

- Mobile wireless broadband services are also becoming available from mobile telephone service providers and others. These services are generally appropriate for highly-mobile customers and require a special PC card with a built in antenna that plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps.

Satellite

Just as satellites orbiting the earth provide necessary links for telephone and television service, they can also provide links for broadband. Satellite broadband is another form of wireless broadband, and isalso useful for serving remote or sparsely populated areas.

Downstream and upstream speeds for satellite broadband depend on several factors, including the provider and service package, the consumer's line of sight to the orbiting satellite, and the weather. Typically a consumer can expect to receive (download) at a speed of about 500 Kbps andsend (upload) at a speed of about 80 Kbps. These speeds may be slower than DSL and cable modem, but they are about 10 times faster than the download speed with dial-up Internet access. Service can be disrupted in extreme weather conditions.

Broadband over Powerline (BPL)

BPL is the delivery of broadband over the existing low- and medium-voltage electric power distribution network. BPL speeds are comparable to DSL and cable modem speeds. BPL can be provided to homes using existing electrical connections and outlets. BPL is an emerging technology that is available in very limited areas. It has significant potential because power lines are installed virtually everywhere, alleviating the need to build new broadband facilities for every customer.

Fiber-to-the-Home (FTTH)

- Fiber optic technology converts electrical signals carrying data to light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by hundreds of Mbps with some providers offering 1Gbps symmetrical service capacity.

- The actual speed you experience will vary depending on a variety of factors, such as how close to your computer the service provider brings the fiber and how the service provider configures the service, including the amount of bandwidth used. The same fiber providing your broadband can also simultaneously deliver voice (VoIP) and video services, including video-on-demand / over the top.

- Variations of the technology run the fiber all the way to the customer's home or business, to the curb outside, or to a location somewhere between the provider's facilities and the customer.

- FTTH networks can be configured and operated in a number of different ways. All configurations pose their own inherent challenges in defining which party is responsible for the operational oversight, costs and maintenance. Some of the high level examples include:
    - Single Service Provider- a single service provider in a closed network environment would assume all the associated costs to build and operate the network.

    - OSP Physical handoff- As an open access dark fiber configuration where, competing providers can lease fiber and place their own optical/electronics to complete the service. In the physical handoff model the costs for construction of the Hub/Distribution facility, physical distribution network(s), as well as the maintenance and repair costs of physical network would be the responsibility of the dark fiber owner. The service provider would be responsible for the optical/electronics in the Hub/Distribution facility and end user electronics.

    - Electronic handoff- As an open access dark fiber configuration where the network owner provides the optical/electronics for competing service providers to patch their backhaul service to the optical/electronics and then leases the dark fiber distribution network to competing providers. In the service handoff model the competing providers are responsible for signal backhaul presence and customer equipment. IT management, equipment compatibility and operational cost considerations require clearly defined contractual agreements in this model and are well suited for larger scale FTTH projects where the initial total number of services can support the providers' upfront Capital investment. Additionally, identification and estimation of costs are inherently difficult to calculate increasing the risk assessment of the model.

- Software handoff- As a Software Defined Network, where competing providers interconnect with the electronics at the physical network handoff. Users select their provider in a virtual manner; however, end user electronics as well as provider equipment must be compatible. All associated construction, operation, and maintenance costs would be the responsibility of the physical plant owner.

Inventory of Existing Broadband Infrastructure

Consolidated Communications, Comcast and Mansfield Community Fiber are the only known land based providers to service the NRPC communities. Satellite based HughesNet & Viasat services are available to both areas. PDF maps of their reported infrastructure for each community may be found on the VT Public Service Maps. As such, Matrix audited each provider's infrastructure by electronic street view where applicable and available identifying the infrastructure present on the utility poles in each community. The competitive price point for consideration in terms of the price elasticity of demand for entry to market in the unserved areas of this study shall be compared against satellite providers or similar fiber service providers competitively expanding in the same markets. Additionally, the competitive price point for baseline comparison in Underserved areas shall be any land based provider with fiber capacity with special considerations applied to account for survey data on overall value and applied use of the network.

Current Service Providers				
Pricing	**Service Provider**	**Download Speeds**	**Upload Speeds**	**Cap**
Land Based Services				
$31.04	Consolidated Communications	10Mbps		-
$42.04	Consolidated Communications	25Mbps		-
$54.04	Consolidated Communications	50Mbps		-
$49.99	Comcast Communications (Promotional Rate Year 1)	100Mbps	5Mbps	-
$80.95	Comcast Communications (Regular Rate Year 2)	100Mbps	5Mbps	-
$90.00	Mansfield Community Fiber	35Mbps	35Mbps	-
$180.00	Mansfield Community Fiber	400Mbps	400Mbps	-

Current Service Providers				
Pricing	**Service Provider**	**Download Speeds**	**Upload Speeds**	**Cap**
Satellite Based Services				
$59.99	HughesNet	25Mbps	3Mbps	10GB
$69.99	HughesNet	25Mbps	3Mbps	20GB
$99.99	HughesNet	25Mbps	3Mbps	30GB
$149.99	HughesNet	25Mbps	3Mbps	50GB
$65.00	ViaSat	12Mbps	3Mbps	40GB
$85.00	ViaSat	25Mbps	3Mbps	60GB
$120.00	ViaSat	30Mbps	3Mbps	100GB

Land Based Providers

Consolidated Communications

For Consolidated Communications we have identified areas where their service is available through their copper DSL network. For residences, Consolidated Communications can provide a maximum 50Mbps service in some areas with a majority of their service area at or below 25Mbps. Business service is available and pricing can be quoted on an individual case basis.

Similar to cable internet DSL networks required substantial operational costs balancing usage between network equipment and separated nodes causing inherent service speeds to slow during peak times of increased bandwidth usage. Customer confidence in these active systems has diminished concurrently with increased demand due to Covid-19 creating a demand to market entry for passive fiber systems capable of unlimited scaling for bandwidth usage. With that being said, individual case use for higher bandwidth would drive the take rate at the “higher Tiered” services required for effective deployment for households with mostly complied of professional users, gaming and educators in these markets.

Comcast Communications (Xfinity)

Xfinity’s current network consists of a hybrid fiber deep model and DOCSIS 3.0 & 3.1 cable data service. For areas served within these collective communities subscribers can get entry level broadband service at “up to” 100/5 for $39.99/month, for the first 12 months as an introductory rate, followed by $80.95/month after the expiration of the promotional period.

Additional fiber service up to 2 gbps symmetrical is available but mostly reserved for business class customers and cost prohibitive for FTTH model to be feasible. Note that active systems such as DOCSIS require continual balancing and additional operational expenses often time passed through to the customer in the form of data cap charges to offset these expansion and maintenance costs.

Source: https://www.xfinity.com/learn/offers/details?offerId=1626100229

Mansfield Community Fiber

Mansfield Community Fiber is a locally owned and operated business founded in 2016 offering FTTH services to underserved communities of Vermont along the southern edge of the study area. Entry level symmetrical download/upload services for light users begin at 35/35 mbps @ $90.00/month for residential customers and $135.00/month for business customers. Premier services are limited to 400/400 mbps @ $180.00/month for residential customers and $225/Month for business customers. Aggressive construction projections are underway for expansion northward further into the study area and should serve as the most accurate baseline for comparison of this feasibility study.

Source: Service Area Map – Mansfield Community Fiber (mcfibervt.com)

Satellite Providers

HughesNet

As one of the nations' largest satellite data providers HughesNet advertises broadband speeds at 25/3; however, packages are structured to throttle down those speeds based on usage past 10GB down to speeds around 3/1 making the service mostly useless for the demand requirements for streaming services. Essentially this service is tiered to increase pricing as usage increases without claiming "Data Caps"; however, this service can prove useful for the light user where physical access restrictions would make construction of a land based system prohibitive to the consumer.

Advertised service rates for data limits 10GB @ "up to" 25/3 begin @ $49.99/Month and "Heavy User" plans of 50GB @ "up to" 25/3 top out at $139.99/Month. Note that this technology is currently limited by line of sight interference and speeds are inherently throttled due to distance to target limitations. Data packet delivery is also inherently limited in this type of system in the form of decreased speeds due to bandwidth interference when using multiple devices or larger file transfers. The geographic elevation changes accompanied with the expansive foliage found in the Green Mountain State should serve as formidable obstacles for consideration prior to satellite provider investment to improve service. With consideration of the aforementioned limitations this service cannot be fully considered a true competitor to the land based systems within the study. Although technological improvements may change the competitive climate in the future it would require substantial capital investment and operational expense in deployment to retrofit or replace existing satellites to meet demand.

Source: Product selection (hughesnet.com)

Viasat

Although very similar in application to HughesNet we found that Viasat advertises slightly higher download speeds from "up to" 12/3, 25/3, 30/3; however, following the data limits of 80GB, 120GB & 200GB respectively Viasat will "prioritize your data behind other customers during network congestion."

Viasat is not exempt from the same line of sight interference limitations as other satellite service providers nor the associated capital and operational investment required to be considered a true competitor within the broadband market within this study area. With that being said, this service can prove as a useful alternative for some of unreachable areas where the cost of construction would be prohibitive whereas light users also reside.

Viasat offers entry level introductory period pricing (3 Months) for their "Unlimited Bronze"plan "up to" 12/3 service @ $65.00/Month followed by $85.00/Month for continued service. The "Unlimited Gold" plans service for "up to" 30/3 is introduced for the first 3 months will cost the subscriber $120/Month followed by $170.00/Month for continued service.

Source: Viasat High Speed Satellite Internet Services - Viasat.com

SpaceX Starlink

The reported service price is $99/month with a $499 one-time equipment fee. The speeds are a reported 100 Mbps (or better) download but just 10 to 38 Mbps upload speeds. It should be noted that these upload speeds do not conform to the State's 2024 goal of 100 Mbps symmetrical. SpaceX hopes to eventually have 12,000 Starlink satellites and has FCC approval to launch 4,409 satellites but that approval is contingent on SpaceX launching at least half of those satellites in the next six years. Currently there are roughly 1,100 satellites in Low Earth Orbit (LEO).

Since it is a LEO and not geostationary the service works by connecting to one satellite and continuously “hopping” to other satellites as they pass into and out of your service area. Until all the satellites are in place getting “dropped calls” will be an issue because of gaps in coverage. This will make live applications like Zoom calls and distance learning applications problematic.

The FCC has granted Starlink 1 million licenses for service devices in the US. Starlink was also awarded $855 million in FCC subsidiaries via the RDOF process covering almost 643,000 locations. Starlink service is currently in Beta release and going forward RDOF locations will be given priority which could use up much of those 1 million FCC license. There are roughly just 135 RDOF locations awarded to Starlink in the NRPC study area.

High-level Engineering and Design Plans

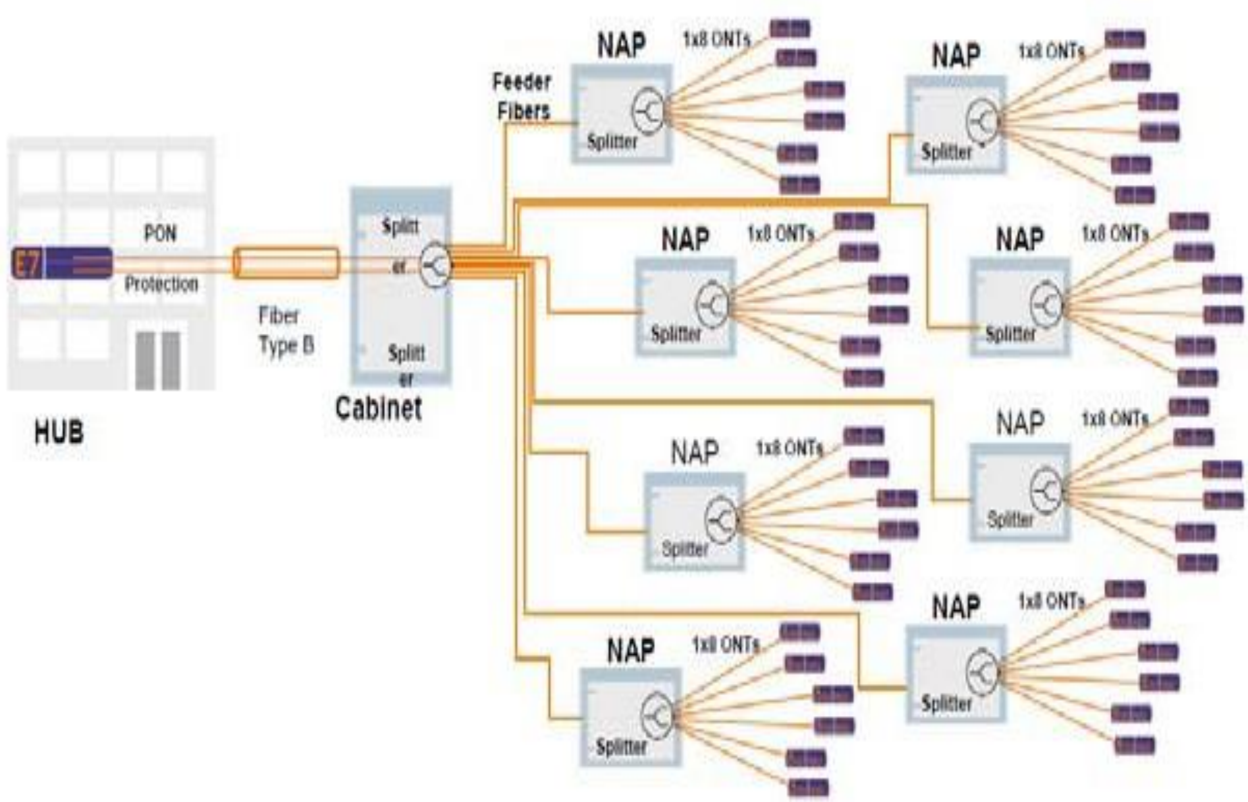
Basic Network Design

The recommended access mechanism for these networks is an optical fiber Gigabit Passive Optical Network (GPON). Its main characteristic is the use of passive splitters in the fiber distribution network, enabling one single feeding fiber from the provider's central office to serve multiple homes and small businesses. GPON networks have become the standard for municipal broadband and for Fiber-to the- Premise projects in the US. The infrastructure is scalable and is limited only by the equipment on both ends of the fiber. The fiber network is future-proof, as needs and increased bandwidth and capacityare necessary, the electronic equipment can be upgraded without needing to rebuild the base fiber architecture. PON standards provide a maximum distance for class B+ optics of 20km (~12.4 miles) between the Optical Network Terminal location in a local hub cabinet and the end user. Extended reach with C+ optics may be used in certain circumstances for up to 58 km (~36 miles). The initial network will consist of a hub location in each town connected to each other with 10 Gb fiber transport.The initial design will include 1 major hub location serving both towns that will also house the routing equipment, servers to access the Internet. Equipment located with the home will also be gigabit compatible.

High Level network design and cost estimates assumptions:

1. Build Costs to house and power the hub facilities throughout the service area(s). The cost estimates including freight, site preparation, foundation or slab, HVAC units, and generator needed to operate the network equipment.
2. Right-of-Way Make Ready costs for aerial attachments, grant funding offsets and municipal bond financing costs.
3. Outside Plant fiber construction for distribution & transmission cable(s) to be in the public right-of-way or existing utility easements.
4. Fiber is to be installed in the communications space of poles where joint use poles are currentlypresent. Industry standard communication attachment methods using steel strand and lashing wire to attach the fiber optic cable to the right of way pole attachments.
5. The network is to be designed to service all buildable lots, MUD's and businesses regardless ofwhether services from the fiber system are elected by the consumer. In other words, including 100% of existing structures being passed in the Right-of-Way adjacent to said structure.

6. Active equipment to utilize Cisco & Calix electronics.
7. Passive splitters to be located both centrally within Hub & in the field.



Hub Design

Interior – Specifications

Minimum dimensions required are 12’ Long x 9’ Wide x 7.5’ High. Wall and ceiling to use R11 insulation as required by local authority having jurisdiction, with white FRP on ½’ wood substrate trim and cove base throughout. Floor standard 12” VCT. (3) 4’ florescent light fixtures with on/off switch by entry. Four double duplex 110V 20a electrical outlets, two on each long wall. (2) 120V 30A L5-30 outlets for battery backup unit(s).

Exterior – Specifications

Insulated entry door, frame and drip cap, lever handle, lock with changeable core, weather stripping, pick plate and aluminum threshold, and entry illumination necessary for entry door with photocell and motion detector.

Electrical – Specifications

Dedicated 100 Amp 120/240V electrical services, manual disconnect, automatic generator transferswitch, Backup generator mounted outdoors stationary, propane or dual fueled, tank sized to run the Hub for a minimum of 72 hours uninterrupted before refueling. Maintenance contract recommended for fueling, maintenance & emergency service to generator unit.

