Forth Replacement Crossing

DMRB Stage 2 Corridor Report

Volume 1 (Main Report and Appendices)

Report on Scheme Development Work: May to August 2008

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Part 3: Environmental Assessment

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Bibliography and Workstream Timeline

As highlighted below, this is the second of a series of reports which cover the project development work carried out during 2008, following completion of the Forth Replacement Crossing Study during 2007.

Ref	Report Title and Work Period	Report synopsis
1.	*Forth Replacement Crossing Study Report 5: Final Report* *Work pre-June 2007.*	Report on work undertaken by Jacobs and Faber Maunsell to June 2007 to assess the options for a replacement crossing which recommended that a cable stayed bridge in 'Corridor D' – a crossing point immediately upstream of the Forth Road Bridge - be taken forward as the best overall performing option.
2.	*Forth Replacement Crossing Route Corridor Options Review:* *Work carried out by Jacobs Arup, January to* *May 2008.*	Report to assess 9 mainline connecting road corridors: three in the Northern Study Area and six in the Southern Study Area. It recommended that two of the northern and two of the southern corridor options be taken forward for further assessment.
3.	*Forth Replacement Crossing DMRB Stage 2 Corridor Report:* *Work carried out by Jacobs Arup, May to August 2008.*	Report on the assessment of the shortlisted corridor options and a supplementary assessment of a variant version of a connecting road corridor in the Southern Study Area. The report recommended that work continue to identify in detail the optimum road improvement within North Corridor Option 1 and South Corridor Option 1.
4.	*Forth Replacement Crossing, Main Crossing (Bridge) Scheme Assessment Report, Development of Options:* *Work carried out by Jacobs Arup, January to August 2008.*	Report on the assessment of options for the outline design of the replacement crossing.
5.	*Forth Road Bridge – Feasibility of Multi-Modal Corridor:* *Work carried out by Jacobs Arup, August to October 2008.*	Report on the feasibility of utilising the existing Forth Road Bridge for non motorised and public transport/light road traffic, including for a potential future guided bus/tram/ light rail facility. The report concluded that this would be a feasible option.
6.	*Forth Road Bridge - Audit of Feasibility of Future Multi-Modal Use - Summary Report* *Work carried out by Faber Maunsell to November 2008*	Independent summary of review on the Jacobs-Arup assessment of the feasibility of utilising the existing Forth Road Bridge for non motorised and public transport/light road traffic, including for a potential future guided bus/tram/ light rail facility. The report concluded that the Forth Road Bridge could, in principle, be adapted for future LRT

Ref	Report Title and Work Period	Report synopsis
7.	*Forth Replacement Crossing, Main Crossing (Bridge) Scheme Assessment Report, Development of D2M Alternatives:* *Work carried out by Jacobs Arup, October to November 2008.*	Report on the assessment of options for a narrower replacement crossing to carry a dual carriageway road with hard shoulders.
8.	*Forth Replacement Crossing, Scheme Definition Report.* *Work carried out by Jacobs Arup, July to November 2008*	The final report on the project planning work carried out during 2008 which provides recommendations of the road connections and the incorporation of the Forth Road Bridge as an integral element of the proposals for use by pedestrians, cyclists, public transport and any future multi-modal facility.

Glossary

'A' weighting dB(A)	The human ear does not respond uniformly to different frequencies. A-weighting is commonly used to simulate the frequency response of the ear.
Above Ordnance Datum (aOD)	The mean sea level at Newlyn (UK) used as a base measurement on Ordnance Survey Maps for contours.
Allocation	A proposal for land for housing, industry or other uses within a Local Plan that identifies a specific area of land to be developed within the time period of the plan.
Alluvium	Sediment deposited by a river.
Ambient Noise	The all encompassing sound at any point in time.
Amenity Value	Defined as the relative pleasantness of a journey and relates in particular to the exposure of pedestrians and others to traffic.
Ancient Woodland Inventory	Aims to list all probable ancient semi-natural woodlands on a county basis together with those woodlands in other ancient categories of lesser woodland nature conservation interest.
Appropriate Assessment	An assessment of likely impacts associated with a development on a European Protected Site. An Appropriate Assessment is required by law under Regulation 48 of the Habitats Regulations (1994), implementing Article 6(3) of the Habitats Directive (92/43/EEC).
Aquifer	A body of rock through which appreciable amounts of water can flow.
Assessment	An umbrella term for description, analysis and evaluation.
Attenuation	Increase in duration of flow hydrograph with a consequent reduction in peak flow.
Baseline	The existing conditions which form the basis or start point of the environmental assessment.
Bathymetric Surveys	The measurement and description of underwater depths taken from the water surface.
Bedrock	Hard rock that lies beneath a superficial cover of soils and sediments.
Benefit to Cost Ratio (BCR)	An indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms.
Bing	A heap or pile of material typically amassed from the by-products of mining. Alternatively referred to as a slag heap.
Biodiversity	Biological diversity, or richness of living organisms present in representative communities and populations.

Brae	A slope or a hillside.
Broadleaved Woodland	An area of woodland with predominantly deciduous tree species (less than 10% coniferous trees in the canopy).
Brownfield	Industrial or commercial property or land that is abandoned or underused and often environmentally contaminated, especially one considered as a potential site for redevelopment.
Bund	An embankment, wall or dam that can be used to minimise noise or alternatively built around an oil tank to contain the contents in the event of spillage.
Calcareous	Refers to a sediment, sedimentary rock, or soil type which is formed from or contains a high proportion of calcium carbonate.
Cetacean	Refers to a group of marine mammals that includes whales, dolphins and porpoises.
Compulsory Purchase Order (CPO)	A legal document giving the government (Scottish Ministers) power to compulsorily purchase the areas of land necessary for the construction of the scheme.
Community Severance	Community severance is defined here as the separation of residents from facilities and services they use within their community caused by new or improved roads or by changes in traffic flows.
Coniferous Woodland	An area of woodland with predominantly coniferous tree species (less than 10% deciduous trees in the canopy).
Contaminated Land	The 'Environment Protection Act 1990' defines Contaminated Land as 'any land which appears to the local authority as to be in such condition, by reason of substances, on or under the land, that significant harm is being caused or there is a significant possibility of such harm being caused; … or pollution of controlled water is being, or likely to be caused'.
Conservation Area	Area of special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance. Designated under section 61 Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997.
Controlled Activity Regulations (Scotland) 2005	Controls all engineering activity in or near watercourses.
Culvert	A metal, wooden, plastic, or concrete conduit through which surface water can flow under or across roads.
Cutting	Typically where part of a hill or mountain is cut out to make way for a road or railway line.

Critical Load	The quantitative estimate of the level of exposure of natural systems to pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur.
Curtilage	The enclosed area of land around a dwelling.
Cut-and-cover	This type of construction involves excavating a trench from the surface, building a tunnel and then backfilling and restoring the ground.
Decibel (dB)	The range of audible sound pressures is approximately 0.00002 Pa to 200 Pa. Using decibel notation presents this range in a more manageable form, 0 dB to 140 dB. Mathematically: Sound pressure Level (dB) = 20 log (p_t / p_0) where $p_0 = 2 \times 10^{-5}$ Pa
Diverge	A link road departing the main carriageway to a subsidiary road or junction.
Do-minimum	Environmental Assessment: The base situation where there are no modifications to the existing road network. May also refer to the minimum modifications, which will necessarily take place in the absence of a proposed scheme. Economic Assessment: The continued operation of the existing road network with permanent closure of the Forth Road Bridge.
Drift Deposits	Drift geology overlying bedrock.
Effect	The result of change or changes on specific environmental resources or receptors.
Element	A component part of the landscape or environment (e.g. roods, hedges, woodlands).
Environmental Impact Assessment (EIA)	The process by which information about the environmental effects of a project is evaluated and mitigation measures are identified.
Environmental Statement (ES)	Document provided by the Developer to the Competent Authority, containing environmental information required under Article 5 of Directive 85/337/EEC as amended.
European Union (EU)	Union of European States.

Eutrophication	A process where water bodies receive excess nutrients that stimulate excessive plant growth. This can lead to effects such as lack of oxygen and reductions in water quality, fish, and other animal populations.
Façade	Measurement made at 1m from façade (façade effect +2.5/3dB(A))
Fen	A wetland that, like a bog, has organic soil. In contrast with bogs, fens receive most of their water from the surrounding groundwater, and consequently can be either acidic or alkaline, depending on the surrounding earth. They support a greater variety of plants than bogs, but are often still dominated by peat.
Fill	Material deposited by man in ground depression or excavated area.
Flight Line	A route, usually along linear or habitat feature, which is used by bats for commuting between landscape features.
Floodplain	Land adjacent to a river, which is subject to regular flooding.
Fluvial Geomorphology	The study of landforms associated with river channels and the sediment processes which form them.
Foraging	Searching for food or provisions.
Fork	An arrangement whereby two roads merge into one or alternatively where a single road splits into two. Typically implemented within a large junction or interchange.
Fragmentation	Breaking up of an organism's habitat into smaller fragments that may vary in size.
Free Flow Junction	A junction allowing traffic to move unhindered between individual roads without formal traffic control (i.e traffic signals, stop lines).
General Traffic	General modes of traffic including private light goods vehicles, vans, lorries and buses.
Geomorphology	The branch of geology concerned with the structure, origin and development of topographical features of the earth's crust.
Geophysical Survey	Geophysical survey is a non-intrusive *pre-construction archaeological evaluation* technique that exploits a variety of physical or chemical characteristics of rocks and soils etc, in an attempt to locate underground features of archaeological interest. Types of geophysical survey include magnetometer survey, magnetic susceptibility survey and resistivity survey.
Glaciofluvial	Pertaining to streams fed by melting glaciers, or to the deposits and landforms produced by such streams.
Glacial Till	Glacial till is that part of glacial drift which was deposited directly by the glacier. It may vary from clays to mixtures of clay, sand, gravel and boulders.
Grade Separated Junction	A junction arrangement that is separated by level from the through carriageway.

Ground Investigation	Exploratory investigation to determine the structure and characteristics of the ground influenced by a development. The collected information is used to establish or predict ground and groundwater behaviour during, and subsequent to, construction.
Groundwater	Water below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.
Habitat	Term most accurately meaning the place in which a species lives, but also used to describe plant communities or agglomerations of plant communities, as used, for example in a Phase 1 Habitat Survey.
Habitats Directive	EC Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.
Heavy Goods Vehicle (HGV)	Vehicles with 3 axles (articulated) or 4 or more axles (rigid and articulated).
HaHa	A boundary barrier that does not block the view e.g. where a retaining wall is built into a ditch.
Hard Shoulder Running	The use of the emergency lane sited to the nearside of the trafficked carriageway for the running of vehicles.
HB Rating/Loading	A loading arrangement defined within bridge design standards comprising a vehicle with 4 axles and 4 wheels per axle.
Hydrodynamic	Of, relating to, or operated by the force of liquid in motion.
Hydrogeology	The branch of geology that deals with the occurrence, distribution, and effect of ground water.
Hydrological	The exchange of water between the atmosphere, the land and the oceans.
Igneous Petrology	The study of igneous rocks, their occurrence, composition, and origin.
Impact	Any changes attributable to the proposed scheme that have the potential to have environmental effects (i.e. the causes of the effects).
Impermeable	Material that does not allow fluids to pass through it.
Incidental Sighting	Casual observation of a plant or animal of one or more species recorded whilst performing a non-relevant ecological survey.
Inter-bedded	Alternating layers of different materials in a section of bedded rocks.
Interchange Link	A connecting road, within a large junction carrying free flowing traffic between one road and another.
L_{Aeq}	Equivalent Continuous Sound Level. A notional steady sound level which would cause the same A-weighted sound energy to be received as that due to the actual, possibly fluctuating, sound level over a given period of time.

Landform	Combination of slope and elevation producing the shape and form of the land surface.
Landscape	Human perception of the land, conditioned by knowledge and identity with a place.
Landtake	Acquired land which is necessary to construct the scheme and associated infrastructure and to undertake the essential environmental mitigation measures.
Leveret	A young hare. They are born fully furred and with their eyes open. They are independent after approximately three weeks.
Listed Building	Building included on the list of buildings of special architectural or historic interest and afforded statutory protection under the 'Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997' and other planning legislation. Classified categories A – C(s).
Littoral Sediment	Sediment moved by waves and currents of the littoral zone: the area between high and low water marks.
Local Road	An A, B or C classified road (non Trunk Road) typically operated by a local authority or council.
Loop	A connecting road, utilising a continuous curve in the connection of two roads within a junction.
Made Ground	Material deposited by man i.e. not natural.
Magnitude	Size, extent, scale and duration of an impact.
Mainline	The principle road being considered, namely the A90/M90 or the road proposed as its replacement.
Merge	A link road accessing the main carriageway from a subsidiary road or junction.
Mitigation	Term used to indicate avoidance, remediation or alleviation of adverse impacts.
Natal Range	The territory in which the young where born.
Native	A species occurring naturally, in its normal geographic range.
Net Present Value	The total present value of a time series of cash flows. It is a standard method for using the time value of money to appraise long-term projects.
Neutral Grassland	Grassland communities that grow on neutral soils (pH 5.5 – 7).
Non Prime Land	Agricultural land of Land Capability for Agriculture (LCA) classes 3.2 to 7.
Northern Route Corridor Options	The route corridor options considered north of the Firth of Forth connecting the proposed replacement bridge to existing roads infrastructure.

Northern Study Area	The area to the north of the Firth of Forth in which preliminary investigations have been undertaken as part of the Forth Replacement Crossing Project.
Open Space	Any land laid out as public parks or used for the purpose of public recreation, or land which is a disused burial ground.
Ornithological	The branch of zoology that deals with the study of birds.
Pedestrians and others	Pedestrians, cyclists and equestrians.
Phase 1 Habitat Survey	This identifies the different habitats that are contained within or make up a site, and the key plant species for each of those habitat types.
Plantation Woodland	Woodland of any age that obviously originated from planting.
Polycyclic aromatic hydrocarbon (PAH)	Any of a class of carcinogenic organic molecules that consist of three or more benzene rings and are commonly produced by fossil fuel combustion.
Prime Agricultural Land	Agricultural land of Land Capability for Agriculture (LCA) classes 1, 2 and 3.
Proposed Replacement Bridge	The cable stayed bridge structure proposed as a replacement to the Forth Road Bridge.
Ramsar Sites	Internationally important wetland identified for conservation under the Ramsar convention (1971).
Regionally Important Geological Sites (RIGS)	Sites designated by regional geological groups on locally developed criteria, currently the most important places for geology and geomorphology outside statutorily protected land such as Sites of Special Scientific Interest (SSSI).
Riffle	A shallow section of a river/stream where the water is fast-flowing over a gravel/cobble substrate.
Riparian Habitat	Natural home for plants and animals occurring in a thin strip of land bordering a stream or river.
Rockhead	The surface representing the top of the solid geological strata, i.e. below any drift deposits.
Roost	Any resting site used by bats including maternity roosts which are used by females and their young, hibernacula which are used during winter hibernation and transitional roosts which may be used at any time.
Runoff	Water that flows over the ground surface to the drainage system. This occurs if the ground is impermeable or if permeable ground is saturated.
Salmonid	Belonging to the salmon family.
Scheduled Ancient Monument (SAM)	A monument which has been scheduled by the Scottish Ministers as being of national importance under the terms of the ‘Ancient Monuments and Archaeological Areas Act 1979’.

Scrub	Climax vegetation dominated by locally native shrubs, usually less than 5m tall.
Semi-improved grassland	Grassland that has been modified by fertilizers, drainage or intensive grazing. Contain less species diversity than unimproved grasslands.
Semi-natural woodland	Woodland that does not obviously originate from planting. The distribution of species will generally reflect the variations in the site and the soil. Planted trees must account for less than 30% of the canopy composition.
Sett	The burrow system of badgers comprising a series of underground tunnels and chambers. There are several categories of sett including a main sett, annexe sett, subsidiary sett and outlier sett.
Severance	The separation of communities from facilities and services they use within their community. Alternatively, in relation to agricultural land, the division of plots of land into separate land parcels, potentially affecting access or creating areas that may be impractical for agricultural use.
Sites of Biological Importance (SBIs)	A non-statutory designation used locally by some local authorities to protect locally valued sites of biological diversity. Also known as Local Wildlife Sites.
Site of Importance to Nature Conservation (SINC)	Non-statutory designation which seeks to protect areas of high wildlife value at a local level.
Sites of Special Scientific Interest (SSSI)	Areas of national importance. The aim of the SSSI network is to maintain an adequate representation of all natural and semi-natural habitats and native species across Britain. The site network is protected under the provisions of Sections 28 and 19 of the Wildlife and Countryside Act 1981 as well as the Amendment Act 1985 and the Environmental Protection Act 1990.
Slip Road	A connector road facilitating access between one road and another.
Souterrain	A late Prehistoric underground chamber usually curvilinear in plan and stone lined with a narrow entrance. The function of such structures is unknown but there are theories that they were used for either storage or ritual.
Southern Route Corridor Options	The route corridors options considered south of the Firth of Forth connecting the proposed replacement bridge to existing roads infrastructure.
Southern Study Area	The area to the south of the Firth of Forth in which preliminary investigations have been undertaken as part of the Forth Replacement Crossing Project.
Special Area of Conservation (SAC)	An area designated under the EC Habitats Directive to ensure that rare, endangered or vulnerable habitats or species of community interest are either maintained at or restored to a favourable conservation status.
Special Protection Area (SPA)	An area designated under the Wild Birds Directive (Directive74/409/EEC) to protect important bird habitats. Implemented under the Wildlife and Countryside Act 1981. Under the Habitats Directive, all SPAs will be proposed Special Areas of Conservation.

Spoil Ground	An area within a body of water, especially in the sea, where dredged material is deposited.
Spraint	Otter faeces.
Strategic Environmental Assessment (SEA)	The process by which information about the environmental effects of proposed plans, policies and programmes are evaluated.
Strategic Transport Project Review (STPR)	A two year review of the Scottish transport network being undertaken by Transport Scotland. It aims to identify and prioritise road, rail and other interventions of national significance, which will be taken forward to improve the network. Through selecting which transport projects of national significance should be progressed, the STPR would also affect regional and local transport networks.
Superficial Deposits	The youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back 1.8 million years from the present.
Surface Water Hydrology and Flood Risk	The study of water on or near the land surface.
Susceptibility	The ability to accommodate change arising from the proposed road without adverse effect.
Sustainable Drainage Systems (SUDS)	A sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques.
Threshold	The minimum intensity or value of a signal etc that will produce a response or specified effect.
Turbid	High concentrations of suspended sediment and particulates in the water column.
Vernacular	Refers to a type of architecture which is indigenous to a specific time or place.
Visual envelope	The visual envelope illustrates the extent of potential visibility to or from a specific area.
Vulnerable groups	Children, elderly and disabled.
Water Framework Directive (WFD)	Wide-ranging European environmental legislation (2000/60/EC). Addresses inland surface waters, estuarine and coastal waters and groundwater. The fundamental objective of the WFD is to maintain “high status” of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least “good status” in relation to all waters by 2015.

Water Quality	The chemical and biological status of various parameters within the water column and their interactions, for example dissolved oxygen, indicator metals such as dissolved copper, or suspended solids (the movement of which is determined by hydrological process and forms geomorphological landforms).
Wildlife and Countryside Act 1981	Principal mechanism for wildlife protection in the UK.

Abbreviations

AADT	Annual Average Daily Traffic
AEP	Annual Exceedance Probability
AGLV	Area of Great Landscape Value
aOD	above Ordnance Datum
AOLQ	Area of Outstanding Landscape Quality
AONB	Areas of Outstanding Natural Beauty
APIS	Air Pollution Information System
AQMA	Air Quality Management Area
ASAI	Area of Special Agricultural Importance
ATC	Automatic Traffic Count
BAP	Biodiversity Action Plan
BCR	Benefit to Cost Ratio
BDMLR	British Divers Marine Life Rescue
bgl	Below ground level
BGS	British Geological Survey
BRT	Bus Rapid Transit
BS	British Standard
BSBI	Botanical Society of the British Isles
BTO	British Trust for Ornithology
CAR	Water Environment (Controlled Activities) (Scotland) Regulations 2005
CEC	City of Edinburgh Council
CEH	Centre for Ecology and Hydrology
CIRIA	Construction Industry Research and Information Association
CO_2	Carbon Dioxide
CoCP	Code of Construction Practice
CoPA	Control of Pollution Act (1974)

CPO	Compulsory Purchase Order
CROW	Catalogue of Rights of Way
CRTN	Calculation of Road Traffic Noise
CSM	Conceptual Site Model
DCLP	Dunfermline and the Coast Local Plan
DEFRA	Department of the Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
EEC	European Economic Committee
EIA	Environmental Impact Assessment
ELSP	Edinburgh and the Lothians Structure Plan
EPA	Environmental Protection Act (1990)
ERM	Environmental Resource Management
EU	European Union
FC	Fife Council
FEH	Flood Estimation Handbook
FETA	Forth Estuary Transport Authority
FFSP	Finalise Fife Structure Plan
FLCA	Fife Landscape Character Assessment
Forthtag	Forth Tunnel Action Group
FRS	Fisheries Research Services
FSP	Fife Structure Plan
GDPO	General Development Procedure (Scotland) Order 1992
GIS	Geographic Information System
GL	Ground level
GPZ	Groundwater Protection Zones
ha	Hectare

HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
HOV	High Occupancy Vehicle
HLA	Historic Landscape Assessment
HSE	Health and Safety Executive
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IIAA	Information to Inform an Appropriate Assessment
IPPC	Integrated Pollution Prevention and Control
ITS	Intelligent Transport System
JNCC	Joint Nature Conservation Council
Km	Kilometres
Kph	Kilometres per hour
Kv	Kilovolt
LAQM	Local Air Quality Management
LCA	Landscape Character Assessment
LCT	Landscape Character Type
LLCA	Local Landscape Character Area
LLG	Lower Limestone Group
LNR	Local Nature Reserve
LRT	Light Rapid Transit
LWIC	Lothian Wildlife Information Centre
MAC	Mobility and Access Committee
MLURI	Macaulay Land Use Research Institute
NAQS	National Air Quality Strategy
NBN	National Biodiversity Network
NCR	National Cycle Route

NMRS	National Monuments Record of Scotland
NMU	Non Motorised User
NNR	National Nature Reserve
NTS	National Transport Strategy
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NPF	National Planning Framework
NPF2	National Planning Framework 2
NPPG	National Planning Policy Guidelines
NPV	Net Present Value
NSCA	National Society for Clean Air
OFD	Oil Fuel Depot
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PAN	Planning Advice Note
PM_{10}	Particulate Matter
POL	Proudman Oceanographic Laboratory
PPC	Pollution Prevention and Control
PPG	Pollution Prevention Guideline
PVB	Present Value of Benefits
PVC	Present Value of Costs
PWS	Private Water Supply
RCAHMS	Royal Commission on Ancient and Historical Monuments of Scotland
RIGS	Regionally Important Geological Sites
RSI	Roadside Interview Survey
RSPB	Royal Society for the Protection of Birds

RTA	Road Traffic Accident
RWELP	Rural West Edinburgh Local Plan
R720	A radius applied in the design of the horizontal or vertical geometry of the route corridor. For example R720 corresponds to a radius of 720 metres.
SAC	Special Area of Conservation
SAM	Scheduled Ancient Monument
SBI	Site of Biological Importance
Scotways	Scottish Rights of Way and Access Society
SCURL	Scottish Confederation of University and Research Libraries
SEA	Strategic Environmental Assessment
SEERAD	Scottish Executive Rural Development Department
SEPA	Scottish Environment Protection Agency
SEStran	South East Scotland Transport Partnership
SG	Strathclyde Group
SHEP	Scottish Historic Environmental Policies
SINC	Site of Importance to Nature Conservation
SLF	Scottish Landowners Federation
SMC	Scottish Monument Consent
SNH	Scottish Natural Heritage
SOC	Scottish Ornithological Club
SPA	Special Protection Area
SPP	Scottish Planning Policy
SRPBA	Scottish Rural Property & Business Association (formerly SLF)
SSSI	Site of Special Scientific Interest
STAG	Scottish Transport Appraisal Guidance
STPR	Strategic Transport Projects Review
SUDS	Sustainable Urban Drainage Systems
SWI	Site of Wildlife Importance

SWT	Scottish Wildlife Trust
TACTRANS	Tayside and Central Scotland Transport Partnership
TLLCA	The Lothian Landscape Character Assessment
TMfS	Transport Model for Scotland
TPO	Tree Preservation Order
UKBAP	UK Biodiversity Action Plan
USA	Updating and Screening Assessment
vkt	Vehicle kilometres travelled
VOC	Volatile Organic Compound
VWT	Vincent Wildlife Trust
WCA	Wildlife and Countryside Act
WDCS	Whale and Dolphin Conservation Society
WeBS	Wetland Bird Survey
WFD	Water Framework Directive
WLC	West Lothian Council
WLLP	West Lothian Structure Plan
WoSAS	West of Scotland Archaeological Service
WWF	World Wide Fund for Nature

Introduction

- On 14 February 2007, the Scottish Government gave its approval for the promotion of a replacement crossing over the Firth of Forth between the Lothians and Fife.
- This announcement was made in response to ongoing concerns over the condition of the Forth Road Bridge. Intrusive investigations undertaken on behalf of the Forth Estuary Transport Authority (FETA) indicate that the main suspension cables supporting the bridge have suffered a significant loss of strength through corrosion.
- The lack of certainty over the future of the Forth Road Bridge led to the commissioning of the Forth Replacement Crossing Study by Transport Scotland. An initial sixty five options were considered by the study. A sifting exercise eliminated options which did not meet National/Regional Planning Objectives or study objectives and those which were not technically feasible. The completion of this exercise resulted in five crossing locations being progressed for further assessment.
- A detailed review of the remaining options identified a short-list of three corridors that were considered suitable for further study. These were taken forward for Scottish Transport Appraisal Guidance (STAG) Part 1 Appraisal. This appraisal measured the performance of each of the corridors available establishing the preferred form of crossing in each, a bridge or a tunnel. A development of the options recommended by the STAG Part 1 Appraisal led to a STAG Part 2 Appraisal being undertaken where each of the options carried forward was assessed against the Government's transport appraisal objectives. Following the completion of this assessment and following a period of public consultation, the Cabinet Secretary for Finance and Sustainable Growth announced, on 19 December 2007, that the Forth Replacement Crossing would be a Cable Stayed Bridge in Corridor D upstream of the Forth Road Bridge.
- In January 2008, Jacobs Arup Joint Venture was appointed as consultant to Transport Scotland to manage the delivery of the Forth Replacement Crossing Project.
- Throughout 2008, Jacobs Arup has been engaged in the development of all aspects of the Forth Replacement Crossing Project, considering the proposed replacement bridge itself and the roads infrastructure associated with it.
- This DMRB Stage 2 Corridor Report considers the roads infrastructure aspect of the project only. Its purpose is to establish the preferred route corridor north and south of the Firth of Forth.
- For the purposes of DMRB Stage 2 assessment, the route corridor options discussed within this report have been considered over the full extents of the Forth Replacement Crossing study area. As a part of the next stage of design and assessment, further detailed consideration shall be given to the form and function of the junctions required and the extent of the optimal road infrastructure improvement provided within the preferred corridor. The developing design shall also reflect future consideration of the use of the Forth Road Bridge.

JACOBS ARUP

Forth Replacement Crossing

DMRB Stage 2 Corridor Report

Part 1: The Scheme

Report on Scheme Development Work: May to August 2008

Contents: Volume 1 (Main Report and Appendices)

Part 1: The Scheme

1. Scheme Background

1.1 Forth Replacement Crossing

1.1.1 This is the DMRB Stage 2 Corridor Report for the Forth Replacement Crossing, one of twenty nine strategic transport interventions identified within the Strategic Transport Projects Review (Section 1.2) which reflect the diversity of the country whilst addressing the issues that currently exist or are expected to exist in the future.

1.1.2 The Forth Replacement Crossing is a fast tracked component of the Strategic Transport Projects Review, and will ensure that this key river crossing is maintained, protecting the economies of Fife, Edinburgh and beyond from the disruption stemming from the uncertainty over the long term viability and operation of the Forth Road Bridge and concerns over the current operational characteristics of the surrounding road network.

1.2 Strategic Transport Projects Review

1.2.1 The Strategic Transport Projects Review (STPR) is a body of work which has been undertaken by Transport Scotland to define the most appropriate strategic investments in Scotland's national transport network between 2012 and 2022.

1.2.2 The review, which commenced in the summer of 2006, has culminated in the publication of a report detailing a portfolio of land based interventions to be taken forward, further developing Scotland's transport infrastructure to meet the demands of the 21st century.

1.2.3 The focus of the STPR is in the identification of those interventions that most effectively contribute towards the Government's purpose of increasing sustainable economic growth. Its objective led evidence based approach enables transport issues to be appraised and addressed effectively. This system of assessment is comparable to that implemented in STAG and ensures that the national priorities of a Wealthier and Fairer, Healthier, Safer and Stronger, Smarter and Greener Scotland are met and that investment is targeted on the measures which will best assist in the promotion of Scotland's sustainable economic development.

1.2.4 The outcome of the STPR is based on a tiered system of investment structured around the following priorities:

- Maintaining and safely operating existing assets;
- Promoting a range of measures, including innovative solutions that make better use of existing capacity; and
- Promoting targeted infrastructure improvements where these are necessary, affordable and practicable.

1.2.5 Through the implementation of this approach, best use can be made of the limited resources available, ensuring that new infrastructure is identified only after other interventions have been appraised and considered.

1.2.6 This has been achieved through:

- Looking at what the picture of transport might look like in the future and identifying the issues this creates in terms of achieving the Government's Purpose;
- Allowing a range of interventions, covering a variety of modes across Scotland, judged comparatively on their merits; specifically in terms of their ability to address these issues and support the Government's Purpose; and

- Prioritising investment to meet the Government's Purpose and the complementary objectives of the National Transport Strategy.

1.2.7 Taking the above into consideration, the Forth Replacement Crossing forms a key piece of infrastructure investment in Scotland.

1.2.8 The Forth Replacement Crossing Study (Section 1.3), undertaken as part of the STPR, was brought forward as a result of the findings relating to the deteriorating condition of the Forth Road Bridge and considered potential options in the provision of a replacement crossing of the Firth of Forth.

1.3 Previous Studies: Forth Replacement Crossing Study

1.3.1 The Forth Replacement Crossing Study was commissioned by Transport Scotland in 2006. Its purpose was to identify the scope, form and function of any potential replacement to the Forth Road Bridge. Reports 1 to 5 containing the findings of the study were published in 2007.

1.3.2 The need for a replacement crossing was justified for the following reasons:

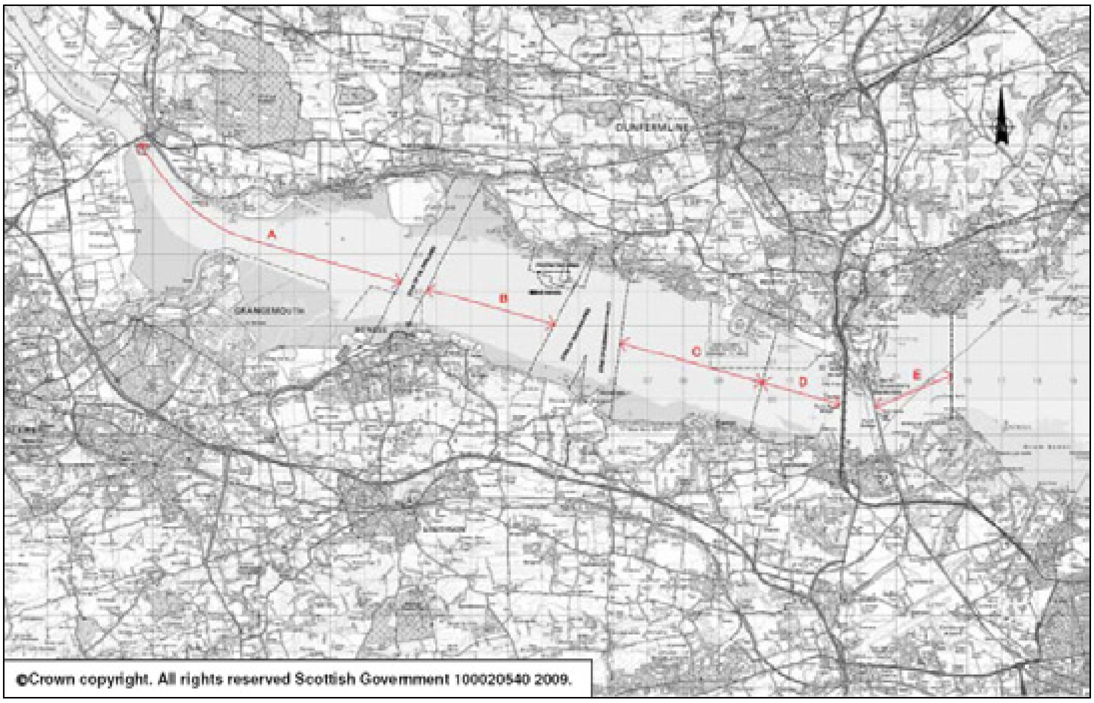
- There is a lack of certainty that the existing Forth Road Bridge is going to be available in the future; and
- The repair/refurbishment of the existing crossing has too severe a set of impacts on the east of Scotland economy if it were to be closed (or even severely restricted) for a period of time.

1.3.3 In the consideration of potential locations for a replacement crossing of the Firth of Forth, a list of sixty five potential options was generated. These options were assessed through an initial sifting process with options which did not satisfy national and regional policy objectives or the study objectives being eliminated. The study objectives are reflected within the Forth Replacement Crossing Project's Scheme Objectives (Section 1.4). Following this initial sifting exercise the provision of a replacement crossing was considered in the following corridors:

- A – Grangemouth
- B – East of Bo'ness
- C – West of Rosyth
- D – East of Rosyth/West of Queensferry
- E – East of Queensferry

1.3.4 Each of these corridors is displayed graphically in Figure 1.1.

Figure 1.1: Forth Replacement Crossing Study – Replacement Crossing Corridors



1.3.5 The suitability of each corridor was assessed for a bridge or tunnel crossing. Through the undertaking of this work, it was established that Corridors A and B did not meet the scheme objectives and as such these were rejected. Corridors C, D and E were deemed to perform well against the objectives and were taken forward for assessment as part of a STAG Part 1 Appraisal, with both bridge and tunnel options being considered for all three corridors.

1.3.6 The outcome of the STAG Part 1 Appraisal resulted in bridge options for Corridors C and E being set aside from further consideration due to their impact on Forth Special Protection Areas (SPA). Corridors C (Tunnel), Corridor D (Bridge or Tunnel) and Corridor E (Tunnel) were taken forward for further development.

1.3.7 Through the undertaking of a STAG Part 2 Appraisal, the principal factors differentiating the options were implementation, environmental impact and economic efficiency.

1.3.8 The recommendation from this appraisal was that Corridor E should not be considered further on the basis of environmental impact, the implementation risk associated with tunnels, the impact of drill and blast construction techniques on Hound Point (Marine Terminal for Oil Export), mine workings and the high costs involved.

1.3.9 Of the remaining tunnelling options, little difference was reported between Corridors C and D, both taking the same time to construct and requiring similar budgets. Corridor D did perform marginally better economically but considering the replacement crossing as a whole, the provision of a tunnel did not provide the same level of service as a bridge, with access being restricted to motorised vehicles only.

1.3.10 The Forth Replacement Crossing Study concluded that a cable stayed bridge in Corridor D was the best overall performing option in relation to:

- Cost - It is significantly cheaper than the tunnel options;
- Construction Programme - It can be delivered quicker;
- Construction Risk - It has fewer risks associated with its construction; and
- Economics - It has the best Benefit to Cost Ratio (BCR).

1.3.11 The findings of the Forth Replacement Crossing Study were the basis for the decision of the Scottish Government, announced by the Cabinet Secretary for Finance and Sustainable Growth on 19 December 2007.

1.4 Scheme Objectives

1.4.1 The scheme objectives outlined from the conception of the Forth Replacement Crossing Study are as follows:

- to maintain cross-Forth transport links for all modes to at least the level of service offered in 2006;
- to connect to the strategic transport network to aid optimisation of the network as a whole;
- to improve the reliability of journey times for all modes;
- to increase travel choices and improve integration across modes to encourage modal shift of people and goods;
- to improve accessibility and social inclusion;
- to minimise the impacts of maintenance on the effective operation of the transport network;
- to support sustainable development and economic growth; and
- to minimise the impact on people, and the natural and cultural heritage of the Forth area.

1.4.2 In relation to the above, the announcement made by the Cabinet Secretary for Finance and Sustainable Growth on 19 December 2007 stated that the Forth Replacement Crossing Project would provide:

- a replacement for the Forth Road Bridge;
- a dual carriageway with hard shoulders and facilities for cyclists and pedestrians;
- provision for future multi-modal public transport;
- connecting roads to allow greater choices and opportunities to West Lothian and to protect and promote development areas in Fife.

1.4.3 The provision of a multi-modal transport corridor will allow future consideration to be given to the introduction of Light Rapid Transit (LRT), Bus Rapid Transit (BRT), guided buses or trams in future years if required.

1.5 Sustainable Development Objectives

1.5.1 One of the main commitments made in the scheme objectives is *'to support sustainable development and economic growth'* making it clear that the concept of sustainability is at the heart of the Forth Replacement Crossing Project.

1.5.2 Transport Scotland recognises this and has set out a sustainable development policy for the scheme including a vision statement and objectives. The vision is **'***To deliver an iconic project that respects the environment, contributes to the regional and Scottish economy and facilitates efficient public transport whilst minimising disruption to the community and reducing the use of non-renewable resources during its construction and throughout its life'*.

1.5.3 Beneath this vision is a set of sustainable development objectives and the reader is referred to Transport Scotland's 'Forth Replacement Crossing Sustainable Development Policy' for more details about the objectives and how these relate to the Government's Sustainable Development Strategy for Scotland and the Scottish Government's 'New Purpose and Strategic Objectives'.

1.5.4 Consideration of sustainable development will form a core thread throughout all the activities of the project team and stages in the project life cycle including:

- Project design and appraisal;
- Preparation of contract documents, and hence tenderers' designs (dependent on procurement method);
- Tender evaluation;
- Construction;
- Maintenance;
- Operation

1.5.5 An overview of the sustainability assessment that underpins the DMRB Stage 2 assessment is presented in Part 5 of this report.

1.6 DMRB Stage 2 Corridor Report Methodology

1.6.1 This DMRB Stage 2 Corridor Report has been prepared in accordance with TD37/93, Scheme Assessment Reporting, of the Design Manual for Roads and Bridges (DMRB).

1.6.2 The purpose of this report is to document the factors that have been taken into account in the provision of alternative route corridor options, considering the scheme objectives and the engineering, environmental, traffic and economic advantages/disadvantages and constraints associated with each.

1.6.3 To demonstrate the possible extent of the improvements (subject to further scheme definition work), preliminary layout drawings have been prepared and are included within Volume 2 of this report.

1.6.4 It should be noted that whilst the proposed replacement bridge forms a significant element of the Forth Replacement Crossing Project, its alignment has no effect on the route corridor option selection process, its position and bearing having been fixed to allow the effective design of associated roads infrastructure.

1.6.5 For the purposes of DMRB Stage 2 assessment, the route corridor options discussed within this report have been considered over the full extents of the Forth Replacement Crossing study area. As a part of the next stage of design and assessment, further detailed consideration shall be given to the form and function of the junctions required and the extent of the optimal road infrastructure improvement provided within the preferred corridor. The developing design shall also reflect future consideration of the use of the Forth Road Bridge.

Report Layout

1.6.6 Whilst following the format prescribed in TD 37/93 to the extent practicable, the volume of information presented within this DMRB Stage 2 Corridor Report dictates that it be presented in the following chapters:

- Part 1: The Scheme
- Part 2: Engineering Assessment
- Part 3: Environmental Assessment
- Part 4: Transport and Economic Assessment
- Part 5: Sustainability Assessment
- Part 6: Southern Route Corridor - Combination Option Assessment
- Part 7: Conclusion and Recommendation
- Part 8: Appendices

2 Existing Roads Infrastructure Conditions

2.1 Forth Road Bridge

2.1.1 The existing Forth Road Bridge forms a key link in Scotland's transport network, providing a strategic connection between the north of Scotland and the central belt through its connection of the M90 to the M9 via the A90 and M9 Spur. The existence of the bridge is also key to the east of Scotland economy, providing a vital connection between Edinburgh, the Lothians and Fife. The roads infrastructure connections associated with the Forth Road Bridge are shown in Figure 2.1 and Figure 2.2 (Volume 2).

2.1.2 Operated by the Forth Estuary Transport Authority (FETA), the Forth Road Bridge opened in 1964. Throughout its life, the bridge has seen a marked increase in traffic growth and now carries in excess of 65,000 vehicles per day, equating to 70% of all cross-Forth traffic (Kincardine Bridge and the Forth Rail Bridge providing alternative routes and means of travel).

2.1.3 Although well maintained throughout its 44 year existence, the bridge now shows signs of deterioration, climatic influences, weather and increased traffic volumes all having an effect. Several major maintenance projects have been undertaken over the years to replace, strengthen and improve elements of the structure in an attempt to mitigate against deterioration, traffic loading, shipping impact and design code changes.

2.1.4 The work undertaken has included the strengthening of viaduct box girders, wind bracing and main towers, hanger replacement and the construction of pier defences. Maintenance of the main suspension cables has also been undertaken, with regular external inspections having been carried out.

2.1.5 The first internal inspection of the main cables was undertaken in 2004, significant corrosion being discovered with the loss of strength being interpreted at between 8% and 10%. Predictions indicate that unchecked, the rate of corrosion experienced could lead to the factor of safety falling below the acceptable value of 2.0 by 2014. Live load restrictions would be necessary to cater for such a situation. HGV restrictions would be implemented in the first instance with further restrictions being required within five years to extend the life of the bridge.

2.1.6 In assessing the current rate of deterioration, acoustic monitoring equipment has been installed on the bridge, capable of detecting the failure of cable strands.

2.1.7 In addition, FETA in association with their consultants Faber Maunsell and Weidlinger Associates are now attempting to arrest the deterioration of the main cables through the implementation of a dehumidification system. The system will be completed in 2009. Its success will not be known until 2012 when a further inspection will be carried out.

2.1.8 As part of the second inspection undertaken during 2008 the main cables were deemed to have lost 10% of their strength. FETA and their consultants are optimistic that the rate of deterioration is slower than first thought, with load restrictions considered now likely to be deferred until sometime between 2017 and 2021.

2.2 Existing Road Network - North of Firth of Forth

2.2.1 The A90/M90 forms a strategic link between the Forth Road Bridge and the north, providing access to the substantial population centres of Dunfermline, Perth, Dundee, Aberdeen and Inverness (via the A9). Figure 2.1 (Volume 2) details the existing road network north of the Firth of Forth on approach to the existing bridge.

2.2.2 Departing the Forth Road Bridge northbound, the route is designated as the A90, a dual two lane all purpose road with discontinuous hard shoulders. Passing to the west of North Queensferry, the route descends through Ferry Hills into a valley where the grade separated Ferrytoll Junction provides access to Rosyth, Rosyth Dockyard, Inverkeithing and North Queensferry via Ferry Toll Road, the B980 and B981. Also providing access and egress to Ferrytoll Park and Ride, the junction is situated at existing ground level, the A90 being carried on structure above.

2.2.3 Continuing north, the A90 passes to the east of Castlandhill, significant rock cuttings being associated with the route through this section. Cresting in the vicinity of Dunfermline Wynd Overbridge, the route then descends toward Admiralty Junction. Through this section, a hard shoulder is provided to the northbound carriageway. The opposing southbound hard shoulder is utilised as an auxiliary lane providing access to North Queensferry, Inverkeithing and Ferrytoll Park and Ride via Ferrytoll Junction.

2.2.4 The grade separated Admiralty Junction, provides further access to Rosyth and Inverkeithing from the A90 via the A985 and A921. Utilising a roundabout to maintain traffic movements, the junction is situated beneath the mainline carriageway, the A90 being carried on structure.

2.2.5 North of Admiralty Junction, the route classification changes from dual two lane all purpose road to dual two lane motorway with the implementation of the M90. From a low point west of Belleknowes Industrial Estate, the route climbs out of a valley on viaduct towards Masterton Junction, where free flow links provide access to Rosyth and Dunfermline via the A823(M). The Fife Circle Railway line is also located in the area, passing beneath the viaduct on an east to west bearing.

2.2.6 Beyond Masterton, the route continues to rise passing to the southeast of Middlebank on a north easterly orientation. Continuing to climb through an area of predominant farmland, the route sweeps north towards Halbeath Interchange where access is provided to east Fife via the A92 and Dunfermline via the A907.

Design Standards

2.2.7 The geometry of the existing A90/M90 does not conform to the current design standards laid out in the DMRB. Of particular concern is the section of carriageway between Admiralty and Masterton where traffic merging and diverging between the junctions has a very short weaving distance within which to manoeuvre. Additionally the horizontal geometry of the mainline contains substandard elements in proximity to Admiralty Junction and Masterton Junction, horizontal radii of up to two design speed steps below desirable minimum being experienced.

2.2.8 **Road Pavement**

2.2.9 Following an initial review of available pavement information, the predominant pavement type on the trunk road network has been found to be of flexible composite construction, where a bituminous layer of material overlays a cementitious base.

2.2.10 The surface condition of the pavement has been found to be performing generally well, the lengths of carriageway requiring improvement coinciding with the areas that require strengthening through an overlay of bituminous material.

Structures

2.2.11 The structures associated with the existing A90/M90 route corridor are detailed in the following paragraphs. The location of each is presented in Figure 4.5 (Volume 2).

2.2.12 The structures referencing system used in this report has been developed in tandem with the optioneering work undertaken to date on the Forth Replacement Crossing Project. It is a stand alone project based referencing system which does not correlate with any existing system that might be in use by Transport Scotland or BEAR Scotland Ltd.

Structures 177-4 and 177-5

2.2.13 Structures 177-4 and 177-5 carry the A90 over Ferrytoll Junction. Both are single span structures with maximum span lengths of 11.89 metres with no skew. They are both insitu reinforced concrete portal frame structures of integral construction founded on spread footings.

Structures 177-10, 177-11 and 177-12

2.2.14 Structure 177-10 is the Ferrytoll railway tunnel located beneath the A90 at Ferrytoll Junction. It is a single span structure with an overall length of approximately 95 metres comprising a maximum span of 4.95 metres at a varying skew.

2.2.15 Structure 177-11 carries the B980 over the Inverkeithing South Junction – Rosyth Dockyard Branch Line Railway close to the entrance/exit to the tunnel. It is a single span structure with a maximum span of 5.88 metres at a skew of 23°.

2.2.16 Structures 177-10 and 177-11 are concrete arch structures of integral construction. Structure 177-10 is founded on spread footings, however the foundation type for Structure 177-11 is unknown.

2.2.17 Structure 177-12 is located adjacent to structure 177-11. It is a single span structure with a span of 20.5 metres at a skew of 23°. It is a precast beam and slab structure of integral construction founded on spread footings and was built circa 2006.

Structure 170-1

2.2.18 Structure 170-1, Dunfermline Wynd Overbridge, carries Dunfermline Wynd over the A90. It is a three span structure with an overall length of 71.8 metres between abutment centres with a maximum span length of 32.2 metres. It comprises a haunched concrete deck with a voided suspended main span. The piers are founded on spread footings and the abutments on piles.

Structures 182-8 and 182-9

2.2.19 Structures 182-8 and 182-9 are retaining walls at Admiralty Junction on the northwest and southeast sides respectively. The northwest wall has a maximum retained height of 5 metres and an overall length of 86 metres. The southeast wall has a maximum retained height of 6 metres and an overall length of 135 metres. Both are of mass concrete construction with masonry facing and are founded on spread footings.

Structures 182-6 and 182-7

2.2.20 Structures 182-6 and 182-7 carry the M90 over Admiralty Junction. Both are single span structures with spans of 15 metres at skews of 30° and 30.5° respectively. Both are reinforced concrete portal frame structures with Structure 182-7 founded on spread footings and Structure 182-6 on bored concrete piles.

Structure 182-5

2.2.21 Structure 182-5 is a concrete arch culvert which carries the Brankholm Burn beneath the M90. It is a single span structure with a clear span of 3.6 metres at a skew of 10°.

Structure 182-1

2.2.22 Structure 182-1, Masterton Viaduct, carries the M90 over the A823 comprising twin decks running parallel to each other in a generally north / south direction. The decks are supported on a common reinforced concrete pier at each intermediate support and on full height abutments at each end.

2.2.23 It is a ten span structure which is approximately 183m long overall and has a span arrangement, running south to north, of 14.9m (over railway), 7 x 18.6m, 19.2m and 18.75m at a skew of 4°.

2.2.24 Generally, the decks comprise of reinforced concrete slabs. However, the southern end span of each deck over the railway consists of steel/concrete filler beam construction comprising steel castellated beams with a precast bottom concrete flange which acts as permanent formwork to concrete infill between and over the beams.

2.2.25 The existing Masterton Viaduct is capable of sustaining 40 tonne assessment loading and accidental vehicle loading in both longitudinal bending and shear. The HB rating of the structure ranges from 20 units based on longitudinal bending to 35 units in shear for the 3 span intermediate sections.

Structure 182-2

2.2.26 Structure 182-2 carries the M90 northbound off slip road to the A823(M) over the Fife Circle Railway Line. It is a single span structure with a span of approximately 50 metres at a skew of 50°.

Structure 182-13

2.2.27 Structure 182-13 carries the B981 over Inverkeithing East Railway Junction.

Structure 182-14

2.2.28 Structure 182-14 is located beneath the A823(M) on the approach to Masterton Junction.

Structures 182-3 and 182-4

2.2.29 Structure 182-3 carries the A823(M) to M90 southbound slip road over the M90. Structure 182-4 carries Masterton Road over the M90. Both are single span structures, Structure 182-3 having a span of 36 metres at a varying skew and Structure 182-4 having a span of 38.4 metres. Both structures are reinforced concrete portal frame structures founded on spread footings.

Structure 171-2

2.2.30 Structure 171-2, Duloch Overbridge, carries the B916 Aberdour Road over the M90. It is a two span structure with an overall skew length of 30.9 metres (between abutment centres) with a maximum span length of 14.9 metres at a skew of 10°. It is a variable depth concrete slab structure founded on a reinforced leaf pier and full height abutments, all founded on spread footings.

Structure 000-1

2.2.31 Structure 000-1, Calais Muir Overbridge, carries a side road over the M90 close to Calais Muir Wood. It is a four span structure with an overall skew length of 52.3 metres (between abutment centres) with a maximum span length of 14.8 metres. It is an insitu reinforced concrete slab structure founded on leaf piers and bankseat abutments, all founded on piles.

Existing Traffic Patterns

2.2.32 The principle links north of the Firth of Forth are:

- M90/A90 Inverkeithing – Fraserburgh Trunk Road;
- A921 forming an east - west route between Kirkcaldy and Admiralty Junction (M90 Junction 1);
- A985 Kincardine – Rosyth Trunk Road forming an east - west route between Admirality Junction (M90 Junction 1) and Kincardine;
- A823/A823(M) Pitreavie Spur Trunk Road forming an east - west route between Masterton Junction (M90 Junction 2) and Dunfermline;
- A907/A92 East Fife Regional Road forming an east - west route between Kirkcaldy and Dunfermline via Halbeath Interchange (M90 Junction 2a/M90 Junction 3).

2.2.33 Annual Average Daily Traffic (AADT) volumes for 2006 at selected points along the M90 north of the Firth of Forth are summarised in Figure 2.3 (Volume 2). This indicates that the most heavily trafficked section of the M90 north of the Firth of Forth is between Masterton (M90 Junction 2) and Admiralty (M90 Junction 1), and that the majority of traffic joining or leaving the M90 within the northern study area does so at the Halbeath Interchange (M90 Junction 2a / M90 Junction 3).

2.2.34 Further evidence of the traffic volumes using the junctions and ramps at M90 Junction 2a and M90 Junction 3 is provided by the 2008 Automatic Traffic Count (ATC) data provided by Transport Scotland, as summarised in Table 2.1. Of particular note is the tidal traffic flow to/from the A92 and east Fife via M90 Junction 2a.

Table 2.1: M90 Link Flows (2008) – Northern Study Area

Count Location	Direction	Time Period	
		AM (0800-0900)	PM (1700-1800)
Halbeath – A92 ramps (M90 Junction 2a)	NB	400	1000
	SB	1200	1100
M90 (south of M90 Junction 2a)	NB	2500	3400
	SB	2200	2100
M90 (between Admiralty & Ferrytoll)	NB	2700	3600
	SB	2500	2700

Note: Units are total vehicles, to the nearest 100. Data derived from Transport Scotland Automatic Traffic Counters.

