



DEVELOP NOVA SCOTIA

# Cell Gap Analysis

Final Report



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# 1. Introduction

This report presents the results of the Cell Gap Analysis study completed by FarrPoint for Develop Nova Scotia (DNS).

## 1.1. Background

The importance of excellent cell coverage is well understood across the marketplace as being a key enabler for business and social activities, whether that be on the move, at home or in the workplace. There is a global move towards increased digitalisation and a continuing need to develop and invest in the underlying infrastructure, while in parallel helping to develop digital skills in the labour force. This need has been further highlighted through the COVID pandemic as the workforce is dispersed from traditional urban settings and the issues of urban/rural divide are evident. Cellular usage is predominantly based on LTE (4G) technology as the current widely available standard. This provides good, responsive speeds which are adequate for the vast majority of use cases and with multiple handsets and packages available to allow widespread adoption.

Coverage is provided across Nova Scotia by the commercial cellular operators Bell, Rogers, Telus and Eastlink through a network of cell towers and roaming agreements. The coverage from these towers depends on technical parameters including frequency, antenna height and power which can vary by tower location and operator. The performance to the end user is also reliant on the data throughput from these towers and that again depends on the technical parameters of frequency channel and onward connectivity from the towers into the operators' networks.

Tower locations are designed on a cost/benefit basis to provide the maximum return for the operators in terms of subscriber take-up and retention. The effect of this is that in rural areas where subscriber numbers are low, or in hard to serve areas where the cost to provide is high, coverage will be less.

Good cellular provision is complementary to good, fixed broadband connectivity and is an essential part of the mix in delivering a well-connected province. DNS appointed FarrPoint to undertake a study to map out and measure the cellular connectivity capabilities across Nova Scotia.

## 1.2. Project Approach

The study is based on a combination of desktop analysis, complemented by on the ground measurements and analysis. This is shown in Figure 1.



Figure 1: Project Approach

## 1.3. Report Structure

Following this introductory section, the remainder of the report is set out as follows:

- Section 2 presents the initial desktop results of coverage;
- Section 3 describes the drive surveys undertaken and their input to the analysis;
- Section 4 presents details of the coverage infill solutions and costs;
- Section 5 provides conclusions.

## 2. Initial Results & Analysis

### 2.1. Approach

Desktop analysis was conducted of coverage using available data on tower locations, heights, frequency, channel bandwidth, and power. This detail was sourced from the Government of Canada Spectrum Management System Data and input into FarrPoint's ATDI HTZ Communications radio planning software to assess potential coverage from each tower.

The results were then input to FarrPoint's online GIS (Geographic Information System) and online mapping portal, together with an overlay of the following data sets: Civic Address points (Feb 2022), NBD Pseudo-household points (Feb 2022) and Roads (Feb 2022).

This allowed for the calculation of the number of locations without coverage, the % geographic coverage and % road coverage, across the province.

### 2.2. Signal Thresholds

Indoor and outdoor thresholds were used for RSRP (Reference Signal Received Power) which is a commonly used metric for measuring LTE signal strength. The thresholds are commonly used by cell operators as a basis for measurement and by a number of industry sources<sup>1</sup>. The comments provided in Figure 2 are an indication of the type of service that users may experience from these different signal levels. However, numerous factors are at play that will influence this experience including the channel bandwidth implemented by the cell operator and the number of simultaneous users on the site.

Measure	Threshold	User Experience Comments
Outdoor	-114dBm	Voice and Basic Data outdoors
In Car / Rural	-110dBm	Voice and Basic Data in vehicle and rural indoor
Indoor Suburban	-102dBm	Improved in vehicle and indoor rural data. Basic indoor suburban service
Indoor Urban	-95dBm	Enhanced indoor data experience
Indoor Dense Urban	-91dBm	Good service level in most environments

Figure 2: Signal Strength Thresholds

<sup>1</sup> Eg [https://www.ofcom.org.uk/\\_\\_data/assets/pdf\\_file/0012/122250/about-mobile-luaa-data.pdf](https://www.ofcom.org.uk/__data/assets/pdf_file/0012/122250/about-mobile-luaa-data.pdf)

This means that any signal less than -114dBm is treated as no coverage. The maps shown in this report use these thresholds as indicated in the accompanying legends. The thresholds shown above these levels will be unlikely to provide significantly better throughput, but these stronger signal levels will improve the stability and quality of the connection.

## 2.3. Initial Results

The results are broken down into:

- overall geographic coverage;
- address coverage;
- primary road coverage.

### 2.3.1. Geographic Coverage

Figure 3 presents the indoor and outdoor area coverage of the whole province for each operator (anonymised).

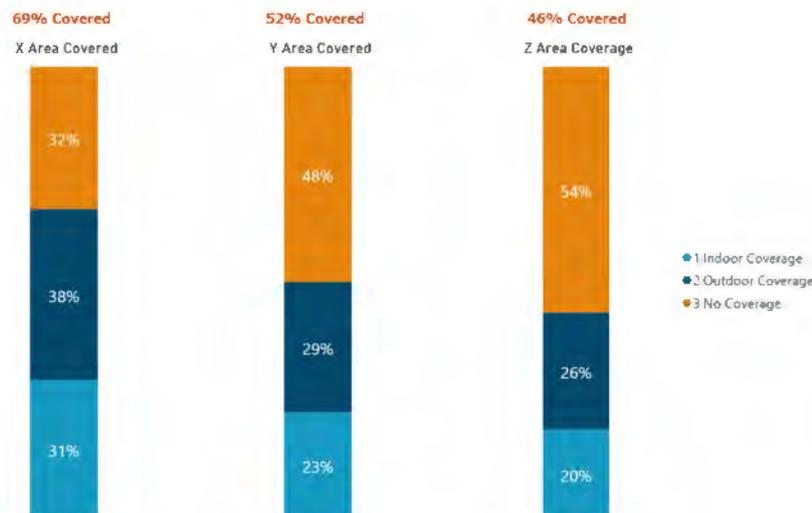


Figure 3: Geographic Coverage by Operator

Geographic coverage will of course include areas with no population and with no road network and so areas of no coverage would be expected. The metrics of address coverage and road coverage are of more interest to support economic and social activity.

### 2.3.2. Address Coverage

Figure 4 presents the indoor and outdoor coverage of the total number of civic addresses in the province for each operator (anonymised). This shows, for example, that Operator X covers 94% of addresses compared to Operator Z who cover 84% of the addresses.

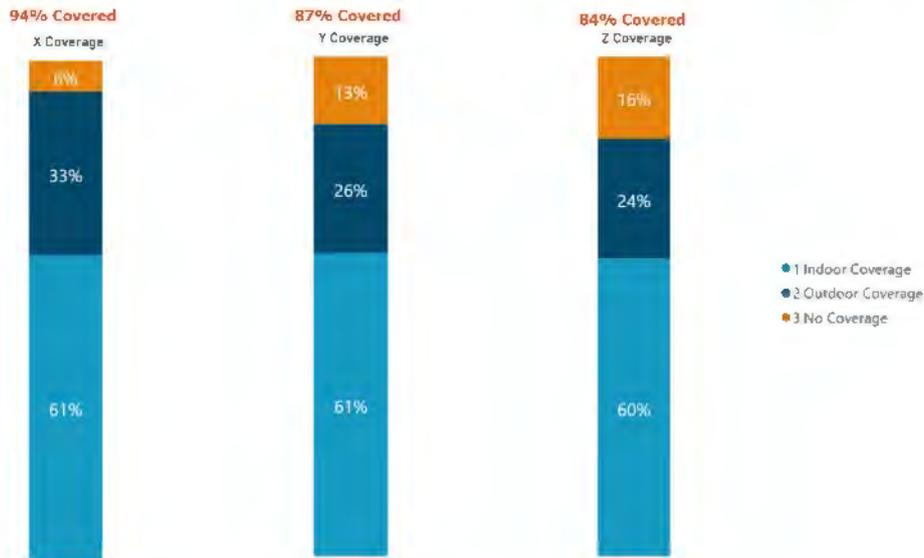


Figure 4: Civic address coverage by operator

This is also represented in the mapping portal by the number of civic addresses that can receive service from at least one operator as shown in Figure 5.

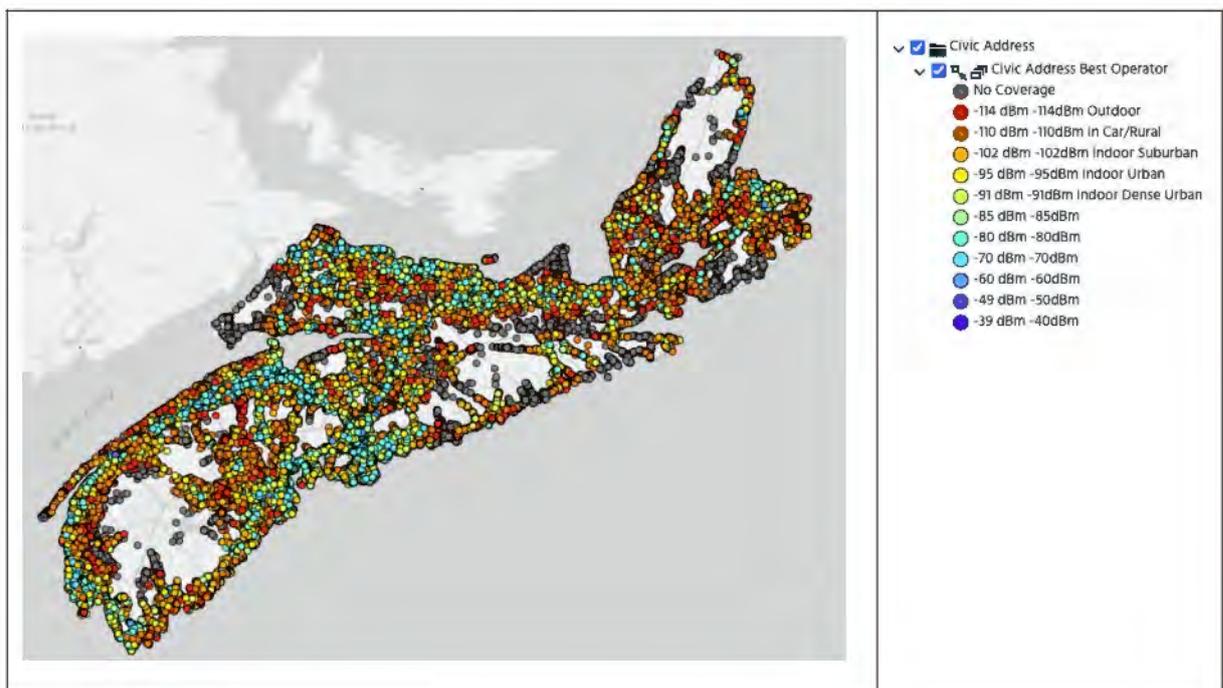


Figure 5: Address Coverage

Figure 5 shows significant areas with no coverage as shown in grey, particularly in the west of Cumberland County, across Guysborough County, Antigonish, Richmond and through Inverness County. The signal level thresholds shown in the legend range from basic (voice and low level data access) outdoors shown in red, through orange (the same service level inside a vehicle) and three further thresholds for indoor coverage in various urban densities.

