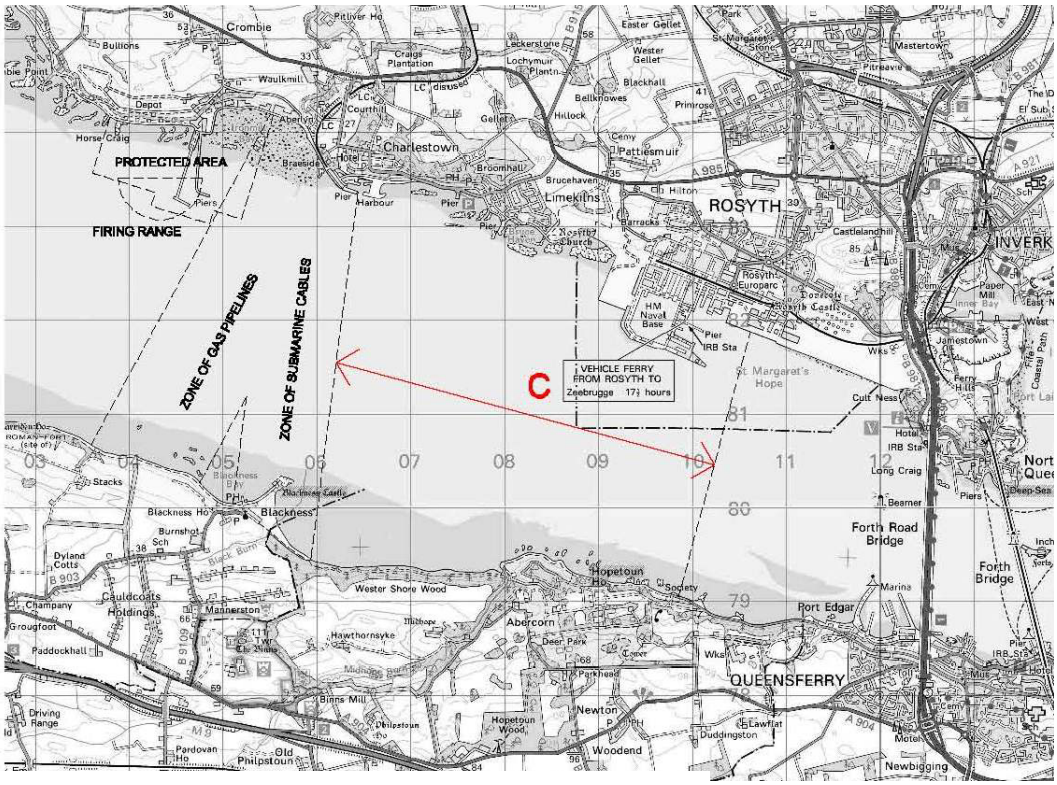
APPENDIX D - ASSESSMENT OF CORRIDOR C

D1 DESCRIPTION OF CORRIDOR

Corridor C is the third of the options to be assessed. It is shown in Drawing Number. 49550/G/02 and an extract is given below showing the corridor. It is defined on its western edge by the electricity lines crossing the Forth between Blackness and Charleston. The eastern edge is just east of Rosyth on the north shore and the grounds of Hopetoun House on the south.



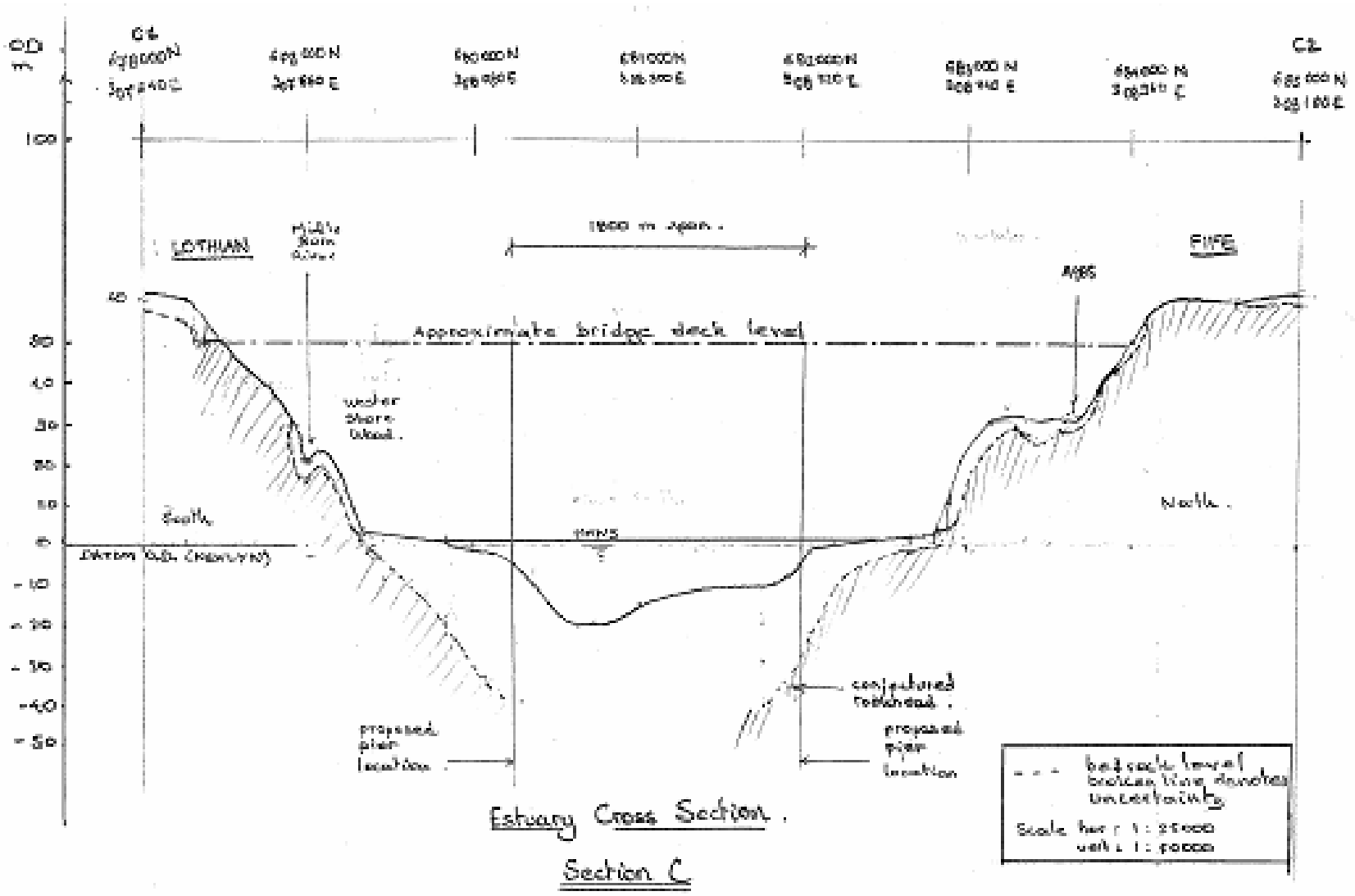
D2 INFLUENCE OF GEOLOGY

The geotechnical considerations relating to crossing Corridor C are subject to the similar to those that apply for Corridor B. There is a similar degree of uncertainty as to the depth to bedrock and the exact nature of the overlying sediments. At this location, the main channel of the River Forth is both wider and deeper than that in Corridor B.

A likely crossing within Corridor C would be located between the bedrock outcrops of Blackness on the southern shore and Crombie Point on the northern shore. It should be stressed that the 30m rockhead depth contours are not established in this locality, but they appear to have converged relative to their upstream positions. Potentially this location could be a more suitable bridge crossing than either Corridor A or Corridor B, although boreholes in the Firth have been advanced to more than 90m depth to the west of Crombie Jetty, without encountering bedrock.

A cross section of the Firth within this corridor has been prepared to illustrate the approximate geology. Again, this has been done using available information and is shown in Figure D.1 below.

Figure: D.1 Geological Cross-Section at Alignment CB1



D3 TRANSPORT PLANNING

A test of Corridor C's operational performance has been undertaken using the TMfS. This test is representative of both a tunnel and a bridge option in this corridor as both would have similar capacities. For the purposes of the test, the crossing is connected to the M9 in the vicinity of Junction 2 (Philipstoun). The current junction at this location would be incorporated into the new junction and expanded to allow all turning movements to take place. On the north side, the crossing connects to the A985 at Limekilns and then forms part of the proposed Rosyth Bypass, connecting to the A823(M) at Pitreavie.

This test has been run in two different scenarios. The first assumes that the new crossing is simply added to the existing network and there are therefore two road crossings available to vehicles. This test has been run for the forecast years of 2012, 2017 and 2022.

Although Corridor C is closer to the existing Forth Road Bridge than both Corridors A and B it is still some distance from the existing Forth Road Bridge and once again the results from the TMfS reflect this. In the first model scenario, around 10 per cent of traffic diverts from the existing Forth Road Bridge in 2012. This increases to around 20 per cent in 2022.

The second scenario modelled assumes that the existing Forth Road Bridge is closed to all traffic and therefore only the new crossing is available for cross Forth trips in this area. This latter case is representative of the situation that might exist when the existing bridge has to be closed for maintenance purposes. This has been run for 2012 only. In the second model scenario there is a two per cent increase in daily vehicle kilometres but no increase in daily vehicle hours.

The origins of southbound peak hour traffic on the existing bridge showed that 19 per cent came from the M90 north of Junction 3 (Halbeath) 23 per cent came from the A92 East Fife Distributor Road, 29 per cent came from Dunfermline town, 20 per cent came from the south Fife coastal routes and five per cent from Rosyth. More importantly the destinations of this traffic saw only three per cent heading for the M9 corridor and 19 per cent for the M8 corridor. It is therefore not surprising that this corridor does not adequately cater for traffic movements.

With both crossings available (the first scenario) the daily traffic flow on the existing Forth Road Bridge is envisaged to be around 65,000 in 2012 and in 2022. This is less than current levels and it is therefore concluded that the first objective of maintaining cross-Forth transport links to at least the level of service offered in 2006 is more likely to be met for a crossing in Corridor C than in Corridors A and B.

There is a small increase in distance travelled during closure of the Forth Road Bridge which would result in additional economic costs. In addition there would be consequential environmental impacts from the additional distance travelled.

It is considered that Corridor C would provide better flexibility during periods of major maintenance at the Forth Road Bridge than Corridors A and B. This is purely as a consequence of its greater proximity to the existing crossing. The operation of the new crossing as a high wind diversion route is also better with Corridor C compared with A and B.

There is greater potential to include public transport services into this corridor. This option would lend itself well to providing direct public transport services connecting into Dunfermline and may go some way to improving linkages between Dunfermline and West Lothian. Therefore it is considered that this option performs better than Corridors A and B when measured against the public transport and accessibility objectives. LRT connections are possible within this corridor. However, the southern landfall would require lengthy connections to the proposed Edinburgh tram network, should this be extended across the Forth. Possible network connections for LRT services are shown on Drawing Numbers 49550/N/02 and 03. Alternatively public transport services might be given priority on the existing Forth Road Bridge.

In summary, Corridor C performs better against the transport planning objectives than Corridors A and B.

D4 BRIDGE CROSSING OPTIONS

D4.1 Detailed Summary of Constraints

The Fife coast within the area affected by Corridor C is dominated by areas of mudflats extending from Charleston to the western edge of Rosyth. This area is a SSSI and a SPA and these environmental features represent a major constraint to construction. In addition, there is a protected area around Rosyth dock yard in which entry by unauthorised vessels is prohibited.

Along the south shore, the SSI and SPA areas extend from Blackness through to the western edge of the grounds of Hopetoun House. These grounds extend along the south shore of the Firth for the remaining length of Corridor C. Within the grounds of Hopetoun House, there are several listed buildings.