2.2.35 As shown in Table 2.1, the southbound AM flow on the A92 at M90 Junction 2a is higher than the equivalent northbound flow of vehicles during the same time period. With tidal traffic flows, which are commonly represented by commuting trips, a reverse of the AM flows is generally found in the PM period. The northbound flow does increase at this location during the PM, however the overall trend is for southbound flows to be higher than northbound flows during both peaks. Elsewhere, southbound flows are broadly similar in both the AM and PM periods, northbound flows being higher in the PM.

Congestion

2.2.36 Congestion is present in the form of southbound queues approaching the Forth Road Bridge, predominantly in the AM peak. This queue can extend for several kilometres in normal conditions. Close spacing of junctions along the road approaching the bridge contributes to the formation and extension of queues in the morning as traffic attempts to join the mainline from Masterton, Admiralty and Ferrytoll Junctions.

Road Accidents

2.2.37 The incidence of road accidents between 2000 and 2007 throughout the northern study area is presented in Figure 2.4 (Volume 2). Accident locations are colour coded to indicate the severity of personal injury. All data is based upon reported road accidents on major road links provided by Fife Council. The accident data covers both the scheme corridor and the main alternative routes.

2.2.38 Whilst there are concentrations of accidents around the junctions on the M90 and A90, the majority of accidents are slight injury accidents. The main concentrations of accidents, in the study area, are in and around Dunfermline town centre, rather than in the scheme corridor or alternative routes. These roads and hence accident rates are not seen as directly relating to the scheme and accident rates in this area are unlikely to be significantly affected by the scheme.

2.2.39 Table 2.2 presents the distribution of reported road accidents by injury severity across the northern study area, compared to the same distribution for Scotland as a whole. This shows the northern study area to have lower than expected fatal injuries, but higher than expected severe injuries. No fatal injuries have been recorded on the M90/A90.

Table 2.2: Accidents by Severity (2000-2007), Northern Study Area (Fife Council)

Severity	Northern Study Area		Scotland	
	No. of Accidents	Percentage (%)	No. of Accidents	Percentage (%)
Fatal	8	1.2%	2,227	2.0%
Severe	130	19.0%	19,837	17.9%
Slight	546	79.8%	88,810	80.1%
Total	684	100.0%	110,924	100.0%

Note: Scotland-wide data sourced from: *'Key Road Accident Statistics 2007' – 'Table 1: Injury Road Accidents by Severity, 1970-2007'* (2008), The Scottish Government. This includes provisional 2007 data.

2.2.40 Table 2.3 presents recent annual changes in accidents by severity. This shows an increasing trend in the total number of recorded accidents since 2001. Within this trend, however, there are some year-on-year declines in 2002, 2004, and 2005.

Table 2.3: Number of Accidents by Severity (2000-2007), Northern Study Area

Severity	Year						
	2001	2002	2003	2004	2005	2006	2007
Fatal	1	0	2	1	1	1	2
Severe	15	14	15	24	16	26	20
Slight	56	44	100	85	79	86	96
Total	72	58	117	110	96	113	118

2.3 Existing Road Network - South of Firth of Forth

Features

2.3.1 South of the Forth Road Bridge, the A90 and the M9 Spur form the principle traffic links to Edinburgh and the central Scotland motorway network.

2.3.2 Departing the Forth Road Bridge, the A90 as a dual three lane all purpose road provides access to all routes with local access connectivity to the A8000 and A904 provided through Echline Junction. The junction arrangement itself takes the form of a grade separated roundabout, bridge structures allowing the A90 to pass beneath.

2.3.3 South of Echline Junction, the A90 climbs with existing ground topography towards Scotstoun Junction. The junction, which was opened in conjunction with the M9 Spur Extension in 2007, provides direct access between the Forth Road Bridge and the M9, a lane drop and lane gain arrangement maintaining access to the A90 and the north of Edinburgh.

2.3.4 The M9 Spur, encompassing the M9 Spur Extension, provides a dual two lane motorway between Scotstoun Junction and M9 Junction 1a. Running parallel to the Falkirk-Fife Railway Line between Scotstoun Junction and Humbie Overbridge, the route replaces the A8000 as the principle route between the M9 and the Forth Road Bridge.

2.3.5 In its provision, a number of new structures and culverts have been constructed, crossings being situated at Dolphington Burn, Milton Farm Road and the B800. Existing crossings of the Falkirk – Fife Railway Line and the B9080 have been retained from the original M9 Spur link to the A8000.

2.3.6 The provision of access between the M9 and M9 Spur is facilitated through a free flow junction arrangement at M9 Junction 1a. Providing M9 east facing connectivity only, a loop connects the M9 to the M9 Spur northbound, a simple slip road arrangement providing connectivity between the M9 Spur and the M9 eastbound.

2.3.7 Given the lack of connectivity to the M9 westbound, traffic west of M9 Junction 1a wishing to access the Forth Road Bridge is required to travel via alternative routes, the A904 providing access to Bo'ness and M9 Junction 2 located north of Winchburgh.

2.3.8 Access and egress to/from the west of Edinburgh is provided through Newbridge Roundabout, situated to the south of M9 Junction 1a. A number of key routes converge on this junction, the A8 providing access to the west of Edinburgh, the A89 providing access to West Lothian and the M8 providing access to Glasgow and the A720 Edinburgh City Bypass.

Design Standards

2.3.9 Given the recent upgrades to highways infrastructure south of the Forth Road Bridge, the design standard issues applicable to the route revolve around junction provision to the M9.

2.3.10 The existing M9 Junction 1a loop arrangement providing access to the M9 Spur from the M9 is operated with an advisory 30mph speed limit. Furthermore, the slip road arrangement connecting the M9 Spur to the M9 eastbound is in close proximity to the links associated with Newbridge Roundabout, an auxiliary lane being provided to improve provision for weaving movements.

Road Pavement

2.3.11 Following an initial review of available pavement information, the predominant pavement type on the trunk road network has been found to be of flexible composite construction, where a bituminous layer of material overlays a cementitious base.

2.3.12 The surface condition of the pavement has been found to be performing generally well, the lengths of carriageway requiring improvement coinciding with the areas that require strengthening through an overlay of bituminous material.

Structures

2.3.13 The structures associated with the existing A90/M90 route corridor are detailed in the following paragraphs. The location of each is presented in Figure 4.15 (Volume 2).

<u>Structure 167-9</u>

2.3.14 Structure 167-9 is a culvert carrying the Niddry Burn under the existing M9.

<u>Structure 167-10</u>

2.3.15 Structure 167-10 carries the M9 Spur over the M9. It is a three span structure with a maximum span length of 40 metres with an overall length of 85 metres at a skew of 10°. It is a steel/concrete composite structure founded on spread footings.

<u>Structures 167-8 and 187-8</u>

2.3.16 Structure 167-8 is a twin barrel culvert carrying the M9 Spur to M9 eastbound slip road over the Swine Burn. It is a single span structure with an overall length of 142 metres and headroom clearance of 4.3 metres.

2.3.17 Structure 187-8 is a culvert which carries the M9 Spur over the Dolphington Burn.

<u>Structure 167-5</u>

2.3.18 Structure 167-5 carries the M9 Spur over B9080. It is a single span bridge and has a span of 29 metres with no skew. It is an insitu slab structure founded on spread footings.

<u>Structure 167-7</u>

2.3.19 Structure 167-7 carries the M9 over an existing side road west of M9 Junction 1a. It is a two hinged portal single span structure with a span of 10 metres at a skew of 18°.

<u>Structure 167-11</u>

2.3.20 Structure 167-11, Humbie Railway Bridge, carries the M9 Spur over the Falkirk-Fife Railway Line. It is a single span bridge and has an approximate span of 17 metres at a skew of 40°. It is a prestressed beam and slab structure founded on piles.

<u>Structure 239-11</u>

2.3.21 Structure 239-11 carries the M9 Spur link road over the A90 westbound. This structure was provided as part of the M9 Spur Extension contract and to date no record information has been made available as to its form of construction.

<u>Structure 239-3</u>

2.3.22 Structure 239-3 carries the A8000 over the A90. It is a two span bridge with an overall length of 29.6 metres comprising a maximum span of 14.8 metres at a skew of 20°. It is an insitu slab structure supported on spread footings.

<u>Structure 187-4</u>

2.3.23 Structure 187-4 carries the Echline Junction over the A90. It is a single span structure with a span of 30 metres with no skew. It is an insitu concrete slab structure founded on spread footings.

Existing Traffic Patterns

2.3.24 The principle links south of the Firth of Forth are:

- A90 between the north of Edinburgh and South Queensferry;
- M9 Spur (including the recently constructed M9 Spur Extension) between M9 Junction 1a and Scotstoun Junction;
- M9 Edinburgh – Stirling – Thurso Trunk Road;
- M8/A8 Edinburgh – Greenock Trunk Road;
- A8/A89 forming an east - west route between Edinburgh, West Lothian and beyond;
- A8000 forming a north - south route between South Queensferry and Kirkliston
- A720 Edinburgh City Bypass;
- A904 forming an east - west route between Bo’ness and South Queensferry.

2.3.25 2006 Annual Average Daily Traffic (AADT) volumes were obtained from Transport Scotland for key road bridge connections south of the Firth of Forth. These are summarised in Figure 2.5 (Volume 2).

2.3.26 From the above, the following operational trends can be identified:

- The most heavily trafficked roads directly linked to the Forth Road Bridge within the southern study area are the A90 to/from Edinburgh, and the M9 (south of M9 Junction 1a);
- 14,400 vehicles per day use the A904 as a means of travelling to/from the west. Approximately double this number (27,000 vehicles) use the M9 to travel to/from the west.

2.3.27 The data presented above represents the 2006 network traffic flows, prior to the opening of the M9 Spur Extension between M9 Junction 1a and the A90 at Scotstoun Junction in 2007. The M9 Spur now provides an alternative to the A8000 for traffic travelling between these points. As shown in Tables 2.4 and 2.5 for the weekday morning and evening peaks respectively, the resulting additional traffic demand on the M9 Spur contributed to a reduction in traffic demand on the A90 between the Forth Road Bridge and Edinburgh. This also includes the effect of removing tolls on the Forth Road Bridge.

Table 2.4: Effect of the M9 Spur Extension on A90 and M9 Spur Traffic Flows (Morning Peak)

Count Year	A90		M9 Spur	
	Westbound	Eastbound	Northbound	Southbound
2006	1500	1500	900	1200
2008	1300	1400	1400	1300
Total vehicle change	-200	-100	+500	+100
%age change	-13	-7	+56	+8

Note: Morning Peak, 0800-0900 hours. Units are total vehicles, to the nearest 100. Data derived from Transport Scotland Automatic Traffic Counters.

Table 2.5: Effect of the M9 Spur Extension on A90 and M9 Spur Traffic Flows (Evening Peak)

Count Year	A90		M9 Spur	
	Westbound	Eastbound	Northbound	Southbound
2006	2200	2200	900	1000
2008	1900	1300	1500	1400
Total vehicle change	-300	-900	+600	+400
%age change	-14	-41	+67	+40

Note: Evening Peak, 1700-1800 hours. Units are total vehicles, to the nearest 100. Data derived from Transport Scotland Automatic Traffic Counters.

2.3.28 Current peak hour traffic flows on other selected key links in the southern study area are shown in Table 2.6.

Table 2.6: Link Flows (2008) – Southern Study Area

Count Location	Direction	Time Period	
		AM (0800-0900)	PM (1700-1800)
M8 (west of Newbridge)	WB	2300	3250
	EB	3450	2250
M8 (between Newbridge & Hermiston Gait)	WB	2550	3600
	EB	3800	2050
A720 (south of Hermiston Gait)	NB	2400	2300
	SB	2600	3050
A720 (between Hermiston Gait & Gogar)	NB	2050	800
	SB	1150	2300
A8 (Glasgow Road)	WB	950	950
	EB	1250	900
A8 (between Gogar & Edinburgh Airport)	WB	1700	2100
	EB	3000	2150
A8 (between Edinburgh Airport & Newbridge)	WB	1500	1750
	EB	3150	1550

Note Units are total vehicles, to the nearest 50.

2.3.29 Table 2.6 reveals a tidal pattern of commuting traffic travelling to and from Edinburgh along the M8. Connections between a variety of key destinations other than Edinburgh City Centre (e.g. Edinburgh Airport) via the A8 and A720 Edinburgh City Bypass result in a more complex distribution of traffic demand on these routes.

Congestion

2.3.30 Congestion is present in the form of northbound queues approaching the Forth Road Bridge, predominantly in the PM peak. These queues are largely as a result of 2 lanes from the A90 merging with 2 lanes from the M9 Spur, into 3 lanes and then into 2 lanes as the road passes under Echline Junction. At this point, traffic from Echline merges with the bridge traffic, further adding to the congestion effects. North of the Forth Road Bridge, there is less indication of congestion as traffic travels north.

2.3.31 In the AM period, southbound traffic queues on the M9 Spur. Completion of the M9 Spur has encouraged some southbound traffic to re-route to the M9, from the A90 (to Barnton). This increased traffic regularly forms a queue on the M9 Spur as it approaches M9 Junction 1a. The M9 Spur narrows from 2 lanes to 1 lane as it merges with the motorway and this narrowing of the carriageway contributes to queue formation at this location.

Road Accidents

2.3.32 The locations and severity of road accidents between 2000 and 2007 throughout the southern study area are presented in Figure 2.6 (Volume 2), based on reported accidents data supplied by the City of Edinburgh Council (CEC) and West Lothian Council (WLC). Figure 2.6 illustrates the density of accidents throughout the northern and southern study areas with accident clusters shown in and around a number of key junctions across the network. In the southern study area, these include:

- M8 Extension/A720 Edinburgh City Bypass, near Hermiston Gait;
- A8/A720 Edinburgh City Bypass Gogar Roundabout;
- Maybury traffic signals on the A8;
- Drum Brae Roundabout (A8, Corstorphine Road);
- Edinburgh Airport dumb-bell access roundabouts (A8);
- M9/A8/A89 Newbridge Roundabout;
- Barnton traffic signals on the A90; and
- A90/A904 at Echline Junction.

2.3.33 Table 2.7 presents the distribution of reported road accidents by injury severity across the southern study area, compared to the same distribution for Scotland as a whole. This shows that the southern study area has lower than expected fatal and severe injuries, but higher than expected slight injuries.

Table 2.7: Accidents by Severity (2000-2007), Southern Study Area

Severity	Southern Study Area		Scotland	
	No. of Accidents	Percentage	No. of Accidents	Percentage
Fatal	29	1.2%	2,227	2.0%
Severe	268	10.8%	19,837	17.9%
Slight	2181	88.0%	88,810	80.1%
Total	2478	100.0%	110,924	100.0%

Note: Scotland-wide data sourced from: *'Key Road Accident Statistics 2007' – 'Table 1: Injury Road Accidents by Severity, 1970-2007'* (2008), The Scottish Government. This includes provisional 2007 data.

2.3.34 Southern study area accident statistics are presented by year in Table 2.8. This shows that total accidents declined between 2001 and 2007, although this includes some year-on-year rises in 2003 and 2006.

Table 2.8: Number of Accidents by Severity (2000-2007), Southern Study Area

Severity	Year						
	2001	2002	2003	2004	2005	2006	2007
Fatal	4	2	4	4	6	6	2
Severe	41	38	37	35	46	41	24
Slight	333	316	320	315	285	307	296
Total	378	356	361	354	337	354	322

3 Description of Route Corridor Options

3.1 Introduction

3.1.1 The development of the proposed replacement bridge and its associated connections has been undertaken according to capacity management and access strategies. Each of these strategies has been developed for the Forth Replacement Crossing Project based on the requirements of current and national transport policy.

3.1.2 The capacity management and access strategies will be supported and complemented by a subsidiary strategy for Intelligent Transport Systems (ITS). The multi-modal strategy considers the future implementation of public transport systems such as Light Rapid Transit (LRT), Bus Rapid Transit (BRT), guided buses and trams.

3.1.3 Whilst providing a description of the route corridor options assessed within this DMRB Stage 2 Corridor Report, this chapter also provides an overview of the past assessment work undertaken and the strategies and criteria used in the development of roads infrastructure to complement the proposed replacement bridge.

Route Corridor Option Sifting

3.1.4 The Jacobs Arup report “Forth Replacement Crossing, Route Corridor Options Review” details each of the corridor options considered in the provision of road connections to the proposed replacement bridge. A two staged assessment was undertaken as a part of this process including an initial assessment, where a high level study allowed the least favoured options to be removed from further consideration, and a further assessment, where the remaining options were considered in greater detail.

Initial Assessment

3.1.5 As a part of the initial phase of assessment, a total of nine route corridor options were identified for consideration, three to the north of the Firth of Forth and six to the south of the Firth of Forth.

3.1.6 The three available route corridor options north of the Firth of Forth were all considered viable during this initial period of assessment and hence were taken forward for further assessment.

3.1.7 South of the Firth of Forth, three of the route corridor options were carried forward, each providing an alternative connection to the existing road network via the A90, M9 or M9 Spur. In addition, a combination option providing a direct connection from the proposed replacement bridge to the M9 and the A90 was also carried forward for further consideration.

3.1.8 The three remaining route corridor options south of the Firth of Forth were removed from further consideration on the basis that they did not best meet the scheme objectives. Furthermore, it was deemed that each of these route corridor options would require significant additional costs to implement taking into consideration land acquisition, the requirement for sizable junction arrangements and the possible requirement for substantial geotechnical investigation and consolidation of existing mine workings.

Further Assessment

3.1.9 The mainline route corridor options considered for further assessment were developed taking cognisance of carriageway provision, junction connectivity and relevant design standards as set out within the DMRB. Each corridor was designed to current standards over its full length. It is recognised that shorter improvements are feasible in each corridor. Following the consideration of the mainline carriageway design, the suitability of each route corridor option was assessed considering environmental, geotechnical, structural and traffic impacts.

3.1.10 North of the Firth of Forth, it was deemed that North Corridor Option 1 and North Corridor Option 2 should be taken forward as a part of the DMRB Stage 2 assessment process. These options are detailed in Figure 3.1 and Figure 3.2 (Volume 2).

3.1.11 North Corridor Option 3, the remaining route corridor option and a combination of North Corridor Option 1 and North Corridor Option 2, was not deemed to provide any additional benefits. It is the least effective in meeting the scheme objectives and provides the least amount of junction functionality. In addition, it generates a deterioration of local air quality to the highest number of properties.

3.1.12 South of the Firth of Forth, it was deemed that South Corridor Option 1 and South Corridor Option 2 should be taken forward as part of the DMRB Stage 2 assessment process. These options are detailed in Figure 3.3 and Figure 3.4 (Volume 2).

3.1.13 South Corridor Option 3, the remaining route corridor option, was deemed to have the greatest level of impact with regards to residential property demolition. The provision of connectivity to the existing road network also presented difficulties with a requirement for large junctions and significant land acquisition. In addition, the complexity of the junction interface with the M9 Spur raised a number of design standard concerns and highlighted the need for a number of new structural crossings of road and rail at significant cost.

3.1.14 The combination option, South Corridor Option 4A, encompassing South Corridor Option 1 and South Corridor Option 2, was also removed from further consideration at this stage. The requirement for significant land acquisition, the effects that the option would have on the existing landscape and the cost of its implementation were all key factors in it not being carried forward to DMRB Stage 2 assessment.

3.2 Capacity Management Strategy

3.2.1 A strategy for the management of capacity associated with the Forth Replacement Crossing Project has been developed, consistent with national transport planning policy, as defined by:

- The Government Economic Strategy
- The National Transport Strategy (NTS, 2006).

3.2.2 The Scottish Government's National Transport Strategy (NTS) sets out three strategic outcomes designed to meet the key challenges facing transport in Scotland over the next 20 years.

- Improve journey times and connections, to tackle congestion and the lack of integration and connections in transport which impact on our high level objectives for economic growth, social inclusion, integration and safety.
- Reduce emissions, to tackle the issues of climate change, air quality and health improvement which impact on our high level objective for protecting the environment and improving health.

- Improve quality, accessibility and affordability to give people a choice of public transport, where availability means better quality transport services, value for money and a realistic alternative to the car.

3.2.3 The Strategic Transport Projects Review (STPR) has been taken forward based on these strategic outcomes for the NTS to enhance Scotland's strategic transport network. As an early priority project of the STPR, the proposed replacement bridge is expected to contribute to the NTS strategic outcomes and form part of the overall strategy for investment in Scotland's transport network.

3.2.4 Through the STPR, Transport Scotland has defined the following hierarchy for investment in transport infrastructure:

- Firstly, at maintaining and safely operating existing assets;
- Secondly, at promoting a range of measures, including innovative solutions, to make better use of existing capacity (Interventions may include technology based, fiscal and 'soft measures' in addition to engineering solutions); and
- Thirdly, at promoting targeted infrastructure improvements.

3.2.5 As an early priority project of the STPR, option development for the proposed replacement bridge is guided by this investment hierarchy. The proposed replacement bridge, as a 'level 3' targeted infrastructure improvement, is under consideration because the continued maintenance and safe operation of the Forth Road Bridge (a preferred 'level 1' solution) is known to be subject to significant uncertainty.

3.2.6 However, this targeted investment must also be seen in the context of other complementary investments being promoted in the potential absence of the Forth Road Bridge. These aim to make best use of existing cross-Forth capacity ('level 2' solutions) in order to manage demand for cross-Forth travel and access. Many of these are being considered within the STPR framework as described above. Others are being promoted and developed by local authorities in the Forth catchment area and the South East of Scotland Transport Partnership (SEStran). These include rail and tram improvements, Intelligent Transport Systems (ITS), ferry options, and public transport priority schemes and interchanges.

3.2.7 A key element of the option development process is therefore to prioritise proposed replacement bridge options which provide targeted infrastructure replacement, sufficient to meet continuing demands for its use, in the context of the potential contribution to be made by more preferable 'level 1' and 'level 2' solutions for investing in cross-Forth transport systems, and in such a way that the viability of these preferred alternatives are not undermined.

3.2.8 In practice, this means generating preferred configurations for the proposed replacement bridge and its connections at no more than replacement levels of road capacity. Consequently, as the Forth Road Bridge and its immediate connections are designed utilising dual two lane all purpose carriageway/dual two lane motorway, the assumption is that any replacement infrastructure should be provided to the same or equivalent specification. Any additional capacity is only considered where, consistent with scheme objectives, it is either:

- reserved for priority users (e.g. public transport, emergency vehicles); or
- forms part of an existing and transferable commitment for improvements to the Forth Road Bridge and its associated direct connections; or
- where there are other requirements (e.g. safety, transport/land use/policy integration, design standards) for additional investment over and above that required for replacement

purposes. This excludes providing for forecast growth in non-priority traffic (e.g. single occupancy vehicles) beyond a level that would have been provided for by the Forth Road Bridge.

3.3 Access Strategy

3.3.1 In addition to the Capacity Management Strategy, an Access Strategy has also been developed to ensure the integration of options with key schemes and policies in the region. The Access Strategy for the Forth Replacement Crossing Project has been developed taking cognisance of the following transport planning policies, and a detailed interpretation of the Scheme Objectives.

- The National Planning Framework 2 (NPF2) discussion draft (2008).
- The West Edinburgh Planning Framework;
- SEStran draft Regional Transport Strategies;
- FETA Local Transport Strategy; and
- Fife Structure Plan/Edinburgh and Lothians Structure Plan.

3.3.2 The resulting access strategy objectives are set out in Table 3.1.

Table 3.1: Access Strategy for Option Development

Scheme Objective	Access Strategy Objectives
Maintain cross-Forth transport links for all modes to at least the level of service offered in 2006	• Maintain cross-Forth journey times for motorised and non-motorised travel between key areas in the local Forth catchment. • Maintain cross-Forth journey times for motorised travel between major urban centres in the strategic Forth catchment
Connect to the strategic transport network to aid optimisation of the network as a whole	• Positively contribute to the management of road congestion in west Edinburgh, along the A90 • Positively contribute to the operational and safety performance of the A985 between Rosyth and Kincardine
Improve the reliability of journey times for all modes	• Provide access to alternative cross-Forth routes in the event of restrictions being placed on the proposed replacement bridge. • Provide sufficient and targeted capacity on the proposed replacement bridge and its approaches to accommodate daily fluctuations in traffic demand
Increase travel choices and improve integration across modes to encourage modal shift of people and goods	• Facilitate improved connections, integrating with Park & Choose proposals at Halbeath, Rosyth, Ferrytoll, Dalgety Bay and Inverkeithing • Facilitate improved access to Rosyth International Container Terminal and Grangemouth freight hub to encourage goods transport mode transfer
Improve accessibility and social inclusion	• Reduce journey times between areas of social deprivation in Fife, West Lothian and Edinburgh to centres of major employment in the SEStran area • Facilitate improved public transport accessibility in west Edinburgh
Minimise the impacts of maintenance on the effective operation of the transport network	• Refer to "Improve the reliability of journey times for all modes" Scheme Objective.
Support sustainable development and economic growth	• Facilitate improved access to Edinburgh Airport, Rosyth International Container Terminal and Grangemouth Freight Hub (see also criteria for mode shift objective) • Where practicable, prioritise road space for buses, High Occupancy Vehicles (HOV) and LRT/BRT systems to maximise efficient use of transport resources
Minimise the impact on people, the natural and cultural heritage of the Forth area	• Minimise impacts on areas of environmental sensitivity. (See also prioritisation of road space criteria for sustainable development objective)

3.4 Bus Priority and High Occupancy Vehicles (HOVs)

3.4.1 Based on the access strategy objective to support sustainable development and consistent with the investment principle of making best use of existing assets, one of the features relevant to the function of the proposed replacement bridge includes the consideration of bus and HOV lanes.

3.4.2 The consideration within the overall access strategy to implement priority use of the proposed replacement bridge and associated roads infrastructure by buses and, potentially, HOVs has therefore been developed to guide option development. Bus priority measures developed by SEStran include 'Park & Choose' bus/rail/car-sharing interchange facilities along the A90/M90 corridor in Fife at Ferrytoll, Rosyth, Halbeath, Dalgety Bay, and Inverkeithing. These would also integrate with a number of existing facilities for priority vehicle use within the immediate Forth catchment, including:

- City of Edinburgh radial bus priority infrastructure along the A90, A8 and A71; and
- a car-sharing database, operated by SEStran to match drivers to potential passengers undertaking the same or similar journeys.

3.4.3 In this context, bus and HOV considerations are:

- To consider the potential for bus priority and HOV measures along the A90/M90 corridor between Halbeath Interchange (M9 Junction 3) and North Queensferry.
- To consider the potential for the linked provision of bus priority and HOV measures between South Queensferry, west Edinburgh, and central Edinburgh.

3.4.4 These considerations are consistent with the other access strategy objectives presented in Section 3.3, in particular:

- Facilitating improved connections with Park & Choose facilities to meet scheme objectives to increase travel choices, improve integration and encourage modal shift of personal travel.
- Facilitating improved public transport accessibility in west Edinburgh to meet the scheme objective of improved accessibility and social inclusion.
- Positively contribute to the management of road congestion in west Edinburgh along the A90 to address the scheme objective of network optimisation.

3.5 Intelligent Transport Systems Strategy

3.5.1 An Intelligent Transport Systems (ITS) strategy has been developed for the proposed replacement bridge in support of the overall access strategy defined in Section 3.3. ITS is also a key component of Transport Scotland's investment hierarchy and will also therefore contribute to the capacity management strategy defined in Section 3.2.

3.5.2 For the Forth Replacement Crossing Project the ITS strategy addresses:

- Public Transport Measures
- Priority Vehicle Operation
- Journey Time Reliability
- Safety Management
- Emissions Management
- Demand Management
- Network Operation
- Integration

3.5.3 The strategy will propose ITS measures according to the following five integrated and overlapping categories of use:

- General provision – universal measures required for the route corridor
- Mainline junctions and local network – measures targeted at the interface between the mainline, strategic and local roads
- Public Transport – measures to manage bus, train and LRT movements
- Priority Vehicles – measures to manage priority vehicles
- Mainline Route Corridor – measures targeted at the management of mainline traffic movements

3.5.4 Within each of these categories, a suite of 'mature' and 'emerging' ITS measures are proposed for further development and consideration as the scheme progresses. These are summarised in Table 3.2.

Table 3.2: ITS Strategy – Technologies for Potential Adoption

Use Category	Mature technologies	Emerging technologies
General Provision	Traffic/Transport Management Centre Communications Network Closed Circuit Television (CCTV) Height Warning Weigh-in-Motion (WIM) Meteorological Systems Web Services/SMS/ Media Logistics Tracking and Port Information	Journey Time Measurement (JTM) Incident Management (VMS) Mobility Card Traffic Radio Channel Security and Access Control
Mainline junctions and local network	Variable Message Signs (VMS) Vehicle Detection Automatic Detection Systems Automatic Number Plate Recognition (ANPR) Traffic Signal Coordination Green Wave Compliance Speed/Red Light Bus Priority/Selective Vehicle Priority Highway Lighting	Mobile ITS Dynamic Lane Markings Freight Traffic Exit Filter
Public transport	Vehicle Detection Car Park Management Real-Time Passenger Information (RTPI) Information Points	Exit Queue Management Journey Planning and Live Update
Priority vehicles	Lane Control Signals (LCS) Variable Message Signs (VMS) Vehicle Detection Automatic Detection Systems Automatic Number Plate Recognition (ANPR) Traffic Signal Coordination Traffic Network Gating (28) Bus Priority/Selective Vehicle Priority	Intelligent Road Studs Hard Shoulder Operation Hard Shoulder Incident Management Entry Ramp Metering Exit Queue Management Variable Speed Limits (VSL) Dynamic Lane Markings Freight Traffic Exit Filter
Mainline Route Corridor	Lane Control Signals (LCS) Variable Message Signs (VMS) Vehicle Detection Automatic Detection Systems Automatic Number Plate Recognition (ANPR) Emergency Roadside Telephones (ERT) Green Wave Compliance Speed/Red Light Highway Lighting	Mobile ITS Intelligent Road Studs Hard Shoulder Operation Hard Shoulder Incident Management Entry Ramp Metering Exit Queue Management Variable Speed Limits (VSL) Dynamic Lane Markings Freight Traffic Exit Filter

3.6 Multi-modal Strategy

3.6.1 The Forth Replacement Crossing Project shall make provision for public transport and traffic management practices. In its provision, the proposed replacement bridge must not preclude the implementation of future transport systems such as Light Rapid Transit (LRT), Bus Rapid Transit (BRT), guided buses or trams.

3.6.2 To future-proof the scheme for the implementation of possible future transport modes, a multi-modal corridor is to be provided.

3.6.3 In the initial phase of operation it is possible that the multi-modal corridor could be used for the running of road based public transport or HOV traffic, although this would increase overall road capacity. On approach to the proposed replacement bridge, this traffic would be directed into the multi-modal corridor to cross the Firth of Forth. On departure from the multi-modal corridor at the opposing ends of the proposed replacement bridge, it would rejoin the main carriageway.

3.6.4 On the implementation of a system such as LRT or BRT, the interim priority given to buses or HOVs would be removed and this traffic would utilise the same carriageway used by general traffic on the proposed replacement bridge, allowing the LRT/BRT system to be isolated from normal vehicular traffic.

3.6.5 To safeguard the connectivity of future LRT/BRT systems and taking cognisance of potential infrastructural requirements, it is necessary that access and egress points for the LRT/BRT system be catered for within the design at an early stage, ensuring minimum disruption to local and strategic routes upon its implementation.

3.6.6 The potential termination points for the implementation of such a system have been defined in line with the scheme objectives and access strategy objectives detailed in Table 3.1 and following a review of public transport infrastructure being implemented or considered by local authorities.

3.6.7 North of the Firth of Forth, it is deemed appropriate that LRT/BRT provision be terminated at Ferrytoll Junction enabling the system to interact with future public transport initiatives being considered by Fife Council and SEStran. Termination at this point would enable interaction with the Ferrytoll Park and Ride site, and local communities in west Fife including North Queensferry, Rosyth, Inverkeithing, Dalgety Bay and Dunfermline.

3.6.8 South of the Firth of Forth, it is considered that the potential LRT/BRT connections would be established through a new interface with the A904. Termination at this point would enable interaction with any future expansion of the Edinburgh Tram Project to West Lothian, providing alternative direct public transport links between Fife and Edinburgh.

3.6.9 There are currently no committed proposals for a cross-Forth LRT or BRT system. As a consequence the connecting roads to the proposed replacement bridge will be designed such that they will not preclude the future construction of a LRT or BRT system as far as is reasonably practicable.

3.7 North Corridor Option 1

3.7.1 Details of North Corridor Option 1 are provided in Figure 3.1 (Volume 2).

3.7.2 At 7.1km in length, North Corridor Option 1 utilises much of the existing A90/M90 corridor between Ferrytoll Junction and Halbeath Interchange, passing east of Rosyth and west of Inverkeithing. In the provision of this option, the A90 and M90 would be reconstructed to dual three lane motorway standard, and provision could be made for HOVs in the outer of the three trafficked lanes. As noted in Section 3.6.3, this arrangement would have the disadvantage of increasing capacity and could lead to induced traffic and wider network impacts.

3.7.3 Whilst utilising much of the existing A90/M90 route corridor, the construction of a new section of carriageway is required between the proposed replacement bridge and the A90/M90. Descending in a north easterly direction from the north bridgehead at St Margaret's Hill toward Ferrytoll Junction on viaduct, the route corridor clips the edge of St Margaret's Marsh, before crossing the B981 east of Dunfermline Waste Water Treatment Works. This section shall be operated as an all purpose carriageway with hardshoulder to maintain cross-Forth links for non-motorway traffic.

3.7.4 Whilst tying into the existing horizontal and vertical geometry of the A90 at Ferrytoll Junction, the change in bearing associated with the provision of the new section of carriageway necessitates the reconstruction of the existing junction arrangement. As part of its reconstruction, a number of new structures will be required. Existing structures shall be retained or widened as appropriate. The new junction shall cater for non-motorway traffic and local traffic with links being provided to the B980, B981 and Ferry Toll Road.

3.7.5 North of Ferrytoll, motorway restrictions are implemented. The corridor retains the horizontal and vertical geometry associated with the existing A90/M90 crossing beneath Dunfermline Wynd before cresting on Muckle Hill. The corridor then descends toward Admiralty Junction, located east of Rosyth, where the existing junction arrangement is to be reconfigured to improve operational safety. The measures to be implemented would include the closure of the north facing slip roads.

3.7.6 Continuing north, the corridor crosses Brankholm Burn west of Belleknowes Industrial Estate before crossing the Fife Circle Railway Line and swinging northeast through Masterton Junction. Located within the junction area, Masterton Viaduct which carries the M90 over the railway line and the existing southbound M90 link to the A823 will be widened to accommodate the proposed dual three lane motorway. Masterton Junction itself will be reconstructed, in part, to improve operational safety and also to provide additional links, compensating for the removal of the north facing slip roads at Admiralty Junction.

3.7.7 From Masterton Junction, the dual three lane motorway continues northeast passing beneath Masterton Road and the B981 before swinging north towards Halbeath Interchange. Located east of Fife Leisure Park, Halbeath Interchange is where the scheme terminates, the proposed dual three lane motorway reducing to dual two lane motorway standard, via a lane drop, so to comply with existing M90 carriageway cross section. In the implementation of North Corridor Option 1, it is proposed that any HOV lanes would terminate five hundred metres north of Masterton Junction.

Junction Arrangements

3.7.8 In the provision of North Corridor Option 1, the reconfiguration or reconstruction of the following junctions has been considered. The junction configurations are indicative at this stage, the requirements for each being considered in detail should this option be taken forward for DMRB Stage 3 assessment.

Ferrytoll Junction

3.7.9 The provision of a new junction at Ferrytoll is a key requirement in the maintaining of access between the mainline carriageway, Ferrytoll Park and Ride, Rosyth Dockyard and west Fife.

3.7.10 The current layout, taking the form of a roundabout is to be partially retained for use in the new junction design, its eastern extents being utilised in the provision of southbound merge/diverge movements to the mainline carriageway. It shall also serve the existing Ferrytoll Park and Ride facility. Northbound, merge/diverge movements to the mainline carriageway are catered for through a new roundabout located north of the existing junction on the line of the existing B980 Castlandhill Road. The position of this new roundabout is dictated by the level difference between the mainline departing the proposed replacement bridge and the existing local road network.

3.7.11 Whilst the future of the Forth Road Bridge remains undefined, to ensure that any future reconnection proposal can be accommodated, new slip roads have been designed to provide access. Dedicated links can be constructed to the M90 with local connectivity being maintained through the construction of additional links to Ferrytoll Junction.

3.7.12 The new Ferrytoll Junction also takes into consideration the possible future developments of a LRT system or BRT system.

3.7.13 The multi-modal requirements of the project dictate that the provision of a system such as LRT or BRT must have an entry/exit point. North of the Firth of Forth, Ferrytoll Junction shall be designed such that it will not preclude this feature, the multi-modal corridor dropping beneath the mainline into the junction area allowing local connections to be established in future years.

Admiralty Junction

3.7.14 In the provision of North Corridor Option 1, the existing Admiralty Junction is retained in part, with access maintained between Rosyth (A985) and Inverkeithing (A921).

3.7.15 To address the safety concerns associated with the proximity of Admiralty and Masterton Junctions, the north facing slip roads linking the existing M90 to the local road network are to be closed. Under North Corridor Option 1, additional functionality is provided at Masterton Junction to cater for their closure. Through the implementation of this measure, the short weaving distance currently experienced between the junctions on the M90 is addressed.

3.7.16 The existing south facing slip roads at Admiralty Junction are to be retained. The merge and diverge noses to the M90 shall be adapted to accommodate the proposed dual three motorway.

Masterton Junction

3.7.17 In the reconstruction of Masterton Junction, a new partial cloverleaf arrangement is provided serving southbound traffic movements between the M90 and A823(M). To facilitate this connection, the A823(M) is carried on structure over the M90 with improved horizontal and vertical geometry implemented to remove existing operational safety concerns.

3.7.18 In addition to the new A823(M) links, a new arrangement is provided to the A921. The new layout facilitates access between Inverkeithing and the M90 to the north. This additional functionality is provided to compensate for the closure of the north facing slip roads at Admiralty Junction.

3.7.19 The existing M90 to A823(M) northbound merge and diverge layouts are retained as a feature of the new junction layout. Modifications to the merge and diverge noses to the M90 will be required to accommodate the proposed dual three lane motorway.

3.8 North Corridor Option 2

3.8.1 Details of North Corridor Option 2 are provided in Figure 3.2 (Volume 2).

3.8.2 At 7.0km in length, North Corridor Option 2 is an offline solution which enables much of the existing A90/M90 associated with the Forth Road Bridge to be left in-situ between Ferrytoll Junction and Masterton Junction. Utilising the existing A90/M90 as a local distributor road, North Corridor Option 2 is to be constructed to dual two lane motorway standard, a combination of the new corridor and the existing A90/M90 serving to provide local access and any desired HOV functionality.

3.8.3 Connecting to the north bridgehead at St Margaret’s Hill, the new carriageway descends on viaduct in a northerly direction passing through the eastern extents of St Margaret’s Marsh before crossing the B981 southeast of Dunfermline Waste Water Treatment Works. This section shall be operated as an all purpose carriageway with hard shoulder to maintain cross-Forth links for non-motorway traffic. Located west of the existing A90 through Ferrytoll, North Corridor Option 2 requires the provision of a new junction at this location, providing access and egress between the proposed replacement bridge, B980, B981 and Ferry Toll Road. In the provision of this junction a significant number of structural crossings are required of both road and rail, the Rosyth Dockyard Branch Line Railway traversing the corridor at this location.

3.8.4 North of Ferrytoll, motorway restrictions are implemented as the corridor climbs on a shallow gradient towards Castlandhill. Clipping the corner of Castlandhill Woods, the corridor sweeps northeast, a cut and cover tunnel solution being utilised east of Castlandhill Steadings to mask its presence. Crossing the existing A90 on structure south of Admiralty Junction, the corridor continues on a north easterly bearing towards Belleknowes Industrial Estate north of Inverkeithing.

3.8.5 Passing through a valley, a further structure is required in the form of a viaduct so to clear the railway sidings located at Inverkeithing Junction, north of Belleknowes Industrial Estate. The viaduct commences south of the A921 and terminates having crossed the railway line.

3.8.6 North of the viaduct, the corridor climbs to intersect the existing M90, 1.2km north of Masterton Junction. In achieving this, the corridor passes through broadleaved woodland west of Pinkerton Burn. It then passes to the west of Dales Farm on embankment requiring the realignment of the B981 through this section.

3.8.7 Connection to the existing M90 is achieved east of Duloch Farm.

3.8.8 Given the offline nature of North Corridor Option 2, as described in 3.8.2, it is proposed that the existing A90/M90 be retained as a local distributor road. To facilitate access between the existing road network and the M90 to the north of the scheme, north facing slip roads will be provided northeast of Masterton Junction maintaining local access to west Fife.

Junction Arrangements

3.8.9 In the provision of North Corridor Option 2, the construction of the following junction has been considered. The junction configuration is indicative at this stage, the requirements for its implementation being considered in detail should this option be taken forward for DMRB Stage 3 assessment.

<u>Ferrytoll Junction & M90 Connectivity</u>

3.8.10 As with North Corridor Option 1, a new junction at Ferrytoll in the provision of North Corridor Option 2 is a key requirement, maintaining access between the proposed mainline, Ferrytoll Park and Ride, Rosyth Dockyard and west Fife. Located to the west of the existing Ferrytoll Junction, the new junction consists of a grade separated dumb bell arrangement facilitating all movements.

3.8.11 In the provision of the northbound diverging lane from the proposed mainline, a significant structural requirement exists, the new slip road descending on viaduct from St Margaret's Hill through St Margaret's Marsh to its interface with a new roundabout situated southeast of Castlandhill Woods. On approach to the new roundabout, diverging traffic from the proposed replacement bridge merges with local traffic utilising the B981 from North Queensferry.

3.8.12 In the connection of this link, a further structural crossing of the Rosyth Dockyard Branch Line Railway is required northeast of Dunfermline Waste Water Treatment Works.

3.8.13 Through the provision of a new roundabout, northbound connections are also catered for. Rather than connecting to the new mainline carriageway, strategic northbound traffic and local traffic wishing to commute between North Queensferry, Rosyth, Inverkeithing and Dunfermline is routed via the existing A90/M90. The existing junctions at Admiralty and Masterton are retained and continue to operate in their current form. Connection to the M90 is achieved north of Masterton Junction where simple north facing merge and diverge links are provided.

3.8.14 Southbound, traffic from the A823(M), Rosyth and Inverkeithing is routed via the A90/M90 to Ferrytoll Junction where new slip roads facilitate movements between the new dual two lane motorway and the existing local road network. A direct link from the existing A90/M90 to the proposed replacement bridge is provided through the junction area as a free flow link.

3.8.15 As per North Corridor Option 1, the Ferrytoll Junction layout associated with North Corridor Option 2 takes into consideration the potential future development of a LRT system or BRT system, the multi-modal corridor dropping beneath the new M90 into the junction area enabling future connections to be made to a number of local destinations.

3.8.16 As per North Corridor Option 1, any future reconnection proposals for the Forth Road Bridge could be accommodated through the utilisation of the new junction at Ferrytoll, the provision of further links facilitating partial free flow connectivity.

3.9 South Corridor Option 1

3.9.1 Details of South Corridor Option 1 are provided in Figure 3.3 (Volume 2).

3.9.2 At 2.75km in length, the mainline carriageway associated with South Corridor Option 1 provides a link between the proposed replacement bridge west of South Queensferry and the existing A90 southeast of Echline Junction. In the provision of this option, best use is made of the existing roads infrastructure associated with the Forth Road Bridge including the A90 and recently completed M9 Spur Extension. Building on past improvements to the road network, further connectivity enhancements are proposed with the full reconstruction of M9 Junction 1a, connecting the M9 to the M9 Spur, and a reconfiguration of Scotstoun Junction.

3.9.3 Commencing approximately 250m east of the A8000, South Corridor Option 1 has been developed as a dual three lane carriageway with hardshoulder. As with North Corridor Option 1, provision could be made for HOV functionality in the outer of the three trafficked lanes.

3.9.4 Passing beneath the A8000, requiring a reconstruction of the existing A8000 overbridge, the corridor departs the existing A90 in a westerly direction towards the fields of Dundas Home Farm. Through this area, the corridor is to be constructed on moderate embankment for part of its length so to accommodate the existing BP Pipeline situated below ground level.

3.9.5 Continuing west through Dundas Home Farm, a new junction is provided to facilitate local access between the proposed replacement bridge, the A904, the A90 and the M9 Spur. Beyond the new junction, the corridor swings north through Dundas Estate before crossing beneath the A904, the vertical geometry descending throughout so to provide adequate headroom clearance to the local road above.

3.9.6 On approach to the proposed replacement bridge, the corridor passes to the west of South Queensferry through Scottish Ministers land, the existing topography of the area descending towards the Firth of Forth. Through this section, the corridor transitions from cutting to embankment, the vertical geometry rising to meet the approach structure associated with the proposed replacement bridge, east of Inchgarvie House.

3.9.7 With reference to any potential future transportation developments such as the introduction of LRT or BRT, the A904 located to the south would be used as the interface for such a system. Routing via the A904 would enable future connections to be established with a number of local destinations.

Junction Arrangements

3.9.8 In the provision of South Corridor Option 1, the provision of the following new and reconstructed junctions has been considered. The junction configurations are indicative at this stage, the requirements for each being considered in detail should this option be taken forward for DMRB Stage 3 assessment.

<u>M9 Junction 1a</u>

3.9.9 In the facilitation of improved cross-Forth connections, M9 Junction 1a is to be reconstructed under South Corridor Option 1, becoming a free flow junction with all ways functionality between the M9 and the M9 Spur.

3.9.10 The existing loop arrangement is to be removed and replaced with a new link, improving junction connections between the M8, M9, A8, South Queensferry and the proposed replacement bridge.

3.9.11 Increased accessibility being a key strategic aim, west facing slip roads connecting the M9 to the M9 Spur are included within the new M9 Junction 1a arrangement, a movement not currently provided for.

Echline/Scotstoun Combination Junction

3.9.12 Echline/Scotstoun Combination Junction facilitates access between South Queensferry, the M9 Spur, A90 and the A904.

3.9.13 The South Corridor Option 1 mainline and the proposed replacement bridge will have priority through the junction area with a through connection to the M9 Spur. Connections to the A90 and the north of Edinburgh are maintained through the use of Scotstoun Junction.

3.9.14 Traffic wishing to access South Queensferry from Edinburgh and the M9 Spur will be catered for through the provision of additional slip road arrangements to Scotstoun Junction. A new link will cross the proposed mainline on structure, north of Dundas Home Farm, before interfacing with the A904 and A8000 at Echline Junction.

3.9.15 Traffic wishing to access the proposed replacement bridge, the A90 or the M9 Spur from the A904 or A8000 is catered for with the provision of a new grade separated junction to the west of the existing Echline Junction. The existing junction arrangement will only serve local traffic and northbound traffic from Edinburgh and the M9 Spur.

3.10 South Corridor Option 2

3.10.1 Details of South Corridor Option 2 are provided in Figure 3.4 (Volume 2).

3.10.2 At 5.1km in length, South Corridor Option 2 provides a direct connection between the M9 and the proposed replacement bridge.

3.10.3 To be constructed as a dual three lane motorway, connection to the M9 is achieved to the northeast of Winchburgh through the provision of a new free flow junction arrangement with all ways functionality.

3.10.4 As with other options, provision could be made for the running of HOVs in the outer of the three trafficked lanes.

3.10.5 Departing the M9, the new dual three lane motorway climbs on embankment crossing the B9080 and the Falkirk-Fife Railway Line. Cresting on approach to Swine Burn, the corridor continues in a northerly direction descending into cutting as it passes to the east of Westmuir Riding Centre.

3.10.6 Continuing north along the boundary of Dundas Estate, the corridor continues to descend in cutting, crossing beneath Builyeon Road on approach to the A904. At the A904, motorway restrictions cease on the mainline with north facing slip roads being provided to the A904 facilitating cross-Forth travel for non-motorway traffic and local traffic.

3.10.7 On approach to the proposed replacement bridge, the corridor passes to the west of South Queensferry through Scottish Ministers land, the existing topography of the area descending toward the Firth of Forth. Through this section, the corridor transitions from cutting to embankment, the vertical geometry rising to meet the approach structure associated with the proposed replacement bridge, east of Inchgarvie House.

3.10.8 With reference to any potential future transportation developments such as the introduction of LRT or BRT, the A904 located to the south would be used as the interface for such a system. Interacting with the provision of a new junction on the A904, future connections would be possible to a number of local destinations.

Junction Arrangements

3.10.9 In the provision of South Corridor Option 2, the provision of the following new and reconstructed junctions has been considered. The junction configurations are indicative at this stage, the requirements for each being considered in detail should this option be taken forward for DMRB Stage 3 assessment.

<u>M9 Junction</u>

3.10.10 The M9 Junction arrangement associated with South Corridor Option 2 consists of a complex layout, a number of slip roads being required to establish free flow connections between the M9, M9 Spur and proposed replacement bridge.

3.10.11 Similar to the layout proposed under South Corridor Option 1, all ways functionality is offered to road users of the M9 and M9 Spur with the existing loop arrangement being removed in favour of a simple link arrangement and the addition of west facing slip roads.

3.10.12 In addition and so to provide all ways functionality between the proposed replacement bridge and the M9, further link roads are provided, a large junction footprint being required to accommodate them. East facing slip roads are provided in the vicinity of the M9 Spur, south of Humbie Farm, enabling traffic to access both the M9 and M9 Spur.

3.10.13 To facilitate westbound movements between the proposed replacement bridge and the M9, a diverging slip road from the new dual three lane motorway is provided to the east of Humbie Reservoir. The opposing slip road, merging to the new dual three lane motorway from the M9, clips the eastern extents of Muiriehall Wood. In the provision of these links, a further 2 structural crossings of the Falkirk-Fife Railway Line are required.

<u>A904 Junction</u>

3.10.14 In the provision of a half diamond junction on the A904, local access connectivity is provided to the proposed replacement bridge. The provision of this junction also provides the functionality required to remove non-motorway traffic from the mainline carriageway prior to motorway restrictions commencing south of the A904.

3.10.15 The junction, proposed in a dumbbell roundabout configuration will require a minor reconfiguration of the A904, the existing local road crossing the proposed mainline carriageway on structure.

<u>Scotstoun Junction</u>

3.10.16 In addition to the required junctions on the M9 and A904, a reconstruction of Scotstoun Junction is also proposed as part of South Corridor Option 2.

3.10.17 The revised layout will provide all ways functionality between the A90 and the M9 Spur. In the provision of these additional movements, the priority route through Scotstoun Junction is changed from M9 Spur – A90 Westbound to M9 Spur – A90 Eastbound, new slip road arrangements maintaining access to South Queensferry and the existing Forth Road Bridge should there be a desire for its reconnection.

3.10.18 The provision of the new eastbound link from the M9 Spur to the A90 will complement the increased level of service offered by the new junction on the M9, facilitating direct access to the north of Edinburgh.

3.11 Do-Minimum Option

3.11.1 As indicated in the Forth Replacement Crossing Study, the do-minimum option for the Forth Replacement Crossing Project has to reflect what would happen if the proposed replacement bridge was not built.

3.11.2 At present, the future of the Forth Road Bridge is uncertain. Whilst it might continue to operate without the need for a high level of disruptive maintenance, the success of the dehumidification work, scheduled for completion in 2009, will not be known until 2012. A likely scenario is that the Forth Road Bridge will require a sustained period of refurbishment, causing significant disruption to cross-Forth travel through a requirement for partial or full closures. In light of this uncertainty and for the purposes of economic assessment, the route corridor options were assessed against a do-minimum which assumed that the existing Forth Road Bridge would be permanently closed to all traffic.

3.11.3 To effectively report the environmental impacts of the Forth Replacement Crossing Project, the continuing operation of the Forth Road Bridge at its present level of service will be considered as the do-minimum within this DMRB Stage 2 Corridor Report, providing an understandable baseline from which to undertake relevant assessment.

3.12 Cost Estimates

3.12.1 The cost estimates for each of the northern and southern route corridor options have been based on Quarter 4 2006 cost information and have been derived from historical tender information.

3.12.2 The figures quoted are for comparison purposes only. These are not to be mistaken for construction costs or final scheme outturn costs. Furthermore, the costs associated with each option do not take into consideration the costs associated with the proposed replacement bridge.

3.12.3 No cost estimate has been prepared for the do-minimum option. Should the Forth Road Bridge be closed, cross-Forth traffic will be redirected via existing roads infrastructure such as the M9, A977 and Kincardine Bridge.

