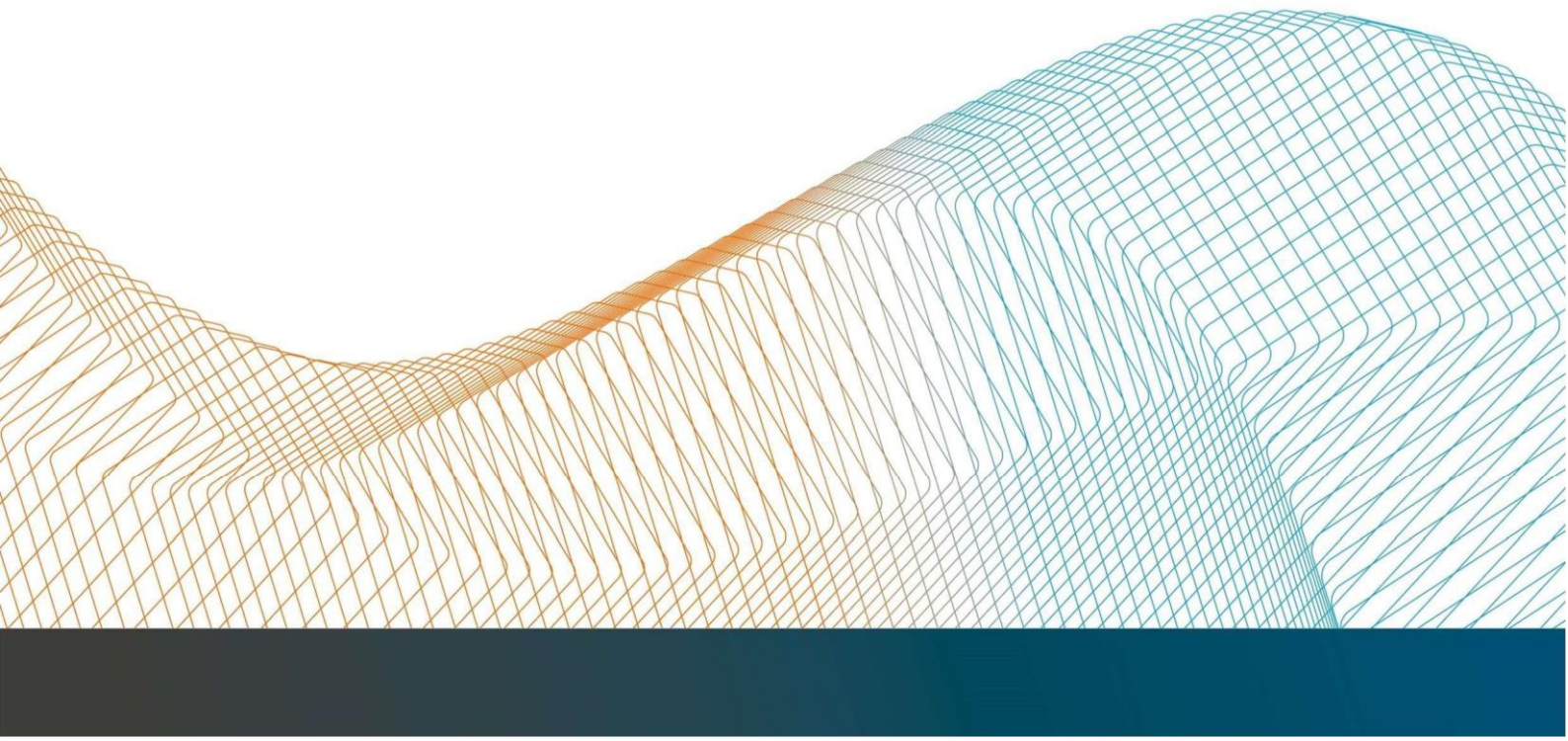
FarrPoint
Go Further

Highlands & Islands Airports Ltd

Connectivity Review

HIA1D1V2.0

July 2019



Contents

1. Introduction

1.1. Background

This report presents the findings of the recent connectivity review completed by FarrPoint for Highlands and Islands Airports (HIAL). This follows the brief which described the Air Traffic Management 2030 Programme (ATMS2030) which will change the way that air traffic services are provided at up to 7 HIAL airports by centralising activities in a remote/digital tower and surveillance centre, and by introducing a major airspace change.

To support this, high capacity resilient links are required between sites. The delivery of a remote/digital tower solution will require viable communications solutions to enable radio transmitter and receiver data together with other data (such as video data, local weather information, NAVAID status etc.) to be relayed from the airports to the Remote Tower Centre (RTC).

An initial feasibility study for the programme has suggested the following likely requirements as provided in the brief:

- Resilient communications links are required between the CSC (Centralised Surveillance Centre), the backup CSC and each aerodrome;
- Required Bandwidth will be between 150-300Mbps for the main centre;
- Required Bandwidth between backup CSC and main CSC will be 1 Gbps;
- Required Bandwidth for lower bandwidth redundancy with be > 5Mbps; (see note in Summary at the end of this document)
- The data will need to be sent with minimal delay, in addition to resilience and fail-safe requirements to ensure service continuity. Assumed latency to be < 1 second.

For the purposes of this exercise, the ATMS2030 Programme is looking for this review to provide information which will enable HIAL to determine how close they are to the safety case, and what work/cost might be involved to get to the desired specification.

1.2. Format

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

Section 2 provides background on the connectivity market solutions and developments which may be relevant to HIAL.

Section 3 provides the analysis of each of the identified HIAL sites.

Section 4 provides a conclusion, cost summary and comment on a trial system.

2. Connectivity Market

2.1. General

In this report, FarrPoint has sought to provide a picture of the connectivity that is available to each of the airport locations identified in HIAL's Invitation to Quote document, along with connectivity to the provisional CSC locations also identified in the same document.

We have researched the existing telecom duct routes in and around the locations from key operators, identified the locations of BT exchanges in these areas and analysed the potential for diverse routing as required by HIAL. In addition, microwave radio options have been assessed for each site to provide diverse routing and, in some cases, as an economical solution compared to the excess construction costs that could be incurred by creating a new diverse duct or fibre routes.

For each location, we have shown on a site map where we believe duct routes exist. We have also shown microwave radio paths where we have assessed that Line of Sight exists from the airport location to an existing radio site. Radio sites were chosen that we believe have existing fibre duct and are managed by organisations open to site sharing arrangements.

Whilst the location for the CSC is not known at this stage, it is generally assumed it will be within close proximity of Inverness. This is reflected in the example locations shown in the HIAL document. In order to comply with HIAL's diversity routing requirement, FarrPoint has assumed a main circuit will be connected between each of the seven airport locations and the main CSC. A backup circuit will also be connected between each of the seven airports and the Backup CSC. At the airport sites, the fibre will take a diverse route into the building, or where this is impractical, a radio circuit will provide the diverse route into the provider's network. At the CSC side, diverse fibre routes will be connected between the main and backup CSCs. Where this is impractical or uneconomic, a single fibre route may be taken and a radio link provided directly between the CSC buildings, assuming Line of Sight exists.

Resiliency vs Diversity: Diverse routes are routes that take different geographical paths but terminate at the same end points, whereas resilient cable routes may take the same geographical route but provide fibres in different sub-ducts. Where possible, FarrPoint has attempted to indicate diverse routing options.

Remote Towers: For the purposes of this report, the remote tower locations at each of the seven airports has been taken as the location of the existing control tower. It is recognised that this may not be the location for the new remote tower installation and therefore additional excess construction charges may apply. Key to this is the location of existing fibre duct around the HIAL aerodromes.

Microwave Radio: Microwave radio has traditionally been used to provide telecoms connections particularly in the more remote areas of Scotland. Many of the islands have been connected solely by microwave radio for telephony up until recently. Capacity on microwave links has evolved with the technology and bandwidths of multiple gigabits can be achieved across licensed fixed links and over short distances using light licensed radio. Microwave link planning takes into account typical rainfall rates for the specific location concerned and therefore a specific link availability figure can be forecast.

2.2. Services and Operators

BT: BT Group Plc are the dominant telecommunication operator in Scotland and own significant infrastructure throughout the region. The infrastructure assets are operated by Openreach Ltd on behalf of BT Group Plc following the Ofcom agreed separation of Openreach from BT group functions. Openreach provide wholesale services to registered communication providers including other operators/ integrators such as SSE Telecom, Vodafone, BT Wholesale, City Fibre and Capita (SWAN) etc. and business/ residential broadband retail service providers such as Sky, TalkTalk, BT Retail etc. Openreach also offer duct and pole access to BT assets under the Passive Infrastructure Access (PIA) agreement which allows certain accredited communications providers the ability to install their own fibre cables in BT ducts. Openreach fibre cables and associated products can be delivered with various service level agreements and resiliency options including duct route diversity and cable diversity. Services obtained from Openreach, whether directly or via a registered Communications Provider, may be subject to Excess Construction Charges (ECCs) which are payable (in addition to normal connection charges) at Openreach's sole discretion and apply where the provision of additional infrastructure is required to give a new or extended service at a site. Where Openreach has decided to extend its network for commercial reasons as a consequence of end-user orders, they may waive part or all ECC's. Openreach currently have underground duct connections to all seven HIAL airports within the scope of this study with both fibre and copper cables feeding various buildings within the curtilage of the airports.

Vodafone: Vodafone is best known as a mobile network operator, but in Scotland, Vodafone has acquired ownership of the ex-Thus and Cable and Wireless fibre networks. It is understood that any development of these networks has been discontinued and that connection via the existing fibre is problematic. The ex-Thus fibre network is known to pass by Dundee, Inverness and Wick HIAL airports. Whilst this could potentially provide diverse routing, obtaining a connection may be commercially difficult. It should be noted that CityFibre may have an interest in these networks in the future and in that case, connectivity may become more realistic.

SWAN: The Scottish Wide Area Network (SWAN) is a single public services network for the use of all public service organisations within Scotland. It is being delivered through a framework contract with Capita IT Enterprise Services. Note that SWAN and the provider Capita do not install network of their own; all connectivity services provided by Capita through the SWAN contract are provided by existing telecom operators such as Openreach, Virgin Media, CityFibre etc. Fibre connectivity options proposed in this report could be acquired by HIAL via SWAN.