Figure 6 presents the % indoor and outdoor coverage from any operator of the total number of civic addresses, broken down by county.

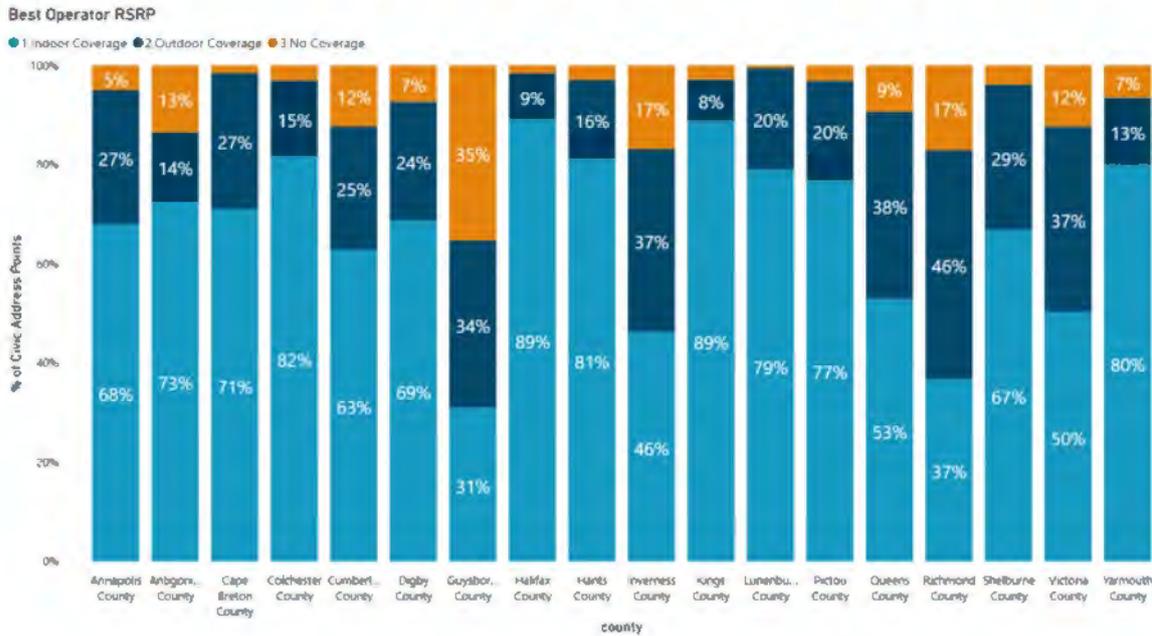


Figure 6: Civic address % coverage by any operator

For example, this shows that Guysborough County has 35% of the addresses not covered by any operator whereas Cape Breton County has only 2% of the addresses not covered by an operator.

In terms of absolute numbers, Figure 7 shows the breakdown per county of coverage, including addresses not covered by any operator:

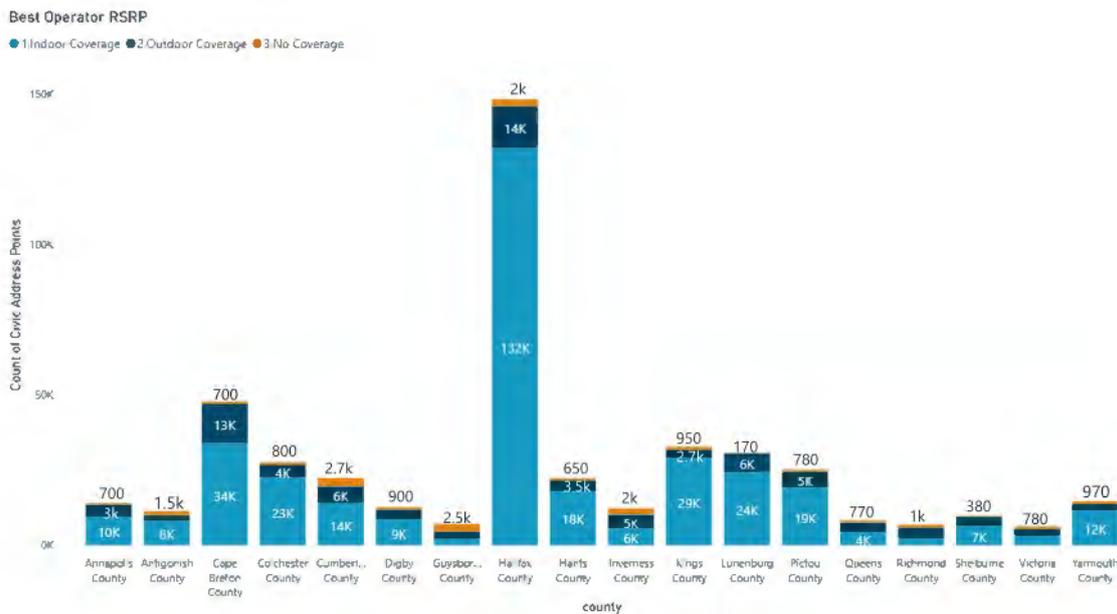


Figure 7: Civic Address Coverage by any Operator

This shows that Cumberland County, Guysborough County, Halifax County and Inverness County all have over 2,000 uncovered civic addresses each and represent the largest geographic uncovered areas.

### 2.3.3. Road Coverage

Figure 8 presents the indoor and outdoor coverage along the primary roads of the province for each operator. This shows, for example, that Operator X covers 84% of primary roads compared to Operator Z who cover 64%. In the case of roads, the indoor coverage can be considered equivalent to the coverage that can be obtained while inside a vehicle.

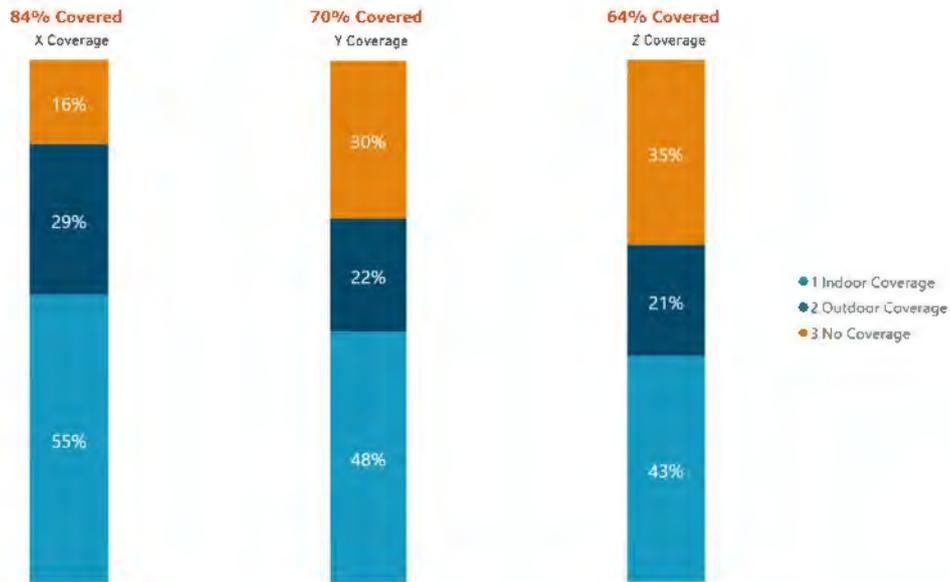


Figure 8: Primary Road coverage by operator

This is also represented in the mapping portal by the length of road where coverage is available from at least one operator as shown in Figure 9.

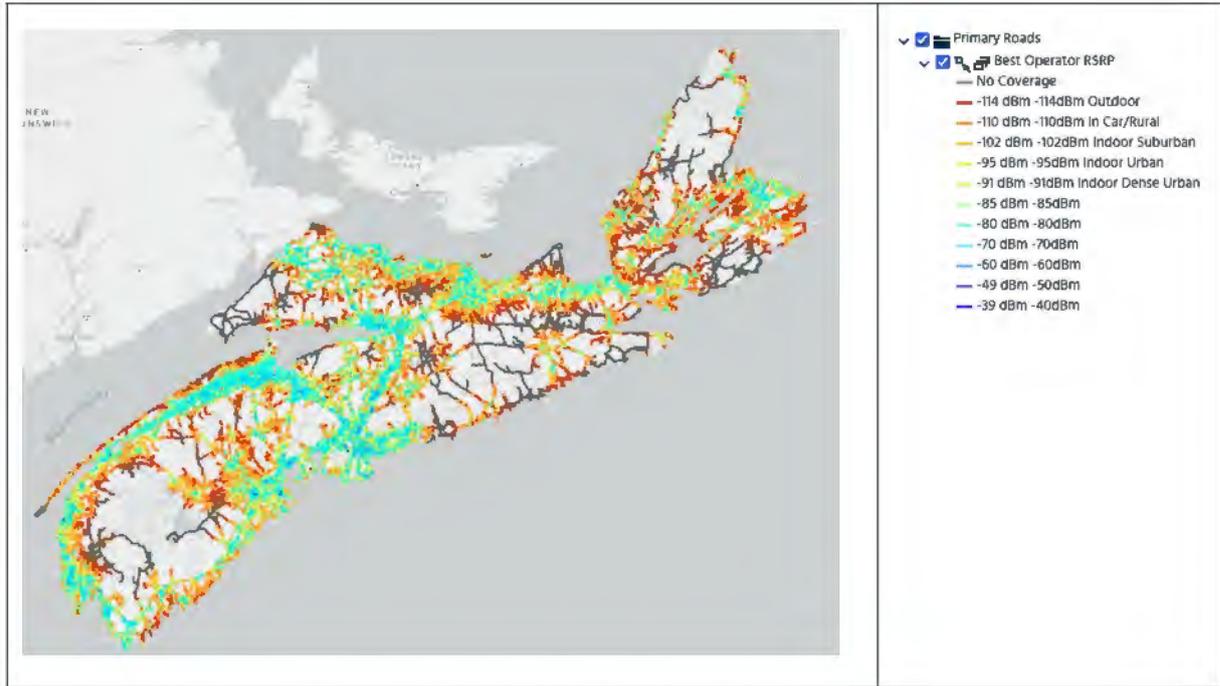


Figure 9: Primary Road Coverage by Best Operator

Figure 9 shows areas of no coverage on the 209 in Cumberland County, cross-province routes in the north east (374, 348), the 245 in Antigonish, the 316 in Guysborough County, Richmond and through Inverness County. Approximately 100km of the 298km Cabot Trail is also shown as uncovered by any operator.