3.12.4 The main roads infrastructure elements considered for cost estimation are detailed in Table 3.3. In the preparation of these cost estimates, the areas required to establish site clearance and road pavement have been calculated from the developing alignment designs associated with the northern and southern route corridor options. The requirements for fencing, earthworks and structures have also been calculated.

3.12.5 The bulk earthworks quantities calculated have been adjusted to reflect the presence of a capping layer and road pavement. It is assumed that a certain proportion of excavated material will be acceptable for use as engineering fill or landscape fill. This is based on a brief interpretation of the earliest results from the initial ground investigation work undertaken during 2008.

Table 3.3: Cost Estimate Assumptions

Road Works	Assumption
Site Clearance	Area of influence assumed to be 10 metres beyond proposed earthworks interface with existing ground level.
Fencing	Boundary fencing assumed to be sited 5 metres from earthworks interface with existing ground level.
Road Restraint Systems	Road restraint systems provided where embankments are ≥6 metres in height, at road, rail or watercourse crossings, structures and in central reservation
Drainage	Pre-earthwork drains located at top of significant cut slopes Pre-earthworks drains located at toe of significant embankment slopes Slot drains and/or gullies to central reservation SUDS compliant over the edge drainage to mainline carriageway. Outfall locations
Earthworks	Topsoil assumed at 300mm thick Roadbox assumed to be 750mm (including 300mm capping layer throughout) Slopes assumed at 1 in 2 for embankment, 1 in 2.5 for cutting
Road Pavement	Area based on length multiplied by cross section. Existing carriageway assumed to be fully reconstructed High friction surfacing assumed on junction approaches
Kerbs, Footways & Paved Areas	No kerbing to mainline (except structures) Side Roads – kerbing provided to existing kerbed side roads only Junctions – kerbing assumed in junction areas, islands and entry/exit arms Footways provided at junctions, over structures and on side roads where already provided
Traffic Signs & Road Markings	Cost of gantries to fall within Integrated Traffic System costs
Road Lighting	Junctions and mainline approaches to junctions lit from nearside. 36 metre column spacing assumed on mainline and in junction areas. 30 metre column spacing assumed on side roads
Structures	Structural requirements to include Bridge Works, Structural Retaining Walls, Culverts and Viaducts.

3.12.6 A risk allowance of 10% has been factored in to the cost estimates provided for each route corridor option. This figure is derived from the sum total of the total construction cost, Employers Costs and Statutory Undertakers Costs. Contingency costs are taken account of with the risk allowance.

3.12.7 Optimism Bias is assumed at a level of 25%, in accordance with Her Majesty's Treasury Guidance.

3.12.8 The total cost quoted for each route corridor option is exclusive of Value Added Tax (VAT).

3.12.9 Land acquisition and compensation agreements have not been considered within the cost estimates provided.

3.12.10 The cost estimate for each northern and southern route corridor option is provided for comparison in Table 3.4.

Table 3.4: Route Corridor Options - Cost Estimate Comparison

Route Corridor Option	Cost Estimate (Excluding VAT)
North Corridor Option 1	£518,760,000.00
North Corridor Option 2	£671,500,000.00
South Corridor Option 1	£318,260,000.00
South Corridor Option 2	£454,150,000.00

3.13 Proposed Replacement Bridge

3.13.1 Whilst the form of the proposed replacement bridge has no influence on the route corridor option selection process, for reporting completeness, an overview of the designs being considered as part of the ongoing assessment work is provided below.

3.13.2 The proposed replacement bridge is likely to encompass two cable stayed spans, each of approximately 650 metres, and three support towers, the central tower being located on Beamer Rock.

3.13.3 The landing points for the proposed replacement bridge to the north and south of the Firth of Forth are as follows:

- North – St Margaret's Hill, east of Rosyth
- South – Fields at Echline, west of South Queensferry

3.13.4 Further development of the bridge design is ongoing and will be reported upon as part of the continuing scheme assessment process.

3.14 References

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The Highways Agency. The Design Manual for Roads and Bridges (May 2008)

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- Forth Replacement Crossing Study, Report 1: Access Existing, and Forecast Future, Conditions of the Transport Network within the vicinity of the Forth Road and Rail Bridges, February 2007
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Forth Replacement Crossing

DMRB Stage 2 Corridor Report

Part 2: Engineering Assessment

Report on Scheme Development Work: May to August 2008

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4 Engineering Description

4.1 Introduction

4.1.1 This chapter presents the engineering assessment of the DMRB Stage 2 route corridor options for the Forth Replacement Crossing.

4.1.2 In the preparation of options for DMRB Stage 2 assessment, each corridor has over its full length been designed to current standards utilising the technical guidance provided by the Design Manual for Roads and Bridges (DMRB). Shorter improvements within each corridor are feasible and will be considered at the next stage of the study. The following documents have been referenced in the development of both the northern route corridor options and southern route corridor options:

- TD 9/93 Highway Link Design
- TD 27/05 Cross-Sections and Headrooms
- TD 22/06 Layout of Grade Separated Junctions
- TD 39/94 The Design of Major Interchanges
- TD 40/94 Layout of Compact Grade Separated Junctions
- TD 42/95 Geometric Design of Major/Minor Priority Junctions
- TD 50/04 The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts

Design Considerations

4.1.3 In addition to the implementation of best practise through the use of the relevant design standards, the following physical features have been considered:

- Existing topography, the vertical geometry of each route corridor option being designed to achieve the best cut-fill balance possible, minimising the transportation of acceptable material.
- Headroom clearance requirements to road, rail and watercourse crossings.
- Connections to the proposed replacement bridge; and
- Requirements in the vicinity of local communities where screening or depressed vertical geometry may be required to minimise the visual impact of the corridor.

4.1.4 The design of the northern and southern route corridor options for DMRB Stage 2 assessment has been undertaken using a ground survey contour model. Produced from LiDAR Survey, this model does not recognise all of the features associated with the existing topography of the area.

4.1.5 In the preparation of design work for DMRB Stage 3 assessment, a new topographical survey model in the form of a detailed ground survey will be utilised. This will enable the horizontal and vertical geometry of the selected route corridor options to be further refined, confirming any departures from standard or geotechnical solutions which might be required.

4.1.6 For the purposes of DMRB Stage 2 assessment, the route corridor options discussed within this report have been considered over the full extents of the Forth Replacement Crossing study area. The preferred corridor identified need not be implemented in full as a single scheme. As a part of the next stage of design and assessment, further detailed consideration shall be given to the form and function of the junctions required and the extent and timing of the road infrastructure improvements provided within the preferred corridors.

The developing design shall also reflect future consideration of the use of the Forth Road Bridge.

Junctions

4.1.7 The junction configurations provided in association with each of the northern and southern route corridor options are indicative layouts at this stage, capable of maintaining/improving access between local and strategic connections. The level of service and form of junction provided is subject to ongoing development. A more detailed assessment of junction provision will be included within the DMRB Stage 3 Report relative to the northern and southern route corridor options identified for further assessment.

Drainage

4.1.8 No detailed drainage design has yet been undertaken however the design shall incorporate Sustainable Drainage Systems (SUDS) which may include the provision of swales and filter trenches. The intention of such systems is to limit the amount of surface water discharging from the carriageway into existing watercourses in all but extreme weather situations. This will be achieved through the provision of attenuation ponds and/or lagoons at frequent intervals, containing the surface water runoff generated by the corridor.

4.1.9 The design of drainage systems to complement the roads infrastructure associated with the proposed replacement bridge will be undertaken as part of the DMRB Stage 3 assessment process.

4.1.10 The extents of the drainage provided as part of the Forth Replacement Crossing project will be based upon a predetermined storm return frequency, the drainage design being tailored to the topography of the area.

4.1.11 A thorough consultation process will be instigated with Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH) and other relevant consultees to ensure that water quality targets are met.

Earthworks

4.1.12 A detailed earthworks design has not yet been undertaken, however features likely to be required include: cuttings with mid-slope and/or rockhead berms, rock slope stabilisation measures, embankments, ground stabilisation measures to accommodate construction over soft deposits and minimise settlement, treatment of abandoned mineworkings, and appropriate associated surface and in-slope drainage measures to tie-in with the carriageway drainage systems.

4.1.13 A suitable design for the earthworks associated with the proposed roads infrastructure will be developed as part of the DMRB Stage 3 assessment process.

4.1.14 In the initial development of the northern and southern route corridor options, earthworks slopes of 1:2 (vertical:horizontal) for embankment and 1:2.5 for cuttings have been implemented. The geotechnical assessment of each route corridor option provides guidance on the earthworks slopes which may be implemented through design development.

4.1.15 This assessment is based on the preliminary data from the 2008 ground investigations, together with pre-existing historical borehole information where relevant. The assessment of soil / rock types is based on the log descriptions, to BS5930:1999, as they stand at present, however these have not been finalised. No checking of soil descriptions against laboratory testing has been undertaken to confirm the soil type / classification. The co-ordinates and ground levels for the exploratory holes are preliminary and unchecked at present.

Pavement Design

4.1.16 The provision of a detailed pavement design has not been considered as a part of this DMRB Stage 2 assessment, a broad based assessment having been undertaken for cost estimate purposes only. The pavement design will be considered as a part of the DMRB Stage 3 assessment, taking account of any existing pavement which might be utilised following a detailed analysis of its condition.

4.1.17 The pavement design for new and reconstructed sections of carriageway shall be either of fully flexible or flexible composite construction, the pavement thickness being designed to suit the predicted traffic flow. Pavement surfacing materials promoting reduced traffic noise and reduced surface spray in wet conditions shall be considered. Rigid pavements are unlikely to be specified for the roads infrastructure connecting the proposed replacement bridge to the existing trunk road/local road network.

Road Restraint Systems

4.1.18 Given the extent of the options being considered as part of this DMRB Stage 2 assessment, a detailed design considering road restraint systems has not been developed. Taking into account the requirement for land acquisition, a broad-based assessment has been undertaken for cost estimate purposes only.

4.1.19 Hazard locations in accordance with TD 19/06 – Requirements for Road Restraint Systems will be identified and assessed, a suitable design being provided for the route corridor options taken forward to DMRB Stage 3 assessment.

Traffic Signs / Carriageway Finishes

4.1.20 The detailed design of traffic signs, delineation and road markings has not been considered as part of the DMRB Stage 2 assessment, a broad-based assessment having been undertaken for cost estimate purposes only. The provision of such details will be considered as part of the DMRB Stage 3 assessment process with reference paid to relevant design standards including The Traffic Signs Regulations and General Directions 2002 and the Traffic Signs Manual.

Structures

4.1.21 Each of the route corridor options under consideration requires significant structural provision. Whilst the widening of existing structures can be considered in some instances, new structures will be required for new and improved junctions, major side road crossings, railway crossings, private rights of way and drainage features.

4.1.22 Where possible, all structures shall be designed to minimise their impact on the surrounding landscape. The maintenance requirement applicable to each structure shall be examined to ensure minimum disruption to the surrounding environment whilst ensuring the effective operation of the proposed corridor.

High Occupancy Vehicle (HOV) Lanes

4.1.23 Each of the northern and southern route corridor options under consideration as part of this DMRB Stage 2 assessment is capable of practically providing for a high occupancy vehicle lane in each direction only if the improvement is carried out over the full length of the corridor. They may not be feasible for a more limited corridor upgrade.

4.1.24 The location of such provision is dependant on the carriageway cross section implemented. The requirement exists to maintain two lanes of general traffic in addition to any HOV lane provided, in each direction at all times.

4.1.25 In the provision of North Corridor Option 1, South Corridor Option 1 and South Corridor Option 2, an HOV lane can be accommodated, running in the outer of the three trafficked lanes provided on the mainline carriageway.

4.1.26 In the implementation of North Corridor Option 2, only two trafficked lanes are provided, requiring a compromise solution to be considered. In this instance general traffic and HOV provision would be split between the proposed North Corridor Option 2 mainline and the existing A90/M90.

4.2 North Corridor Option 1

4.2.1 Table 4.1 read in conjunction with Figure 4.1 (Volume 2) provides a description of the North Corridor Option 1 mainline carriageway design.

Table 4.1: Engineering Description of North Corridor Option 1 Mainline

Corridor	Mainline Description
North Corridor Option 1	<u>Design Details</u> • Route Corridor Length: 7.1km • Design Speed: 120kph • Dual three lane motorway (D3M) encompassing: o 11m running carriageway o 3.6m hard shoulders (where practicable for future hard shoulder running) o 0.7m hardstrips o 3.1m central reserve o 1.5m verge <u>Design Geometry</u> • Minimum Horizontal Radius = 600m • Minimum Vertical Gradient = 1.1% • Maximum Vertical Gradient = 4% • Minimum Sag Curve Radius = 5500m • Minimum Crest Curve Radius = 5500m

Engineering Constraints

4.2.2 The design of North Corridor Option 1 takes into consideration the following physical engineering constraints.

- Existing topography
- A90/M90 route corridor
- Junction provision and side roads connectivity
- Side road crossings
- Adoption of existing structures
- Railway crossings at Ferrytoll Junction and Masterton Junction
- Environmentally significant areas (refer to Part 3)
- Possible future multi-modal developments (LRT, BRT, guided buses or trams)

Mainline Features

4.2.3 A full improvement to North Corridor Option 1 consists of the online upgrading of the existing A90/M90 to dual three lane motorway standard. South of Ferrytoll Junction, the mainline shall be implemented as an all purpose carriageway with hard shoulder to maintain cross-Forth access for non-motorway traffic.

4.2.4 Departing the proposed replacement bridge northwards at St Margaret's Hill, the corridor descends on a vertical gradient of 3.5% towards Dunfermline Waste Water Treatment Works and Ferrytoll Junction.

4.2.5 To facilitate connection between the proposed replacement bridge and the A90/M90 route corridor, a R720 metre left hand horizontal curve is provided sweeping the alignment along the eastern perimeter of St Margaret's Marsh. The horizontal and vertical tie in to the existing carriageway is coincidental with Ferrytoll Junction, a junction which is to be reconstructed as part of this option.

4.2.6 Mirroring the horizontal geometry of the existing A90/M90, the corridor continues north on a gentle incline of 1.1% requiring the widening of significant cut slopes to accommodate the dual three lane motorway cross section. Passing to the west of Ferrytoll Park and Ride on a R690 metre right hand horizontal curve the corridor then climbs Muckle Hill at 3.3% cresting to the east of Castlandhill in close proximity to Dunfermline Wynd Overbridge.

4.2.7 The corridor then descends at 4% towards a revised Admiralty Junction, its low point situated west of Belleknowes Industrial Estate. Continuing north through Admiralty Junction on a R600 metre right hand curve, the corridor then rises at a gradient of 3.5% towards Masterton Junction.

4.2.8 On approach to Masterton Junction, the corridor is carried on viaduct, crossing the Fife Circle Railway Line and link roads providing access to the A823(M). Passing through Masterton Junction itself, the corridor turns northeast through an R650 metre horizontal right hand curve passing to the south of the properties at Middlebank. Situated on embankment, the corridor then returns to a northerly bearing, a R960 metre left hand curve facilitating this.

4.2.9 North of Middlebank, the dual three lane motorway continues to climb towards Halbeath Interchange, requiring the widening of cutting and embankment slopes. At Halbeath Interchange itself, a lane drop/lane gain arrangement is provided to the A92, facilitating a cross section transition to the dual two lane motorway standard associated with the existing M90.

Departures from Standard

4.2.10 Incorporating much of the A90/M90 route corridor, North Corridor Option 1 inherits the horizontal and vertical geometry associated with the existing corridor. Whilst many of the substandard characteristics of the mainline carriageway can be eliminated through the implementation of improvements at detailed design stage, substandard geometry elements are likely to remain.

4.2.11 The existing R600 metre right hand curve located at Admiralty Junction and the R650 metre right hand curve located within the junction area at Masterton represent relaxations of 2 design speed steps below desirable minimum. Whilst permissible in isolation, their provision in combination with a reduction in stopping sight distance is not and hence it is likely that Departures from Standard will be required. A coincidental relaxation of this nature is only permitted up to 1 design speed step below desirable minimum.

4.2.12 Initial discussions have been held with Transport Scotland's Standards Branch as to the suitability of the design work undertaken to date. Should this option be taken forward to DMRB Stage 3 assessment, the development of the design shall be discussed further with Standards Branch, any departures from standard being highlighted at an early stage.

Junction Provision

4.2.13 Table 4.2 read in conjunction with Figures 4.2 and 4.3 (Volume 2) gives an overview of the indicative junction arrangements developed for North Corridor Option 1.

Table 4.2: Engineering Description of North Corridor Option 1 Junctions

Corridor	Junction Description

North Corridor Option 1	<u>Ferrytoll Junction</u>
	• New Grade Separated Junction arrangement providing local and non-motorway access.
	• Northbound, new roundabout provided for strategic/local connectivity.
	• Northbound interaction between mainline and local roads through new slip road arrangements.
	  ○ Mainline Diverge to Ferrytoll Junction
	  ○ Mainline Merge from Ferrytoll Junction
	  ○ Access maintained to B980, B981 & Ferry Toll Rd
	• Southbound, existing roundabout adapted allowing interaction between mainline, local roads and Ferrytoll Park & Ride through new slip road arrangements.
	  ○ Mainline Diverge to Ferrytoll Junction
	  ○ Mainline Merge from Ferrytoll Junction
	  ○ Access maintained to B980, B981 & Ferry Toll Rd
	• Bus priority functionality provided through hard shoulder running on slips.
	• Junction future-proofed for future transport modes i.e. LRT, BRT, guided buses or trams.
	• Connection to the Forth Road Bridge to be maintained through the provision of new links.
	<u>Admiralty Junction</u>
	• Existing Grade Separated Junction retained.
	• South facing slip road provision reconfigured for implementation of D3M mainline cross section.
	• North facing slip roads closed, improving operational safety of mainline.
	• Through access maintained between A985 & A921.
	<u>Masterton Junction</u>
	• New free flow all movements junction
	• Northbound merge/diverge movements between mainline & A823(M) retained with some reconfiguration.
	  ○ Mainline Diverge to A823(M)
	  ○ Mainline Merge from A823(M)
	• Southbound links reconstructed, including provision of loop arrangement, improving operational safety.
	  ○ Mainline Diverge to A823(M)
	  ○ Mainline Merge from A823(M) – Simple Loop
	• New roundabout provided connecting to A921 & B981, compensating for loss of north facing slip roads at Admiralty.
	  ○ Southbound slip road to A921 abutted to A823(M) Mainline Diverge. .
	  ○ Northbound link connects A921 and B981 between new roundabout and Mainline Merge from A823(M).

Topography & Land use

4.2.14 North Corridor Option 1, utilising much of the A90/M90 route corridor, passes through a mixture of residential, commercial and agricultural land.

4.2.15 To the south, the coastal flats of the Firth of Forth are a prominent feature with pockets of woodland and St Margaret's Marsh dominating the northern shoreline. To the east, the village of North Queensferry is situated upon coastal hills. To the west the former Naval Dockyard at Rosyth signifies the area's maritime heritage. Closed as an operational naval base in 1994, the facility is now being re-developed for private sector use with the provision of ferry and cargo terminal facilities and a new business park.

4.2.16 Continuing north, the coastal flats associated with the Firth of Forth give way to a more rugged landscape, the terrain steepening to the south of Rosyth where Castlandhill, a prominent coastal hill, is situated. The corridor passes to the east of Castlandhill, the rugged landscape of the area requiring the widening of existing cut slopes so to accommodate the increased dual three lane motorway cross section.

4.2.17 North of Castlandhill, the corridor descends into a valley dominated by residential and commercial properties. The town of Rosyth, situated to the west of the corridor, has a distinct industrial history having been developed as a garden city to house the workers from the neighbouring dockyard. To the east is situated the town of Inverkeithing. Like Rosyth, Inverkeithing is also associated with maritime activities, its ship-breaking yard being situated in Inverkeithing Bay (Inner Bay). Industry continues to be a prominent feature in the area with significant commercial premises still present. East of the corridor and to the north of Inverkeithing, Belleknowes Industrial Estate contains a number of industrial premises. Network Rail property is also a prominent feature with the Fife Circle Railway Line passing beneath the mainline south of Masterton Junction, linking Rosyth and Inverkeithing.

4.2.18 Beyond Masterton Junction, agricultural land becomes a prominent feature, the topography of the area rising towards Crossgates and Halbeath. To the east, areas of woodland intersperse farm properties. To the west, agricultural properties are bounded by long established woodland and historical quarrying sites bearing limestone and sandstone. Beyond lies the town of Dunfermline.

Geotechnical Summary

4.2.19 North Corridor Option 1 utilises much of the existing A90/M90 corridor, however to accommodate the widened carriageway, junctions and tie-ins to the proposed replacement bridge, construction or modification of cuttings and embankments will be required.

4.2.20 Until the completion of the ground investigations and associated testing, an assessment of the likely slope angles will not be undertaken. The general design assumptions for slopes at present are that they will not be steeper than 26.6^{o} (1V:2H) for both embankments and cuttings. However, in certain cases these may have to be relaxed to satisfy the stability of the slope. Steeper angles of 60^{o} to 80^{o} (2V:1H - 5V:1H) may be possible in rock depending on rock type, discontinuity orientations, spacing and type/extent of infill material, and groundwater.

4.2.21 The cuttings are likely to be formed partially within superficial deposits and partially within rock. Rock slope drainage measures such as raking drains and relief drains may be required, as well as standard rock slope stabilisation treatment.

4.2.22 A limit of around 7 metres has been assumed in terms of maximum height/depth of a feature before an interim berm is required. This is for improved stability as well as maintenance access. A berm at the soil/rock contact will also be required for slope stability and drainage.

4.2.23 Soft alluvial deposits are recorded in the vicinity of Masterton Junction. Where these deposits are encountered within the footprint of the road embankment, consideration must be given to the avoidance of residual settlement (post construction). This may take the form of ground treatment; including pre-loading with or without band drains and replacement of soft deposits, or programming of construction to allow for settlement to occur. Artesian groundwater conditions were encountered in association with these deposits; they will require to be taken into consideration during design and construction in this area.

Geotechnical Summary

4.2.24 Table 4.3, in association with Figure 4.4 (Volume 2), provides an indication of the geotechnical features and anticipated earthworks associated with North Corridor Option 1. Where minimal alteration is proposed to the vertical alignment of the centreline, an indicative dimension of the existing earthworks has been derived from the earthwork interface drawings. Modification of the existing earthworks may be required to accommodate the additional carriageway width.

Table 4.3: Geotechnical Summary of North Corridor Option 1

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section		Groundwater Encountered (bgl)	Remarks
6800m to 7200m	6850m	41.87m	Structure	GL to 1.2m 1.2m+	Topsoil Bedrock (Dolerite)	None	
7200m to 7400m	7250m	24.8m	Structure	GL to 5.3m 5.3m+	Made Ground Bedrock (Sandstone)	>2.0m	
7400m to 7500m	7450m	8.59m	Structure / (Embankment 1V:2H)	GL to 1.8m 1.8m to 12m 12m to 33.7m 33.7m+	Made Ground Dolerite Boulders Soft silty clay Bedrock (Mudstone)	>3.2m	High embankment, intermediate berms and slope drainage will be required.
7500m to 7800m	7800m	9m	Structure / (Embankment 1V:2H)	GL to 8.0m 8.0m+	Made Ground / Glacial Sands and Gravels Bedrock (Dolerite)	None Encountered	
7800m to 8150m	8050m	N/A 15m (Cutting)	At Grade (East) Cutting (West) 1V:2H	GL to 2.0m 2.0m to 4.00m 4.0m+	Made Ground Alluvium Bedrock (Dolerite)	13.1m	

Table 4.3 (cont'd): Geotechnical Summary of North Corridor Option 1

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section	Groundwater Encountered (bgl)	Remarks
8150m to 8700m	8450m	23m (Cutting) 7m (Embankment)	Cutting (East) Embankment (West) 1V:2H	East Side of Existing Road GL to 2.0m Weathered Glacial Till 2.0m+ Bedrock (Dolerite) West Side of Existing Road GL to 1.8m Made Ground 1.8m to 6.70m Alluvium 6.70m to 8.0m Peat 8.0m to 14.3m Alluvium 14.3m to 19.65m Glacial Till 19.65m to 20.15m Weathered Bedrock 20.15m+ Bedrock (Mudstone)	2.80m Heavy Strike at 14.30m	Problems may arise with settlement of soft deposits and differential settlement due to variable rockhead.
8700m to 9150m	8900m	26m	Cutting 1V:2H	West Side of Existing Road GL to 10.2m Glacial Till 10.2m+ Bedrock (Mudstone) East Side of Existing Road GL to 3.0m Weathered Glacial Till 3.0m 30.1m Glacial Till 30.1m + Bedrock (Sandstone) Bedrock was only found at Ch 8900	15.4m	Deep cutting with groundwater anticipated towards the base of the cutting. Berms will be required at regular intervals, with soil/rock berm. Rock slope drainage and surface drainage. Rock cut angle to be confirmed.
9150m to 9400m	9150m	5m	Embankment 1V:2H	GL to 2.2m Made Ground 2.2m to 20.5m Glacial Till 20.5m+ Bedrock (Dolerite), Mudstone to North	None Encountered	Low height embankment. Strength of Glacial Till may decide capping thickness for majority of embankment.
9400m to 9700m	9500m	7m	Embankment / Structure	GL to 12.7m Weathered Glacial Till/Glacial Sands & Gravels 12.7m+ Bedrock (Dolerite)	2.0m	

Table 4.3 (cont'd): Geotechnical Summary of North Corridor Option 1

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section	Groundwater Encountered (bgl)	Remarks
9700m to 10100m	-	N/A	At Grade	General Ground Conditions GL to 9.0m Weathered Glacial Till 9.0m to 15.2m Glacial Sands and Gravels 15.2m to 16.3m Weathered Bedrock 16.3m+ Bedrock (Sandstone)	1.8m	
10100m to 10400m	10400m	11.7m	Embankment/ Structure	GL to 21.0m Glacial Till and Glacial Sands & Gravels 21.0m+ Bedrock (Mudstone)	10.0m	High embankment will require intermediate berms.
10400m to 10700m	10450m	10.1m	Embankment	GL to 3.4m Weathered Glacial Till 3.0m+ Bedrock (Sandstone)	None Encountered	High embankment will require intermediate berms.
10700m to 11100m	11050m	12.6m	Embankment	GL to 3.0m Weathered Bedrock 3.0m+ Bedrock (Mudstone) On East side of existing road; Bedrock is interbedded mudstone and siltstone BHN 1047m: GL to 2.20m Weathered Glacial Till 2.20m to 2.80m Bedrock (Mudstone) 2.80m to 3.40m Coal 3.40m + Mudstone	None Encountered	High embankment will require intermediate berms.
11100m to 11900	11500m	5m, locally 15m (Cutting) 2m (Embankment)	Cutting (W) Embankment (E) 1V:2H	GL to 2.0m Weathered Glacial Till 2.0m+ Bedrock (Sandstone)	3m	

Table 4.3 (cont'd): Geotechnical Summary of North Corridor Option 1

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section	Groundwater Encountered (bgl)	Remarks
11900m to 12500	12100m	2m	Embankment 1V:2H	<u>West Side of Existing Road</u> GL to 2.5m Weathered Glacial Till 2.5m+ Bedrock (Mudstone) <u>East Side of Existing Road</u> GL to 2.0m Weathered Glacial Till 2.0m to 7.0m Glacial Till 7.0m + Bedrock (Sandstone) occasional shallow rockhead of mudstone in this area	2.5m	

* - Cutting Depths are based on the centreline long section and the earthworks interface drawings, Figures 4.4a and 4.4b (Volume 2).

Mineworkings

4.2.25 Ten designated mineral holes were undertaken during the 2008 ground investigation in proximity to the M90 north of Masterton Junction. Intact coal was encountered in nine of the boreholes with the remaining borehole, located adjacent to proposed cutting at approximate Chainage 10,900 metres, recording broken ground. Broken ground was encountered at a depth corresponding to the anticipated level of the coal seam in this borehole (between 14.7 metres and 16.2 metres below ground level) and is considered to be associated with the workings that are recorded on the mine abandonment plan in the vicinity of the borehole.

4.2.26 In most boreholes, the intact coal is considered to represent the thin coal seam underlying the Charlestown Main Limestone, due to the presence of a prominent limestone horizon within the sequence immediately overlying the coal in some of the deeper boreholes. The stratigraphical sequence and the location and depth of the coal are generally consistent with available geological information. Two of the positions encountered coal at or around its subcrop at a level of 2.8 metres below ground level, with a further borehole to the southeast in proximity to the new southbound diverge link encountering coal at subcrop at a deeper level of 8 metres below ground level. The thickness of the coal was found to vary between 0.2 and 1.0 metres thick. A deeper intact coal seam with a thickness of 0.5 metres was encountered north of the A823(M) to M90 northbound slip road, at a level of 17.6 metres below ground level.

4.2.27 Outwith the designated mineral holes area, intact coal has also been encountered at one borehole further northeast along the existing M90. It is not apparent from the geological plans with which seam this can be stratigraphically correlated as there are no coal subcrops shown in the vicinity of this location. The coal was recorded to be 0.7 metres thick with the top of the coal at a level of 8.45 metres below ground level. A further assessment of mineworkings would be necessary should this option be taken forward.

Hydrology

4.2.28 Figure 8.1 (Volume 2) details the watercourses within the study area of the Forth Replacement Crossing Project. Further information on hydrology is provided in Part 3, Chapter 8 of this report.

4.2.29 Brankholm Burn flows west to east through the town of Rosyth and traverses the M90 south of Masterton Junction. During the construction phase, an extension or replacement of the existing culvert will be required.

4.2.30 Pinkerton Burn traverses the M90 north of Masterton Junction. The condition of the existing structure at this crossing point will determine whether it needs to be extended or replaced.

4.2.31 In the provision of a link to the A921 from the reconstructed Masterton Junction, a new culvert crossing to the northeast of Inverkeithing Railway Junction is likely to be required.

Structures

4.2.32 The following paragraphs read in conjunction with Figure 4.5 (Volume 2) detail the structural requirements associated with North Corridor Option 1.

Structures 177-4 and 177-5

4.2.33 Structures 177-4 and 177-5 carry the existing A90 over Ferrytoll Junction. Both structures will require widening to accommodate the dual three lane motorway. The widening comprises precast beam and slab integral construction founded on spread footings.

Structures 177-10, 177-11 and 177-12

4.2.34 Structure 177-10 is the existing Ferrytoll railway tunnel under the existing A90 and the new mainline and its slip roads. It is a single span structure with an overall length of approximately 95 metres comprising a maximum span of 4.95 metres at a varying skew.

4.2.35 Structure 177-11 is an existing structure which carries the B980 over the Inverkeithing South Junction – Rosyth Dockyard Branch Line Railway close to the entrance/exit to the tunnel. It is a single span structure with a maximum span of 5.88 metres at a skew of 23°.

4.2.36 Both Structures 177-10 and 177-11 are concrete arch structures of integral construction. Bridge 177-10 is founded on spread footings; however the foundation type for structure 177-11 is unknown.

4.2.37 Structure 177-12 is located adjacent to structure 177-11. It is a single span structure with a span of 20.5 metres at a skew of 23°. It is a precast beam and slab structure of integral construction founded on spread footings and was built circa 2006.

4.2.38 The intention is that all structures shall be retained for use with North Corridor Option 1.

Structures 177-1, 177-2, 177-3 and 177-8

4.2.39 Structure 177-1 will carry the mainline from the new crossing to Ferrytoll. Structure 177-2 will carry the slip road from the proposed replacement bridge to Ferrytoll. Structure 177-3 will carry the link road from the Forth Road Bridge to the new mainline at Ferrytoll and Structure 177-8 will carry the link road from the M90 southbound to the Forth Road Bridge.

4.2.40 Structure 177-1 consists of eight spans with an overall approximate length of 625 metres with a maximum span of 90 metres. Structures 177-2, 177-3 and 177-8 are also multiple span structures with overall approximate lengths of 550 metres, 570 metres and 550 metres respectively. All four structures comprise steel/concrete composite construction founded on either bored concrete piles or spread footings. Structure 177-1 is on a very high skew, has bifurcations on the road and a varying road width. Access to Structures 177-1, 177-2 and 177-3 is very difficult due to the location and steep gradient of the surrounding land. Structure 177-8 will be of complex construction as it is curved in plan and crosses existing side roads. The construction of these bridges will require major traffic management.

Structures 177-6, 177-7 and 177-9

4.2.41 Structures 177-6 and 177-7 will carry the northbound diverge slip road from the proposed replacement bridge over the existing Ferrytoll Junction. Structure 177-9 will carry the slip road over the Inverkeithing South Junction – Rosyth Dockyard Branch Line Railway, north of the existing Ferrytoll roundabout.

4.2.42 Structures 177-6, 177-7 and 177-9 comprise single span structures with spans of 10 metres, 15 metres and 15 metres respectively. All three structures comprise of precast beam and slab integral construction founded on spread footings.

4.2.43 Structures 177-6 and 177-7 will be constructed over the existing Ferrytoll roundabout which will require significant traffic management. Structure 177-9 will require stringent measures during construction over the railway with disruptive possessions likely to be required.

Structure 170-1

4.2.44 The reconstructed Dunfermline Wynd Overbridge will carry Dunfermline Wynd over the new mainline. It is a three span structure with an overall approximate length of 90 metres with two end spans of 25 metres and a central span of 40 metres. It comprises of steel/concrete composite integral construction founded on spread footings.

Structure 182-8

4.2.45 Structure 182-8, an existing retaining wall at Admiralty Junction, is no longer required and is to be demolished.

Structures 182-9 and 182-11

4.2.46 The rebuilt Structure 182-9 and new Structure 182-11 will be cantilever retaining walls on the southeast and southwest sides of the Admiralty Junction respectively, built to accommodate the new dual three lane motorway. The walls will have a maximum retained height of 8 metres and an overall length of 120 metres. Both will be constructed using reinforced concrete and founded on spread footings.

Structures 182-6 and 182-7

4.2.47 Existing Structures 182-6 and 182-7 carry the M90 over Admiralty Junction. They will be widened with the widening in the form of a precast beam and slab deck supported on extended sections of the existing abutments. New wingwalls will be provided where required.

Structure 182-5

4.2.48 Structure 182-5 is an existing concrete arch culvert carrying the Brankholm Burn under the new road. The existing concrete arch culvert requires to be extended by approximately 8 metres to accommodate the road widening from a dual two lane motorway to dual three lane motorway.

Structures 182-12 and 182-15

4.2.49 Structure 182-12 will carry a new link road to the M90 northbound over Masterton Viaduct and the A823(M). Structure number 182-15 will carry the A823(M) over the M90 at Masterton Viaduct.

4.2.50 Structure 182-12 comprises a ten span structure with an overall approximate length of 410 metres consisting of four spans of 40 metres, three spans of 50 metres, two spans of 35 metres and one span of 30 metres. It is curved in plan.

4.2.51 Structure 182-15 comprises a three span structure with an overall approximate length of 120 metres consisting of two spans of 35 metres and one span of 50 metres.

4.2.52 Both structures comprise of steel/concrete composite construction founded on bored concrete piles. Constructed over the existing Masterton Viaduct, major traffic management will be required.

Structure 182-10

4.2.53 Structure 182-10 will carry Masterton Road over the M90 southbound off slip road at Masterton Junction. It consists of a single span with an approximate length of 15.3 metres at a skew of 20°. It comprises of precast beam and slab integral construction founded on spread footings.

Structure 171-2

4.2.54 The reconstructed Duloch Overbridge, Structure 171-2, will carry Aberdour Road over the new mainline. It consists of a three span structure with an overall approximate length of 66 metres consisting of two shorter spans of 15.5 metres and a maximum span of 35 metres at a skew of 10°. It comprises of steel/concrete composite integral construction founded on bored concrete piles.

Structure 000-1

4.2.55 The reconstructed Calais Muir Overbridge, Structure 000-1, will carry a side road over the new mainline. It consists of a three span structure with an overall approximate length of 65 metres consisting of two shorter spans of 15 metres and a maximum span of 35 metres. It comprises of steel/concrete composite integral construction founded on bored concrete piles.

Structure 182-1

4.2.56 Structure number 182-1, Masterton Viaduct, carries the M90 over the A823(M)

4.2.57 To incorporate the existing Masterton Viaduct as part of North Corridor Option 1, the following recommendations shall be considered:

- where required, widen the existing railway spans with either precast prestressed concrete beam and infill or steel filler beam type construction;
- where required, widen the existing concrete spans with either a reinforced concrete slab or precast prestressed concrete beam and infill type construction;
- in order to remain outwith the required railway clearance envelope for the southbound carriageway, consider carrying the A823(M) eastbound to M90 southbound on-slip on a separate structure, tying back into the M90 south of the existing south abutment;
- north of the structure, provide a link from the M90 southbound carriageway onto a new southbound on-slip to carry the abnormal SV196 load over a new southbound on-slip structure; and
- ensure the effect of the abnormal load from the widened section onto the existing structure is no more severe than current capacity.

4.2.58 Further details for the possible inclusion of the existing Masterton Viaduct will be considered further as part of the DMRB Stage 3 assessment process.

Structure 182-2

4.2.59 Structure 182-2, an existing single span structure carrying the M90 northbound off slip road to the A823(M) over the Fife Circle Railway Line is to be retained for use.

Structure 182-13

4.2.60 Replacement Structure 182-13 comprises a single span with a maximum length of 25 metres at a skew of 15°. It consists of precast beam and slab integral construction founded on bored concrete piles. The structure will require stringent measures during demolition and re-construction over the railway with disruptive possessions likely to be required.

Structure 182-14

4.2.61 Structure 182-14, an existing structure under the A823(M) is no longer required and will be demolished.

Structure 182-3

4.2.62 Structure 182-3, an existing structure carrying the A823(M) over the M90 is no longer required and will be demolished.

Structure 182-4

4.2.63 Replacement Structure 182-4 will carry Masterton Road over the M90. It comprises a single span with a span length of 28 metres. It consists of a steel/concrete composite integral construction founded on bored concrete piles.

Public Utilities

4.2.64 North Corridor Option 1 is likely to impact the following public utilities plant :

- 18no. Crossings of high voltage electric cables at 33Kv (overhead)
- 10no. Crossing of high voltage electric cable at 11Kv (underground)
- 2no. Crossings of intermediate pressure gas main (2 to 7 bar pressure)
- 7no. Crossings of medium pressure gas main (0.75 to 2 bar pressure)
- 7no. Crossings of trunk water mains

4.2.65 In addition to the above, other small-scale plant is affected such as telecommunication cables, street lighting cables, low-pressure gas pipes and small diameter water supply pipes.

Constructability

4.2.66 Whilst online widening of the existing A90/M90 makes best use of the existing corridor, its implementation is not without difficulty. As detailed, a widening of the carriageway cross section to dual three lane motorway will require a significant re-engineering of existing earthworks, embankments and cut slopes so to accommodate a continuous hard shoulder and an additional running lane. To implement such a proposal, a continuous traffic management system would be required on the mainline throughout the construction period so to maintain two lanes of traffic in each direction. Should this option be taken forward to DMRB Stage 3 assessment, significant thought shall be given to construction phasing and the maintaining of access between local and national routes during the construction period.

4.3 North Corridor Option 2

4.3.1 Table 4.4 read in conjunction with Figure 4.6 (Volume 2) provides a description of the North Corridor Option 2 mainline carriageway design.

Table 4.4: Engineering Description of North Corridor Option 2 Mainline

Corridor	Mainline Description
North Corridor Option 2	**Mainline** Design Details • Route Corridor Length: 7.0km • Design Speed: 120kph • Dual two lane motorway (D2M) encompassing: ○ 7.3m running carriageway ○ 3.6m hard shoulders (where practicable for future hard shoulder running) ○ 0.7m hardstrips ○ 3.1m central reserve ○ 1.5m verge Design Geometry • Minimum Horizontal Radius = 1020m • Minimum Vertical Gradient = 0.7% • Maximum Vertical Gradient = 2.4% • Minimum Sag Curve Radius = 3700m • Minimum Crest Curve Radius = 3700m

Engineering Constraints

- Existing topography
- Connection to A90/M90 route corridor
- Junction provision and side roads connectivity
- Side road crossings
- Railway Crossings at Ferrytoll and Inverkeithing
- Proximity of Rosyth and Inverkeithing
- Environmentally significant areas (refer to Part 3)
- Possible future multi-modal developments (LRT, BRT, guided buses or trams)

Mainline Features

4.3.2 A full improvement to North Corridor Option 2 consists of an offline dual two lane motorway connecting the proposed replacement bridge to the M90 north of Masterton Junction. South of Ferrytoll Junction, the mainline shall be implemented as an all purpose carriageway with hard shoulder to maintain cross-Forth access for non-motorway traffic.

4.3.3 Interfacing with the proposed replacement bridge at St Margaret's Hill, the corridor descends to the west of the existing A90/M90 route corridor at 3% passing through St Margaret's Marsh on a R1020 metre left hand horizontal curve before crossing Ferry Toll Road, west of Dunfermline Waste Water Treatment Works.

4.3.4 The provision of offline geometry requires a new junction arrangement to be constructed at Ferrytoll, catering for all traffic movements between the mainline and the local road network.

A new structural crossing of the Rosyth Dockyard Branch Line Railway will be required in its implementation. The section of the A90/M90 severed by the provision of this route corridor option will continue to be of service as a local distributor road for west Fife, the new junction arrangement at Ferrytoll providing access and egress.

4.3.5 Continuing north, the corridor runs parallel to the existing A90/M90 between Ferrytoll Junction and Castlandhill. The earthworks associated with this section transition from embankment to cutting, with significant cut slopes being required on approach to Castlandhill itself, the corridor climbing at a gradient of between 0.7% and 3%. Passing to the east of Castlandhill Woods the corridor turns northeast by way of a R1440 metre right hand horizontal curve.

4.3.6 Upon reaching Castlandhill, the significant level difference encountered between the proposed vertical geometry and existing ground level requires consideration to be given to a cut and cover solution, minimising as best as possible the visual impact of the corridor on the surrounding area.

4.3.7 Exiting the cut and cover section northeast of Castlandhill, the corridor passes beneath Castlandhill Road before crossing the existing A90/M90 on a structure. Having traversed the A90/M90, the corridor then descends at 3.5% passing over the A921 northwest of Inverkeithing.

4.3.8 The topography of the area through this section transitions from the rugged landscape of coastal hills to a shallow valley in which Belleknowes Industrial Estate and the Fife Circle Railway Line are located. To cater for this sharp change in landscape, the construction of a new viaduct is required carrying the corridor over the A921, through Belleknowes Industrial Estate and over the railway line.

4.3.9 In achieving a connection to the existing M90, the corridor climbs out of the valley at a gradient of 4% turning on a R2800 metre left hand horizontal curve to achieve the necessary approach bearing required to generate a suitable tie in. Passing to the west of The Dales Farmhouse, the provision of a tie in to the M90 at the B916 Aberdour Road requires a significant length of cutting on approach.

4.3.10 Coincidental with the tie in to the existing M90, a simple slip road arrangement facilitates access to the redundant section of the A90/M90 carriageway, providing connectivity to Rosyth, Inverkeithing and Dalgety Bay through the use of the existing Admiralty and Masterton Junctions.

Departures from Standard

4.3.11 At present, no mainline departures from standard have been identified in the development of North Corridor Option 2. A number of existing departures are inherent within the A90/M90 however which would be retained. In addition, there are potential departures within the vicinity of junctions.

4.3.12 Initial discussions have been held with Transport Scotland’s Standards Branch as to the suitability of the design work undertaken to date. Should this option be taken forward to DMRB Stage 3 assessment, the development of the design shall be discussed further with Standards Branch, any departures from standard being highlighted at an early stage.

Junction Provision

4.3.13 Table 4.5 read in conjunction with Figures 4.7 and 4.8 (Volume 2) gives an overview of the indicative junction arrangements developed for North Corridor Option 2.

Table 4.5: Engineering Description of North Corridor Option 2 Junctions

Corridor	Description
North Corridor Option 2	**Junction Provision** Ferrytoll Junction • New Grade Separated Junction arrangement providing local and non-motorway access. • Northbound, new roundabout provided, enabling northbound interaction between the mainline and local roads through new slip arrangements. ○ Mainline Diverge to roundabout and local routes ○ Mainline Diverge to existing A90/M90 ○ Mainline Merge – Fork merge arrangement to A90/M90 ○ Access maintained to B980, B981 & Ferrytoll Rd through new link roads • Southbound, existing roundabout utilised allowing interaction between the mainline, local roads and Ferrytoll Park & Ride through new slip arrangements. ○ Mainline Diverge: Local access taken from M90 via new slip road arrangement sited north of Masterton Junction. Existing A90/M90 access arrangements utilised. ○ Mainline Merge: New link provided to new mainline from existing A90/M90. ○ Access maintained to B980, B981 & Ferry Toll Rd via existing road network and new link road beneath mainline. • Bus functionality provided through hard shoulder running on slips. • Junction future proofed for the provision of additional transport modes i.e. LRT, BRT, guided buses or trams. • Access to Forth Road Bridge maintained through the provision of additional slip road arrangements at Ferrytoll Junction. Admiralty Junction • Existing junction functionality retained between the A90/M90, A985 and A921 Masterton Junction • Existing junction functionality retained between the A90/M90 and A823(M) A90/M90 Link to North Corridor Option 2 • North facing slip roads provided north of Masterton Junction providing connectivity between existing A90/M90 and North Corridor Option 2.

Topography & Land use

4.3.14 The topography encountered in the provision of North Corridor Option 2 is similar to that experienced in the implementation of North Corridor Option 1, with a mixture of residential, commercial and agriculture land use being prevalent.

4.3.15 To the south, the coastal flats of the Firth of Forth are again the prominent feature with pockets of woodland and St Margaret's Marsh dominating the northern shoreline.

4.3.16 Continuing north, as the corridor ascends Castlandhill, significant cut slopes and the provision of a cut and cover solution will be required to establish the corridor. The construction of such measures will, require significant excavation to implement.

4.3.17 The route will be on viaduct over Belleknowes Industrial Estate and the construction of the viaduct will impact the A921 and the Fife Circle Railway Line.

4.3.18 The rugged topography associated with the north of Inverkeithing will also be affected with significant earthworks being required in the routing of this option to the east of the existing A90/M90 corridor.

4.3.19 Continuing north where agricultural land use is more prevalent, a further permanent change in topography will occur, the corridor requiring the provision of a significant length of cutting so to tie into the existing M90 north of Masterton Junction.

Geotechnical Summary

4.3.20 North Corridor Option 2 is situated offline from the existing A90/M90 corridor. Therefore, to accommodate the proposed vertical alignment, more extensive earthworks would be required than for North Corridor Option 1.

4.3.21 Until the completion of the ground investigations and associated testing, an assessment of the likely slope angles will not be undertaken. The general design assumptions for slopes at present are that they will not be steeper than 26.6^{o} (1V:2H) for both embankments and cuttings. However, in certain cases these may have to be relaxed to satisfy the stability of the slope. Steeper angles of 60^{o} to 80^{o} (2V:1H - 5V:1H) may be possible in rock depending on rock type, discontinuity orientations, spacing and type/extent of infill material, and groundwater.

4.3.22 The cuttings are likely to be formed predominantly within rock. The excavation of cuttings will produce considerable quantities of excavated material, some of which may be appropriate for re-use within the project earthworks. Rock slope drainage measures such as raking drains and relief drains may be required, as well as standard rock slope stabilisation treatment.

4.3.23 A limit of around 7 metres has been assumed in terms of maximum height/depth of a feature before an interim berm is required. This is for improved stability as well as maintenance access. A berm at the soil/rock contact will also be required for slope stability and drainage.

4.3.24 Where soft alluvial deposits or large thicknesses of glacial till are recorded beneath the footprint of proposed embankments, consideration must be given to avoidance of residual settlement (post construction). This may take the form of ground treatment; including pre-loading with or without band drains and replacement of soft deposits, or programming of construction to allow for settlement to occur.

Geotechnical Summary

4.3.25 Table 4.6, in association with Figure 4.9 (Volume 2), provides an indication of the anticipated earthworks associated with North Corridor Option 2.

Table 4.6: Geotechnical Summary of North Corridor Option 2

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section		Groundwater Encountered (bgl)	Remarks
7200m to 7400m	7250m	30.9m	Structure	GL to 5.3m 5.3m+	Made Ground Bedrock (Sandstone)	>2.5m	
7400m to 7500m	7400m	28.4m	Embankment 1V:2H / Structure	GL to 1.8m 1.8m to 12m 12m to 33.7m 33.7m+	Made Ground Dolerite 'boulders' Soft silty clay Bedrock (Mudstone)	>3.2m	High embankment, intermediate berms and slope drainage will be required.
7500m to 7800m	7550m	15.1m	Embankment (West), Cutting (East) 1V:2H	GL to 2.0m 2.0m to 4.00m 4.0m+	Made Ground Weathered Glacial Till/Glacial Sands and Gravels Bedrock (Dolerite)	None Encountered	Soil/Rock bench required.
7800m to 8000m	7900m	6.7m	Embankment 1V:2H	GL to 2.0m 2.0m to 4.00m 4.0m+	Made Ground Alluvium Bedrock (Dolerite)	13.1m	Majority of embankment low height, where strength of alluvium may decide capping thickness.
8000m to 8400m	8300m	25m	Cutting 1V:2H	GL to 1.2m 1.2m+	Weathered Glacial Till Bedrock (Dolerite)	None Encountered	Steeper cut angle probable in rock. Intermediate berms. Rock slope drainage; surface drainage. Rock slope stabilisation measures.

Table 4.6 (cont'd): Geotechnical Summary of North Corridor Option 2

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section		Groundwater Encountered (bgl)	Remarks
8400m to 9050m	8700m	26.7m	Cutting 1V:2H	GL to 2m 2m to 33.1m 33.1m + Locally at Ch8800 bedrock is present at 6m and 13m	Weathered Glacial Till Glacial Till Bedrock (Mudstone)	10.5m	Deep cutting will require intermediate berms and slope drainage.
9050m to 9300m	9250m	16.2m	Embankment 1V:2H	GL to 25m 25m+	Glacial Till Bedrock (Mudstone)	2.50m	Issues may arise with settlement of deep Glacial Till deposits beneath the embankment.
9300m to 9500m	9300m	20m	Embankment 1V:2H	GL to 0.2m 0.2m+	Topsoil Bedrock (Dolerite)	20.1m	
9500m to 9650m	9550	21m	Cutting 1V:2H	GL to 1.0m 1.0m+	Topsoil Bedrock (Sandstone)	None Encountered	Intermediate berms and slope drainage
9650m to 11100m	9900m	23m	Embankment 1V:2H	GL to 9.80m 9.80m+	Weathered Glacial Till/Glacial Sands and Gravels Bedrock (Dolerite)	Artesian 0.3m above GL	Issues may arise with settlement of the Weathered Glacial Till deposits beneath the embankment.
11100m to 12100m	11600m	17.8m	Cutting 1V:2H	GL to 2.0m 2.0m to 4.0m 4.0m+	Weathered Glacial Till Glacial Till Bedrock (Limestone/Mudstone/ Basalt)	None Encountered	Steeper cut angle probable. Intermediate berms. Rock slope drainage; surface drainage.

* - Cutting Depths are based on the centreline long section and the earthworks interface drawings, Figures 4.9a and 4.9b (Volume 2).

Mineworkings

4.3.26 One previously unrecorded coal seam was encountered to the east of Masterton Junction during the ground investigation. The boreholes did not suggest that these seams had been worked at these locations. No mineworkings are recorded to occur beneath North Corridor Option 2. A further assessment of mineworkings would be necessary should this option be taken forward.

Hydrology

4.3.27 Figure 8.1 (Volume 2) details the watercourses within the study area of the Forth Replacement Crossing Project. Further information on hydrology is provided in Part 3, Chapter 8 of this report.

4.3.28 Through the implementation of North Corridor Option 2, Pinkerton Burn flowing north to south from Middlebank, and Brankholm Burn, flowing west to east through Rosyth will require to be re-routed through new structures beneath the proposed mainline carriageway. Both watercourses are tributaries of Keithing Burn.

Structures

4.3.29 The following paragraphs read in conjunction with Figure 4.10 (Volume 2) detail the structural requirements associated with North Corridor Option 2.

Structures 178-1 and 178-2

4.3.30 Structures 178-1 and 178-2 carry the mainline and northbound diverge slip road from the proposed replacement bridge over local access roads and Ferrytoll Junction. Structure 178-1 comprises an eight span structure with an overall approximate length of 950 metres with a maximum span of 90 metres at a varying skew. Structure 178-2 comprises an overall approximate length of 560 metres at a varying skew. Both are proposed as steel/concrete composite construction founded on bored concrete piles. Both structures have very difficult access on side long ground and Structure 178-1 is also highly skewed with bifurcations and varies in width.

Structure 178-5 and 178-6

4.3.31 Structures 178-5 and 178-6 carry the existing A90 over the Ferrytoll Junction. Both structures will be demolished as they are no longer required.