Virgin Media: Virgin Media has fibre infrastructure in the Dundee area and there is potential for diverse routing at Dundee airport via VM network.

SSE Telecom: SSE Enterprise Telecoms (SSEET) is a part of SSE PLC and offers dark fibre and optical wavelength connectivity across their existing managed infrastructure. SSEET also offer services across third party infrastructure providers such as BT (via Openreach), Vodafone and CityFibre via existing wholesale agreements. SSEET provide Gigabit Ethernet connectivity with standard and bespoke service level agreements and a range of options for route security, separation, latency, and availability. Currently, SSEET do not have infrastructure at many of the airports within the scope of this study and would therefore relay on third party owners/ operators to provide such services.

2.3. Island Resiliency

Currently the three main island groups of the Western Isles, Orkney and Shetland are connected to the Scottish mainland by subsea fibre cables. The Western Isles are connected via resilient subsea fibre routes provided by BT under the Highlands and Islands Enterprise funded next generation broadband project. Links across the Minch to Stornoway, down to Benbecula (via a Sound of Harris Subsea cable) and over to Skye connect these exchanges to the BT resilient 21st Century core Network (21CN).

The Orkney islands are connected via the BT owned and operated 67km Northern Lights subsea fibre from Dunnet Head on the Scottish mainland to Sandwick on the Orkney mainland with the Faroese Telecom SHEFA-2 subsea cable from Orkney to the Moray coast providing the resilient second route.
These routes connect the BT exchange at Kirkwall to the 21CN network.

The Shetland Islands are connected to the Scottish mainland via the SHEFA-2 subsea cable connecting Sandwick in Shetland to Orkney (and then on to the Scottish mainland as described above). The other leg of the SHEFA-2 cable departs Shetland to the Faroe Islands and on to Iceland with a return to the Scottish mainland via the FARICE-1 cable directly from the Faroe Islands. The BT exchange in Lerwick is connected to the 21CN resilient network via these routes. It should be noted that recently announced plans by SSE to provide a subsea 600 megawatt power interconnect with embedded fibre from the Scottish mainland to the Shetlands will provide an additional fibre route.

Subsea cable routes are shown in the following diagram.

Figure 1 – Inter-Island Subsea Routes

3. Site Analysis

3.1. Benbecula

3.1.1. Connectivity Options

Fibre Options

The following diagram shows how we have estimated the path that the main BT route will take from the airport to the BT exchange. Also shown is the backup radio link line of sight path to the roof of the exchange. The BT 21CN core route directions are also indicated.

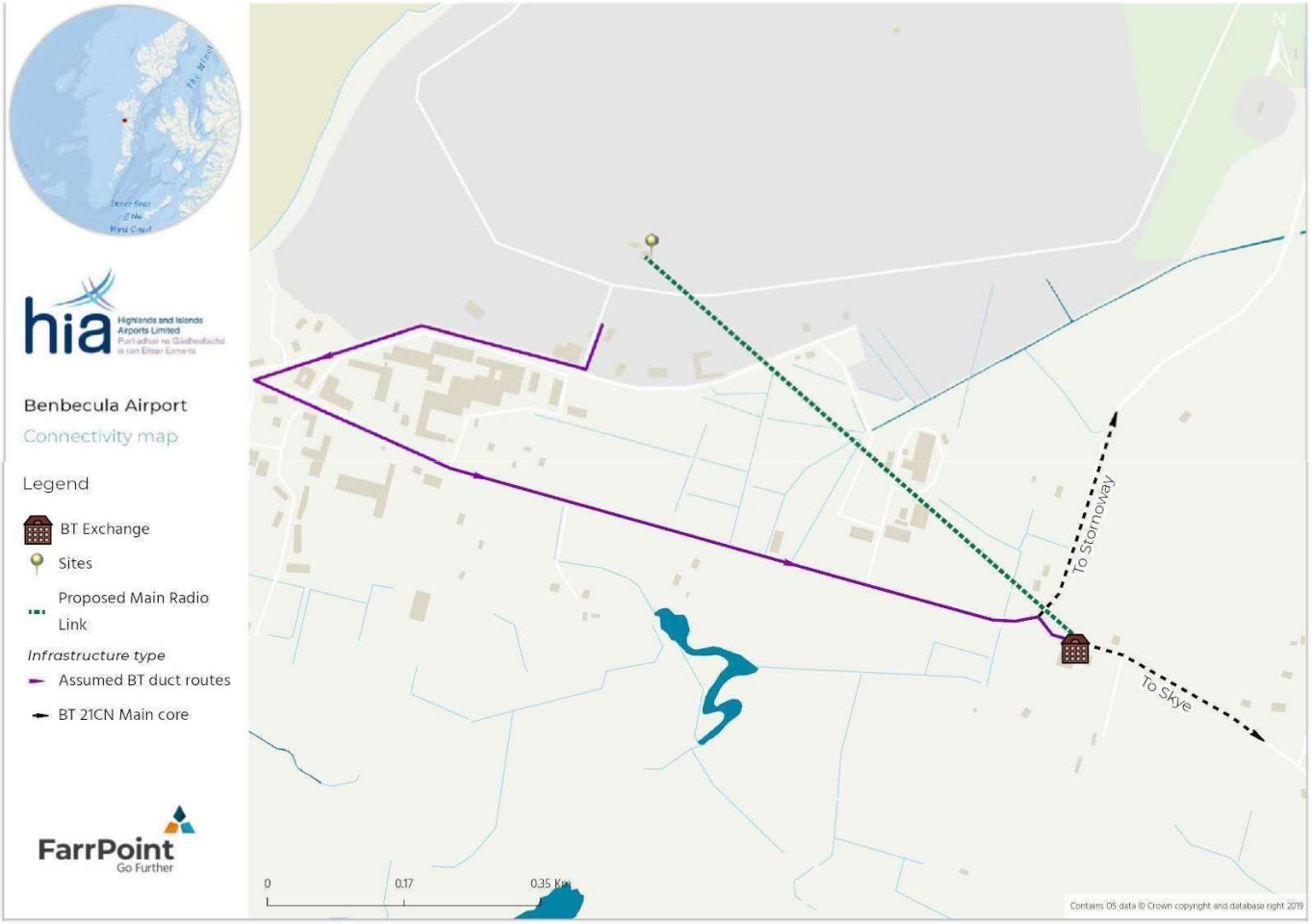


Figure 2 – Benbecula Fibre Route

Radio Options

It is unlikely that diverse fibre routes will be available into Benbecula airport, therefore radio options were investigated as an alternative. FarrPoint has estimated that line of sight is likely to exist between the current tower location and the Benbecula BT exchange. One building near the BT exchange could obstruct the path, however it is likely that enough height can be achieved either side to clear this obstruction. A 38GHz link using a 28MHz channel bandwidth and 1 x 0.3 metre dish antenna each side will be capable of providing 250Mbps throughput (full duplex) at an availability figure of 99.99%. Because of the geography and remote nature of the area, only one other alternative link was found to be feasible, which is the NATS site at Cleitreabhal. It is believed there is BT fibre duct existing at Cleitreabhal. This link crosses water and is

likely to be affected by tidal reflection multipath. The standard method of mitigating the effect of tidal multipath is to use a space diversity antenna configuration, therefore this hardware configuration was designed and budgeted for. A 15GHz link using a 28MHz channel bandwidth and 2 x 0.6metre dish antennae each side will be capable of providing 93Mbps throughput (full duplex) at an availability figure of 99.99%. Using Adaptive Code Modulation (ACM), higher modulations will be available for the majority of time offering up to 250Mbps at a lower availability figure.

Costings have been provided for the 38GHz link to the BT exchange using a 1+1 space diversity hardware configuration. Should a lower throughput be deemed sufficient, the channel bandwidth could be reduced to 14MHz which would also reduce the annual Ofcom fee by 50%.

The diagram below shows the alternative radio route to Cleitreabhal radio site described above.

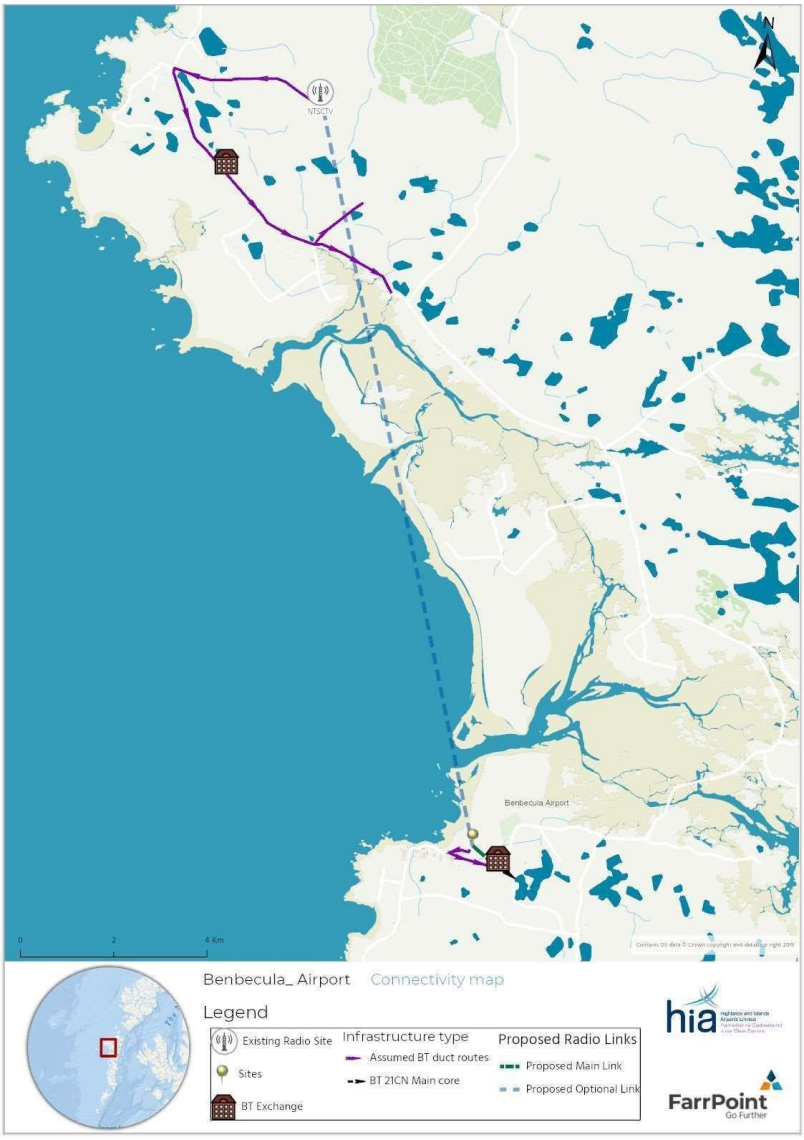


Figure 3 – Benbecula Alternative radio link

3.1.2. Costings

Item	Link Type	Total (£)
Main Link Excess Construction	500Mbps fibre	[Redacted - Commercial Information]
Main Link Installation Charge	500Mbps fibre	[Redacted - Commercial Information]
Backup Link Excess Construction	BT Exchange – no excess construction.	[Redacted - Commercial Information]
Backup Link Installation	100Mbps fibre @ Benbecula exchange	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 1 - Benbecula Fibre Connectivity – Capital Supply costs