West of Rosyth, the main navigational channel is located relatively close to the north shore. It leads upstream to the Grangemouth refinery. East of Rosyth there is a separate navigation channel serving Rosyth. Within the central portion of the Firth, the Charlestown Roads is an area designated for the anchorage of small vessels and HM Ships. Adjacent to Abercorn point is a “Foul Area” where vessels are warned not to anchor or fish in the area owing to the existence of an underwater obstruction.

D4.2 Bridge Options (Refer to Drawing 49550/B/03)

Several bridge alignments have been reviewed to determine if it is possible to construct a bridge crossing within Corridor C. Given the extent of environmental constraints, combined with the presence of Rosyth dockyards and Hopetoun House there appears to be only one broadly feasible route for such a crossing. This option (titled CB1) is summarised below. A minor alternative alignment, CB2, is also described below but was discarded as part of the overall assessment as it did not provide any additional benefits than alignment CB1.

The southern landfall of alignment CB1 would be at the junction between the SPA and the grounds of Hopetoun House. This location could help to minimise the overall impact of a crossing on these sensitive areas. Consideration has been given to crossing options just to the east and west of this landfall. In either case, this would lead to major disruption in one area with a reduction in the impact on the other. It should be noted that alignment CB1 passes over the "Foul Area" described earlier. This area would require significant ground investigation to determine the presence of any obstructions that might affect the construction of any bridge foundations.

The northern landfall of alignment CB1 would pass over the SPA immediately west of Rosyth. It should be noted that the alignment also passes close to Rosyth Church, which is a listed building.

In order to minimise disruption to the berths within the Forth, a suspension bridge could be used to span over the navigation channel and provide unhindered area for berthing ships. It has been assumed in this case that it will not be possible to remove these berthing areas for HM ships. A probable bridge option for this alignment is a suspension bridge with a main span of approximately 1800m and side spans of 550m.

Using the available geological data and conjectured bedrock level, it is estimated that the bedrock level at the proposed location for the main towers of such a suspension bridge would be approximately 30-40m below water level. It is considered that this will be practicable for construction as the southern tower of the existing Forth Road Bridge has foundations in a similar depth of water.

Multi-span cable stayed bridge options with spans of 600m were also considered for alignment CB1. These were reliant on it being possible to build a bridge pier in the vicinity of the berthing area for HM ships. However, the depth to bedrock level for the centre tower is likely to be excessively deep for practical foundation construction. It was, in addition, concluded that a cable stayed bridge did not offer any operational benefits over the suspension bridge.

Combining the technical disadvantages for the increased number of piers with the requirement to sustain berths for HM ships, it is likely that a suspension bridge would be selected as the most practical and deliverable bridge type for this corridor. A cable stayed solution should not, however, be ruled out entirely at this stage, as there are a number of significant unknowns regarding some characteristics of the corridor. It is strongly recommended that, if a decision is taken to develop options in this corridor that a preliminary ground investigation be carried out as early as possible.

For alignment CB2, the north landfall would be similar to that of alignment CB1. However, the crossing would be skewed across the Firth in order to avoid the "Foul Area" noted in CB1. This option crosses over the SPA on the south shore and is slightly longer than the equivalent crossing for CB1.

Due to the increased environmental impact and the increase in length and cost of the crossing, alignment CB2 was discarded from any further consideration.

D4.3 Risks Associated with Bridge Crossing in Corridor C

The risks associated with the bridge option in Corridor C are as follows:

- The depth to bedrock level has not been established from site investigation. The information used to derive the current estimate is set out in section 2.3 of the main report. Assumptions have been made regarding the depth to bedrock in establishing the cost. In order to mitigate the risk, ground investigation would be required to establish the actual depth of bedrock. It is possible that the rockhead is at a depth which would allow a feasible, cost effective foundation for a large span suspension bridge to be built.
- Proximity to Rosyth Docks. An allowance has been made in the selection of this alignment to avoid the Rosyth Docks. However, it may be necessary to move the alignment further to the west. If this happened, it would increase the length of the approach viaducts, the overall cost and an increased impact on the SSSI.
- Aerodynamic stability of large span. This risk can be eliminated at the design stage through wind tunnel testing and analysis. There is a small risk that this mayl lead to an increase in the width of the bridge deck and hence an increase in the cost.
- Proximity to Hopetoun House.
- The presence of the oil pipeline on the south shore between Kinneil and Dalmeny represents a risk to construction. The exact location needs to be determined and adequately protected on site for all envisaged loads during and after construction.

D4.4 Costing

A preliminary comparative costing exercise has been carried out for the suspension bridge option in Corridor C. This bridge crossing will be approximately 1.6 times the cheapest crossing option.

D5 TUNNEL CROSSING OPTION (Refer to Drawing 49550/T/01)

D5.1 Tunnel Options

Corridor C is bounded to the west by submarine cables between Blackness and Charlestown. While a bored tunnel could be excavated without affecting these cables, the proposed alignment for a tunnel in Corridor C avoids these areas to reduce the number of third parties affected.

The corridor is bounded to the east by the Rosyth Naval Base. This facility is likely to be sensitive to undermining by tunnelling operations. Therefore the possible tunnel alignment in this corridor avoids this facility.

The preferred tunnel alignment would link the A823(M) Junction at St. Margaret's Stone to Junction 2 of the M9. It would comprise a tunnel from a point close to Pattiesmuir and under Limekilns, reaching the south shore around Abercorn. The tunnel would then rise to a portal between Duntarvie and Carmelhill.

Tunnel work sites and toll plazas could be positioned between Primrose and Pattiesmuir on the north bank and between Duntarvie and Junction 1A of the M9 to the south. This offers the opportunity to work from both ends of the alignment and flexibility in the final toll plaza location. Additional worksites may be required on either shoreline to allow tunnelling to be separated into individual contract packages.

A tunnel beneath the Forth is likely to be sited in sands and gravels which would be under high water pressure. Tunnelling on both shores is likely to be in limestone/sandstone/shales. Dolerite intrusions are less likely to be encountered this far west of Queensferry than would be expected closer to the existing Forth Bridge. This would have to be investigated during design.

The Corridor C tunnel alignment would cross under or adjacent to a number of historic and environmentally sensitive structures. It is anticipated that tunnelling in this area would be in rock and therefore the risk of settlement would be minimised. This alignment would involve approximately 8km of twin-bore tunnel.

D5.2 Costings

A preliminary comparative costing exercise has been undertaken for this tunnel option. This crossing will be approximately 2.4 times the cheapest crossing option.

D5.3 Tunnel Corridor Risks

Tunnelling risks for this corridor will be likely to include the following;

- Faulting or other unforeseen ground conditions that require alternative methods or deviation of the alignments. This may include the presence of dolerite dykes in the river channel deposits.

- Old mine workings. The number of old mine works tends to increase away from the existing bridges. However, the presence of mine workings may require realignment of this option. If extensive workings are present, this may undermine the feasibility of this corridor.

- Lack of available worksites due to environmental constraints. These may include the areas of great landscape value north west of Rosyth and similar areas north east of Junction 2 of the M9.

- Proximity of tunnelling adjacent to Rosyth Docks may require a realignment that would be likely to increase the tunnel length.

- Difficulty siting ventilation plant to avoid discharge close to urban areas. This would be more of a problem at the northern end of the alignment.

D.6 NETWORK LINKAGES

D6.1 Bridge Crossing Option (Refer to Drawing 49550/N/02)

The southern landfall of Corridor C lies to the west of Abercorn. There are two likely options for connecting into the existing road network. The first is to head west towards the existing Junction 2 of the M9. This is an existing westbound facing half diamond interchange. The second is to close the existing Junction 2 and construct a new all movement interchange to its east. The length of the new link from the southern landfall to the M9 would be in the order of 2.5km.

Either of these options appears to be feasible and at this early stage in development, the costs for both have been assumed to be similar. However, the impact of environmental issues and the topography of the sites would be likely to affect the exact placement of the interchange.

For either option, it is anticipated that the A904 to the east of the landfall would require upgrading to dual carriageway standard over a distance of 6.5km. This would be necessary to cater for the level of non-motorway traffic present. Access to the motorway network in both directions would be served by the new all movement interchange. Further traffic modelling work would be needed to ascertain if the level of non-motorway traffic heading west would also result in the need to upgrade the A904 to its junction with the A803, a distance of some 4km.

The northern landfall lies between Limekilns to the west and Rosyth to the east. It is proposed to deliver the tie-in to the existing network by constructing a new 3km dual carriageway link road to the existing junction of the B980/A823/A823(M). The existing junction at this location appears to have been constructed with a view to extending the A823(M) west. A tie-in arrangement would provide a direct link to the M90. It should be noted that the details of the tie in would need to be defined, as the existing roundabout and other junctions on this corridor may need to be reengineered to accommodate new traffic flows.

The estimated construction cost includes the new junction on the M9 and upgrading of the A904 to the east and includes a junction at the A985.

D6.2 Tunnel Crossing Option (Refer to Drawing 49550/N/03)

On the southern side of the Forth, it would be necessary for the proposed tunnel to head either east or west on a large radius curve rather than continuing directly towards the M9 and connecting to it near Philpstoun. This is necessary because a tunnel cannot rise sufficiently quickly to make a junction as this location feasible. As has been stated elsewhere, the gradients of tunnels are limited placing restrictions on some tie-in opportunities. If the tunnel were to sweep to the west, a grade separated junction would be constructed to the west of Junction 2. However, a junction in this location may, impinge on The Binns, a National Trust for Scotland historic site. It may also result in insufficient spacing between the new junction and the existing Junction 3 resulting in insufficient weaving lengths as defined in the DMRB. The westward tie-in also results in a less direct route for motorway traffic heading towards the M8 corridor. However, the westerly route may be more practicable as the topography to the east is such that tying in becomes problematic as both the ground level and the existing M9 generally rise in that direction.

In either case, a grade separated interchange could be provided, offering direct access with the M9 and with linkage to the A904 to allow non-motorway traffic access to the local network. It is anticipated that a 5km improvement of the A904 to the east of the corridor would be required and a 5.5km improvement of the A904 to the west is also a possibility, depending on predicted traffic volumes.

The tunnel would emerge on the north side of the Forth approximately 500m west of the roundabout which currently forms the junction of the B980/A823/A823(M). This is close to an existing railway line. The railway is in cut at this point so it may be possible to bridge over the railway.

The existing roundabout would be amended to become a 4-way roundabout. This would allow motorway traffic to use the A823(M) to access the M90 both north and southwards, whilst non-motorway traffic could use the A823 or the B980 to access the local road network.

Estimated construction cost includes new junctions on the M9 and upgrading of the A904 to the east.

D7 ENVIRONMENT

D7.1 Introduction

This section identifies the environmental constraints for bridge and tunnel options within Corridor C. These are based on international, national and local designations, which have been described previously. The constraints are shown in Figures D.2 and D.3.

This section also discusses potential environmental effects that are not related to statutory designations in this area. These include air quality and community impacts (incorporating visual amenity and noise). Comparisons between corridors have been undertaken on a qualitative basis, concentrating mainly on whether any designated sites are likely to be affected by the proposals. These various designations are listed within Tables D.1 to D.3

The corridor is assessed for its impact on each of:

- ecology;
- landscape;
- archaeology and cultural heritage;
- communities;
- air quality; and
- planning designations.

D7.2 Ecology – Bridge Option

The northern landfall for the Corridor C bridge option crosses the Firth of Forth SPA (also Ramsar and SSSI) at Limekilns in the north and again in the south near Hopetoun. It is possible for the southern landfall to avoid significant loss of the SPA/Ramsar/SSSI designated habitat by careful positioning, but its close proximity to these designated areas may lead to indirect impacts. The inter-tidal habitat at these crossing points is a mix of rocky outcrops, mud and small areas of strandline vegetation. Other designated sites include Philipstoun Muir SSSI, which is situated to the south of the M9. Whilst it lies within Corridor C, the intervening M9 may limit any impact on the site.