Figure 10 presents the primary road % coverage from any operator, broken down by county.

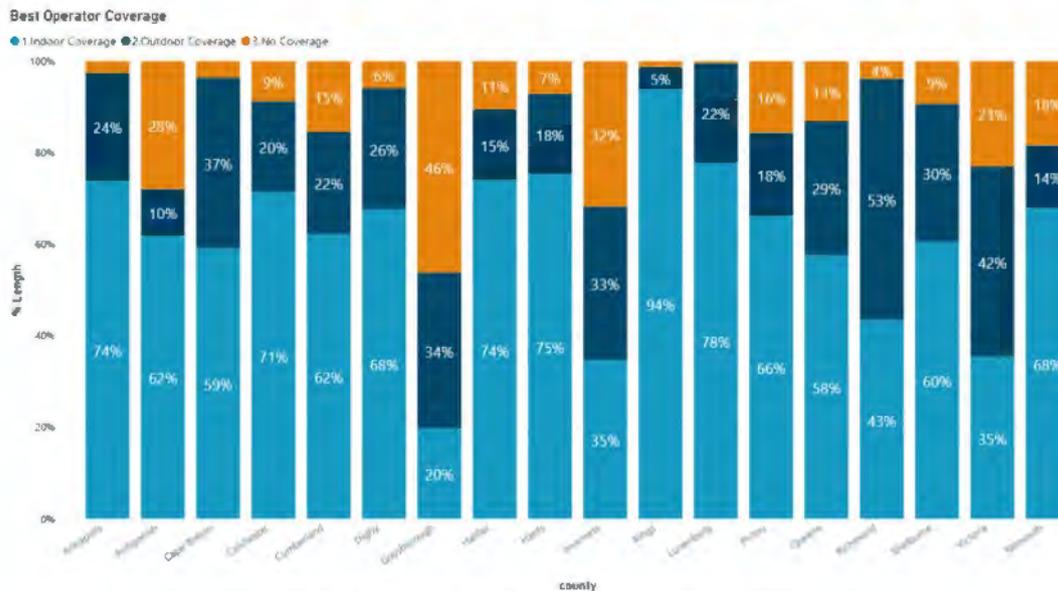


Figure 10: Primary Road % coverage by any operator

This shows, for example, that Guysborough County has 46% of its primary roads not covered by any operator whereas Cape Breton County has only 4% of its primary roads not covered by an operator.

In terms of absolute numbers, Figure 11 shows the breakdown per county of primary roads not covered by an operator in kms:

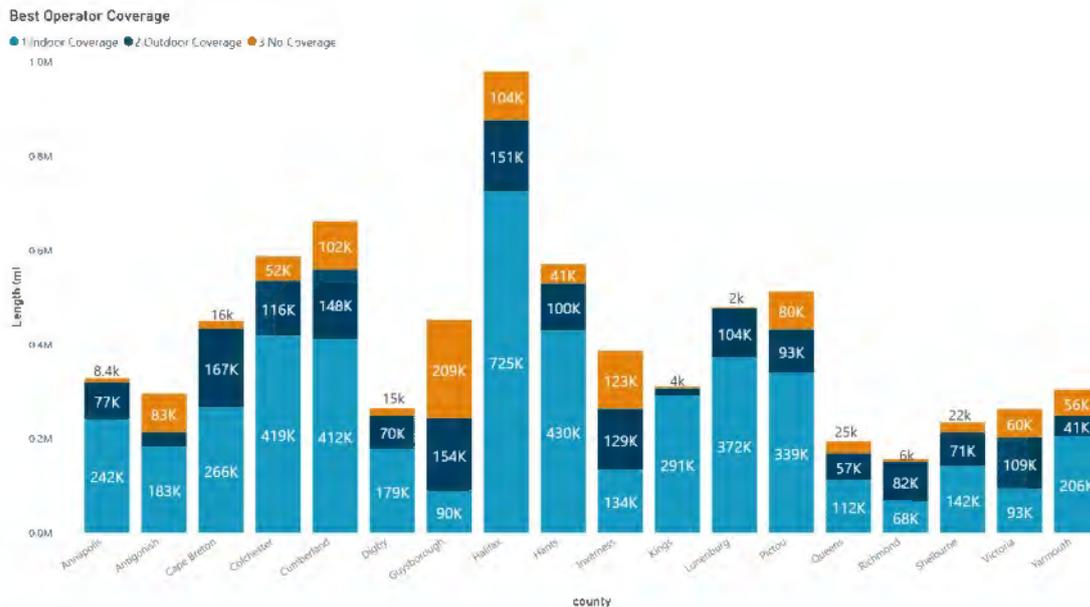


Figure 11: Primary Road coverage by any operator

This shows that Antigonish (83km), Cumberland (102km), Guysborough (209km), Halifax (104km), Inverness (123km) and Pictou (80km) are the counties with the most unserved primary roads.

## 2.4. Conclusions

The desktop coverage analysis carried out, based on the existing tower sites spread across the province, shows a range of civic addresses and road routes with no coverage from any operator. There are large clusters in certain areas and more dispersed pockets of no coverage throughout the province. As expected, the main population centres are better covered than the more rural areas.

The total number of civic addresses with no coverage amounts to 21,143 out of a total 461,000 addresses in the province (4.6%). If we assume that a cell tower could provision a maximum of 1,000 subscribers, then in theory, approximately 21 new tower sites could cover all the unserved addresses. However, that assumes that all 21,000 addresses would be within coverage of these 21 sites, which will not be the case in practice as these addresses are dispersed across the province.

Section 4 outlines the approach used by the planning software to determine how best to serve the maximum number of unserved addresses with the least number of new towers.

Prior to this, Section 3 describes the drive surveys which were undertaken to augment the coverage planning.

## 3. Drive Surveys

### 3.1. Approach

To complement the desktop prediction analysis, drive surveys were carried out by DNS staff using FarrPoint's cellular coverage equipment installed on vehicles driven on chosen routes. This equipment automatically measures the strength of all cellular operators as the vehicle is driven and transfers the data to the FarrPoint mapping portal. The routes driven were as follows:

- Route 1 – Cabot Trail;
- Route 2 – Cape Breton;
- Route 3 – Cumberland;
- Route 4 – Annapolis – West Hants;
- Route 5 – Digby Neck;
- Route 6 – Pictou – Antigonish;
- Route 7 – South West;
- Route 8 – Truro – Guysborough.

#### 3.1.1. Cabot Trail

This route follows the coast around Cape Breton peninsula. It encompasses a number of areas of predicted poor coverage from any operator including significant stretches of primary road north of Petit Étang at the west side and north of Goose Cove on the east side

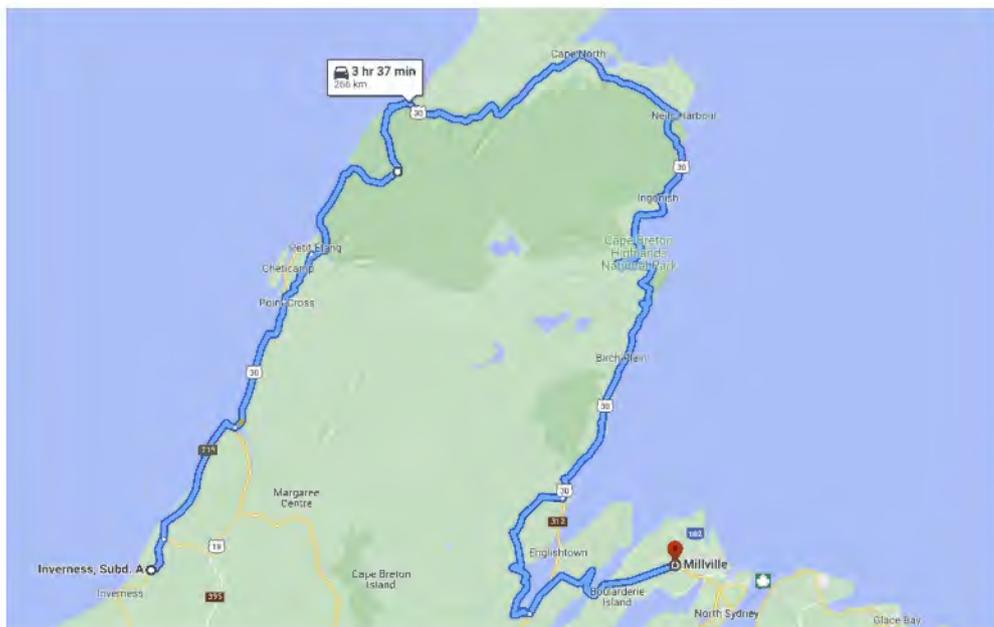


Figure 12: Cabot Trail Drive Route

### 3.1.2. Cape Breton

The route follows the west coast of the Bras d'Or lake, then travels inland to the south towards Grande Anse. From there, the route goes east to St Peter's and on to Framboise. A section of road is driven between Framboise and Stirling. The route then goes on to skirt both sides of the Grand Mira lake and back along the south-east Atlantic coast to Framboise. This route encompasses many areas of poor and no coverage from any operator.