Item	Link Type	Total (£) p.a.
Main Link Annual	500Mbps fibre (SWAN)	[Redacted - Commercial Information]
Backup Link Annual	100Mbps fibre @Benbecula exchange	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Item	Number	Unit (£)	Total (£)
38GHz 1+1 0.3m	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Steelwork per site	2	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Feeders and Miscellaneous	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Installation & Commissioning	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]

Table 2 - Benbecula Fibre Connectivity - recurring Costs

Site Sharer Project Fee	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Project management	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 3 - Benbecula Microwave Radio - Capital Supply Costs

Item	Number	Unit (£)	Total (£) p.a.
Ofcom Licence Fee (38GHz, 28MHz 99.99%)	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharing Fee (BT Exchange)	1x 0.3m Dish	[Redacted - Commercial Information]	[Redacted - Commercial Information]
	1 x Internal Cabinet	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 4 – Benbecula Microwave Radio – Recurring Costs

3.1.3. Issues/Opportunities

Initially, diverse routing was investigated to Cleitreabhal radio site (NATS). This would be a relatively expensive link as it is a 16Km path across the sea that would require a space-diversity antenna configuration.

The planned radio link to Benbecula BT exchange provides adequate diversity and will be a more economical solution. Should this view change, the link to Cleitreabhal could be swapped in.

3.2. Dundee

3.2.1. Connectivity Options

Fibre Options

The following diagram shows how we have estimated the path that the main and backup BT routes will take from the airport to the BT exchange(s). The BT 21CN core route directions are also indicated. One radio route alternative option is also displayed to the Arqiva Tay Bridge site.

Figure 4 - Dundee Fibre Route

Radio Options

Being a metropolitan area, it is likely that diverse fibre routes will be available into Dundee airport. Nonetheless radio options were also investigated as alternatives. Three radio options were found to be feasible, all of which were to Arqiva radio sites. Of these, the most practical option was the Arqiva Tay Bridge radio site at Northfield. It is believed there is BT fibre duct existing at Arqiva Tay Bridge. Although this link crosses the Tay, and therefore could potentially be affected by tidal reflection multipath, calculations show the reflection point to be on the land side and therefore this is not a concern. An 18GHz link using a 28MHz channel bandwidth and 0.3metre dish antennae each side will be capable of providing 200Mbps throughput (full duplex) at an availability figure of 99.99%. Costings have been provided for a 1+1 redundancy hardware configuration. Should a lower throughput be deemed sufficient, the channel bandwidth could be reduced to 14MHz, which would also reduce the annual Ofcom fee by 50%. The alternative two radio site options are shown on the diagram below.

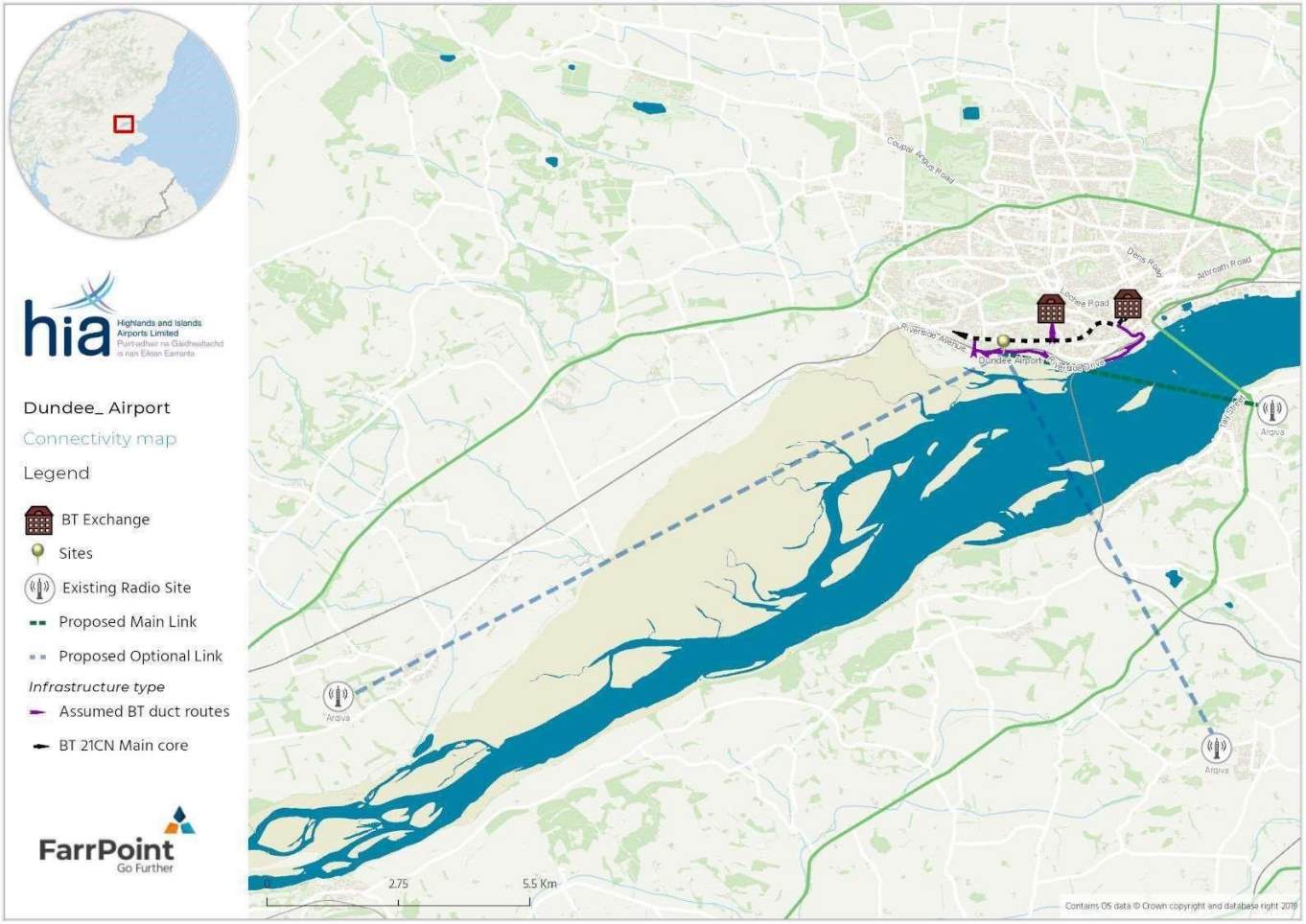


Figure 5 - Dundee Alternative Radio Routes

3.2.2. Costings

Item	Link Type	Total (£)
Main Link Excess Construction	It is likely no excess construction fees will apply at Dundee Airport	[Redacted - Commercial Information]
Main Link Installation (500Mbps)	Average installation fee (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Excess Construction	Backup circuit via fibre; It is likely no excess construction fees will apply.	[Redacted - Commercial Information]
Backup Link Installation	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 5 - Dundee Fibre Connectivity - Capital Supply Costs

Item	Link Type	Total (£) p.a.
Main Link Annual (500Mbps)	Average annual cost (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Annual	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 6 - Dundee Fibre Connectivity - Recurring costs

Item	Number	Unit (£)	Total (£)
18GHz 1+1 0.3m	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Steelwork per site	2	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Feeders and Miscellaneous	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Installation & Commissioning	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharer Project Fee	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Project management	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 7 - Dundee Microwave Radio (Optional) – Capital Supply costs

Item	Number	Unit (£)	Total (£) p.a.
Ofcom Licence Fee (18GHz, 28MHz, 99.99%)	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharing Fee (Arqiva Tay Bridge)	1x 0.3m Dish	[Redacted - Commercial Information]	[Redacted - Commercial Information]

	1 x Internal Cabinet	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 8 - Dundee Microwave Radio (Optional) - Recurring costs

3.2.3. Issues/Opportunities

It seems likely that diverse routing can be achieved using only BT's fibre network as we believe routes exist to the east and west to different exchanges. Virgin Media also has network in the area and a quote received from SSET was for a connection via this network. Vodafone also has fibre nearby from the ex-Thus network although it is not known how feasible it is to obtain a connection via this network.

3.3. Inverness

3.3.1. Connectivity Options

Fibre Options

The following diagram shows how we have estimated the path that the existing BT routes will take from the airport to the BT exchange(s). Radio route alternative options are also displayed to the Arqiva Rosemarkie, Arqiva Mounteagle and WIG Dunain sites.