Structures 178-4, 178-7 and 178-12

4.3.32 Structures 178-4 and 178-7 will carry the A90 link road to the proposed replacement bridge over the realigned B981 and the new Ferrytoll roundabout link respectively. Structure 178-12 carries the new mainline over the new Ferrytoll roundabout link. All structures comprise single spans with Structure 178-4 having a span of 30 metres at a skew of 40° and Structures 178-7 and 178-12 having spans of 25 metres at skews of 25°. All structures comprise precast beam and slab construction with structure 178-4 being non-integral and Structures 178-7 and 178-12 being of integral construction. All structures are founded on spread footings.

Structure 178-3

4.3.33 Structure 178-3 will carry the B981 over the Inverkeithing South Junction – Rosyth Dockyard Branch Line Railway from the relocated Ferrytoll roundabout. It is proposed as a single span structure with a span of 15 metres at a skew of 10°. It comprises precast beam and slab integral construction founded on spread footings. The structure will require stringent measures during construction over the railway with disruptive possessions likely to be required.

Structure 178-8

4.3.34 Structure 178-8 will carry a link road from the proposed replacement bridge to the existing A90 northbound over the new mainline. It is proposed as a four span structure with an overall approximate length of 140 metres comprising two spans of 40 metres and two spans of 30 metres at a skew of 60°. It comprises steel/concrete composite construction founded on spread footings. The structure will be of complex design and construction as it is highly skewed, curved in plan and is to be constructed over the existing M90.

Structures 178-9, 178-10, 178-11

4.3.35 Structure 178-9 is the existing Ferrytoll railway tunnel under the existing A90 and the new mainline and its slip roads. It is a single span structure with a span of 4.95 metres and an overall length of approximately 95 metres. Structure 178-10 is an existing structure which carries the B980 over the Inverkeithing South Junction – Rosyth Dockyard Branch Line Railway close to the entrance/exit to the tunnel. It is a single span structure with a maximum span of 5.88 metres.

4.3.36 Both structures 178-9 and 178-10 are of concrete arch integral construction. Structure 178-9 is founded on spread footings; however the foundation type for structure 178-10 is unknown.

4.3.37 Structure 178-11 is a widened section of Structure 178-10. It is a single span structure with a span of 20.5 metres at a skew of 23°. It is of precast beam and slab integral construction founded on spread footings and was built circa 2006.

4.3.38 The intention is that all structures shall be retained for use with North Corridor Option 2.

Structure 135-8

4.3.39 Structure 135-8 will comprise a tunnel from approximately Ch 8550 metres to 8950 metres. Twin tunnels will be constructed, one for southbound and one for northbound traffic with a clear separation of at least 20 metres between them. A tunnel boring machine type excavation would not be appropriate and hence a sequential excavation will be employed. Sprayed concrete, lattice girders and mesh reinforcement will be used for the primary tunnel lining with a cast insitu concrete lining constructed to complete the tunnel lining. Construction operations will need to take cognisance of potential surface settlement during excavation.

Structure 135-1

4.3.40 Structure 135-1 will carry the B980 over the new mainline. It is proposed as a three span structure with an overall approximate length of 91 metres comprising a maximum span of 42 metres at a skew of 40°. It comprises a steel/concrete composite structure founded on bored concrete piles. The structure is on a very high skew which would result in complex design and construction.

Structure 135-2

4.3.41 Structure 135-2 will carry the new mainline over the existing A90. It is proposed as a three span structure with an overall approximate length of 130 metres with a maximum span of 62 metres at a skew of 60°. It comprises a steel/concrete composite structure founded on bored concrete piles. The structure is on a very high skew which would result in complex design and construction.

Structure 136-3

4.3.42 Structure 136-3 will carry the new mainline over the A921 Admiralty Road, Belleknowes Industrial Estate and Inverkeithing Railway Junction. It is proposed as a nine span structure with an overall approximate length of 550 metres with a maximum span of 75 metres. It comprises a steel/concrete composite structure founded on bored concrete piles. The structure may possibly be constructed by incremental launching to minimise disruption to facilities at ground level.

Structure 136-4

4.3.43 Structure 136-4 will be an underpass carrying the new mainline over Masterton Road. It comprises a single span structure with an overall approximate length of 45 metres between headwalls and a clear span length of 9 metres at a skew of 30°. It is proposed as a portal structure with a precast beam deck founded on spread footings.

Structure 179-1

4.3.44 Structure 179-1 will carry the M90 southbound connection to the proposed replacement bridge. It is considered as a five span structure with an overall approximate length of 225 metres comprising three spans of 45 metres and two spans of 40 metres curved in plan. It comprises a steel/concrete composite structure founded on bored concrete piles. The structure will be of complex construction as it is curved in plan and is to be constructed over the existing M90.

Structure 179-2

4.3.45 The reconstructed bridge, Structure 179-2, will carry the B916 over the M90 and new slip roads. It is proposed as a single span structure with a span of 50 metres and comprises a steel/concrete composite integral structure founded on bored concrete piles.

Structures 135-5 and 000-1

4.3.46 Structure 135-5 Dunfermline Wynd Overbridge carries Dunfermline Wynd over the existing A90. It is a three span structure with an overall length of 71.8 metres between abutment centres with a maximum span length of 32.2 metres. It comprises a haunched concrete deck with a voided suspended main span. The piers are founded on spread footings and the abutments on piles. It will be retained.

4.3.47 Structure 000-1, Calais Muir Overbridge, carries a side road over the existing M90 close to Calais Muir Wood. It is a four span structure with an overall skew length of 52.3 metres (between abutment centres) with a maximum span length of 14.8 metres. It is an insitu reinforced concrete slab structure founded on leaf piers and bankseat abutments, all founded on piles. It will be retained.

Public Utilities

4.3.48 North Corridor Option 2 is likely to impact the following public utilities plant:

- 8no. Crossings of high voltage electric cables at 33Kv (7no. overhead/1no. underground)
- 12no. Crossing of high voltage electric cable at 11Kv (underground)
- 1no. Crossings of intermediate pressure gas main (2 to 7 bar pressure)
- 10no. Crossings of medium pressure gas main (0.75 to 2 bar pressure)
- 3no. Crossings of trunk water mains

4.3.49 In addition to the above, other small-scale plant is affected such as telecommunication cables, street lighting cables, low-pressure gas pipes and small diameter water supply pipes.

Constructability

4.3.50 Constructed offline, the North Corridor Option 2 mainline does not generate the traffic management issues associated with North Corridor Option 1. For long periods traffic would be able to run unhindered on the existing A90/M90, the new corridor being constructed in isolation. Sustained periods of traffic management would only become a factor where structural crossings and new junction arrangements are required. The construction of Ferrytoll Junction would require significant traffic management over a sustained period.

4.3.51 In the construction of North Corridor Option 2, significant impacts would be experienced to the A921, Belleknowes Industrial Estate and Network Rail's property located to the north of Inverkeithing. Should this option be taken forward to DMRB Stage 3 assessment, further detailed consideration of this area will be necessary taking into consideration the requirement for significant earthworks and structural provision.

4.4 South Corridor Option 1

4.4.1 Table 4.7 read in conjunction with Figure 4.11 (Volume 2) provides a description of the South Corridor Option 1 mainline carriageway design.

Table 4.7: Engineering Description of South Corridor Option 1 Mainline

Corridor	Description
South Corridor Option 1	**Mainline** • Route Corridor Length: 2.75km • Design Speed: 120kph • Dual three lane motorway (D3M) cross-section operated as all purpose road o 11m running carriageway o 3.6m hard shoulders (where practicable for future hard shoulder running) o 0.7m hardstrips o 3.1m central reserve o 1.5m verge Design Geometry • Minimum Horizontal Radius = 720m • Minimum Vertical Gradient = 0.5% • Maximum Vertical Gradient = 3.0% • Maximum Sag Curve Radius = 3700m • Minimum Crest Curve Radius = 3700m

Engineering Constraints

- Existing topography
- Connection to existing A90 south of the Forth Road Bridge
- Utilisation of existing roads infrastructure associated with Forth Road Bridge
- Junction provision and side roads connectivity
- Location of BP Pipeline
- Proximity of residential areas
- Environmentally significant areas (refer to Part 3)
- Possible future multi-modal developments (LRT, BRT, guided buses or trams)

Mainline Features

4.4.2 A full improvement to South Corridor Option 1 consists of a dual three lane carriageway to motorway standard connecting the proposed replacement bridge to the A90, a strategically important piece of roads infrastructure which currently connects the Forth Road Bridge to Edinburgh and the central Scotland motorway network. The new carriageway will be operated as an all purpose road facilitating cross-Forth access for non-motorway traffic.

4.4.3 The horizontal and vertical geometry of the South Corridor Option 1 has been carefully designed to minimise the number of crossings of the BP Pipeline required in the provision of the corridor.

4.4.4 The BP Pipeline, passing through the fields to the south of the A904, is also situated in close proximity to the northbound verge of the A90. Consultation with BP Oil UK Ltd is ongoing with regards to their requirements for pipeline protection. The required protection measures shall be fully implemented with any route corridor option taken forward for future consideration as part of the DMRB Stage 3 assessment process.

4.4.5 Tying into the A90 east of the A8000 overbridge, South Corridor Option 1 provides enhancements to the existing Scotstoun Junction whilst maintaining northbound access to South Queensferry for traffic on the A90 and the M9 Spur. In addition, an upgrade of M9 Junction 1a is also proposed, with new free flow links providing all movements in all directions between the M9 and the M9 Spur.

4.4.6 The South Corridor Option 1 mainline departs the A90 in a westerly direction, to the south of the A904. Within this area, it is proposed that a new junction be constructed connecting local communities such as Newton and South Queensferry to the proposed replacement bridge, Edinburgh and the central Scotland motorway network.

4.4.7 Beyond this new junction, the corridor swings north towards the Firth of Forth and the proposed replacement bridge. Utilising a R720 metre right hand horizontal curve and a vertical gradient of 3% gradient, the corridor passes beneath the A904 to the west of South Queensferry. In achieving this, significant cut slopes are necessary, a new overbridge being required to carry the A904 over the new mainline carriageway.

4.4.8 On approach to the proposed replacement bridge the horizontal geometry of the corridor straightens, a shallow incline being implemented to facilitate connection to the bridge approach structure.

Departures from Standard

4.4.9 Considering the engineering constraints associated with this corridor, the horizontal and vertical geometry implemented is subject to a number of relaxations from standard for a 120kph design speed.

4.4.10 In general these relaxations are associated with the vertical geometry of the corridor, R10000 metre crest curves being implemented to form an appropriate tie in with the existing A90 and to provide sufficient clearance to the BP Pipeline.

4.4.11 The R720 metre right hand curve located on approach to the crossing of the A904 and the proposed replacement bridge represents a horizontal relaxation of one design speed step below desirable minimum. Whilst permissible in isolation, its provision in combination with a relaxation in vertical curvature, required in the provision of headroom clearance to the A904, results in a Departure from Standard.

4.4.12 Initial discussions have been held with Transport Scotland's Standards Branch as to the suitability of the design work undertaken to date. Should this option be taken forward to DMRB Stage 3 assessment, the development of the design shall be discussed further with Standards Branch, any departures from standard being highlighted at an early stage.

Junction Provision

4.4.13 Table 4.8 read in conjunction with Figures 4.12 and 4.13 (Volume 2) gives an overview of the indicative junction arrangements developed for South Corridor Option 1.

Table 4.8: Engineering Description of South Corridor Option 1 Junctions

Corridor	Description
South Corridor Option 1	**Junction Provision** Echline/Scotstoun Combination Junction • Existing Scotstoun Junction utilised with additional functionality provided. o Northbound connectivity to A904 and South Queensferry maintained with provision of new link road between M9 Spur and existing Echline Roundabout. o Northbound, diverging slip road from A90 to new link northbound provides connection between north of Edinburgh and A904. o Reconnection of Forth Road Bridge northbound achieved through forking of proposed link road on approach to existing Echline Junction. o Southbound, new link road at Scotstoun Junction provides connection between Forth Road Bridge, M9 Spur and A90. • New Grade Separated Echline Junction in combination with Scotstoun Junction improvements maintains all movement functionality south of proposed replacement bridge. o Northbound, slip road provided between new roundabout on A904 and mainline, maintaining local cross Forth links. o Southbound, simple merge and diverge slip roads provided between mainline and new A904 roundabout facilitating local access for departing bridge traffic. • Dedicated HOV lane provided from new Echline Junction to proposed replacement bridge, allowing safe transition between new mainline and the existing dual three lane all purpose A90 where no such functionality exists. M9 Junction 1a • New free flow, all movements junction linking M9 with M9 Spur. • East facing functionality retained: o Existing loop, facilitating access between M9 Westbound and M9 Spur replaced with simple link, improving junction operation and safety. o Existing M9 Spur to M9 Eastbound slip road utilised with localised improvements to entry/exit tapers and nosings. • West facing functionality added: o New link road provided from M9 Spur to M9 Westbound serving traffic to West Lothian and beyond. o New link road provided from M9 Eastbound to M9 Spur serving traffic from West Lothian, relieving pressure on A904.

Topography & Land use

4.4.14 The topography of the area surrounding South Corridor Option 1 encompasses a mixture of residential and agricultural property.

4.4.15 Passing to the south of the A904, the corridor is situated within lowland hill and valley farmland and crosses Dundas Estate.

4.4.16 To the north, situated on the shoreline of the Firth of Forth lies the town of South Queensferry. Sited close to the Forth Road Bridge and the Forth Rail Bridge, South Queensferry is a popular tourist destination and commuter town for Edinburgh, residential property being the predominant land use.

4.4.17 Whilst the topography of the area generally falls towards the Firth of Forth, the fields affected by the corridor to the south of the A904 gently rise from south to north, the A904 being situated on embankment. North of the A904, the land falls sharply towards the Firth of Forth, a steep change in gradient being experienced between Inchgarvie House and Port Edgar.

Geotechnical Summary

4.4.18 The earthworks associated with South Corridor Option 1 comprise relatively shallow embankment to the south of South Queensferry, descending into cutting to pass beneath the A904.

4.4.19 Until the completion of the ground investigations and associated testing, an assessment of the likely slope angles will not be undertaken. The general design assumptions for slopes at present are that they will not be steeper than 26.6^{o} (1V:2H) for both embankments and cuttings. However, in certain cases these may have to be relaxed to satisfy the stability of the slope. Steeper angles of 60^{o} to 80^{o} (2V:1H - 5V:1H) may be possible in rock depending on rock type, discontinuity orientations, spacing and type/extent of infill material, and groundwater.

4.4.20 The cutting is likely to be partially formed within glacial deposits, and partially within rock. Rock slope drainage measures such as raking drains and relief drains may be required, as well as standard rock slope stabilisation treatment.

4.4.21 A limit of around 7 metres has been assumed in terms of maximum height/depth of a feature before an interim berm is required. This is for improved stability as well as maintenance access. A berm at the soil/rock contact will also be required for slope stability and drainage.

4.4.22 Where large thicknesses of glacial till are recorded beneath the footprint of proposed embankments, consideration must be given to avoidance of residual settlement (post construction). This is of particular importance in the vicinity of the BP Pipeline, and appropriate pipeline protection measures will be accommodated within the design should this option be taken forward for further assessment.

Geotechnical Summary

4.4.23 Table 4.9, in association with Figure 4.14 (Volume 2), provides an indication of the anticipated earthworks associated with South Corridor Option 1.

Table 4.9: Geotechnical Summary of South Corridor Option 1

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section		Groundwater Encountered (bgl)	Remarks
0m to 200m	200m	1.6m	Embankment 1V:2H	GL to 1.7m 1.7m to 3.2m 3.2m to 23.7m 23.7m	Weathered (Cohesive) Glacial Till Granular Glacial Till Cohesive Glacial Till Bedrock (Sandstone)	14m	Existing A90. Rock not encountered in ground investigation.
200m to 475m	400m	2m	Embankment 1V:2H	GL to 3.4m 3.4m to 10m+ 10m+	Weathered Glacial Till Cohesive Glacial Till Anticipated Bedrock (Likely Sandstone)	3.2m	Depth to rockhead near Chainage 300m is 30.4mbgl.
475m to 575m	500m	0.4m	Cutting 1V:2H	GL to 2.1m 2.1m to 33m+ 33m+	Weathered Glacial Till Cohesive Glacial Till Anticipated Bedrock (Likely Sandstone)	2.2m	Depth to rockhead very variable, varies between 1.2mbgl and >33mbgl within 60m.
575m to 1000m	700m	3.8m	Embankment 1V:2H	GL to 1.9m 1.9m to 4.6m ~4.6m	Weathered Glacial Till Cohesive Glacial Till Anticipated Bedrock (Siltstone)	4.6m	Rockhead only encountered offline.
1000m to 1530m	1300m	5.2m	Embankment 1V:2H	GL to 2.5m 2.5m to 14.7m 14.7m	Weathered Glacial Till Cohesive Glacial Till Bedrock (Mudstone)	14.7m	
1530m to 1800m	1750m	2.3m	Cutting 1V:2H	GL to 1.5m 1.5m to 8.0m 8.0m	Weathered Glacial Till Cohesive Glacial Till Bedrock (Sandstone)	1.5m	Depth to rockhead very variable. Soft deposits may affect the stability of the cut slopes locally.

Table 4.9 (cont'd): Geotechnical Summary of South Corridor Option 1

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section		Groundwater Encountered (bgl)	Remarks
1800m to 2350m	2100m	11.4m	Cutting 1V:2H	GL to 2.3m 2.3m	Weathered Glacial Till Bedrock (Sandstone)	1.5m	Depth to rockhead very variable. In-slope drainage and surface drainage may be required. Cohesive Glacial Till present at north end of chainage range. Soft deposits may affect the stability of the cut slopes locally. Localised perched water anticipated at Ch 2250m. Intermediate berms will be required at 7m height as well as soil / rock contact.
2350m to 2600m	2400m	5.6m	Cutting 1V:2H	GL to 1.9m 1.9m to 7.4m 7.4m to 8.2m 8.2m	Weathered Glacial Till Cohesive Glacial Till Gravel Bedrock (Dolerite)	2.5m	Soft and granular deposits may affect the stability of the cut slopes locally.
2600m to 3150m	-	-	Bridge Approach	GL to 1.5m 1.5m to 4.5m 4.5m +	Weathered Glacial Till Granular Glacial Till Bedrock (predominantly Sandstone and Dolerite)	2.1m	Approach to bridge.

* - Cutting Depths are based on the centreline long section and the earthwork interface drawing, Figure 4.14 (Volume 2).

Mineworkings

4.4.24 The majority of the extractable mineral deposits recorded to the south of the Firth of Forth comprise seams of oil shale; however, one coal seam, the Houston Coal, is recorded to occur close to the tie-in between South Corridor Option 1 and the existing A90 near Scotstoun.

4.4.25 No mine-workings are recorded to occur beneath the South Corridor Option 1, either in the coal seam or the oil shales, and the deep boreholes undertaken to date to investigate the recorded seams have not suggested that they have been worked beneath the corridor.

4.4.26 Workings within the Broxburn Shales are recorded in the vicinity of the tie-in between the A90 and M9 Spur close to Dalmeny, and should the proposed junction improvements be required in this area, it is likely that further investigation of the condition of these seams, and possible ground treatment would be required. Some grouting works were undertaken as part of the construction for the M9 Spur Extension; however it is unlikely that the treated zone extends over the area which would be necessary for the junction improvements. A further assessment of mineworkings would be necessary should this option be taken forward.

Hydrology

4.4.27 Figure 8.1 (Volume 2) details the watercourses within the study area of the Forth Replacement Crossing Project. Further information on hydrology is provided in Part 3, Chapter 8 of this report.

4.4.28 Niddry Burn, situated to the south of M9 Junction 1a, crosses the M9 from west to east through an existing culvert. Through the provision of a new junction at this location, it is possible that an extension of this culvert may be required to cater for the provision of the new slip road connecting the M9 westbound carriageway to the M9 Spur.

4.4.29 Swine Burn, located to the north of the M9, flows from west to east with a culvert carrying the watercourse through the area of M9 Junction 1a. It will be necessary for an additional culvert to be constructed beneath the new slip road from the M9 eastbound carriageway to the M9 Spur, requiring a diversion of the watercourse during construction.

4.4.30 Dolphington Burn, located to the south of Scotstoun Junction, will require the provision of an additional watercourse crossing to complement that provided in the construction of the M9 Spur Extension. The new crossing, situated upstream of the existing structure will require a diversion of the watercourse during construction.

4.4.31 Linn Mill Burn, situated to the west of the corridor, is the likely outfall point for the drainage system associated with South Corridor Option 1. Flowing northwards, Linn Mill Burn's point of source is situated at Totleywells, its outfall to the Firth of Forth being situated at Port Edgar.

Structures

4.4.32 The follow paragraphs read in conjunction with Figure 4.15 (Volume 2) detail the structural requirements associated with South Corridor Option 1.

Structure 167-9

4.4.33 Structure 167-9 is an existing culvert carrying the Niddry Burn under the existing M9. The structure is required to be extended to accommodate the increased width of the road. No information is currently available for the existing culvert at this stage however it is assumed that it can be retained.

Structure 167-10

4.4.34 Structure 167-10 is an existing structure which carries the link road from the westbound carriageway of the M9 to the M9 Spur. This existing structure is no longer required as part of the scheme and will be demolished.

Structure 167-6

4.4.35 Structure 167-6 will carry the M9 Spur southbound, over the M9 and new M9 to M9 Spur link road, providing access to the M9 westbound carriageway. A six span structure is proposed with an overall approximate length of 200 metres comprising two 25 metre spans, two 40 metre spans and two 35 metre spans, curved in plan. It comprises a continuous steel/concrete composite deck with piers founded on bored concrete piles.

Structures 167-8

4.4.36 Structure 167-8 is an existing culvert carrying the M9 eastbound link from the M9 Spur over the Swine Burn. It is a twin barrel rectangular culvert that will be retained for use on the new road network.

Structures 187-5 and 187-8

4.4.37 Structure 187-5 will be a new culvert carrying the Dolphington Burn under a new M9 Spur Extension link road at Scotstoun Junction. A single span structure is proposed with an overall approximate length of 25 metres and a clear span of 3 metres. The culvert shall consist of a precast box type structure.

4.4.38 Structure 187-8 is an existing culvert which carries the existing M9 Spur over Dolphington Burn. This structure requires to be lengthened by approximately 60 metres to accommodate the new link road to the spur. The proposed extension comprises a precast box type structure.

Structures 167-1, 167-3 and 167-5

4.4.39 Structures 167-1, 167-3 and rebuilt structure 167-5 will carry: the M9 westbound to M9 Spur northbound link road under the M9 mainline, M9 westbound to M9 Spur northbound link road over the B9080 and the M9 Spur over the B9080 respectively. They comprise of three single span structures with spans of 30 metres and are of precast beam and slab integral construction. Structures 167-1 and 167-5 will require staged construction and major traffic management as both are being constructed under the existing M9 and M9 Spur respectively. The demolition of 167-5 will also require staged construction and major traffic management.

Structures 167-2 and 167-4

4.4.40 Structures 167-2 and 167-4 will take the form of culverts carrying the Swine Burn under the new link roads at M9 Junction 1a. Both structures will be single span with 167-2 and 167-4 having overall approximate lengths of 22 metres and 40 metres respectively. Each structure has a clear span of 3 metres. The culverts shall consist of precast box type structures.

Structure 167-7

4.4.41 Structure 167-7 will carry the M9 Spur slip road tapers over an existing side road west of M9 Junction 1a. It is an existing two hinged portal single span structure with a span of 10 metres at a skew of 18°.

The existing structure requires to be widened by 10 metres to the south and 5 metres to the north in order to accommodate the increase in road width.

Structure 167-11

4.4.42 Existing structure 167-11, Humbie Railway Bridge, carries the M9 Spur over the Falkirk-Fife Railway Line. It is a single span bridge and has an approximate span of 17 metres at a skew of 40°. It is a prestressed beam and slab structure founded on piles. This structure will be retained for use on the new road network.

Structure 265-4

4.4.43 Structure 265-4 will carry a new link from the existing crossing to the M9 Spur southbound over the existing A90. It comprises a seven span structure with an overall approximate length of 300 metres comprising one span of 60 metres, two 50 metre spans, two spans of 40 metres and two spans of 30 metres on a curved alignment. It consists of steel and concrete composite construction founded on bored concrete piles.

Structures 239-5 to 239-10

4.4.44 Structures 239-5 to 239-10 are pipeline protection structures of similar construction to a culvert, built in order to protect a BP Pipeline which runs adjacent to the proposed location of the new mainline and below a number of slip roads. All of the structures are proposed as single spans with numbers 239-5 to 239-10 having approximate lengths of 80 metres, 190 metres, 90 metres, 150 metres, 225 metres and 40 metres respectively. All structures are proposed as precast concrete portal construction founded on spread footings.

4.4.45 The structural details provided in the protection of the BP Pipeline are indicative at this stage and subject to the approval of BP Oil UK Ltd. Further detailed requirements shall be provided as a part of the DMRB Stage 3 Report should this option be progressed.

Structures 239-1 and 239-2

4.4.46 Structures 239-1 and 239-2 will carry on and off slip roads respectively over the new mainline. Both are three span steel/concrete composite structures founded on spread footings. Structure 239-1 has an overall length of approximately 130 metres comprising a main span of 60 metres and two shorter spans of 35 metres at a skew of 40° and Structure 239-2 has an overall length of approximately 145 metres comprising a main span of 65 metres and two shorter spans of 40 metres at a skew of 50°.

Structure 239-3

4.4.47 Rebuilt structure 239-3 will carry the A8000 over the new mainline and slip roads and will replace the existing structure which is to be demolished. It consists of four spans with an overall length of approximately 155 metres comprising spans of 35 metres, 50 metres, 40 metres and 30 metres at a skew of 10°. It is proposed as a steel/concrete composite construction. Traffic management will be required on the existing A90 during construction and the A8000 is likely to be subject to a significant temporary diversion or a temporary structure may be required.

Structure 187-4

4.4.48 Structure 187-4 is an existing structure which carries Echline Junction over the existing A90. It is a single span structure with a span of 30 metres with no skew. It is an insitu concrete slab structure founded on spread footings. The existing bridge is considered adequate to accommodate new A90 northbound link tie in.

Structures 128-1 and 128-2

4.4.49 Structures 128-1 and 128-2 will carry Builyeon Road and the A904 respectively over the new mainline. Both are three span steel/concrete composite structures of integral construction founded on spread footings. Structure 128-1 will have an overall length of approximately 80 metres comprising a maximum span of 41.5 metres, at a skew of 20°. Structure 128-2 will have an overall length of approximately 72.4 metres comprising a maximum span of 39 metres.

Proposed Replacement Bridge Approach Viaduct – South Corridor Option 1

4.4.50 The approach viaduct structure required in the connecting of the proposed replacement bridge to South Corridor Option 1 shall be designed in tandem with the proposed replacement bridge itself. Details of this structure shall be made available within future reports to be produced by the Jacobs Arup Main Crossing Team, the team responsible for the design of the proposed replacement bridge.

Public Utilities

4.4.51 South Corridor Option 1 is likely to impact the following public utilities plant:

- 6no. Crossings of BP Pipeline (1370m of protection required)
- 10no. Crossings of high voltage electric cables at 33Kv (overhead)
- 13no. Crossing of high voltage electric cable at 11Kv (4no. overhead/9no. underground)
- 5no. Crossings of medium pressure gas main (0.75 to 2 bar pressure)
- 7no. Crossings of trunk water mains
- Possible impact on fibre optic cable at M9 Junction 1a

4.4.52 In addition to the above, other small-scale plant is affected such as telecommunication cables, street lighting cables, low-pressure gas pipes and small diameter water supply pipes.

Constructability

4.4.53 Situated offline, the South Corridor Option 1 mainline will have little impact on the operation of the A90 during the construction period, traffic management only being required in the connection of the new corridor to the existing road network. In the provision of new junction arrangements at M9 Junction 1a and Echline/Scotstoun, appropriate construction phasing will be required to ensure through flow of traffic at all times. Additionally, traffic management and diversionary measures on the A904 may be required whilst a new structure is provided, enabling the South Corridor Option 1 mainline to pass beneath.

4.4.54 With respect to the BP Pipeline, consultation meetings shall continue to be held with BP Oil UK Ltd so that suitable mitigation measures can be encompassed within the design should it be progressed to DMRB Stage 3 assessment.

4.5 South Corridor Option 2

4.5.1 Table 4.10 read in conjunction with Figure 4.16 (Volume 2) provides a description of the South Corridor Option 2 mainline carriageway design.

4.5.2 **Table 4.10: Engineering Description of South Corridor Option 2 Mainline**

Corridor	Description
South Corridor Option 2	**Mainline** • Route Corridor Length: 5.1km • Design Speed: 120kph • Dual three lane motorway (D3M) o 11m running carriageway o 3.6m hard shoulders (where practicable for future hard shoulder running) o 0.7m hardstrips o 3.1m central reserve o 1.5m verge <u>Design Geometry</u> • Minimum Horizontal Radius = 1020m • Minimum Vertical Gradient = 2.4% • Maximum Vertical Gradient = 2.4% • Maximum Sag Curve Radius = 4500m • Minimum Crest Curve Radius = 4500m

Engineering Constraints

- Existing topography
- Connection to existing M9 east of Winchburgh
- Junction provision and side roads connectivity
- Location of BP Pipeline
- Environmentally significant areas (refer to Part 3)
- Possible future multi-modal developments (LRT, BRT, guided buses or trams)

Mainline Features

4.5.3 A full improvement to South Corridor Option 2 consists of an offline dual three lane motorway providing a direct connection between the proposed replacement bridge and the central Scotland motorway network via the M9. In providing this connection, a new junction is required providing traffic movements in all directions between the M9, M9 Spur and the proposed replacement bridge. In addition, existing roads infrastructure is upgraded to complement the new provision, Scotstoun Junction being reconstructed to provide access/egress to the west of Edinburgh via the A90.

4.5.4 From the new junction arrangement, situated east of Winchburgh, the corridor departs the M9 on a R1020 metre horizontal curve, requiring new crossings of the B9080 and the Falkirk–Fife Railway Line. To provide sufficient headroom clearance, a gradient of 2.4% is implemented on approach.

4.5.5 Passing to the west of Humbie Reservoir, the corridor is situated on significant embankment. The requirement for structural crossings of existing local roads dictates the vertical geometry through this section.

4.5.6 Continuing north, the corridor crests to the south of its first crossing of Builyeon Road, descending at 2.4% on approach to Westmuir Riding Centre.

4.5.7 Passing to the west of Dundas Estate, the corridor transitions from embankment into cutting, cut slopes in excess of 10 metres being implemented to ensure that sufficient headroom clearance can be generated prior to the second crossing of Builyeon Road. The horizontal geometry of the corridor is fairly straight through this section, matching the bearing of the proposed replacement bridge.

4.5.8 Proceeding north in cutting, the corridor passes beneath the A904. At this point motorway restrictions shall cease allowing non-motorway traffic and local traffic to access the proposed replacement bridge. This will be achieved through a new junction arrangement to the A904, providing north facing slip roads only. Beyond the new junction, the corridor exits cutting to the west of South Queensferry, a gentle incline facilitating connection to the bridge approach structure.

4.5.9 In considering the location of the BP Pipeline, significant changes to the vertical geometry of this corridor would be required in the vicinity of Builyeon Road, with changes in structural provision required. The implementation of such a change would require consideration to be given to the vertical geometry of existing side roads in the area, with Builyeon Road and the A904 most likely to be affected.

Departures from Standard

4.5.10 At present, no mainline departures from standard have been identified in the development of South Corridor Option 2. However, a number of departures may be required in the vicinity of the M9 Junction encompassing Junction 1a.

4.5.11 Initial discussions have been held with Transport Scotland's Standards Branch as to the suitability of the design work undertaken to date. Should this option be taken forward to DMRB Stage 3 assessment, the development of the design shall be discussed further with Standards Branch, any departures from standard being highlighted at an early stage.

Junction Provision

4.5.12 Table 4.11 read in conjunction with Figures 4.17, 4.18 and 4.19 (Volume 2) gives an overview of the indicative junction arrangements developed for South Corridor Option 2.

Table 4.11: Engineering Description of South Corridor Option 2 Junctions

Corridor	Description
South Corridor Option 2	**Junction Provision** M9 Junction • New free flow all movements junction provided to M9. West facing slip roads provided facilitating access between the proposed replacement bridge, West Lothian and beyond. ○ Mainline Diverge to M9 Westbound. ○ Mainline Merge from M9 Eastbound. • The provision of west facing slip roads to the mainline generates D3M cross section through lane drop/lane gain arrangement. • East facing slip roads connecting the corridor to the M9 are provided in tandem with improvements to the existing M9 Junction 1a arrangement. ○ Mainline Diverge to M9 Eastbound. ○ Mainline Merge from M9 Westbound – Link road with forking arrangements to/from M9 Spur. ○ M9 Eastbound Diverge to M9 Spur. ○ M9 Westbound to M9 Spur – Link road generated through fork diverge arrangement associated with South Corridor Option 2 Mainline connection. ○ M9 Spur to South Corridor Option 2 Mainline – Slip Road connected through fast lane merge South Corridor Option 2 mainline interchange link. ○ M9 Spur to M9 Westbound – Slip Road generated through fork diverge of M9 Spur to South Corridor Option 2 Mainline connection. • No M9 Spur to M9 Eastbound connection is provided for with this option, traffic wishing to access Newbridge roundabout from South Queensferry/Dalmeny being re-routed via the A8000/B800 and A89. Scotstoun Junction • New free flow, all movements junction. • M9 Spur to A90 Eastbound becomes priority traffic route. • New M9 Spur to A90 Westbound connectivity provided through new slip arrangements. ○ M9 Spur to A90 Westbound Link ○ A90 Eastbound to M9 Spur Link • The existing A90 connections severed by the change in traffic priority are reconnected through the utilisation of the new interchange links proposed. ○ A90 Westbound – Reconnected through new M9 Spur Link. ○ A90 Eastbound – Reconnected through slip road diverge from A90 Eastbound to M9 Spur Link. A904 Junction • New dumbbell roundabout junction arrangement situated at grade with existing A904. • Junction required to provide access and egress facility for non-motorway bridge traffic, hence only north facing slip roads are provided. • Junction will act as a strategic link for bus traffic. • LRT catered for with any future implementation on proposed replacement bridge

Topography & Land use

4.5.13 The topography of the area surrounding South Corridor Option 2 is of an agricultural and residential nature.

To the southeast, the M9 is bounded by disturbed farmland, encompassing oil shale bings at Niddry Castle, Greendykes and Faucheldean. Beyond this lies the village of Winchburgh. To the east and situated on high embankment lies the M9 Spur beyond which lies the town of Kirkliston. To the south of M9 Junction 1a lies Newliston Estate where arable and livestock farming is the predominant land use.

4.5.14 Continuing north, the corridor climbs passing to the west of Humbie Reservoir, impacting upon the long established woodland at Swineburn and Muiriehall. Situated in significant cutting to the east of Westmuir Farm, the corridor then descends towards the Firth of Forth passing to the west of Dundas Estate.

4.5.15 Throughout, the corridor is predominantly situated in lowland hill and valley farmland. South Queensferry is situated to the east on approach to the location of the proposed replacement bridge. On approach to the southern shoreline of the Firth of Forth the rolling hills previously associated with the corridor give way to a more rugged landscape, a steep change in gradient being experienced between Inchgarvie House and Port Edgar.

Geotechnical Summary

4.5.16 The earthworks associated with South Corridor Option 2 comprise an embankment to carry the corridor from the tie-in to the M9, and a long, relatively deep cutting which extends to the tie-in to the proposed replacement bridge approach. This cutting also passes beneath the existing A904.

4.5.17 Until the completion of the ground investigations and associated testing, an assessment of the likely slope angles will not be undertaken. The general design assumptions for slopes at present are that they will not be steeper than 26.6 ^{o} (1V:2H) for both embankments and cuttings. However, in certain cases these may have to be relaxed to satisfy the stability of the slope. Steeper angles of 60 ^{o} to 80 ^{o} (2V:1H - 5V:1H) may be possible in rock depending on rock type, discontinuity orientations, spacing and type/extent of infill material, and groundwater.

4.5.18 A limit of around 7 metres has been assumed in terms of maximum height/depth of a feature before an interim berm is required. This is for improved stability as well as maintenance access. A berm at the soil/rock contact will also be required for slope stability and drainage.

4.5.19 The cutting is likely to be partially formed within glacial deposits, and partially within rock. The excavation of the cutting will produce considerable quantities of excavated material, some of which may be appropriate for re-use within the project earthworks.

Geotechnical Summary

4.5.20 Table 4.12, in association with Figure 4.20 (Volume 2), provides an indication of the anticipated earthworks associated with South Corridor Option 2.

Table 4.12: Geotechnical Summary of South Corridor Option 2

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section		Groundwater Encountered (bgl)	Remarks
0m to 700m	300m	~2.0m	Embankment / Cutting 1V:2H	GL to 2.2m 2.2m to 4.2m 4.2m	Weathered Glacial Till Cohesive Glacial Till Bedrock (Mudstone)	None Encountered	No exploratory holes undertaken on existing M9 embankment. Indicative ground conditions of adjacent area provided.
700m to 2500m	950m	11.70m	Embankment 1V:2H	GL to 1.5m 1.5m to 3.5m 3.5m to 5.0m 5.0m +	Weathered (Cohesive) Glacial Till Cohesive Glacial Till Granular Glacial Till Anticipated Bedrock	5.0m	Many structures within this embankment. Settlement issues may arise due to thick cohesive deposits.
700m to 2500m	2050m	15.5m	Structure	GL to 1.7m 1.7m to 28.3m 28.3m	Granular Deposits Cohesive Glacial Till Bedrock (Sandstone)	None Encountered	Many structures within this embankment. Thick deposit of cohesive deposits will lead to increased time required for substantial completion of settlement even if amount of total settlement is low.
2500m to 4600m	3050m	18.1m	Cutting* 1V:2H	GL to 2m 2m to 20/25m 20/25m	Weathered Glacial Till Cohesive Glacial Till Bedrock (Mudstone/Sandstone)	1.1m 23m	Large cutting, will require intermediate berms to aid stability. Gas pocket at rockhead to north at Ch. 3400m. Slope drainage (V-channels) on berms with connecting S-channels.
2500m to 4600m	3800m	14.42m	Cutting* 1V:2H	GL to 2m 2m to 6m 6m (Localised granular deposits, to 4m depth)	Weathered Glacial Till Cohesive Glacial Till Bedrock (Basalt, Siltstone)	1.5m	Rock cutting. Will require berms. Rock likely to consist mostly of mudstone, siltstone, and some basalt. Water encountered between 1.5m bgl and exploratory holes being dry. Raking drains and relief drains may be required, plus rock slope stabilisation measures. Steeper angles should be possible.

Table 4.12 (cont'd): Geotechnical Summary of South Corridor Option 2

Chainage (m)	Anticipated Critical Section	Height at Critical Section*	Likely Design Angle	Ground Conditions at Critical Section		Groundwater Encountered (bgl)	Remarks
4575m to 5050m	-	-	Bridge	GL to 1.5m 1.5m to 3.6/7.2m 3.6 to 7.2m (Localised granular deposits)	Weathered Glacial Till Cohesive Glacial Till Bedrock (Sandstone, Mudstone, Dolerite)	At Rockhead	Approach to bridge

* - Cutting Depths are based on the centreline long section and earthworks interface drawings, Figure 4.20a and 4.20b (Volume 2).

Mineworkings

4.5.21 The majority of the extractable mineral deposits recorded to the south of the Firth of Forth comprise seams of oil shale; however one coal seam, the Houston Coal, is recorded to occur close the existing A90 near Scotstoun.

4.5.22 No mine-workings are recorded to occur beneath the South Corridor Option 2, either in the coal seam or the oil shales, and the deep boreholes undertaken to date to investigate the recorded seams have not suggested that they have been worked beneath the corridor.

4.5.23 Workings within the Broxburn Shales are recorded in the vicinity of the tie-in between the A90 and M9 Spur close to Dalmeny, and should the proposed junction improvements be required in this area, it is likely that further investigation of the condition of these seams, and possible ground treatment would be required. Some grouting works were undertaken as part of the construction for the M9 Spur Extension; however it is unlikely that the treated zone extends over the area which would be necessary for the junction improvements. A further assessment of mineworkings would be necessary should this option be taken forward.

Hydrology

4.5.24 Figure 8.1 (Volume 2) details the watercourses within the study area of the Forth Replacement Crossing Project. Further information on hydrology is provided in Part 3, Chapter 8.

4.5.25 The implementation of new junction arrangements in the vicinity of M9 Junction 1a and Scotstoun Junction may require the extension or replacement of existing culverts / structures at Niddry Burn, Swine Burn and Dolphington Burn. New culverts / structures may also be required.

4.5.26 As outlined with South Corridor Option 1, Linn Mill Burn, situated to the west of the corridor, is a likely outfall point for the drainage system associated with South Corridor Option 2. Flowing northwards, the Linn Mill Burn's point of source is situated at Totleywells, its outfall to the Firth of Forth being situated at Port Edgar.

Structures

4.5.27 The following paragraphs read in conjunction with Figure 4.21 (Volume 2) detail the structural requirements associated with South Corridor Option 2.

<u>Structure 163-14</u>

4.5.28 Structure 163-14 is a culvert carrying the existing M9 over the Niddry Burn. The structure is required to be extended to accommodate the increased width of the road. No information is currently available for the existing culvert at this stage however it is assumed that it can be retained.

<u>Structure 163-17</u>

4.5.29 Structure 163-17 carries the M9 to M9 Spur slip road over the M9. This existing bridge is not required in the new road layout and as such is to be demolished.

Structure 163-18

4.5.30 Structure 163-18 is an existing culvert carrying the M9 Spur to the M9 eastbound slip over the Swine Burn. It is a single span structure with an overall length of 142 metres with a clear span length of 4.3 metres. It is a twin barrel rectangular culvert that will be retained for use on the new road network.

Structure 163-19

4.5.31 Structure 163-19, Humbie Railway Bridge, carries the M9 Spur over the Falkirk-Fife Railway Line. It is a single span bridge and has an approximate span of 17 metres at a skew of 40°. It is a prestressed beam and slab structure founded on piles. This structure will be retained for use on the new road network.

Structures 94-4, 162-1, 162-2 and 163-13

4.5.32 Structures 94-4, 162-1, 162-2 and 163-13 each consist of seven spans with overall lengths of 270 metres, 240 metres, 280 metres and 282.5 metres respectively. Each structure comprises:

- 94-4: two spans of 35 metres and five spans of 40 metres
- 162-1: one span of 20 metres, two spans of 30 metres and four spans of 40 metres
- 162-2: two spans of 30 metres, three spans of 40 metres and two spans of 50 metres
- 163-13: two spans of 30 metres, two spans of 40 metres and three spans of 47.5 metres

4.5.33 The structures are of steel/concrete composite construction founded on bored concrete piles and all are curved in plan. Structures 162-2 and 163-13 will require construction over live M9 carriageways.

Structures 162-4, 162-16 and 163-9

4.5.34 Structures 162-4, 162-16 and 163-9 are new single span underpass structures with overall approximate lengths between headwalls of 20 metres, 45 metres and 27 metres respectively. Each structure has a clear span length of 9 metres with 162-4 at a skew of 20° and 162-16 and 163-9 being perpendicular to the carriageway. All three are proposed as portal structures founded on spread footings.

Structure 163-10

4.5.35 Structure 163-10 will carry the M9 mainline over the M9 westbound to M9 Spur northbound link road. It is proposed as a single span structure with a span of 30 metres at a skew of 10°. It comprises precast beam and slab integral construction founded on bored concrete piles. The structure will be built below the existing M9 and will therefore require staged construction and major traffic management.

Structures 163-7, 163-8 and 130-1

4.5.36 Structures 163-7 and 130-1 will carry the M9 westbound to M9 Spur northbound link road and the mainline to the proposed replacement bridge respectively over the B9080. These structures and replacement structure 163-8 are proposed as single span precast beam and slab structures supported on spread footings. Structure numbers 163-7 and 163-8 have spans of 30m and skews of 25° and 0° respectively. Structure 130-1 has a span of 14.3m and a skew of 45°.

4.5.37 Structure 163-8 will require staged reconstruction which will require significant traffic management on the M9 Spur.

Structures 162-5, 163-12 and 163-15

4.5.38 Structures 162-5, 163-12 and 163-15 will take the form of culverts carrying the Swine Burn under new sections of road. All three are proposed as single span structures with overall approximate lengths of 110 metres, 22 metres and 40 metres respectively. Each structure has a clear span length of 3 metres with 162-5 at a skew of 5° and 163-12 and 163-15 at skews of 10°. Precast box type construction is proposed.

Structure 163-11

4.5.39 Structure 163-11 requires to be widened by 10 metres to the south and 5 metres to the north in order to accommodate new slip road arrangements.

Structure 163-6

4.5.40 Structure 163-6 will carry the M9 westbound to the northbound carriageway of the South Corridor Option 2 mainline link over the M9. It comprises a four span structure with an overall approximate length of 180 metres over two spans of 40 metres and two spans of 50 metres at a varying skew. It is proposed as a steel/concrete composite structure founded on bored concrete piles. This structure will require complex design and construction as it is curved in plan and has a very high skew over the existing M9.

Structures 94-7, 94-10, 130-2 and 162-3

4.5.41 Structures 94-7, 94-10, 130-2 and 162-3 are all railway bridges required as part of the scheme.

4.5.42 The reconstructed Structure 94-7 comprises a two span structure with an overall length of 60 metres comprising two spans of 30 metres at a varying skew. It is proposed as a steel/concrete composite structure founded on bored concrete piles.

4.5.43 Structure 94-10 will carry the A90 westbound over the Falkirk–Fife Railway Line and comprises a four span structure with an overall length of 110 metres over two spans of 25 metres and two spans of 30 metres at a varying skew. It is proposed as a steel/concrete composite structure of integral construction founded on bored concrete piles. As the bridge is curved in plan it will add complexity to the design and construction.

4.5.44 Structure 130-2 will carry the mainline over the Falkirk–Fife Railway Line. It consists of a single span structure with a span of 16 metres at a skew of 30° and comprises a precast beam and slab integral structure founded on spread footings.

4.5.45 Structure 162-3 will carry the M9 westbound merge slip road over the Falkirk–Fife Railway Line. It consists of a single span structure with a span of 15 metres at a skew of 30° and comprises a precast beam and slab integral structure founded on bored concrete piles.

4.5.46 All structures will require stringent measures during construction (and demolition of 94-7) over the railway with disruptive possessions likely to be required.

Structures 94-11, 94-12, 94-13 and 130-6

4.5.47 Structures 94-11 to 94-13 and 130-6 are pipeline protection structures of similar construction to a culvert, built in order to protect a BP Pipeline which runs under the South Corridor Option 2 mainline and below Scotstoun Junction. All of the structures are considered as having single spans of 5m with approximate overall lengths of 80 metres, 35 metres, 42 metres and 100 metres respectively. All structures are proposed as precast portal construction founded on spread footings.

4.5.48 The structural details provided in the protection of the BP Pipeline are indicative at this stage and subject to the approval of BP Oil UK Ltd. Further detailed requirements shall be provided as a part of the DMRB Stage 3 Report should this option be progressed.

Structures 130-3, 130-4 and 213-1

4.5.49 Structures 130-3, 130-4 and 213-1 will carry side roads and the A904 over the mainline to the proposed replacement bridge respectively. All three structures comprise three spans with maximum span lengths of 35.7 metres at a skew of 15°, 57.3 metres at a skew of 53° and 38.6 metres at a skew of 25° respectively. The bridges are proposed as steel/concrete composite structures with structures 130-3 and 213-1 being of integral construction and structure 130-4 of non-integral construction. All three structures are founded on spread footings.

Structures 94-1, 94-2 and 94-3

4.5.50 Structures 94-1, 94-2 and 94-3 will take the form of culverts carrying the Dolphington Burn under the Scotstoun Junction. All three are proposed as single span structures having overall approximate lengths of 30 metres, 53 metres and 55 metres respectively. Each structure has a clear span length of 3 metres at a skew of 20°. All structures are proposed as precast boxes founded on spread footings.

Structure 94-5

4.5.51 Structure 94-5 carries the M9 Spur link road over the A90 westbound. This is an existing structure that was constructed as part of the M9 Spur Extension contract. No information is available for this bridge at this stage however it is assumed that it can be retained.

Structure 94-6

4.5.52 Structure 94-6 will carry the M9 Spur southbound link road over the M9 Spur mainline. It is proposed as a three span structure with an overall length of 125 metres comprising two spans of 37.5 metres and one span of 50 metres. It comprises a steel/concrete composite structure founded on bored concrete piles. The proposed structure is likely to require complex design and construction as it is curved in plan.

Structure 94-8

4.5.53 Existing structure 94-8 carries the A90 over Standingstane Road. It is an insitu slab structure with a span of 32.4 metres at a skew of 10° founded on spread footings. Very little record information is available for this structure and however it is assumed that the bridge will be retained for use in the new road network.

Structure 94-9

4.5.54 Structure 94-9 will carry the A90 westbound slip road over Standingstane Road and will effectively widen the existing adjacent A90 bridge (Structure 94-8). It is proposed as a single span structure with a span of 20 metres. It comprises a precast beam and slab structure of integral construction founded on bored concrete piles.

Proposed Replacement Bridge Approach Viaduct – South Corridor Option 2

4.5.55 The approach viaduct structure required in the connecting of the proposed replacement bridge to South Corridor Option 2 shall be designed in tandem with the proposed replacement bridge itself. Details of this structure shall be made available within future reports to be produced by the Jacobs Arup Main Crossing Team, the team responsible for the design of the proposed replacement bridge.

Public Utilities

4.5.56 South Corridor Option 2 is likely to impact the following public utilities plant:

- 5no. crossings of BP Pipeline (1370m of protection required)
- 5no. crossings of high voltage electric cables at 33Kv (4no. overhead/1no. underground)
- 9no. crossing of high voltage electric cables at 11Kv (6no. overhead/3no. underground)
- 12no. crossings of high pressure gas main (7 bar pressure)
- 2no. crossings of medium pressure gas main (0.75 to 2 bar pressure)
- 4no. crossings of trunk water mains
- Possible impact on fibre optic cable at M9 Junction 1a

4.5.57 In addition to the above, other small-scale plant is affected such as telecommunication cables, street lighting cables, low-pressure gas pipes and small diameter water supply pipes.

Constructability

4.5.58 Situated offline, the South Corridor Option 2 mainline will have little impact on the operation of the M9 during the construction period. Traffic management and diversionary measures will be required in the continued operation of local roads such as the A904 and Builyeon Road during construction. In the provision of the new junction arrangements, appropriate construction phasing and traffic management will be required, ensuring that the through flow of traffic can be maintained at all times. In addition, alternative means of access may require consideration insuring that connectivity is maintained between Edinburgh, the Lothians and Fife.

4.5.59 With respect to the BP Pipeline, consultation meetings shall continue to be held with BP Oil UK Ltd so that suitable mitigation measures can be encompassed within the design should it be progressed to DMRB Stage 3 assessment.

4.6 References

The Highways Agency. The Design Manual for Roads and Bridges (May 2008)

Transport Scotland. Structures As-Built Record Information

The City of Edinburgh Council. Structures As-Built Record Information

Fife Council. Structures As-Built Record Information

Public Utilities Information sourced in accordance with New Roads and Street Works Act (NRSWA 1991)

Forth Replacement Crossing

DMRB Stage 2 Corridor Report
Part 3: Environmental Assessment

Report on Scheme Development Work: May to August 2008

Contents: Volume 1 (Main Report and Appendices)

5 Overview of Environmental Assessment

5.1 Introduction

5.1.1 This chapter outlines the general approach followed for the Design Manual for Roads and Bridges (DMRB) Stage 2 environmental assessment of the Forth Replacement Crossing route corridor options, as reported in Chapters 6 to 18. More detailed methodologies are provided in the respective chapters.

5.1.2 Consultation is integral to the project and this chapter therefore describes the Stage 2 consultation process. An overview of the overall environmental consultation strategy for the Forth Replacement Crossing is also provided.

5.2 Scope and Guidance

DMRB Environmental Assessment

5.2.1 Annex E of Circular 8-2007 'Environmental Impact Assessment (Scotland) Regulations 1999' (Scottish Government, 2007) relates to Environmental Impact Assessment (EIA) of trunk road projects and refers to DMRB, first published in 1993 and subsequently amended and updated by the Highways Agency, Scottish Government, Welsh Assembly and Department for Regional Development Northern Ireland.

5.2.2 DMRB sets out governmental guidance on the development of trunk road schemes including motorways and is applicable to the Forth Replacement Crossing. Volume 11 of DMRB specifically provides guidance on EIA, including the level of assessment required at key stages of development and the requirements for reporting environmental effects.