The connecting routes to the existing road network could potentially lead to direct impact of two ancient, semi-natural woodland sites north of the Forth and additional areas of ancient woodland south of the Forth. Avoidance of direct loss of habitat may be possible to the north given the small size of the woodlands and their position. However, it is difficult to avoid direct loss of ancient woodland habitat to the south, as this is more extensive. Detailed positioning of the road may be able to minimise the adverse impacts.

The bridge requires approximately 5-6km of new road to link into the existing network. This infrastructure has potential impacts on protected species, particularly to the south as the route passes through the wooded landscape of the Hopetoun Estate which supports scattered large and old trees. The Midhope Burn enters the Firth in this corridor and is likely to be a focus of otter activity with animals taking refuge in the wooded valley and emerging to feed in the Firth.

Fragmentation, isolation and loss of habitat of importance to otters, badgers and bats may require mitigation that could include appropriate bridge design, wildlife bridges and compensatory habitat creation.

D7.3 Landscape – Bridge Option

Nationally Protected Sites

The proposed alignment crosses through the centre of the Hopetoun House Gardens and Designed Landscapes (GDL) area, located to the west of South Queensferry. The reasons for a site qualifying as a GDL may include it being an important cultural or historic resource, an important part of the scenery of Scotland, a wildlife resource or an example of unique artistic talent in garden and landscape design.

Locally Protected Sites

Areas of Great Landscape Value / Areas of Outstanding Landscape Quality: Corridor C passes through two AGLVs, comprising the Broomhall/Belleknowes AGLV in Fife and the Forth Shore AGLV in West Lothian.

Greenbelt: Corridor C does not cross any Greenbelt land.

D7.4 Archaeology and Cultural Heritage – Bridge Option

Scheduled Ancient Monuments

There are a number of SAMs within the corridor and these are stated in Table D.1 below.

Table D.1: Corridor C (Bridge Option) - Scheduled Ancient Monuments

Council Area	Schedule Ancient Monuments
West Lothian	Fort 450m SW of West Lodge, Abercorn
West Lothian	Midhope Castle

Listed Buildings

Historic Buildings are an important part of Scotland's heritage, providing a link to the history and culture of the country. Within Corridor C and potentially affected by the Bridge Option, there are approximately 58 listed buildings. None fall within the centre line of the proposed alignment.

Conservation Areas / Heritage Conservation

There are Conservation Areas in the vicinity of the corridor (e.g. at South Queensferry) there are none within the corridor.

D7.5 Community Impacts – Bridge Option

Effects on communities and scattered dwellings can take the form of impacts on visual amenity, noise and changes in land use or land take. This section identifies the settlements and dwellings that are located on the centre line of Corridor C (Bridge Option) and any other significant settlements or properties within the Corridor that may be affected by it. The Corridor encompasses a number of settlements and scattered dwellings including:

- Abercorn;
- Limekilns;
- Broomhall;
- Pattiesmuir;
- Blackhall; and
- The outskirts of Rosyth.

There are a number of potential receptors associated with Corridor C particularly on the northern shore at Limekilns and Rosyth. The introduction of a bridge would have a permanent effect on visual amenity and the potential exists for noise impacts as a result of localised increases in traffic levels.

D7.6 Air Quality – Bridge Option

Construction of a new crossing of the Firth of Forth would have local and global air quality impacts. Introducing a new road into an area is likely to increase the levels of traffic emissions in that area and, consequently, cause a localised decrease in air quality. In addition construction of an additional crossing is likely to encourage increased road travel which is likely to lead to an increase in global CO_2 emissions. However, the introduction of complementary measures such as enhanced public transport services and HOV in the overall strategy will help to reduce this increase.

D7.7 Planning Designations – Bridge Option

There are no significant housing proposals within the corridor.

D7.8 Environmental Conclusions – Bridge Option

This section summarises the potential environmental constraints present within Corridor C (Bridge Option). The baseline study has found a wide variety of designations, some of which pose more of a constraint to the proposed crossing than others. The Firth of Forth SPA (which is also a Ramsar site and a SSSI) represents the overriding constraint on the northern and southern fringes of the Firth. It is afforded the highest level of protection in the UK. Its designation means that there is a presumption against causing adverse impact unless the development concerned is of overriding public interest and there are no alternatives. In addition to these effects, any impacts to the qualifying bird

species using the Firth outwith the SPA may impact on the ecological integrity of the SPA itself.

Other significant constraints comprise the GDL at Hopetoun House and AGLVs both in Fife and in West Lothian. In addition, some areas of Ancient Woodland and listed buildings would be affected by this alignment.

Construction of a bridge in this area would impact on local communities and on visual amenity. It would also introduce a new noise source to the general area, which may be a significant source depending on the proximity of sensitive receptors within dwellings, etc. The bridge is also likely to reduce local air quality as well as contributing to increased global CO_2 due to overall increases in traffic across the Forth.

D7.9 Ecology – Tunnel Option

A tunnel of the style envisaged for Corridor C would largely avoid direct impact on the Firth of Forth SPA/Ramsar/SSSI, provided that cut and cover construction methods are not used in the inter-tidal zones. The zone of direct impact of the tunnel in Corridor C is not currently known, as the details for its construction have yet to be established.

D7.10 Landscape – Tunnel Option

Nationally Protected Sites

The proposed alignment runs between the western edge of the Hopetoun House GDL and the eastern edge of the House of the Binns GDL, both in West Lothian.

Locally Protected Sites

Corridor C passes through two AGLVs, comprising the Broomhall/Belleknowes AGLV in Fife and the Forth Shore AGLV in West Lothian.

Greenbelt: Corridor C does not cross any Greenbelt land.

D7.11 Archaeology and Cultural Heritage – Tunnel Option

Scheduled Ancient Monuments
There are a number of SAMs within the corridor and these are stated in Table D.2 below.

Table D.2: Corridor C (Tunnel Option) - Scheduled Ancient Monuments

Council Area	Scheduled Ancient Monuments
West Lothian	Fort 450m SW of West Lodge, Abercorn
West Lothian	Union Canal, River Almond to River Avon
Fife	Rosyth Old Kirk

Listed Buildings
There are approximately 46 listed buildings within the route corridor and two are located close to the proposed alignment as stated in Table D.3.

Table D.3: Corridor C (Tunnel Option) – Listed Buildings

Council Area	Listed Building	Category
Fife	Brucehaven	Category C(s)
Fife	Philipstoun House	Category (B)

Conservation Areas / Heritage Conservation
Provision for Conservation Areas is also defined by the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 and although there are Conservation Areas in the vicinity (e.g. at Linlithgow) there are none within the corridor.

D7.12 Community Impacts – Tunnel Option

Effects on communities and scattered dwellings can take the form of impacts on visual amenity, noise levels and changes in land use or land take. This section identifies the settlements and dwellings that are located on the centre line of the tunnel envisaged for Corridor C and any other significant settlements or properties within the corridor.

The south shore of the Corridor includes Craigton and Abercorn. On the north shore, the fringes of Limekilns and Rosyth and scattered dwellings at Pattiesmuir, Brucehaven and Blackhall are also affected.

As this option includes a tunnel, the impacts associated with visual amenity would be limited to the effects resulting from the network tie-ins on the southern and northern shores. It is expected that these would be significantly less than the equivalent Corridor C Bridge Option. However, there is the potential for effects as a result of traffic related noise, although again this would be confined to the sections of the route out with the tunnel.

D7.13 Air Quality – Tunnel Option

Construction of a new crossing of the Firth of Forth would have local and global air quality impacts. Introducing a new road into an area is likely to increase the amount of traffic emissions and therefore cause a localised decrease in air quality. However, there are opportunities to control local air quality through filtering, ventilation and other measures associated with the tunnel. Nevertheless, construction of an additional crossing of the Forth is likely to encourage increased road travel which is likely to lead to an increase in global CO_2 emissions. As with the bridge option, the introduction of complementary measures such as enhanced public transport services and HOV in the overall strategy will help to reduce this increase.

D7.14 Planning Designations – Tunnel Option

There are no significant housing proposals within the corridor

D7.15 Environmental Conclusions – Tunnel Option

This section of the report summarises the potential environmental constraints present within Corridor C (Tunnel Option). The tunnel option would avoid direct impact on the Firth of Forth SPA. However, indirect impacts cannot be assessed until a more detailed design is available. The baseline study has found a wide variety of designations, some of which pose more of a constraint to the proposed crossing than others. The most significant environmental constraints comprise the GDL at Hopetoun House and AGLVs both in Fife and in West Lothian. In addition, some areas of Ancient Woodland and listed buildings would be affected by this option. Assuming that no cut and cover or other excavations are required within inter-tidal zones, direct impacts on the Firth of Forth SPA would be avoided. Construction of a tunnel in this area would impact on local communities less than a bridge option with lower visual impacts and noise levels being created. In addition, there are opportunities to control local air quality although any new crossing of the Forth will increase global CO_2 due to overall growth in traffic across the Forth.

D8 CONCLUSION

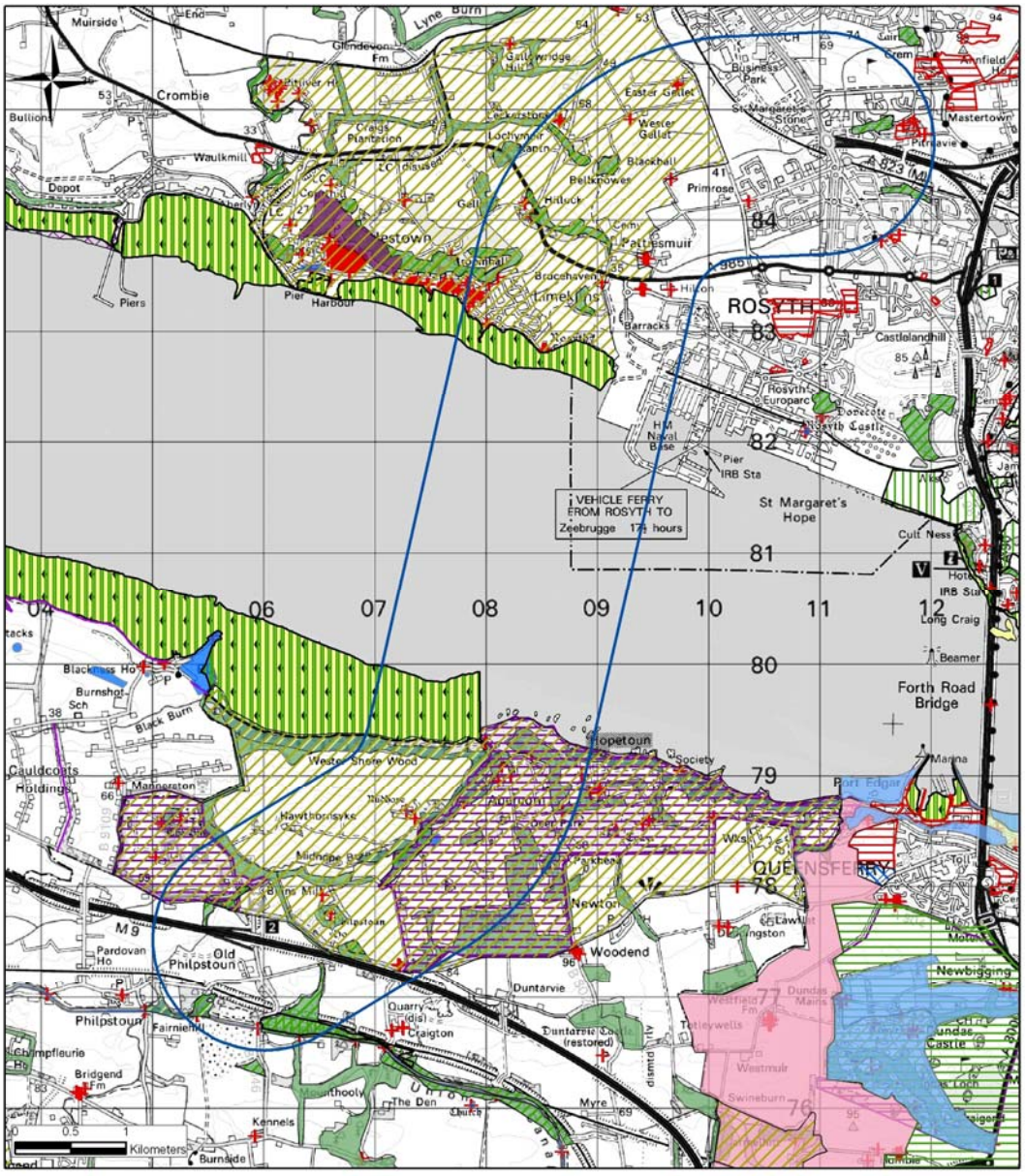
Both a bridge structure and a tunnel can be provided within this corridor. In the case of the bridge it is most likely to be a suspension bridge with a main span of 1800m. A span of this length would be among the longest in the world. The cost of this option is likely to be around 1.6 times the cost of the cheapest option.