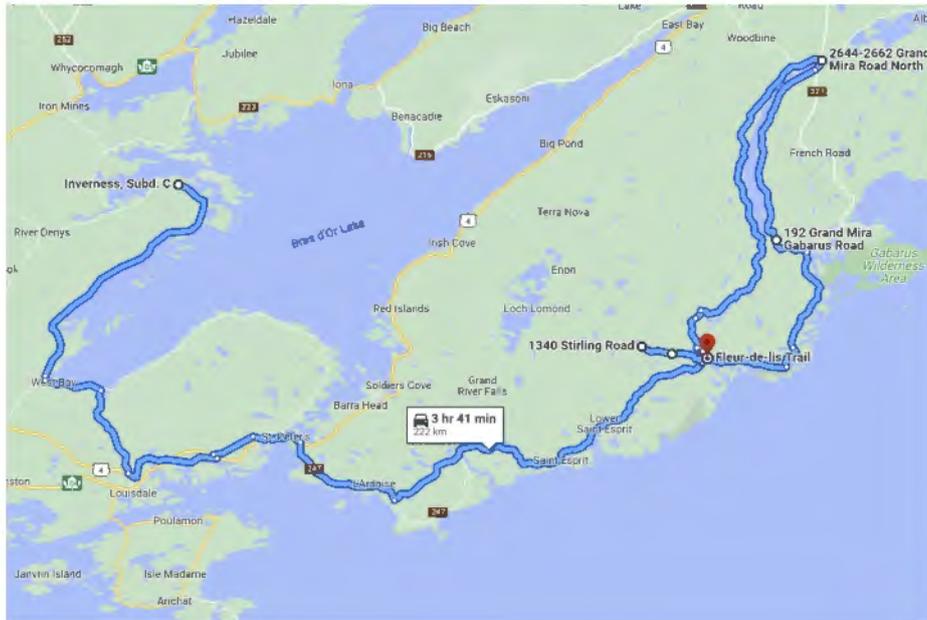


Figure 13: Cape Breton Drive Route

### 3.1.3. Cumberland

Two drive routes were chosen in Cumberland. These include a loop around the area of Red River and a leg east towards Parrsboro, then north to Southampton and on to Amherst. The second route is centred around Earlstown. Large parts of these routes were predicted to have little or no coverage.

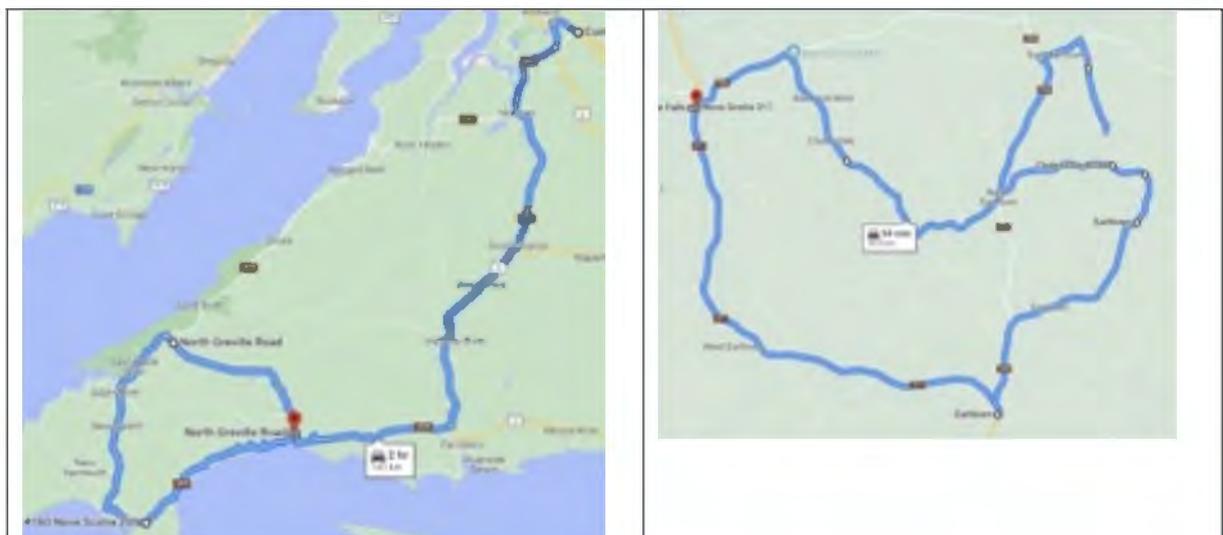


Figure 14: Cumberland Drive Routes

### 3.1.4. Annapolis – West Hants

This route follows the coast from Cheverie in the west to Tennycape in the east and also a southerly route from Walton to Cogmagun River. The majority of this route was predicted to have no coverage.

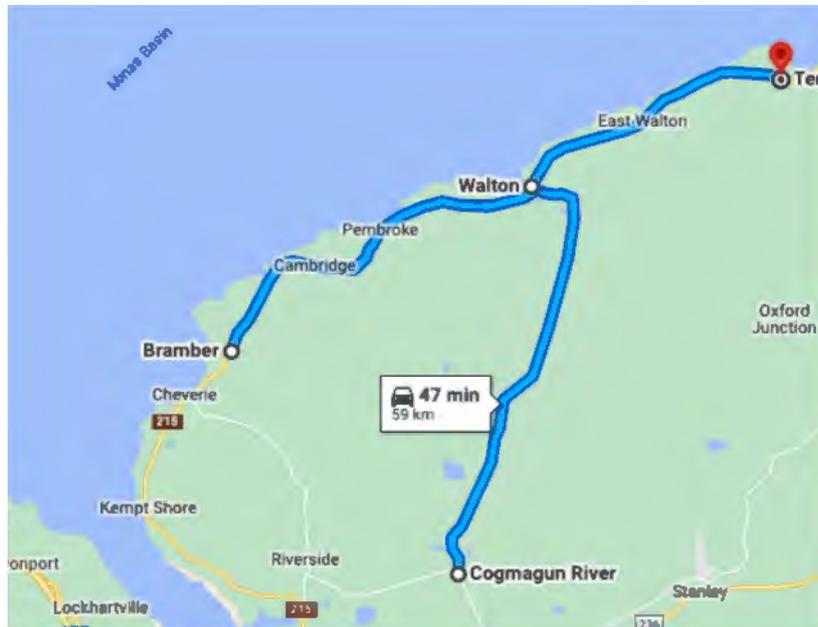


Figure 15: Annapolis – West Hants Drive Route

### 3.1.5. Digby Neck

This route follows the Digby Neck peninsula. Coverage was predicted to be poor with no coverage at the southern-most tip.



Figure 16: Digby Neck Drive Route

### 3.1.6. Pictou – Antigonish

The route follows the coast road from Arisaig in the west to Antigonish at the north-east tip, then takes a loop south to West Lakevale and on to Maryvale and finally north to Malignant Cove. Most of this route was predicted to have no coverage.

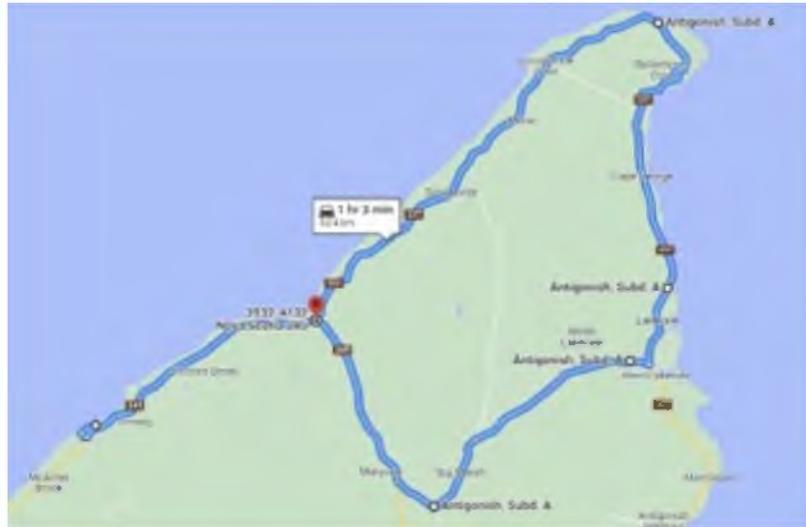


Figure 17: Pictou - Antigonish Drive Route

### 3.1.7. South West

The drive route goes east from Carleton towards Shelburne, then along the 103 to Liverpool where there is a loop to the north-west via Lake Rossignol and Pleasantfield then back to Liverpool. The road east from Carleton and the loop north-west of Liverpool were predicted to have poor or no coverage.

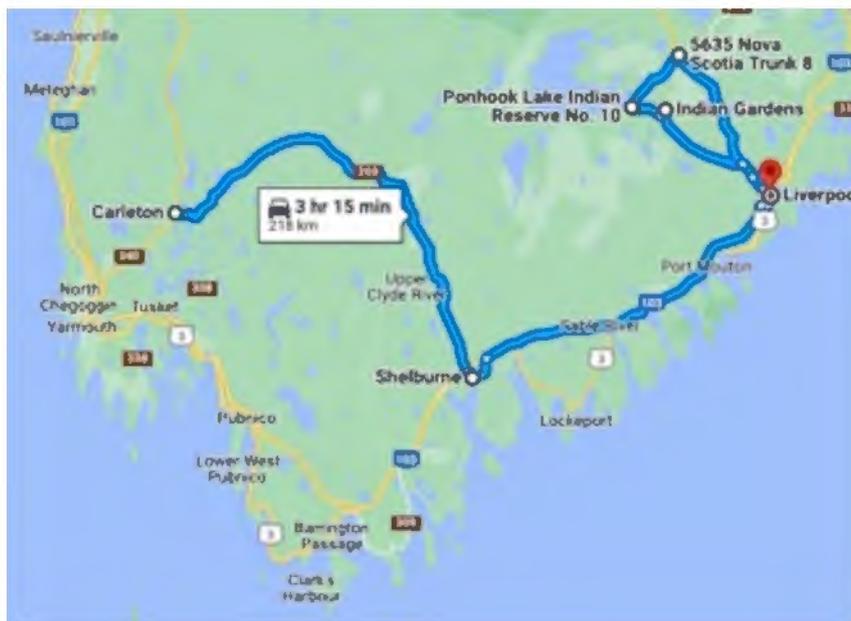


Figure 18: South West Drive Route

### 3.1.8. Truro – Guysborough

The route goes east along the coast from Musquodoboit Harbour towards Sheet Harbour, then continues east along the coast to Larry’s River where the route goes north towards Guysborough. From Guysborough, the route goes west inland towards South Lochaber then on towards Lorne, where it then turns south back to Sheet Harbour. A significant portion of this route was predicted to have poor or no coverage.