5.2.3 The objectives of Stage 2 assessment are to identify the factors and effects to be taken into account in the selection of route corridor options and to identify the environmental advantages, disadvantages and constraints associated with these route corridors.

Scheme Components Assessed

5.2.4 The following components of the Forth Replacement Crossing were considered in the environmental assessment and reported separately:

- Proposed Replacement Bridge;
- Northern Route Corridor Options; and
- Southern Route Corridor Options.

<u>Proposed Replacement Bridge</u>

5.2.5 For the purposes of assessing the route corridor options, the proposed replacement bridge (also referred to as the 'main crossing') was considered to be common to all options. The likely impact of the proposed replacement bridge is therefore reported within each chapter as noted above, but did not form part of the formal Stage 2 assessment in terms of route corridor selection.

<u>Northern and Southern Route Corridor Options</u>

5.2.6 This Stage 2 report provides the findings of the environmental assessment of the following route corridor options (as described in Part 1, Chapter 3 and illustrated on Figure 5.1):

- North Corridor Option 1;
- North Corridor Option 2;
- South Corridor Option 1; and
- South Corridor Option 2.

5.2.7 It should be noted that pre-Stage 2 environmental assessment of a much wider range of route corridor options and junction arrangements was also undertaken, with the issues identified during this process informing the development of the route corridor options and the decision regarding the route corridors to be reported at Stage 2. This process is described separately within the Jacobs Arup report 'Forth Replacement Crossing, Route Options Review'.

Scope of Environmental Assessment

5.2.8 In accordance with DMRB Volume 11, assessment has been undertaken of the following environmental parameters (reported in chapters 6 to 18 respectively):

- Land Use;
- Geology, Contaminated Land and Groundwater;
- Water Environment (Hydrodynamics, Surface Water Quality and Hydrogeology);
- Ecology and Nature Conservation;
- Landscape;
- Visual;
- Cultural Heritage;
- Air Quality;
- Traffic Noise and Vibration;
- Pedestrians, Cyclists, Equestrians and Community Effects;
- Vehicle Travellers;
- Disruption Due to Construction; and
- Policies and Plans.

Study Area

5.2.9 Field and desk-based survey to inform DMRB Stage 2 (and for DMRB Stage 3 where appropriate, due to programming considerations) commenced in January 2008, although surveys for breeding and wintering birds began in 2007 (by MBEC; Mackenzie Bradshaw Environmental Consulting, on behalf of Transport Scotland) to ensure that the appropriate level of seasonal information was available.

5.2.10 The study area required or recommended by DMRB and best practice guidance varies depending on the specific environmental parameter being assessed but is typically 500m in each direction from the centreline of each route corridor option. However, baseline environmental surveys commenced in parallel with the pre-Stage 2 consideration of a wide range of options, and accordingly a wider study area was defined to enable flexibility in the progression of the route corridor options. This study area is shown on Figure 5.1.

5.3 Environmental Reporting

Chapter Structure

5.3.1 Each environmental chapter[1] as listed in Section 5.2 (Scope and Guidance) provides the following:

- an *introduction* to the subject area;
- *approach and methods* used in the assessment;
- *baseline conditions* (i.e. the 'existing' situation);
- *potential impacts* of the proposed replacement bridge and the route corridor options;
- *potential mitigation*, focussing on standard or typical mitigation that is anticipated would be developed for the preferred route corridor at DMRB Stage 3;
- *summary of route corridor options assessment* (taking account of potential mitigation); and
- *references*.

General Approach

Baseline Conditions

5.3.2 The assessment of impacts on each environmental parameter is undertaken in comparison to baseline conditions, which were determined though field survey, desk-based review and consultation. Baseline conditions describes the existing environmental conditions at the site (and in the wider area as pertinent to the particular environmental parameter) including, where applicable, if/how this would be expected to change if the proposed scheme did not go ahead (i.e. the 'Do Minimum' scenario).

Potential Impacts

5.3.3 The general approach to assessment is based on the determination of impact significance from a combination of the sensitivity or importance of the baseline conditions (i.e. the current site and its environs, including the sensitivity of receptors) and the magnitude of potential impacts. This process is described in the respective environmental chapters, and where this approach was not appropriate (e.g. consideration of policy compliance in Chapter 18: Policies and Plans), alternative approaches are described and justified.

5.3.4 It should be noted that the magnitude and significance reported within the 'Potential Impacts' section of each chapter have been considered in the absence of mitigation. The 'Summary of Route Corridor Options Assessment' then takes into account potential mitigation as described below.

5.3.5 For the purposes of this DMRB Stage 2 route corridor options assessment, construction impacts[2] are considered temporary. Any exceptions to this are noted. Operational impacts are considered long term or permanent, again with any exceptions being noted.

[1] The exception to this structure is Chapter 18 (Policies and Plans) which differs slightly as it considers policy compliance/conflict and as such is not impact assessment.

[2] Impacts may start during construction (e.g. land take) but if they persist during operation they are considered operational impacts.

Potential Mitigation

5.3.6 As noted within the respective environmental chapters, the detailed design has not been developed at DMRB Stage 2 assessment of route corridor options, and mitigation detail therefore cannot be confirmed. The assessments therefore identify 'standard' or 'anticipated' mitigation taking into account best practice, legislation and guidance and the experience of the team. Mitigation also takes into account principles identified in the Strategic Environmental Assessment (SEA) (Jacobs et al., 2007a) and SEA Post Adoption Statement (Jacobs et al., 2008).

5.3.7 Generally, potential impacts of 'Moderate' or greater significance would be identified as priorities for mitigation. However, the need for mitigation will be confirmed during more detailed assessment at DMRB Stage 3.

Summary of Route Corridor Options Assessment

5.3.8 This section identifies likely residual impacts taking into account identified potential mitigation to provide a robust basis for comparative assessment and for the selection of a preferred route corridor option to be taken forward to DMRB Stage 3.

5.4 Consultation

Introduction

5.4.1 Consultation for the Forth Replacement Crossing is being undertaken according to the guidance provided in Planning Advice Note (PAN) 58: Environmental Impact Assessment (Scottish Executive, 1999) and with cognisance of PAN 81: Community Engagement (Scottish Executive, 2007). The importance of successful consultation has been strengthened by the Planning etc. (Scotland Act) 2006 (where pre-application consultations are a prerequisite for projects such as the Forth Replacement Crossing) and by the publication of best practice guidance set out in PAN 81 and other guidance documents.

5.4.2 New secondary legislation, stemming from the 2006 Act on procedures relating to processing planning applications (referred to as 'development management') will be coming into force in stages from January 2009 through to June 2009 (Scottish Government, 2008). A significant element relates to new inclusion measures. The way ahead, as reflected in the 2006 Act, is to improve involvement at the development planning stage, when the local policy context for considering development proposals is being prepared, to allow local communities a greater role at the pre-application stages of certain applications, to influence the nature of the proposals themselves and to allow enhanced scrutiny during the processing of such applications. In addition, new measures to ensure greater awareness of proposals and transparency of decision-making are also being introduced.

5.4.3 As best practice and to meet the likely requirements of this future legislation, public participation is being encouraged as part of the progression of the Forth Replacement Crossing. Where appropriate, issues raised through the public participation process will be taken into consideration as part of the environmental assessment process.

5.4.4 Consultations will continue throughout the EIA process. At Stage 2, consultation will seek to:

- ensure that statutory consultees and other bodies with a particular interest in the environment are informed of the proposal and provided with an opportunity to comment;
- obtain baseline information regarding existing environmental site conditions;
- establish key environmental issues and identify potential impacts to be considered during the EIA;

- identify those issues which are likely to require more detailed study and those which can be justifiably excluded from further assessment; and
- provide a means of identifying the most appropriate methods of impact assessment.

Consultation List

5.4.5 A stakeholder mapping exercise was undertaken to establish a list of consultees. This process aimed to ensure that all relevant consultees were added to the stakeholder database, and involved the following stages:

- Review of stakeholders involved on other major projects and related studies in the Forth Estuary area. These included Kincardine Bridge, Setting Forth and previous studies for the Forth Replacement Crossing undertaken by Faber Maunsell. The list of stakeholders involved in the Strategic Transport Project Review (STPR) was also reviewed and used to identify stakeholders for the Forth Replacement Crossing.
- Input from the environment team. The environment team has been proactive in identifying additional consultees of importance to their area of expertise. These have been and will continue to be added to the database as appropriate.
- Consideration of the scale, size and impact of the proposed scheme. The wider community has been taken into consideration. In addition to those directly affected by the scheme (e.g. landowners), communities and local authorities outwith the direct area of influence have also been included where there is potential for the scheme to affect them. A large number of environmental organisations have also been included.

5.4.6 The organisations currently being consulted as part of the EIA are listed in Appendix A5.1. This comprises:

- statutory consultees;
- non-statutory consultees;
- community councils; and
- interest groups.

5.4.7 It should be noted that this chapter relates specifically to consultation in the context of environmental issues but that the Project Team and Transport Scotland are also undertaking separate consultations throughout the progression of the project.

Review of Previous Consultations

5.4.8 A review of consultations carried out as part of the following previous studies relating to the Forth area has been carried out and relevant comments taken into account during the scoping of issues:

- Forth Replacement Crossing Study including an appraisal of options following Scottish Transport Appraisal Guidance (STAG).
- Strategic Environmental Assessment (SEA) of the short-listed options identified from the Forth Replacement Crossing Study.
- Appropriate Assessment of the SEA short-listed options. This considered the effects of the options on areas of the Firth of Forth designated for their European nature conservation value, at a strategic level.

Stage 2 Consultation

5.4.9 Early consultation with a range of statutory bodies, non-statutory bodies and community councils has taken place through a series of start-up briefings. These briefings were held during March 2008, and included 14 key consultees including environmental groups. Attendees included: Scottish Natural Heritage (SNH), Historic Scotland, Royal Society for the Protection of Birds (RSPB), Forth Ports, West Lothian Council, representatives of the Crown Estate, Fisheries Research Services (FRC) and the National Trust for Scotland. One-to-one meetings were held with the following consultees who were unable to attend the briefing: Scottish Environment Protection Agency (SEPA), Architecture & Design Scotland, Health and Safety Scotland, SESTRAN, Fife Council and City of Edinburgh Council

5.4.10 In total, 159 Stage 2 letters were issued to environmental consultees, the majority in March 2008. A plan showing the study area was enclosed with the letter. This point of contact provided an opportunity for consultees to provide any baseline information and scope key issues with statutory consultees.

5.4.11 Follow up letters were issued to environmental consultees in June 2008 to either confirm receipt of a response, or if no response was received, to provide the opportunity for consultees to request to be removed from the consultation list if they wished.

5.4.12 Both letters issued included information on how to obtain further information on the project and how to contact the Transport Scotland Forth Replacement Crossing Team. This included guidance on how to sign up to the electronic newsletter for regular updates, and details of a project enquiry line and mailbox address.

Stage 2 Consultation Responses

Scope of Assessment

5.4.13 Due to the scale and nature of the proposals, all environmental topic areas as identified in DMRB Volume 11 were scoped 'in' for further environmental assessment. The scope of assessment for each topic area was informed by review of previous studies and by relevant regulations and best practice guidance.

5.4.14 During the Stage 2 consultation, consultees had an opportunity to provide comment on the scope of the EIA.

5.4.15 Technical meetings and ongoing close liaison was undertaken with key consultees such as SNH and SEPA to ensure that key issues were identified and assessed appropriately. Due to the complex nature of field surveys and the sensitivity of the environment in the study area (e.g. Firth of Forth Site of Special Scientific Interest, SSSI; Special Protection Area, SPA; and Ramsar), an Ecology Scoping Report was prepared and issued to SNH and SEPA for comment.

Consultee Feedback

5.4.16 Feedback from the Stage 2 consultation letters and start up briefings were collated and incorporated into the scheme design and EIA where appropriate. Previous consultation findings and the baseline information provided by consultees has been used to inform the assessment and is reported separately for each environmental topic area (chapters 6 to 18).

Overall Consultation Approach

Consultation Programme

5.4.17 Consultation undertaken to date is reported as part of Stage 2. However, consultation is an integral and ongoing component of the project. This section identifies the key stages in this process, and Table 5.1 provides an overview of the consultation programme.

Table 5.1: Consultation Programme

Date of Consultation	Description	Completed/ Pending
February – June 2008	Project start up briefings	Completed
March 2008	Stage 2 consultation letters issued	Completed
Early 2009	Stage 2 public exhibitions Stage 3 consultation letters	Pending Pending
Late 2008 – Mid 2009	Ongoing consultation to develop the detailed design and appropriate mitigation within preferred corridor.	Pending
End 2009	Consultation on published Environmental Statement	Pending

Stage 3 Consultation

5.4.18 Stage 3 consultation letters will be issued to environmental consultees to invite comments, request more detailed information and inform the development of appropriate mitigation.

5.4.19 In addition to the Stage 3 letters, further consultation will be required with statutory, non statutory consultees and landowners. The nature of these consultations is yet to be confirmed, however they are likely to be in the form of stakeholder forums, workshops and/or one-to-one meetings. Ongoing liaison will occur throughout the design process in the form of telephone discussions, emails and letters.

Public Exhibitions

5.4.20 A series of Stage 2 public exhibitions will be held in early 2009 at various locations around the Forth area. These will present the route corridor options assessed and provide an opportunity for members of the public to influence the detailed design of the preferred corridor. Further public exhibitions will be held at the end of Stage 3.

5.4.21 The exhibitions will support the formal EIA consultation process (i.e. Stage 2 and Stage 3 consultations). Queries and comments raised during the public exhibitions will be taken into account during the design and environmental assessment process. Feedback forms (both electronic and hard copy) will be made available.

Logging Correspondence and Feedback

5.4.22 All correspondence is logged so that the information can usefully inform the assessment and so that the consultation process is clearly auditable and transparent. The parliamentary procedure for private bills requires that an explanation of the consultation process within the Promoter's Memorandum. This will be presented in the form of a Consultation Report which will provide an overview of the consultation process undertaken for the Forth Replacement Crossing and will clearly demonstrate what has changed as a result of consultation and how the involvement has influenced the preparation of documents.

5.5 References

Jacobs / Faber Maunsell / AECOM (2007a). Forth Replacement Crossing Study - Strategic Environmental Assessment – Environmental Report. Prepared on behalf of Transport Scotland.

Jacobs / Faber Maunsell / AECOM (2007b). Transport Scotland Forth Replacement Crossing Study. Strategic Environmental Assessment. Information to Inform Appropriate Assessment. Report by Faber Maunsell/AECOM to Jacobs, December 2007.

Jacobs / Faber Maunsell / AECOM (2007c). Transport Scotland Strategic Transport Projects Review. Prepared on behalf of Transport Scotland.

Jacobs / Faber Maunsell / AECOM (2008). Forth Replacement Crossing Study - Strategic Environmental Assessment – Post Adoption Statement.

Scottish Government (2007). Circular 8-2007: Environmental Impact Assessment (Scotland) Regulations 1999.

Scottish Executive (2007). Planning Advice Note (PAN) 81: Community Engagement.

Scottish Government (2008). Timetable for Implementation of the Planning etc. (Scotland) Act 2006. Updated: June 2008.

The Highways Agency et al. (1993). DMRB Volume 11, June 1993. The Highways Agency, Scottish Executive Development Department, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

6 Land Use

6.1 Introduction

6.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of existing and future land use. The types of land use addressed in this chapter include agriculture, community land, buildings and commercial areas and development land.

6.1.2 The assessment focuses on the direct impacts of the route corridor options including agricultural, community or allocated development land that may be lost and also of residential or commercial buildings that may be demolished. Possible mitigation measures that could be put in place to prevent, reduce or compensate for adverse effects are also identified.

6.1.3 The assessment focuses on operational impacts. Potential land use impacts during construction are considered separately in Chapter 17 (Disruption Due to Construction).

6.2 Approach and Methods

6.2.1 In accordance with DMRB (Volume 11: Section 3), for the purposes of this assessment 'land use' is assumed to comprise the following topic areas:

- effects on residential and commercial land use;
- loss of land used by the community;
- effects on development land;
- effects on agricultural land; and
- effects on waterway development or restoration projects.

6.2.2 The objective of DMRB Stage 2 assessment is to undertake sufficient baseline data collection and assessment to support the selection and refinement of route corridor options. The assessment therefore focuses on land use directly affected by the route corridor options and includes:

- a broad estimate of the type and number of properties at risk of demolition or land take;
- an estimation of the likely loss of community land or areas which fall within local authority development designations; and
- a broad assessment of the likely impacts on individual farm units and on any designated agricultural areas; and
- consideration of the effects on proposals for restoration of un-navigable, disused or abandoned waterways or development of new waterways.

Baseline Conditions

<u>Residential and Commercial Land</u>

6.2.3 Baseline conditions were determined for residential and commercial properties through a review of Ordnance Survey (OS) maps, ArcView GIS and site surveys.

<u>Community Land</u>

6.2.4 Community land was identified through a review of OS maps, ArcView GIS, site surveys and review of Local Plans. A survey of the number of users has not been undertaken as knowledge on the type or level of users is not essential for Stage 2 particularly given the low level of community land affected.

6.2.5 For the purposes of this land use assessment, community land is considered to specifically relate to areas that provide an established public recreational resource (such as playing fields, Country Parks, or areas identified as community land within Local Plans i.e. Public Open Space). The potential for other areas to be used for informal recreation is also recognised, however this will be considered further at Stage 3 following consultation with landowners and community councils, and utilising feedback gained from public exhibitions.

Development Land

6.2.6 Potential development land was identified using land allocations set out in the relevant Development Plans for Fife Council for the northern route corridor options and the City of Edinburgh Council and West Lothian Council for the southern route corridor options. The three local authorities were contacted to identify current planning applications within the study area and a brief review of planning applications was also undertaken.

Agricultural Land

6.2.7 Information on the land capability of existing agricultural land was obtained from the Macaulay Land Use Research Institute (MLURI). The MLURI Land Capability for Agriculture classification system provides an indication of the capability of the land to grow certain types of crops and grass. Land is classified into seven main classes, some of which have sub-divisions. Class 1 is the best quality land and Class 7 is the poorest. Classes 1, 2 and 3_1 are regarded as the best and most versatile agricultural land and are referred to as prime quality land. The requirement to notify Scottish Ministers of applications affecting prime agricultural land was withdrawn in October 2002. However, Scottish Planning Policy (SPP)15: Planning for Rural Development states that prime quality agricultural land should continue to be protected and only used to meet strategic development objectives.

6.2.8 Agricultural land interests were identified as part of the landowner consultation process. This involved the identification of all owners of land directly affected by the emerging route corridor options or in close vicinity through direct consultation with landowners and using title deeds where available. Agricultural land use was identified using a combination of site visits to the locality, OS maps, aerial photographs and local knowledge. The assessment focuses on those areas classified by MLURI as agricultural land and includes areas of grassland, arable fields and woodland. In addition, the extent of the land holdings was determined as well as the form of land tenure.

6.2.9 Although woodland is included in the assessment of impacts on land owners, any commercial use of such woodland is not identified at Stage 2. Value of woodland was however considered qualitatively as low, moderate or high value by taking into account likely commercial, conservation, species or age characteristics that are assessed as being of moderate value.

Waterway Projects

6.2.10 No un-navigable, disused or abandoned waterways have been identified at this stage although ongoing consultation is being undertaken and if necessary this will be considered further at Stage 3.

Impact Assessment

6.2.11 As described below, significance of impacts on community land and agricultural land are assessed taking into account receptor sensitivity and impact magnitude. However, a different approach is described for assessment of residential and commercial land and of development land as standard significance terms are not used.

Impacts on Residential and Commercial Land

6.2.12 The assessment of residential and commercial uses does not assign standard significance terms (e.g. 'Moderate' significance), and is instead based on qualitative assessment of the direct adverse impacts caused by changes in access or land take as a consequence of the footprint of the route corridor. This approach is followed for residential uses because all such receptors are considered to be high sensitivity and for commercial uses because it is difficult to confirm impact significance without incorporating detailed assessment of businesses viability (which was not considered appropriate at this stage in the project; refer to Limitations to Assessment below).

6.2.13 It should be noted that there would also be potential indirect impacts such as changes in visual amenity, air quality and traffic noise. These are considered respectively in Chapter 11 (Visual), Chapter 13 (Air Quality) and Chapter 14 (Traffic Noise and Vibration) but indirect impacts on individual properties or businesses in the context of changes in land use cannot be determined at this stage.

Impacts on Community Land

6.2.14 Assessment of the impact of route corridor options on community land was undertaken by applying the sensitivity and magnitude criteria given in Table 6.1 and Table 6.2 below. The impact significance was then determined using Table 6.3.

Table 6.1: Criteria for Sensitivity of Community Land

Sensitivity	Description
High	Community land of national importance, e.g. National Parks.
Medium	Land used by the community on a regional scale, e.g. Country Parks, forests and other land managed in such a way as to attract visitors from a regional (or wider), catchment.
Low	Locally used community land, e.g. local parks and playing fields.

Table 6.2: Magnitude of Impact Criteria for Community Land

Magnitude of Impact	Description
High	>50% loss of land and/or complete severance of an identified area of community land.
Medium	Loss of part of a site (between approximately 15% and 50%) and/or major severance of an identified area of community land.
Low	<15% loss and/or partial severance of an identified area of community land.
Negligible	Very slight change from the baseline condition. Change hardly discernible, approximating to a 'no change' in conditions.

Table 6.3: Matrix for Determination of Impact Significance for Community Land

Magnitude / Sensitivity	Negligible	Low	Medium	High
High	Slight	Slight/Moderate	Moderate/Substantial	Substantial
Medium	Negligible/Slight	Slight	Moderate	Moderate/Substantial
Low	Negligible	Negligible/Slight	Slight/Moderate	Moderate

Impacts on Development Land

6.2.15 The assessment of development land does not use the standard significance criteria and instead qualitatively considers where the route corridor options directly conflict with a development land allocation or planning approval, leading to either partial or total loss of the development capability of the sites preferred use. This approach is followed as it is difficult to determine the magnitude or sensitivity of effects due to the uncertainties concerning the nature of future development. Potential changes in air quality, traffic and noise are considered respectively in Chapter 11 (Visual), Chapter 13 (Air Quality) and Chapter 14 (Traffic Noise and Vibration). The assessment considers potential changes in amenity but indirect impacts on individual applications in the context of changes in land use cannot be determined at this stage.

6.2.16 Detailed information on development plans for Fife, Edinburgh and West Lothian is considered separately in Chapter 18 (Policies and Plans). The Policies and Plans chapter also highlights other major developments that are likely to take place within the study area during similar timeframes as the Forth Replacement Crossing which may give rise to cumulative effects.

Effects on Agricultural Land

6.2.17 Assessment of the impact of route corridor options on agricultural land use was undertaken by applying the sensitivity and magnitude criteria given in Table 6.4 and Table 6.5 below. The impact significance was then determined using Table 6.6.

Table 6.4: Sensitivity of Receptor for Agricultural Land

Sensitivity	Characteristics
High	Presence of prime quality land (Class 1, 2 and 3_1). Arable cropping or intensive livestock systems (e.g. dairying). High value woodland that is rare or distinctive and susceptible to small changes.
Medium	Presence of land of moderate quality (Class 3_2, and 4). Mixed cropping and livestock systems of moderate intensity. Moderate value woodlands tolerant to moderate levels of change.
Low	Presence of land of low quality (Class 5, 6 and 7). Extensive livestock systems or agricultural land in non-agricultural use. More commonplace woodland tolerant of noticeable change or undergoing substantial development.

Table 6.5: Magnitude of Impact for Agricultural Land

Magnitude of impact	Impact Description
High	Loss of more than 10% of the land holding. High degree of severance extending to more than 20% of the land holding. Access to agricultural and forestry land restricted. Noticeable change to the woodland over a wide area or an intensive change over a limited area.
Medium	Loss of between 5% and 10% of the land holding. Moderate degree of severance extending to between 10% and 20% of the land holding. Access to agricultural and forestry land compromised. Small changes to the woodland over a wide area or a noticeable change over a limited area.
Low	Loss of less than 5% of the land holding. Low degree of severance extending to less than 10% of the land holding. Minimal change in access to agricultural and forestry land. Very minor changes to the woodland over a wide area or minor changes over a limited area.
Negligible	Negligible change to any of the above factors.

Table 6.6: Matrix for Determination of Impact Significance for Agricultural Land

Sensitivity \ Magnitude	Negligible	Low	Medium	High
High	Slight	Slight/Moderate	Moderate/Substantial	Substantial
Medium	Negligible/Slight	Slight	Moderate	Moderate/Substantial
Low	Negligible	Negligible/Slight	Slight/Moderate	Moderate

6.2.18 As indicated in Table 6.5 above, the magnitude of impacts was estimated by using professional judgement, taking into account factors such as land take, severance and access. Severance effects refer to where the road cuts through land parcels, potentially affecting access and also creating field sizes and shapes which may become impractical for agricultural use. Severance is calculated based on the area affected by the footprint of the route corridor options together with any areas of severed land parcels that would be rendered redundant for agricultural use.

Limitations to Assessment

6.2.19 The baseline information presented in this chapter is based on data available at the time of assessment. More detailed assessment will be undertaken at Stage 3 as indicated below. However, the assessment as reported in this chapter is considered to provide a sufficiently robust basis for DMRB Stage 2 assessment.

<u>Residential and Commercial Land</u>

6.2.20 Due to the sensitive nature of the assessment and ongoing refinement of route corridor options, interviews have not been undertaken with businesses at this stage. A more detailed assessment of the effects on land owners, farms and businesses will be undertaken in Stage 3, including consideration of issues such as commercial viability and also effects such as changes in traffic flows, noise, air quality and visual impacts on individual businesses and residential properties.

6.2.21 It is possible that as the scheme design is progressed through Stage 3, the construction requirements may result in a change to the assessment of property demolitions. Similarly, it should be noted that the estimates of land take are based on the footprint of the route corridor options including currently anticipated junction designs and earthworks. At this stage however, no provision is made for potential additional land take required for aspects such as landscape planting or other essential mitigation.

<u>Community Land</u>

6.2.22 Community Land has been defined as described in paragraph 6.2.4. However, as noted in Chapter 15 (Pedestrians, Cyclists, Equestrians and Community Effects), the Land Reform (Scotland) Act 2003 establishes statutory rights of responsible access on and over most land. It is therefore acknowledged that additional areas of privately owned land may be used informally by the community. These will be identified through consultation at Stage 3 and assessed, with mitigation proposed as necessary.

<u>Development Land</u>

6.2.23 In-confidence views of councils regarding the potential impact on local development policies were not specifically obtained as part of the environmental assessment. However, the project team (including Traffic and Roads Teams) and Transport Scotland have held meetings with the councils to obtain views and these have been taken into account as appropriate during development of the Stage 2 route corridor options.

Agricultural Land

6.2.24 Information on agricultural land capability is based on MLURI Land Capability for Agriculture data. In accordance with this information, the area of land to the west of the A90 (affected by North Corridor Option 2) is not classified as agricultural land and is therefore not included in the assessment. This relates to the land at Castlandhill (approximately 87,055m^2), Broomhall Estate (approximately 61,449m^2) and also land owned by Fife Council (approximately 8,145m^2). Although this area (156,699m^2 or 15.7ha in total) is classed as 'land covered up by built up areas, quarries, ground workings or collieries', during the walkover survey, it was noted that some fields in this area may be used for agriculture. This information will be verified through detailed survey work and consultation in Stage 3.

6.2.25 As per the Commercial and Residential assessment, interviews with agricultural land interests are not part of this assessment but will be undertaken at Stage 3 once a preferred corridor has been identified. Absolute and percentage loss of agricultural land has been estimated using current understanding of landowner boundaries, identified through landowner consultation and legal title deeds where available. These are indicative only as landownership will continue to be informed by ongoing legal title deed searches by Transport Scotland as the project progresses. As such the landowner boundaries are not shown on the figures.

6.3 Baseline Conditions

6.3.1 Land use within the study area is indicated on Figures 6.1 and 6.2 (agricultural use and general use respectively), and described further below.

Residential and Commercial Land

6.3.2 The main concentrations of residential properties to the north of the Firth of Forth are located in the settlements of North Queensferry, Rosyth, Dunfermline, and Inverkeithing. To the south of the Firth of Forth, residential uses are focused within the settlements of South Queensferry and Kirkliston. There are a growing number of satellite residential communities, such as Duloch Farm in the north.

6.3.3 The main concentration of commercial land use to the north of the Firth of Forth is located between Rosyth and Inverkeithing. This includes the Belleknowes Industrial Estate located just to the east of the A90/M90 and also Masterton Park to the north of the A823. There are also a number of additional commercial properties however, these are either individual units or are located over 100m from the route corridor options. Table 6.7 provides details on the number of businesses within 100m of the footprint of each route corridor option.

Table 6.7: Businesses within 100m of the footprint of each Route Corridor Option

Northern Route Corridor Options	No. of businesses
North Corridor Option 1	35
North Corridor Option 2	34
Southern Route Corridor Options	**No. of businesses**
South Corridor Option 1	6
South Corridor Option 2	7

*Estimated number of businesses present.

Community Land

6.3.4 Community land use in the study area constitutes a horse riding centre, reservoir and a number of areas of Open Space such as playing fields. These areas are established public recreational resources and likely to be used by the public for sports or activities such as dog walking (refer to Figure 6.2). There also are a number of footpaths within and between many of these areas which provide access for the public which may be used by the local community for recreational purposes. Further information regarding rights of way and footpaths is provided in Chapter 15 (Pedestrians, Cyclists, Equestrians and Community Effects). Some of these areas are of recognised scenic value and include designated gardens and landscapes as described in Chapter 10 (Landscape). Although Port Edgar Marina provides access to the Firth of Forth for recreational use such as sailing, potential impacts on the marina are considered under the residential and commercial assessment. Similarly, Westmuir Riding School may be used for recreation and is also a business, however, its primary function is reliant on its agricultural (land) assets therefore it has been assessed under agricultural land.

6.3.5 Sites of community land within 100m of the route corridor options are detailed in Table 6.8. All community land in the study area is of low sensitivity due to the land being of local and not regional or national significance. Impacts on landscape and visual issues are addressed separately in Chapter 10 (Landscape) and Chapter 11 (Visual). Figure 10.3 identifies the location of Gardens and Designated Landscapes.

Table 6.8: Key Sites of Community Land

Open Space (as identified in Local Plans)
Duloch Meadow (Green Corridor)
Open Space southwest of M90 Junction 2
Playing fields at Cameron Grove, Inverkeithing
Muckle Hill, Inverkeithing (Open Space)
Land part of Kirkliston Leisure Centre
Areas to the south and southwest periphery of Kirkliston (Open Space and Site of Importance for Nature Conservation)
School grounds south of Dalmeny
Other areas used for recreation
Westmuir Riding Centre
Humbie Reservoir

Development Land

6.3.6 Potential development land was identified within the Development Plans covering the study area (Development Plan framework is described further in Chapter 18: Policies and Plans). Table 6.9 provides a summary of the main allocations within the study area and these are also indicated on Figure 6.2. Please note that the more generic environmental protection policies are dealt with in detail in Chapter 18 (Policies and Plans).

Table 6.9: Development Plan Allocations

Development Plan	Status of Plan	Development Plan Allocation	Location
Rural West Edinburgh Local Plan (2006)	Adopted	ENV6, Environmental Improvement, Springfield Road	South Queensferry
		HSG6/ECON10 Port Edgar, mixed use development.	South Queensferry
		HSG7 Housing Allocation, Society Road	Queensferry
		HSG 2, Housing Allocation, Springfield Road.	Queensferry
Finalised West Lothian Local Plan (2005)	Finalised	CDA 9 Winchburgh Core Development Area	Winchburgh
		TRAN 29 – New Motorway junction on M9 associated with CDA9	Winchburgh
Dunfermline and the Coast Local Plan (2002)	Adopted	BE 7 Brownfield Development sites, S17 Belleknowes industrial Estate	Rosyth
		H2 Strategic housing allocation, S 97, Kingdom gateway I	East Dunfermline Expansion Area
		COU 7/ COU9 Green Corridors/Proposed Open Space, S 142 Duloch Meadow	East Dunfermline Expansion Area

Rural West Edinburgh Local Plan.

6.3.7 The main allocation identified by the Rural West Edinburgh Local Plan is the planned mixed use development at Port Edgar (HSG6/ECON10). This allocation lies immediately east of the Forth Replacement Crossing and is a site designated for a mixed use development including marina uses, marine businesses and housing. The development is the subject of a separate Development Brief which has recently been the subject of public consultation.

Finalised West Lothian Local Plan

6.3.8 The main allocation identified by the Finalised West Lothian Local Plan is the mixed use development (CDA 9) and new junction on the M9 to the northeast of Winchburgh. The new motorway junction is required to facilitate the major residential (5,500 dwellings) and employment (40ha minimum) development.

Dunfermline and the Coast Local Plan

6.3.9 The main allocations identified by the Dunfermline and Coast Local Plan relate to policies H1 and H2 which identify effective and strategic housing sites. In particular, the East Dunfermline Expansion Area includes most of the land between Dunfermline and the M90 and is identified as the main focus for growth over the next 10 to 15 years. When complete, more than 4,000 houses, 131 hectares of employment land and a commercial leisure park will be linked by an integrated transport network.

6.3.10 The Local Plan also promotes the redevelopment of Rosyth naval base for industrial and commercial uses as well as the reuse of a number of brownfield sites including MOD owned land. Land has also been safeguarded for the Rosyth by-pass and a road link from the M90 to Rosyth Europarc.

Planning Applications

6.3.11 Appendix A6.1 provides a list of planning applications that have been approved, together with applications awaiting determination, by each local planning authority in the past 5 years

(May 2003 to May 2008). These include a number of applications that relate to the planning allocations indicated above.

Agricultural Land

6.3.12 The land within the northern study area is less rural in character than that in the southern study area which has a greater proportion under agricultural use. The quality of agricultural land in the study area is high. Land within the Northern study area is predominantly of Class 3_2 with prime quality land of Class 2 and Class 3_1 north of Inverkeithing. There is a predominance of prime agricultural land within the Southern study area.

6.3.13 Arable farming is the predominant form of agriculture within the study area which reflects the quality of land available. Figure 6.1 presents the classification of agricultural land in accordance with MLURI data.

6.3.14 There are a number of mature broadleaf woodlands including around Ferrytoll (Castlandhill Woods) and to the east of Middlebank at Duloch House and Dales Steading in the northern study area and around Dundas Castle in the southern study area. Figure 9.1 presents the classification of habitats in the study area and identifies areas of woodland.

6.3.15 A summary of the sensitivity of the land interests is provided in Table 6.10.

Table 6.10: Sensitivity of Land Interests

Land Interest	Agricultural/Forestry Activity	Sensitivity
N-6, Masterton Farm	Arable based farming systems Prime and non-prime land	High
N-7, Balbougie Farm	Arable based farming systems Non-prime land	Medium
N-18, Masterton Pitreavie	Arable based farming systems Non-prime land	Medium
N-19, Broomhall Estate	Arable based farming systems Prime	High
N-20, Spencerfield	Arable based farming systems Prime and non-prime land	High
N-22, Scottish Enterprise	Arable based farming systems Non-prime land	Medium
N-23, George Wimpey East Scotland	Arable based farming systems Prime and non-prime land	Medium
N-33, Gatehouse of Duloch	Arable based farming systems Non-prime land	Medium
N-47, Hidden Valley	Non-prime land Moderate value woodland	Medium
S-1, Dundas Estate	Arable based farming systems Prime and non-prime land	High
S-2, Humbie Farm	Arable based farming systems Prime land Moderate value woodland	High
S-9, Dalmeny Estate	Arable based farming systems Prime land	High
S-10a, Aithrie Estate	Arable based farming systems Prime land	High
S-19a, Newliston Estate	Arable based farming systems Prime land	High

Land Interest	Agricultural/Forestry Activity	Sensitivity
S-27, Dundas Mains	Arable based farming systems Prime land	High
S 33, Westmuir Riding Centre	Equestrian Prime land	High
S-34, Scottish Ministers Land	Arable based farming systems Prime land	High

6.3.16 As indicated in Table 6.10, land interest S-34 refers to an area of land to the west of South Queensferry owned by Scottish Ministers. This has been purchased to protect the bridge head location in anticipation of the future requirement for a replacement bridge. Although not currently used for agriculture, MLURI identifies this as prime quality agricultural land and as such of high sensitivity, however it is excluded from the assessment of potential impacts given its purchase to meet strategic development objectives (i.e. the Forth Replacement Crossing) and in recognition of the fact that impacts on this area are common to all southern corridor options.

6.4 Potential Impacts

6.4.1 The following section identifies potential impacts in the absence of mitigation. Anticipated mitigation is then set out in Section 6.5 (Potential Mitigation).

Proposed Replacement Bridge

Residential and Commercial Land

6.4.2 The design of the proposed replacement bridge is important for the consideration of impacts on residential and commercial properties. There are residential properties and commercial buildings within close proximity to the footprint of the proposed replacement bridge. However, the preliminary design of the bridge indicates that no buildings would be demolished.

Loss of Community Land

6.4.3 The proposed replacement bridge could potentially affect access to the Firth of Forth for recreational use, although no direct impacts are anticipated on the Port Edgar Centre which offers water sports facilities. As there are no areas of community land located directly under the landing of the proposed replacement bridge, the design options would not affect the impacts on identified areas of community land.

Development Land

6.4.4 The proposed replacement bridge landing on the south of the Firth of Forth would have an adverse impact on the following developments planned in South Queensferry.

- Port Edgar (HSG 6/ECON 10) - local plan allocation for a mixed use development located immediately east of the proposed replacement bridge;
- Port Edgar (03/01969/FUL,) - new clubhouse facility for Port Edgar Yacht club (Planning Application 1 shown on Figure 6.2c);
- Society Road, Queensferry (HSG7) - Site for housing development; and
- Springfield Road, South Queensferry (ENV 6 and HSG2) – one site for housing development and one site for environmental improvement associated with housing development.

6.4.5 The amenity for all use classes would be adversely affected, including visual, noise and dust impacts (refer to Chapter 10: Landscape, Chapter 14: Traffic Noise and Vibration, and Chapter 13: Air Quality). The severity of these impacts would need to be assessed further, including consultation with the City of Edinburgh Council.

Agricultural Land

6.4.6 No agricultural or forestry land would be affected by the proposed replacement crossing.

Northern Route Corridor Options

Impacts Common to Both Northern Route Corridor Options

Residential and Commercial Land

6.4.7 Both northern route corridor options would result in the land take at one commercial/residential premises as identified in Table 6.11.

Table 6.11: Potential Impacts on Property - Common to Both Northern Route Corridor Options

Receptor	Land Use	Potential Impact (unmitigated)	
		Type	Significance
St. Margaret's Hope (Kapital Assets Ltd)	Commercial and residential	Land take	Adverse

Community Land

6.4.8 Both northern route corridor options would have impacts on one area of community land as detailed in Table 6.12.

Table 6.12: Potential Impacts on Community Land - Common to Both Northern Route Corridor Options

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Duloch Meadow (Green Corridor) (approximately 0.1ha)	Low	Negligible	Negligible

Development Land

6.4.9 Both northern route corridor options have the potential to affect future developments highlighted in the Development Plan Allocations and Planning Applications relating to the Dunfermline East Expansion Area (i.e. applications at Masterton Road and Masterton Park). However, the significance of the effects on individual planning applications/allocations cannot be determined at this stage.

Table 6.13: Potential Impacts on Development Land - Common to Both Northern Route Corridor Options

Planning Application Site	Proposed Development	Status of Application	Potential Impact (unmitigated)
Fife Council			
08/00984/WEIA, Rosyth Railway Station (Figure 6.2a - Planning Application 2)	Construction of 500 spaces park and ride facility, and associated landscaping and works	Pending Consideration	No direct land take although changes in amenity uncertain.
07/01337/WFULL, Masterton Road, Dunfermline (Figure 6.2a - Planning Application 3)	Erection of 62 houses, 18 flats and associated roads, parking and landscaping	Pending Decision	
06/04235/WARM Masterton Park R5 (Figure 6.2a - Planning Application 4)	Reserved matters application for the erection of 203 houses, 24 flats, formation of new road access, footpaths, roads, open space, play areas, landscaping and drainage pond.	Pending Consideration	No direct land take although changes in amenity uncertain.
H2, Site 97, Kingdom Gateway I	Strategic housing allocation, Duloch, Dunfermline	Local Plan Allocation	
COU 7/ COU9 Site 142 Duloch Meadow	Green Corridors/Proposed Open Space, Dunfermline	Local Plan Allocation	
BE 7 ,Site 17 Belleknowes industrial Estate	Brownfield Development sites, Rosyth	Local Plan Allocation	

North Corridor Option 1

Residential and Commercial Land

6.4.10 As shown in Table 6.14, North Corridor Option 1 would have an impact on land take for one residential property (in addition to those impacts listed in Table 6.11 as common to both northern route corridor options).

Table 6.14: Potential Impacts on Property - North Corridor Option 1

Receptor	Land Use Type	Potential Impact (unmitigated)	Significance
Welldean Cottages (potentially only garages exist in this area, to be verified during Stage 3)	Residential	Land take	Adverse

Community Land

6.4.11 North Corridor Option 1 would not affect any additional areas of community land, to those listed in Table 6.12 as common to both northern route corridor options.

Development Land

6.4.12 North Corridor Option 1 would not affect any areas of development land in addition to those listed in Table 6.13 as common to both northern route corridor options.

Agricultural Land

6.4.13 A total of eight land interests would potentially be affected by North Corridor Option 1. The impacts on each land interest are summarised in the Table 6.15.

Table 6.15: Potential Impacts on Agricultural Land - North Corridor Option 1

Land Interest	Loss of Land					Severance	Potential Impact (unmitigated)	
	No. of Fields*	Area Lost (ha)			% of total farmed area		Magnitude	Significance
		Prime	Non-Prime	Wood				
N-6 Masterton Farm	2	4.0	0.0	0.0	5%	10-20%	low	Slight/ Moderate
N-7 Balbougie Farm	1	0.0	0.1	0.0	<1%	Negligible change	Negligible	Negligible/ Slight
N-18 Masterton Pitreavie	1	0.0	2.1	0.0	7%	Negligible change	Medium	Moderate
N-22 Scottish Enterprise	1	0.0	0.1	0.0	<1%	Negligible change	Negligible	Negligible/ Slight
N-23 George Wimpey East Scotland Ltd	1	0.0	0.1	0.0	1%	Negligible change	Negligible	Negligible/ Slight
N-33 Gatehouse of Duloch	1	0.0	0.1	0.0	2%	Negligible change	Low	Slight
N-47 Hidden Valley	1	0.0	0.0	0.1	1%	Negligible change	Low	Slight
N20 Spencerfield	2	0.9	0.0	0.1	2%	10-20%	Low	Slight/ Moderate
Totals	8	4.9	2.5	0.2				

Note: * = Number of fields partially affected or lost

6.4.14 A total of approximately 4.9ha of prime land and 2.5ha of non-prime land would be lost to North Corridor Option 1. Additionally, 0.2ha of woodland would be lost. This equates to a total land loss of 7.6ha. Overall, there is a low degree of severance for North Corridor Option 1. Impact significance taking into account both land loss and severance is Moderate for one land interest.

North Corridor Option 2

Residential and Commercial Land

6.4.15 For North Corridor Option 2, one residential property and four commercial buildings would be demolished (in addition to those impacts listed in Table 6.11 as common to both northern route corridor options). Although Well Dean Cottages are indicated on OS maps, site visits indicate that only garages exist in this area (to be verified during Stage 3). This option could also potentially impact on access for 20 residential properties at Castlandhill.

6.4.16 A summary of the potential impacts on commercial and residential properties is provided in Table 6.16.

Table 6.16: Potential Impacts on Property – North Corridor Option 2

Receptor	Land Use Type	Potential Impact (unmitigated)	Significance
Welldean Cottages (potentially only garages exist in this area, to be verified during Stage 3)	Residential	Demolition	Adverse
Castlandhill Community	Residential	Option could potentially affect the only access road for 20 properties	
Belleknowes Industrial Estate (10 businesses)	Commercial	3 buildings demolished (assumed to be 3 businesses at this stage). Estate would be split into two which could cause access problems for one additional building (assumed to be 1 business at this stage).	
Co-Part Scrap Yard	Commercial	1 building to be demolished plus land take (assumed to be 1 business at this stage).	

Community Land

6.4.17 North Corridor Option 2 would not affect any areas of community land in addition to those listed in Table 6.12 as common to both northern route corridor options.

Development Land

6.4.18 North Corridor Option 2 would not affect any areas of development land in addition to those listed in Table 6.13 as common to both northern route corridor options.

Agricultural Land

6.4.19 A total of six land interests would potentially be affected by North Corridor Option 2, as listed in Table 6.17.

Table 6.17: Potential Impacts on Agricultural Land – North Corridor Option 2

Land Interest	Loss of Land					Severance	Potential Impact (unmitigated)	
	No. of Fields*	Area Lost (ha)			% of Total Farmed Area		Magnitude	Significance
		Prime	Non-Prime	Wood				
N-6 Masterton Farm	4	4.6	1.6	0.0	7%	<20%	High	Substantial
N-7 Balbougie Farm	1	0.0	2.3	0.0	11%	Negligible change	High	Moderate/ Substantial
N-19 Broomhall Estate	1	0.4	0.0	0.0	1%	Negligible change	Low	Slight/Moderate
N-22 Scottish Enterprise	1	0.0	0.1	0.0	<1%	Negligible change	Negligible	Negligible/Slight
N-33 Gatehouse of Duloch	1	0.0	0.1	0.0	8%	Negligible change	Medium	Moderate
N-47 Hidden Valley	1	0.0	0.0	0.4	6%	Negligible change	Medium	Moderate
Totals	9	5.0	4.1	0.4				

Note: * = Number of fields partially affected or lost

6.4.20 A total of approximately 5.0ha of prime land and 4.1ha of non-prime land would be lost to North Corridor Option 2. Additionally, 0.4ha of woodland would be lost. This equates to a total land loss of 9.5ha. The severance impact is generally low on all but Masterton Farm where there is a high degree of severance. Nevertheless, overall there is considered to be a low degree of severance for North Corridor Option 2. Impact significance taking into account both land loss and severance is Moderate or greater for four land interests.

Southern Route Corridor Options

Impacts Common to Both Southern Route Corridor Options

Residential and Commercial Land

6.4.21 Both southern route corridor options would result in direct land take for one residential property and also for commercial buildings at Port Edgar (Table 6.18).

Table 6.18: Potential Impacts on Property - Common to Both Southern Route Corridor Options

Receptor	Land Use Type	Potential Impact (unmitigated)	Significance
Inchgarvie House	Residential	Land take	Adverse
Stores at Port Edgar (warehouse buildings include some commercial uses and boat storage)	Commercial	Land take	

Development Land

6.4.22 For southern route corridor options, approximately 0.5ha of direct land take from Society Road housing allocation and 4.4ha from allocations at Springfield Road would potentially occur. There are also a number of potential future developments that have been identified in close proximity to the route corridors. No direct land take is identified however there could be changes in amenity such as traffic, noise and air quality. As indicated by Table 6.19, these include allocations at Port Edgar and South Queensferry and also application at Dundas Castle Estate. However, the significance of the effects on individual planning applications/allocations cannot be determined at this stage.

Table 6.19: Potential Impacts on Development Land - Common to Both Southern Route Corridor Options

Planning Application Site	Proposed Development	Status of Application	Potential Impact (unmitigated)
City of Edinburgh Council			
04/03280/FUL, Bo'ness Road, South Queensferry (Figure 6.2c - Planning Application 5)	Construction of new Waste Water Treatment Works	Application granted	No direct land take although changes in amenity uncertain.
08/01440/FUL, Dundas Castle Estate (Figure 6.2c - Planning Application 6)	Restore semi derelict stable wing to create en-suite bedrooms and studio	Application granted	
07/04254/FUL, Queensferry Road, Kirkliston (Figure 6.2c - Planning Application 7)	Carry out infrastructure works, for future development at North Kirkliston	Application granted	
HSG 6/ECON 10 Port Edgar	Allocation for a mixed use development including Class 4 marina uses, marine businesses and housing proposed.	Local plan allocation and subject of a Development Brief which has recently undergone public consultation.	No direct land take although changes in amenity uncertain.
03/01969/FUL, Port Edgar (Figure 6.2c Planning Application 1)	New clubhouse facility for Port Edgar Yacht club.	Application granted	
Site H7, Society Road, South Queensferry	Housing land allocation.	Local plan allocation	Direct land take (0.5ha)
ENV 6, Springfield Road, South Queensferry	Site for environmental improvement associated with housing development.	Local plan allocation	Direct land take (4.4 ha)
HSG2, Springfield Road, South Queensferry	Housing development with associated environmental improvements.	Local plan allocation	

<u>South Corridor Option 1</u>

Residential and Commercial Land

6.4.23 South Corridor Option 1 is not expected to have any direct impacts due to land take, demolitions or changes in access (with the exception of impacts identified in Table 6.18 as common to both southern route corridor options).

Development Land

6.4.24 As shown in Table 6.20 the proposed development at Winchburgh could be affected by South Corridor Option 1 due to changes in amenity (e.g. traffic, noise and air quality effects). However, the significance of impacts on individual planning applications/allocations cannot be determined at this stage. As explained in Chapter 18 (Policies and Plans), it is assumed that the Forth Replacement Crossing would not prevent access to this development site.

Table 6.20: Potential Impacts on Development Land - South Corridor Option 1

Planning Application Site	Proposed Development	Status of Application	Potential Impact (unmitigated)
West Lothian Council			
Winchburgh, 1012/p/05 (Figure 6.2c - Planning Application 8)	Outline Planning Permission for 352 ha mixed use development in line with Local plan Allocation CDA 9	Awaiting determination	Changes in amenity uncertain. Junction arrangement unchanged.
TRAN 29	New Motorway junction on M9 associated with CDA9, Winchburgh	Local Plan Allocation	

Agricultural Land

6.4.25 A total of five land interests would potentially be affected by this option, as listed in Table 6.21.

Table 6.21: Potential Impacts on Agricultural Land - South Corridor Option 1

Land Interest	Loss of Land					Severance	Potential Impact (unmitigated)	
	No. of Fields*	Area Lost (ha)			% of Total Farmed Area		Magnitude	Significance
		Prime	Non-Prime	Wood				
S-1 Dundas Estate	4	8.2	0.0	0.0	2%	<10%	Low	Slight/ Moderate
S-2 Humbie Farm	2	5.4	0.0	0.0	3%	Negligible change	Low	Slight/ Moderate
S-9 Dalmeny Estate	4	3.5	0.0	0.0	1%	Negligible change	Negligible	Slight
S-19a Newliston Estate	3	4.0	0.0	0.0	5%	Negligible change	Medium	Moderate/ Substantial
S-27 Dundas Mains	2	9.7	0.0	0.0	16%	10-20%	High	Substantial
Totals	18	30.8	0.0	0.0				

Note: * = Number of fields partially affected or lost

6.4.26 A total of approximately 30.8 ha of prime land would be lost to this South Corridor Option 1. No non-prime land or woodland would be affected. The severance impact varies although overall there is considered to be a low degree of severance for South Corridor Option 1. Significance taking into account both land loss and severance is Moderate or greater for two land interests.

South Corridor Option 2

Residential and Commercial Land

6.4.27 For South Corridor Option 2, with the exception of impacts identified in Table 6.18 as common to both southern route corridor options, only a water tank in the small community of Westfield would be demolished (Table 6.22).

Table 6.22: Potential Impacts on Property - South Corridor Option 2

Receptor	Land Use Type	Potential Impact (unmitigated)	Significance
Westfield tank (assumed to be for water)	Commercial	Potential demolition	Adverse

Community Land

6.4.28 As shown in Table 6.23, South Corridor Option 2 would affect one area of community land. Significance is Negligible/Slight for one area of community land.

Table 6.23: Potential Impacts on Community Land - South Corridor Option 2

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Humbie Reservoir (approximately 2.7ha)	Low	Low	Negligible/Slight

Development Land

6.4.29 As shown in Table 6.24, no direct land take is identified for the proposed development at Winchburgh, however there could be changes in amenity such as traffic, noise and air quality. The significance of the effects on individual planning applications/allocations cannot be determined at this stage. As explained in Chapter 18 (Policies and Plans), it is assumed that the Forth Replacement Crossing would not prevent access to this development site.