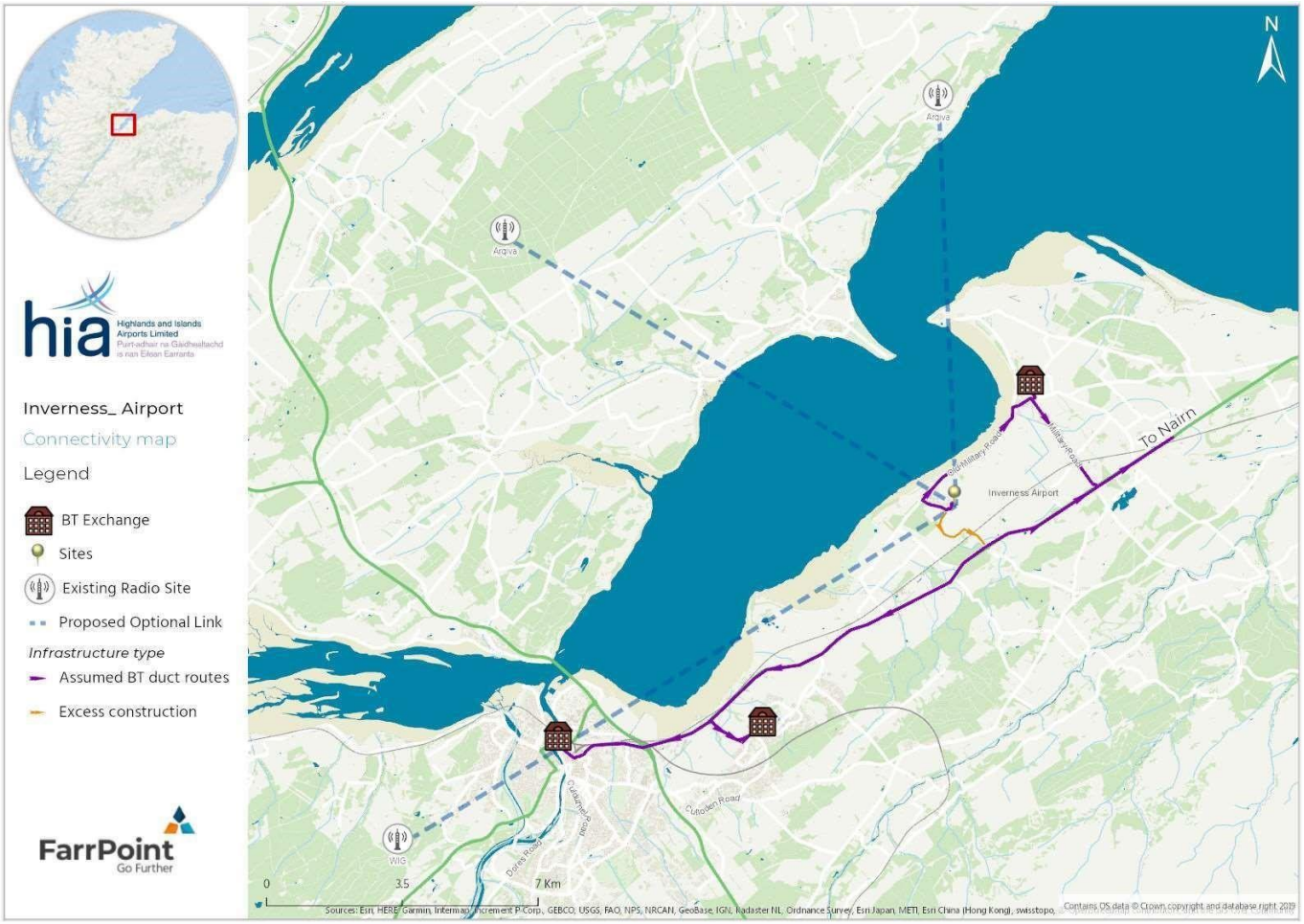


Figure 6 – Inverness Fibre and Radio routes

Radio Options

Being a metropolitan area, it is likely that diverse fibre routes will be available into Inverness airport, so it is unlikely microwave radio will be required as backup connectivity. Some radio options were investigated, nonetheless. Line of sight is available to WIG Dunain, WIG Mount Eagle and Arqiva Rosemarkie, all of which we believe have BT fibre duct existing. These options are shown on the diagram above and could be investigated further if necessary.

3.3.2. Costings

Item	Link Type	Total (£)
Main Link Excess Construction	No ECC on main fibre route	[Redacted - Commercial Information]

Main Link Installation	Average installation fee (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Excess Construction	Subduct and blown fibre to road end.	[Redacted - Commercial Information]
Backup Link Installation	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 9 - Inverness Fibre Connectivity – Capital Supply costs

Item	Link Type	Total (£) p.a.
Main Link Annual	Average annual cost (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Annual	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 10 - Inverness Fibre Connectivity - Recurring costs

3.3.3. Issues/Opportunities

BT connectivity is currently likely to be via the Ardersier exchange. A diverse route would be preferable via Nairn exchange.

3.4. Kirkwall

3.4.1. Connectivity Options

Fibre Options

There are two potential scenarios that may affect excess construction charges.

- Option 1 assumes that fibre is at a VDSL cabinet (between Heathfield and Sunnyside). Costs are provided for subduct and blown fibre from there to the airport.

- Option 2 assumes the fibre splice point is further down the road (at Sunnybank junction). There is another VDSL cabinet in Sunnybank road. Costs are for blown fibre from this point, but only new subduct from the above location.

Costs are given for the worst-case scenario (Option 2)

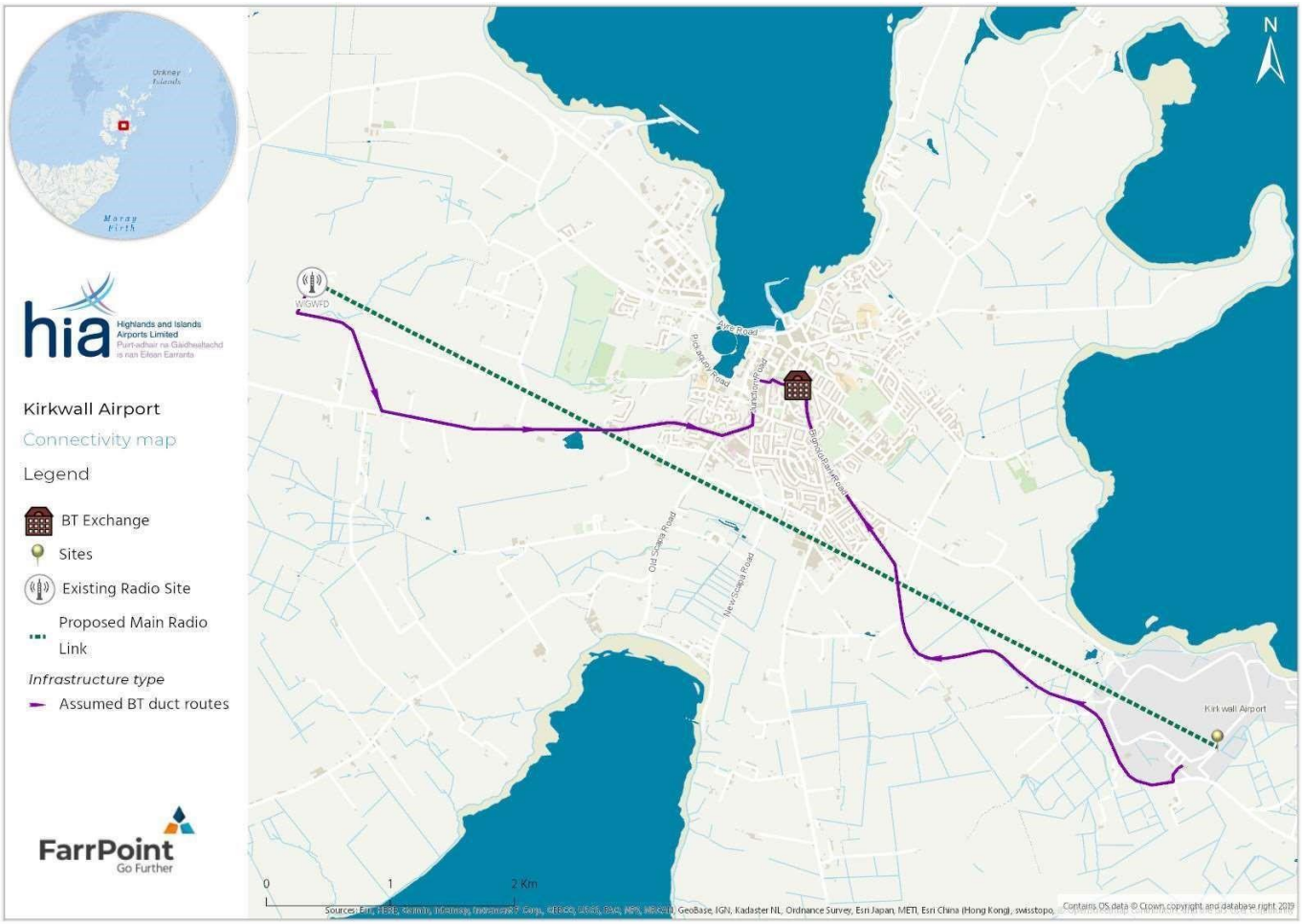


Figure 7 – Kirkwall Fibre and Radio routes

Radio Options

It is unlikely that diverse fibre routes will be available into Kirkwall airport, therefore radio options were investigated. Two radio options were found to be feasible, one to WIG Wideford and one to a Vodafone site at Towerhill. Of these, the most practical option was the WIG site at Wideford. This is a major communications node and the structures represent a better likelihood of site share availability.
It is believed there is existing BT fibre duct at Wideford.

A 18GHz link using a 28MHz channel bandwidth and 0.6 metre dish antennae each side will be capable of providing 200Mbps throughput (full duplex) at an availability figure of 99.99%. Costings have been provided for a 1+1 redundancy hardware configuration. Should a lower throughput be deemed sufficient, the channel bandwidth could be reduced to 14MHz which would also reduce the annual Ofcom fee by 50%. Additionally, reduced antenna size would allow for a lower throughput, but provide savings on site sharing costs.

The alternative two radio site options are shown on the diagram above.