Conduits/Points of Entry – Specifications

From nearest riser pole to Hub (2) 4" SCH40 PVC conduits for telecom use (F1 fiber feed(s) & middle mile drop), all telecom conduits should extend to a minimum of 10' up the riser pole to prevent vandalism.

Environmental – Specifications

(1) 12,000BTU HVAC unit, separate electrical circuits and individual programmable controls, status contact outputs- on/off/failure/trouble, auxiliary exhaust fan, and emergency interior lighting fixture with flood lamps, fire extinguisher suitable for electronic equipment room.

Network – Specifications

Internet access backhaul, bandwidth = 10GigE, Access Sub Bandwidth = 2000 Mbps. Access Bandwidth to scale as needed proportionally to unmetered network usage.

Customer Premise Design

Customer Premises with existing aerial or underground pathways capable of accommodating a new fiber drop cable for the purposes of directly interfacing the customer premise into the fiber distributionsystem shall be considered a standard installation. For the purposes of the construction costs calculations the average drop length is assumed to be less than 300'. Within each premise at the time of final installation an Optical Network Terminal (ONT) should be provided with a fiber interface for direct connection into the fiber distribution network. ONT to also have RJ45 (Ethernet) & RJ11 (POTS) interface for optional router or POTS phone.

Network Design Overview

The design of the physical fiber transmissions & distribution plant determines the network's future scalability and restricts how the plant is operated & maintained. The architecture is also the main determinant of the total cost of the deployment.

Active Ethernet (AE) technology is a point to point application whereas each subscriber has dedicated Transmitter and bandwidth through the deployment of dedicated lasers at the Optical Line Terminal (OLT) and assigned dedicated fiber to the Optical Network Terminal (ONT). When comparing AE to current GPON technology service providers can expect an estimated increase of $1,200 per subscriber in network equipment and lasers, increased capital material expenditure due to fiber sizing (1 fiber=1 subscriber) and increased labor costs associated with the total number of fibers joined for splicing at around $30.00 per fiber.

Due to the difference in network architecture, more efficient use of materials and equipment along with the cost of construction services, Gigabit Passive Optical Network (GPON) is the recommended method of broadband deployment in this study. Current GPON technology can sustain 1 Gbps symmetrical service utilizing an increased form factor through up to 1x64 optical splitters. This allows maximum flexibility and minimum expense in selecting materials and design topology throughout the network.

The next page shows high-level network architecture for a GPON FTTH network. The drawing illustrates the primary devices and components required to operate and support a scalable network. Due to the inherent design of a GPON system, should dedicated links be required for business or government connections, the reserve fiber not allocated to subscribers but rather dedicated for future expansion can provide dedicated circuits should the need arise to accommodate individual Active Ethernet (AE) connections.

Components of the network design:

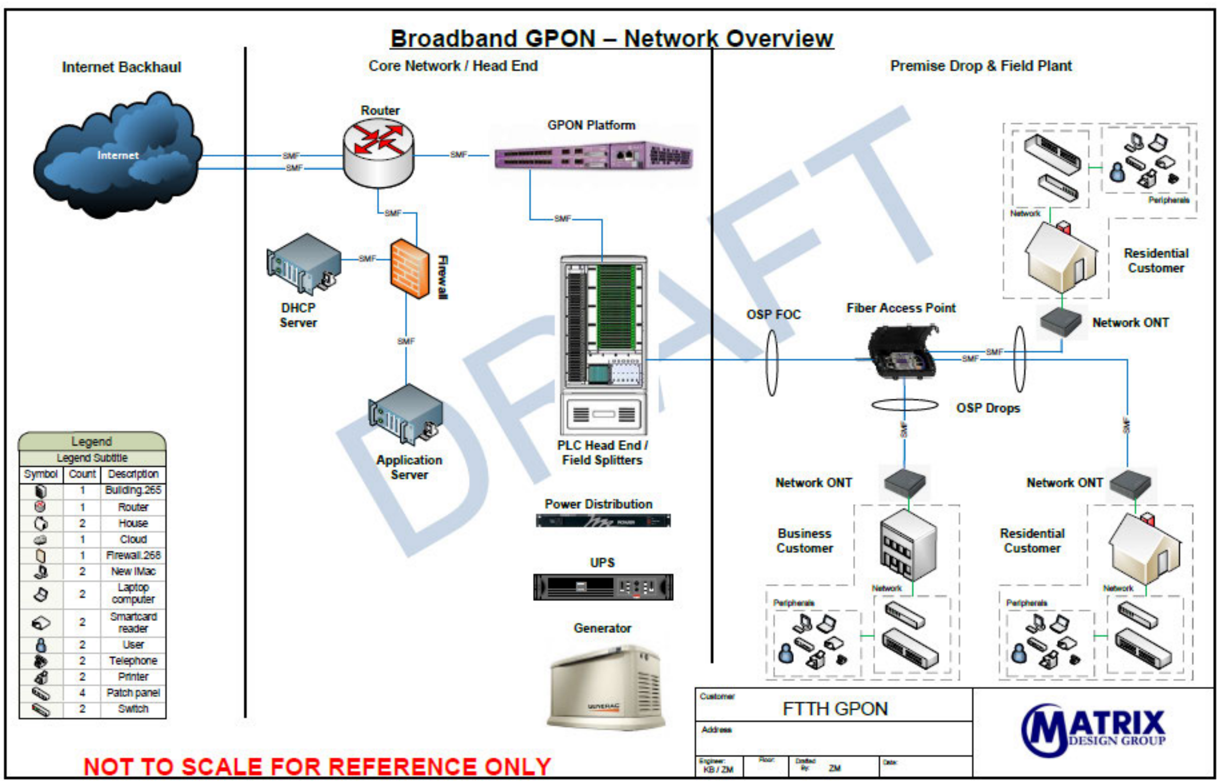
- Internet / Back-Haul – Connection from the Hub site to a core site or central office
- Core Network / Managed Services – Router, firewall, and network management servers
- Head End – OLT equipment, provisions for fault detection, traffic re-routing, traffic

flow, flexibility for service class changes, physical & logical layers

- Premise drops

GPON Architecture Benefits:

- **Efficiency** – Cost effective servicing many subscribers from a single fiber. Passive components don't require external power in the field unlike a hybrid fiber coaxial system. With a lower fiber density in the event of damage restoration is typically completed quicker than a more fiber dense active Ethernet model.
- **Manageability** – simplified provisioning and management of subscribers and services
- **Flexibility** – Providing varying levels and classes of service to different customer locations. Variable speed tiers, phone options, and dedicated links may be offered.



Market Analysis

High speed broadband is a critical base to any thriving, diverse economy in the current economic climate and as surely this demand will increase in the future as more and more personal and commercial business is conducted online. In the same way as both urban and commercial areas need to be connected to conduct business, residential internet service is essential for home businesses and those who work from home. Prior to the emergence of the COVID-19 pandemic and physical distancing guidelines set out by the CDC, working from home needed to be an option for many residents.

In an area such as Franklin & Grand Isle County the ability to have vacation homes and second homes connected to high speed broadband throughout the area is immensely important as it will encourage vacationers to stay longer because they can work remotely, which will in turn bring more business to local economies. These services can detrimental to provide additional opportunities to those communities with less diverse localized economies to expand. According to studies, access to fiber broadband also raises property values by 3%[1], and apartment buildings with fiber fill vacancies faster than ones without it.[2] With broadband internet having such a large impact on everyday life the ability to sell the home at top market value will have an effect. Bringing broadband to the unserved areas of the NRPC will clearly increase the economic potential of those communities.

There has never been a time like this before where there was such a heavy reliance on virtual learning. The education system relies on broadband to connect students with teachers, to provide adult online education resources, and to give the people of Vermont better access to education and quality of life. The effect of creating an affordable pathway to advanced educational opportunities for less affluent communities will be a necessary tool in the advancement of those communities for generations. Broadband is also critical to healthcare, connecting patients with medical providers for telehealth appointments and information, and for remote treatment sessions. In workplace, healthcare, and education contexts' alike, the ability to video conference in high definition, consistent streaming quality, and low latency allows participants to read facial expressions and empathize, creating a communication environment that leads to better quality patient care. Importantly, fiber broadband is also future-proof, meaning it will remain relevant, competitive, and scalable as the technology enmeshed in our lives continues to advance and evolve. A future proof fiber network will serve the region's bandwidth needs today and for decades to come.

Enable Remote Work & Remote Education

Increase Home Values

Attract new companies

Broadband services are as essential to a community today as power was years ago. With access to broadband communities can preserve the lifestyle residents appreciate and ensure sustainability for the future of community.

Sources:

1 https://www.fiberbroadband.org/blog/study-shows-home-values-up-3.1-with-access-to-fiber

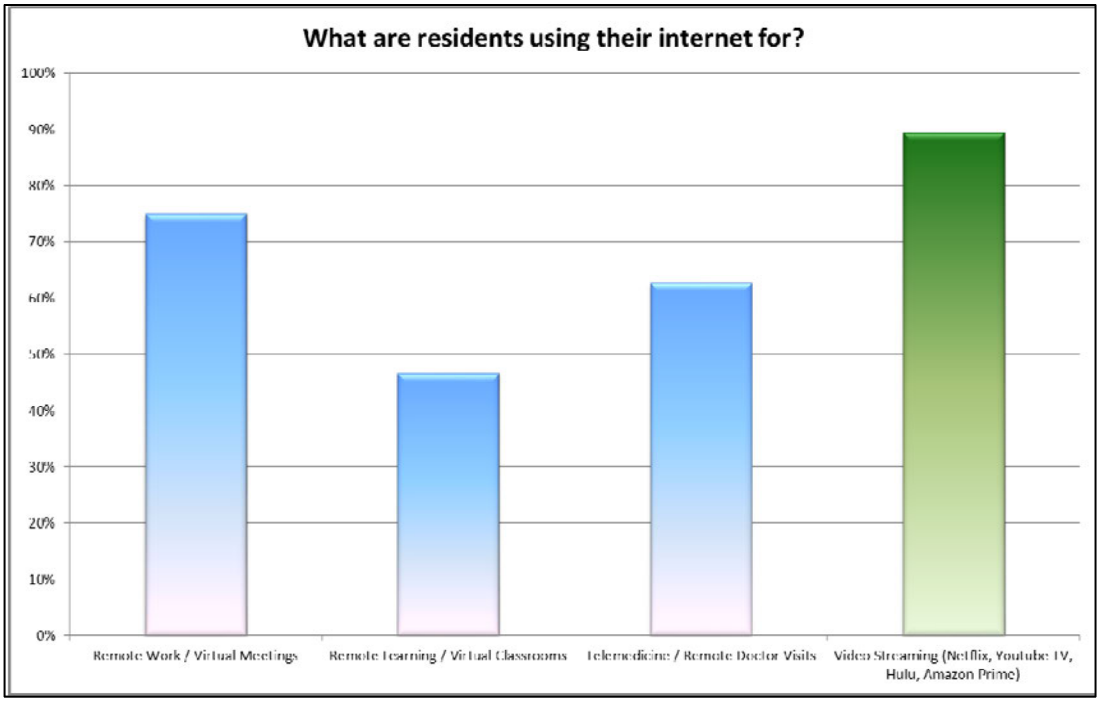
2 Knutson, Ryan, "How Fast Internet Affects Home Prices," *Wall Street Journal,* June 30, 2015,https://www.wsj.com/articles/SB110643412133885342696045810779728978223 58

Importance of Broadband Access

According to the Internet/Broadband Fact Sheet (Figure 1) created by the Pew Research Center in 2019, which has been documenting internet usage growth for over 15 years, over 90% of U.S adults use the internet. Source: https://www.pewresearch.org/internet/fact-sheet/internet-broadband/

Bandwidth Needs

Projected bandwidth needs of potential subscribers begin at a minimum of 100Mbps for download speeds and 100Mbps for upload speeds. Due to the future proof nature of GPON network model this can be scaled up to 1Gbps as subscriber bandwidth usage increase in the future with little to no impact on the system overall.


What are residents using their internet for?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Remote Work / Virtual Meetings
Remote Learning / Virtual Classrooms
Telemedicine / Remote Doctor Visits
Video Streaming (Netflix, Youtube TV, Hulu, Amazon Prime)

Operational Tasks & Role Assignment Assumptions

Design & Project Management

The professional services firm will be responsible for surveying, pole applications, permitting, network design, bill-of-materials, material ordering oversight, material tracking & logistics, fiber testing specifications & criteria, pole-make-ready processing, utility joint ride-outs, make-ready process management, construction supervision, construction inspection, HUB locations selection, Hub design, HUB site-development, HUB construction, HUB activation & testing, middle mile selection & management, materials ordering, Network operator oversight and program management. Responsivities to also include ISP peripheral oversight by network operator; including but not limited to phone service, electronic billing system, website, customer portal, network monitoring, ticketing, etc.

Construction

The construction contractor will be responsible for outside plant equipment deployment, including but not limited to; aerial fiber plant installation & construction, splicing & testing, installation and construction of subscriber service drops. The construction team is to provide all as-built documentation to Network Operator and Project Manager. Network operator to determine final needs of on-call restoration and maintenance options after substantial completion is completed.

Network Operations

The network operator will be responsible for Hub equipment, back-haul internet connectivity, customer activation, marketing, sales, customer service, billing, collections, equipment, maintenance, and overall plant management.

Network operator shall:

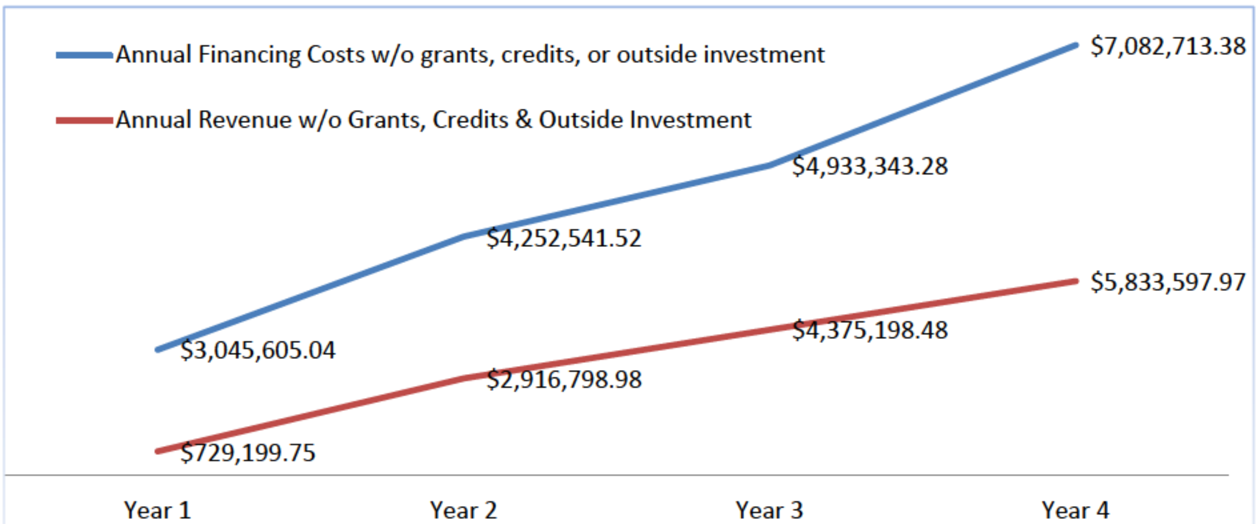
- Abide by regulatory agency compliance required to support Net Neutrality
- Coordinate community early sign-ups (Where applicable)
- Configure network to support symmetrical service for all subscribers
- Integrate protections for subscriber traffic separation from interception
    - Provide customer support recommendation:
    - 24/7 Telephone availability

    - 24/7 Email support
    - 24/7 Ticketing system
    - 24/7 Network monitoring
- Provide Customer with optional VoIP phone service
- Facilitate and execute phone port for customers who may opt for maintaining their currentlyassigned phone number
- Provision VoIP phone system offering recommendation:
    - Anonymous call rejections
    - Call blocking
    - Call forwarding
        - Always
        - Busy line
        - Don’t answer
        - Not reachable
        - Selective
    - Call logs
    - Call return
    - Call waiting
    - Caller ID
    - Caller ID delivery blocking
    - Do not disturb
    - Follow-me/Find-me
    - Speed dial
    - 2 way calling
    - Voicemail
    - Voicemail to Email
- Monitor and maintain sufficient capacity to handle the network load from the customers.
- Provide, maintain, activate customer premise equipment
- Operational Policies
- Marketing & sales campaigns
- Service interruption notifications
- Service calls
    - Scheduling
    - Coordination
    - Troubleshooting solution and repairs
- Billing & collections
    - Monthly billing

- Payment processing
    - ACH
    - Credit Card
    - Check
- Provide customer billing portal
- Provide options paper mailed monthly bill
- Network monitoring
    - 24/7
    - Repairs or restoration from damages
- Backup configuration maintenance
- New customer sign-up
- Website hosting & regular maintenance
- Network insurance
- Staffing suggestion
    - Officers
        - General Manager
        - Chief Technology Officer
    - Outside Plant
        - Aerial line crew(s)
        - Repair Technicians for premise installation or troubleshooting
    - Customer Service
        - Representatives
            - Troubleshooting
            - Billing
- Finance
    - Accounting
- Optional Service Offerings
    - Wi-Fi Router
    - Wi-Fi Extender
    - Static IP address
    - Business VoIP phone

Study Area Overview

The study finds that without substantial capital offsets the larger geographic region encompassing this study cannot be considered viable as a whole by year three and limited by the accumulated Capital Costs of network construction in perpetuity along with the associated Construction time –to-completion. The large scale efforts required to service the overall area with regards to an all-encompassing network and the lag time to accumulated Revenue as shown in the graph below directed efforts to identify a more detailed and geographically targeted approach to further advance the study.