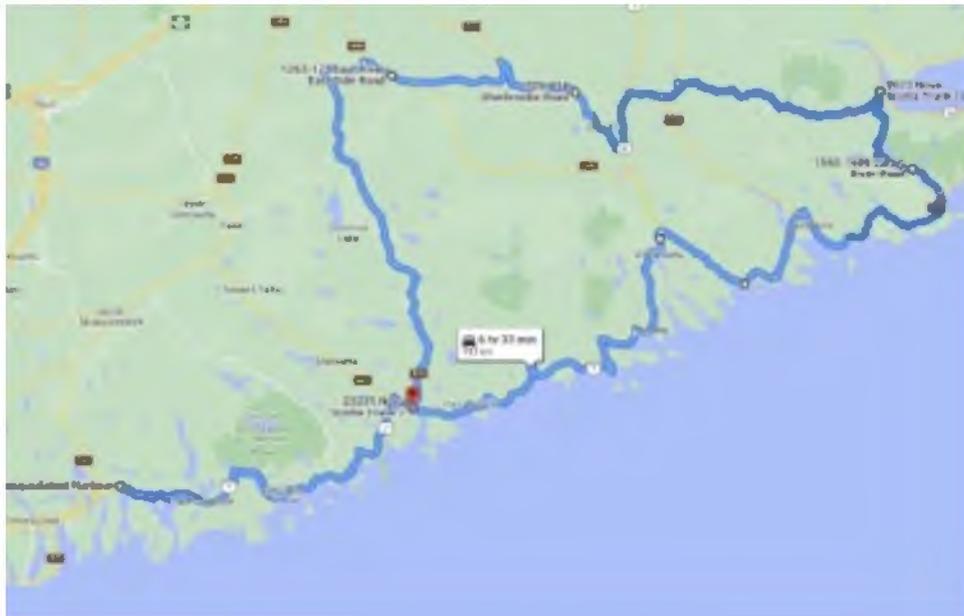


Figure 19: Truro - Guysborough Drive Route

## 3.2. Updated Results

The results in this section show the predicted "best operator" signal level alongside the drive survey maps for each route. The predicted maps show areas where there was no usable signal predicted by any operator in grey. The drive survey maps show the areas with zero operators in red. The grey areas on the predicted maps can be taken as approximately equivalent to the red areas on the drive survey maps.

### 3.2.1. Cabot Trail

Figure 20 shows the predicted coverage along the Cabot Trail route, with the areas of no coverage from any operator coloured in grey. Figure 21 shows the result of the drive surveys on the route. The results show that the areas of poor and no coverage largely follow the predicted coverage plot.



- Primary Roads
- Best Operator RSRP
  - No Coverage
  - 114 dBm -114dBm Outdoor
  - 110 dBm -110dBm In Car/Rural
  - 102 dBm -102dBm Indoor Suburban
  - 95 dBm -95dBm Indoor Urban
  - 91 dBm -91dBm Indoor Dense Urban
  - 85 dBm -85dBm
  - 80 dBm -80dBm
  - 70 dBm -70dBm
  - 60 dBm -60dBm
  - 49 dBm -50dBm
  - 39 dBm -40dBm

Figure 20: Predicted Coverage around Cabot Trail Drive Route



- Outdoor Coverage (>05dBm)
  - DNS2\_mobile\_120k\_opscount\_105
    - 3 Ops
    - 2 Ops
    - 1 Op
    - Zero Ops

Figure 21: Drive Survey Results around Cabot Trail Drive Route

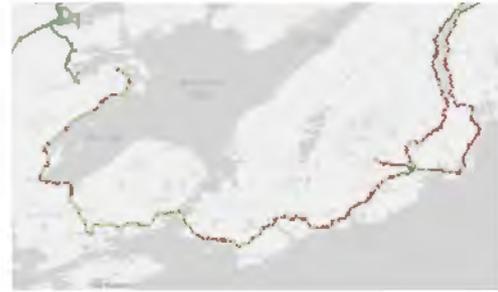
### 3.2.2. Cape Breton

Figure 22 shows the predicted coverage along the Cape Breton route, with the areas of no coverage from any operator coloured in grey. Figure 23 shows the result of the drive surveys on the route. The results show that the areas of poor and no coverage largely follow the predicted coverage plot. However, coverage does exist around the Framboise area from all three operators in an area that was predicted to have no coverage. It is likely this is due to a newly commissioned cell tower in this area that did not exist in the government database at the time of downloading.



- Primary Roads
- Best Operator RSRP
  - No Coverage
  - 114 dBm -114dBm Outdoor
  - 110 dBm -110dBm In Car/Rural
  - 102 dBm -102dBm Indoor Suburban
  - 95 dBm -95dBm Indoor Urban
  - 91 dBm -91dBm Indoor Dense Urban
  - 85 dBm -85dBm
  - 80 dBm -80dBm
  - 70 dBm -70dBm
  - 60 dBm -60dBm
  - 49 dBm -50dBm
  - 39 dBm -40dBm

Figure 22: Predicted Coverage around Cape Breton

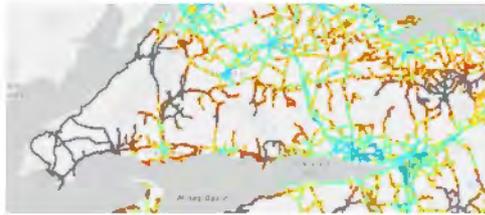


- Outdoor Coverage (-105dBm)
- DNS52\_mobile\_120k\_opscount\_105
  - 3 Ops
  - 2 Ops
  - 1 Op
  - Zero Ops

Figure 23: Drive Survey Results around Cape Breton

### 3.2.3. Cumberland

Figure 24 shows the predicted coverage along the Cumberland route, with the areas of no coverage from any operator coloured in grey. Figure 25 shows the result of the drive surveys on the route. The results show that the areas of poor and no coverage largely follow the predicted coverage plot.



- Primary Roads
- Best Operator RSRP
  - No Coverage
  - 114 dBm -114dBm Outdoor
  - 110 dBm -110dBm In Car/Rural
  - 102 dBm -102dBm Indoor Suburban
  - 95 dBm -95dBm Indoor Urban
  - 91 dBm -91dBm Indoor Dense Urban
  - 85 dBm -85dBm
  - 80 dBm -80dBm
  - 70 dBm -70dBm
  - 60 dBm -60dBm
  - 49 dBm -50dBm
  - 39 dBm -40dBm

Figure 24: Predicted Coverage around Cumberland



- Outdoor Coverage (-105dBm)
- DNS52\_mobile\_120k\_opscount\_105
  - 3 Ops
  - 2 Ops
  - 1 Op
  - Zero Ops



Figure 25: Drive Survey Results around Cumberland

### 3.2.4. Annapolis – West Hants

Figure 26 shows the predicted coverage along the Annapolis-West Hants route, with the areas of no coverage from any operator coloured in grey. Figure 27 shows the result of the drive surveys on the route. Coverage on the eastern section of the route is better than predicted. This is likely due to one or more newly commissioned cell towers in this area that did not exist in the government database at the time of downloading.



- Primary Roads
  - Best Operator RSRP
    - No Coverage
    - 114 dBm -114dBm Outdoor
    - 110 dBm -110dBm In Car/Rural
    - 102 dBm -102dBm Indoor Suburban
    - 95 dBm -95dBm Indoor Urban
    - 91 dBm -91dBm Indoor Dense Urban
    - 85 dBm -85dBm
    - 80 dBm -80dBm
    - 70 dBm -70dBm
    - 60 dBm -60dBm
    - 49 dBm -50dBm
    - 39 dBm -40dBm

Figure 26: Predicted Coverage around Annapolis – West Hants



- Outdoor Coverage (-105dBm)
  - DNS2\_mobile\_120k\_opscount\_105
    - 3 Ops
    - 2 Ops
    - 1 Op
    - Zero Ops

Figure 27: Drive Survey Results around Annapolis – West Hants

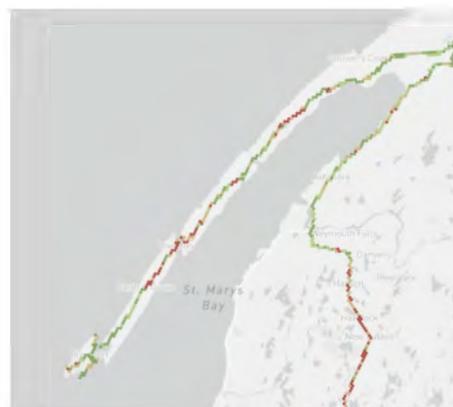
### 3.2.5. Digby Neck

Figure 28 shows the predicted coverage along the Digby Neck route, with the areas of no coverage from any operator coloured in grey. Figure 29 shows the result of the drive surveys on the route. The results show that the areas of poor and no coverage largely follow the predicted coverage plot. However, some coverage exists at the southern-most tip of the peninsula that wasn't predicted. This is likely due to a newly commissioned site that did not exist in the government database at the time of downloading.



- Primary Roads
- Best Operator RSRP
  - No Coverage
  - 114 dBm -114dBm Outdoor
  - 110 dBm -110dBm In Car/Rural
  - 102 dBm -102dBm Indoor Suburban
  - 95 dBm -95dBm Indoor Urban
  - 91 dBm -91dBm Indoor Dense Urban
  - 85 dBm -85dBm
  - 80 dBm -80dBm
  - 70 dBm -70dBm
  - 60 dBm -60dBm
  - 49 dBm -50dBm
  - 39 dBm -40dBm

Figure 28: Predicted Coverage around Digby Neck

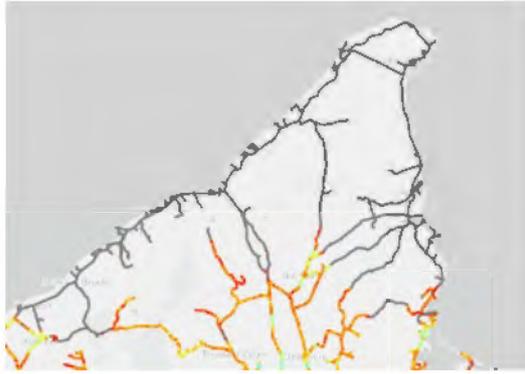


- Outdoor Coverage (<105dBm)
- DNS2\_mobile\_120k\_opscount\_105
  - 3 Ops
  - 2 Ops
  - 1 Op
  - Zero Ops

Figure 29: Drive Survey Results around Digby Neck

### 3.2.6. Pictou – Antigonish

Figure 30 shows the predicted coverage along the Pictou - Antigonish route, with the areas of no coverage from any operator coloured in grey. Figure 31 shows the result of the drive surveys on the route. The majority of this route was predicted to have no coverage. The actual coverage measured is in some areas an improvement on that predicted. This is likely due to newly commissioned towers that were not in the government database at the time of downloading.