3.4.2. Costings

Item	Link Type	Total (£)
Main Link Excess Construction	No ECC on main fibre route	[Redacted - Commercial Information]
Main Link Installation	Average installation fee (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Excess Construction	See note above	[Redacted - Commercial Information]
Backup Link Installation	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 11 - Kirkwall Fibre Connectivity – Capital Supply costs

Table 12 - Kirkwall Fibre Connectivity - Recurring costs

Item	Link type	Total (£) p.a.
Main Link Annual	Average annual cost (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Annual	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Item	Number	Unit (£)	Total (£)
18GHz 1+1 0.6m	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Steelwork per site	2	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Feeders and Miscellaneous	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Installation & Commissioning	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharer Project Fee	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Project management	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]

Total			[Redacted - Commercial Information]

Table 13 - Kirkwall Microwave Radio – Capital Supply costs

Item	Number	Unit (£)	Total (£) p.a.
Ofcom Licence Fee (18GHz, 28MHz, 99.99%)	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharing Fee (WIG Wideford)	1x 0.6m Dish	[Redacted - Commercial Information]	[Redacted - Commercial Information]
	1 x Internal Cabinet	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 14 - Kirkwall Microwave Radio - Recurring costs

3.4.3. Issues/Opportunities

It is believed that a single fibre route exists between Kirkwall BT exchange and Kirkwall airport and therefore this is an area of vulnerability. Short of installing a new fibre route from the airport all the way to the exchange, the only way to deliver diverse routing is via microwave radio. The suggested link to Wideford Hill radio site achieves this diversity effectively by providing a high availability radio link to existing fibre network at Wideford.

3.5. Stornoway

3.5.1. Connectivity Options

Fibre Options

Anecdotal information suggests there may be extensive duct within the airfield, possibly as a result of it being an old RAF base. Duct may exist under the runway and there is a potential diverse route from there to the exchange. Two options may impact ECC costs:

- Option 1 - There may be a new cabinet installed at the junction of Constable Road and North Road. If so, we could assume subduct and blown fibre in the existing airport ducts.
- Option 2 - Option 1 above may not occur and so connection would be required to the Steinish junction as there is an existing VDSL cabinet going down into Steinish. Blown fibre would be required from this point.

Costs are given for the worst-case scenario (Option 2)

Figure 8 – Stornoway Fibre and Radio options

Radio Options

Diverse fibre routes may be available into Stornoway airport, although this is not confirmed and therefore radio options were investigated. Two radio options were found to be feasible, one to WIG Benadrove and one to the NATS radar site at the west of the airport. Of these, the most practical option was the NATS site. It is believed there is BT fibre duct existing at this site, along with Vodafone (ex Thus) duct.

A 38GHz link using a 28MHz channel bandwidth and 0.3 metre dish antennae each side will be capable of providing 250Mbps throughput (full duplex) at an availability figure of 99.99%. Costings have been provided for a 1+1 redundancy hardware configuration. Should a lower throughput be deemed sufficient, the channel bandwidth could be reduced to 14MHz which would also reduce the annual Ofcom fee by 50%.

The alternative radio site option to Benadrove is shown on the diagram below.

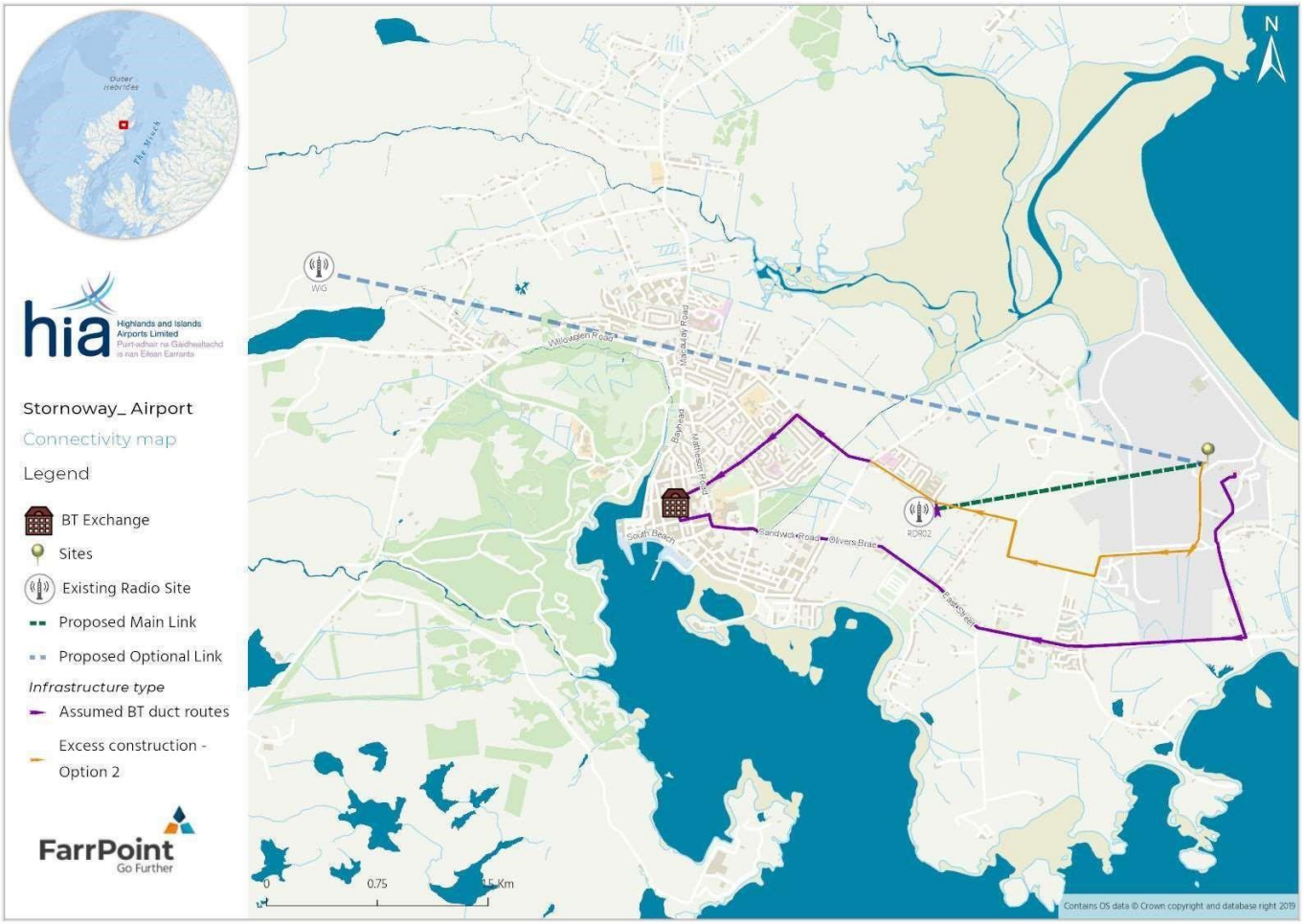


Figure 9 – Stornoway Alternative Radio Link

3.5.2. Costings

Item	Link type	Total (£)
Main Link Excess Construction	No ECC on main fibre route	[Redacted - Commercial Information]
Main Link Installation	Average installation fee (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Excess Construction	See note above	[Redacted - Commercial Information]
Backup Link Installation	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 15 - Stornoway Fibre Connectivity – Capital Supply costs

Table 16 - Stornoway Fibre Connectivity Recurring costs

Item	Link Type	Total (£) p.a.
Main Link Annual	Average annual cost (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Annual	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 17 - Stornoway Microwave Radio – Capital Supply costs

Item	Number	Unit (£)	Total (£)
38GHz 1+1 0.3m	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Steelwork per site	2	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Feeders and Miscellaneous	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Installation & Commissioning	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Project management	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 18 - Stornoway Microwave Radio - Recurring costs

Item	Number	Unit (£)	Total (£) p.a.
Ofcom Licence Fee (38GHz, 28MHz, 99.99%)	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

3.5.3. Issues/Opportunities

Whilst diverse routing may be achievable on BT's network, this is not confirmed and therefore radio diversity was costed. Initially a link was planned to Benadrove radio site (WIG), however, a link to the NATS radar site to the west of the airport could achieve the same level of protection without the site sharing costs associated with Benadrove.

Connectivity may exist at the radar installation to the Vodafone (ex-Thus) network. Further investigation could be carried out to establish whether this might prove advantageous for diversity purposes.

3.6. Sumburgh

3.6.1. Connectivity Options

Fibre Options

The backup circuit for Sumburgh will be to a radio site to the east of Sandwick. We believe Shetland Telecom fibre exists at Sandwick school and have estimated trenching costs from the school to the radio site at Sandwick.

The diagram below shows how we have estimated the path that the main BT route will take from the airport to the BT exchange. Also shown is the backup radio link Line of sight path to the Sandwick radio site.