Table 6.24: Potential Impacts on Development Land - South Corridor Option 2

Planning Application Site	Proposed Development	Status of Application	Potential Impact (unmitigated)
West Lothian Council			
Winchburgh, 1012/p/05 (Figure 6.2c - Planning Application 8)	Outline Planning Permission for 352 ha mixed use development in line with Local plan Allocation CDA 9	Awaiting determination	Changes in amenity uncertain. Route corridor may affect the location of the new junction.
TRAN 29	New Motorway junction on M9 associated with CDA9, Winchburgh	Local Plan Allocation	

Agricultural Land

6.4.30 A total of six land interests would potentially be affected by this option, as listed in Table 6.25.

Table 6.25: Potential Impacts on Agricultural Land - South Corridor Option 2

Land Interest	Loss of Land					Severance	Potential Impact (unmitigated)	
	No. of Fields*	Area Lost (ha)			% of Total Farmed Area		Magnitude	Significance
		Prime	Non-Prime	Wood				
S-1 Dundas Estate	9	13.2	0.0	0.0	3%	>20%	Medium	Moderate/ Substantial
S-2 Humbie Farm	8	14.3	0.0	1.6	9%	Negligible change	Medium	Moderate/ Substantial
S-9 Dalmeny Estate	5	12.4	0.0	0.0	3%	Negligible change	Low	Slight/ Moderate
S-10a Aithrie Estate	4	2.3	0.0	0.1	<1%	>10%	Negligible	Slight
S-19a Newliston Estate	4	11.4	0.0	0.0	14%	Negligible change	High	Substantial
S-33 Westmuir Riding Centre	3	1.1	0.0	0.0	15%	>10%	High	Substantial
Totals	36	54.7	0.0	1.7				

Note: * = Number of fields partially affected or lost

6.4.31 A total of approximately 54.7ha of prime land would be lost to South Corridor Option 2. No non-prime land would be affected, however, 1.7ha of woodland would be lost. This equates to a total land loss of 56.4.1ha. The severance impact varies and but overall there is considered to be a moderate degree of severance for South Corridor Option 2. Significance taking into account both land loss and severance is Moderate or greater for four land interests.

6.5 Potential Mitigation

6.5.1 At DMRB Stage 2 assessment of route corridor options the detailed design has not been developed and mitigation detail therefore cannot be accurately defined. The objective of this section is to identify 'standard' or 'anticipated' mitigation taking into account best practice, legislation and guidance. It also identifies aspects of the design such as cut and cover that would be used. This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 6.4 (Potential Impacts), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

Residential and Commercial Land

6.5.2 The design of the proposed replacement bridge landing would mitigate a number of potential negative residential and commercial property impacts. There are a number of commercial buildings and also two residential properties within close proximity to the footprint of the bridge, however the preliminary design indicates that no demolitions would be required.

6.5.3 The current design of North Corridor Option 2 incorporates a 'cut and cover' section that would mitigate potential access impacts for a number of properties in the community of Castlandhill. Similarly provision of alternative access could mitigate the adverse access impacts to the Belleknowes Industrial Estate.

6.5.4 Where land take is still required following mitigation for the route corridor options and bridge and would result in the loss of residential and commercial properties, land owners would be compensated financially. Further details of the extent of financial compensation are beyond the scope of this assessment and will be provided by the District Valuer.

Community Land

6.5.5 Potential mitigation measures for community land could include the provision of paths where public or private access has been affected. and planting to mitigate the loss of woodland areas.

6.5.6 Due to the small area affected, the loss of community land is not considered to be significant. However, financial compensation would be provided to the landowner for the loss of land. None of the route corridors have any significant impact on any areas of allocated Public Open Space therefore it is assumed that no areas of exchange land would need to be provided.

Development Land

6.5.7 Potential mitigation measures relating to development land could include reducing any potential impacts on amenity. Specific measures such as noise barriers, landscaping etc will be developed during DMRB Stage 3 to reduce impacts in accordance with the results of the air quality, noise, landscape and visual assessments.

6.5.8 Since the realisation of the Winchburgh development is dependent on the provision of a junction onto the M9 motorway, the design of both southern route corridor options has taken this into account. It is anticipated that access would be gained either by the later installation of a dedicated junction on the M9 (for South Corridor Option 1) or a slip road from the M9 junction proposed as part of South Corridor Option 2.

Agricultural Land

6.5.9 Mitigation measures can be developed with the aim of protecting the agricultural capability of the land and soils and maintenance of the viability of farming units.

6.5.10 Typical mitigation measures incorporate the following principles:

- reinstatement of agricultural land to reduce land take where possible post construction;
- provision of access for land interests to their holdings including the provision of accommodation over bridges or underpasses to mitigate potential severance where appropriate;
- reinstatement/provision of new drainage as required to maintain agricultural land capability and avoid flooding issues; and
- provision of financial compensation for land take, as agreed and determined by the District Valuer.

6.6 Summary of Route Corridor Options Assessment

6.6.1 The assessment of community land impacts does not identify any adverse impacts of greater than Negligible/Slight significance. A total of approximately 0.1ha of community land would be affected by both northern options and 2.7ha by South Corridor Option 2. However, it should be noted that as all community land is classified by MLURI as agricultural land, these areas are included in the agricultural assessment and are therefore not repeated in the summary tables below. All community land in the study area was found to be of low sensitivity due to the land being of local and not regional or national significance. Landscape planting would be likely to further reduce the significance of any impacts on community land.

6.6.2 For the agricultural assessment, the residual impacts assume mitigation measures to reduce severance, including the provision of overbridges or underpasses for Humbie Farm and Dundas Estate in South Corridor Option 2. Nevertheless, land take remains and consequently it is not expected that mitigation will reduce the significance of impact for the affected land interests. Although possible mitigation includes returning land to agricultural use, some additional land (i.e. beyond the footprint of the scheme) would be required for environmental mitigation such as landscape planting. For the purposes of the assessment, the areas of land take reported in this chapter are therefore assumed not to be reduced by mitigation.

Northern Route Corridor Options

6.6.3 For the northern route corridor options, North Corridor Option 1 has the lowest overall land use impacts. This option affects the least number of land interests and also has less direct impacts on residential or commercial uses.

Table 6.26: Summary of Impacts common to Both Northern Route Corridor Options

Land Use Issue	Impact	Significance
Residential and Commercial Uses	Land take for one commercial/residential property	Adverse
Development Land	Number of development plan allocations and planning applications where future development could potentially be affected by changes in amenity. These include any future development associated with the Dunfermline East Expansion Area. The potential impacts and mitigation are currently unknown however, these will be assessed by the Air Quality, Landscape, Visual, Traffic Noise and Vibration assessments for Stage 3.	Significance cannot be determined at this stage.

Table 6.27: Summary of Impacts for North Corridor Option 1 and North Corridor Option 2

Land Use Issue	Impact	Significance
North Corridor Option 1		
Residential and Commercial Uses	One residential property would be affected by direct land take.	Adverse
Agricultural Land	Total of 4.9ha of prime land, 2.5ha of non-prime land and 0.2ha of woodland would be lost. Total land loss of 7.6ha. Overall, the degree of severance for this route corridor option is low.	Moderate impacts for one land interest.
North Corridor Option 2		
Residential and Commercial Uses	One residential property (site visit indicates potentially only garages are present in this area) and four commercial buildings (three at Belleknowes Industrial Estate and one at Co-Part Scrap Yard) would also be demolished. This option could potentially impact on access for 20 residential properties at Castlandhill although this would be mitigated through a 'cut and cover' at this section.	Adverse
Agricultural Land	Total of 5.0ha of prime land, 4.1ha of non-prime land and 0.4ha of woodland would be lost. Total land loss of 9.5ha. The severance impact varies but overall the degree of severance for this route corridor option is considered to be low. In addition, 15.7ha of land not classified by MLURI data but also likely to be agricultural land would be affected.	Impacts are Moderate or above for four land interests. Adverse impacts on 3 other land interests likely to be agricultural land but not classified as such by MLURI.

Southern Route Corridor Options

6.6.4 For the southern options, South Corridor Option 1 has the lowest overall land use impacts. This option affects the least number of land interests and has fewer direct impacts on residential or commercial uses. South Corridor Option 1 also has fewer implications on the proposed junction required to facilitate the planning allocation at Winchburgh.

Table 6.28: Summary of Impacts Common to Both Southern Route Corridor Options

Land Use Issue	Impact	Significance
Residential and Commercial Uses	All southern route corridor options will result in direct land take at the Stores at Port Edgar and also at one residential property.	Adverse
Development Land	Total land take of approximately 4.9ha total land take from planning allocations at Society Road (Housing) and Springfield Road (Housing and Environmental Improvements). Number of potential future developments that could be affected by changes in amenity including Development Plan Allocations and Planning Applications related to the Dunfermline East Expansion Area. However, the exact nature of the effects on individual applications cannot be determined at this stage.	Significance cannot be determined at this stage

Table 6.29: Summary of Impacts for South Corridor Option 1 and South Corridor Option 2

Land Use Issue	Impact	Significance
South Corridor Option 1		
Development Land	A planning allocation for mixed use development at Winchburgh could be affected due to changes in amenity. The potential impacts and mitigation are currently unknown. The new motorway junction required to facilitate the development at Winchburgh development would be unaffected.	Significance cannot be determined at this stage
Agricultural Land	Total of 30.8 ha of prime land would be lost. No non-prime land or woodland would be affected. The severance impact varies but overall the degree of severance for this route corridor option is considered to be low. There is a significant impact (moderate and above) for two land interests.	Impacts are Moderate or above for two land interests.
South Corridor Option 2		
Residential and Commercial Uses	Demolition of a water tank.	Adverse
Development Land	A planning allocation for mixed use development at Winchburgh could be affected due to changes in amenity. The potential impacts and mitigation are currently unknown. The realisation of the Winchburgh development is dependent on the provision of a junction onto the M9 motorway. As such, access would be gained by the provision of a slip road from the M9 junction proposed as part of South Corridor Option 2.	Significance cannot be determined at this stage
Agricultural Land	Total of 54.7ha of prime land would be lost and 1.7ha of woodland. No non-prime land would be affected. Total land loss of 56.4ha. The severance impact varies but overall there is considered to be a moderate degree of severance.	Impacts are Moderate or above for four land interests.

6.7 Scope of Stage 3 Assessment

6.7.1 Stage 3 assessment for land use will be undertaken in accordance with DMRB Volume 11, Section 3, Part 6 and will include the following:

- Detailed consideration of properties at risk of demolition or land take including consideration of likely effect on the future viability of businesses.
- Further consultation to identify community land including any areas of importance for informal use.
- Review of any new planning applications or changes in the status of applications previously identified. The local planning authority will be asked to give its views on how the preferred corridor may affect its development designations.

- Further assessment of impacts on land owners, including consultation to inform access arrangements for individual farm units, consideration of the likely viability of the units and the loss of any features being managed to achieve the objectives of any grant schemes. Further consultation will be undertaken with land owners.
- Socio-economic assessment will also be undertaken to provide information in relation to business land use impacts as well as inputting to assessment of community impacts, sustainability, health and compliance with plans and policies.
- Input into scheme design and identification of mitigation as appropriate.

6.8 References

Edinburgh City Council (2004) Edinburgh and the Lothians Structure Plan 2015, Approved 17 June 2004.

Edinburgh City Council (2006) North Kirkliston Development Brief, Approved October 2006

Edinburgh City Council (2006) Rural West Edinburgh Local Plan, Adopted June 2006.

Edinburgh City Council (2008) Port Edgar, Consultation Draft,. Approved for consultation February 2008.

Fife Council (2002) Dunfermline and the Coast Local Plan, Adopted April 2002.

Fife Council (2002) Fife Structure Plan 2001 – 2011, Approved 8 July 2002.

Fife Council (2002) Finalised Fife Structure Plan 2006 – 2026, Finalised April 2006.

Linlithgow Area Local Plan, Adopted December 1994

Ordnance Survey (2006) Explorer Map 1:25000, Sheet 350: Edinburgh, Musselburgh & Queensferry.

Scottish Executive (2005) Scottish Planning Policy (SPP)15: Planning for Rural Development.

The Highways Agency et al. (2001). Design Manual for Roads and Bridges (DMRB). Volume 11. Section 3, Part 6. The Highways Agency, Scottish Executive Development Department, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

West Lothian Council (2005). West Lothian Local Plan, finalised 2005, to be adopted 2008.

7 Geology, Contaminated Land and Groundwater

7.1 Introduction

7.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of geology, groundwater and contaminated land issues.

7.1.2 There are a variety of ways in which road developments can impact on geological resources. Excavating or masking exposures of rocks or superficial geological deposits of specific scientific interest can represent a serious impact if the features of interest are not reproduced elsewhere in the area. Impacts can also affect the existing or the potential commercial exploitation of resources. Road schemes can also have potential impacts on underlying groundwater aquifers both during construction and operation. For example, construction works involving excavation can lead to dewatering of shallow aquifers. There is also a risk of spillage or leakage of fuel or oil from storage tanks or construction plant. Without suitable mitigation measures, these pollutants can enter the aquifers. Once a new road is opened, runoff from the surface may contain elevated concentrations of pollutants such as oils, suspended solids, metals (e.g. copper and zinc) and, in winter, salt and engine coolants (e.g. ethylene glycol). Ground conditions can also impose constraints on a proposed road scheme, for example, where land has become unstable due to mining or has been contaminated by previous land uses.

7.1.3 This chapter presents the following:

- baseline conditions within the route corridors relating to solid and drift geology, mineral extraction, contaminated land, groundwater and location of private water supplies;
- potential impacts of each route corridor option with regard to the identified baseline conditions;
- outline or anticipated mitigation measures that might be developed at DMRB Stage 3 of a preferred option; and
- a summary of the route corridor option assessment identifying residual impacts and taking into account likely mitigation.

7.1.4 This assessment has been undertaken using the guidance contained in DMRB Volume 11 ‘Geology and Soils’ (The Highways Agency et al., 1993), taking into account updated guidance on contaminated land risk assessment where appropriate. With the exception of contaminated land, impacts on soils are not assessed in detail in this chapter. The principal issue with regard to soils is deterioration of agricultural soil quality due to disturbance at construction stage (and subsequent storage/reuse). Measures to address this are considered in the context of agricultural land capability in Chapter 17 (Disruption Due to Construction).

7.2 Approach and Methods

7.2.1 The assessment covers a wide study area as shown on Figure 5.1 and described in Chapter 5. Figure 7.1 (Contaminated Land), Figure 7.2 (Geological Constraints) and Figure 7.3 (Hydrogeological Constraints) present the information used for this assessment.

7.2.2 The assessment has been undertaken for the following aspects of ground conditions:

- solid and drift geology;
- features of geological and geomorphological importance;
- mineral extraction and reserves;
- contaminated land;

- groundwater environment; and
- private water supplies.

Baseline Conditions

7.2.3 Baseline conditions were determined though a desk-based assessment, field surveys and consultation with statutory and non-statutory bodies.

Desk-based Assessment

7.2.4 The desk-based assessment included a review of the following information:

- British Geological Society (BGS) data including BGS Drift and Solid Geological Maps, BGS borehole logs, BGS Hydrogeological and Groundwater Vulnerability Maps;
- Department of Environment Industrial Profiles and Contaminated Land Report (CLR) 8 (DEFRA, 2002) to identify the character of potentially contaminated land;
- Ordnance Survey (OS) historical maps dating back to 1856 for information on former land use, any potential contamination and physical hazards and information on private water supplies;
- SEPA Groundwater Vulnerability Maps;
- Scottish National Heritage designation database (SNH, 2008);
- previous reports commissioned by Fife Council in the St. Margaret's Marsh area for information on previous land use in the area (Envirocentre, 2003; Envirocentre, 2004); and
- results of previous studies including the Forth Replacement Study Initial Desk Study Report December 2007 (Jacobs/AECOM/Faber Maunsell, 2007).

Field Surveys

7.2.5 Field surveys were undertaken at targeted locations along the route corridors, based on the findings of the desk-based assessment. The surveys undertaken include:

- Contaminated land site reconnaissance to identify any additional areas of potential contaminated land and to clarify current land use as identified from historical maps.
- Geological site reconnaissance to identify any potential areas of geological/geomorphological importance and identify any in-filled quarry areas.
- Hydrogeological survey to gather information relating to sensitive areas potentially supplied by groundwater within the vicinity of the proposed options and to record any features that may provide further information with regard to the importance of the quality and supply of groundwater in these areas.

Consultations

7.2.6 Consultations were undertaken with a number of statutory and non-statutory bodies in Scotland in order to assess geological and hydrogeological impacts and contaminated land. These include the following:

- Coal Authority for information on past, current and potential future mine workings within the route corridor and how they may affect future development;
- Fife Council, City of Edinburgh Council and West Lothian Council for information on former contaminated land use, Part IIA determinations, private water supplies, licensed fuel storage and any additional relevant information;

- BGS for information regarding the nature of geology and hydrogeology in the near vicinity of the proposed route corridor options;
- SEPA and SNH for information on the location and extent of environmental or historical sensitivities in the vicinity of the proposed route corridor options and to establish any future development constraints; and
- local groups for information on any existing private water supplies (PWS).

Impact Assessment

7.2.7 As described below, significance of impacts on geology/geomorphology and contaminated land were assessed taking into account receptor sensitivity and impact magnitude.

7.2.8 Specific sensitivity and impact magnitude criteria are not defined for the assessment of mineral extraction or contaminated land as these aspects primarily represent engineering considerations for the scheme construction. However, the occurrence and proposed management of these aspects has been considered, assessed qualitatively, and presented as part of this assessment.

Solid and Drift Geology

7.2.9 For the purposes of this assessment, the sensitivity of geological features of interest within the study area is taken to include solid and drift geology including geomorphological interest. Assessment of the impact of route corridor options was undertaken by applying the sensitivity and magnitude criteria given in Table 7.1 and Table 7.2 below. The impact significance was then determined using Table 7.3.

Table 7.1: Sensitivity Criteria - Geological Features

Sensitivity	Description
High	Areas containing geological or geomorphological features considered to be of national interest. e.g. Sites of Special Scientific Interest (SSSIs).
Medium	Areas containing features of designated regional importance considered worthy of protection for their educational, research, historic or aesthetic importance. e.g. Regionally Important Geological Sites (RIGS).
Low	Features not currently protected but that may require specific protection in the future.
Negligible	Features not currently protected and unlikely to require specific protection in the future.

Table 7.2: Magnitude Criteria - Geology

Magnitude	Description
High	Partial (greater than 50%) or total loss of a site, or where there would be complete severance of a site such as to affect the value of the site.
Medium	Loss of part (between approximately 15% and 50%) of a site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree.
Low	Minimal effect on a site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected.
Negligible	Very slight change from baseline condition. Change hardly discernible, approximating to ‘no change’ conditions.

Table 7.3: Matrix for Determination of Impact Significance – Geology

Sensitivity / Magnitude	Negligible	Low	Medium	High
High	Slight	Moderate	Moderate/ Substantial	Substantial
Medium	Negligible/ slight	Slight/Moderate	Moderate	Moderate/ Substantial
Low	Negligible	Negligible/Slight	Slight/Moderate	Moderate
Negligible	Negligible	Negligible	Negligible/Slight	Slight

Mineral Extraction

7.2.10 At DMRB Stage 2, potential areas of mineral resources and mineral extraction are identified. However, these aspects primarily represent engineering considerations for the scheme construction and their extent, nature and required mitigation can only be assessed fully by intrusive site investigation, which will be undertaken prior to detailed design.

Contaminated Land

7.2.11 This assessment focuses on the potential for impacts on receptors as a consequence of encountering contaminated land (including construction workers), using a conceptual site model (CSM). The CSM represents a network of relationships between potential hazards from within and adjacent to the site area and the receptors that may be exposed to the hazards through linking pathways. The CSM eliminates those pathways that are incomplete and therefore cannot pose a risk, and where complete potential pollutant linkages exist, a qualitative risk assessment is undertaken. For the qualitative risk assessment, the term 'sensitivity' is not appropriate and the 'likelihood' of a complete pollutant linkage being present is considered.

7.2.12 The likelihood of a complete pollutant linkage being present is defined in CIRIA 552 (CIRIA, 2001) and summarised in Table 7.4 and the magnitude, or 'consequence', of the effect of contaminated land on likely receptors is outlined in Table 7.5. The qualitative risk assessment of potential risk to receptors posed by contaminated land was then undertaken by determining the probability of a complete pollutant linkage being present and the potential consequences, with reference to the matrix detailed in Table 7.6.

Table 7.4: Likelihood Criteria – Contaminated Land

Likelihood	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over a long term.
Low likelihood	There is a pollution linkage and the circumstances are possible under which and event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 7.5: Magnitude (Consequence) Criteria – Contaminated Land

Magnitude	Definition
Severe	Short-term (acute) damage to human health (significant harm). Pollution of sensitive water resources as a result of short-term exposure. Catastrophic damage to buildings/property. Damage to a particular ecosystem as a result of acute exposure.
Medium	Chronic damage to human health (significant harm). Pollution of sensitive water resources. A significant change in a particular ecosystem, or organism forming part of such an ecosystem.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.
Minor	Harm (not necessarily significant), which may result in financial loss or expenditure to resolve. Non-permanent health affects to human health. Easily repairable damage to buildings, structures and services.

Table 7.6: Matrix for Determination of Qualitative Risk Assessment: Contaminated Land

Likelihood / Consequence	Unlikely	Low likelihood	Likely	High likelihood
Severe	Moderate	Moderate	High	Very high
Medium	Low	Moderate/low	Moderate	High
Mild	Very low	Low	Moderate/low	Moderate
Minor	Very low	Very low	Low	Moderate/low

<u>Groundwater</u>

7.2.13 DMRB Stage 2 assessment considers groundwater sensitivity in the context of hydrogeological conditions including aquifer resources, and on the proximity of private water supplies where known. Subsequent assessment at Stage 3 will utilise more detailed information on groundwater conditions (i.e. groundwater levels) and on private water supplies (e.g. depth of water level and total depth of well, density of private water supplies).

7.2.14 Assessment of the impact of route corridor options was undertaken by applying the sensitivity and magnitude criteria given in Table 7.7 and Table 7.8 below. The impact significance was then determined using the same matrix as for geology/geomorphology (Table 7.3).

Table 7.7: Sensitivity Criteria - Groundwater (Including Private Water Supplies)

Sensitivity	Description
High	1) Local aquifer(s) constitutes a valuable resource because of its high quality and yield, or extensive exploitation for public, private domestic, agricultural and/or industrial supply. 2) Private water supply positions close to the route corridor option (<100m) and highly vulnerable to any modification of hydrogeological condition in the vicinity of the supply.
Medium	1) Local aquifer(s) of limited value because quality does not allow potable or other quality sensitive uses. Exploitation of local groundwater is not extensive. 2) Private water supply positions at medium distance from the route corridor option (100-500m) and moderately vulnerable to modification of hydrogeological conditions along the nearest area of the route corridor option.
Low	1) Poor groundwater quality and/or very low permeability make exploitation of the aquifer(s) unfeasible. 2) Private water supply positions at approximately 500-800m from the route corridor option and slightly vulnerable to modification of hydrogeological condition along the nearest section of route corridor option.
Negligible	Private water supply is abandoned or not used or at greater than approximately 800m from the route corridor option.

Table 7.8: Magnitude Criteria - Groundwater

Magnitude	Description
High	Major permanent or long-term change to groundwater quality or available yield. Existing resource use is irreparably impacted upon. Changes to quality or water table level would have an impact upon local ecology.
Medium	Changes to the local groundwater regime are predicted to have a slight impact on resource use. Minor impacts on local ecology may result.
Low	Changes to groundwater quality, levels or yields do not represent a risk to existing resource use or ecology.
Negligible	Very slight change from groundwater baseline conditions approximating to a 'no change' situation.

Table 7.9: Matrix for Determination of Impact Significance – Geology

Sensitivity / Magnitude	Negligible	Low	Medium	High
High	Slight	Moderate	Moderate/ Substantial	Substantial
Medium	Negligible/ slight	Slight/Moderate	Moderate	Moderate/ Substantial
Low	Negligible	Negligible/Slight	Slight/Moderate	Moderate
Negligible	Negligible	Negligible	Negligible/Slight	Slight

Limitations to Assessment

7.2.15 Limitations to this assessment are as follows:

- The extent and quantum of land contamination cannot be determined from desk based studies and site walk-overs. Whilst these processes identify and inform an evaluation of the potential for contamination, the nature, extent, severity and location of soil and groundwater contamination cannot be determined without intrusive site investigation and the chemical analysis of samples of soil and groundwater collected at the location.
- The accuracy and level of detail of documented sources. For example, the identification of potential contamination sources relies on the accuracy of historical mapping.

- The scale and information contained in the Hydrogeological and Groundwater Vulnerability Map of Scotland mean that the characterisation of the baseline conditions, and hence a detailed analysis of the potential impacts, is limited at this stage. Detailed site investigations and further PWS consultation will be available in the future before the detailed design of the preferred option and the hydrogeological assessment will be updated accordingly.
- Available private water supplies information is presented within this chapter. However, it should be noted that this will be augmented at Stage 3 by detailed landowner consultation, and as such the exact location of some springs and wells is currently not known.

7.2.16 The above limitations are typical of Stage 2 assessment, and the assessment reported in this chapter is considered robust and of an appropriate level of detail and in line with the DMRB guidance.

7.3 Baseline Conditions

7.3.1 This section describes the baseline conditions identified through the collection and review of information from existing sources, additional survey work and consultation responses.

Solid and Drift Geology

7.3.2 Information on geology and on geological/geomorphological features of importance has been sourced from relevant BGS geological maps (BGS, 1962 to 1994), SNH databases (2008) and previous desk study reports (Jacobs et al., 2007).

<u>Firth of Forth</u>

7.3.3 The bridge corridor starts at the southern shore to the west of the Port Edgar Marina and crosses gently sloping tidal flats for a distance of about 500m at which point the river bed falls more steeply at a gradient of about 1 in 8 at the southern edge of the main channel reaching a level of about -45m above Ordnance Datum (aOD). The river bed rises steeply at Beamer Rock which reaches an elevation of about +3m aOD close to the existing lighthouse. The area of rock exposed varies with the tide reaching about 45m by 95m at low water springs. The bathymetric surveys have shown that the south and east sides of Beamer rock are extremely steep with near vertical faces. The north edge is less steep with gradients of around 1:1 reported.

7.3.4 To the north of Beamer Rock the river bed falls to about -33m aOD at the north channel. The bed level then rises northwards to the Rosyth Channel which is dredged to a depth of -12 to -16m aOD. The north margin of this channel rises at a gradient of about 1 in 10 towards the more gently sloping north foreshore which extends for about 300m towards the northern landfall of the crossing corridor to the east of Cult Ness.

7.3.5 Rock outcrops at the surface at Beamer Rock but elsewhere the bedrock is generally overlain by alluvial and glacial deposits. These form a complex sequence of fine grained and granular deposits which increase in thickness at the southern and northern margins of the deep channels to 25 to 30m within the limits investigated. The upper part of these deposits is typically of very soft or loose consistency. The 1993 'Setting Forth' study (Scottish Office Development Department, 1996) investigations indicate that rockhead falls to about -35m aOD at the preliminary location of the north tower and about -50m aOD at the preliminary location of the south tower (based on extrapolation of the geophysical survey which was affected by acoustic masking in this area).

7.3.6 The ground investigations carried out as part of the 'Setting Forth' study (Scottish Office Development Department, 1996) revealed frequent dolerite intrusions up to a few metres thick within the West Lothian Oil Shale Formation rocks to the south of Beamer Rock whilst to the north of Beamer Rock, layers of tuff were found.

7.3.7 The Admiralty Chart Sheet 736 shows a 'spoil ground' immediately upstream of Beamer Rock.

7.3.8 No areas of geological/geomorphological importance were identified within the Firth of Forth.

Northern Study Area

7.3.9 The solid geology beneath the study area consists of sedimentary rocks of the Carboniferous Lower Limestone Group (LLG) and Strathclyde Group (SG), comprising inter-bedded sandstones, siltstones, mudstones and limestones with mainly thin coal seams (limestone, coal and mudstone have been known to be worked locally). Towards the southern section of the route corridor, (possibly Permian) igneous rocks comprising quartz dolerite are present. The east-west trending Rosyth Fault crosses the approximate northerly mid point of the route corridor; igneous rocks and rocks of the SG are predominantly present to the south of the Rosyth Fault, while rocks of the LLG are predominantly present to the north.

7.3.10 The superficial deposits present beneath the route corridor include made ground, late glacial raised marine deposits, raised beach, lake deposits and glacial till.

7.3.11 Made ground is indicated at the following locations, which are shown on Figure 7.1:

- St Margaret's Marsh, reclaimed land which may be variable in composition, and may include compressible material;
- industrial areas in the vicinity of Belleknowes Industrial Estate including a back-filled clay pit adjacent to the former brick and tile works; and
- embankments associated with the existing road and railway network.

7.3.12 The late-glacial raised marine deposits and lake deposits located in the vicinity of Rosyth, and in the southern part of Masterton Junction, are recorded as comprising mainly clay, with inter-bedded silt and sand bands. A buried channel feature, trending east to west, is recorded in this area, with superficial deposits in excess of 30m recorded in the published geological data.

7.3.13 The raised beach deposits, located to the west of Masterton Junction are described as comprising mainly loose to medium dense, occasional dense, sands and gravels, and may include very clayey and silty horizons with some cobbles.

7.3.14 The glacial till in this area is recorded as comprising a firm to stiff, becoming very stiff sandy silty clay with fine to coarse gravel and occasional cobbles and boulders. This deposit extends over much of the northern part of the study area, between Masterton and Halbeath, and also occurs between the rock exposures near Castlandhill.

7.3.15 A number of areas of geological/geomorphological importance have been identified within the study area and are listed in Table 7.10 and illustrated on Figure 7.2 (Geological Constraints).

Table 7.10: Geological Features of Importance in the Northern Study Area

Area Name	Designation	Cited Feature	Aspect of Geological Relevance
St. Margaret's Marsh	SSSI	Salt Marsh	Littoral sediment (Coast)
Ferry Hills	SSSI	Carboniferous-Permian Igneous	Igneous petrology
Firth of Forth	SSSI	Carboniferous-Permian Igneous	Igneous petrology
		Coastal Geomorphology of Scotland	Geomorphology

Southern Study Area

7.3.16 The majority of the solid geology beneath the study area consists of Lower Carboniferous sedimentary rocks of the Upper and Lower Oil Shale Groups, which mainly comprise sandstones and marls, with shale, oil/bituminous shale and occasional limestone beds. Igneous intrusive rocks comprising teshcenite, also of Lower Carboniferous age, are present within some areas, particularly at the coastline towards the north of the study area.

7.3.17 The superficial deposits present beneath the route corridor include made ground, alluvium, raised beach deposits and glacial till:

- made ground is located at embankments associated with the existing road and railway network;
- small areas of undifferentiated alluvium are recorded in association with Humbie Reservoir;
- raised beach deposits are located in a thin strip parallel to the shoreline, and are described as comprising mainly loose to medium dense, occasional dense, sands and gravels, and may include very clayey and silty horizons and some cobbles; and
- glacial till covers the majority of the study area and is described as very uniform in characteristic and in excess of 20m thick in places.

7.3.18 A number of areas of geological/geomorphological importance have been identified within the study area and are listed in Table 7.11 and illustrated on Figure 7.2 (Geological Constraints).

Table 7.11: Geological Features of Importance in the Southern Study Area

Area Name	Designation	Feature	Category
Firth of Forth	SSSI	Carboniferous-Permian Igneous	Igneous petrology
		Coastal Geomorphology of Scotland	Geomorphology

Mineral Extraction

Firth of Forth

7.3.19 Although coal reserves exist in this area, Coal Authority records (Coal Authority, 2008) state that the Firth of Forth is not within an area which is likely to be influenced by past or present underground or open cast coal mining and associated workings. In addition, the Firth of Forth is not within an area for which the Coal Authority has granted, or is determining whether to grant, a licence to remove coal using underground workings.

Northern Study Area

7.3.20 Historical pits and quarries have been identified following a review of historical maps (1856 - 2007). The quarries noted within the Northern study area are listed in Table 7.12.

Table 7.12: Mineral Extraction Northern Study Area

Name	Grid Reference	Dates Marked on OS Maps
Old Quarry	NT 12550 80700	1896-1915
Quarry	NT 12580 80650	1915-1927
St. Margaret's Quarry	NT 12650 81000	1896-1927 (1961 marked disused)
Quarry	NT 12680 81240	1915-1961
Welldean Quarry	NT 12560 81240	1856;1896(Disused); 1915-1927 (Quarry); 1916 (pond)
Old Quarry	NT 12310 81910	1896-1927(marked as stone from 1961-current day)
Old Quarry (whinstone)	NT 12310 81870	1856-1927(marked as stone from 1961-current day)
Ferry Toll Quarry	NT 12630 81550	1896-1927 (marked disused from 1961 to current day)
Castlelandhill Quarry	NT 11990 82290	1915-1927(1961-1967 marked disused and small pond)
Old Quarry	NT 12480 82670	1896
Old Quarry	NT 12510 82890	1896-current
Old Quarry	NT 12430 83450	1915-1926
Fairykirk Quarry	NT 12460 83380	1951-current
Gravel Pit	NT 13260 84750	1915-1966
Old Quarry	NT 13400 84700	1915
Dulloch Quarries (limestone)	NT 13300 86600	1896-1927 (1965-current marked as ponds)

7.3.21 According to Coal Authority records (Coal Authority, 2008b, 2008c, 2008d, 2008e), the Northern study area does not lie within an area which is likely to be influenced by past or present underground coal workings. However, coal is believed to be at or close to the surface in the Halbeath, Masterton and Inverkeithing areas and may have been worked at some time in the past.

7.3.22 The Northern study area is not within an area for which the Coal Authority has granted, or is determining whether to grant, a licence to remove coal using underground workings. However, coal is known to exist in the Halbeath, Masterton and Inverkeithing areas and these deposits may be worked some time in the future.

7.3.23 The Northern study area does not lie within the boundaries of any present or likely future open cast coal mines. The Halbeath and Masterton areas lie within the boundary of a past opencast site, the details of which are unknown.

7.3.24 There is no record of mine gas emissions requiring action by the Coal Authority within the Northern study area.

Southern Study Area

7.3.25 Historical pits and quarries have been identified following a review of historical maps (Ordnance Survey, 1853-2007). The quarries noted within the Southern study area are listed in Table 7.13 and illustrated on Figure 7.1c.

Table 7.13: Mineral Extraction Southern Study Area

Name	Grid Reference	Dates Marked on OS Maps
Old Quarries	NT 11760 78500	1896-1916
Old Quarry	NT 11250 74270	1855-present day
Quarry	NT 10900 77880	1856-1915(1964 refuse tip)

7.3.26 According to Coal Authority records (Coal Authority, 2008f, 2008g, 2008h, 2008i), the Dalmeny and South Queensferry areas of the Southern study area are in the likely zone of influence from workings in three seams of oil shale at shallow to 320m depth which were last worked in 1901. Nine disused mine shafts and adits associated with this oil shale have been identified by the Coal Authority.

7.3.27 The Coal Authority Report (2008f, 2008g, 2008h, 2008i) indicates that coal may exist at or close to the surface in the Dalmeny and South Queensferry areas and that this coal may have been worked in the past.

7.3.28 The Southern study area is not within an area for which the Coal Authority has granted, or is determining whether to grant, a licence to remove coal using underground workings. However, coal is known to exist in the Dalmeny and South Queensferry areas and these deposits may be worked some time in the future.

7.3.29 The Southern study area does not lie within the boundaries of any past, present or likely future open cast coal mines.

Contaminated Land

Firth of Forth

7.3.30 The Firth of Forth has been dredged extensively throughout the course of the twentieth century to ensure the free passage of shipping to Rosyth and Grangemouth. Extensive dredging has been undertaken by the Navy during the development of Port Edgar and Rosyth with approximately three million cubic metres of material removed from the sea bed at Rosyth alone (Jacobs et. al.,2007).

Northern Study Area

7.3.31 Features and activities within the Northern study area with the potential for producing contaminated ground were identified through the examination of historical OS maps (Ordnance Survey, 1856- 2007) and site reconnaissance; the areas identified are presented on Figure 7.1 (Contaminated Land).

7.3.32 Large areas of the land within the Northern study area have undergone industrial development; the relevant areas are detailed in the following sections.

St. Margaret's Marsh

7.3.33 St. Margaret's Marsh is located on the north shore of the Firth of Forth, immediately west of the Forth Road Bridge (Figure 7.2b). This area originally comprised a natural inter-tidal zone, becoming artificially in-filled prior to the 1960s. The infill material is not known; however, it is likely to comprise marine sediments from the vicinity of the nearby Rosyth Naval Base. Low level radioactive waste has been historically discharged from the Rosyth Naval Base as part of nuclear submarine maintenance operations as part of a formal discharge consent. Monitoring data from the nearby inter-tidal zones suggest that radiation levels are not elevated above background; however, no data is available for the St. Margaret's Marsh area and its presence cannot be completely discounted.

7.3.34 The eastern extent of St Margaret's Marsh (St Margaret's Bay) was used as a landfill between 1958 and 1972, receiving general / domestic waste. The fill thickness is indicated in reports supplied by Fife Council as being up to 2-3m, overlying marine clays (part of the reclaimed land). During previous investigations, elevated concentrations of methane were not identified; carbon dioxide was identified at concentrations of up to 1.7% v/v (volume of CO_2 / total volume of gas) and risks to human health were identified from toxic metals at depths of greater than 1m below ground level (bgl). There is no evidence that suggests that monitoring is currently taking place and no venting system appears to have been installed. However based on the latest investigation results, it is understood that the landfill vented in the past via the monitoring boreholes, allowing gas concentrations to decrease in time.

7.3.35 A wastewater treatment works, constructed prior to the 1980s, is located within the northern area of St. Margaret's Marsh (NT 12182 81612).

Belleknowes Industrial Estate and Surrounding Industrial Area

7.3.36 Both route corridor options either cross or run adjacent to the Belleknowes Industrial Estate shown on Figure 7.1a and b (approximate National Grid reference NT 12700 83700), which contains a former brick and tile works and clay pit, a Network Rail Sidings Depot, a scrap metal yard, a conservatory manufacturer and additional industrial units.

7.3.37 The Network Rail Discharge Sidings Depot has been in operation since approximately 1961. During a recent site visit, poor storage of materials and spillages of tars and oils was noted. In addition, an oily sheen was identified in the marsh area adjacent to the main railway sidings area.

7.3.38 The brick and tile works was operated up to approximately 1950 and used the natural clays adjacent to the works as production materials, thus forming the current pond area.

Refuse Tips

7.3.39 A number of refuse tips / landfills have been identified within the Northern study area and are listed in Table 7.14 and shown on Figure 7.1.

Table 7.14: Refuse Tips in the Northern Study Area

Grid Reference	Location	Historical Information
NT 12365 81380	Eastern portion of St. Margaret's Marsh	Only marked on 1967 map. Additional information in paragraph 7.3.33.
NT 12710 81570	200m east of proposed route corridors, north of North Queensferry.	Marked on OS maps from 1980-1994
NT 12780 81400	200m east of proposed route corridors, north of North Queensferry.	Marked on OS maps from 1980-1987
NT 12580 83360	Adjacent to Fairy Kirk Quarry.	Marked on OS maps from 1957 to present day. Tips could not be identified during site visit.

7.3.40 Contaminants associated with historical landfill use may include heavy metals, asbestos and hydrocarbon contamination including polycyclic aromatic hydrocarbons (PAHs) and oil/fuel hydrocarbons.

Additional Potential Contamination Sources

7.3.41 Additional potential sources of contamination within the study area include:

- historical and current tanks located both on the route corridor and in the near vicinity of the route corridors (NT 12395 80995; NT 12900 84510; NT12010 81790; NT 13360 84010). No further information on the nature of these tanks was available at the time of this report;
- former railway lines and associated tunnels which cross the proposed route corridors which date from 1896;
- saltpans works and associated tanks present from 1896 to 1927 to the east of the route corridor options (NT 12660 82020);
- unnamed works from 1961 to present day located on route corridor (NT 13200 83780);
- electrical substation from 1982 to present day to the east of the route corridor options(NT 13520 84140);

- a cemetery to the east of the route corridor options (NT 12460 82270); and
- quarries and mineral extraction areas as detailed in paragraph 7.3.19.

Southern Study Area

7.3.42 Features and activities within the Southern study area with the potential for producing contaminated ground were identified through the examination of historical maps (Ordnance Survey, 1853-2007) and site reconnaissance; this is illustrated on Figure 7.1 (Contaminated Land).

7.3.43 The land areas in the Southern study area of the Forth Replacement Crossing have largely remained undeveloped, with the exception of the shore area, which is discussed below, and mainly consist of open land or cultivated fields.

Southern Shore Works Area

7.3.44 Part of the study area adjacent to the southern shore has been developed for industrial and residential purposes. The following areas where contamination may be present as a result of historic and current land uses have been identified:

- the sewerage pumping station, which has been present since 1993 to the east of the route corridor options (NT 11740 78640);
- dredging depot, in operation from 1915 to 1980, to the east of the route corridor (NT 11800 78670);
- stores area, which as been present from 1966, directly on route corridor with South Corridor Option 1 (NT 11700 78700); and
- Dundas Lime Works, marked only on the 1856 OS Maps to the east of the route corridor (NT 11740 78630).

Additional Features

7.3.45 The following additional areas of potential contamination have been identified:

- a refuse tip, in operation from 1973 to 1983, present to the north of Corridor Option 1 (NT 12300 77700);
- a refuse tip to the south of South Corridor Option 2, marked only on the 1973 OS Map (NT 11250 74270);
- unidentified storage tanks to the west of the route corridor (NT 10490 76440; NT 10720 76780). No further information on the nature of these tanks was available at the time of this report;
- land marked as a 'Depot' in 1967 and as a riding school (Westmuir Riding Centre) from 1977 to the present day (NT 10520 76460);
- an oil storage depot located to the east of South Corridor Option 1 and to the southeast of South Corridor Option 2 (NT 14570 76692);
- a slag heap, present from 1973, to the south of South Corridor Option 2 (NT 10100 74700); and
- disused oil shale mining shafts and adits within the Dalmeny area.

Groundwater

7.3.46 Information on groundwater has been gathered from the Hydrogeological Map of Scotland 1:625,000 (BGS, 1988d), the Groundwater Vulnerability Map of Scotland 1:625,000 (BGS, 1995), the Hydrogeological Map of Fife & Kinross scale 1:100,000 (1986) and SEPA's consultation response.

7.3.47 Information provided by SEPA indicates that in the region there are two Drinking Water Zones related to groundwater. These have been identified as 'South Fife bedrock and localised sand and gravel aquifers' to the north of the Firth of Forth and 'Edinburgh and Livingston bedrock and localised sand and gravel aquifers' to the south of the Firth of Forth. Despite the different names these strata are expected to have similar hydrogeological characteristics to the north and the south of the Firth of Forth.

7.3.48 Consultation responses received at this stage have not indicated any public groundwater or surface water supply in the vicinity of the proposed route corridor options.

7.3.49 The Hydrogeological Map of Scotland (BGS, 1988) does not report any sand and gravel aquifer in the vicinity of the proposed route corridor options, although localised areas of sand and gravel (glaciofluvial deposits) are indicated on the geological maps to the eastern end of South Corridor Options 1 and 2, near to the River Almond (Southern study area, Figure 7.3i).

7.3.50 According to BGS (2004) alluvial deposits are locally classified as Intergranular High Productivity Drift Aquifers. Alluvial deposits occupy a significant area around the River Almond (Southern study area, Figure 7.3i) and may host important groundwater resources. However, such deposits will only be marginally affected by the proposed options and no groundwater supplies have been identified at this stage in this area.

7.3.51 BGS geological maps NT07NE, NT17NW, NT17SW, NT18NW and NT18SW have been used to refine the accuracy of the aquifer mapping as shown in the Hydrogeological Constraints Map (Figure 7.3). Figure 7.3 classifies the aquifers on the basis of their productivity and the presence of drift cover. The potentiality of the aquifer and the presence of superficial deposits with thickness greater than 1m are used as a simple tool to identify those areas that are more vulnerable to pollution.

7.3.52 The hydrogeological characteristics of the different geological units typical in the study area are summarised in Table 7.15.

7.3.53 Table 7.15 and Figure 7.3 indicate that groundwater in the region is of medium sensitivity because of the presence of potential private water supplies, although the information available to date suggests that the aquifers are not extensively exploited. Furthermore, groundwater in the region generally is not regarded as highly vulnerable to potential pollution because it is largely covered by drift deposits, which are usually of significant thickness and low permeability (e.g. till).

7.3.54 A high well density area has been identified in the Northern study area in the vicinity of the Masterton Junction. Here, the bedrock is either outcropping or near to the surface in several localities and as a result, the groundwater is considered more vulnerable to pollution.

7.3.55 Although considered impermeable, the igneous complexes are often outcropping or are near to the surface and host groundwater at shallow depths. The permeability characteristics of these rocks (by flow in fractures in the rock) and their low storage capacity and extension make these local aquifers extremely vulnerable to pollution and hydrodynamic disturbance.

Table 7.15: Hydrogeological Characteristics of Drift and Bedrock Units

Geological unit		Geological characteristics	Hydrogeological characteristics
Drift Deposits	Alluvium	Fine sand, silt, some clay with thin peat bands in place and locally some gravel. [1]	Groundwater supplies are limited[1] except where significant proportions of sand and gravel are present. Groundwater flow is intergranular.
	Glaciofluvial deposits.	Mainly sand and gravel[1].	Groundwater potential of these deposits is generally poor because the water table is often near or below their bases[1]. Groundwater flow is intergranular.
	Till and undifferentiated drift	In large part represented by silty sandy clay till with clasts up to boulders (boulder clay) with subordinate marine deposits[1]. Made ground is locally important (e.g. St Margaret's Marsh).	None of these deposits yields groundwater[1]. However, shallow groundwater in made ground (dredged silts and clays) overlying natural marine silts and clays has been recorded in the St Margaret's Marsh area (ENVIRONUK, 2007) and it is influenced by tides.
Bedrock	Dinantian and Namurian sedimentary strata (Upper and Lower Oil-Shale Group, Calciferous Sandstones Measures, Lower Limestone Group and Limestone Coal Group).	Sedimentary sequence comprising mainly sandstones, mudstones, siltstones and limestones. Beds of coals and oil-shales are present in particular to the south of Fife.	Moderately productive aquifers with fracture/intergranular flow[2]. Borehole yields no greater than 10 L/s in the Calciferous Sandstones Measures. In the Lower Limestone Group the groundwater potential is generally poor (borehole yields typically less than 0.5 L/s) [1,3]. In the Limestone Coal Group the sandstones sustain borehole yields of 10 to 30 L/s particularly near old mine workings[1]. In the Limestone Coal Group groundwater quality is generally poor because of commonly highly mineralised reducing waters and bicarbonate concentration exceeding often 400 mg/L with high sulphate levels. Groundwater may also be rich in iron especially near old abandoned mines[1]. In the Calciferous Sandstones groundwater is in general of good quality and numerous boreholes have recorded yields of 4 to 12 L/s[1].
	Mid Valley Sill complex and East Fife basanitic-foiditic Plugs and Vents.	Fine to medium grained sub volcanic - intrusive rocks.	These are considered as impermeable rocks, generally without groundwater except at shallow depth, where joints and fissures produce small springs[1]. Small-scale private groundwater wells are sometimes present.

Based on: [1] Hydrogeological Map of Fife & Kinross (BGS, 1986); [2] BGS Commissioned Report CR/04/04/7N; [3] Hydrogeological Map of Scotland (BGS, 1988) and Groundwater Vulnerability Map of Scotland (BGS, 1995).

Areas potentially supported by groundwater

7.3.56 During a recent site visit to St. Margaret's Marsh undertaken on 02 May 2008 no obvious spring flows were observed into the marsh. A small channel was observed that connected the wooded area to the south of the site to the marsh; however, this was dry at the time of the site visit. Along the exposed rock promontory of the dolerite sill, drainage channels were noted but they too were dry at the time of the site visit. At this stage, the contribution of groundwater supply to the marshland at St Margaret's Marsh can not be confirmed, but the features noted during the site visit and as described above would indicate that groundwater in this sector of the marsh is not very shallow and as such is not supporting the marshland.

7.3.57 Groundwater monitoring undertaken by ENVIRON UK Ltd. (Environ, 2007) between 2005 to 2007 shows that in the St. Margaret's Marsh area shallow groundwater near to the foreshore is influenced by the tidal variations. This influence decreases as the distance away from the Firth of Forth increases. This is in agreement with a previous study on the east corner of the site (Envirocentre, 2004). Monitoring undertaken by ENVIRON UK Ltd. (Environ, 2007) indicates that water level in the drift fluctuates between 0.32m below ground level (bgl) (on

28/03/06) near to the foreshore and 3.98m bgl (on 04/07/06) at some 250m from the foreshore. In the bedrock the water level varies between 0.67m bgl (on 05/03/07) near to the foreshore to 4.26m bgl (on 04/07/06) at some 250m from the foreshore. According to ENVIRON UK Ltd. (2007), the bedrock aquifer behaviour is influenced by the tidal regime across the site. Groundwater flows from the marsh towards the Oil Fuel Depot (OFD) located to the northwest of St Margaret's Marsh but reclamation of the site is expected to reverse the flow. The above considerations suggest that shallow groundwater which exists across the site is likely to support vegetation, especially close to the shoreline.

7.3.58 South Corridor Option 2 passes close to the Humbie Reservoir (NT 10500 75500). During a recent site visit, no obvious springs or groundwater seepages around the reservoir were observed. However, it may be in hydraulic continuity with shallow groundwater in the drift and may receive some recharge in the form of basal flow. The presence of a large area of marshy ground to the western end of the reservoir suggests the valley is a focus for shallow groundwater flow. The marshy area could be present as a result of a high water table.

7.3.59 An area of hydrological and landscape interest (Dundas Loch) is present on Dundas Estate (NT 11800 76100). The absence of superficial inflows and outflows suggests that the loch may be supported by shallow groundwater. Whether this is shallow groundwater in the drift, in the bedrock or in both it is unclear, and therefore the possibility that this loch may be fed by an underlying network of former mine workings can not be ruled out.

<u>Private Water Supplies (PWS)</u>

7.3.60 Information on the location of PWS such as wells and springs in the vicinity of the proposed route corridor options was obtained from current and historical OS maps. Where possible, these locations were confirmed during site walkover, and where feasible, additional information on their characteristics was gathered on site.

7.3.61 During DMRB Stage 2 consultation, North Queensferry Community Council provided information relating to an historic well in the Ferry Hill (well N03, Table 7.16). No other PWS information was gained during Stage 2 consultation.

7.3.62 Table 7.16 (for the Northern study area) and Table 7.17 (for the Southern study area) list the PWS identified in the vicinity of the proposed options. These are also indicated on Figure 7.3.

7.3.63 The presence of several wells and some springs in the igneous rocks indicates that these PWS are likely to be sourced by the groundwater that flows in fissures and joints at shallow depths. The presence of faults at or close to wells N01, N02, N03, N11, N12, N18, N19 and N20, suggests that the fracture network may be particularly developed at these locations, creating favourable conditions for the movement of groundwater.