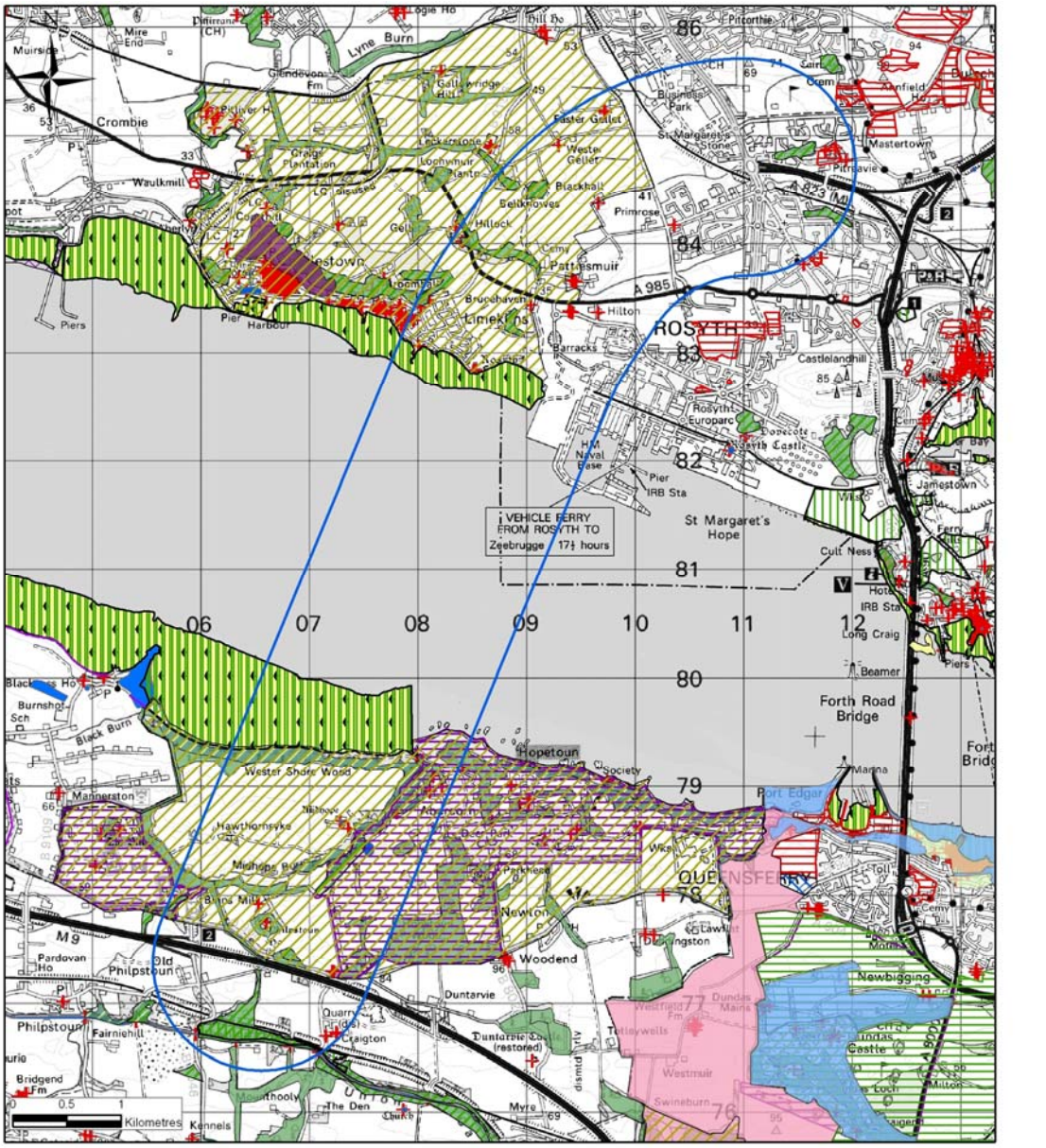
A tunnel option is likely to be around 9km long and would cost around 2.4 times the cost of the cheapest crossing.

This corridor performs better than Corridors A and B against the objectives. However it is still some distance from the existing Forth Road Bridge and its ability to integrate effectively during periods of planned maintenance or during periods of high winds could be limited. This corridor would not serve public transport markets very efficiently although the north landfall would make it suitable for services to Dunfermline. But the existing Forth Road Bridge could provide this function.

The bridge option would potentially impact upon the SPA particularly on the north side, through direct intrusion of piers, etc, and through disturbance of sediments during construction. However, the tunnel option would likely avoid any such impacts, as well as having lower visual and noise impacts. As a consequence, the tunnel is a better option than the bridge when viewed against the environmental objectives of the study.

Figure D2 – Corridor C – Bridge Option

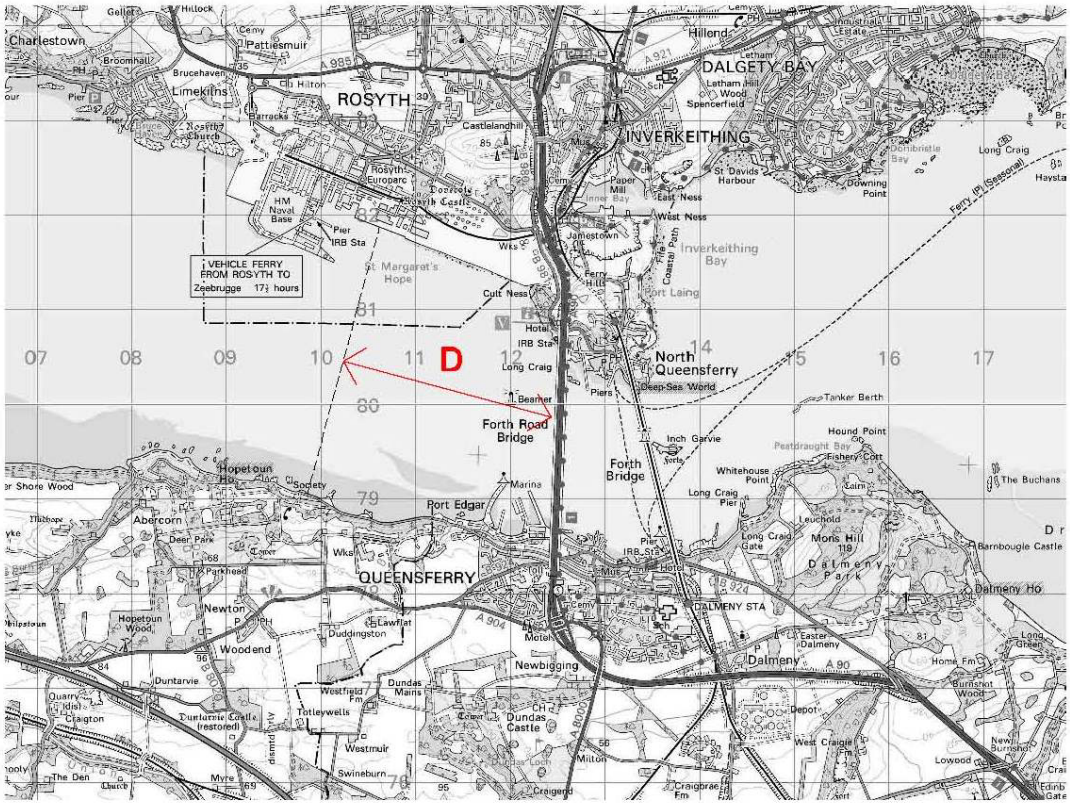




APPENDIX E - ASSESSMENT OF CORRIDOR D

E1 DESCRIPTION OF CORRIDOR

Corridor D is shown on Drawing Number 49550/G/02 and an extract is given below showing the corridor. It is defined on its western edge by the east side of Rosyth and the eastern side of Hopetoun Gardens in the south. The eastern edge is formed by the Forth Road Bridge.



E2 INFLUENCE OF GEOLOGY

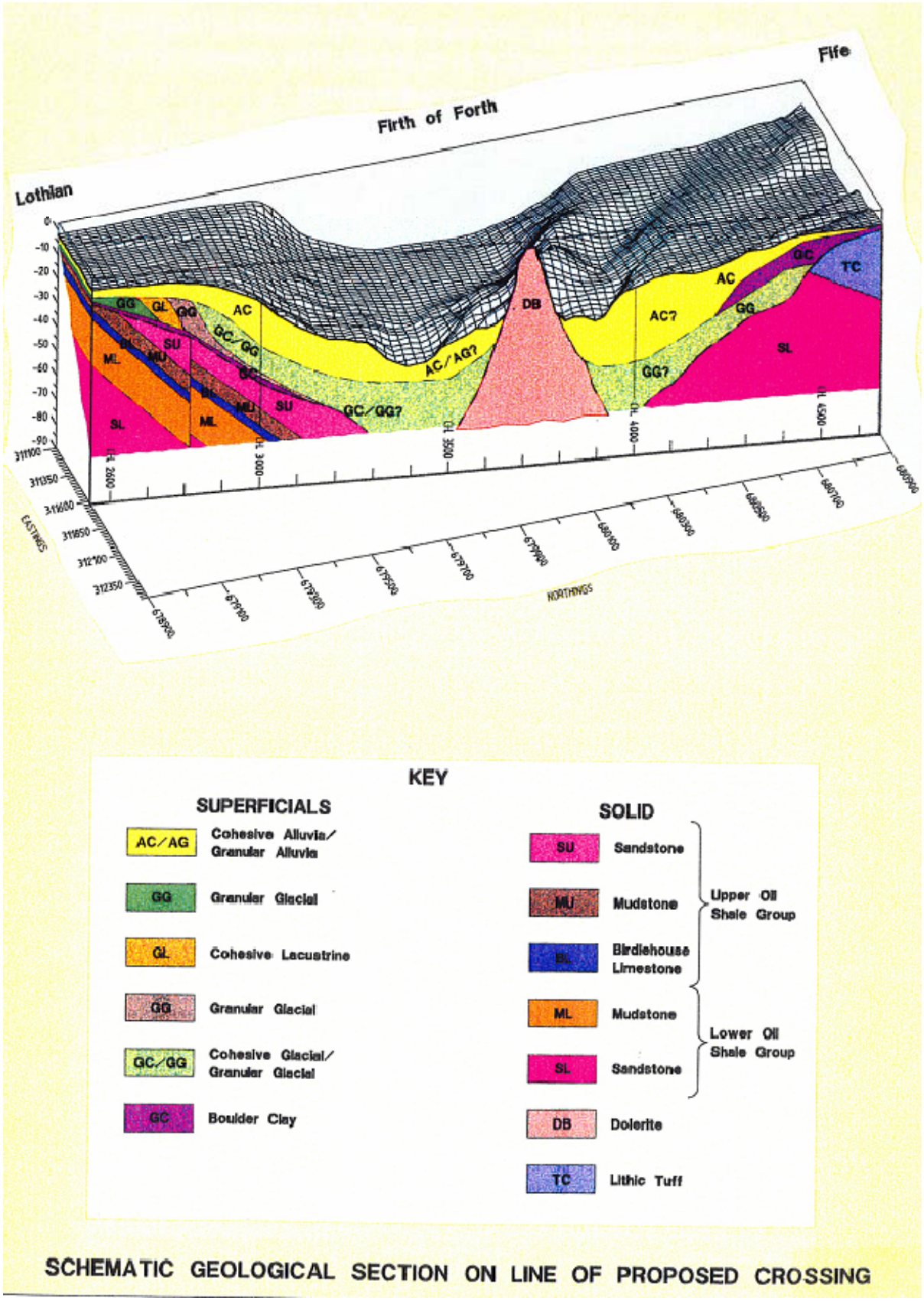
A combined marine ground investigation and geophysical survey was carried out in 1993 to gather further information on the geological sequence and structure beneath the Firth in this area. The investigations were designed only to support feasibility studies and were not intended nor expected to fulfil final design requirements.