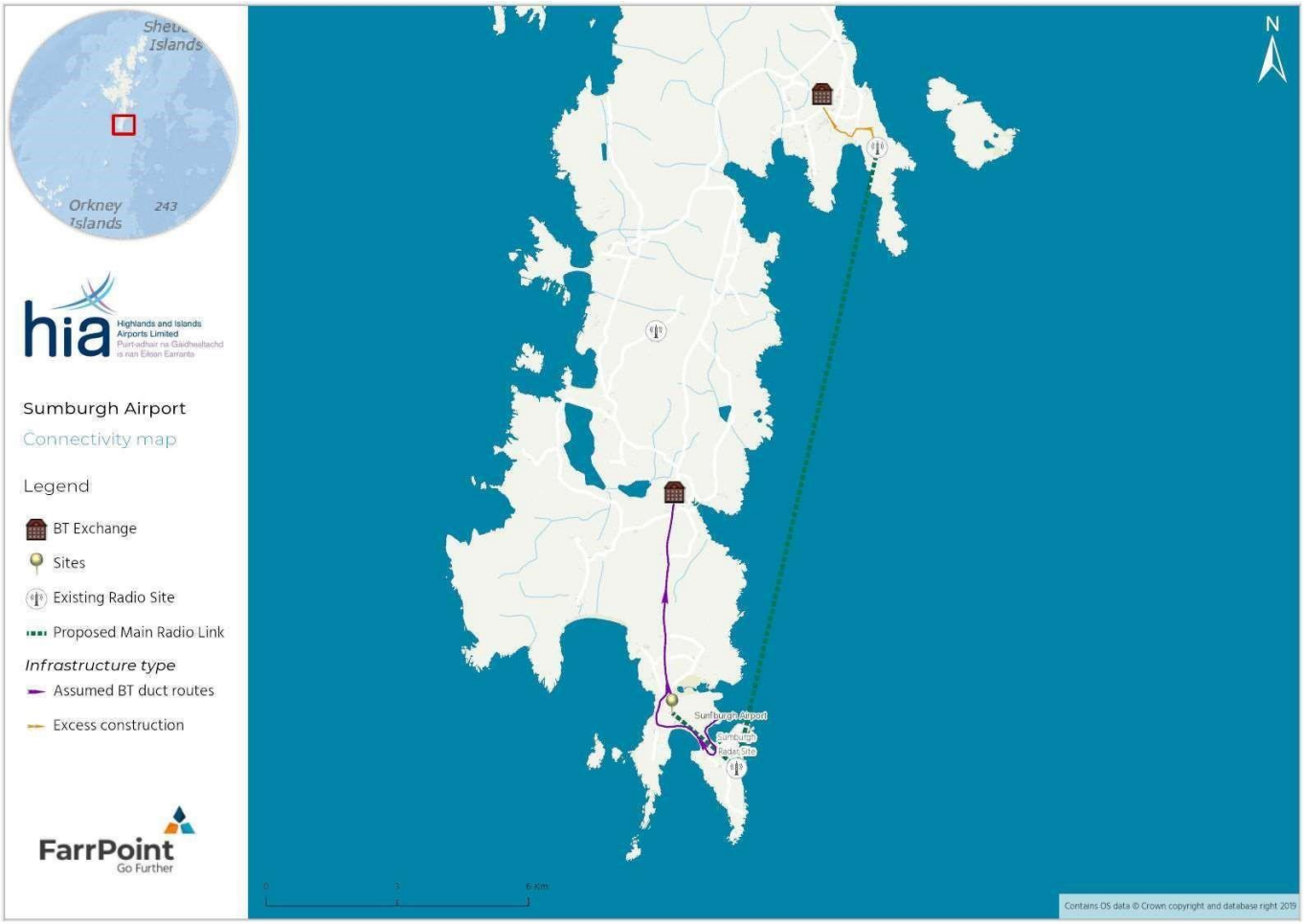


Figure 10 - Sumburgh Fibre Route

Radio Options

It is unlikely that diverse fibre routes will be available into Sumburgh airport, therefore radio options were investigated. Sumburgh airport requires two radio links in order to provide connectivity to the north, due to the local geography. A key site was found to be a radar installation 1.9Km to the southeast of the airport. It is assumed this is a NATS facility and may be available to the airport for antenna siting. Three radio options were found to be feasible as onward paths from this site. These are Bressay (Vodafone, ex CW), Sandwick (Vodafone) and Scousburgh (BT). Of these, the site chosen was Sandwick as this offers a diverse route via Shetland Telecom fibre. However, this is an over-water link and space diversity hardware will be required.

Confirmation would be required that the Vodafone tower has the loading capacity for a further two 0.6m dishes. Additionally, the radar structure at Sumburgh would need to be examined for suitability for a spacediversity array. The most likely alternative link is to Scousburgh as this will require only a single dish.

A 15GHz link using a 28MHz channel bandwidth and 0.6 metre dish antennae each side will be capable of providing 125Mbps throughput (full duplex) at an availability figure of 99.99%. Costings have been provided for a 1+1 redundancy hardware configuration. Should a lower throughput be deemed sufficient, the channel bandwidth could be reduced to 14MHz which would also reduce the annual Ofcom fee by 50%. Additionally, reduced antenna size would allow for a lower throughput, but provide savings on site sharing costs, though due to the path length, this is unlikely to be feasible.

The two alternative radio site options are shown on the diagram below.

Figure 11 – Sumburgh Alternative Radio Routes

Item	Link Type	Total (£)
Main Link Excess Construction	No ECC on main fibre route	[Redacted - Commercial Information]
Main Link Installation	Average installation fee (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Excess Construction	See note above	[Redacted - Commercial Information]

Backup Link Installation	100Mbps fibre	[Redacted - Commercial Information]

3.6.2. Costings

Total		[Redacted - Commercial Information]

Table 19 - Sumburgh Fibre Connectivity – Capital Supply costs

Table 20 - Sumburgh Fibre Connectivity - Recurring costs

Item	Link Type	Total (£) p.a.
Main Link Annual	Average annual cost (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Annual	100Mbps fibre	[Redacted - Commercial Information]

Item	Number	Unit (£)	Total (£)
Total	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
18GHz 1+1 Space Diversity 0.6m			
18GHz 1+1 0.3m	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Steelwork per site	3	[Redacted - Commercial Information]	[Redacted - Commercial Information]
External Cabinet	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Cabinet Foundation	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Electricity Meter Cabinet	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Electricity Supply	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Feeders and Miscellaneous	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Installation & Commissioning	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharer Project Fee	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Project management	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]

Total			[Redacted - Commercial Information]

Table 21 - Sumburgh Microwave Radio – Capital Supply costs

Item	Number	Unit (£)	Total (£) p.a.
Ofcom Licence Fee (18GHz, 28MHz 99.99%)	2	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharing Fee (Sandwick)	2 x 0.6m Dish	[Redacted - Commercial Information]	[Redacted - Commercial Information]
	1 x External Cabinet	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Electricity	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 22 - Sumburgh Microwave Radio - Recurring costs

3.6.3. Issues/Opportunities

Sumburgh is perhaps the most difficult location to provide diverse routing, both from a fibre and a radio perspective. It is believed a single fibre route exists between Sumburgh airport and Sumburgh BT exchange, which is in fact around 5km further north near Dunrossness. This makes diversity via fibre difficult without installing another fibre route between these points. Even if this were done, it is believed the onward connection from Sumburgh BT exchange to the north also follows a single route and so represents a vulnerability.

Radio connectivity out of Sumburgh airport is problematic due to a hill immediately to the north. However, line-of-sight exists from a radar tower 1km south-east of the control tower to a number of third-party radio sites. Two radio links are therefore required out of Sumburgh airport to obtain a route to the north. As mentioned above, a site at Sandwick is advantageous as this could provide diversity via the Shetland Telecom fibre network. Further work is required on the feasibility of this and other radio/fibre combinations.

3.7. Wick

3.7.1. Connectivity Options

Fibre Options

Backup connection is proposed via a radio link to an Arqiva site at Albert Street in Wick town. Two options are suggested for backup connectivity to the Arqiva site:

- Option 1 assumes duct is available from the main road (VDSL cabinet at the junction of Francis Street and Northcote Street) and so only blown fibre and tubing required from this location to the Arqiva site.
- Option 2 as above but with some new duct required across Albert Street.

Costs are given for the worst-case scenario (Option 2)

The Highland Council City deal initiative includes plans to provide duct/ fibre from Wick town centre to the Wick Industrial Estate adjacent to the airport via an alternate telecoms supplier. Timescales for completion are expected to be by 2021. Provision of this duct/ cable and a short extension into the airport would therefore provide a diverse routing.

The diagram below shows how we have estimated the path that the main BT route will take from the airport to the BT exchange. Also shown is the backup radio link line of sight path to the Arqiva Wick radio site.

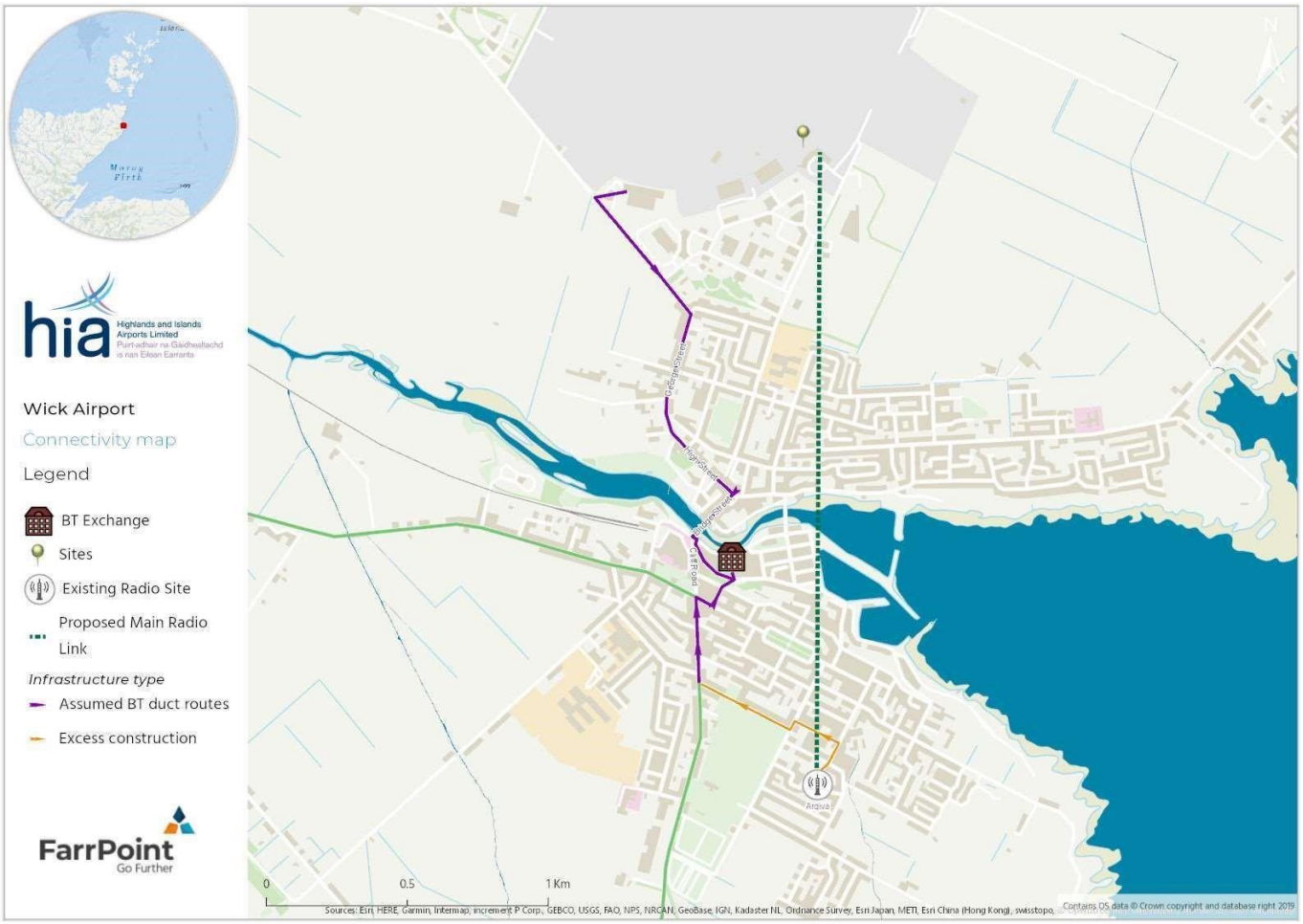


Figure 12 – Fibre and Radio options

Radio Options

It is unlikely that diverse fibre routes will be available into Wick airport, therefore radio options were investigated. Three radio options were found to be feasible, one to Arqiva Thrumster, one to a Vodafone site at Mount Pleasant to the north, and to an Arqiva site in Wick town. Of these, the most practical option was the Arqiva site in Wick. This is a 30 metre tower and the structure represents a better likelihood of site share availability. It is believed there is BT fibre duct existing at Arqiva Wick.