Sources of Capital

Vermont Economic Development Authority-

(VEDA) Broadband Expansion Loan Program allows eligible borrowers to borrow up to 90% of project costs with a maximum loan amount of $4,000,000.00 with term lengths from ten to fifteen years. Interest rates are variable and reflect appropriate risk-based variables. Payments on these loans may be deferred up to two years and usually require collateral in the form of first security interest (lien holder position) in all business assets and personal guarantees of owners of 20% or more.

Source: VEDA Broadband Expansion Loan Program

Low interest rates compared to private held securities along with the option of deferring payments during the first two years during the pole licensing- make ready process, HUB location build and fiber distribution network construction makes this an attractive option for Capital funding. The determination of this study finds that this Capital funding source will not be adequate to provide the total funding to service the entire region covered in this study but may serve useful for a more localized and time phased approach concentrating on the most densely populated unserved communities.

Vermont Public Utility Commission

Broadband Deployment Program-Vermont Electric Co-op (VEC) & Green Mountain Power (GMP) offering $2,000 per unserved location for infrastructure connection costs. "This program aims to create greater equity for customers to access the economic, educational and social benefits that come with connectivity." These capital expenditure offset credits are used in the beginning phases of pole licensing and make ready and could possibly be combined with other capital sources and financing to help reduce the overall per subscriber costs.

Source: Vermont Electric Co-op and Green Mountain Power Announce New Broadband Deployment Program to Leverage Utility Infrastructure to Increase Access and Affordability for Hardest-to-Reach Customers - Green Mountain Power

Venture Capital Investment (Private)-

Private investment firms and/or individuals interested, willing and able to lend funds to start-up companies with growth potential are an option for funding. Typically these firms require terms including high interest rates, ownership interest, and/or varying collateral interests in a network. Benefits from these capital sources having the options to provide expanded loan term lengths as the long-term growth rate and potential increases. Due to the varying investor risk assessment structures as well as the individual firm or institutions asset leverage and market positions the terms of any financing for individual projects is inherently difficult to estimate. However, to suit this study a considerably liberal assumption of 6% interest rate over a 30 note was used for comparison purposes. Consideration of terms should include ownership and collateral leverage to benefit the un/underserved community rather than financial interest of a third party.

Rural Digital Opportunity Fund (RDOF)

The Federal Communications Commission's Rural Digital Opportunity Fund (RDOF) broadband initiative is the single largest distribution of Universal Service Fund (USF) dollars made available to communications service providers in US history. RDOF will provide 20.4 billion in funding over a 10 year period to support the rural construction of broadband networks across the country.

Phase 1's qualified bidder list is located through the link of source 2 below with eligible participants from the region along with new competitors to market can be expected; however, the distribution of funds along with deployment of resources in the region could vary greatly. Speed to market considerations and strategies to capture more localized demand may be advantageous as opposed to waiting for the RDOF phase 2 bidder selections to begin. Phase 2 bidder qualification should remain a target to continue expansion efforts throughout the NRPC area once an initial push to market is successfully achieved.

Source: 1) https://www.rdof.com/ 2) https://docs.fcc.gov/public/attachments/DA-20-1187A2.pdf

Public-Private Partnership

Public-Private Partnerships offer several benefits to both market sectors where each participant is responsible for completing the tasks in which they thrive. Public sponsored projects are conducted with the overall goal to provide critical infrastructure to the community in which it represents; however, most often these projects are not executed in the most efficient manner due to increased regulatory process and procedure requiring government oversight and compliance. Privately sponsored projects are mostly designed to deliver the most efficient time to completion and fastest return on investment through efficiency refinement and industry specialized construction management and technical efficacy.

This partnership can provide the necessary Capital funds along with the specialized skills and experience with regards to industry and trade knowledge to a public interest project; however, it requires a clearly defined contractual agreement to benefit both parties independently.

Revenue Bonds

Vermont Economic Development Authority (VEDA) Tax-Exempt 501(c)(3) Revenue Bond Program is designed to aid certain entities to access the bond market for fixed-asset projects. Certain borrowers may be able to refinance debt and/or finance working capital used to support operations. This source is generally appropriate for projects in excess of $1 million and can be issued for a term of up to 120% of the useful life of the assets financed. Outside plant assets should be the target of revenue bonds due to the extended useful life of fiber as opposed to network electronics that often have a lower life span due to emerging technology and compatibility.

Unfortunately, due to the parameters of this study revenue bonds cannot be considered useful in determining feasibility mostly due to the lag time from the first debt obligation to any significant subscriber revenue given the time scaled efforts of construction by year 3. However, this option should prove useful for any areas found EBITDA positive in year 3 to otherwise to assist in network expansion efforts.

Source: https://www.veda.org/financing-options/vermont-commercial-financing/revenue-bond-program/

United State Department of Agriculture (USDA) Rural Utilities Service (RUS)

Notice of Solicitation of Applications (NOSA) on April 1, 2021 advertised $750 million in loan funding available for Fiscal Year 2021. Applications must be received or post marked no later than 5:00PM (EDT) June 1, 2021. Unfortunately for consideration of this study VTEL Wireless, INC. is considered the "Protected Broadband Borrower" in a large majority of the NRPC area. limited areas available for applications are mostly limited to the open space and non-settled areas limited by geographically oriented elevational changes and protected state and federal lands. Additionally, RUS loans are in vast majority required to reside in the first lien holder position where the option to leverage multiple or additional debt instruments may be unavailable.

Source:
https://ruraldevelopment.maps.arcgis.com/apps/webappviewer/index.html?id=51bbfce8e72549dcb5374d0aa32e1736

Financial Assumptions & Project Process

Capital Expenses

1. **Network Design and Engineering-**
   1.1. Network Pathway Survey
      1.1.1. Pole Data Collection-$240.00-$360.00/Mile
      1.1.2. UG Pathway Area Data-$240.00-$450.00
         1.1.2.1. Locate, GPR (Ground Penetrating Radar), Conduit Survey, Etc. vary costs
      1.1.3. Environmental Impact Studies- Cost Varies Greatly
   1.2. Network Pathway Design
      1.2.1. Pole Licensing Application Processing
      1.2.2. UG Pathway Area Design-
   1.3. Network Outside Plant Make-Ready
      1.3.1. Pole Replacement-$3,000-$4,500/Location
      1.3.2. Existing Attachment transfers-Averaged with Replacement above $450.00/pole
      1.3.3. UG Conduit Design & Professional Engineering (PE) Review-Varying Factors

- 1.4. Head End Distribution Facility Design (HUB)
  - 1.4.1. Land Purchase, Lease Agreement, & Location Preparation-$100,000.00-$500,000.00
  - 1.4.2. Facility Layout Design
    - 1.4.2.1. Floor Plan
    - 1.4.2.2. Conduit/Attachment Design
    - 1.4.2.3. Elevation Plans
    - 1.4.2.4. Foundation Installation
- 1.5. Outside Plant Distribution Design
  - 1.5.1. Fiber sizing & allocations
  - 1.5.2. Architecture and Loss Modeling
  - 1.5.3. Material Selection & Procurement
  - 1.5.4. Construction Plan Development
- 1.6. Contractor Bid Document Generation & Hosting Services
  - 1.6.1. Bid Analysis

2. HUB Electronics- $100,000.00-$300,000.00

- 2.1. Architecture Design
- 2.2. Material Procurement

3. Subscriber Electronics

- 3.1. ONT (Optical Network Terminal) $100.00/Subscriber
- 3.2. UPS Battery Back Up $80.00/Subscriber
- 3.3. NID (Network Interface Device)- Exterior Structure Handoff-$20.00/Subscriber

4. Distribution Materials

- 4.1. ROW Fiber-Size Dependent to Cost, Range $0.26-$4.75 per foot
- 4.2. ROW Steel Strand Support & Hardware-$2572.20/Mile
  - 4.2.1. Subject to commodity pricing of steel
- 4.3. Distribution Splice Cases & Hardware-$600.00/Mile (Varies to Design & Cable Sizing)
- 4.4. FAP (Fiber Access Point) Splice Cases & Hardware-$70.00/Subscriber
- 4.5. Drop Fiber-$50-$75 per Subscriber average assumed

5. Construction & Project Management Services

- 5.1. Construction Plan & Contractor Bid Hosting
- 5.2. Material Staging & Receiving Area
- 5.3. Material Management Equipment & Oversight
- 5.4. Technical Field Oversight and Review
- 5.5. Target Subscriber Marketing & Outreach Services
  - 5.5.1. Rolling Subscriber Installations & Construction Coordination
- 5.6. Technical Oversight-Electronics Management
- 5.7. Final Documentation Acceptance and Testing Services

Operational Expenses:

1. **Operations Management Oversight Services**
    1.1. Network Operations Center (NOC) Monitoring Management
    1.2. Customer Service Representative Management
    1.3. Technical Support Management
    1.4. Outside Plant (OSP) Network Management

2. **Outside Plant (OSP) Network Maintenance & Repair**
    2.1.1. Installation Technician(s)
    2.1.2. Fiber Related Field Equipment (Splicing, Testing, Troubleshooting)
    2.1.3. Hoisting Equipment & Resources
        2.1.3.1. Bucket Trucks
        2.1.3.2. Splice Labs
        2.1.3.3. Excavation Equipment
        2.1.3.4. Specialty Equipment
3. **Electronics Integration & Management**
    3.1. Network Hardware & Software Maintenance
    3.2. Network Engineering Platform Workflow Management
    3.3. End User Electronics Integration
    3.4. Ticketing & Billing System Integrations
    3.5. Troubleshooting

Potential Subscriber Survey Summary

A recent online survey conducted by NWCUD was launched in October of 2020 to assess the overall parameters, with regards to usage type, area, service, provider confidence, and financial criteria of potential new subscribers within the NRPC region. This was completed as such an exercise to aid in the assessment and development of estimates related to market penetration or “take rate” of such communities. It is important to note that while this survey provides additional insight to the motives and objectives of the end user significant variance in estimation may occur in these same communities due to the amount of subjective socio-economic variables and diversity of the study area. It is in the opinion of the author that given this level of variance a conservative measure is best suited to help assist in additional risk mitigation.

A total of 1,056 respondents were asked 18 questions in relation to broadband service and summarized into the categories below for this study.

Areas of Highest Interest-Attraction

Question: What community do you call home?

Within the NRPC area the communities having the largest percentage of respondents being were from Alburgh 18.56%, Fairfax 17.47% and Bakersfield 13.37%. However, it is important to note that in unserved and underserved areas of this study an online survey may be skewed do to the same limited availability of broadband access to participate in such a survey.

Broadband Task Related Need

Question: Do you perform any of the following tasks at home?

Survey results of respondents found that 76.61% use data for remote work/virtual meetings, 53.88% use data for remote learning/virtual classrooms, 63.35% use data for telemedicine/remote doctor visits, 91.57% use data for Video Streaming and Entertainment related services.

An important note for the data point classification of video streaming and entertainment related services would not usually be considered an essential need for public benefit; however, with the recent Covid-19 pandemic forcing more employees and students to conduct their business from home the additional speed and bandwidth could be considered an important data point with regards to the current customer satisfaction rate.

Question: Does it meet your connectivity needs?

Of the total respondents 68.17% answered “No”, “Rarely” or “Sometimes” indicating that current un/underserved are the main respondents to the survey. These respondents are most likely to support broadband efforts and subscribe to services to meet their end use objectives and should serve well as a baseline market penetration “take rate” to those whom are less price sensitive. However, the survey data finding that the respondents whom chose their current provider due to “best price” would have to be accounted for in the baseline take rate assumption moving it down by up to 9% for services costing more than the $86.00 average monthly service cost pulled from this survey.

Current Service Availability

Question: Do you currently have home internet service?

Survey results found that (1) 96.5% of respondents answered “Yes” when asked if they currently have home internet service, (2) 1.7% of respondents answered “No” and (3) 1.8% of respondents answered “Cellular only”.

Question: Current Download/Upload Speed?

Survey results found the average download speed from respondents was 23 Mbps and 6 Mbps for upload speed. However, only 65% of all respondents answered this question and with varying applications supporting the variance of any real metrics are inherently skewed.

Question: What Internet Provider do you currently have?

64.61% of Respondents reported DSL service through several optional providers, 19.10% of Respondents reported Cable service from Comcast, 10.53% of Respondents reported Fixed Wireless, with the remaining +/- 5% reporting either satellite or cellular service.

When asked why respondents chose their current internet provider 72.15% reported that there were no other options available in their market. This question helps solidify customer migration from existing providers in the area; however, this metric can only be used to measure the underserved not the unserved. Additional considerations of market penetration should be applied such as the price elasticity of demand for service should an existing provider lower pricing for customer retainage during capital investment. In markets where as the median income level increase the market penetration rate of underserved should also increase based on the subscribers ability to pay for premium services.

Current Service Cost Assessment

Question: How much do you pay for internet each month?

Approximately 66.5% respondents answered this question reflecting the overall respondent's financial insight to current service. Given this data point a reasonable assumption that the same percentage of respondents overall were the decision makers or largest stakeholders in the household. Of those respondents the average monthly cost was $67.00/Month far below the closest competitor providing fiber within the region.

Perceived value for service given this price point comparison should be leveraged during any marketing campaign throughout the region to solidify potential subscriber knowledge and continued market penetration growth during and after all construction efforts.

Question: If you would/could switch internet providers what would be most important to you?

Respondents answered that "better speed & reliability" would be at the top of their list with "cost" and "customer service" falling behind as overall reasons to switch providers. This data point affirms functionality to the end user's needs is more important of a factor than cost; however, the question of the end user's means to pay and the overall price point entry to market (perceived value) was not a question asked during the survey.

Feasibility Summary

Pursuant to the State of Vermont, Broadband Innovation Grant (BIG) this Feasibility Study was conducted under the parameters for which a project is considered feasible for (1) all unserved and underserved E-911 locations within the study area or (2) where any partial individual study areas of those unserved and underserved E-911 locations are projected to be cash-flow positive for earnings before interest, taxes, depreciation, and amortization (EBITDA) within (3) Years of receipt of required initial investment.

During this study special consideration was isolated to those townships with the highest rate of unserved and underserved populations, access to network backhaul, population density and ease of access to aerial right of way. Additionally an estimated percentage of the unserved areas, by road miles, was then applied to those currently served with broadband in an effort to appropriately scale the quantity of available subscribers geographically; however, network construction costs remain unchanged in these areas due to population density of the served communities being geographically diverse and would require passing in order to reach the unserved and underserved in the same township.

Assumptions:

To aid in the efforts of this study's parameters an aggressive schedule was developed to maximize the total quantity of subscribers available for revenue prior to year 3. However, several factors can affect the outcome of this timeline including, but not limited to, material shortages/lead times, availability of qualified contractors, project management and oversight quality, make-ready activities, etc. Additionally the common materials and electronics used in fiber network construction are subject to fluctuating prices due to commodity and futures market volatility that may affect the financial models applied below.