The solid geology within the area of the crossing proposed in 1993 consists of sedimentary rocks of the carboniferous limestone series. Interbedded sandstone, silt stones and mudstones of varying quantity make up the sedimentary sequence. Economic minerals, including coal seams, oil shale bands and limestone beds are also present and have been widely exploited, though none are known within the crossing corridor.

In this locality maximum depth to rockhead across the Forth was proven to be about 70m. This was established from a line of relatively closely spaced boreholes traversing from shore to shore. Rockhead founding depths for the two bridge towers of the modelled crossing would stand in the Firth at a minimum depth of about 30m in each case.

A geological cross section was prepared for the Setting Forth Project in the mid 1990's and is presented below in Figure E.1. This was referred to as alignment DB1 and further information on this and other alignments can be found in Section E.4

Figure: E.1 Geological Cross-Section at Alignment DB1 (Setting Forth Option)



SCHEMATIC GEOLOGICAL SECTION ON LINE OF PROPOSED CROSSING

E3 TRANSPORT PLANNING

A test of Corridor D's operational performance has been undertaken using the TMfS. This test is representative of both a tunnel and a bridge option in this corridor. In this test, the envisaged crossing is connected in the south to the M9 west of Junction 1 (M9 Spur). On the north side of the crossing, it connects to the A90/M90 immediately to the north of the existing Forth Road Bridge.

This test has been run in two different scenarios. The first assumes that the new crossing is simply added to the existing network and there are two crossings available to vehicles. This test has been run for the forecast years of 2012, 2017 and 2022.

Given that this corridor is the closest of the five being modelled to the existing Forth Road Bridge, it attracts a significant amount of traffic from the current crossing. In the first model scenario around 17 per cent diverts from the existing Forth Road Bridge in 2012 rising to 23 per cent in 2022.

The second scenario modelled assumes that the existing Forth Road Bridge is closed to all traffic and therefore only the new crossing is available. This latter case is representative of the situation that might exist when the existing bridge has to be closed for maintenance purposes. This test was run for 2012 only.

In this scenario there is a two per cent increase in daily distance travelled. There will be additional economic costs incurred as a consequence of the additional mileage driven. In addition, there will also be environmental impacts from the additional distance travelled.

The origins of southbound peak hour traffic on the existing bridge showed that 19 per cent came from the M90 north of Junction 3 (Halbeath) 23 per cent came from the A92 East Fife Distributor Road, 29 per cent came from Dunfermline town, 20 per cent came from the south Fife coastal routes and five per cent from Rosyth. More importantly the destinations of this traffic saw only three per cent heading for the M9 corridor and 19 per cent for the M8 corridor. It is therefore not surprising that this corridor does not adequately cater for traffic movements.

Clearly this corridor caters better for both the northern and southern traffic origins and destinations than the previous 3 corridors.

With both crossings available (the first scenario) the daily traffic flow on the existing Forth Road Bridge is envisaged to be around 60,000 throughout the 2012 – 2022 period. This is less than current levels and it is therefore considered that the first objective of maintaining cross-Forth transport links to at least the level of service offered in 2006 is more likely to be met than with the previous corridors.

It is considered that this corridor would provide better flexibility during periods of major maintenance on the Forth Road Bridge purely as a consequence of its proximity. The operation of the new crossing as a high wind diversion route when closures are imposed on wind susceptible vehicles makes Corridor D a better prospect compared with A, B and C.

This corridor is closer to the Forth Road Bridge and the Forth Bridge than Corridors A, B and C. Therefore there are greater possibilities available to include public transport services into this corridor. It could include extensions of the proposed Edinburgh Tram Network across into Fife or the expansion of express bus services serving a variety of destinations including Dunfermline to West Lothian. The Forth Road Bridge could also provide priority for public transport. This corridor clearly provides flexibility in this regard.

In summary Corridor D performs well against the transport planning objectives for this study.

E4 BRIDGE CROSSING OPTIONS

E4.1 Detailed Summary of Constraints

Along the north shore, the area immediately to the east of Rosyth is currently being developed. In addition, the area closest to the Forth Road Bridge is a SSSI. On the western side of the corridor at its southern end, the landscaped grounds forming part of Hopetoun House limit corridor choice. Also in this area is a Microsoft Factory, which may add to these limitations. The south shore to the west of Port Edgar is the property of the Scottish Ministers as is the south landing for the preferred bridge option identified during the Setting Forth Project.

East of Rosyth, any bridge crossing would need to span the Rosyth and Grangemouth Navigation Channels. Beamer Rock is located in the central portion of the Firth and forms a natural divider between the two channels. At the time of Setting Forth, the Grangemouth channel was set at a width of 550m. Recent information from Forth Ports PLC confirms that this has not changed since the mid 1990s. The width of the Forth reduces significantly at the site of the Forth Road Bridge and the water depth under the Bridge exceeds 50m.

Several bridge alignments and structural forms were studied during the Setting Forth Project to determine if it was possible to construct a bridge crossing through this zone. These alternatives have been reviewed as part of this report to determine if there have been any significant changes to the design criteria. (Refer to Figure E.2 for locations of the following alignments).

E4.2 Alignment DB1

This alignment is the preferred option adopted in the Setting Forth Project. This will be detailed later in this report.

E4.3 Alignment DB2

On this alignment the new bridge is built immediately to the east and parallel to the existing road bridge. This alignment was considered to allow operation of the two bridges acting as a pair of one-way bridges.

The main engineering implications of such a bridge were summarised as follows. Firstly, due to the close proximity of the new and existing bridges there is a high probability of aerodynamic instability due to turbulence in the wake of the downwind structure. This could occur even at relatively low wind speeds and would be of

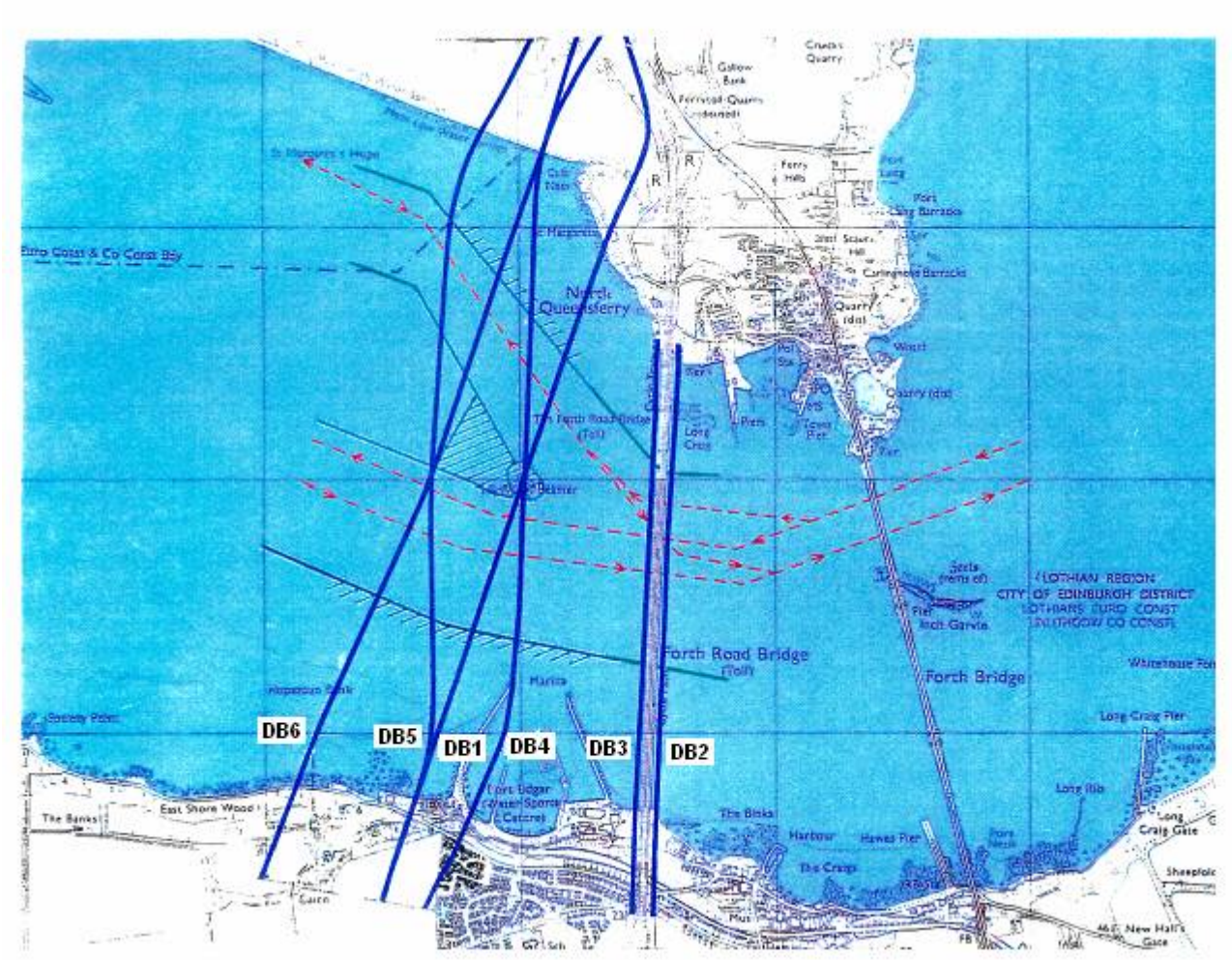
particular concern as the existing bridge would probably require significant structural modifications.

There is also a possibility that, with the two bridges in such close proximity, the foundations of the new bridge could undermine or reduce the capacity of those of the existing bridge.

In addition, safety aspects during construction of the new bridge gave cause for some concern, This is particularly true for the rock cutting through the rock outcrop at North Queensferry. Finally, the reconstruction of the toll plaza required would impose severe restrictions on traffic using the existing bridge.

For the reasons noted above plus concerns over aesthetics and wind shielding the above option was discarded.

Figure: E.2 Alternative Alignments DB1- DB6



E4.4 Alignment DB3

The alignment is very similar to DB2 except the new bridge is built immediately to the west of the existing bridge.

Similar engineering principles to DB2 apply to this alignment. The comments and issues raised above also apply and this alignment is discarded for the same reasons

E4.5 Alignment DB4

The alignment is parallel to and approximately 500m to the west of the existing bridge. It crosses Beamer Rock which could, in this case, be used to provide a foundation for a cable stayed bridge with three towers.