- ✓  Primary Roads
- ✓  Best Operator RSRP
  - No Coverage
  - -114 dBm -114dBm Outdoor
  - -110 dBm -110dBm In Car/Rural
  - -102 dBm -102dBm Indoor Suburban
  - -95 dBm -95dBm Indoor Urban
  - -91 dBm -91dBm Indoor Dense Urban
  - -85 dBm -85dBm
  - -80 dBm -80dBm
  - -70 dBm -70dBm
  - -60 dBm -60dBm
  - -49 dBm -50dBm
  - -39 dBm -40dBm

Figure 30: Predicted Coverage around Pictou - Antigonish



- ✓  Outdoor, Coverage (-90dBm)
- ✓  DNS2\_mobile\_120k\_opscount\_105
  - 3 Ops
  - 2 Ops
  - 1 Op
  - Zero Ops

Figure 31: Drive Survey Results around Pictou - Antigonish

### 3.2.7. South West

Figure 32 shows the predicted coverage along the South West route, with the areas of no coverage from any operator coloured in grey. Figure 33 shows the result of the drive surveys on the route. The results show that the areas of poor and no coverage largely follow the predicted coverage plot.

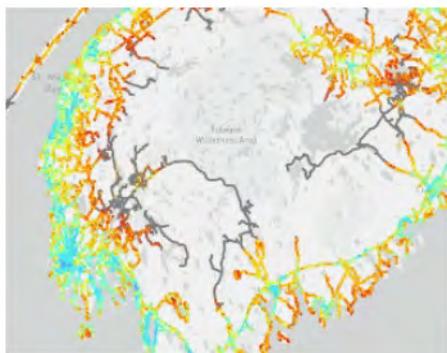




Figure 32: Predicted Coverage around South West

Figure 33: Drive Survey Results around South West

### 3.2.8. Truro – Guysborough

Figure 34 shows the predicted coverage along the Truro – Guysborough route, with the areas of no coverage from any operator coloured in grey. Figure 35 shows the result of the drive surveys on the route. The results show that the areas of poor and no coverage largely follow the predicted coverage plot.

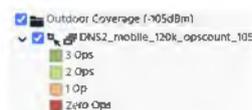
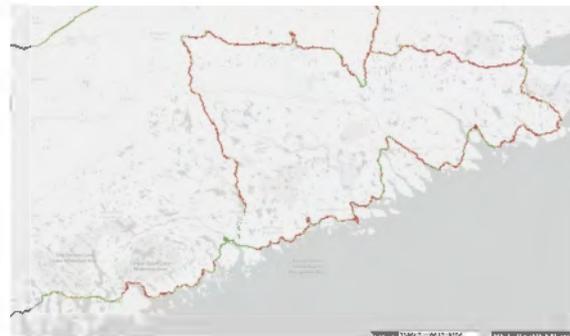


Figure 34: Predicted Coverage around South West

Figure 35: Drive Survey Results around South West

### 3.3. Conclusions

The drive surveys confirm that the areas of predicted poor or no coverage are accurate with the following exceptions:

- Cape Breton – Coverage exists around the Framboise area that was not predicted;
- Annapolis – West Hants – Coverage exists on the eastern leg of the drive route that was not predicted;
- Digby Neck – Coverage exists at the southern tip of the peninsula that was not predicted;
- Pictou – Antigonish – Coverage exists on the western leg of drive route and at the eastern tip of the peninsula that was not predicted.

The remaining areas will be considered within the infill solutions in Section 4.

## 4. Infill Solutions

### 4.1. Introduction

The analysis has shown a number of areas of poor coverage across the province. This can take the form of 'total not-spots' where there is no coverage from any provider or 'partial not-spots' where there is coverage from at least one provider but not all three. To a customer of one of these absent providers, this location would also be seen as a not-spot.

In order to look at options to address these poor coverage areas, and specifically the total not-spots, potential new infill sites were investigated to determine what locations would provide the most benefit in terms of increased coverage.

### 4.2. Approach

New tower locations were determined using FarrPoint's HTZ Communications radio planning software which was programmed to determine the best location of towers to cover the most unserved addresses. Radio propagation models were developed to provide coverage analysis from these new locations. The tower parameters used were similar to neighbouring towers in terms of frequency and channel bandwidth with height and power being optimised for each location.

The planning software will continue to identify new tower sites until all unserved addresses are connected, even if that means the last few towers only have one or two subscribers, which is clearly uneconomic. A threshold is needed and in this case a threshold of 20 connected subscribers was used at which point the software would stop identifying further new tower sites.

### 4.3. Costs

Budgetary capital costs for new tower locations have been developed based on the following cost elements:

- Tower structure;
- Land cost;
- Tower build;
- Access cost and power provision;
- Backhaul provision;
- LTE equipment.

The capital costs provide an indication of the scale of investment that would be required at each new tower location. The allocation of costs between government subsidy and commercial operator is not made and would be subject to the design of any intervention that may be planned.

The cost breakdown is as follows:

Item	Unit cost	Comment
14(1); 17(1)		

This gives a budgetary cost of 14(1); 17(1) per tower. ~~The most significant factor is the access cost and power provision, and this has been investigated further for each new tower location identified.~~

## 4.4. Results

### 4.4.1. Initial Results

The initial results of the planning exercise show that 75 new tower locations would cover an additional 15,516 civic addresses of the 21,143 which are unserved.

However, the planning software places sites with no regard to how practical these locations may be in terms of access to nearby services or suitability of location e.g. within a national park etc. In order to check and refine these locations, a manual review was conducted of each location and adjustments made as necessary.

### 4.4.2. Final Results

The final results of the planning exercise show the following potential new tower locations, ordered by the number of unserved addresses which are now covered:



Ref	Station #	Site Location	Longitude 4DMS	Latitude 4DMS	No. connected sub	Ref	Station #	Site Location	Longitude 4DMS	Latitude 4DMS	No. connected sub
1	14	Cape D'Or Road	64°45'22.9"W	45°18'55.4"N	761	39	35	Hampton, Annapolis County	65°21'06.0"W	44°54'17.9"N	160
2	19	E side lake Charlotte	62°57'53.7"W	44°47'24.8"N	658	40	64	NE Economy	63°52'11.2"W	45°23'19.8"N	159
3	18	NW Wellington, Lunenburg Cty	64°51'01.6"W	44°19'47.2"N	646	41	24	S Garden of Eden	62°17'43.4"W	45°24'31.2"N	152
4	9	E Margaree Centre, CB	60°56'51.3"W	46°21'13.1"N	604	42	54	Grand River, Richmond Cty	60°39'27.1"W	45°38'55.3"N	146
5	21	E Carlton, Yarmouth cty	65°54'15.7"W	44°00'22.4"N	499	43	69	Margaretsville, Kings County	65°03'53.9"W	45°02'55.0"N	144
6	27	Tidnish	64°01'17.0"W	45°58'56.2"N	466	44	41	Drum Head, Goldboro	61°36'10.6"W	45°08'59.6"N	143
7	15	Freeport, Digby Neck	66°19'33.8"W	44°15'57.8"N	457	45	46	W Pleasant Bay	60°48'28.6"W	46°49'37.6"N	143
8	10	Ballantynes Cove, Cape George	61°54'35.2"W	45°51'49.5"N	429	46	3	NE of Diligent River	64°25'42.2"W	45°27'00.4"N	142
9	7	NE River Hebert	64°21'27.1"W	45°42'20.0"N	425	47	29	W Lake Paul, Kings County	64°40'42.4"W	44°51'56.4"N	142
10	11	N Lochaber, E side of lake	62°01'01.3"W	45°26'03.4"N	359	48	32	Lake George, Kings County	64°41'19.0"W	44°55'41.0"N	141
11	45	S West Quoddy	62°20'60.0"W	44°53'32.1"N	333	49	53	North River Bridge, CB	60°37'27.3"W	46°18'37.7"N	141
12	26	E Ecum Secum Harbour	62°08'56.7"W	44°57'53.7"N	311	50	43	S East Lake Ainslie	61°08'34.9"W	46°05'35.7"N	123
13	16	W Upper Stewiacke	63°02'33.7"W	45°12'09.6"N	306	51	60	S Burtons,	63°34'09.2"W	45°13'18.0"N	123
14	39	E Larry's River, Guysborough	61°22'27.5"W	45°13'36.1"N	291	52	62	Erinville, Guysborough Cty	61°44'00.3"W	45°22'10.9"N	119
15	12	St. Francis Harbour, Guysborough	61°18'23.2"W	45°26'32.4"N	282	53	67	N Waddens Cove	59°51'39.6"W	46°05'35.9"N	119
16	68	Lower Cove	64°26'05.2"W	45°43'38.4"N	259	54	61	Eliscomb mills	62°02'58.5"W	45°00'17.7"N	118
17	37	Little Harbour, Halifax County	62°50'33.4"W	44°42'59.5"N	255	55	74	NW Richfield, Yarmouth Cty	65°58'34.7"W	44°07'47.6"N	117
18	42	Malignant Cove	62°04'31.2"W	45°47'34.2"N	250	56	47	East River Saint Marys	62°08'39.7"W	45°23'02.4"N	114
19	33	SE East Jeddore	63°00'31.5"W	44°43'15.2"N	241	57	31	Guysborough Intervale	61°34'14.4"W	45°27'09.7"N	112
20	34	Moser River	62°15'02.2"W	44°58'43.6"N	232	58	51	N Forchu, CB	60°15'37.0"W	45°43'13.8"N	111
21	6	Lorneville	63°56'37.0"W	45°59'19.1"N	231	59	52	Bear River, Annapolis Cty	65°38'03.5"W	44°34'29.0"N	111
22	23	NE Arisaig	62°08'33.3"W	45°46'10.5"N	225	60	63	E Centre Musquodoboit	62°59'54.5"W	45°06'54.8"N	109
23	8	SE River Denys	61°06'07.4"W	45°47'37.7"N	219	61	44	Petit de Gras	60°56'09.1"W	45°30'01.7"N	106
24	2	Westbrook, North of Parrsboro	64°17'23.0"W	45°34'16.0"N	211	62	72	SE Lower Ship Harbour	62°48'38.5"W	44°46'22.9"N	100
25	36	SE Loch Lomond	60°33'57.6"W	45°45'59.4"N	210	63	50	W Earltown	63°08'15.7"W	45°34'45.6"N	98
26	30	NE Goshen	61°57'29.9"W	45°22'40.3"N	206	64	55	E South West Margaree	61°09'49.2"W	46°16'48.0"N	86
27	22	SW Sunnybrae, Mid NS	62°30'53.8"W	45°23'46.5"N	203	65	73	SE Bangs Falls	64°49'22.3"W	44°14'27.3"N	84
28	17	Morden, Kings County	64°56'46.2"W	45°06'08.6"N	198	66	59	Apple River, Cumberland County	64°47'08.9"W	45°27'41.3"N	79
29	20	Port Bickerton, Guysborough Cty	61°43'55.7"W	45°06'13.1"N	195	67	49	NE Lismore	62°14'50.1"W	45°42'52.3"N	75
30	75	West Bay East side, N point	60°57'32.4"W	45°45'55.4"N	189	68	48	Point Aconi	60°19'03.6"W	46°19'20.6"N	66
31	4	Cambridge, Noel Shore	64°06'20.3"W	45°12'05.9"N	186	69	1	West of Lower River Hebert	64°22'14.1"W	45°43'35.5"N	65
32	28	Walton, Noel Shore	64°00'23.2"W	45°13'23.8"N	186	70	57	W Bay St. Lawrence	60°29'18.3"W	46°59'54.2"N	62
33	65	Kempt Back Lake	65°50'03.1"W	44°02'52.1"N	185	71	70	NE Caledonia	62°23'43.8"W	45°16'49.1"N	54
34	13	Port Felix, Guysborough	61°13'08.0"W	45°15'00.0"N	184	72	66	Indian Harbour Lake	61°52'22.7"W	45°07'46.6"N	52
35	38	NW New Harbour West, Guysborough	61°30'26.4"W	45°12'14.7"N	175	73	5	Minasville, Noel Shore	63°49'24.8"W	45°16'42.8"N	48
36	56	E East Quinan	65°47'06.8"W	43°56'42.5"N	171	74	71	S New Salem, Cumberland Cty.	64°47'37.4"W	45°24'45.2"N	47
37	25	West side Grand Mira South	60°17'18.4"W	45°53'36.8"N	165	75	58	South Ingonish Harbour	60°25'55.4"W	46°37'37.5"N	38
38	40	Englishtown	60°32'33.6"W	46°16'59.2"N	164						