Network Construction-High Level Timeline Assumptions

<table>
<tr><th>Year 1 Task Summary</th><th>Year 2 Task Summary</th><th>Year 3 Task Summary</th><th>Year 4 Task Summary</th></tr>
<tr><td>Network Survey & Engineering</td><td>Land/Building-Purchase/Lease (Head End)</td><td>Outside Plant Distribution Construction 50%</td><td>Outside Plant Distribution Construction 25%</td></tr>
<tr><td>Attacher Licensing Application</td><td>Outside Plant Make-Ready</td><td>Customer Fiber Drop Installation and Provisioning 50%</td><td>Customer Fiber Drop Installation and Provisioning 25%</td></tr>
<tr><td>Network Architecture & Schematics</td><td>Construction Design</td><td>Customer Service Department Development</td><td rowspan="4">Construction CapEx Transitioning tasks moved to OpEX</td></tr>
<tr><td>Network Construction Design-Outside Plant</td><td>Head End Construction & Testing</td><td>Operations Management Development</td></tr>
<tr><td>Network Head End Design</td><td>Construction Bid Package Development & Execution</td><td rowspan="7">Potential 50% of Subscriber Revenue Available by end of Year for Appropriate Network Scaling and Construction Sub Phasing</td></tr>
<tr><td>Network Backhaul Construction & Hand Off Preparations</td><td>Network Installation-Project Development & Commencement</td></tr>
<tr><td>Bill of Materials Development</td><td>Outside Plant Network Infrastructure Construction</td><td rowspan="5">Remaining Potential 25% Subscriber Revenue Available by end of Year for Appropriate Network Scaling and Construction Sub Phasing</td></tr>
<tr><td>Head End Electronics Procurement</td><td>Outside Plant Distribution Construction 25%</td></tr>
<tr><td>End User Electronics Procurement</td><td>Customer Fiber Drop Installation & Provisioning 25%</td></tr>
<tr><td>Outside Plant Material Procurement</td><td>Billing & Ticketing system integration</td></tr>
<tr><td>Program Management and Operations Development</td><td>Potential 25% Subscriber Revenue Available Under Appropriate Network Scaling and Construction Sub Phasing</td></tr>
</table>

Once these areas were identified (3) targeted funding options were analyzed and applied to these townships outlined below:

Option #1:

Privately sourced subordinated debt with escrowed collateral scaled to network asset depreciation obtained over a 30 year note @ 6% interest rate. 100% of Capital Expenses would be required prior to project commencement to accelerate the time to revenue collection. Please note that in accordance with this study the individual townships were assessed as a whole entity; however, privately held debt instruments could be appropriately dispersed with a structured business plan to reduce lender risk and manage ISP cash flow more successfully.

Option #2:

Vermont Economic Development Authority (VEDA) secured capital investment loan limited by $4,000,000.00 investment over 15 years @ 3% Interest Rate. This option was applied to those townships where the total capital expenses could be appropriated in year 1 to accelerate the time to completion and thus revenue collection. This method is only viable under the correct scale with consideration to ease of access to the right of way attachments and minimal project delays due to make ready efforts and where the initial homes per mile passed are focused to obtain a larger proportional revenue before year 3. Therefore, the smallest unserved townships by land area and largest population density should be considered ideal for this option to minimize accumulated Capital Expenses in any subsequent business plan.

Option #3:

Vermont Economic Development Authority (VEDA) secured capital investment loan limited by $4,000,000.00 investment amortized over a 15 year note with years 1 & 2 deferred and capital balance reductions through the Department of Public Service Un-Underserved credits applied during the make ready process. This option provides the maximum financial flexibility and schedule contingency during the planning and initial construction of the network. Individual townships with greater population dispersion geographically should be considered using this method to maximize the reach of the network prior to revenue collection.

Risk Management

Project Risks

Any project of this scale involves risks that need to be evaluated and prepared for constantly. Some of the biggest risks to the project are outlined below:

Make Ready

The first step to constructing a fiber network is to complete make-ready on any utility poles that the fiber will be attached to. This involves moving any existing cables attached to the pole to make room for the new fiber. This work must be completed by the pole owner which can lead to lengthy delays depending on their schedules and resources. Due to this process being dependent on the pole owner it is one of the most common delays experienced when constructing a new network.

Materials

With the main component of a broadband FTTH network being the fiber on the poles any delays in manufacturing will have a significant impact on the project. The temporary shutdown of manufacturing facilities due to the COVID-19 pandemic is an ongoing concern as raw material and port shutdowns continue to strain the factories. With a flexible design some materials may have alternatives for substitution should a particular component have. Critical materials should be ordered as soon as feasible to allow for some contingency protection. The project schedule will have some flexibly between construction operations for the first phase of the project but in latter phases as tasks are completed less opportunity for adjustments in construction tasks will remain. We recommend working with manufactures and distributors as soon as possible to coordinate the large orders have allotments scheduled.

Construction and Installation Contractors

With broadband infrastructure being discussed as a priority for one of the upcoming COVID-19 stimulus bills, there is a chance that resources might strained as fiber broadband projects and 5G across the country begin ramp up at similar rates. Distribution of resources across the market place may lead to labor issues to incentivize larger contractors whom may have a larger work force to work in an area geographically distanced from major cities.

Construction Execution

With capital at risk the allotment of construction duration will not be flexible. Construction will need to be completed in 18-24. Excluding a 20% factor for contingency the project will need to be substantially completed within 19 months or risk possible stress due to any delays in generating revenue from the network.

Town Summary

Summary of towns that are considered feasible

The towns of Richford, Enosburg, St. Albans Town, St. Albans City, Swanton, High Gate, Sheldon, Georgia, and Montgomery are considered feasible under the study parameters; however, special considerations should be given to the construction methods and speed of deployment due to additional competitive providers having immediate access to pole attachment rights and physical assets in the region to delay take rates and speed to market. Successful presubscription campaign and experienced construction management services are critical to obtaining substantial network construction within the 3 year window. Long term-small scale investment strategies in this area may be best directed toward isolated public sectors such as schools, low income housing units and local/state/federal government service to maintain a presence in the region for maximum flexibility and community benefit.

Summary of towns that are not considered feasible

The towns of Fairfax, Fletcher, Bakersfield, Berkshire, Fairfield, Franklin, South Hero, Grand Isle, and North Hero are not considered feasible by this study taking into consideration the total quantity of subscribers available compared to the land mass, road miles and location of the currently served areas. Without targeting the currently served within the most densely populated areas of the towns, risk analysis and assessment studies of this area are recommended to identify possible methods of phased construction, subscriber pre-subscription programs, and/or public-private partnerships that could potentially be beneficial in determining feasibility under different parameters than this study allows. Migration of existing served customers would be detrimental to project success; however, the lag time to market given the make ready process would provide opportunity for existing providers to effectively reach customers prior to network deployment in the largest population density areas of the towns. It may be useful to group some areas together such as the town(s) of Fletcher, Fairfield, and Bakersfield using a phased approach and offsetting Capital expenses through a more detailed regional construction and network distribution business plan.

Appendix A - Glossary of terms commonly used in the FTTx industry

Adapter: A mechanical media termination device designed to align and join fiber optic connectors often referred to as coupling, bulkhead, or interconnect sleeve.

Angled Polish Connector: (APC) Connectors which have their end-face mating surface polished at an 8-degree angle to the fiber axis. Minimizes reflections; required in RF video applications.

Architecture: Describes how network elements logically relate to each other.

Armor: Additional protective element beneath outer jacket to provide protection against severe outdoor environments. Usually made of plastic-coated steel, it may be corrugated for flexibility.

Attenuation: The decrease in a signal's magnitude of power during transmission between points. A term used for expressing the total loss of an optical system, normally measured in decibels (dB) at a specific wavelength.

Attenuation Coefficient: The rate of optical power loss with respect to distance along the fiber, usually measured in decibels per kilometer (dB/km) at a specific wavelength. The lower the number, the better the fiber's attenuation. Multimode wavelengths are 850 and 1300 nanometers (nm); single-mode wavelengths are 1310 and 1550 nm. Note: When specifying the attenuation, it is important to note whether the value is average or nominal.

Brownfield: Existing neighborhoods and/or MDUs already served by at least one provider.

Buffer Tube: Extruded cylindrical tube covering optical fiber(s) used for protection and isolation

Business: Refers to large (corporate), medium, and small (small business/ small office/home office) business users. Businesses may occupy a multitenant unit (MTU), such as an office block/ tower, or a single-tenanted unit (STU), such as a stand-alone office building or warehouse.

Cable Assembly: Optical fiber cable that has connectors installed on one or both ends. General use of these cable assemblies includes the interconnection of optical fiber cable systems and optoelectronic equipment. If connectors are attached to only one end of a cable, it is known as a pigtail. If connectors are attached to both ends, it is known as a jumper or patch cord.

Central Office (CO): The telephone company's central location containing active (powered) equipment, from which services are provided. May contain telephone switching equipment and/or optical line terminals and RF video for GPON systems.

Cladding: The material surrounding the core of an optical waveguide. The cladding must have a lower index of refraction to keep the light reflecting through the core.

Conduit: Pipe or tubing through which cables can be pulled or housed.

Connector Panel: A patch panel designed for use with fiber optic hardware; it contains either 6, 8, or 12 connector adapters pre-installed for use with field-installable or preconnectorized termination methods.

Core: The central region of an optical fiber through which light propagates from the transmitter.

Decibel (dB): Unit for measuring the relative strength of light signals. Normally expressed in dB, it is equal to one-tenth the common logarithm of the ratio of the two levels dB = 10 log Pout in. Expressed in dBm when a power level is compared to a milliwatt. Note: 1 mW (electrical) = 0 dBm (optical), dBm = 10 log mW.

Digital: A data format that uses differing physical levels to transmit information corresponding to zeros and ones. A discrete or discontinuous signal.

EPON: Ethernet Passive Optical Network

Fiber: An optical waveguide consisting of a core and cladding that is capable of carrying information in the form of light signals.

Fiber Bend Radius: Radius a fiber can bend before it risks breakage or an increase in attenuation. Fiber Optics Light transmission through optical fibers for communication or signaling.

Fiber to the x (FTTx): Refers to a host of acronyms based on taking fiber to the home (FTTH), node (FTTN), curb (FTTC), etc.

Future-Ready: Design decision process in which elements that may not be required today, but which are very likely to be needed in the future, are either built into the design up front or are planned as simple upgrades.

GbE: Gigabit Ethernet

Gigabit Passive Optical Network (GPON): based on higher gigabit speeds. These systems may use an RF overlay for video, but because of their increased bandwidth per subscriber, are also being used for IPTV deployment, in which all services (voice, video, and data) are placed on the GPON and the RF video overlay is not required.

Gbps: Gigabits per second; 1 billion bits transmitted per second.

Greenfield: New construction of MDUs and neighborhoods. In this case, no service provider and no broadband network communications exists. Fiber cable system can be planned and placed efficiently while walls, ceilings, basements, and attics are openly accessible to create pathways.

Headend (HE): Cable television term analogous to the telephone company's central office.

Homerun Installation: in which fiber cables are pulled from each outlet or device back to one common location, such as the ONT in a living unit or from each living unit to a common location for the MDU building.

Homes Connected: Number of residential and business premises to which a service provider is supplying FTTH services under a commercial contract.

Homes Passed: Number of residential and business premises to which a service provider has access to deliver FTTH services within the standard service activation period (for example 30 days) should the owners/occupiers sign a contract for an access service.

Internet: Refers to use of the Public Internet for exchanging email, Web-browsing, video gaming, etc.

Jumper: Optical fiber cable that has connectors installed on both ends.

Laser: Term originated as an acronym for "light amplification by stimulated emission of radiation." An opto-electronic device that produces coherent light with a narrow range of wavelengths, typically centered around 850, 1310, or 1550 nm. Lasers with wavelengths centered around 850 nm are commonly referred to as VCSEL.

Link: A telecommunications circuit between any two telecommunications devices, excluding the equipment connectors.

Mechanical Splicing: Joining two fibers together by permanent or temporary mechanical means (vs. fusion splicing or connectors) to enable a continuous signal.

Open Access (Duct): Refers to the situation where multiple retail or wholesale service providers may share the use of a duct network covering a substantial region by drawing or blowing their fiber cables through the shared ducts and compete to offer their services.

Open Access (Fiber): Refers to the situation where multiple retail or wholesale service providers may use the FTTH network by connecting at a physical layer ("dark" fiber) interface and compete to offer their services.

Open Access (Packet): Refers to the situation where multiple retail service providers may use the FTTH network by connecting at a packet layer interface and compete to offer their services to end users. Corning/Optical Communications/FTTH Glossary/EVO-871-EN Page 8 FTTH Glossary

Open Access (Wavelength): Refers to the situation where multiple retail or wholesale service providers may use the FTTH network by connecting at a wavelength layer interface and compete to offer their services.

Optical Line Terminal (OLT): For GPON systems, this is the electronics located in the CO/HE and which control the ONTs served at each subscriber's location. Typically, OLTs service 16, 32, or 64 ONTs.

Optical Network Terminal (ONT:) For GPON systems, this is the electronics located at the subscriber's premises. The ONT converts the optical signal to copper and coax-based signals for connection to phones, computers, and televisions in the residence.

Optical Return Loss (ORL): For an optical network, as a system, ORL is a measure of the total reflected signal relative to the signal being transmitted into the network (the incident signal). ORL includes all components, end to end, such as fiber, connectors, splices, etc. in the link. ORL is expressed as a positive value, and the larger the value, the better the performance. For example, 60 dB means the total signal reflected back is 60 dB below the incident being transmitted into the network.

Outside Plant (OSP): Cabling outside of buildings, including aerial and buried installations.

Patch Cord: A fiber optic interconnect or cross-connect jumper.

Patch Panel: A length of optical cable with a plug on one or both ends.

Pathway: The path planned and used for cable placement. It includes ducts, raceway, aerial strand, directly buried, etc.

Pigtail: Optical fiber cable that has a connector installed on one end.

Riser: Pathways in a building that go from floor to floor. Cables and nonmetallic duct must be "riser rated" to control flame propagation building in this space. The exception, depending on local codes, is for cables placed in sealed metallic duct/conduits.

Single-Mode (SM): Fiber An optical waveguide (or fiber) in which the signal travels in one mode. The fiber has a small core diameter, typically 8.3 to 9.5 µm

Splice Closure: A container used to organize and protect splice trays and splices. Typically used in outside plant environments.

Splice Tray: A container used to secure, organize, and protect spliced fibers.

Splicing The permanent joining of a bare fiber end to another fiber, either one pair at a time or in a mass.

Splitter (Optical):An optical device which splits the optical power of one signal into multiple outputs, each containing the same signal, but at a lower power level. For BPON and GPON systems, splits of 1x16, 1x32, and 1x64 are used.

TIA: Telecommunications Industry Association

Topology: The physical layout of the network that describes how the system components are actually placed and connected to each other. While the architecture is the logical view, the topology is a physical view of the network.

Transmitter (Tx): An electronic package used to convert an electrical information carrying signal to a corresponding optical signal for transmission by fiber. The transmitter is usually a light-emitting diode (LED) or laser diode.

Video: Refers to the exchange of visual material by use of IP, RF (carried via a separate optical wavelength), or other encoding and transport protocols.

VFL: Visual fault locator

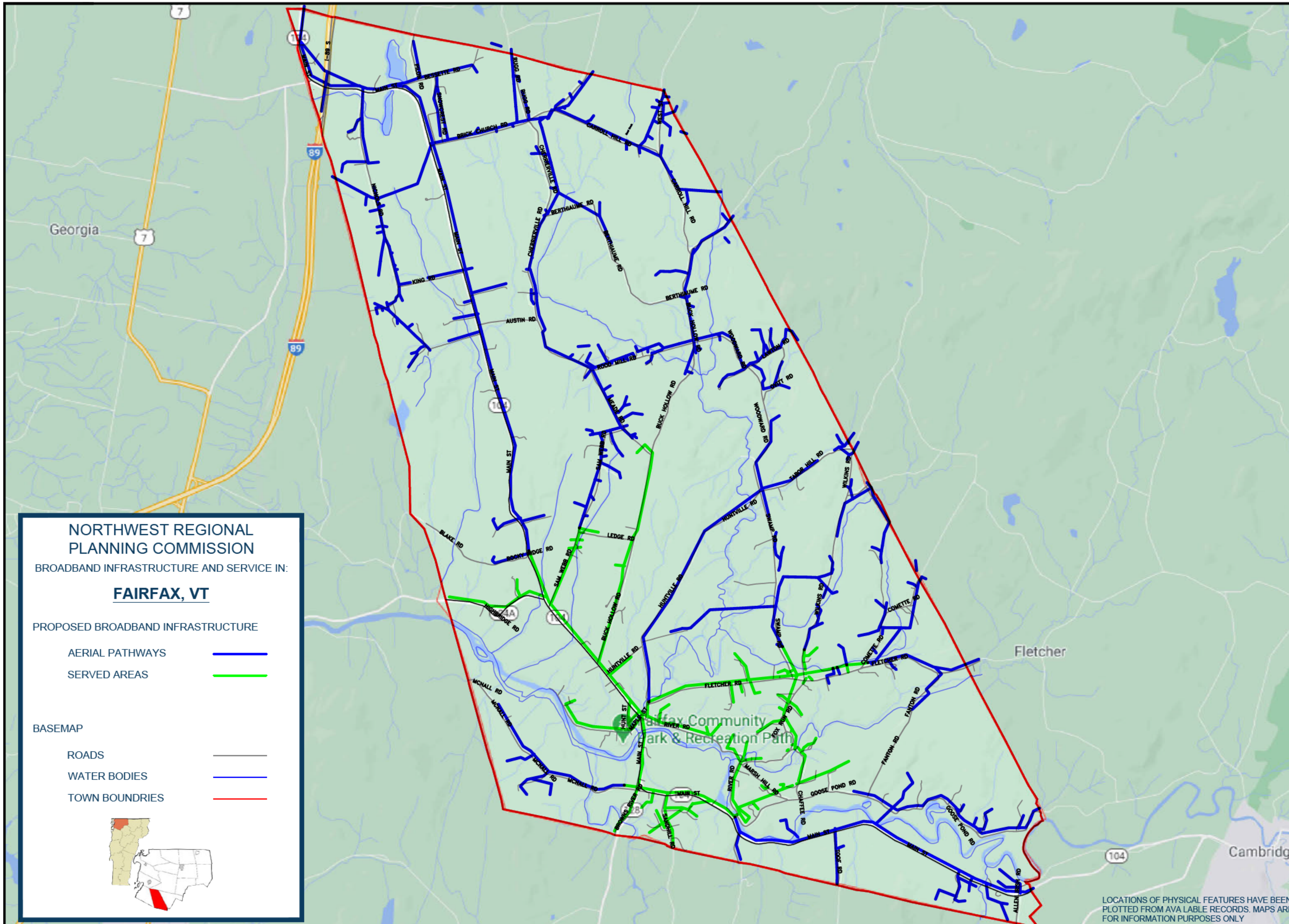
Voice: Refers to the exchange of human conversations by use of IP or other encoding and transport protocols.