To the north, the approaches for the new bridge pass over St Margaret's Marsh. To the south the bridge approaches would pass through Port Edgar and the housing on the western fringes of Queensferry.

Both a cable stayed bridge or suspension bridge solution are achievable for this alignment. In order to reduce the environmental impact at the Northern landfall it is possible to curve the approach span structures resulting in an increase in cost and complexity. For a cable stayed bridge the curve could be incorporated in the approach spans. For the suspension bridge solution it may be possible to curve the back spans but this would result in these not being suspended. They would need to revert to conventional viaducts. It was estimated that the increase in cost to accommodate curved approaches is approximately 20 to 30 per cent higher than those for the broadly similar alignment DB1.

Due to the increase in cost and higher environmental impact this alignment was discarded.

E4.6 Alignment DB5

This alignment is parallel to and approximately 900m to the west of the existing bridge. Because it is further west than alignment DB4, it avoids the direct impact on Port Edgar and Queensferry.

In order to tie in with the approach road links it would be necessary to curve the approach viaducts to a new bridge on this alignment.

The alignment crosses the two diverging navigation channels at a point which would dictate that one of three options be pursued.;

- A suspension bridge with a main span of 1570m. The length of the suspended backspan would be short (and hence less economical) to allow the curved alignment to be achieved. The top of the towers would be approximately 200m above water level compared to 156m for the existing bridge. However wind shielding would be a major concern for this increased span. It was considered that the width of the deck would need to be increased to ensure aerodynamic stability and it was further estimated that there would be an increase in cost to achieve this of approximately 35 per cent. Combined with the increase in cost of the larger

span and the cost of constructing curved viaducts, the overall cost was found to be approximately 75 per cent higher than alignment DB1.

- A cable stayed bridge with two spans of 785m. At the time of the Setting Forth Project this span length was equivalent to the then record cable stayed single span of the Pont de Normandie but could not be considered for two adjacent cable stayed spans. It was considered at the time, therefore, that the only feasible form for this crossing would be back-to-back suspension bridges. The overall length of suspended structure would be slightly less, but the problems associated with the two span arrangement and the need for an additional tower founded in deep water in the middle of the Firth kept the cost similar to the first option.

- The third option was a three span suspended structure. However this structure was not developed in any detail as it offered little benefits over the first two options.

For the reasons outlined above, this option was not pursued further.

E4.7 Alignment DB6

This alignment is approximately parallel to and 300m west of alignment DB1.

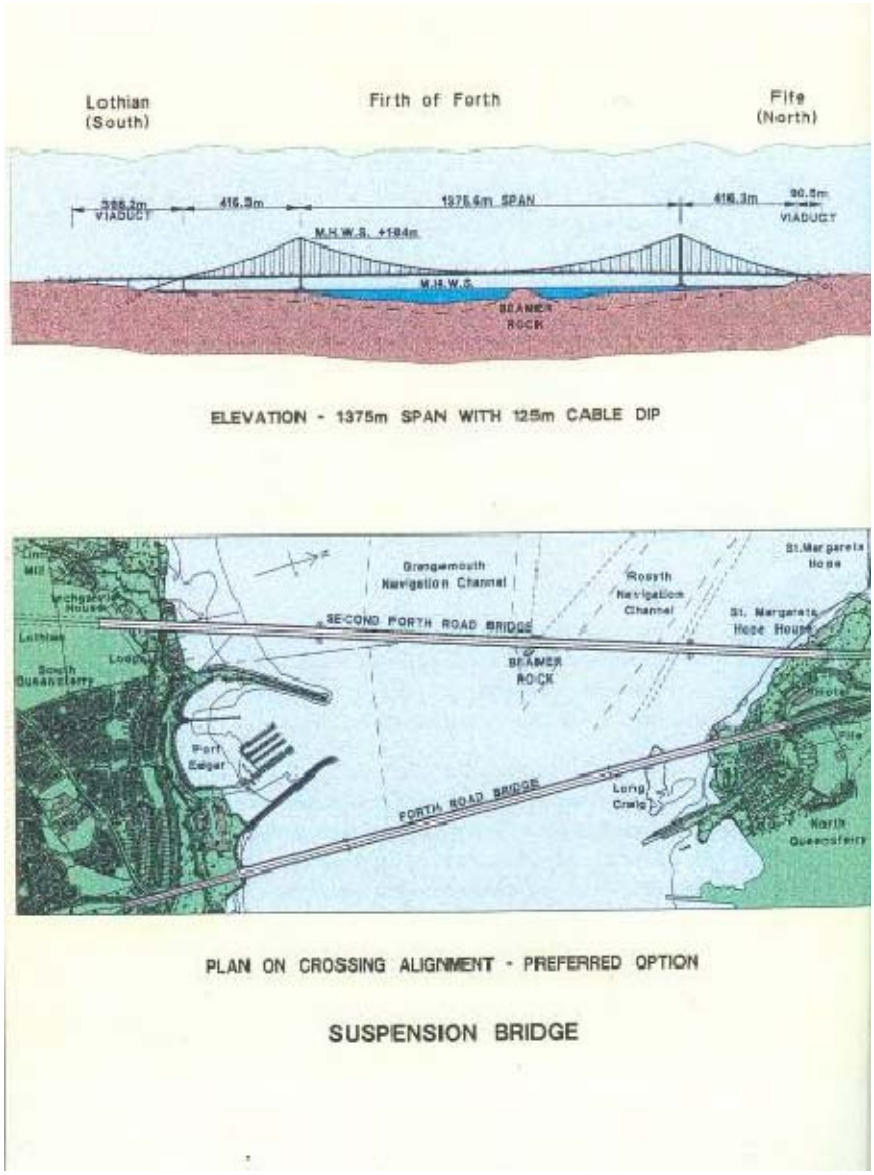
Suitable structures on this alignment are essentially similar to those on Alignment DB5 but of reduced overall length. The bridge could be straight over the full length of the structure, so reducing cost and potential complexity. It was estimated that the cost of a cable stayed solution would be 15 per cent higher than that at DB1. The cost of the suspension bridge option would also be 15 per cent higher than that for DB1. However, as for DB5, if wind shielding were to be added, the width of the deck would need to be increased to ensure aerodynamic stability. This would result in an increase in cost of 25 to 30 per cent over the cost of the DB1 alignment.

The recommended option for a new bridge on this alignment consists of a suspension bridge which would run from the northern end of a toll plaza between Linn Mill and South Queensferry, over Beamer rock to Cult Ness headland between St. Margaret's Hope House and Queensferry Lodge Hotel.

E4.8 Description of Suspension Bridge at Alignment DB1 (Refer to Drawing No 49550/B/04

The overall length of the suspension bridge would be approximately 2.2km with a proposed main span of 1375m and two equal side spans of 416m, see Figure E.3. The proposed cable dip between the tops of the towers and the mid-point of the deck would be 125m.

Figure E.3 – Suspension Bridge



The towers for this arrangement would be 184m high. The preferred arrangement allows the Grangemouth and Rosyth navigation channels in the Firth to be crossed by a single span and avoids the requirement for an anchorage structure for the cables in the Firth.

The towers would be founded on reinforced concrete foundations taken down to the mudstones and sandstones below the soft alluvial and glacial deposits in the Firth.

E4.9 Cable Stayed Bridge Option at Alignment DB1 (Refer to Drawing 49550/B/05)

During the Setting Forth Project, detailed studies were also carried out to look at the cable stayed bridges. Several minor variations in structural form and span arrangements were studied to optimise cost.

The final preferred cable stayed bridge had two main spans of 650m and 600m with the central tower supported on Beamer Rock. The environmental impact of landing a tower on Beamer Rock would need to be examined in detail to determine if the cable stayed bridge is a feasible option.

A comparative costing exercise was carried out at the time of the Setting Forth project and it was estimated that the suspension bridge was the cheaper option. With improvements and advances in technology and strength of cables, it will be extremely important to re-examine these costs in more details as the project proceeds.

E4.10 Costing

A preliminary costing exercise has been carried out to update estimates established during Setting Forth. This bridge crossing has been established as the cheapest crossing of the Firth of Forth. The cost of this option is the baseline against which the other options are based.

E4.11 Risks Associated with Bridge Crossing DB1

This option is based on the Setting Forth work and many of the risks have been reduced through feasibility design work, site investigation, wind tunnel testing and the like. The main risks associated with this option are as follows:

- Impact on SPA on north shore
- The presence of the oil pipeline on the south shore between Kinneil and Dalmeny represents a risk to construction. The exact location needs to be determined and adequately protected on site for all envisaged loads during and after construction.
- Proximity to western edge of Queensferry could lead to objections from residents and local businesses.

E5 TUNNEL CROSSING OPTION

E5.1 Tunnel Option (Refer to Drawing 49550/T/02)

Alignment options in Corridor D are constrained by Rosyth Naval Base and the existing road bridge.

The alignment in this corridor would connect the M90 at Junction 1 to Junction 1A of the M9. The topography around the M90 junction is dominated by Castleland Hill. The alignment in this area may have to be locally increased above 3 per cent to allow it to descend below the water level at the shoreline. The alignment would then sweep west of Beamer Rock to reduce the likelihood of encountering dolerite during tunnelling. The alignment would cross the south shore at Port Edgar and then rise to a portal between Dundas Mains and Junction 1A of the M9.

The alignment between the M90 and the north shore may be predominantly within dolerite. Given the limited space available and the rock conditions, a worksite on the foreshore to the east of Rosyth could be used to tunnel north to Junction 1 on the M90. This could also be used as a launch point for a TBM to excavate south under the Forth.

There are likely to be potential work sites between Dundas Mains and Humbie Farm. Construction could therefore take place from both ends of the alignment. There is limited opportunity for a toll plaza on the north shore and therefore a single southern toll plaza is therefore more likely. Additional worksites may be required on either shoreline to allow tunnelling to be divided into separate contract packages.

A tunnel on this alignment would be approximately 8km long of which approximately 2km would be mined, 6km being constructed by twin bore TBM.

E5.2 Costings

A preliminary comparative costing exercise has been carried out for this tunnel option. This crossing would be approximately 2.7 times the cheapest crossing option.

E5.3 Tunnel Option Risk

Tunnelling risks associated with this option include:

- Ground conditions. This alignment is closer to the known area of dolerite intrusion including Beamer Rock. If encountered, dolerite intrusions may require realignment of this option (which is likely to lengthen it), or may reduce the overall feasibility of this corridor, depending on the extent of the dolerite.

- Mine workings are less likely closer to the existing bridge. However, surface and underground workings may be more likely on the southern approach tunnels.

- Drill and blast mining may be required through the dolerite rocks between the north shore of the Firth and Junction 1 of the M90. Vibration and noise limitations may affect the feasibility of this construction methodology.

E6 NETWORK LINKAGES

E6.1 Bridge Crossing Option (Refer to Drawing 49550/N/04)

The previous study “Setting Forth” indicated that a link road heading south for a distance of approximately 3.5km could be used for this corridor. This would tie into the M9 at a new all movement interchange (provisionally named “Duntarvie”) approximately 2.5km west of the existing interchange with the M9 Spur (Junction 1a). It also contained provision for a new all movement interchange with the A904 (provisionally named “West Echline”), lying approximately 0.75km south of the bridge landfall and 1km west of the Echline Junction on the A90.

This arrangement would allow non-motorway traffic to access and egress the new bridge via the A904 towards Falkirk and the A904/A90 to the M8 Corridor and Edinburgh. It would also allow motorway traffic direct access to the M9 both east and west, thereby offering entry to the motorway network.

The “Setting Forth” study indicated the new crossing tying into the existing A90 at the Ferry Toll Junction. The A90 would be realigned to feed the new crossing, while traffic for the existing bridge would leave the A90 and negotiate the Ferry Toll Roundabout before continuing along the existing crossing. A new northbound merge slip road onto the A90 would need to be constructed. Alternatively the B980 could be upgraded for a distance of 250m until it meets the existing northbound merge. This would allow vehicles to access the M90.