An 18GHz link using a 28MHz channel bandwidth and 0.3 metre dish antenna each side will be capable of providing 250Mbps throughput (full duplex) at an availability figure of 99.99%. Costings have been

provided for a 1+1 redundancy hardware configuration. Should a lower throughput be deemed sufficient, the channel bandwidth could be reduced to 14MHz which would also reduce the annual Ofcom fee by 50%. Additionally, reduced antenna size would allow for a lower throughput, but provide savings on site sharing costs.

The alternative two radio site options are shown on the diagram below.

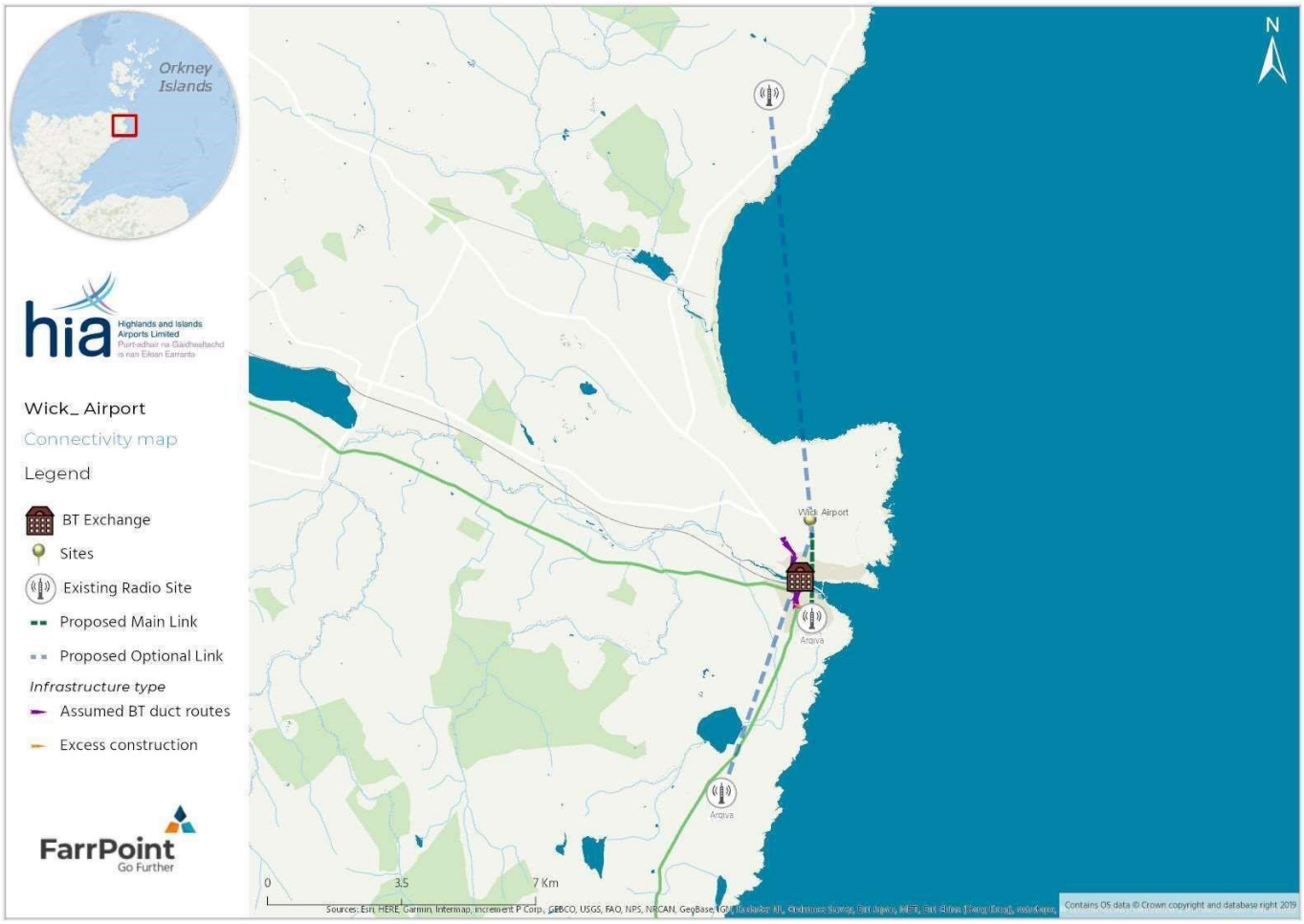


Figure 13 – Wick Alternative Radio Routes

Item	Link Type	Total (£)
Main Link Excess Construction	No ECC on main fibre route	[Redacted - Commercial Information]
Main Link Installation	Average installation fee (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Excess Construction	See note above	[Redacted - Commercial Information]
Backup Link Installation	100Mbps fibre	[Redacted - Commercial Information]

Total		[Redacted - Commercial Information]

3.7.2. Costings

Table 23 - Wick Fibre Connectivity – Capital Supply costs

Table 24 - Wick Fibre Connectivity Recurring costs

Item	Link Type	Total (£) p.a.
Main Link Annual	Average annual cost (300/500Mbps fibre)	[Redacted - Commercial Information]
Backup Link Annual	100Mbps fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 25 - Wick Microwave Radio – Capital Supply costs

Item	Number	Unit (£)	Total (£)
18GHz 1+1 0.3m	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Steelwork per site	2	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Feeders and Miscellaneous	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Installation & Commissioning	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharer Project Fee	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Project management	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Item	Number	Unit (£)	Total (£) p.a.
Ofcom Licence Fee (18GHz, 28MHz, 99.99%)	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Site Sharing Fee (Arqiva Wick)	1x 0.3m Dish	[Redacted - Commercial Information]	[Redacted - Commercial Information]

	1 x Internal Cabinet	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Table 26 - Wick Microwave Radio - Recurring costs

3.7.3. Issues/Opportunities

It is believed there is Vodafone (ex-Thus) fibre network nearby Wick airport. There is potential this could be used for diverse routing, but the feasibility of obtaining a connection via this network is unknown.

3.8. CSC Options

3.8.1. Connectivity Options

Fibre Options

For the CSC location at the stadium/ former Longman landfill site, we believe the cost may be prohibitive as no duct route currently exists under the A9 at this location. Therefore, any new building may have to include major works under the A9 to extend suppliers duct routes (e.g. BT, Vodafone, City Fibre etc.). Plans by Highland Council to develop the site around the stadium and former Longman landfill site would most likely include diversionary works on the A9 at the Longman roundabout which would present the opportunity to install telecommunications duct, however the timescales around any such development are unknown.

For the CSC location at Longman Drive we can assume there is fibre at the Scottish Water offices in Henderson Drive and that it can be extended from there. Costs will be for blown fibre and subduct (although given the comment above regarding the A9, this location may not be attractive).

For the CSC location at the Campus, we have assumed no excess construction charges as duct and fibre exist and that connectivity from Openreach can be provided under standard tariffs. We are aware of the Highland Council City Deal initiative which aims to extend duct and fibre connectivity to this location from alternate suppliers, thus providing an alternative route/ supplier into the area. Timescales for completion are expected to be by 2021. In addition, Highland Council plans for a vehicle bridge from the Campus across the railway to the Inverness Business and Retail Park may also provide an alternate duct route, however the timescales for this potential development are unknown.