Wavelength: The distance between two successive points of an electromagnetic waveform, usually measured in nanometers (nm).

Wavelength Division Multiplexer: (WDM) A passive device used to combine and/or separate optical signals of different wavelengths. Example: WDMs combine the downstream data/voice signals (1490 nm) with RF video signals (1550 nm) in the CO to be sent out toward subscribers.

Appendix B - Town Maps

County	Town	Total Buildings	Served 100/100 or Better	Percent Served 100/100 or Better	Served 25/3 or Better	Percent Served 25/3 or Better	Served 4/1 or Better	Percent Served 4/1 or Better	Underserved	Percent Underserved
FRANKLIN	Bakersfield	695	0	0.0%	227	32.7%	530	76.3%	165	23.7%
FRANKLIN	Berkshire	723	0	0.0%	154	21.3%	557	77.0%	166	23.0%
FRANKLIN	Enosburgh	1283	0	0.0%	695	54.2%	1,147	89.4%	136	10.6%
FRANKLIN	Fairfax	1784	3	0.2%	899	50.4%	1,379	77.3%	405	22.7%
FRANKLIN	Fairfield	994	0	0.0%	104	10.5%	589	59.3%	405	40.7%
FRANKLIN	Fletcher	658	183	27.8%	194	29.5%	524	79.6%	134	20.4%
FRANKLIN	Franklin	936	509	54.4%	510	54.5%	907	96.9%	29	3.1%
FRANKLIN	Georgia	2054	0	0.0%	1,805	87.9%	1,967	95.8%	87	4.2%
FRANKLIN	Highgate	1833	65	3.5%	1,794	97.9%	1,817	99.1%	16	0.9%
FRANKLIN	Montgomery	827	4	0.5%	249	30.1%	677	81.9%	150	18.1%
FRANKLIN	Richford	1084	0	0.0%	759	70.0%	960	88.6%	124	11.4%
FRANKLIN	Sheldon	987	85	8.6%	334	33.8%	830	84.1%	157	15.9%
FRANKLIN	St. Albans City	2515	8	0.3%	2,515	100.0%	2,515	100.0%		0.0%
FRANKLIN	St. Albans Town	3184	6	0.2%	2,978	93.5%	3,105	97.5%	79	2.5%
FRANKLIN	Swanton	3110	0	0.0%	2,916	93.8%	2,945	94.7%	165	5.3%
GRAND ISLE	Alburgh	1826	0	0.0%	468	25.6%	1,546	84.7%	280	15.3%
GRAND ISLE	Grand Isle	1316	0	0.0%	1,306	99.2%	1,310	99.5%	6	0.5%
GRAND ISLE	Isle La Motte	563	0	0.0%	150	26.6%	556	98.8%	7	1.2%
GRAND ISLE	North Hero	1099	0	0.0%	1,026	93.4%	1,027	93.4%	72	6.6%
GRAND ISLE	South Hero	1539	0	0.0%	1,510	98.1%	1,510	98.1%	29	1.9%



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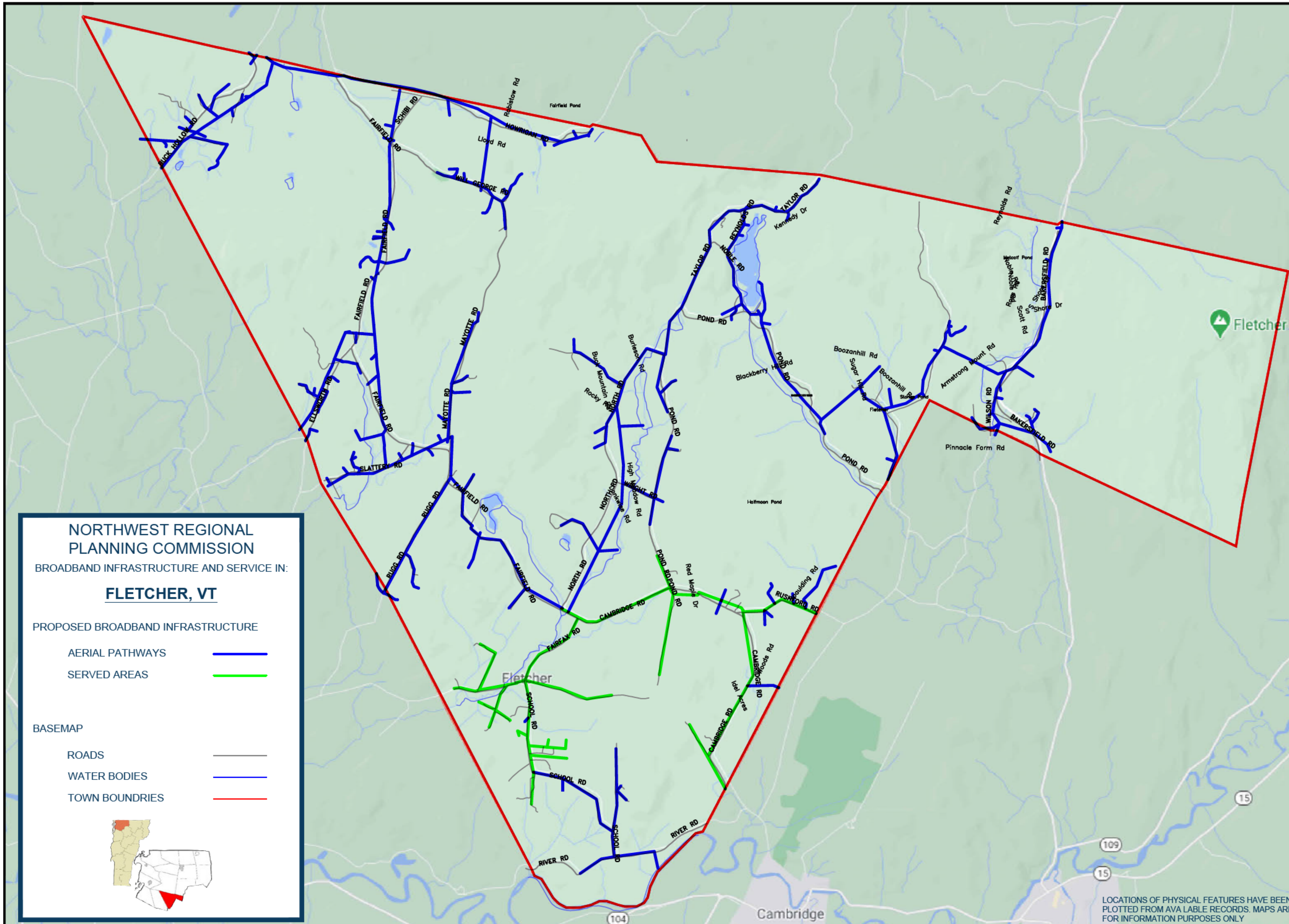

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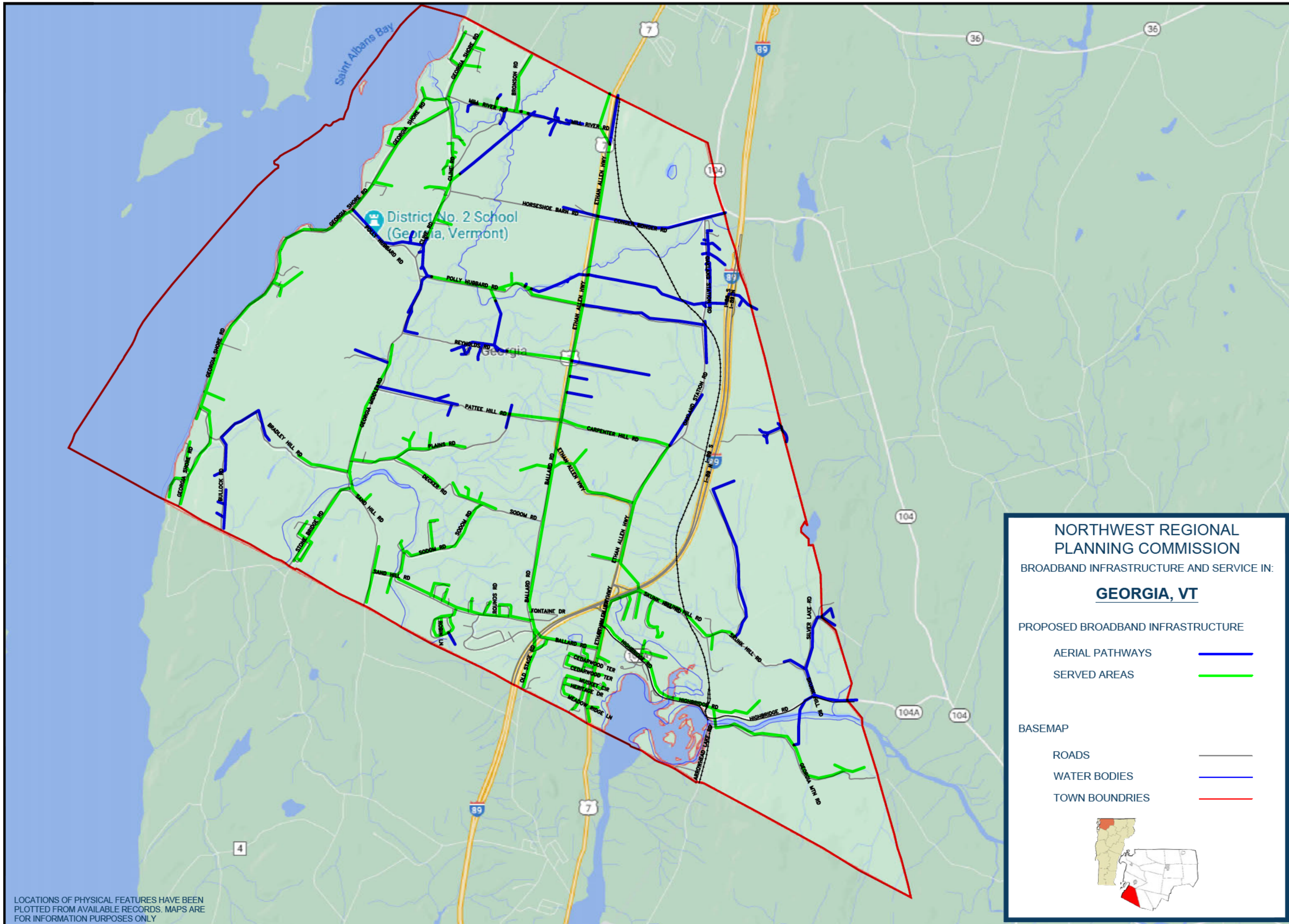

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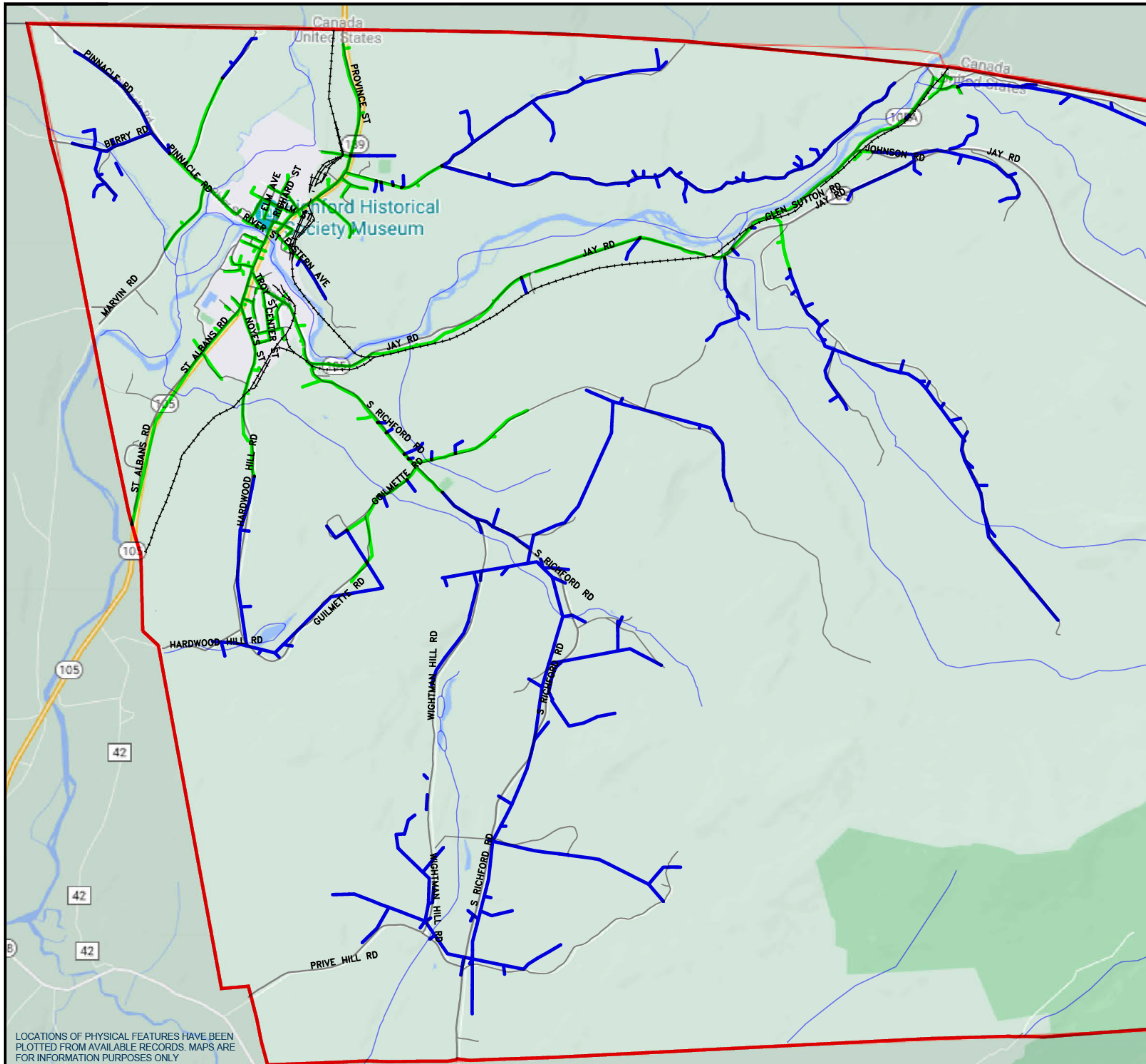

NORTHWEST REGIONAL PLANNING COMMISSION

BROADBAND INFRASTRUCTURE AND SERVICE IN:

RICHFORD, VT

PROPOSED BROADBAND INFRASTRUCTURE

- AERIAL PATHWAYS
- SERVED AREAS

BASEMAP

- ROADS
- WATER BODIES
- TOWN BOUNDRIES

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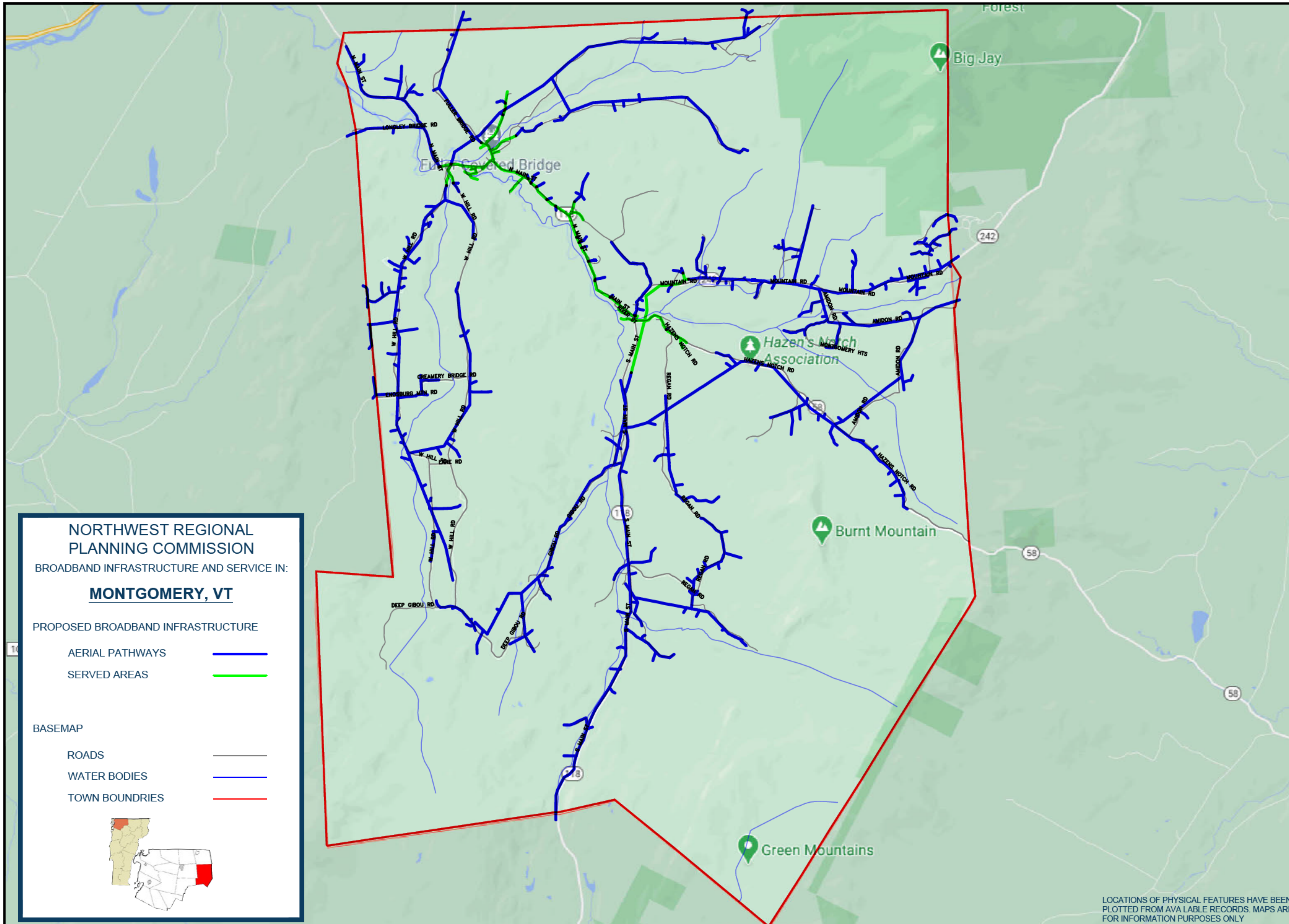

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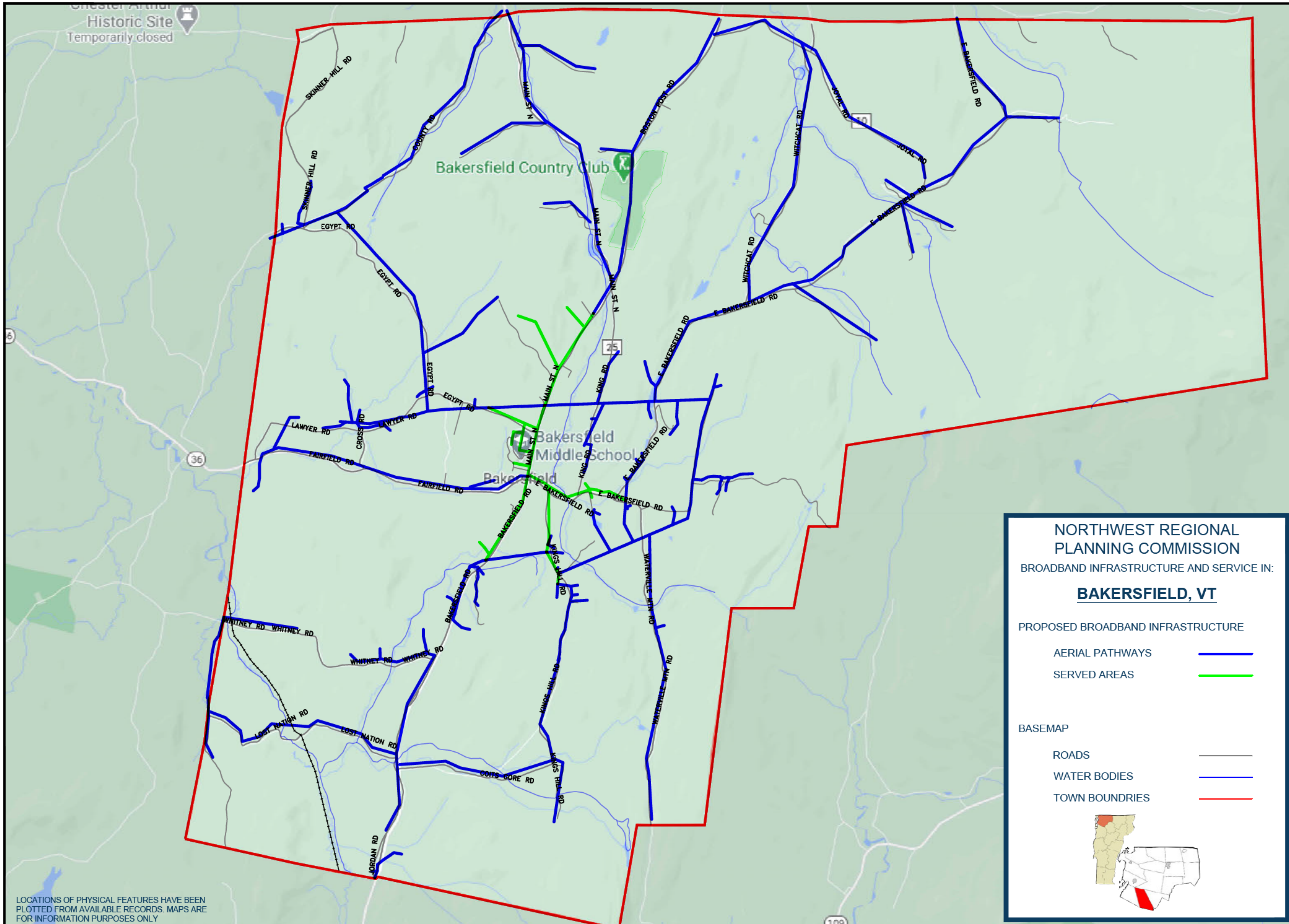

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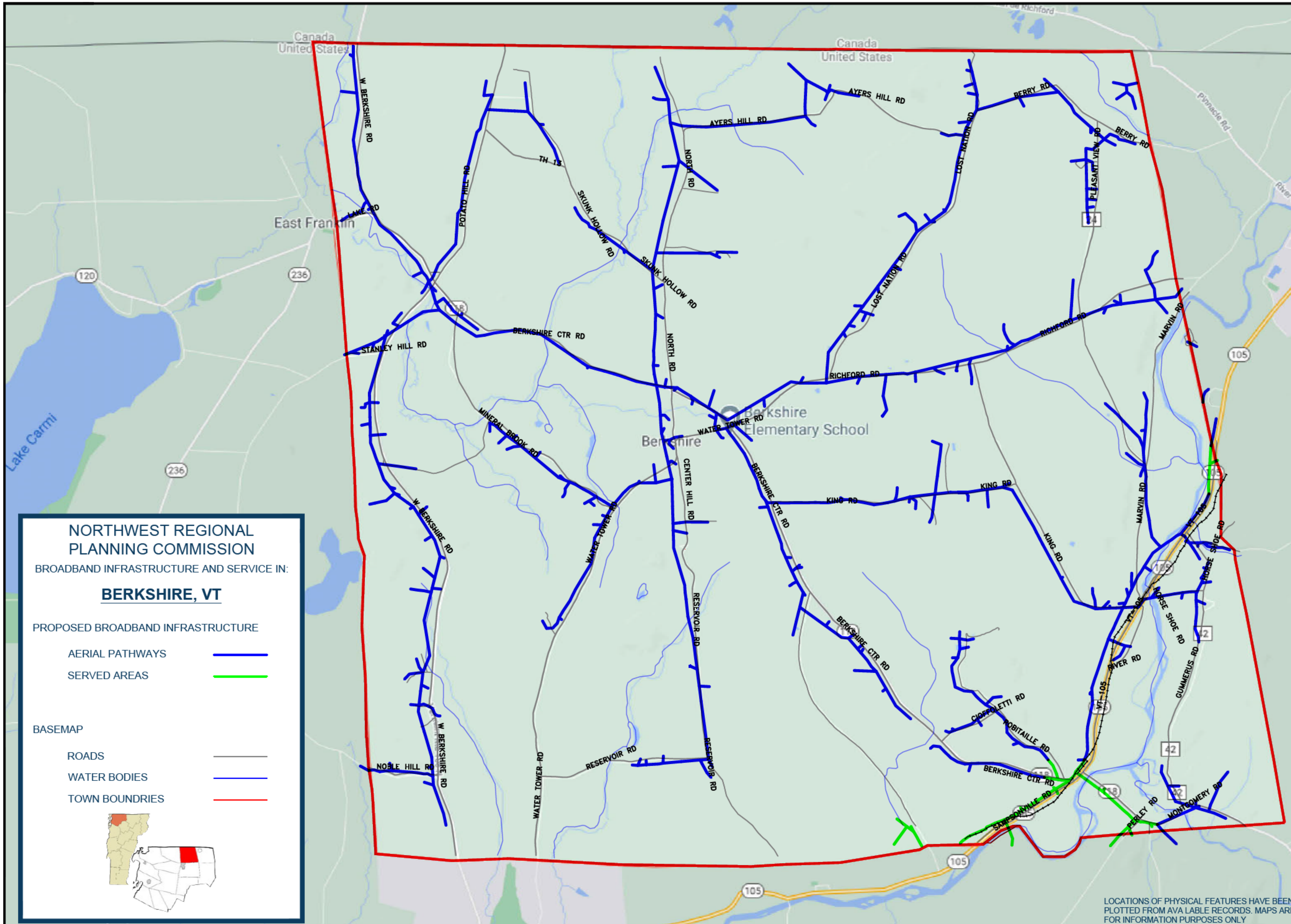

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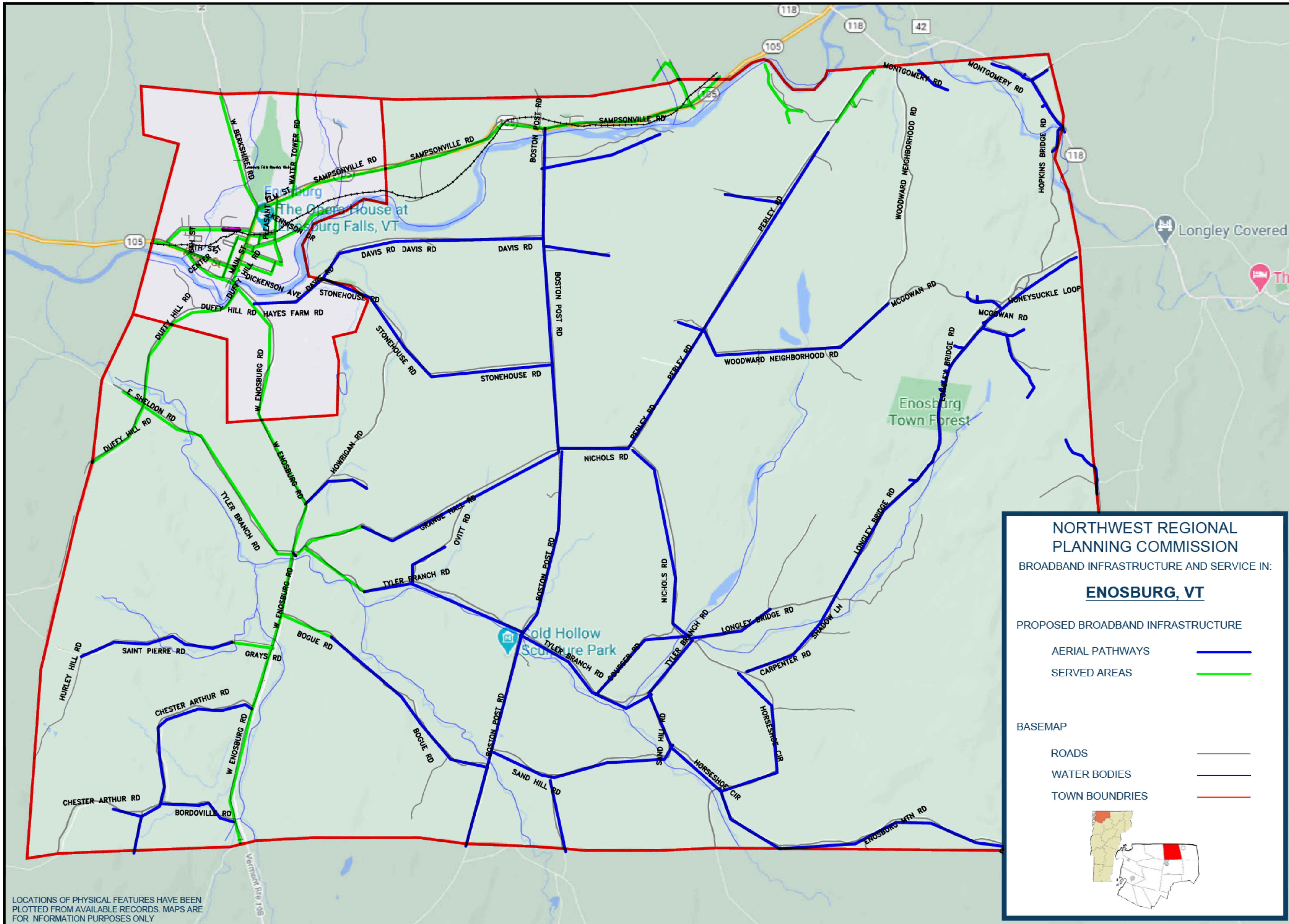

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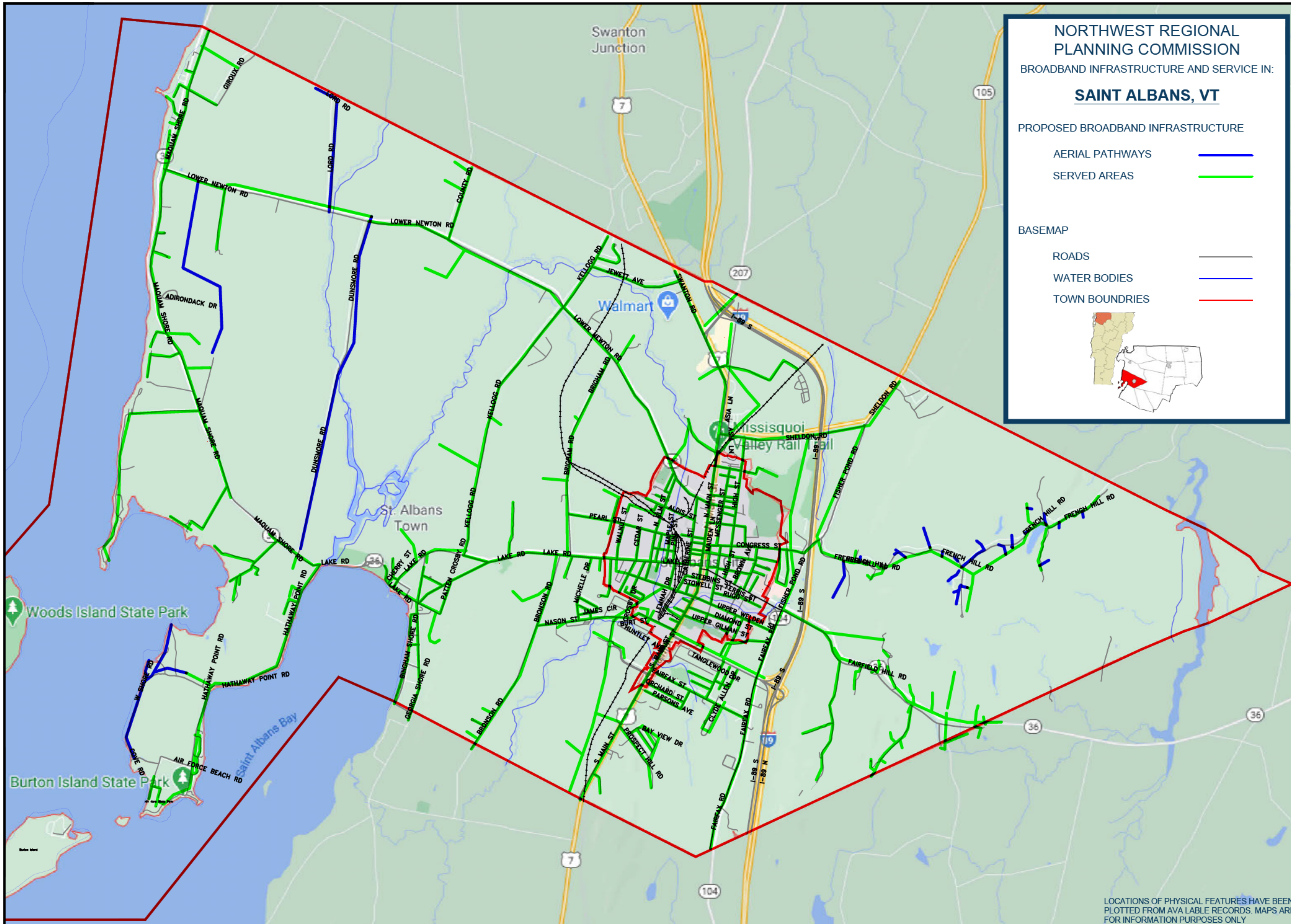