Table 7.16: Groundwater Supplies in the Northern Study Area

Supply No.	Location	Type	Hydrogeological assumptions
N01	Main Road, North Queensferry	Well	Geological and Hydrogeological maps suggest that the well is sourced by shallow groundwater in the fractured dolerite sill. It is unknown whether the well is operational.
N02	Brock Street, North Queensferry	Spring	Geological and Hydrogeological maps suggest that the spring is sourced by shallow groundwater in the fractured dolerite sill. It is unknown whether the spring is used.
N03	Ferry Loch, Ferry Hills	Well	Geological and Hydrogeological maps suggest that the well is sourced by shallow groundwater in the fractured dolerite sill. It is unknown whether the well is operational.
N04	Castlandhill House	Well	Geological and Hydrogeological maps suggest that the well is sourced by shallow groundwater in the dolerite sill. It is unknown whether the well is operational.
N05	The Hills, Inverkeithing	Well	Geological and Hydrogeological maps suggest that the well is sourced by shallow groundwater in the fractured dolerite sill. It is unknown whether the well is operational.
N06	Mills, Inverkeithing	Well	Geological and Hydrogeological maps suggest that the well is sourced by shallow groundwater in fractured the dolerite sill. It is unknown whether the well is operational.
N07	District offices, Inverkeithing	Well	Geological and Hydrogeological maps suggest that the well is sourced by shallow groundwater in the fractured dolerite sill. It is unknown whether the well is operational.
N08	The Wilderness, Rosyth	Spring	From the available geological and hydrogeological maps it is unclear the origin of the spring. It is also unknown whether the spring is used.
N09	Middlebank House, Middlebank	Well	Geological and Hydrogeological maps suggest that the well may be sourced by the Lower Limestone Group. It is unknown whether the well is operational.
N10	Mastertown	Well	Drift thickness map (NT18SW) suggests that this area is underlain by glacial till less than 5 m thick. There is the possibility that the well is sourced by groundwater in the underlying limestones. It is unknown whether the well is operational.
N11	St Theriots' Well, Fordell Castle	Well	Geological and Hydrogeological maps suggest that the well is sourced by groundwater in the fractured sub volcanic/limestone rocks. The fracturing is assumed to be important at this location because of the presence of a fault. It is unknown whether the well is operational.
N12	Belleknowes Industrial Estate	Well	Geological and Hydrogeological maps suggest that the spring is sourced by shallow groundwater in the fractured sub volcanic/limestone rocks. The fracturing is assumed to be important at this location because of the presence of a fault. It is unknown whether the well is operational.
N13	Dales Farm	Spring	Drift thickness map (NT18SW) suggests that this area is underlain by drift deposits less than 7-8 m thick. It is unknown whether the spring is used.
N14	Dales Farm Cottages	Well	Drift thickness map (NT18SW) indicates that bedrock is near to the ground surface at this location. Well possibly sourced by the Carboniferous limestones. It is unknown whether the well is operational.
N15	Middlebank	Well	Drift thickness map (NT18SW) suggests that the well is sourced by the Carboniferous limestones. It is unknown whether the well is operational.
N16	Duloch House	Well	Drift thickness map (NT18SW) indicates that bedrock is relatively near to the ground surface at this location. Well possibly sourced by the Carboniferous limestones. It is unknown whether the well is operational.
N17	Old Duloch	Well	This location is underlain by till of unknown thickness. Unknown whether the well is sourced by the underlying Carboniferous limestones. It is also unknown whether the well is operational.
N18	Coldwells Cottages	Well	A recent site visit indicated that the well is approximately 3-4m deep and the water was approximately 1m below the top of the well. Abandoned well: the proprietor indicated that the property was on mains supply and they had no intention of using the well in the future. The landowner stated that during very wet weather the water levels quickly rise to the top of the well and frequently overflow flooding the garden. On these occasions the landowner

Supply No.	Location	Type	Hydrogeological assumptions
			pumps water out of the well and can reduce the level by several metres within 10 minutes. The well may be sourced by the soil and shallow groundwater in the fractured bedrock.
N19	Blazehill Plantation, Fordell Firs Activity Centre	Well	A recent site visit confirmed that the well is located at the edge of the marshy ground and is of a brick lined construction. No measurements were taken but it is approximately 3-4m deep and the water was approximately 1m below the top of the well. There was no infrastructure or buildings near the well and it is assumed to be abandoned. The well may be sourced by the soil and shallow groundwater in the fractured bedrock.
N20	Fordell Firs Scout Camp Site	Well	Geological and Hydrogeological maps suggest that the spring is sourced by groundwater in the fractured sub volcanic/limestone rocks. The fracturing is assumed to be important at this location because of the presence of a fault. It is unknown whether the well is operational.
N21	Perth Lodge	Well	Geological and Hydrogeological maps suggest that the well may be sourced by shallow groundwater in the fractured sub volcanic rocks. It is unknown whether the well is operational.
N22	Annfield	Well	Geological and Hydrogeological maps suggest that the well is sourced by shallow groundwater in the fractured sub volcanic rocks. It is unknown whether the well is operational.

Table 7.17 Groundwater Supplies in the Southern Study Area

Supply No.	Location	Type	Hydrogeological assumptions
S01	Milrig	Well	Well at or adjacent to glaciofluvial deposits. Unknown source of groundwater. It is also unknown whether the well is operational.
S02	Newliston	Spring	Spring at or adjacent geological contact between intrusive and sedimentary rocks. Unknown source of groundwater and whether the spring is used.
S03	Overton	Well	Well in area of sedimentary bedrock outcropping or near to ground surface. Likely to be sourced by fractures in the sedimentary rocks. It is unknown whether the well is operational.
S04	Humbie Farm	Well	The well is in an area of glacial till. Source of groundwater and use of the well is unknown.
S05	Whitelees	Well	Well in area covered by drift deposits. Unknown source of groundwater. It is also unknown whether the well is operational.
S06	Chapel Acre, Dundas Castle	Well	Well in area of dolerite outcropping or near to surface. Well possibly sourced by shallow groundwater circulating in the fractures of the bedrock. It unknown whether the well is operational.
S07	B924, South Queensferry	Well	Well in area of sedimentary bedrock outcropping or close to ground surface. Well possibly sourced by groundwater circulating in the fractures of the sedimentary rocks. It is unknown whether the well is operational.

7.4 Potential Impacts

7.4.1 The following section identifies potential impacts in the absence of mitigation. The approach to mitigation is set out in Section 7.5 (Potential Mitigation).

Proposed Replacement Bridge

7.4.2 No sites or designated features of geological/geomorphological interest would be affected by the proposed replacement bridge. The geology is therefore considered to have a low sensitivity and as a consequence predicted potential impacts are considered to be Negligible.

7.4.3 In relation to mineral extraction, no potential impacts are predicted from the development of the bridge itself.

7.4.4 As discussed in paragraph 7.3.30, the Firth of Forth has been extensively dredged and reworked over the last century. Residual contamination from industries present in the banks of the river, including radioactive particles and metals, may be present in the sediments on the river bed.

7.4.5 The potential risk to receptors from potential contamination is summarised in Table 7.18. The detailed site investigation that is being undertaken at the time of this report will provide more information on the true nature and extent of contamination in this area.

Table 7.18: Summary of Potential Risks Associated with Contaminated Land - Firth of Forth

Source	Pathway	Receptor	Probability	Consequence	Risk (unmitigated)
Residual contamination in the river bed sediments including heavy metals and radioactive particles	Dermal contact	Construction workers	Likely	Medium	Moderate
	Inhalation		Low likelihood	Medium	Moderate/Low
	Ingestion		Unlikely	Medium	Low
	Migration of contamination during construction	Marine ecology	Likely	Mild	Moderate/Low
	Migration of contamination during construction	Firth of Forth	Likely	Mild	Moderate/Low
	Migration of contamination during construction	Groundwater	Low likelihood	Mild	Low

7.4.6 In relation to the groundwater environment and PWS, no potential impacts are expected from the development of the bridge itself.

Northern Route Corridor Options

Impacts Common to Both Northern Route Corridor Options

7.4.7 Both options would impact equally upon the geologically important Firth of the Forth SSSI as both proposed route corridors cut through a section of this area. The geology within this designated area is considered to have a high sensitivity. The magnitude of the impact of the Forth Replacement Crossing construction is considered to be low as the land area which would be affected is relatively small in relation to the area covered by the designation. The potential impact of both northern route corridor options on the geological features of the Firth of Forth SSSI is therefore considered to be of Moderate significance.

7.4.8 With regards to mineral extraction, both options cross over or would be expanded into a number of former quarries. A number of these quarries remain visible, with the remainder either filled or reworked during earlier construction. Where these quarries are backfilled, the potential for subsidence due to the weight of roads infrastructure would need to be considered, although the nature of the backfilled material is currently unknown. No quarries within the study are known to be currently active and therefore there would be no economic impact on quarry production as a result of the Forth Replacement Crossing.

7.4.9 Both options would cross through or would expand into areas where reserves of coal are believed to exist; however, no currently active coal mines are located within the Northern study area and no future mining licences are currently being considered by the Coal Authority. As discussed in paragraph 7.2.8, the existence of coal primarily represents engineering considerations for the Forth Replacement Crossing construction and their extent, nature and required mitigation can only be assessed fully by intrusive site investigation.

7.4.10 With regards to contaminated land, the former Rosyth and Mineral Railways would cross both northern route corridor options . There is the potential for historic residual contamination to be present in these areas including heavy metals, hydrocarbons and pesticides. The risks posed by these railways are considered to be moderate to low.

7.4.11 The rationale and criteria given below to identify potential impacts on groundwater are valid for both the options in the Northern study area:

- Local groundwater flows and levels can be affected in areas of deep road cutting that extend below local groundwater levels. The resultant dewatering of the groundwater bodies into the road drainage and locally reduced groundwater levels can affect habitats sustained by groundwater (e.g. marshlands), groundwater abstractions and in extreme cases can significantly reduce low flows in watercourses.
- In the event of an accidental road spillage, particularly during construction, contamination may migrate through the unsaturated zone and impairing underlying groundwater quality, unless appropriate drainage protection or other suitable mitigation measures are implemented; this is considered in Chapter 8 (Water Environment).

7.4.12 The area of high well density encountered in the vicinity of Masterton Junction under either northern route corridor option faces a section of embankment and a section of cutting.

North Corridor Option 1

Geology and Geological/Geomorphological Features of Importance

7.4.13 The road widening associated with North Corridor Option 1 marginally infringes into two areas of the Ferry Hills SSSI (geological), including the former Ferrytoll Quarry area. In addition, the embankments associated with this route corridor marginally infringe on the eastern edge of the St. Margaret's Marsh SSSI (biological). The potential impact of North Corridor Option 1 on these sites is outlined in Table 7.19.

Table 7.19: Summary of Potential Impacts on Geologically Important Sites - North Corridor Option 1

Receptor	Sensitivity	Magnitude	Significance (unmitigated)
Ferry Hills SSSI (protected igneous geology)	High	Low - the loss of volume of igneous geology as a consequence of the excavation would only marginally infringe on these areas. - the obscuring of existing rock outcrops along the A90 would be minimal.	Moderate
St. Margaret's Marsh SSSI (biological but supported by geomorphological feature- salt marsh)	High	Low - only a small proportion of the widened road would be located in this area, with relatively little loss of littoral landscape as a consequence.	Moderate

Mineral Extraction

7.4.14 Potential impacts are common to both northern route corridor options and are discussed in paragraphs 7.4.8 and 7.4.9.

Contaminated Land

7.4.15 Several quarries have been identified in this study area, including a number of historic quarries which coincide with the route corridor.. North Corridor Option 1 crosses over one of these quarries, the former Welldean Quarry, and also marginally infringes on the former Ferrytoll Quarry as a result of the proposed road widening. These quarries are not considered likely to pose a contamination risk; however, the nature and source of fill used during the construction is unknown and there is therefore some uncertainty as to whether contaminated materials may be intercepted by the North Corridor Option 1 roadworks in these areas.

7.4.16 This route corridor option lies immediately adjacent to Belleknowes Industrial Estate which includes the former brick and tile works and associated clay pit. Historically, many of the resulting 'clay pits' associated with former brick works were backfilled with a range of commercial and industrial wastes. It is not known whether this practice has been adopted in this instance as the former clay pit is currently filled with water. There is the potential for contaminants, including heavy metals and organic contaminants, to migrate from this potential source towards the area of construction; however, no evidence of this has been recorded to date. Work in this area would involve road widening in line with the existing road and the likelihood of the construction workers coming in contact with contamination is low.

7.4.17 There is also the potential for contamination and in-filled ground to be present as a result of other historical industries located within the Belleknowes Industrial Estate. Again, as work in this area would involve road widening in line with the existing road, the likelihood of encountering contamination is low.

7.4.18 The embankments associated with North Corridor Option 1 marginally infringe on the St. Margaret's Marsh area. There is the potential for contaminants, including radioactive particles and landfill gas, to be present in this area; however, as only embankments are to be located in this area the risk associated with this potential contamination is low. No evidence of the migration of contaminants in to the works area has been recorded to date.

7.4.19 The former Ferrytoll Quarry Works (Figure 7.1b: Contaminated Land) lies in the route corridor, within the footprint of the former Ferry Toll Quarry. There is the potential for residual contamination to be present in this area; however, as this area was significantly excavated, reworked and restored during the construction of the Forth Road Bridge, it is therefore likely to pose only a minor risk. In addition, the majority of the former works is now occupied by the existing A90/M90 and would therefore be subject to minimal disturbance during the works.

7.4.20 A wastewater treatment works is located approximately 50m west of North Corridor Option 1 (Figure 7.1b). There is the potential for contaminants, including heavy metals, pathogens and organic contaminants, to migrate from this potential source towards the area of construction.

7.4.21 A summary of the potential risks posed by encountering contaminated land during construction of the Forth Replacement Crossing are summarised in Table 7.20.

Table 7.20: Summary of Potential Risks Associate with Contaminated Land - North Corridor Option 1

Source	Pathway	Receptor	Likelihood	Consequence	Risk (unmitigated)
Made ground in in-filled quarries	Dermal contact	Construction workers	Low	Medium	Moderate/Low
	Inhalation		Unlikely	Medium	Low
	Ingestion		Unlikely	Medium	Low
	Migration of contamination	Surface water	Low	Medium	Moderate/Low
		Groundwater	Low	Mild	Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Unlikely	Mild	Very Low
Past and present industrial processes, including a brick and tile works, on the Belleknowes Industrial Estate.	Historical migration leading to potential direct contact, inhalation or ingestion.	Construction workers	Low	Medium	Moderate/Low
	Migration of contamination	Surface water	Low	Mild	Low
		Groundwater	Low	Mild	Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Low	Mild	Low
Radioactive and landfill-related contamination from St. Margaret's Marsh area	Historical migration of contamination leading to potential direct contact, inhalation or ingestion.	Construction workers	Low	Medium	Moderate/low
	Migration of landfill gases		Low	Medium	Moderate/Low
Former Ferrytoll Quarry Works	Dermal contact	Construction workers	Low	Medium	Moderate/Low
	Inhalation		Unlikely	Medium	Low
	Ingestion		Unlikely	Medium	Low
	Migration of contamination	Surface water	Unlikely	Medium	Low
		Groundwater	Unlikely	Mild	Very Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Unlikely	Mild	Very Low
Waste water treatment works	Historical migration leading to potential direct contact, inhalation or ingestion.	Construction workers	Unlikely	Medium	Low
	Migration of contamination	Surface water	Unlikely	Medium	Low
		Groundwater	Unlikely	Mild	Very Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Unlikely	Mild	Very Low

7.4.22 Dependant on the type of contamination present, soils may need to be transported from site or treated on site in line with current regulations. The Ground Investigation being undertaken at the time of this report will provide more information on the ground conditions in these areas.

Groundwater Environment

7.4.23 Potential impacts on the following groundwater body and potentially groundwater-supported feature may occur along the North Corridor Option 1. However, as the proposed route corridor largely comprises marginal expansions of an existing road corridor rather than a new road, the magnitude of the impacts of this route corridor option are low, as shown in Table 7.21.

Table 7.21: Summary of Potential Impacts on North Corridor Option 1

Groundwater Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	**Significance**
Shallow groundwater potentially supporting St Margaret's Marsh	High	Low (and very localised): - drainage system related to the new road embankment could potentially alter existing surface water inflows to the marsh and therefore its groundwater balance. - potentially contaminated runoff from the proposed road may enter the shallow groundwater.	Moderate

7.4.24 North Corridor Option 1 passes over areas where the Lower Limestone Group is exposed or close to the ground surface. These areas are located in the surroundings of Middlebank (Figure 7.3b). Because of the presence of fractures in the unsaturated zone of the limestone, potential pollutants produced during the construction (i.e. storage of oils and fuel) and operation (oils, fuel, coolants, salts and heavy metals) of the proposed route corridor option may enter the unsaturated zone and travel quickly and with low attenuation to the saturated zone. On this basis, these areas are considered as highly vulnerable to potential pollution incidents which may occur during the construction of the road and its operation.

7.4.25 It is not known at this stage whether the shallow groundwater supports any of the designated surface water features (i.e. stream and ponds).

7.4.26 In addition to direct recharge from rainfall and indirect recharge from runoff, it is possible that the superficial deposits in St Margaret's Marsh area are receiving some indirect recharge in the form of lateral flow through the shallow fractured bedrock. However, the superficial deposits are obviously receiving seawater either indirectly or directly as evidenced by salinity of the groundwater as reported in the previous contaminated land investigations (Environ, 2007). It is not possible to determine the proportions and relative hydrological importance of the four sources of recharge on St Margaret's Marsh at this stage. In this locality, the proposed route corridor would incorporate an embankment along the south eastern boundary of the marsh. An embankment is already present along this boundary of the marsh and it is not known whether this influences the water balance of the marsh. The new embankment is unlikely to cause a significant reduction in the lateral groundwater component previously introduced. However, during its construction, the same surface water inflows and therefore the same groundwater balance of the marsh needs to be preserved. Road drainage proposals in this area will need to take cognisance of the marsh sensitivity to avoid contamination; this is considered in Chapter 8 (Water Environment).

Private Water Supplies (PWS)

7.4.27 Magnitude of impact on PWS quality is assessed as high in a cutting area and medium in an embankment area. Magnitude of impact on PWS flow is assessed as follows (taking into account uncertainties on likely cutting depths):

- high in cutting areas;
- medium in cutting area which is on or adjacent to an existing A90 cutting;
- medium in a transition embankment/cutting zone;
- low in a transition embankment/cutting zone where the cutting is on or adjacent to an existing A90 cutting; and

- negligible in an embankment area.

7.4.28 Significance of potential impacts of North Corridor Option 1 on individual PWS on both quality and flow taking account of sensitivity and magnitude identified above are reported in Table 7.22. This indicates that PWS N05 and N15 are potentially the two supplies the most at risk in terms of quality and flow in the absence of mitigation (Moderate/Substantial significance).

Table 7.22: Summary of Potential Impacts Associated with PWS - North Corridor Option 1

PWS	Sensitivity	Potential impact on groundwater quality (unmitigated)		Potential Impact on groundwater flow (unmitigated)	
		Magnitude	Significance	Magnitude	Significance
N01	Low	High	Moderate	Medium	Slight/Moderate
N02	Low	High	Moderate	Medium	Slight/Moderate
N03	Medium	High	Moderate/Substantial	Medium	Moderate
N04	Medium	High	Moderate/Substantial	Medium	Moderate
N05	High	High	Substantial	Medium	Moderate/Substantial
N06	Medium	High	Moderate/Substantial	Medium	Moderate
N07	Low	High	Moderate	Medium	Slight/Moderate
N08	Medium	Medium	Moderate	Negligible	Negligible/Slight
N09	High	Medium	Moderate/Substantial	Negligible	Slight
N10	Medium	Medium	Moderate	Negligible	Negligible/Slight
N11	Negligible	High	Slight	Medium	Negligible/Slight
N12	Medium	Medium	Moderate	Negligible	Negligible/Slight
N13	Medium	Medium	Moderate	Negligible	Negligible/Slight
N14	Medium	Medium	Moderate	Negligible	Negligible/Slight
N15	High	High	Substantial	Medium	Moderate/Substantial
N16	Medium	High	Moderate/Substantial	Medium	Moderate
N17	Medium	High	Moderate/Substantial	Medium	Moderate
N18	Negligible	High	Slight	Medium	Negligible/Slight
N19	Medium	High	Moderate/Substantial	Medium	Moderate
N20	Medium	High	Moderate/Substantial	Medium	Moderate
N21	Medium	High	Moderate/Substantial	Medium	Moderate
N22	Negligible	High	Slight	Medium	Negligible/Slight

North Corridor Option 2

Geology and Geological/Geomorphological Features of Importance

7.4.29 North Corridor Option 2 crosses through approximately 5% of the Ferry Hills SSSI (geological) including the former Fairy Kirk Quarry area, and over approximately 10% of St. Margaret's Marsh SSSI (biological). The potential impact of North Corridor Option 2 on this site is outlined in Table 7.23.

Table 7.23: Summary of Potential Impacts on Geologically Important Sites- North Corridor Option 2

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	**Significance**
St. Margaret's Marsh SSSI (biological but supported by geomorphological feature- salt marsh)	High	Medium - significant area (approximately 10%) of the littoral landscape would be lost.	Moderate/ Substantial
Ferry Hills SSSI (protected igneous geology)	High	Low - the road and associated cuttings would remove the majority of the Fairy Kirk Quarry area (protected igneous geology), totalling approximately 5% of the overall designated area.	Moderate

Mineral Extraction

7.4.30 The potential impacts are common to both options and are discussed in paragraphs 7.4.8 and 7.4.9.

Contaminated Land

7.4.31 Several former and present quarries have been identified in line with the route corridor, including Fairy Kirk Quarry which is directly in line with North Corridor Option 2. As a result of the desk study and site visits, it has been determined that these quarries are unlikely to pose a significant potential source of contamination. However, the possibility of partial filling cannot be ruled out. As with North Corridor Option 1, the nature and source of any fill material used in the past is unknown and further investigation would be required to identify any contamination present in the made ground in these areas.

7.4.32 St Margaret's Marsh and the landfill located within this area lie in the path of the North Corridor Option 2 and are likely to present a significant source of contaminants, including typical landfill contaminants such as heavy metals and nitrates and landfill gases such as methane and carbon monoxide. In addition, there is also the potential for low level radioactivity to be present in these areas.

7.4.33 There is a large wastewater treatment works to the immediate west of the embankment associated with North Corridor Option 2 to the north of St. Margaret's Marsh (Figure 7.1b). There is the potential for contamination to migrate from this works into the near by soils in the construction area and may include metals, organics and pathogens.

7.4.34 North Corridor Option 2 crosses through the Belleknowes Industrial Estate and the Network Rail North Discharge sidings area. Visual evidence of surface hydrocarbon contamination was observed during a site visit to the Network Rail Yard. In addition, there is potential for contamination across the remainder of this area due to past and current industrial use.

7.4.35 The former Ferrytoll Quarry Works lies in the path of North Corridor Option 2. There is the potential for residual contamination to be present in this area; however, as this area was significantly excavated, reworked and covered over during the construction of the Forth Road Bridge and is therefore likely to only pose a minor risk.

7.4.36 A summary of the potential risks posed by encountering contaminated land during construction of the Forth Replacement Crossing are summarised in Table 7.24.

Table 7.24: Summary of Potential Risks Associated with Contaminated Land - North Corridor Option 2

Source	Pathway	Receptor	Likelihood	Consequence	Risk (unmitigated)
Made ground in in-filled quarries	Dermal contact	Construction workers	Low	Medium	Moderate/low
	Inhalation		Unlikely	Medium	Low
	Ingestion		Unlikely	Medium	Low
	Migration of contamination	Surface water	Low	Medium	Moderate/low
		Groundwater	Low	Mild	Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Unlikely	Mild	Very low
Past and present industrial processes, including Network Rail Discharge sidings (Belleknowes Industrial Estate)	Dermal contact	Construction workers	High	Medium	High
	Inhalation		Likely	Medium	Moderate
	Ingestion		Low	Medium	Moderate/low
	Migration of contamination	Surface water	Low	Mild	Low risk
	Migration of contamination during construction	Groundwater	Low	Mild	Low risk
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Low	Mild	Low
Radioactive and landfill-related contamination from St. Margaret's Marsh area	Dermal contact	Construction workers	High	Medium	High
	Inhalation		Likely	Medium	Moderate
	Ingestion		Low	Medium	Moderate/Low
	Migration of contamination	Surface water	Likely	Medium	Moderate
		Groundwater	Likely	Mild	Moderate/Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Low	Mild	Low
Former Ferrytoll Quarry Works	Dermal contact	Construction workers	Low	Medium	Moderate/Low
	Inhalation		Unlikely	Medium	Low
	Ingestion		Unlikely	Medium	Low
	Migration of contamination	Surface water	Unlikely	Medium	Low
		Groundwater	Unlikely	Mild	Very Low
	Migration of contamination leading to plant uptake or dermal contact	Ecological	Unlikely	Mild	Very Low
Waste water treatment works	Historical migration of contamination leading to potential direct contact, inhalation, ingestion	Construction workers	Low	Medium	Moderate/Low
	Migration of contamination	Surface water	Unlikely	Medium	Low
		Groundwater	Unlikely	Mild	Very Low
	Migration of contamination leading to plant uptake and dermal contact by animals	Ecological	Unlikely	Mild	Very Low

7.4.37 Depending on the type of contamination present, soils may need to be transported from site or treated on site in line with current regulation. The detailed site investigation that is being undertaken at the time of this report will provide more information on the ground conditions in these areas.

Groundwater Environment

7.4.38 Potential impacts on the following groundwater body and potentially groundwater-supported feature may occur along the North Corridor Option 2 , as summarised in Table 7.25

Table 7.25: Summary of Potential Hydrogeological Impacts on Sensitive Receptors - North Corridor Option 2

Groundwater Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Shallow groundwater potentially supporting St Margaret's Marsh	High	Moderate - drainage system related to the new road embankment could potentially alter existing surface water inflows to the marsh and therefore its groundwater balance. - potentially contaminated runoff from the proposed road may enter the shallow groundwater.	Moderate/ Substantial

7.4.39 North Corridor Option 1 would pass to the east of the Middlebank area, which has been previously identified as an area highly vulnerable to pollution. For this reason, groundwater quality beneath parts of North Corridor Option 2 is considered to be less vulnerable to pollution than those beneath North Corridor Option 1.

7.4.40 However, overall impacts on groundwater flow and quality are expected to be greater than in North Corridor Option 1 because North Corridor Option 2 is not online and would cause considerably greater disturbance.

7.4.41 The greatest impacts in terms of groundwater quality along North Corridor Option 2 are expected in the area in the vicinity of Dales Farm Cottages (Figure 7.3b).

7.4.42 In relation to groundwater supporting sensitive habitats, the considerations set out in paragraph 7.4.26 are still valid. However, it is worthwhile noting that the North Corridor Option 2 land take is likely to have a slightly greater impact on St Margaret's Marsh as there is a greater potential for reducing the inflows into the marsh, depending on where the road drainage is directed.

Private Water Supplies (PWS)

7.4.43 Magnitude of impact on PWS quality is assessed as high in a cutting area and medium in an embankment area. Magnitude of impact on PWS flow is assessed as follows (taking into account uncertainties on likely cutting depths):

- high in cutting areas;
- medium in cutting area which is on or adjacent to an existing A90 cutting;
- medium in a transition embankment/cutting zone;
- low in a transition embankment/cutting zone where the cutting is on or adjacent to an existing A90 cutting; and
- negligible in an embankment area.

7.4.44 Significance of potential impacts of North Corridor Option 2 on individual PWS on both quality and flow taking account sensitivity and magnitude identified above are reported in Table 7.22. This indicates that the highest significance of potential impact is N04 and N05 (Moderate/Substantial).

Table 7.26: Summary of Potential Impacts Associated with PWS - North Corridor Option 2

PWS	Sensitivity	Potential impact on groundwater quality (unmitigated)		Potential Impact on groundwater flow (unmitigated)	
		Magnitude	Significance	Magnitude	Significance
N01	Low	Medium	Slight/Moderate	Negligible	Negligible
N02	Low	Medium	Slight/Moderate	Negligible	Negligible
N03	Medium	Medium	Moderate	Negligible	Negligible/Slight
N04	Medium	High	Moderate/Substantial	High	Moderate/Substantial
N05	Medium	High	Moderate/Substantial	High	Moderate/Substantial
N06	Low	High	Moderate	High	Moderate
N07	Low	Medium/High	Moderate	Low	Negligible/Slight
N08	Negligible	Medium	Negligible/Slight	Negligible	Negligible
N09	Medium	Medium	Moderate	Negligible	Negligible/Slight
N10	Negligible	Medium	Negligible/Slight	Negligible	Negligible
N11	Negligible	High	Slight	Medium	Negligible/Slight
N12	High	Medium	Moderate/Substantial	Negligible	Slight
N13	Medium	Medium	Moderate	Negligible	Negligible/Slight
N14	High	Medium	Moderate/Substantial	Negligible	Slight
N15	Medium	Medium/High	Moderate	Medium	Moderate
N16	Medium	High	Moderate/Substantial	Medium	Moderate
N17	Medium	High	Moderate/Substantial	Medium	Moderate
N18	Negligible	High	Slight	Medium	Negligible/Slight
N19	Medium	High	Moderate/Substantial	Medium	Moderate
N20	Medium	High	Moderate/Substantial	Medium	Moderate
N21	Medium	High	Moderate/Substantial	Medium	Moderate
N22	Negligible	High	Slight	Medium	Negligible/Slight

Southern Route Corridor Options

Impacts Common to Both Southern Route Corridor Options

7.4.45 No impacts on sites of geological/geomorphological importance have been identified from either of the southern route corridor options or associated cuttings. The Firth of Forth SSSI area lies to the east of the route corridor options and it is not anticipated that it would be affected by the works.

7.4.46 No former quarrying areas would be affected by either of the two southern route corridor options.

7.4.47 Both southern route corridor options would cross over the Stores area via a viaduct at the southern shore. The Stores area is currently occupied by several small industrial units connected with the sailing industry. It is expected that made ground would be present in this area and that residual contamination, including organic contaminants from historical fuel storage, may be present in the soils in this area.

7.4.48 A summary of the potential risks posed by contaminated land in the Stores area as a result of the construction of the Forth Replacement Crossing are detailed in Table 7.27.

Table 7.27: Summary of Potential Risks Associated with Contaminated Land - Common to Both Southern Route Corridor Options

Source	Pathway	Receptor	Likelihood	Consequence	Risk (unmitigated)
Residual contamination associated with the Stores area and associated potential fuel storage	Dermal contact	Construction workers	Low	Medium	Moderate/Low
	Inhalation		Unlikely	Medium	Low
	Ingestion		Unlikely	Medium	Low
	Migration of contamination during construction	Surface waters	Unlikely	Medium	Low
		Groundwater	Unlikely	Mild	Very Low
	Migration of contamination during construction leading to plant uptake or dermal contact by animals	Ecological	Unlikely	Mild	Very Low

7.4.49 Dependant on the type of contamination present in the Stores area, soils may need to be transported from site or treated on site in line with current regulation during viaduct construction. The detailed site investigation being undertaken at the time of this report will provide more information on the ground conditions in these areas.

South Corridor Option 1

Mineral Extraction

7.4.50 South Corridor Option 1 crosses through areas where reserves of coal are believed to exist; however, no currently active coal mines are located within the near vicinity and no future mining licences are currently being considered by the Coal Authority.

7.4.51 Disused oil shale mining shafts and adits have been identified in the near vicinity of this route corridor option. Although oil shale mining is no longer undertaken in this area, the construction of South Corridor Option 1 could potentially deplete oil shale resources which may be of use in the future to produce products such as synthetic crude oil.

Groundwater

7.4.52 South Corridor Option 1 does not appear to cross extensive areas where bedrock is either exposed or lies near to surface. Most of the bedrock in the area is covered by low permeability drift with significant thickness (i.e. > 1m; Figure 7.3). As a result, the bedrock aquifers are not considered to be highly vulnerable to contamination. The groundwater vulnerability will depend however, on the depth of the water table (or thickness of the unsaturated zone) and the exact thickness and composition of the drift. At this stage, data are scarce and it is not possible to consider this aspect in more detail.

7.4.53 The only area where bedrock is exposed, or may be near to surface, is between the B924 and Dundas Mains. Only one PWS was identified in this area (S07; refer to paragraph 7.3.55).

Private Water Supplies (PWS)

7.4.54 Magnitude of impact on PWS quality is assessed as high in a cutting area and medium in an embankment area. Magnitude of impact on PWS flow is assessed as follows (taking into account uncertainties on likely cutting depths):

- High in cutting areas;
- Medium in cutting area which is on or adjacent to an existing A90 cutting;

- Medium in a transition embankment/cutting zone;
- Low in a transition embankment/cutting zone where the cutting is on or adjacent to an existing A90 cutting; and
- Negligible in an embankment area.

7.4.55 Significance of potential impacts of South Corridor Option 1 on PWS are presented in Table 7.28. This indicates that the highest significance of potential impact is at S07 (Moderate/Substantial).

Table 7.28: Summary of Potential Impacts Associated to PWS - South Corridor Option 1

PWS	Sensitivity	Potential impact on groundwater quality (unmitigated)		Potential Impact on groundwater flow (unmitigated)	
		Magnitude	Significance	Magnitude	Significance
S01	Low	Medium	Slight/Moderate	Negligible	Negligible
S02	Negligible	Medium/High	Slight	Medium	Negligible/Slight
S03	Medium	Medium/High	Moderate	Medium	Moderate
S04	Medium	Medium	Moderate	Negligible	Negligible/Slight
S05	Low	Medium/High	Moderate	Low	Slight
S06	Low	High	Moderate	High	Moderate
S07	Medium	High	Moderate/Substantial	High	Moderate/Substantial

<u>South Corridor Option 2</u>

Mineral Extraction

7.4.56 South Corridor Option 2 crosses through areas where reserves of coal are believed to exist; however, no currently active coal mines are located in the vicinity and no future mining licences area currently being considered by the Coal Authority.

7.4.57 Disused oil shale mining shafts and adits have been identified in the vicinity of this route corridor option. Although oil shale mining is no longer undertaken in this area, the construction of South Corridor Option 2 could potentially deplete oil shale resources which may be of use in the future to produce products such as synthetic crude oil.

Contaminated Land

7.4.58 The route corridor crosses through the former Depot/Westmuir Riding Centre, as illustrated on Figure 7.1c, which is now Westmuir Riding Centre. Although made ground is anticipated in this area, the likelihood of contamination is considered low due to the historical land use.

7.4.59 The route corridor also crosses through and adjacent to a number of former oil shale mineshafts and adits. There is the potential for contamination to be present in these areas due to the possible infilling of these shafts with mining spoil. In addition, there is also the potential for mine gas to be present.

7.4.60 The oil storage depot at Dalmeny, as illustrated in Figure 7.1c, is located approximately 100m south of South Corridor Option 2. There is the potential for contamination to migrate from this area into the near by soils in the construction area and may include organics contaminants.

7.4.61 Potential risks associated with contaminated land in South Corridor Option 2 are summarised in Table 7.29.

Table 7.29: Summary of Potential Risks Associate with Contaminated Land - South Corridor Option 2

Source	Pathway	Receptor	Likelihood	Consequence	Risk (unmitigated)
Former depot area	Dermal contact	Construction workers	Unlikely	Medium	Low
	Inhalation		Unlikely	Medium	Low
	Ingestion		Unlikely	Medium	Low
	Migration of contamination during construction	Surface water	Unlikely	Medium	Low
		Groundwater	Unlikely	Mild	Very Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Unlikely	Mild	Very Low
Disused Oil Shale Mine Shafts and Adits	Dermal contact	Construction workers	Low	Medium	Moderate/Low
	Inhalation/ Explosion of mine gas		Low	Severe	Moderate
	Ingestion		Unlikely	Medium	Low
	Migration of contamination during construction	Surface water	Low	Medium	Moderate/Low
		Groundwater	Likely	Mild	Moderate/Low
	Migration of contamination leading to plant uptake or dermal contact by animals	Ecological	Low	Mild	Low
Oil storage depot	Historical migration of contamination leading to potential direct contact, inhalation, ingestion	Construction workers	Low	Medium	Moderate/Low
	Migration of contamination	Surface water	Low	Medium	Moderate/Low
		Groundwater	Low	Mild	Low
	Migration of contamination leading to plant uptake and dermal contact by animals	Ecological	Unlikely	Mild	Very Low

7.4.62 Additional potential impacts are common to both options and are discussed previously.

7.4.63 Dependant on the type of contamination present in the Depot and disused mineshafts area, soils may need to be transported from site or treated on site in line with current regulation. The detailed site investigation that is being undertaken at the time of this report will provide more information on the ground conditions in these areas.

Groundwater Environment

7.4.64 South Corridor Option 2 passes over areas where the bedrock is covered by drift deposits with thickness greater than 1m (Figure 7.3). On this basis the bedrock aquifers are not considered to be highly vulnerable to pollution.

7.4.65 South Corridor Option 2 passes near Humbie Reservoir however, no impacts are predicted on groundwater flow potentially supporting the reservoir while impacts on the water quality of the reservoir are addressed in Chapter 8 (Water Environment).

Private Water Supplies

7.4.66 Magnitude of impact on PWS quality is assessed as high in a cutting area and medium in an embankment area. Magnitude of impact on PWS flow is assessed as follows (taking into account uncertainties on likely cutting depths):

- high in cutting areas;
- medium in cutting area which is on or adjacent to an existing A90 cutting;
- medium in a transition embankment/cutting zone;
- low in a transition embankment/cutting zone where the cutting is on or adjacent to an existing A90 cutting; and
- negligible in an embankment area.

7.4.67 Signifiance of potential impacts on PWS on both quality and flow taking account sensitivity and magnitude are reported in Table 7.30. This indicates that the highest significance of potential impact are at S03 and S07 (Moderate).

Table 7.30: Summary of Potential Impacts Associated with PWS - South Corridor Option 2

PWS	Sensitivity	Potential impact on groundwater quality (unmitigated)		Potential Impact on groundwater flow (unmitigated)	
		Magnitude	Significance	Magnitude	Significance
S01	Medium	Medium	Moderate	Negligible	Neligible/Slight
S02	Negligible	Medium/High	Slight	Medium	Negligible/Slight
S03	Medium	Medium/High	Moderate	Medium	Moderate
S04	Medium	Medium	Moderate	Negligible	Negligible/Slight
S05	Low	Medium/High	Moderate	Low	Slight
S06	Low	Medium/High	Moderate	Medium	Slight/Moderate
S07	Low	High	Moderate	High	Moderate

7.5 Potential Mitigation

7.5.1 At DMRB Stage 2 assessment of route corridor options the detailed design has not been developed and mitigation detail therefore cannot be accurately defined. The objective of this section is therefore to identify ‘standard’ or ‘anticipated’ mitigation taking into account best practice, legislation and guidance. This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 7.4 (Potential Impacts), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

7.5.2 In order to determine the nature and extent of contamination present, soil and groundwater samples are being collected and analysed during the current geotechnical ground investigation. Where contamination is identified, a full assessment will be undertaken pre-construction to determine what mitigation, if any, is required. Mitigation measures may include removal of waste soils from site, consolidation of waste for treatment ex-situ or treatment of wastes in situ.

7.5.3 Where impacts on geologically important features and mineral extraction have been identified, further consideration with regards to engineering solutions which protect or preserve the feature concerned, will be required at DMRB Stage 3.

7.5.4 Although further investigation is required, potential mitigation measures with regards to the groundwater environment and public water supplies are summarised in paragraphs 7.5.5 to 7.5.7.

7.5.5 Prior to and during the construction and at the beginning of the operational phase, the following is proposed:

- Mitigation measures prior to the construction may include a programme of monitoring of the private water supplies to identify baseline conditions for groundwater. This baseline values will be useful to identify any impairment in the groundwater quality/quantity following the construction and at the beginning of the operational phase.
- The monitoring of PWS identified as being potentially at risk will provide a better understanding of groundwater flow and groundwater quality. This will enable the potential impact on private groundwater supplies to be determined with more accuracy, and mitigation developed as appropriate.
- Based on the groundwater monitoring and assessment, further mitigation measures may be proposed in relation to specific groundwater supplies. It may be necessary to undertake monitoring of selected groundwater supply sources during construction and into the start of the operational phase to assess whether there has been any discernible effect on the supply. If yields of water supplies are shown to be reduced, mitigation measures would be likely to include an alternative or replacement supply.
- Avoidance of areas of potential contamination and where necessary implementing specific measures to ensure that people and environment are not at risk from the mobilisation of contaminants.

7.5.6 During the construction phase, the following is proposed:

- Chapter 8 (Water Environment) lists anticipated mitigation to address potential impacts on surface waters, including adherence to SEPA Pollution Prevention Guidelines (PPGs) during construction, and appropriate highways drainage and treatment. These measures would also mitigate against water pollution risk to groundwater by reducing the potential for pollutant release and preventing any contaminated runoff produced by the works from entering groundwater via the unsaturated zone or via losing streams[1] that may recharge directly into the bedrock aquifers.
- Any contaminated waters will need to be removed for off-site disposal at an appropriate licensed facility in accordance with Waste Management Licensing Regulations 1994 (as amended), or treated on-site and discharged in compliance with a Consent to Discharge issued by SEPA.

7.5.7 During the operational phase, the following is proposed:

- Mitigation measures may include the lining of the road drainage to prevent accidental spillages and/or contaminated runoff form the road surface migrating to the unsaturated zone and reaching the groundwater.
- Appropriate drainage measures would be required for embankments to the east of St Margaret's Marsh in order to preserve the hydrological balance of the Marsh (refer to Chapter 8: Water Environment). These mitigation measures will be defined after detailed investigations of the surface and sub-surface hydrological connectivity of the marsh.
- Mitigation measures to prevent any contaminated runoff from entering shallow groundwater which may be supporting St Margaret's Marsh, or any other designated area (i.e. watercourse or pond), are the same as those identified in Chapter 8 (Water Environment).

[1] a watercourse in which water may move downwards through the stream bed to an underlying aquifer.

7.6 Summary of Route Corridor Options Assessment

Northern Route Corridor Options

North Corridor Option 1

7.6.1 With regards to sites of geological/geomorphological importance and mineral extraction, North Corridor Option 1 is likely to have a lower impact than North Corridor Option 2 as it would remove the least area of land at the identified SSSI sites. The impact of road construction in areas associated with this route corridor will depend on the mitigation measures incorporated within the final design. Following application of 'typical' mitigation measures, the impacts on these sensitive areas by North Corridor Option 1 are of Negligible significance.

7.6.2 North Corridor Option 1 is at a significantly lower risk from contaminated land than North Corridor Option 2. With appropriate mitigation measures, the effect of contamination on the surrounding environment can be minimised.

7.6.3 North Corridor Option 1 crosses or is in the vicinity of areas of groundwater designated as highly vulnerable to pollution and, as such, is considered to have a greater vulnerability than North Corridor Option 2 in the groundwater environment. However, this potential impact would be greatly limited on this route corridor as this is mostly an online option and direct impacts would thus be limited. If the appropriate mitigation measures described in paragraphs 7.5.5 to 7.5.7 are implemented, the residual impacts on both groundwater quality and quantity are expected to be Negligible to Slight.

7.6.4 North Corridor Option 1 is considered the preferred option on account of its potentially lower impact on sites of geological/geomorphological importance and lower impact from contaminated land.

North Corridor Option 2

7.6.5 North Corridor Option 2 would have a higher impact on sites of geological/geomorphological importance and mineral extraction than North Corridor Option 1. The impact of road construction in areas associated with this route corridor will depend on the mitigation measures incorporated within the final design. It is likely that even after application of 'typical' mitigation measures, a Low to Moderate residual impact on sites of geological/geomorphological importance may remain for North Corridor Option 2.

7.6.6 North Corridor Option 2 is at the greatest potential risk from contaminated land, mainly as a result of the route corridor crossing the St. Margaret's Marsh area and former landfill. As with North Corridor Option 1, with appropriate mitigation measures, the effect of contamination on the surrounding environment can be minimised.

7.6.7 North Corridor Option 2 was assessed to have a greater potential impact then North Corridor Option 1 on groundwater flow, water quality and on groundwater-supported habitats, in particular in the St. Margaret's Marsh area. If the appropriate mitigation measures described in paragraphs 7.5.5 to 7.5.7 are implemented, the residual impacts on both groundwater quality and quantity are expected to be Negligible to Slight.

7.6.8 North Corridor Option 2 is considered the lesser preferred option on account of its potentially higher impact on sites of geological/geomorphological importance and higher impact from contaminated land, particularly in the St. Margaret's Marsh area.

Southern Route Corridor Options

South Corridor Option 1

7.6.9 With regards to sites of geological/geomorphological importance and mineral extraction, no impacts have been identified for South Corridor Option 1.

7.6.10 South Corridor Option 1 is at a lower risk from potentially contaminated land than South Corridor Option 2.

7.6.11 South Corridor Option 1 is likely to have a similar potential impact to South Corridor Option 2 on the groundwater environment. As with the northern route corridor options, if the appropriate mitigation measures are implemented, the residual impacts on both groundwater quality and quantity are expected to be negligible to slight.

7.6.12 Overall, South Corridor Option 1 is considered the preferred option on account of its potentially lower impact from contaminated land.

South Corridor Option 2

7.6.13 With regards to sites of geological/geomorphological importance and mineral extraction, no impacts have been identified for South Corridor Option 2.

7.6.14 South Corridor Option 2 presents a higher risk than South Corridor Option 1 with regards to contaminated land. This is mainly as a result of the route corridor crossing areas where former oil shale mines are known to exist. With appropriate mitigation measures, the effect of contamination on the surrounding environment can be minimised.

7.6.15 South Corridor Option 2 is likely to have a similar potential impact to South Corridor Option 1 on the groundwater environment. As with the northern route corridor options, if the appropriate mitigation measures are implemented, the residual impacts on both groundwater quality and quantity are expected to be Negligible to Slight.

7.6.16 Overall, South Corridor Option 2 is considered the lesser preferred option on account of its potentially higher impact from contaminated land.

7.7 Scope of Stage 3 Assessment

7.7.1 In accordance with DMRB Volume 11, further assessment of the preferred route corridor will be undertaken to refine the identification of any significant impact on geology, soils and groundwater and where appropriate any particular environmental issues associated with contaminated land. It is proposed that the following steps will be taken:

- confirm information gathered from relevant statutory bodies and the local planning authority, and in particular gather views on the hydrological–hydrogeological relationships for functioning of the SSSI and water features of importance as highlighted in Stage 2;
- review and assess the results of the geological ground investigation work currently underway, which will refine the information regarding geology and soil of the study area;
- review and assess the results of contaminated land tests currently underway in targeted made ground areas determined from Stage 2 assessment;
- review and assess the results of hydrogeological ground investigation work to refine drift and bedrock groundwater characteristics;

- undertake consultation with private land owners regarding PWS, and undertake further assessment in areas defined by SEPA as a Drinking Water Zone at Stage 2;
- potentially undertake additional surveys of potentially contaminated sites and key private water supplies; and
- propose appropriate mitigation measures based on refined assessments.

7.8 References

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(1853) Edinburghshire 1:10560	(1957) OS Plan NT17NW and NT17SW 1:10560
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8 Water Environment

8.1 Introduction

8.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of water quality, hydrology, flood risk and fluvial and coastal geomorphology. The assessment methodologies are explained, including details of the main sources of information that were utilised.

8.1.2 The baseline conditions are described, representing the existing or 'do minimum scenario' which is the situation if the proposed Forth Replacement Crossing were not to proceed.

8.1.3 Potential impacts that may occur as a consequence of the different route corridor options are considered and compared. Potential impacts of the northern and southern route corridor options are considered separately. As the bridge is considered to be a 'given' for all route corridor options, potential impacts are assessed in isolation.

8.1.4 Types of mitigation to avoid, reduce or offset the potential impacts are outlined where possible, based on guidance and best practice. In conclusion, there is a summary of the options assessment, which identifies the preferred combination of north and south options from the perspective of protecting the water environment.

8.2 Approach and Methods

8.2.1 This chapter considers and assesses impacts to the surface water environment: hydrology / flood risk; fluvial and coastal geomorphology; and water quality, as outlined below:

- **Hydrology and Flood Risk**: the assessment of potential impacts on the water flow on or near the land surface, which is intrinsically linked to hydrogeology, water quality, geomorphology and ecology.
- **Fluvial and Coastal Geomorphology**: the assessment of landforms associated with river channels and estuaries and the sediment transport processes which form them. Fluvial and coastal processes create a wide range of morphological forms which provide a variety of habitats within and around river / estuarine channels and shorelines.
- **Water Quality**: the assessment of the chemical status of various parameters within the water column and their interactions.

8.2.2 As indicated above, this chapter specifically addresses fluvial and coastal geomorphology; geomorphology in the context of solid and drift geology is considered separately in Chapter 7 (Geology, Contaminated Land and Groundwater). While the relevant fisheries designations have been considered in this chapter, potential impacts on freshwater ecology are considered within Chapter 9 (Ecology and Nature Conservation).

8.2.3 The study area including water features and associated water catchments, are shown on Figures 8.1 and 8.2.

Baseline Conditions

8.2.4 Baseline conditions were identified through a combination of consultation, desk-based assessment and site walkovers.

8.2.5 Data were collated from the following sources:

- Ordnance Survey Maps;
- Flood Estimation Handbook (FEH) Version 2 (Institute of Hydrology, 2007);

- Centre for Ecology and Hydrology (CEH) CD-Rom;
- SEPA indicative flood maps (www.sepa.org.uk/flooding/mapping/index.htm); and
- SEPA water quality monitoring data and designated fisheries information.

8.2.6 Walkover surveys of the study area were undertaken in April and May 2008 to visually inspect watercourses and surface water bodies in order to gain an understanding of the local topography, hydrological regime, sediment processes and characteristics of the water environment.

8.2.7 The water quality assessment was conducted using data from SEPA's website and water chemistry spot sampling undertaken at strategic locations along minor watercourses not monitored by SEPA. These spot samples were undertaken in April and early May 2008, and were used in this assessment to give an indication of the water chemistry of watercourses not monitored by SEPA.

8.2.8 The SEPA flood map provides a Scotland-wide picture of the areas at risk of flooding from rivers and the sea by providing a flood outline for areas estimated to be at risk if there were no flood defences. Flood defences do not completely remove the chance of flooding and can be overtopped or fail in extreme weather conditions. The web version shows an estimate of the areas of Scotland with a 0.5% (1:200) or greater probability of being flooded in any given year.

8.2.9 The SEPA indicative flood maps do not provide sufficient detail to accurately estimate the flood risk associated with individual properties or specific point locations. Local factors such as flood defence schemes, structures in or around river channels such as bridges, buildings and other local influences, which might affect a flood, have not been included. The flood map does not account for flooding from other sources such as surface water runoff, surcharged culverts (where watercourses have been channelled underground) or drainage systems. It is based on a digital terrain model with a vertical accuracy in the range 0.7m – 1.0m, on a grid spacing of 5m. It is not relevant to catchments below $3km^2$.

8.2.10 Catchment areas were determined using the FEH methodology and as such are therefore indicative. Time to peak flows estimated from the FEH indicate that the catchments within the survey area are low to moderate relief.

8.2.11 The 2000/60/EC 'Water Framework Directive' aims to classify surface waters according to their ecological status and sets targets for restoring / improving the ecological status of water bodies. The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) have been introduced (hereafter referred to as CAR) in response to the requirements of the Water Framework Directive (WFD). Under CAR, Environmental Standards for River Morphology have been established (SEPA, 2007b). These standards are used to determine whether the impact of an engineering activity would result in a deterioration in WFD status by establishing 'capacity limits' for future channel modification. As these tests are conducted by SEPA during the CAR application process it is not possible, nor is it a requirement, to apply this methodology at the DMRB Stage 2 assessment. However, the impact magnitude methodology adopted here, which is based on the extent of watercourse engineering activity, does provide a compatible options screening methodology.

8.2.12 As DMRB does not outline a specific methodology to enable the geomorphological impacts to be evaluated, the methodology adopted in this appraisal was developed using the guidelines from Research and Development Programmes of the National Rivers Authority, Environment Agency and SNH (Environment Agency, 1998; Sear et al., 2003). This chapter addresses geomorphology with regard to potential effects on water features, with geomorphology in the context of solid and drift geology considered separately in Chapter 7 (Geology, Contaminated Land and Groundwater).

Impact Assessment

8.2.13 The impact assessment has been carried out using the general approach outlined below, where the level of significance of an impact is assessed based on the sensitivity of the surface water feature and the magnitude of impact.

Sensitivity

8.2.14 The sensitivity of the receiving environment was categorised on a scale of 'Low' to 'High', in accordance with the criteria provided in Table 8.1. Impacts are adverse unless stated otherwise.

Table 8.1: Criteria to Assess the Sensitivity of Water Features

Sensitivity	Criteria
High	**Hydrology and Flood Risk:** A watercourse with direct flood risk to the adjacent populated areas, critical social infrastructure units such as hospitals, schools, safe shelters or land use of great value. Active floodplain area. A watercourse / hydrological feature with hydrological importance to: i) sensitive and protected ecosystems; ii) critical economic and social uses (e.g. water supply, navigation, recreation, amenity etc.). A watercourse / floodplain / hydrological feature that provides critical flood alleviation benefits or any property that is at risk of flooding due to the proposed road scheme. **Fluvial and Coastal Geomorphology:** A watercourse supporting a range of species and habitats sensitive to a change in suspended sediment concentrations and turbidity such as migratory salmon or freshwater pearl mussels. Includes sites with international and UK statutory nature conservation designations due to water-dependent ecosystems. Diverse channel / shoreline morphology, including many natural features such as pools and riffles, active gravel bars, free meandering and varied shoreline / river bank types with good vegetation cover. Such morphological variability is a primary determinant of ecological diversity. High likelihood of adverse morphological adjustment, such as excessive erosion and sediment deposition, as a direct result of engineering activities such as bank protection, culverting and realignment (due to high channel or valley gradient or bed and bank composition). **Water Quality:** Receptor is of high environmental importance or of national or international value. For example, a large or medium-sized watercourse with pristine or near pristine water quality (SEPA water quality A1 (excellent)). Nature conservation designation due to water-dependent ecosystems (including Special Protection Area (SPA), Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI),), or designated for freshwater ecological interest (designated salmonid fishery).
Medium	**Hydrology and Flood Risk:** A watercourse with a possibility of direct flood risk to less populated areas without any critical social infrastructure units such as hospitals, schools, safe shelters and / or utilisable agricultural fields. A watercourse / hydrological feature with some but limited hydrological importance to: i) sensitive or protected ecosystems; ii) economic and social uses (e.g. water supply, navigation, recreation, amenity etc). A watercourse / floodplain / hydrological feature that provides some flood alleviation benefits. **Fluvial and Coastal Geomorphology:** A watercourse supporting some species and habitats sensitive to a change in suspended sediment concentrations and turbidity. Includes non-statutory sites of regional or local importance designated for water-dependent ecosystems. Moderate morphological diversity. Evidence of localised engineering modification such as bank / shoreline protection, but natural features such as intertidal flats, pools and riffles are present. Potential for morphological adjustment, such as erosion and sediment deposition, as direct result of engineering activities such as bank protection, culverting and realignment (due to gradient or bed and bank composition), but which would have limited environmental impact. **Water Quality:** Receptor is of medium environmental importance or of local / regional value. For example SEPA water quality A2 (good) or B (fair), designated cyprinid fishery, salmonid species may be present and catchment locally important for fisheries.
Low	**Hydrology and Flood Risk:** A watercourse passing through uncultivated agricultural land. A watercourse with minimal hydrological importance to: i) sensitive or protected ecosystems; ii) economic and social uses (e.g. water supply, navigation, recreation, amenity etc.). A watercourse / floodplain / hydrological feature that provides minimal flood alleviation benefits. **Fluvial and Coastal Geomorphology:** A watercourse which does not support any significant species sensitive to changes in suspended solids concentration or turbidity. Watercourses exhibiting no morphological diversity; flow is uniform, bars are absent and bank / shoreline types uniform and stable. Evidence of widespread engineering modification such as sea defence, realignment and deepening. Very limited potential for morphological adjustment, such as erosion and sediment deposition, as

Sensitivity	Criteria
	direct result of engineering activities such as bank protection, culverting and realignment (due to low gradient or resistant bed and bank composition). **Water Quality:** Receptor is of low environmental importance. For example SEPA water quality B (fair), C (poor) or D (seriously polluted) and fish sporadically present or restricted, no designated fisheries.