Estimated construction cost includes new junctions on the M9, A904 and the A90 and upgrading of the A904 to the east.

E6.2 Tunnel Crossing Option (Refer to Drawing 49550/N/05)

At the southern end, the topography is such that a tunnel cannot continue on its bearing and tie in with the M9, but must sweep east or west on a large radius to allow a greater distance for the alignment to reach ground level.

If the alignment were to sweep west, a three way grade separated junction could be placed near Duntarvie to provide linkage for motorway traffic. The existing half diamond Junction 2 would be closed and linkage for non-motorway traffic would be provided by tying into the A904. This would result in approximately 5km of upgrading to the A904 to the east and possible further upgrading to the A904 to the west depending on predicted traffic flows.

Alternatively the alignment could sweep to the east. However positioning another junction on the M9 so close to Junction 1a would give significantly reduced weaving lengths. The proposed solution would be to remodel the existing Junction 1a to provide linkage to and from the M9 and M9 Spur, the M9 and the new link road, whilst also providing linkage to the local road network for non-motorway traffic.

A tunnel in Corridor D would emerge in the vicinity of Junction 1 of the M90, Admiralty Interchange. The existing junction would require modification and a number of existing properties in the vicinity of the interchange may require demolition as part of the works. However, connection to the existing network at this location would allow motorway traffic to join the M90, whilst non-motorway traffic could head west on the A985 or east on the A921.

Estimated construction costs include remodelled junctions on the M9 and A90 and upgrading of the A904 and a link to the A8000.

E7 ENVIRONMENT

E7.1 Introduction

This section identifies the environmental constraints for this corridor based on international, national and local designations. These are shown in Figures E.4 and E.5. In addition, potential environmental effects that are not related to statutory designations, such as air quality and community impacts are discussed briefly. Comparisons between corridors have been undertaken on a qualitative basis, concentrating mainly on whether any designated sites are likely to be affected by the proposals. These various designations are listed within Tables E.1 to E.4.

The corridor is assessed for its impact on each of:

- ecology;
- landscape;
- archaeology and cultural heritage;
- communities;
- air quality; and
- planning designations.

E7.2 Ecology – Bridge Option

Corridor D includes a small area of the Firth of Forth SPA (Ramsar and SSSI) in the south and SSSI in the north. However, in the corridor there are options for placing the bridge outside of the SPA to avoid direct impact. The bridge would span the open water of the Firth. There are, therefore, potential issues of disturbance and also the cumulative impact of the proposed bridge with the Forth road and rail bridges on bird movements and utilisation of the open water and intertidal zones out with the SPA boundary.

Corridor D is also within 600m of Long Craig Island which is part of the Forth Islands SPA. This is again designated at an international level for its breeding tern colonies and other breeding seabirds. Construction disturbance on these colonies could be mitigated with seasonal constraints on construction activities.

Three SSSIs occur within the corridor in Fife: Ferry Hills, St. Margaret's Marsh and Carlingnose.

St Margaret's Marsh supports an extensive area of coastal reed bed, salt marsh, tall herb vegetation and scrub. The two main areas of reed bed make up the largest expanses of reed bed in Fife. Together, they represent around three per cent of the Scottish coastal reed bed resource which provides important habitat for uncommon breeding birds.

Ferry Hills SSSI is designated for its geological and biological Importance. The site lies on an exposure of the Great Sill, which has lead to particular soil and exposure conditions. Areas of species-rich, unimproved calcareous and neutral grassland occur on the thin soils overlying the Great Sill. Ferry Loch, a small seasonally-flooded basin mire, is contained within this SSSI.

The Corridor D Bridge Option poses potential impacts on these two SSSIs (through construction impacts, placement of piers, etc., and/or shading). There is already a cutting accommodating the A90 through the edge of Ferry Hill SSSI and St Margaret's Marsh lies immediately adjacent to the A90 indicating that there could be cumulative impacts on both SSSIs.

Non-statutory sites within the corridor include ancient woodlands East Shore Wood on the southern shore and Castlandhill Woods in the northern corridor and several long established plantations.

E7.3 Landscape – Bridge Option

Nationally Protected Sites

The Bridge route for Corridor D passes between but close to the Hopetoun House GDL to the west and the Dundas Castle GDL to the east.

Locally Protected Sites

The route of the bridge option in Corridor D passes through the Forth Shore AGLV in West Lothian.

Corridor D does not cross any Greenbelt land, although it does come close to the western edge of the West Edinburgh Greenbelt.

E7.4 Archaeology and Cultural Heritage – Bridge Option

Table E.1: Corridor D (Bridge Option) - Scheduled Ancient Monuments

Council Area	Schedules Ancient Monuments
Fife	St James' Chapel, North Queensferry
Edinburgh	Old Dundas Castle, comprising castle, sundial and dovecot

Listed Buildings

In the vicinity of the bridge option for Corridor D there are over 100 listed buildings, and there are two listed buildings that lie close to the centreline of the corridor. These are shown on Table E.2.

Table E.2: Corridor D (Bridge Option) Listed Buildings

Council Area	Listed Building	Category
Fife	St Margaret's Hope, Gate Lodge and Gate Piers	Category (B)
Fife	St Margaret's Hope, Walled Garden, Archway on Drive	Category (B)

Conservation Areas / Heritage Conservation

Provision for Conservation Areas is also defined by the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 and although there are Conservation Areas in the vicinity (e.g. at South Queensferry) there are none within the corridor itself.

E7.5 Community Impacts – Bridge Option

Effects on communities and scattered dwellings could take the form of impacts on visual amenity, noise impacts and changes in land use or land take. This section identifies the settlements and dwellings that are located on the centre line of Corridor D and any other significant settlements or properties within the Corridor.

On the south shore the corridor encompasses some scattered rural properties at Dundas Mains. However, the centre alignment of the corridor is located to the immediate west of South Queensferry in an area set aside for housing development. There are already some houses on or close to the centre line of the alignment in this area. On the north shore the alignment crosses above the western fringes of North Queensferry before joining the A90.

There are a large number of potentially sensitive receptors located mainly on the south side of the Firth (i.e. at South Queensferry) that will be sensitive to noise impacts of a new crossing. In addition, there will be significant visual impacts for these receptors. However, for other visual receptors, for example users of the existing bridge the effects on visual amenity and noise resulting from a new bridge adjacent to the existing Forth Road Bridge could be considered less of an issue.

E7.6 Air Quality – Bridge Option

Construction of a new crossing of the Firth of Forth will have local and global air quality impacts. Introducing a new road into an area is likely to increase the amount of traffic emissions and therefore cause a localised decrease in air quality. As this corridor option is close to an existing transport corridor the additive effect of emissions in some locations may be significant. In addition, construction of an additional crossing is likely to encourage increased road travel which is likely to lead to an increase in global CO_2. However the inclusion of the Complementary Measures such as improved public transport services and HOV within the overall strategy will assist in minimising the overall increase.

E7.7 Planning Designations – Bridge Option

Housing

There are two major housing development proposals. These lie very close to the centre line of the Corridor D Bridge Option alignment:

- HSG 6 - Port Edgar (South Queensferry); and
- HSG 2 - Springfield (South Queensferry).

E7.8 Environmental Conclusions – Bridge Option

There are a wide variety of designations, some of which pose more of a constraint to the proposed crossing than others. The Forth Islands and Firth of Forth SPAs (which are also Ramsar sites and SSSI) represent the over riding constraint. These sites are afforded the highest level of protection in the UK and there is a presumption against causing adverse impact to them unless the development is of over riding public interest and there are no alternatives.

However, their locations mean that the option should avoid direct impacts on these areas. Effects on the qualifying bird species using the Firth outwith the SPAs may impact on the ecological integrity of the SPAs themselves.

In addition, the St Margaret's Marsh SSSI lies beneath the likely centre line of the route corridor as does Ferry Hills SSSI. There may be significant direct and indirect impacts on these sites and cumulative impact may also be an issue.

Locally significant constraints comprise the GDLs at Hopetoun House and Dundas Castle and the Forth Shore AGLV in West Lothian. In addition, some areas of Ancient Woodland and listed buildings may be affected by this alignment. The southern end of the alignment also passes through or very close to areas zoned for housing.

Construction of a bridge in this area would impact on local communities and on visual amenity. It would also introduce a new noise source to the area, which may be a significant source depending on the proximity of sensitive receptors within dwellings, etc. The bridge is also likely to reduce local air quality, which may exacerbate the existing air quality situation, as well as contributing to increased global CO_2 due to overall increases in traffic across the Forth.

E7.9 Ecology – Tunnel Option

This corridor includes the same sites as the bridge options discussed above, but there are additional areas listed as long established plantation within the longer corridor, including the access roads that will be required for this option.

E7.10 Landscape – Tunnel Option

Nationally Protected Sites

The tunnel option for corridor D passes between and relatively close to the Hopetoun House GDL to the west and the Dundas Castle GDL to the east.

Locally Protected Sites

Corridor D passes through the Forth Shore AGLV in West Lothian.

Corridor D crosses close to the western edge of the West Edinburgh Greenbelt.

E7.11 Archaeology and Cultural Heritage – Tunnel Option

Scheduled Ancient Monuments

There are a number of SAMs within the corridor and these are listed in Table E.3 below.

Table E.3: Corridor D (Tunnel Option) - Scheduled Ancient Monuments

Council Area	Scheduled Ancient Monuments
Fife	Rosyth Castle Dovecot
West Lothian	Duntarvie Castle
West Lothian	Auldcathie Church
West Lothian	Union Canal, River Almond to River Avon

Listed Buildings

In the vicinity of Corridor D, there are approximately 100 listed buildings but none that lie within the centre line of the corridor.

Conservation Areas / Heritage Conservation

Provision for Conservation Areas is defined by the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 and although there are Conservation Areas in the vicinity (e.g. at South Queensferry) there are none within the corridor itself.

E7.12 Community Impacts – Tunnel Option

Effects on communities and scattered dwellings could take the form of impacts on visual amenity, noise levels and changes in land use or land take. This section identifies the settlements and dwellings that are located on the centre line of Corridor D (tunnel) and any other significant settlements or properties within the corridor.

The corridor encompasses a number of rural properties on the southern shore with the alignment fringing the western outskirts of South Queensferry in an area set aside for housing development. On the northern shore the outskirts of Rosyth and Inverkeithing are located to the west and east of the corridor respectively.

As this corridor is based on the development of a tunnel, the impacts associated with visual amenity would be limited to the effects resulting from the network tie-ins on the southern and northern shores. These would be significantly less than the Route D Bridge Option. There is however, the potential for significant effects as a result of traffic related noise, although again this would be confined to the sections of the route on the links and approaches to the tunnel.

E7.13 Air Quality – Tunnel Option

Construction of a new crossing of the Firth of Forth would have local and global air quality impacts. Introducing a new road into an area is likely to increase the amount of traffic emissions and therefore cause a localised decrease in air quality. However, there are good opportunities to control local air quality through filtering, ventilation and other measures associated with the tunnel. Nevertheless, by construction of an additional crossing of the Forth is likely to encourage increased road travel, which may lead to an increase in global CO_2. However the inclusion of the Complementary Measure such as improved public transport services and HOV within the overall strategy will assist in minimising the overall increase.

E7.14 Planning Designations – Tunnel Option

Housing

There are a number of major housing development proposals within the corridor, although none fall within the centre line. These are shown in Table E.4.