Plotting the profile of sites against the number of addresses covered shows the following profile:

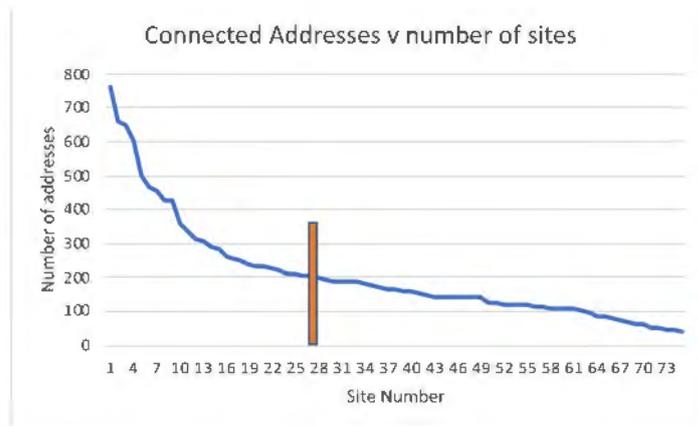


Figure 36: Number of Addresses Covered by Sites Profile

This shows that after around 27 new towers (shown in the figure by an orange bar), the number of additional addresses covered starts to flat line and so in terms of reducing benefit, this could present a cut-off point.

However, the drive surveys suggest that two of these sites may not be needed, site Ref 7 at Freeport and site Ref 8 at Ballantynes Cove. This then reduces the number of new towers to 25.

This would mean that the top 25 sites could become an initial focus as they provide the most benefit in terms of covering the maximum number of addresses per tower. These 25 new towers would cover an additional 9,569 premises of the 21,143 premises with no coverage.

### 4.4.3. Costs

The costs for these top 25 sites have been estimated by assessing their location in terms of access costs and power which were the two most significant variants as described previously.

This then gives an estimated cost for these 25 towers as follows, with the total for 73 sites (initial 75 minus the two sites not needed) for comparison:

Item	Top 25 sites	All 73 sites	Comment
14(1); 17(1)			

## 4.5. Coverage Improvements

The improvement in coverage from these new tower sites is shown below.

### 4.5.1. Address Coverage

Figure 37 shows the initial predicted address coverage with Figure 38 showing the additional locations covered with the inclusion of the 25 new sites. For comparison, Figure 39 shows the improved address coverage from all 73 sites.



Figure 37: Initial Address Coverage



Figure 38: Improved Address Coverage - 25 sites



Figure 39: Improved Address Coverage - 73 sites

Figure 40 shows the initial predicted address coverage within each county. Figure 41 shows the additional address locations covered with the inclusion of the 25 new sites. For example, Antigonish County benefits from an additional 1,466 address locations with indoor coverage and an additional 54 sites with outdoor coverage.

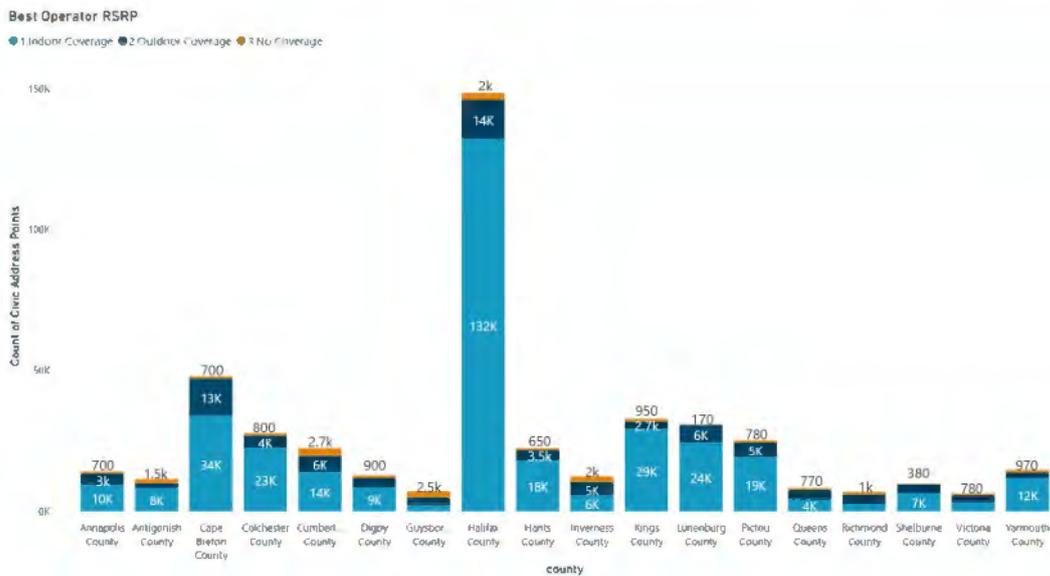


Figure 40: Initial Address Coverage by County

#### Infill Addresses by County

Infill Coverage ● 1. Indoor Coverage ● 2. Outdoor Coverage

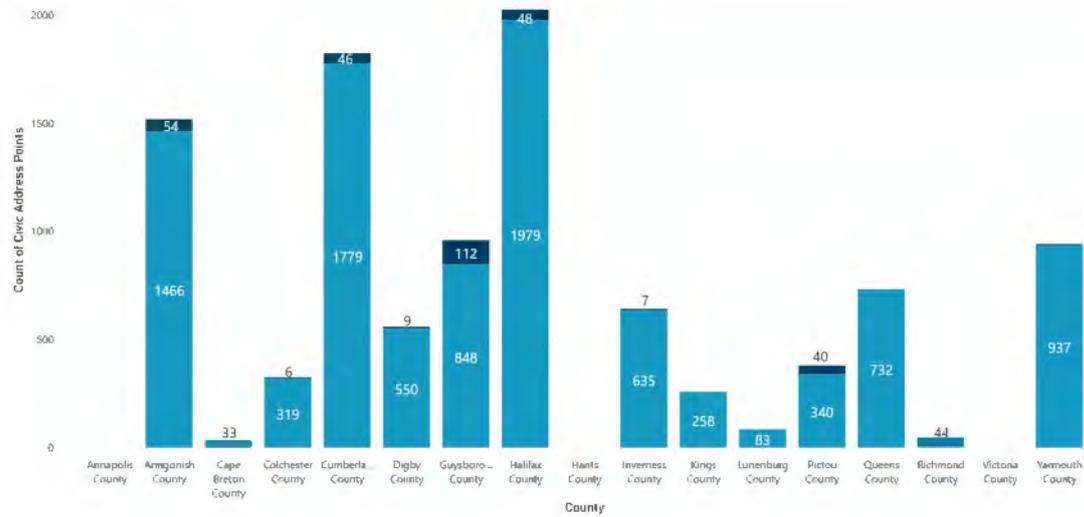


Figure 41: Improved Address Coverage by County

## 4.5.2. Road Coverage

Figure 42 shows the initial predicted roads coverage with Figure 43 showing the additional coverage with the inclusion of the 25 new sites and for comparison, Figure 44 shows the improved roads coverage from all 73 sites.