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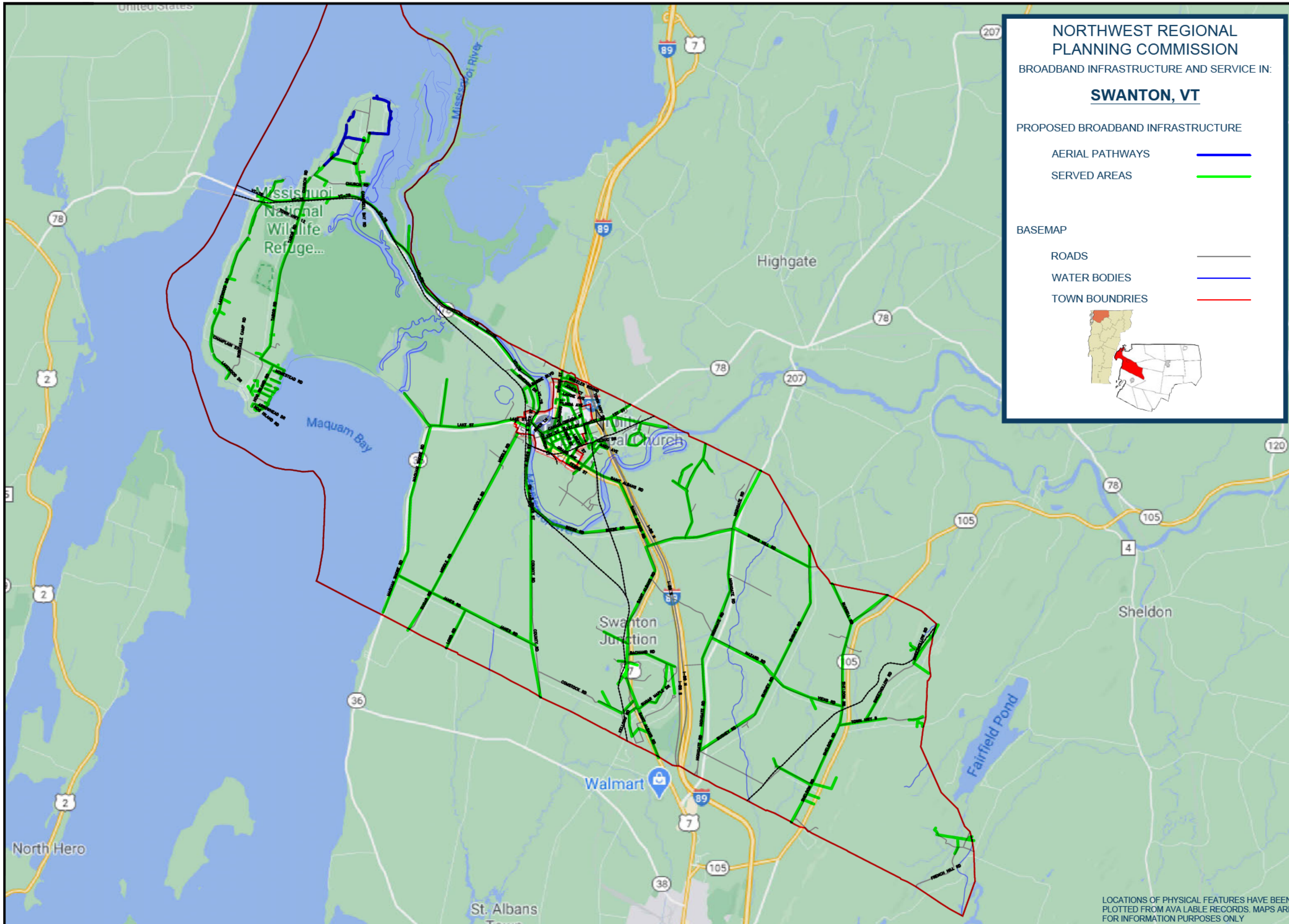

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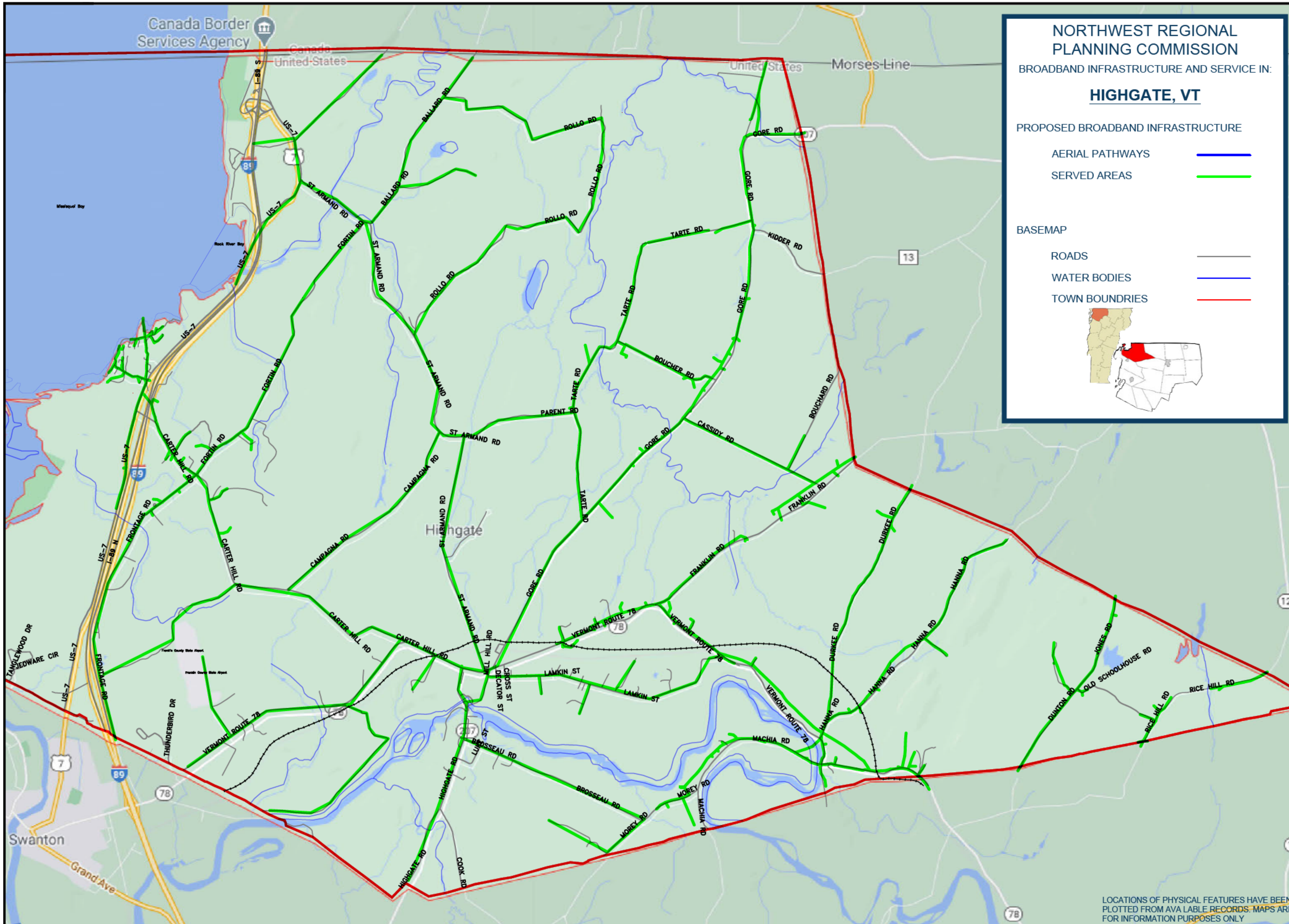

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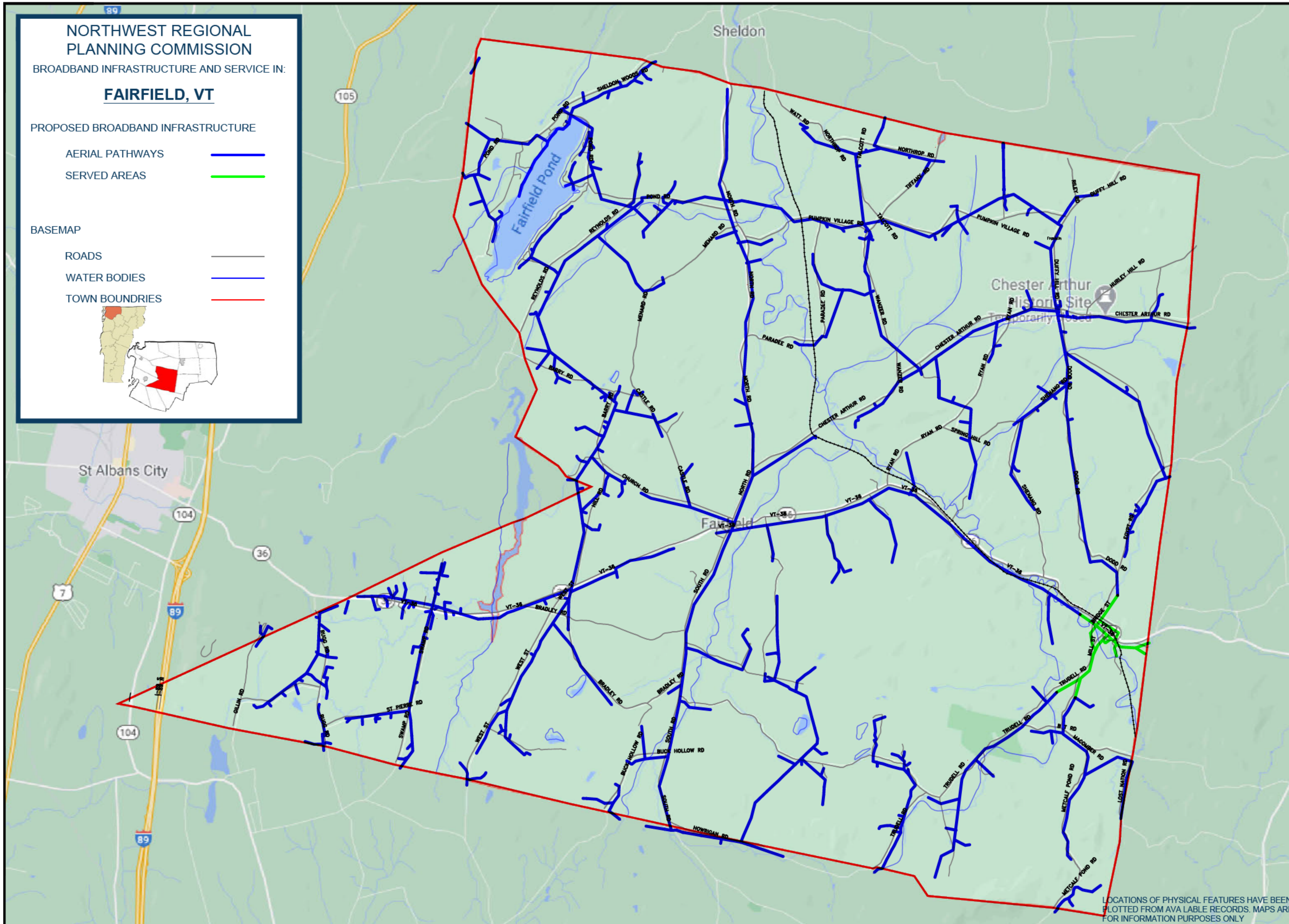

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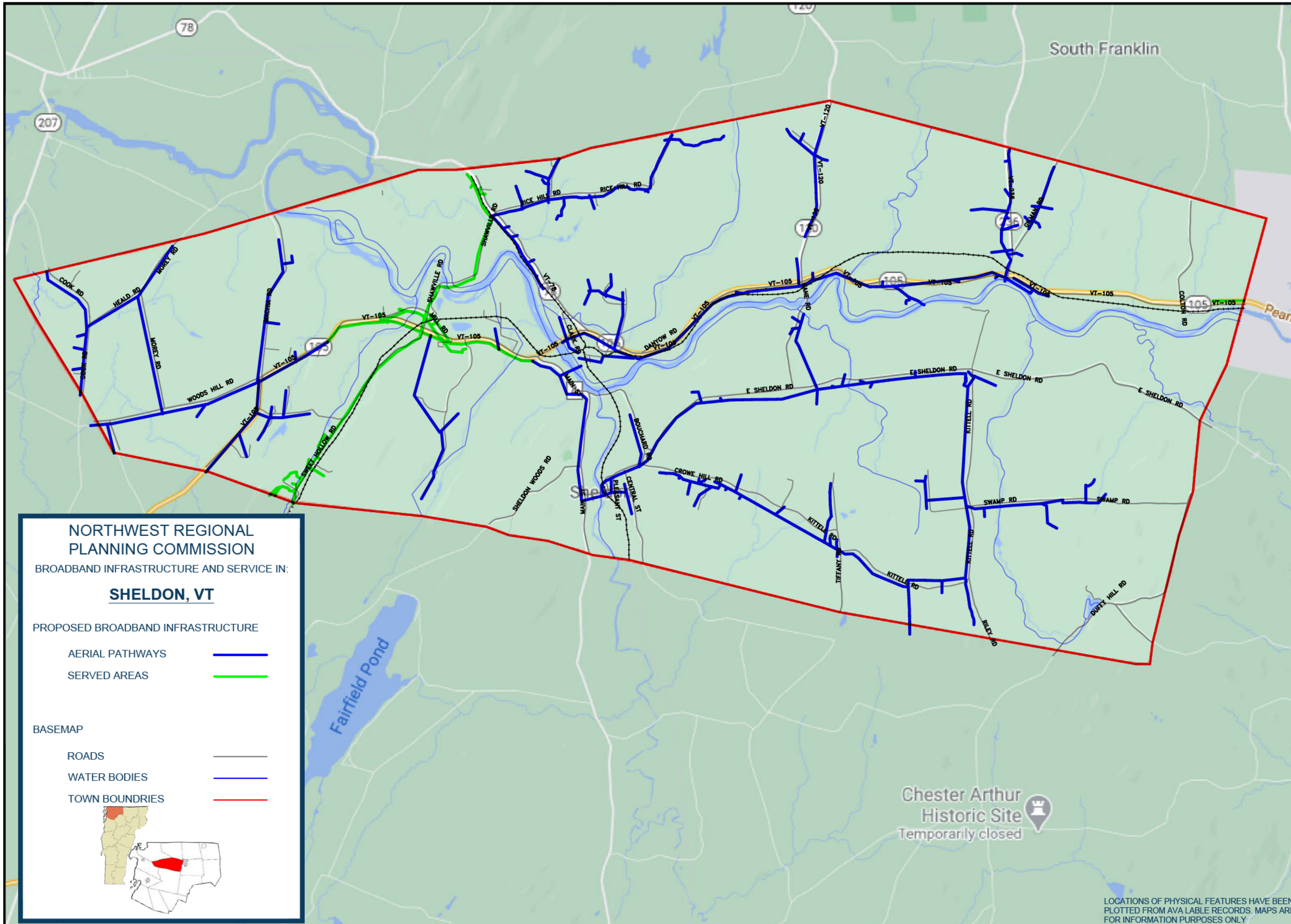