Table E.4: Corridor D (Tunnel Option) – Housing Proposals

Description	Name	Location
Housing Supply for 2006	Roods	Inverkeithing (Fife)
	Service Station Chapel Place	Inverkeithing (Fife)
	Port Street	Inverkeithing (Fife)
	Roman Road	Inverkeithing (Fife)
	Dunfermline Wynd	Inverkeithing (Fife)
	Castlandhill Road	Rosyth (Fife)
	Admiralty Road North	Rosyth (Fife)
	Masonic Lodge	Rosyth (Fife)
	Offices Parkgate	Rosyth (Fife)
	Granville Way 1	Rosyth (Fife)
	Granville Way 2	Rosyth (Fife)
Housing Proposals	Port Edgar - HSG 6	South Queensferry
	Society Road - HSG 7	South Queensferry
	Springfield - HSG 2	South Queensferry

E7.15 Environmental Conclusions – Tunnel Option

This tunnel on this corridor would avoid direct impact on the Firth of Forth SPA. Indirect impacts cannot be assessed until a more detailed design is available.

In addition, the St Margaret's Marsh SSSI lies beneath the likely centre line of the route corridor and there may be significant impacts on this area if, for example, open cut or cut and cover techniques are required.

Locally significant constraints comprise the GDLs at Hopetoun House and Dundas Castle and the Forth Shore AGLV in West Lothian. It is possible that the tunnel could be designed to avoid these. However, some areas of Ancient Woodland and listed buildings may be affected by this alignment, particularly where these lie within the route of any surface infrastructure such as access roads and toll plaza(s).

Construction of a tunnel in this corridor would be likely to impact on local communities to a lesser extent than a bridge option given potentially reduced visual and noise impacts. In addition there are opportunities to control local air quality although any new crossing of the Forth would increase global CO_2 due to overall growth in traffic across the Forth.

E8 CONCLUSION

Both a bridge and a tunnel are feasible options for Corridor D. A suspension bridge and a cable stayed bridge have been examined. The former would have a main span of 1375m and the latter would have spans of 650m and 600m. For the cable stayed bridge, it is envisaged that the central tower would be founded on Beamer Rock. The cost of a bridge in this corridor would be the cheapest of all the crossings examined as part of this study. It is therefore given the cost benchmark of 1.0. This cost is based on a suspension bridge, although it is estimated that the costs of a cable stayed bridge would be broadly similar.

A tunnel crossing in this corridor is likely to be around 7km in length. Due to the existence of a dolerite intrusion on the likely alignment, around 2km of this length would have to be mined instead of created by a bored tunnel. The cost of a tunnel in this location is estimated to cost 2.7 times the cheapest crossing option

This corridor performs considerably better than Corridors A, B and C in terms of its transport planning objectives. Its close proximity to the existing Forth Road Bridge would ensure that it can integrate well with the network to provide maximum flexibility during periods of planned maintenance on either crossing. It would also provide minimum diversion routes for wind susceptible vehicles during high sided vehicle restrictions.

Corridor D in conjunction with the existing Forth Road Bridge, also permits effective use by public transport modes as it is conveniently located to take advantage of existing and proposed public transport services.

In terms of the environment, the bridge does not directly impact on the SPAs. However, there may be indirect impacts through disturbance of sediments during construction. There may, in addition, be disturbance of birds using open water areas outwith the SPA. A bridge here may impact on the St Margaret's SSSI. The tunnel option also avoids any direct impacts on SPAs, but St Margaret's Marsh SSSI, may be affected if cut and cover techniques are used in this area. In addition, in terms of impacts on cultural heritage, landscape, visual impact, noise and local air quality the tunnel option is likely to perform better than the bridge.

Figure F4 – Corridor D – Bridge Option

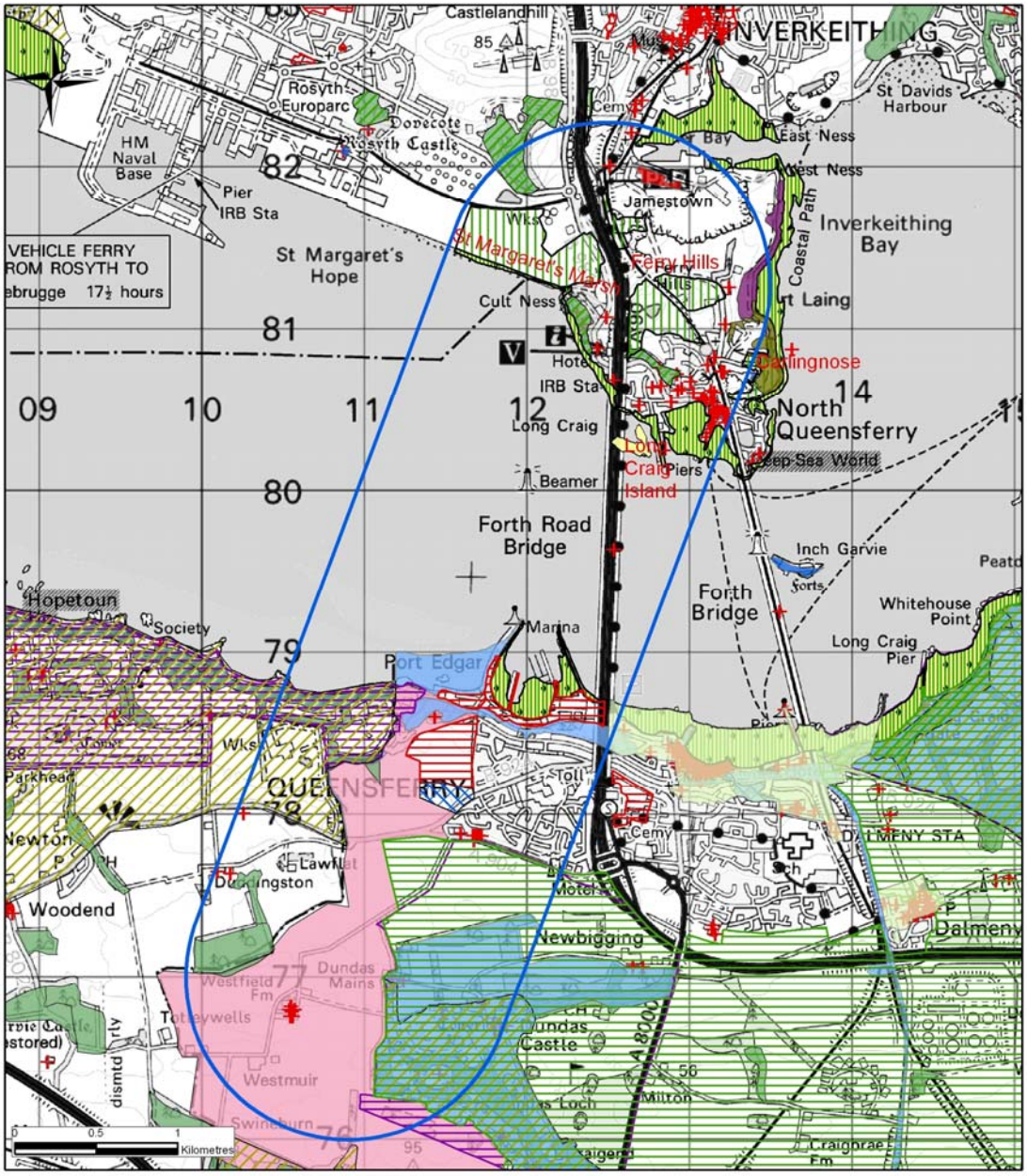
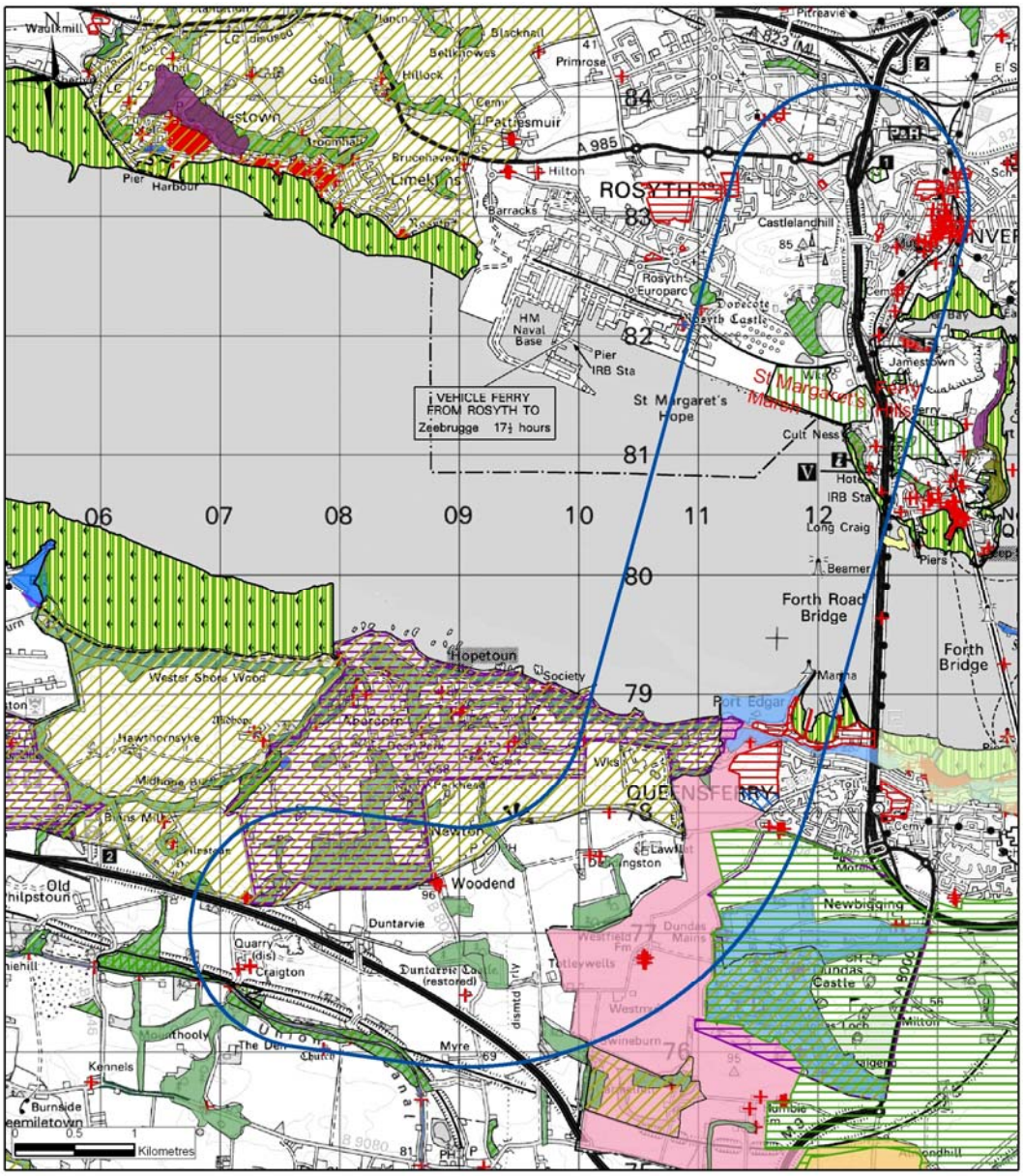


Figure F 5 – Corridor D – Tunnel Options



Key

- Corridor For Tunnel Option D
- Special Scientific Site of Interest (SSSI)
- Special Protection Area (SPA)
- Ramsar
- Listed Buildings
- Scheduled Ancient Monuments
- Conservation area
- Local Nature Reserves
- Country Park
- Gardens & Designed Landscape
- Site of importance for nature conservation (SINC)
- Ancient (of semi-natural origin) Woodland Inventory
- Long-Established (of plantation origin)Woodland Inventory
- Areas of Great Landscape Value
- Countryside policy area
- Housing Supply for 2006 & Housing Proposals
- Strategic Housing Allocations
- Public Parks
- Rights of Way
- Scottish Wildlife Trust Reserve
- Wildlife Site
- Provisional Wildlife Site
- Greenbelt
- Tree Preservation Orders
- Environmental proposals