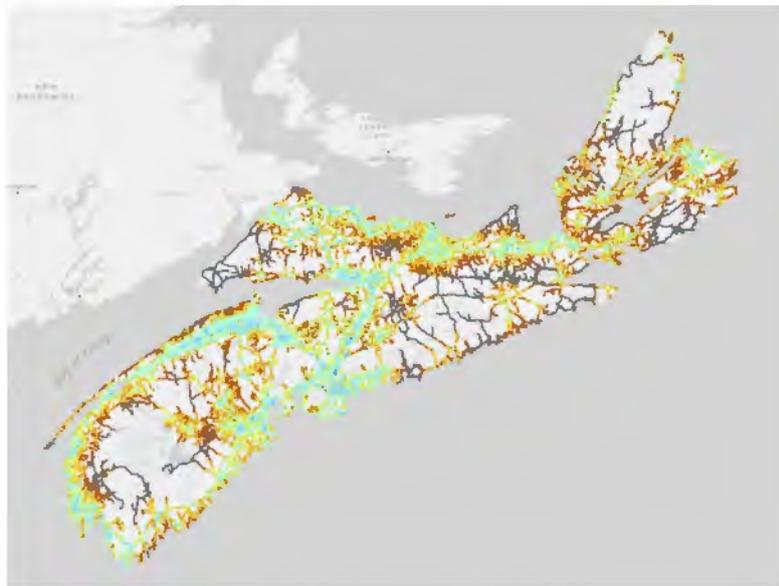


Figure 42: Initial Road Coverage

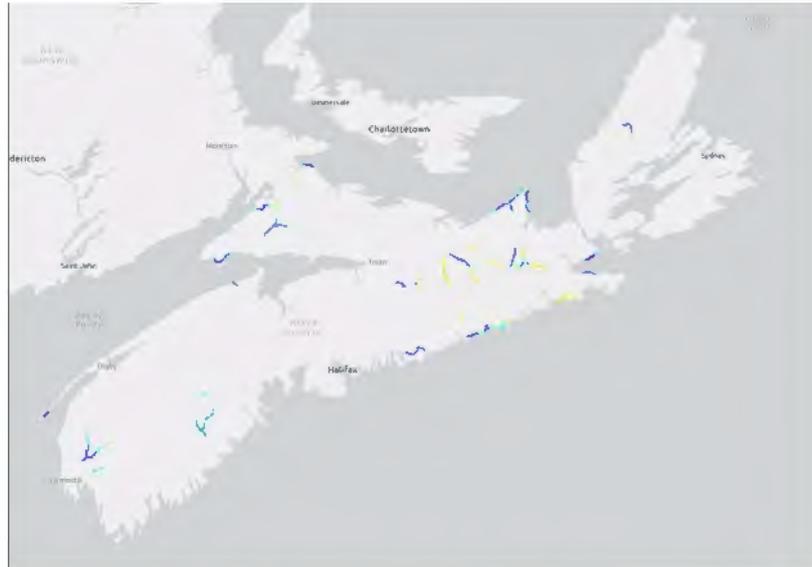


Figure 43: Improved Road Coverage - 25 sites

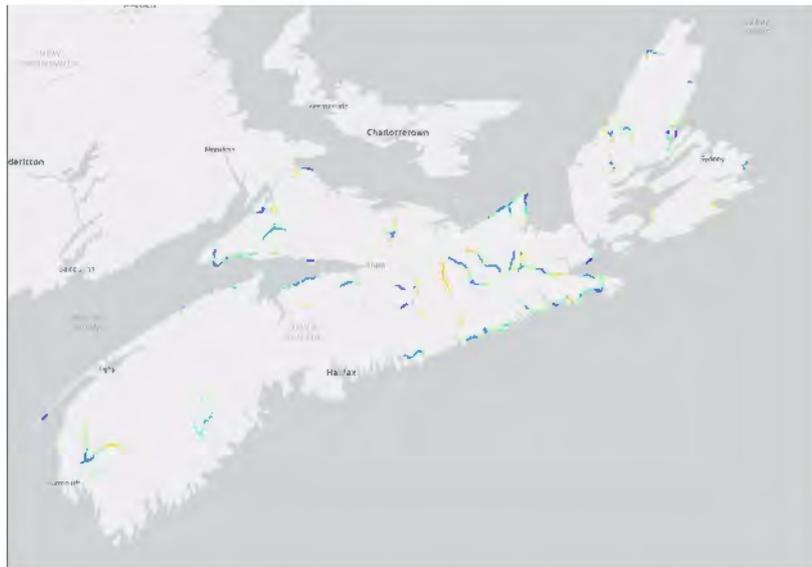


Figure 44: Improved Road Coverage - 73 sites

### 4.5.3. Road Coverage

Figure 45 shows the initial predicted road coverage within each county. Figure 46 shows the additional road sections covered with the inclusion of new sites. For example, Antigonish County benefits from an additional 78km of roads covered at indoor coverage levels and an additional 5km of roads at outdoor coverage level.

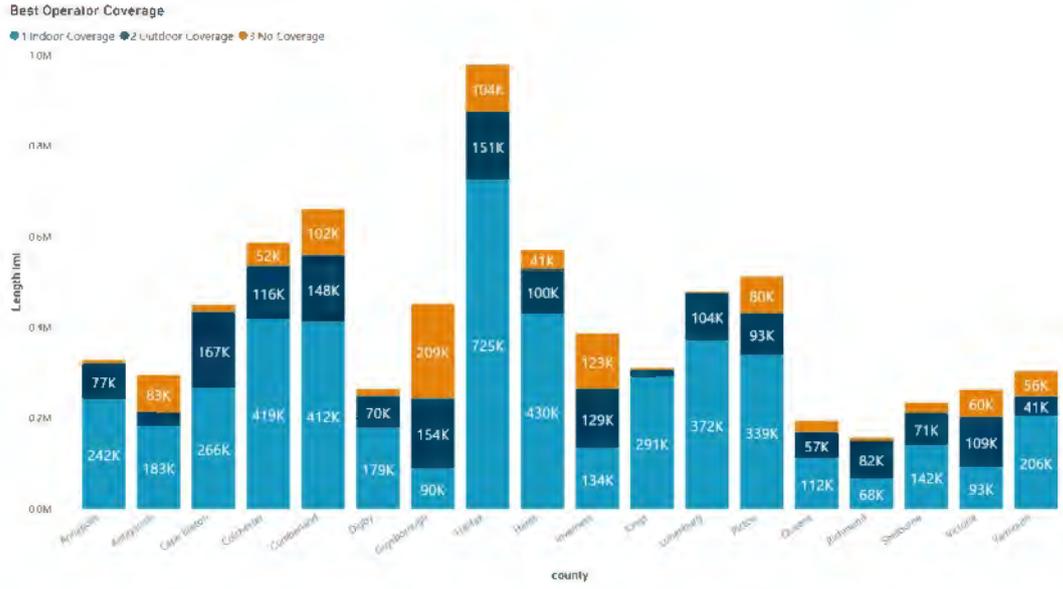


Figure 45: Initial Road Coverage by County

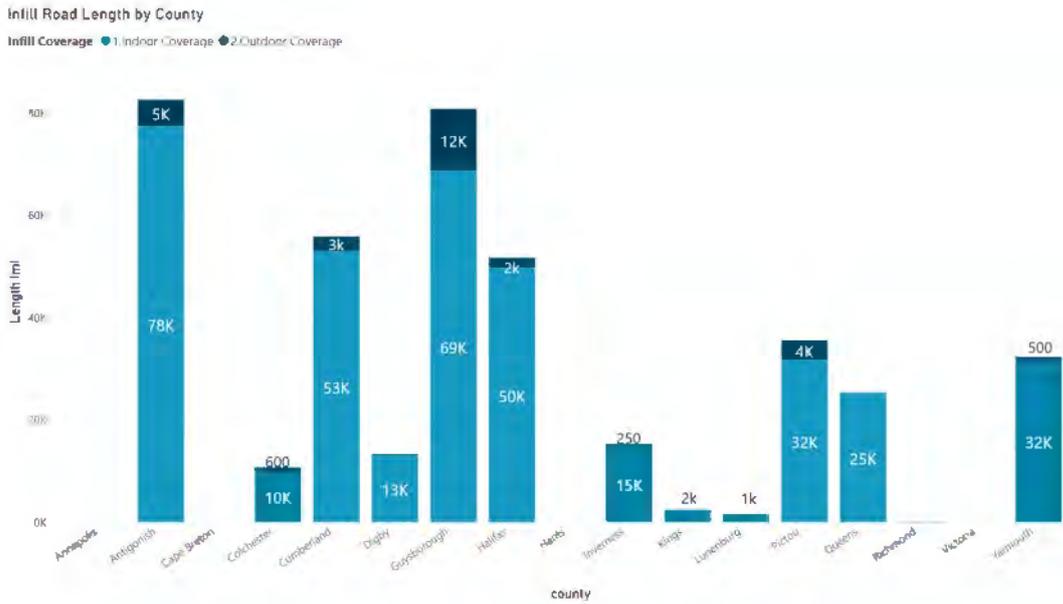


Figure 46: Improved Road Coverage by County

## 5. Conclusions

This study used a mix of desktop analysis and drive surveys to determine the existing cellular coverage position across the province. The results showed areas of partial and total not-spots which were spread across the province as measured by address coverage and primary and minor road coverage.

Potential new tower sites were determined which gave the best coverage of unserved addresses with the top 25 tower locations chosen as providing the best return. This is an arbitrary cut off used to limit the capital spend required and can be adjusted as necessary to build into a future business case for investment if that were required. Further modelling could be completed to focus in on certain areas of concern, for example sections of key road routes etc.

14(1); 17(1)

Costs for the development of these sites were built up using industry standard unit costs which when applied to the 25 sites gives a total cost of [REDACTED]. Costs figures have also been included for all 73 sites at [REDACTED].

With these 25 new sites, a total of 9,569 of the 21,143 uncovered civic addresses could be covered and 407km of the 1,010km unserved primary roads. With 73 sites, 15,516 of the 21,143 uncovered civic addresses are covered and 772km of the 1,010km unserved primary roads.

The 75 sites chosen as a focus for this report were identified through detailed analysis that attempted to minimise costs whilst retaining a practical solution. This involved positioning of sites such that power and backhaul costs were as low as possible, whilst at the same time providing the coverage required to the priority areas. These priority areas were primarily where there are clusters of residential premises with no current cell coverage provision.

Whilst it would be possible to calculate costs for complete geographic coverage, this would inevitably require placement of sites in more remote areas with no current infrastructure or services. This would require a different approach which was outside the scope of this initial report. However, based on an approximation of the land mass without any current cell coverage, full geographic coverage may require up to a further 200 towers over and above the 73 already assessed in this report. The tower cost estimates outlined in this report indicate that a further [REDACTED] could be required to fund these additional 200 towers. It should be noted however that no detailed work has been carried out to calculate this blanket coverage provision and these costs could be significantly higher due to the remote nature of the geography.

In conclusion, DNS are now in a position to better understand the existing cellular coverage across the province and the areas of poor coverage, and the scale of capital cost required to provide additional coverage.

# Visit

## [farrpoint.com](https://farrpoint.com)



### Halifax

1300-1969  
Upper Water Street,  
Halifax, Canada  
NS B3J 3R7

T: +1 902 500 1414



### Edinburgh

Exchange Place 2  
5 Semple Street  
Edinburgh  
EH3 8BL

T: +44 131 202 6018



### Manchester

3 Hardman Square  
Spinningfields  
Manchester  
M3 3EB

T: +44 161 669 5821



### London

1st Floor  
99 Bishopsgate  
London  
EC2M 3XD

T: +44 20 3693 7310