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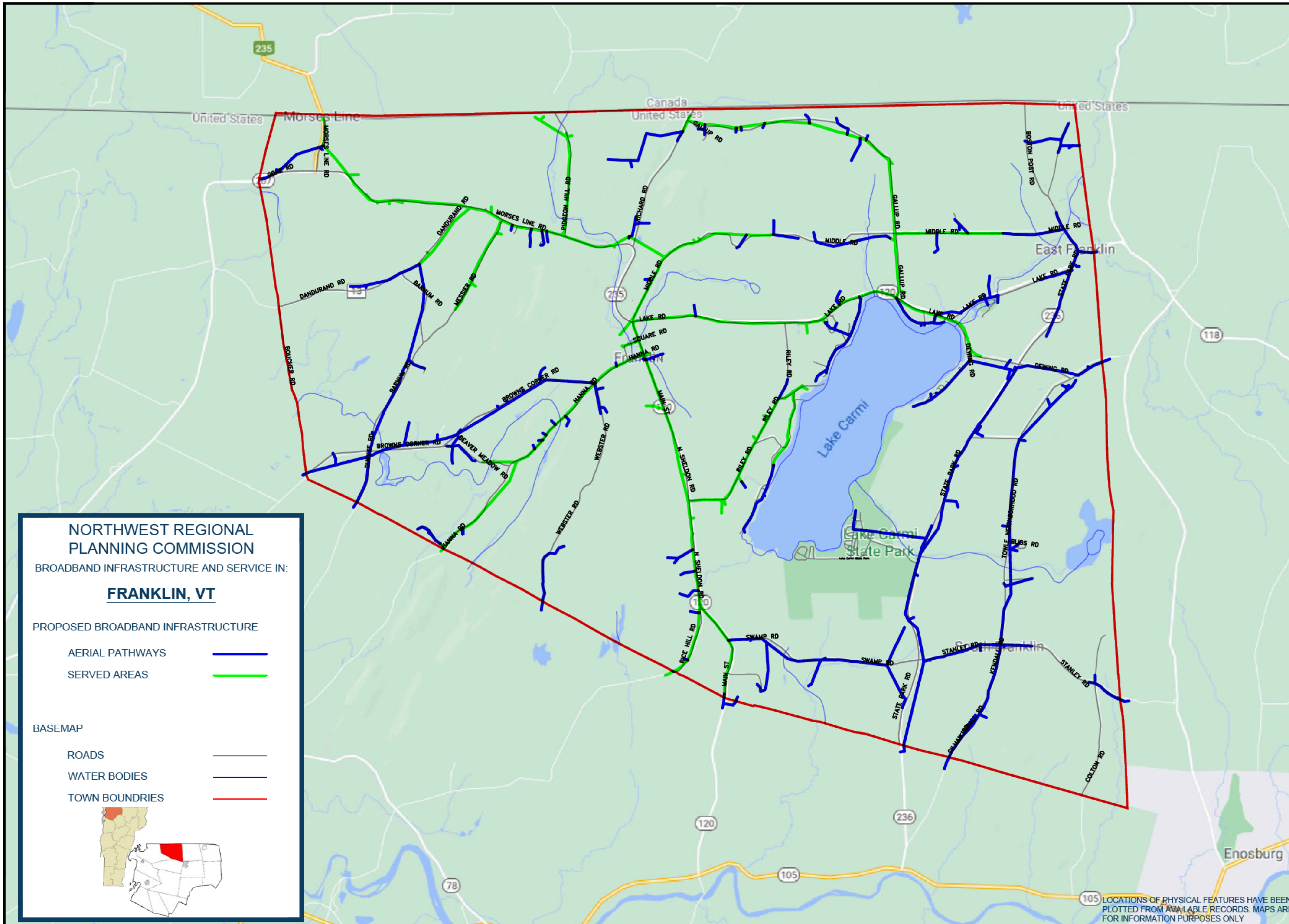

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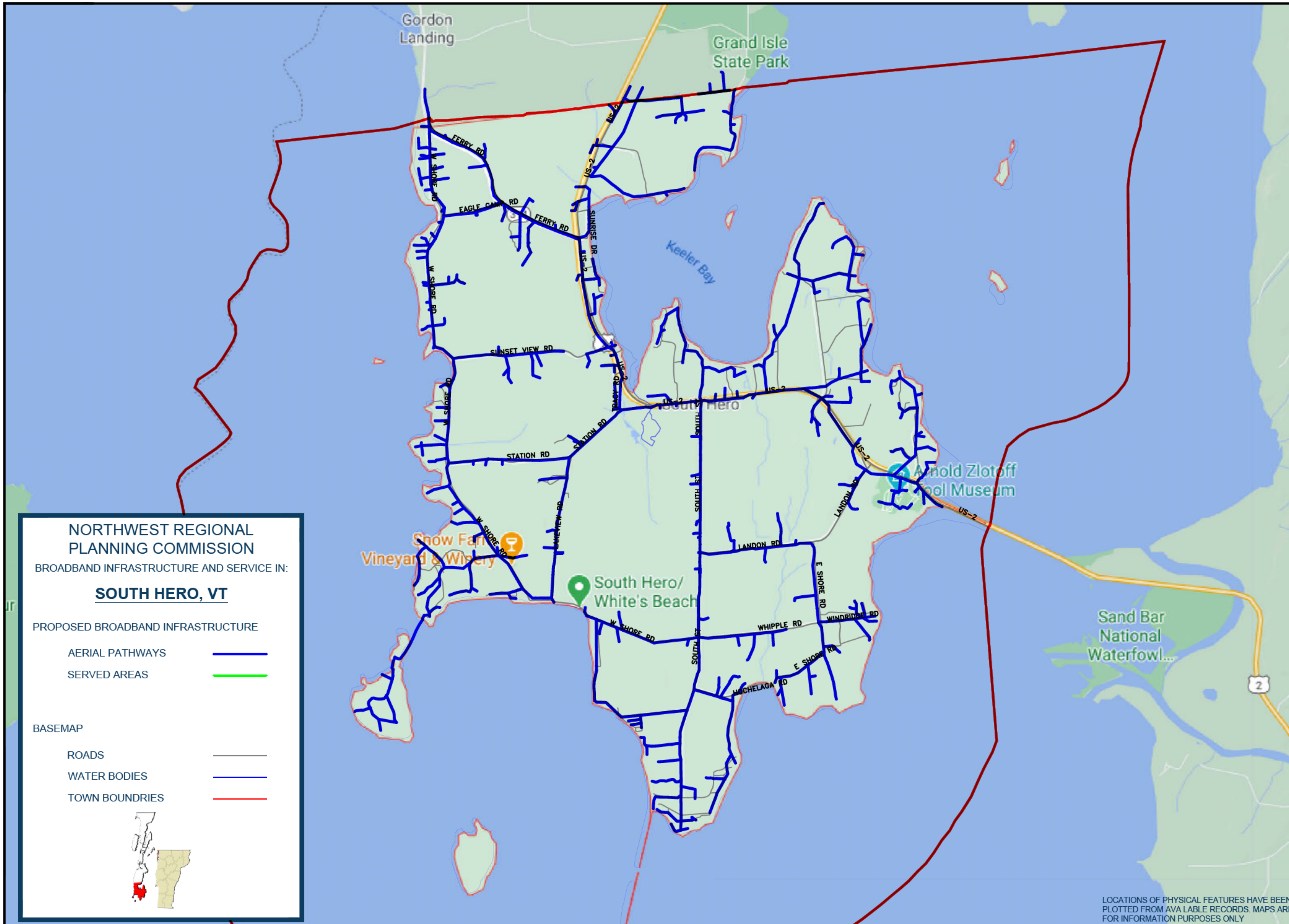
DRAWING TITLE:
FRANKLIN, VT



NORTHWEST REGIONAL PLANNING COMMISSION

BROADBAND INFRASTRUCTURE AND SERVICE IN:

SOUTH HERO, VT

PROPOSED BROADBAND INFRASTRUCTURE

- AERIAL PATHWAYS
- SERVED AREAS

BASEMAP

- ROADS
- WATER BODIES
- TOWN BOUNDRIES

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NORTH

Northwest Regional Planning Commission

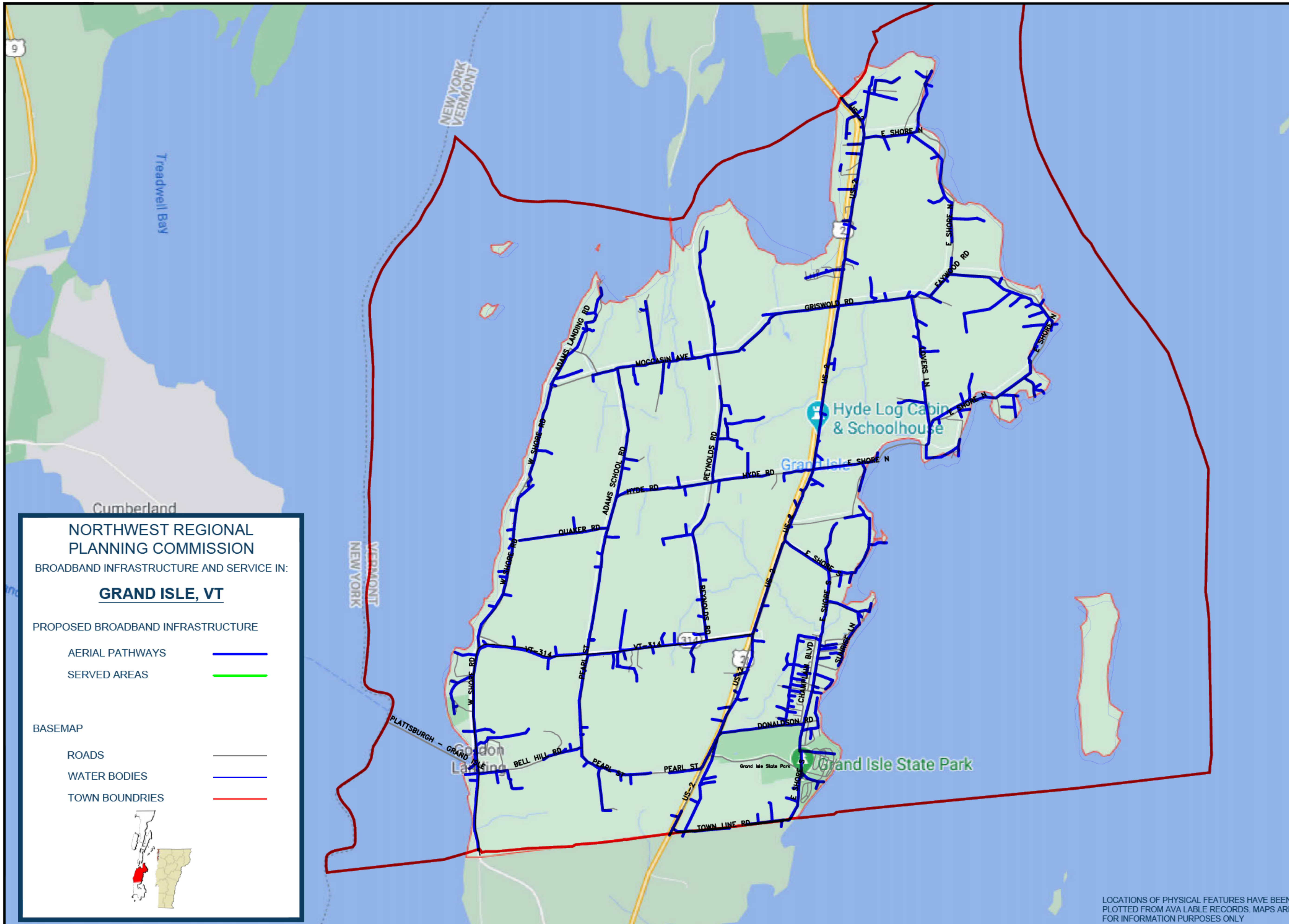
PROJECT: NORTHWEST REGIONAL PLANNING COMMISSION BROADBAND FEASIBILITY STUDY & BUISNESS PLAN

XXX	XXX	XXX
XXX	XXX	XXX
XXX	XXX	XXX

REV	DATE	DESCRIPTION

PROJECT NO.	20-A-2247
DATE:	12/10/20
SCALE:	N.T.S.
DRAWN BY:	----
APPROVED BY:	ZM

DRAWING TITLE: SOUTH HERO, VT



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XXX	XXX	XXX
XXX	XXX	XXX
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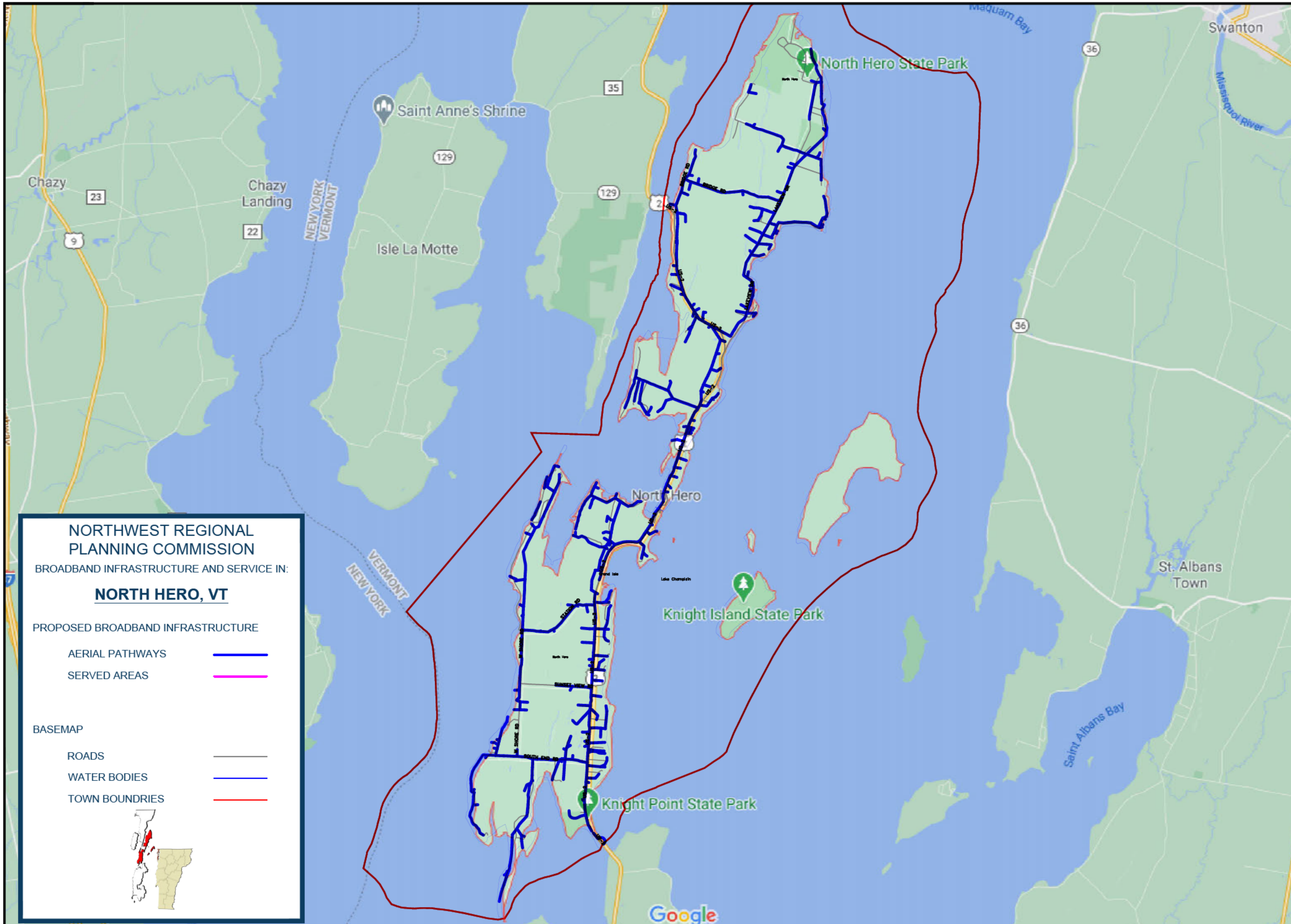
REV	DATE	DESCRIPTION

PROJECT NO.	20-A-2247
DATE:	12/10/20
SCALE:	N.T.S.
DRAWN BY:	----
APPROVED BY:	ZM

DRAWING TITLE:
GRAND ISLE, VT



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Northwest Regional Planning Commission

PROJECT: NORTHWEST REGIONAL PLANNING COMMISSION BROADBAND FEASIBILITY STUDY & BUISNESS PLAN

XXX	XXX	XXX
XXX	XXX	XXX
XXX	XXX	XXX

REV	DATE	DESCRIPTION

PROJECT NO.	20-A-2247
DATE:	12/10/20
SCALE:	N.T.S.
DRAWN BY:	----
APPROVED BY:	ZM

DRAWING TITLE: NORTH HERO, VT

DRAWING NO. AS-102

SHEET X OF XX