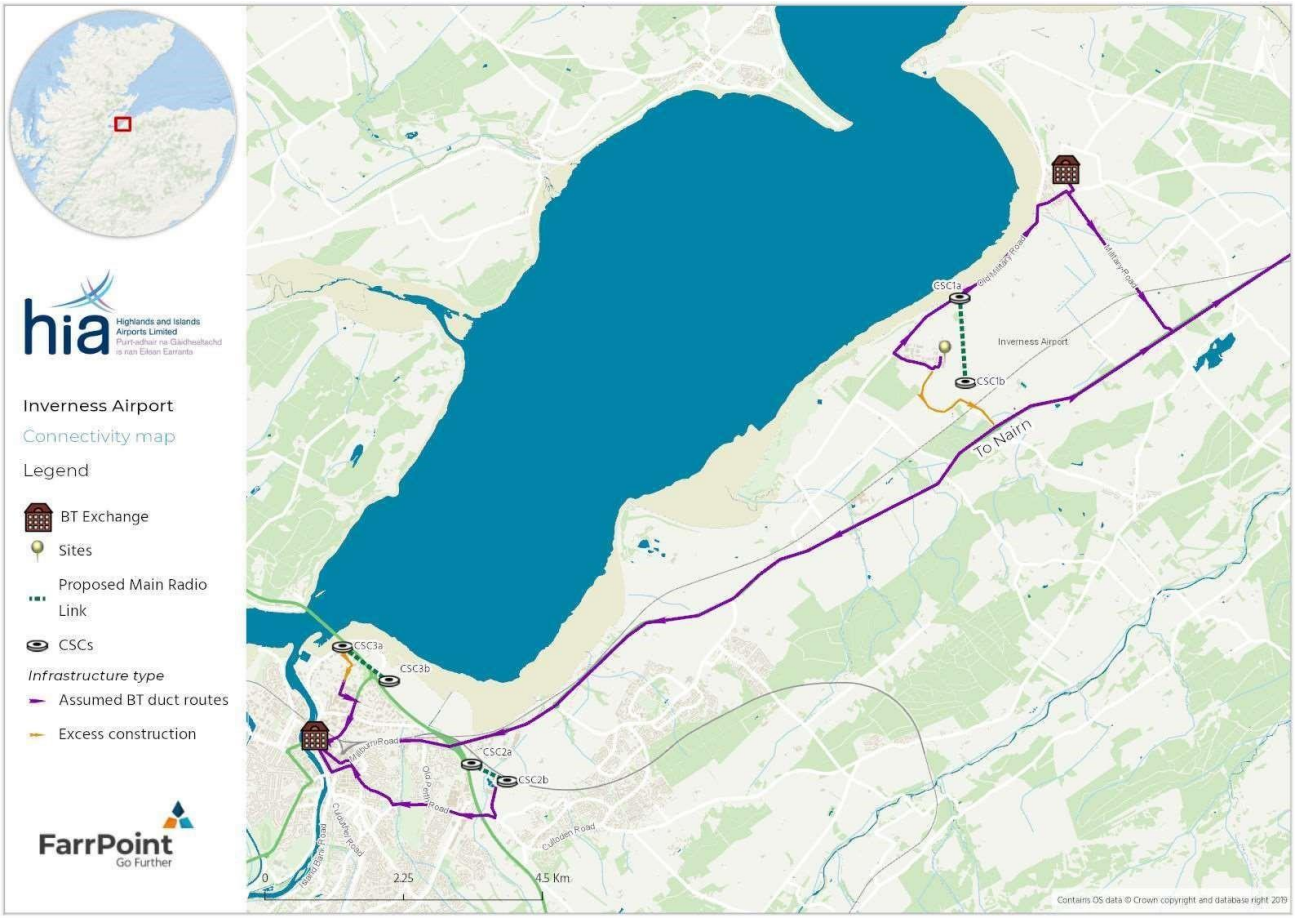


Figure 14 – CSC Fibre Routes

Radio Options

For the CSC, main circuits are expected to be taken to the main CSC building and backup circuits to the backup CSC building. Fibre duct will be required between the two buildings. Resiliency may be provided using a resilient fibre route, however we have provided costings for a radio link between the main and backup CSC buildings. This assumes of course that line of sight exists between the buildings. In the three examples given, it is thought this is likely to be the case from rooftop to rooftop. It should be noted that the three example CSC locations provided also have line of sight to WIG Dunain should there be a requirement for further resiliency.

For the building to building link, a 38GHz link using a 56MHz channel bandwidth and 0.3 metre dish antenna each side will be capable of providing 550Mbps throughput (full duplex) at an availability figure of 99.99%. Costings have been provided for a 1+1 redundancy hardware configuration. Should a lower throughput be deemed sufficient, the channel bandwidth could be reduced to 14MHz, which would also reduce the annual Ofcom fee by 75%.

The alternative resilient radio link options are shown on the diagram above.

3.8.2. Costings

Item	Link Type	Total (£)
Main Link Excess Construction	No ECC on main fibre route	[Redacted - Commercial Information]

Main Link Installation	1Gbps fibre	[Redacted - Commercial Information]
Backup Link Excess Construction	No ECC on backup fibre route	[Redacted - Commercial Information]
Backup Link Installation	1Gbps Fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 27 - CSC Fibre Connectivity – Capital Supply costs

Item	Link Type	Total (£) p.a.
Main Link Annual	1Gbps Fibre	[Redacted - Commercial Information]
Backup Link Annual	1Gbps Fibre	[Redacted - Commercial Information]
Total		[Redacted - Commercial Information]

Table 28 - CSC Fibre Connectivity - Recurring costs

Item	Number	Unit (£)	Total (£)
38GHz 1+1 0.3m	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Steelwork per site	2	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Feeders and Miscellaneous	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Installation & Commissioning	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Project management	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]
Total			[Redacted - Commercial Information]

Item	Number	Unit (£)	Total (£) p.a.
Ofcom Licence Fee (38GHz, 28MHz, 99.99%)	1	[Redacted - Commercial Information]	[Redacted - Commercial Information]

Total			[Redacted - Commercial Information]

Table 29 - CSC Microwave Radio – Capital Supply costs

Table 30 - CSC Microwave Radio - Recurring costs

3.8.3. Issues/Opportunities

As diverse paths are already considered for Inverness airport, were the CSC to be located at the airport, no further connectivity need be considered other than potentially a backup radio link between the main and backup CSCs.

4. Conclusions

4.1. Site Analysis

Excess Construction Charges

Whilst BT publish ECC rates, there is little transparency around how they are applied. BT Wholesale will approach Openreach for the costs; Openreach calculate the costs but may choose to absorb some or all of them. [Redacted - Commercial Information] ECC costs are largely unpredictable without firm quotations.

As we are unaware of the capacity available on BT fibres (this is commercially sensitive information for BT), we cannot precisely predict the likely ECC costs. However, in order to progress an estimate, we have made some assumptions on each site. These are detailed within the site-specific comments in the previous section.

Microwave Radio

Due to the remote nature of many of the airport locations, diverse fibre routing is not a feasible option. Taking Sumburgh as an example, whilst it may be possible to install diverse entry routes to the airport itself incurring some excess construction charges, the route back to the exchange further to the north of the island has currently only one route. Installing a second route over this distance would not be cost-effective. In these cases, creating a backup diverse route via microwave radio becomes the most cost-effective method. Typically, the microwave link will be taken to a point distant from the airport where fibre duct is likely to exist, and a connection taken from that point to the backup CSC.

Microwave is the most cost-effective method for diverse routes at Sumburgh, Kirkwall, Wick, Stornoway and Benbecula. It is likely diverse routes via fibre can be installed at Inverness and Dundee airports.

Nonetheless, a microwave solution was costed for Dundee airport in case this proves more economic than fibre diverse routing.

At this stage, although approximations have been provided for excess construction charges, surveys will need to be carried out by operators and this could result in significant variation from the estimates given.

Summary of Costs

Site	Cost
Sumburgh	[Redacted - Commercial Information]
Kirkwall	[Redacted - Commercial Information]
Wick	[Redacted - Commercial Information]
Stornoway	[Redacted - Commercial Information]
Benbecula	[Redacted - Commercial Information]
Inverness	[Redacted - Commercial Information]
Dundee	[Redacted - Commercial Information]
CSC	[Redacted - Commercial Information]
Total	[Redacted - Commercial Information]

Table 31 - Capital Costs

Site	Cost
Sumburgh	[Redacted - Commercial Information]
Kirkwall	[Redacted - Commercial Information]
Wick	[Redacted - Commercial Information]
Stornoway	[Redacted - Commercial Information]
Benbecula	[Redacted - Commercial Information]
Inverness	[Redacted - Commercial Information]
Dundee	[Redacted - Commercial Information]
CSC	[Redacted - Commercial Information]
Total	[Redacted - Commercial Information]

Table 32 – Annual Recurring Costs

4.2. Trial System

A trial system could be devised at any one of the seven airport locations identified; for practical purposes it may be advantageous for the trial to be based at a convenient location such as Inverness. However, it would be advisable to trial all of the technologies involved in the solution, and so a trial involving a radio link is recommended. It may be best to conduct such a trial at a location where the radio link will ultimately be installed to provide a more realistic "real-world" scenario.

At least one of the communication providers contacted has suggested implementation of a Software Defined WAN (SD-WAN) solution. This could provide seamless switching between WAN links and could be a valuable addition to the HIAL fail-over system.

The most convenient location for a trial in view of the above may be Stornoway. The radio link planned for this location terminates at an existing NATS radar site and so at least in a trial scenario, we assume there will be no site acquisition and site-sharing costs.

4.3. Connectivity Black Spots

All of the areas within the scope of this report are covered, or will shortly be covered, by BT fibre availability. Fibre also exists from alternative operators in the areas of Inverness, Dundee and Wick. A quote from [Redacted - Commercial Information] provided no direct connection via their network, therefore we assume they do not have network in proximity of these sites. Virgin Media has availability for provision in Dundee. There are no connectivity black spots in the areas of the airports concerned, although in many

cases BT provides the only connectivity option. In these cases, FarrPoint has attempted to provide resiliency by planning an alternative route using microwave radio.

4.4. Summary

In summary, this report provides details of the feasible options for resilient connectivity at all sites identified. Options have been reviewed and costed and indicate that in all cases, resilient connectivity could be provided at all sites using a mix of fibre and microwave technologies. Such connectivity could be provided at a capital cost of approximately [Redacted - Commercial Information] and a recurring fee of approximately [Redacted - Commercial Information].

Note that HIAL provided a specification of a minimum backup bandwidth of 5Mbps. In view of this, costs were included in the draft report for the lowest connection size generally available which is 10Mbps. However, subsequent to the clarification meeting on 25/03/19, these have now been revised up to 100Mbps and costs modified to reflect this change. All the microwave links were specified to a greater bandwidth in the first instance (as the additional cost involved is relatively insignificant) and will support up to and beyond 100Mbps. All connectivity described will achieve significantly better than 1 second latency as required in the specification.

This information should enable HIAL to determine how close they are to the safety case and what work/cost might be involved to get to the desired specification, as set out in the project brief.

Version Control

Owner Alan Patterson

Classification Client Confidential

Revision	Description	Author	Checked	Reviewed	Authorised	Date
1.1	Final Report	AP	NW	AM	AM	27/03/2019
1.0	Initial Version	AP	NW	AM	AM	22/03/2019
2.0	Inc. Supplier Responses	AP	NW	AM	AM	04/07/2019

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