Impact Magnitude

8.2.15 The magnitude is influenced by the timing, scale, size and duration of the potential effect, as defined in Table 8.2.

8.2.16 It should be noted that some of the criteria listed in Table 8.2 are to a level of detail beyond the scope of a DMRB Stage 2 assessment and assessment of magnitude has been made on the basis of currently available information regarding engineering design. However the criteria will also form the basis for assessment at Stage 3 which will enable refinement of the assessments using these detailed criteria.

Table 8.2: Criteria to Assess the Magnitude of the Predicted Impact on Water Features

Magnitude	Criteria
High	**Hydrology and Flood Risk:** Major changes to the flow regime (low, mean and / or high flows – at the site, upstream and / or downstream). An alteration to a catchment area in excess of a 25% reduction or increase in area. Significant increase in the extent of “medium to high risk” areas (classified by the Risk Framework of Scottish Planning Policy Guidance 7 (SPP7)). This means there would be significantly more areas / properties at risk from flooding by the 0.5% (1 in 200 year) or greater annual exceedance probability (AEP). **Fluvial and Coastal Geomorphology:** More than one new watercourse crossing will be required. This will increase both the extent of watercourse engineering in the catchment and lead to at least four transitions between new sections of engineered watercourse and the existing channel. These transitions can alter the nature of fluvial processes (paragraphs 8.2.18 and 8.2.19). **Water Quality:** Major shift away from the baseline conditions, fundamental change to water quality condition either by a relatively high amount for a long-term period or by a very high amount for an episode such that watercourse ecology is greatly changed from the baseline situation. Equivalent to downgrading from Class A to C or D, or from B to D or any change that downgrades a site from good status as this does not comply with the Water Framework Directive.
Medium	**Hydrology and Flood Risk:** Moderate shift away from baseline conditions and moderate changes to the flow regime. An alteration to a catchment area in excess of 10% but less than 25%. Moderate increase in the extent of “medium to high risk” areas (SPP7). **Fluvial Geomorphology:** A single additional watercourse crossing will be required. This will increase the extent of watercourse engineering in the catchment and require two transitions between the section of engineered watercourse and the existing channel. These transitions can alter the nature of fluvial processes (paragraphs 8.2.18 and 8.2.19). **Water Quality:** A moderate shift from the baseline conditions that may be long-term or temporary. Results in a change in the ecological status of the watercourse. Equivalent to downgrading one class, for example from C to D.
Low	**Hydrology and Flood Risk:** Minimum changes to the flow regime. An alteration to a catchment area in excess of 1% but less than 10%. Slight increase in the extent of “medium to high risk” areas (SPP7). **Fluvial and Coastal Geomorphology:** Upgrade to, or extension of, existing watercourse crossing. This will result in a less substantial deviation from baseline conditions than adding an entirely new section of watercourse. **Water Quality:** Minor shift away from the baseline conditions. Changes in water quality are likely to be relatively small, or be of a minor temporary nature such that watercourse ecology is slightly affected. Equivalent to minor but measurable change within a class.
Negligible	**Hydrology and Flood Risk:** Negligible changes to the flow regime (i.e. changes that are within the monitoring errors). An alteration to a catchment area of less than 1% reduction or increase in area. Negligible change in the extent of “medium to high risk” areas (SPP7). **Fluvial and Coastal Geomorphology:** No direct engineering impact but potential indirect impact due to proximity of watercourse to road corridor, such as pollution by sediment release. **Water Quality:** Very slight change from the baseline conditions such that no discernible effect upon the watercourse ecology results. No change in classification.

Impact Significance

8.2.17 The significance of impact was determined as a function of the sensitivity of the receiving environment and the magnitude of the impact, as outlined in Table 8.3.

Table 8.3: Significance of Impact

Magnitude / Sensitivity	Negligible	Low	Medium	High
High	Negligible	Moderate	Moderate / Substantial	Substantial
Medium	Negligible	Slight	Moderate	Moderate / Substantial
Low	Negligible	Negligible	Slight	Moderate

8.2.18 The impacts on the geomorphology of the watercourse were assessed using information available at the time of the assessment. This information consisted of the location of proposed crossings but did not include specific information regarding the type of crossing structure or the extent of the impact on the watercourse. The nature and extent of impacts on watercourse geomorphology are influenced by the extent of earthworks required, the type of crossing structure chosen and the need for watercourse realignment which are themselves influenced by topography, existing watercourse geometry and carriageway width. For this reason the assessment was based on the number of potential crossings and whether this involved modification to existing watercourse crossings or construction of entirely new crossing structures.

8.2.19 Although a single large new crossing structure could affect a greater extent of the watercourse than two new small crossing structures, this does not necessarily mean it would have a greater impact on the watercourse. The transitions between the existing watercourse and new sections of channel engineering (such as realignments or culverts) represent locations where geomorphological impacts are likely to be greatest. In the context of the WFD, activities which will increase the extent of modifications to watercourses or lead to potential threats to the status of a water body are undesirable and may potentially be rejected by SEPA during the CAR application process. Therefore, extensive areas of new watercourse engineering can have a high impact on the water environment irrespective of the existing degree of watercourse engineering.

Limitations to Assessment

8.2.20 There are certain limitations within each discipline with regards to the assessment methodologies, which resulted in a number of assumptions being made in the baseline assessment as set out in the following paragraphs. It should be noted, however, that this Stage 2 assessment is considered robust and that such limitations to assessment are considered normal at this stage.

8.2.21 At this stage, road route and junction options are known in plan, with some indication of proposed longitudinal profiles. Apart from the proposed replacement bridge over the Firth of Forth, no specific proposals regarding crossing structure type are available. Details of watercourse engineering, construction activities and road drainage networks are not available at this stage. As the assessment of the magnitude of impact can only be based on available information; this is based on whether existing structures would be modified or whether new structures would be required and the number of such changes proposed on each watercourse.

Hydrology and Flood Risk

8.2.22 No hydrometric data were available for the water features considered in the hydrology assessment, i.e. the watercourses are ungauged. Although suitable methodologies have been applied to these ungauged catchments, the absence of site specific monitoring data inevitably means that larger uncertainties must be attached to these estimates.

Fluvial and Coastal Geomorphology

8.2.23 The approach adopted in this Stage 2 assessment has classified the sensitivity of watercourses taking account of the degree of existing modifications to watercourses (Table 8.1) in accordance with Environment Agency guidance (Environment Agency, 1998, p 15). However, this sensitivity scoring may not necessarily be compatible with the goals of the WFD as watercourses that are already modified by human activities may be at risk of failing their WFD targets making them sensitive to further engineering.

8.2.24 The baseline conditions were judged on field observations recorded during a single site visit. This provides an indication of character at a snap-shot of time rather than over a longer temporal period. As a result, the watercourses were observed under one flow condition (often low flow) rather than under several flow conditions, and therefore may not have accurately reflected average flow conditions and the dynamics of the watercourse. Similarly the density of riparian and channel vegetation along watercourses, which varies seasonally, was recorded within a single season (late spring). Vegetation can obscure sections of channel erosion giving a potentially misleading impression of channel stability.

Water Quality

8.2.25 Spot sampling results provide only a snapshot of the water chemistry conditions in the watercourse at the time the sample was obtained. These results are not considered to be the equivalent of monitoring data and do not provide information in regards to the long-term water quality of the watercourse. Consequently, where watercourses are not classified by SEPA, a judgement has been made as to their quality and sensitivity, based on site visit observations, surrounding land use and designations besides the use of spot sampling data.

8.2.26 No information on abstractions was available at the time of assessment. It is however possible that there are surface water abstractions in the area and these will be identified during ongoing consultation during Stage 3 assessment.

8.3 Baseline Conditions

Introduction

8.3.1 The locations of the water features in the study area are shown on Figure 8.1, water catchments on Figure 8.2 and areas of flood risk on Figure 8.3

8.3.2 Table 8.4 below describes the baseline situation for all water features potentially impacted by the proposed scheme options. The baseline conditions generally reflect the ‘Do Minimum Scenario’, which is based on an assumption of no Forth Replacement Crossing and continued use of the Forth Road Bridge and associated road infrastructure.

8.3.3 SEPA has no records of surface water abstractions in the study area (refer to paragraph 8.2.26). Groundwater abstractions are considered separately in Chapter 7 (Geology, Contaminated Land and Groundwater).

Table 8.4: Baseline Conditions

Water Feature	SEPA Class	Baseline description	Sensitivity
Firth of Forth	B (Good)	**Hydrology and Flood Risk**: The coastline in the survey area is shown by SEPA to be at risk of flooding from the sea on both the North and South shores of the Firth of Forth. **Coastal Geomorphology**: The Firth of Forth is an important estuarine water resource and is of international ecological importance (Firth of Forth SSSI, SPA, and Ramsar) providing habitat (intertidal flat, saltmarsh and rocky shores) for waterfowl and waders. The shoreline in the immediate vicinity of the proposed crossing is also designated as SSSI for its geomorphological and geological value. The proposed crossing is within the Lower Firth of Forth Transitional Water Body (ID 200435) in the Scotland River Basin District as classified by SEPA (2008). Its typology is defined as partly mixed / stratified, mesohaline / polyhaline, strongly mesotidal and sheltered. The water body is identified as WFD risk status: 2a not at risk (probably). It is not considered as a whole to be heavily modified. Identified morphological alteration pressures include dredging (resulting in sediment removal) and land reclamation. Immediately to the west of the proposed crossing on the north bank of the Firth of Forth is the St Margaret's Marsh SSSI. This 26.4 hectares of coastal habitat supports an extensive area of coastal reedbed, saltmarsh, tall herb vegetation and scrub. The morphology of the shoreline of the Firth of Forth is heavily modified by engineering structures including the protruding walls and associated infrastructure of the Port of Rosyth (North Shore) and Port Edgar (South Shore); land claim and sea defence structures at North Queensferry and St Margaret's Marsh (North Shore) and South Queensferry (South Shore); engineered bridge structures relating to the Forth Road Bridge and Forth Rail Bridge affect both the North and South shorelines of the Firth of Forth, as well as the in-channel morphology. **Water Quality**: The Firth of Forth including the waters surrounding the proposed bridge crossing is classified under the SEPA estuarine water quality classification system as Class B (Good). Considered to receive anthropogenic pressure from sewage, industrial and road drainage discharges. However, areas of the estuary are of high environmental importance with areas of water-dependent ecosystems designated as SPA, Ramsar sites and SSSIs.	**Hydrology / Flood Risk**: High **Geomorphology**: High **Water Quality**: High
Northern Study Area			
Balbougie Burn (1.5 km² catchment)	Unclassified	**Hydrology and Flood Risk**: Flooding is not currently indicated by SEPA for this tributary. **Fluvial Geomorphology**: This gravel-bedded stream is a tributary of Keithing Burn, approximately 3.5 km in length. For the majority of its length the burn is set within a steep-sided wooded v-shaped valley. Within the wooded gorge the channel has a sinuous planform with varied channel morphology. However, the watercourse is extensively culverted in its middle reaches where it passes under the M90 and B981 roads. Where the watercourse is located in an area of farmland (upper and lower reaches) the channel is straighter and more uniform in character and appears to reflect past channel modification. Evidence of localised engineering modification principally in the form of culverting and occasional bank protection. **Water Quality**: Not classified under SEPA's Water Quality Classification Scheme. Spot sampling (Jacobs Arup, 2008) results suggest excellent dissolved oxygen (DO) and pH levels. However, this is a small watercourse considered likely to receive anthropogenic pressure from agriculture and road drainage. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	**Hydrology/ Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low
Pinkerton Burn (2.58km² catchment)	Unclassified	**Hydrology and Flood Risk**: shown by SEPA not to be at risk of flooding upstream of the confluence with the Keithing Burn. **Fluvial Geomorphology**: Pinkerton Burn is a tributary of Keithing Burn. This gravel-bed stream is approximately 2.5 km long. In its upper reaches, the catchment is dominated by recently constructed housing estates built on former farmland. Here the watercourse appears to have been subject to channel modifications in the form of localised realignment. In its middle reaches the watercourse is located in a steep-sided v-shaped gorge-like valley. Here both valley and stream have been modified by quarrying activities (disused nineteenth	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**:

Water Feature	SEPA Class	Baseline description	Sensitivity
		century Freestone Quarry) and the M90 which crosses the valley. The watercourse has been modified by culverting (M90), bank walling and weir construction. However, despite this the channel has many sections which are characterised by a diverse channel morphology. Evidence of localised engineering modification principally in the form of culverting and occasional bank protection. **Water Quality**: Not classified under SEPA's Water Quality Classification. Spot sampling (Jacobs Arup, 2008) results suggest excellent dissolved oxygen (DO) and pH levels. However, this is a small watercourse considered likely to receive anthropogenic pressure from agriculture. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	Low
Brankholm Burn (10.59 km^2 catchment)	C (Poor)	**Hydrology and Flood Risk**: Shown by SEPA to be at risk of flooding within Rosyth, both to the west and the east of the M90 and the proposed locations of route options North Corridor Option 1 and North Corridor Option 2, with possible extensive inundation of the surrounding land, including domestic and commercial properties, a school and an industrial estate. **Fluvial Geomorphology**: Brankholm Burn is a tributary of Keithing Burn. The watercourse originates in an area of agriculturally dominated land to the west of Rosyth, however, the urban area of Rosyth dominates much of the catchment. The urbanisation of the catchment has led to extensive modifications to the channel of the burn. The channel has been realigned involving extensive straightening, deepening and localised bank walling. The watercourse is culverted in several places. In general, the watercourse exhibits very limited morphological diversity and shows little evidence of active channel erosion and deposition. **Water Quality**: Classified under SEPA's water quality classification system as Class C (poor). No designated water-dependent ecosystems. Considered to be of local or low environmental importance. Lake present by Belleknowes Industrial Estate in area bounded by the M90, the A921 and the railway.	**Hydrology / Flood Risk**: High **Geomorphology**: Low **Water Quality**: Low
Keithing Burn (19.08 km^2 catchment)	C (Poor) / B (Fair)	**Hydrology and Flood Risk**: Shown by SEPA to be at risk of flooding at its confluence with the Pinkerton Burn and for approximately 1km upstream and downstream to its confluence with the Brankholm Burn with extensive inundation of the surrounding land. The flows from this burn contribute to the extensive inundation as discussed above. Some property and infrastructure would be directly affected by the Keithing Burn flooding. Flood risk is limited to land just outwith the banks from the location of Bois Bridge and the confluence with the Brankholm Burn downstream to the Inner Inverkeithing Bay. **Fluvial Geomorphology**: Keithing Burn is a large gravel-bed stream (approximately 2m wide) located within a broad valley. The watercourse is approximately 7km in length and enters the Firth of Forth at Inverkeithing Bay. Relatively large catchment area which encompasses 4 main tributaries Fordell Burn, Balbougie Burn, Pinkerton Burn and Brankholm Burn. The channel shows evidence of past modification with sections of relatively straight uniform channel morphology. Despite this however, there are sections of more diverse channel morphology where the channel appears to have readjusted following past modifications. Evidence of extensive watercourse engineering modification principally in the form of channel realignment. However the watercourse has a varied bed morphology and appears to have adjusted to this modification. **Water Quality**: Classified under SEPA's water quality classification system as Class C (Poor) upstream of confluence with Brankholm Burn, improving to Class B (Fair) downstream of confluence.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium
Unnamed tributary of Brankholm Burn (5.7km^2 catchment)	Unclassified	**Hydrology and Flood Risk**: Shown by SEPA to be at risk of flooding where it meets the Brankholm Burn within Rosyth. Upstream of the confluence, flood risk is restricted to land just outwith the banks of the tributary. The flows from this burn contribute to the extensive inundation as discussed above, both to the west and the east of the M90. **Fluvial Geomorphology**: Not assessed as not crossed. **Water Quality**: Currently not classified under the SEPA Water Quality Classification Scheme. Spot sampling (Jacobs Arup, 2008) results suggest good dissolved oxygen (DO) and pH levels. However, this is a small watercourse considered likely to receive anthropogenic pressure from urban and industrial sources. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	**Hydrology / Flood Risk**: Low **Geomorphology**: Not applicable **Water Quality**: Low

Water Feature	SEPA Class	Baseline description	Sensitivity
Unnamed ditch (south of Masterton Junction)	Unclassified	**Hydrology and Flood Risk**: Shown by SEPA to be at risk of flooding in the area adjacent to Inverkeithing North and East junctions near the confluences of the Pinkerton, Brankholm and Keithing Burns. **Fluvial Geomorphology**: This gravel-bed stream issues from a pond to the southwest of Inverkeithing North Railway Junction and flows in an easterly direction through an area of grazed land before turning south, beneath a railway line and through an urban area before joining Brankholm Burn. There is a continuous riparian strip approximately 1.5m wide either side of the channel where it is located within agricultural land. The channel has been extensively modified through realignment (straightening), bank walling and culverting. The water is turbid and flow was ponded at the time of survey. The bed has a uniform morphology and is smothered by silt along much of the length of the channel. Locally there is iron staining of the bed sediments; the source of this appears to be a field drain. **Water Quality**: Not classified under the SEPA's Water Quality Classification Scheme. Spot sampling (Jacobs Arup, 2008) results suggest good dissolved oxygen (DO) and pH levels. However, this is a small watercourse acting predominantly as a drainage channel considered likely to receive anthropogenic pressure from urban and industrial sources. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low
The Cast	Unclassified	**Hydrology and Flood Risk**: Shown by SEPA to be at risk of flooding at the confluence with the Keithing Burn. The flows from this watercourse could contribute to the extensive inundation as discussed above. **Fluvial Geomorphology**: The Cast is an artificial watercourse which flows from Mill Lade at Scotts Mill to the Keithing Burn. The watercourse has a uniform trapezoidal channel morphology with a straight planform. Immediately upstream of its confluence with Keithing Burn, the watercourse is culverted to enable it to pass beneath the A921. Extensively engineered channel with very uniform morphology. The relationship of the watercourse to the surrounding topography suggests the watercourse may be artificial in origin. **Water Quality**: Not classified under SEPA's Water Quality Classification Scheme. Spot sampling (Jacobs Arup, 2008) results suggest good dissolved oxygen (DO) and pH levels. However, this is a small watercourse acting predominantly as a drainage channel likely to receive anthropogenic pressure from agriculture. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low
Unnamed ditch of Keithing Burn	Unclassified	**Hydrology and Flood Risk**: Shown by SEPA to be at risk of flooding at the confluence with the Keithing Burn. The flows from this burn contribute to the extensive inundation as discussed above. **Fluvial Geomorphology**: This unnamed ditch exhibits a straight channel with a highly uniform trapezoidal morphology. It flows into Keithing Burn at NT 13268365. It may be connected to Mill Lade upstream at an old derelict mill. **Water Quality**: Not classified under SEPA's Water Quality Classification Scheme. Spot sampling (Jacobs Arup, 2008) results suggest excellent dissolved oxygen (DO) and pH levels. Small watercourse acting predominantly as a drainage channel likely to receive anthropogenic pressure from agriculture. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Low **Water Quality**: Low
Southern Study Area			
Swine Burn (30.64 km^2 catchment)	A2 (Good) / C (Poor)	**Hydrology and Flood Risk**: Hydrological connectivity with Humbie Reservoir. From Kirkliston upstream to Humbie Reservoir the risk of flooding is shown by SEPA as limited to land just outwith the banks; upstream of Humbie Reservoir where the burn crosses the survey boundary there is significant inundation shown to the west and east of the M9 crossing, mainly on the land on the northern bankside. Land at Humbie Reservoir is also shown to be at risk of localised flooding. **Fluvial Geomorphology**: Swine Burn is a tributary of the River Almond. The stream flows in a south easterly direction through a predominantly rural catchment which includes mixed and broadleaf woodland and agricultural land. The lowermost reaches pass through the urban area of Kirkliston. The watercourse is interrupted by Humbie Reservoir (online) and a lake to the west of Kirkliston. These lakes act as sinks for fine sediment. The stream has a gravel bed which frequently shows a high degree of morphological diversity in the form of	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium

Water Feature	SEPA Class	Baseline description	Sensitivity
		pools and riffles. The channel has however been modified in a number of places through localised straightening and deepening. Here the watercourse shows little variation in form. Despite this, the watercourse is characterised by several sections with good morphological diversity and a more sinuous planform. Evidence of engineering modification principally in the form of localised channel realignment, but the channel is also characterised by sections of high morphological diversity. **Water Quality**: Classified under SEPA's water quality classification system as generally of Class A2 (Good), apart from a localised stretch (80m-120m) of Class C (Poor) water quality upstream of confluence with River Almond in vicinity of distillery (approx. NGR NT1228 7430). No designated water-dependent ecosystems. Lake present southwest of Kirkliston. Hopetoun Fishery pond located within Swine Burn Wood.	
Unnamed tributary of Swine Burn	Unclassified	**Hydrology and Flood Risk**: At risk of flooding at Charles Bridge and Ross's Plantation adjacent to the M9, just upstream of its confluence with the Swine Burn. **Fluvial Geomorphology**: This short watercourse originates in Ross's Plantation to the west of the M9 near Charles Bridge. This gravel-bed stream has been extensively modified by straightening and culverting. More than half the length of this watercourse is contained within a culvert beneath the M9. The bed of the watercourse is smothered by fine sediments which results in low morphological diversity and limited flow variation. Short watercourse which is extensively culverted under the M9. **Water Quality**: Not classified under SEPA's Water Quality Classification Scheme and no spot sampling chemistry data available. This is a small watercourse acting predominantly as a drainage channel considered likely to receive anthropogenic pressure from agriculture and forestry. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Low **Water Quality**: Low
Humbie Reservoir	Unclassified	**Hydrology and Flood Risk**: Hydrological connectivity with Swine Burn, shown to be at risk of flooding on the SEPA flood map **Fluvial Geomorphology**: Not assessed as not crossed. **Water Quality**: Not classified under SEPA's Water Quality Classification Scheme and no spot sampling chemistry data available. Impounded river forming a reservoir standing water stocked for angling. No designated water-dependent ecosystems, however considered important for local fisheries interest.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Not applicable **Water Quality**: Medium
Niddry Burn (20.64 km^2 catchment)	B (Fair)	**Hydrology and Flood Risk**: No risk of flooding is indicated by SEPA, although this burn contributes flows to the Almond at Maitland Bridge where there is significant inundation on the opposite bank. **Fluvial Geomorphology**: Niddry Burn is a tributary of the River Almond located to the west of Kirkliston. This gravel-bed stream has been subject to localised modifications in the form of localised realignment and culverting; the watercourse is crossed by the M9. Despite the localised modifications, the watercourse exhibits a number of sections with good morphological diversity and evidence of active bed sediment movement. The channel bed is characterised by pools and riffles and occasional exposed gravel bars are also present. The watercourse is re-naturalising following past modification towards a more natural morphology. **Water Quality**: Classified under SEPA's water quality classification system as Class B (Fair). However, it is included in the designation with the River Almond under Freshwater Fisheries Directive (2006/44/EC) as proposed salmonid waters and considered as high environmental importance.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: High

Water Feature	SEPA Class	Baseline description	Sensitivity
Dolphington Burn (3.7km^2 catchment)	B (Fair) / C (Poor)	**Hydrology and Flood Risk**: SEPA indicate this burn is at risk of flooding downstream of the rail crossing at Dalmeny and towards the Firth of Forth, and is generally limited to land just outwith the banks with the exception of slightly more inundation on the north side of the A90 to the east of Dalmeny. **Fluvial Geomorphology**: Dolphington Burn is located to the south of South Queensferry. The watercourse originates within the Dundas Estate and flows in an easterly direction to the south of Dalmeny. Downstream of the A90 trunk road, to the east of Dalmeny, the burn becomes known as Cockle Burn. This gravel-bed stream has been subject to extensive channel modifications along its entire length. It has been extensively realigned to follow tracks and field boundaries. There is also evidence that the watercourse is periodically dredged to improve flow conveyance. The watercourse flows through a mixture of mixed woodland and agricultural land and has several tributaries, primarily field drains. The burn is frequently culverted where it passes beneath roads, railways and the oil storage depot at Dalmeny. As a result of this extensive modification, the watercourse has a very uniform morphology with little evidence of active fluvial processes. However, where the watercourse passes beneath the recently completed M9 spur road, the channel shows evidence of active adjustment to recent channel engineering. The channel has been realigned under the M9 through a bridge. Here the watercourse has been straightened, deepened and re-profiled. The banks are steep and free from vegetation. As a consequence of this modification the toe of the bank (lower 0.3m) has been eroded by recent high flows releasing sediment downstream, which has created localised areas of siltation. Evidence of extensive watercourse engineering modification principally in the form of historic channel straightening and recent culverting and channel realignment associated with the M9 motorway. **Water Quality**: Classified under SEPA's water quality classification system as Class B (Fair) upstream of oil storage depot, degrading to Class C (Poor) downstream. No designated water-dependent ecosystems. Considered to be of local or low environmental importance. Two ponds (offline) located by railway lines southwest of Dalmeny.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low
Linn Mill Burn (2.99 km^2 catchment)	Unclassified	**Hydrology and Flood Risk**: SEPA indicate no risk of flooding for this burn, although there is risk of flooding from the Firth of Forth at this location. **Fluvial Geomorphology**: Linn Mill Burn is a gravel bed stream of approximately 3.5 km in length which flows in a northerly direction through a rural catchment to the Firth of Forth. The watercourse is characterised by a low sinuosity gravel-bed channel. The watercourse has been modified in a number of places through realignment and channel deepening to improve the surrounding agricultural land. Despite this modification the watercourse has a diverse bed morphology with occasional pools and riffles leading to varied flow. In places the channel shows evidence of geomorphological adjustment to past engineering through the formation of a more sinuous channel course. The watercourse is culverted in a number of places including a relatively long stretch through fields to the south of the A904 road. Evidence of extensive watercourse engineering modification principally in the form of channel realignment. However the watercourse has a varied bed morphology and appears to have adjusted to this modification. **Water Quality**: Not classified under SEPA's water quality classification system. Spot sampling (Jacobs Arup, 2008) results suggest excellent dissolved oxygen (DO) and pH levels. However, this is a small watercourse considered likely to receive anthropogenic pressure from agriculture and urban wastewater. No designated water-dependent ecosystems. Considered to be of local or low environmental importance.	**Hydrology / Flood Risk: Low** **Geomorphology**: Medium **Water Quality**: Low
River Almond (388.13 km^2 catchment)	B (Fair) / C (Poor)	**Hydrology and Flood Risk**: Main watercourse in Southern study area, approx. 50km long. Flood Risk: to the southeast of Kirkliston is shown by SEPA to be at risk of flooding, with quite extensive inundation on the southern bank. The risk continues upstream where the M9 crosses the Almond and in Newbridge. **Fluvial Geomorphology**: Not assessed as not crossed. **Water Quality**: Classified under SEPA's water quality classification system as generally Class B (Fair), with a short stretch of Class C (poor). Designated under Freshwater Fisheries Directive (2006/44/EC) as a proposed salmonid water; designated as a Site of Importance for Nature Conservation (SINC) at county / authority level and considered to be of high environmental importance.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Not applicable **Water Quality**: High

8.4 Potential Impacts

8.4.1 This section describes the potential impacts on the water environment that could arise in the absence of mitigation, during construction and operation of the proposed scheme.

8.4.2 Impacts on the water environment are described separately for construction and operation for each of the three specialist disciplines as detailed in Section 8.2 (Approach and Methods).

8.4.3 Generic potential impacts for each discipline are described, followed by specific impacts on water features for each of the route corridor options, during the construction and operational phases of the scheme.

8.4.4 It is emphasised that the potential impacts presented in this section are assessed assuming no mitigation and hence represent the worst-case scenario for the water environment. These impacts are identified with the principal purpose of comparing route corridor options.

Potential Impacts During Construction

8.4.5 Construction impacts on the water environment are often of short-term duration, although in some cases these can have longer term indirect impacts on dependent freshwater habitats. Impacts are likely to be more intense than during the long-term operational phase, due to the heightened concentration of activities occurring in, or near the waters during this period.

Hydrology and Flood Risk

8.4.6 Potential construction impacts include effects such as increased runoff from soil compaction due to works traffic, sedimentation and disturbance / unintentional changes to channel dimensions which may impact on the hydraulic flow characteristics of a watercourse as well as on geomorphology, ecology and water quality.

8.4.7 During the construction phase, other temporary works that potentially may affect surface hydrology include the following:

- temporary watercourse diversions to facilitate culvert or bridge construction and any associated temporary works;
- watercourse diversions and re-direction through constructed realignments or into pre-earthwork ditches;
- temporary attenuation features at drainage outfalls; and
- temporary arrangements to control runoff.

Fluvial and Coastal Geomorphology

8.4.8 Potential impacts on fluvial geomorphology during construction include:

- alterations to channel morphology during the construction of crossing structures, such as bridges or culverts, and associated channel modifications and the release of sediment into the watercourse; and
- sediment release during in-channel works, site clearance operations and earthworks in the vicinity of watercourses.

8.4.9 These impacts would be likely to be concentrated in locations where construction activities occur within or in the immediate vicinity of watercourses. At this stage, because the likely nature of the construction activities is not known, the relative magnitude of impact is assessed on the broad nature and extent of the channel engineering required (Table 8.2).

8.4.10 Potential impacts on the coastal / estuarine geomorphology of the Firth of Forth during construction could involve alterations to the shoreline and channel morphology during the construction of the crossing structure (i.e. bridge) and the potential for associated release of sediment into the watercourse.

Water Quality

8.4.11 Construction activities may impact on water quality through accidental spillages or disturbance of potentially contaminated land. The potential areas of contaminated land are considered within Chapter 7 (Geology, Contaminated Land and Groundwater). Impacts on water quality are likely to be short-term but may have a longer term indirect effect on aquatic ecology (Chapter 9: Ecology and Nature Conservation).

8.4.12 Potential impacts to water quality during the construction phase include:

- release of turbid site runoff water into watercourse;
- spillage of oils, fuels and chemicals from mobile or stationary plant, resulting in adverse impacts to water quality and freshwater ecology;
- accidental release of concrete, cement and admixtures into watercourses, increasing the alkalinity of the waters and therefore affecting freshwater ecology;
- erosion and sedimentation can result from construction works and adversely affect water quality and ecology;
- accidental / uncontrolled release of sewage from sewers through damage to pipelines during service diversion or unsatisfactory disposal of sewage from site staff facilities; and
- disturbance of potentially contaminated land with potential drainage pathways to surface waters.

Proposed Replacement Bridge (Construction)

8.4.13 The main impacts to the Firth of Forth during the construction phase would result from the bridge construction and associated infrastructure (Table 8.5).

Table 8.5: Summary of Potential Impacts During Construction – Firth of Forth

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Firth of Forth	**Hydrology / Flood Risk**: High **Geomorphology**: High **Water Quality**: High	**Hydrology and Flood Risk**: Increased runoff from construction site. Coastal Geomorphology: Alterations to the shoreline and channel morphology during construction of the bridge and potential for associated release of sediment into the watercourse. Sediment release is likely to arise from shoreline and in-channel works, site clearance operations and earthworks in the vicinity of the estuary. The magnitude of impact of these activities would depend upon the extent of the shoreline and in-channel engineering required. **Water Quality**: Potential risk of accidental spillage of pollutants during construction due to proximity of works to estuary. Bridging is likely to involve extensive earthworks, which may result in sediment release leading to short to medium term increase to suspended sediment loads and turbidity within the channel. However the estuary provides a high dilution capacity.	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Moderate / Substantial **Water Quality**: Moderate / Substantial

Northern Route Corridor Options (Construction)

8.4.14 For both route corridor options (and their respective junction arrangements) in the Northern study area, the following watercourses would be crossed, as detailed in Table 8.6.

Table 8.6: Watercourses to be Crossed by the Proposed Northern Route Corridor Options

Route Corridor Option	Watercourse crossings
North Corridor Option 1	6 crossings: Pinkerton Burn (2 crossings), Brankholm Burn, Keithing Burn, Unnamed ditch of Keithing Burn, The Cast.
North Corridor Option 2	3 crossings: Pinkerton Burn, Unnamed ditch (south of Masterton Junction), Brankholm Burn.

Impacts Common to Both Northern Route Corridor Options

8.4.15 Current route corridor options indicate that Balbougie Burn would not be crossed by either of the northern route corridor options but the proposed works to upgrade the M90 would be within approximately 150m of this watercourse (at the northern end of the routes). The significance of potential impacts on this watercourse as a result of construction are assessed as follows:

- Hydrology and Flood Risk: Negligible.
- Fluvial Geomorphology: Negligible.
- Water Quality: Negligible.

8.4.16 Both route corridor options would pass near a lake located by Belleknowes Industrial Estate within the area bounded by the M90, the A921 and the railway. During construction, there would be a risk of pollution from site runoff to this lake.

North Corridor Option 1

8.4.17 See Table 8.7 below for a description of North Corridor Option 1 and resulting potential impacts to affected watercourses.

North Corridor Option 2

8.4.18 See Table 8.8 below for a description of North Corridor Option 2 and resulting potential impacts to affected watercourses.

Table 8.7: Summary of Potential Impacts During Construction – North Corridor Option 1

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Pinkerton Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Modification to existing crossing structure. Construction of one additional crossing. **Water Quality**: Earthworks associated with activities (crossing replacement, crossing structure and perhaps realignment), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Medium	Hydrology / Flood Risk: Negligible Geomorphology: Moderate Water Quality: Slight
Brankholm Burn	**Hydrology / Flood Risk**: High **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Modification to existing crossing structure. **Water Quality**: Earthworks associated with activities (crossing replacement and outfall construction), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology / Flood Risk**: Moderate **Geomorphology**: Negligible **Water Quality**: Negligible
Keithing Burn	**Hydrology / Flood Risk**: Medium Geomorphology: Medium Water Quality: Medium	**Hydrology / Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. There will be work in the flood plain. **Geomorphology**: Construction of new crossing for link road. Water Quality: Earthworks associated with activities (potential outfall construction and crossing structure), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low / medium dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Moderate **Geomorphology**: Moderate **Water Quality**: Moderate
Unnamed Ditch of Keithing Burn	**Hydrology / Flood Risk**: Medium **Geomorphology**: Low **Water Quality**: Low	**Hydrology / Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. There will be work in the flood plain **Geomorphology**: Construction of new crossing for link road. **Water Quality**: Earthworks associated with activities (crossing structure), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Slight **Geomorphology**: Slight **Water Quality**: Slight
The Cast	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology / Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Geomorphology**: Construction of new crossing for roundabout and link road. **Water Quality**: Earthworks associated with activities (crossing structure), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Slight

Table 8.8: Summary of Potential Impacts During Construction – North Corridor Option 2

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Pinkerton Burn	**Hydrology/ Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of one additional crossing. **Water Quality**: Earthworks associated with activities (crossing structure and perhaps realignment), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Moderate **Water Quality**: Slight
Brankholm Burn	**Hydrology / Flood Risk**: High **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of one additional crossing. **Water Quality**: Earthworks associated with activities (crossing structure and perhaps realignment and outfall construction), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of watercourse.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Moderate / Substantial **Geomorphology**: Slight **Water Quality**: Slight
Unnamed ditch (south of Masterton Junction)	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of one additional crossing. **Water Quality**: Earthworks associated with activities (crossing structure and perhaps realignment), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Slight
Keithing Burn	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: No direct impact as not crossed. **Water Quality**: Earthworks associated with activities (potential outfall construction), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low / medium dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Negligible **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Negligible **Water Quality**: Slight

Southern Route Corridor Options (Construction)

8.4.19 For each of the two route corridor options south of the Firth of Forth, the watercourses that would be crossed are detailed in Table 8.9 below.

Table 8.9: Watercourses to be Crossed by the Proposed Southern Route Corridor Options

Route Corridor Option	Watercourse Crossings
South Corridor Option 1	5 crossings in total: 3 crossings of Swine Burn, 1 crossing of Niddry Burn, 1 crossing of Dolphington Burn.
South Corridor Option 2	11 crossings in total: 5 crossings of Swine Burn, 2 crossings of an unnamed tributary of Swine Burn, 1 crossing of Niddry Burn, 3 crossings of Dolphington Burn.

8.4.20 The main impacts during construction would be for the works required for watercourse crossings, realignments, temporary diversions and outfalls. The potential impacts resulting from these activities are discussed in the Impacts during Construction section above.

Impacts Common to Both Southern Route Corridor Options

8.4.21 Surface water runoff is proposed to outfall into Linn Mill Burn from either route corridor option (NGR NT 1137 7864). Significance of potential impacts to this watercourse as a result of outfall construction are as follows:

- Hydrology and Flood Risk: There is the potential for faster and increased runoff to the burn than the existing situation, with Negligible significance for flood risk.
- Fluvial Geomorphology: Potential release of suspended sediment due to proximity of works to watercourse with a Negligible significance impact on the geomorphology of the watercourse.
- Water Quality: Potential release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse. Linn Mill Burn has been evaluated as of low sensitivity and impacts on water quality have been assessed as low magnitude and therefore Negligible significance.

South Corridor Option 1

8.4.22 See Table 8.10 below for a description of South Corridor Option 1 and resulting potential impacts to affected watercourses.

South Corridor Option 2

8.4.23 See Table 8.11 below for a description of South Corridor Option 2 and resulting potential impacts to affected watercourses.

Table 8.10: Summary of Potential Impacts During Construction – South Corridor Option 1

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Swine Burn	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of two additional crossings and modification of one existing crossing. **Water Quality**: Earthworks associated with activities (crossing structures and perhaps realignment), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low / medium dilution capacity of the watercourse. Risk of pollution to lake southwest of Kirkliston.	**Hydrology / Flood Risk**: Low **Geomorphology**: High **Water Quality**: High	**Hydrology / Flood Risk**: Slight **Geomorphology**: Moderate / Substantial **Water Quality**: Moderate / Substantial
Dolphington Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of one additional crossing. **Water Quality**: Earthworks associated with activities (crossing structure and perhaps realignment), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Slight
Niddry Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: High	**Hydrology and Flood Risk**: Crossing at junction with M9; increased runoff from construction site. **Fluvial Geomorphology**: Modification to existing crossing. **Water Quality**: Earthworks associated with activities (crossing structure and perhaps realignment and outfall construction), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low / medium dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Moderate

Table 8.11: Summary of Potential Impacts During Construction – South Corridor Option 2

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Swine Burn	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of three additional crossings and modifications to two existing crossings. **Water Quality**: Earthworks associated with activities (crossing structures and perhaps realignment and outfall construction), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low / medium dilution capacity of the watercourse. Risk of pollution to Humbie Reservoir and to lake south of Kirkliston. In addition, potential for site runoff to enter Hopetoun Fishery pond.	**Hydrology / Flood Risk**: Medium at M9 **Geomorphology**: High **Water Quality**: High	**Hydrology / Flood Risk**: Moderate **Geomorphology**: Moderate / Substantial **Water Quality**: Moderate / Substantial
Unnamed tributary of Swine Burn	**Hydrology / Flood Risk**: Medium **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of one new crossing and modifications to existing crossing. **Water Quality**: Earthworks associated with activities (crossing structure and perhaps realignment and outfall construction), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: High	**Hydrology / Flood Risk**: Slight **Geomorphology**: Slight **Water Quality**: Moderate
Niddry Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: High	**Hydrology and Flood Risk**: Increased runoff from construction site. **Fluvial Geomorphology**: Potential modification to one existing structure. **Water Quality**: Earthworks associated with activities (crossing structure and outfall construction), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low / medium dilution capacity of the watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Moderate
Dolphington Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There may be requirements for temporary diversion, drainage or redirection of existing flows. **Fluvial Geomorphology**: Construction of two additional crossings and modification of one existing crossing. **Water Quality**: Earthworks associated with activities (crossing structures and perhaps realignments), potentially resulting in release of suspended solids and accidental pollutant spillage due to proximity of works to watercourse. Low dilution capacity of the watercourse. Direct impact on one or both ponds southwest of Dalmeny and risk of pollution from site runoff or accidental spillage.	**Hydrology / Flood Risk**: Low **Geomorphology**: High **Water Quality**: High	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Moderate **Water Quality**: Moderate

Potential Impacts During Operation

8.4.24 Adverse impacts on the water environment during the operational phase of the proposed scheme may result from various features including road drainage, watercourse crossings and watercourse realignments. The potential impacts of each of these features are described below for each discipline.

Hydrology and Flood Risk

8.4.25 Road Drainage: The route corridor options would introduce new impermeable areas to the watercourse catchment, potentially increasing the volume and peak flow of surface runoff reaching a watercourse as less would be lost to infiltration into the ground.

8.4.26 The road and its drainage system may act as a barrier to water movement within current catchments. In addition, a road scheme can potentially result in rain falling in one catchment being discharged to another via the road drainage system.

8.4.27 Watercourse crossings: Impacts of watercourse crossing on surface hydrology could occur through alteration of the physical flow and water level regimes.

8.4.28 Watercourse realignments: Realignments would potentially change the discharge regime of watercourses, however, with appropriate design in terms of hydraulic considerations, these realignments would not affect surface water hydrology unless the realignment significantly changes the catchment of the watercourse.

8.4.29 Where a route corridor option crosses a floodplain on embankment, there would be a potential loss of flood storage volume.

Fluvial and Coastal Geomorphology

8.4.30 Road Drainage: Increased discharge along the watercourse as discussed above (Hydrology and Flood Risk) may increase geomorphological activity within the channel. This could result in an increase in turbidity; greater sediment transport downstream; and increased erosion of the channel bed and banks with morphological diversity being reduced or improved depending on sediment supply.

8.4.31 The polluting load in road runoff may include fine sediment accumulations, which are washed from the road into the drainage system and discharged to receiving watercourses. Increasing the suspended sediment fraction of runoff may lead to:

- channel sedimentation, causing a reduction in dynamic processes;
- increased transportation (turbidity) and deposition of fine sediment (sedimentation); and
- a reduction of morphological and consequently, ecological diversity due to fine sediment deposition.

8.4.32 The volume of sediment generated by the operation of the road and discharged to a particular watercourse would vary depending on the area of road from which runoff would be directed.

8.4.33 At drainage outfalls scour may occur leading to increased sediment supply / deposition, localised alterations to flow and changes to channel morphology.

8.4.34 Watercourse crossings can alter patterns of sediment transfer and deposition, and lead to loss of morphological features due to the land claim required for the footprint (e.g. bridge piers and embankments).

8.4.35 Where culverting increases the channel gradient, the scour of the bed and banks at culvert outlets often occurs, leading to an increase in the supply of sediment to the watercourse downstream.

8.4.36 Morphological diversity of a watercourse within a culvert would be greatly reduced. Culverts constrain the channel preventing lateral and vertical adjustment. The use of bridges generally reduces geomorphological impacts by maintaining morphological diversity and not constraining the bed in the same way as a culvert.

8.4.37 Watercourse Realignments: Over time realignments may lead to a change in the geomorphological behaviour of a watercourse. This includes changes to sediment supply, rate of sediment transfer downstream, and deposition zones. Disruption to the channel bed may be temporary and realignment may lead to an improvement in channel morphology. In poor quality streams, realignment provides opportunity to restore / rehabilitate low quality watercourses.

Water Quality

8.4.38 Road Drainage: During operation, the main potential impacts on water quality would be from pollutants transported in road runoff. Impacts to water quality are intrinsically linked to aquatic ecology and therefore these impacts should be read in conjunction with Chapter 9 (Ecology and Nature Conservation). These pollutants result from a number of direct and diffuse sources including vehicles (e.g. tyre rubber, brake and clutch linings, fuel, oil and coolant), highway maintenance and general road surface degradation.

8.4.39 There are a wide range of pollutants which may impact on the receiving water and its associated aquatic ecology, including:

- metals such as dissolved copper, total zinc, lead and other soluble pollutants;
- suspended solids and contaminants bound to them;
- organic compounds such as oils and other hydrocarbons;
- biodegradable organic material such as grass cuttings which can contain high levels of nutrients; and
- de-icing salt and alternative de-icing agents.

8.4.40 A quantitative assessment of the potential impact of proposed highway discharges on concentrations of total zinc and dissolved copper in receiving watercourses will be undertaken at Stage 3.

8.4.41 Watercourse Crossings: As noted above, culverting could potentially change the riverbed morphological diversity and sediment regime of the watercourses which may also have associated impacts on water quality by releasing previously locked contaminants into the water.

8.4.42 Watercourse Realignments: The main impact of realignments on water quality could occur as a result of altered geomorphology. Changes to the sediment regime may re-entrain contaminated sediments and increase pollutant concentrations in the water column.

Proposed Replacement Bridge (Operation)

8.4.43 The main potential impacts to the Firth of Forth during the long-term operation phase could result from pollution incidents and accidental spillages from increased traffic loadings and vehicular collisions (see Table 8.12 below).

Table 8.12: Summary of Potential Impacts During Operation – Firth of Forth

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Firth of Forth	**Hydrology / Flood Risk**: High **Geomorphology**: High **Water Quality**: High	**Hydrology and Flood Risk**: Potential minor change to discharge regime due to road runoff to the Estuary. **Coastal Geomorphology**: New crossing structure (Bridge) interacting with estuarine morphology. Loss of estuarine features due to land claim for structure. **Water Quality**: Road runoff discharge may lead to siltation and indirect impacts on coastal habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage. However the estuary provides a high dilution capacity.	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Medium **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Moderate / Substantial **Water Quality**: Moderate

Northern Route Corridor Options (Operation)

Impacts Common to Both Northern Route Corridor Options

8.4.44 Balbougie Burn: each route corridor option extends northwards along the M90 to the B916, approximately 150m south of the M90 crossing over Balbougie Burn. Significance of potential impacts to this watercourse during the operational phase are as follows:

- Hydrology and Flood Risk: Negligible unless the route corridor options are extended further north.
- Fluvial Geomorphology: Negligible unless the existing crossing structure is modified or replaced.
- Water Quality: Impacts from diffuse pollution sources likely to be insignificant. No road drainage discharges are proposed to Balbougie Burn. Consequently, impacts on water quality have been assessed as of Negligible significance.

North Corridor Option 1

8.4.45 See Table 8.13 below for an assessment of potential impacts to affected watercourses during the operational phase of North Corridor Option 1.

North Corridor Option 2

8.4.46 See Table 8.14 below for an assessment of potential impacts to affected watercourses during the operational phase of North Corridor Option 2.

Table 8.13: Summary of Potential Impacts During Operation – North Corridor Option 1

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Pinkerton Burn	**Hydrology** / **Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology and Flood Risk**: There would be greater runoff volumes than existing. **Fluvial Geomorphology**: Modified crossing structure and one additional crossing structure. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology** / **Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology** / **Flood Risk**: Negligible **Geomorphology**: Moderate **Water Quality**: Negligible
Brankholm Burn	**Hydrology** / **Flood Risk**: High **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: Surface water runoff from the road proposed to discharge into Brankholm Burn. Change to discharge regime due to road runoff discharge to the burn may lead to siltation and the periodic requirement for dredging. There would be greater runoff volumes than existing. **Fluvial Geomorphology**: Modified crossing structure. **Water Quality**: Proposed road drainage discharge may lead to siltation and indirect impacts on freshwater habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage. Low dilution capacity of watercourse. Due to online construction there is potential to improve water quality by upgrading existing drainage of the carriageway.	**Hydrology** / **Flood Risk**: Low **Geomorphology**: Low **Water Quality**: High	**Hydrology** / **Flood Risk**: Moderate **Geomorphology**: Negligible **Water Quality**: Moderate
Keithing Burn	**Hydrology** / **Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: Runoff may be increased and faster than baseline conditions. Flood plain will be reduced by proposed slip roads. **Fluvial Geomorphology**: Crossed by new link road. **Water Quality**: Proposed road drainage discharge may lead to siltation and indirect impacts on freshwater habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage. Low / medium dilution capacity of watercourse.	**Hydrology** / **Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: High	**Hydrology** / **Flood Risk**: Moderate **Geomorphology**: Moderate **Water Quality**: Moderate / Substantial
Unnamed ditch of Keithing Burn	**Hydrology** / **Flood Risk**: Medium **Geomorphology**: Low **Water Quality**: Low	**Hydrology** / **Flood Risk**: Runoff may be increased and faster than baseline conditions. Flood plain will be reduced by proposed slip roads. **Geomorphology**: Crossed by new link road. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology** / **Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology** / **Flood Risk**: Slight **Geomorphology**: Slight **Water Quality**: Negligible
The Cast	**Hydrology** / **Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology** / **Flood Risk**: Runoff may be increased and faster than baseline conditions. **Geomorphology**: New crossing for roundabout and link road. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology** / **Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology** / **Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Negligible

Table 8.14: Summary of Potential Impacts During Operation – North Corridor Option 2

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Pinkerton Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology and Flood Risk**: Alterations to existing flow and flooding regime due to new crossing, and a greater impermeable area / more / faster runoff than baseline. **Fluvial Geomorphology**: One additional crossing. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Low	**Hydrology / Flood Risk**: Slight **Geomorphology**: Moderate **Water Quality**: Negligible
Brankholm Burn	**Hydrology / Flood Risk**: High **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: Surface water runoff from the road may discharge into Brankholm Burn. Possible alterations to existing flow and flooding regime due to new crossing, greater impermeable area / more / faster runoff than baseline. **Fluvial Geomorphology**: One additional crossing. **Water Quality**: Proposed road drainage discharge may lead to siltation and indirect impacts on freshwater habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage; could result in a major shift from baseline due to discharge of untreated road runoff and accidental spillages, due to increased traffic loadings, sediment load, soluble and insoluble pollutants. Low dilution capacity of watercourse.	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: High	**Hydrology / Flood Risk**: Moderate / Substantial **Geomorphology**: Slight **Water Quality**: Moderate
Unnamed ditch (south of Masterton Junction)	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There could be alterations to existing flow and flooding regime due to new crossing, there would be greater impermeable area / more and faster runoff than baseline. **Fluvial Geomorphology**: One additional crossing. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Negligible
Keithing Burn	**Hydrology / Flood Risk**: Medium **Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: Runoff may be increased and faster than baseline conditions. **Fluvial Geomorphology**: No direct impact as not crossed. **Water Quality**: Proposed road drainage discharge may lead to siltation and indirect impacts on freshwater habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage. Low / medium dilution capacity of watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Negligible **Water Quality**: High	**Hydrology / Flood Risk**: Slight **Geomorphology**: Negligible **Water Quality**: Moderate / Substantial

Southern Route Corridor Options (Operation)

Impacts Common to Both Southern Route Corridor Options

8.4.47 Surface water runoff is proposed to outfall into Linn Mill Burn from both route corridor options (NGR NT11377864). Potential impacts on this watercourse as a result of road runoff discharge include:

- Hydrology and Flood Risk: The routes do not cross Linn Mill Burn, but do run through its catchment area and could cause alterations to the runoff regime. There would be a greater impermeable area in the catchment area with the potential for more and faster runoff than baseline. Linn Mill Burn has been assigned low sensitivity and impacts on hydrology / flood risk have been assessed as low magnitude with a consequent Negligible significance.
- Fluvial Geomorphology: Suspended sediment supplied from road drainage may be deposited on the bed of the watercourse. However the low volume of sediment and potential for dilution and downstream transfer means this would have an impact of Negligible significance on the fluvial geomorphology of the watercourse.
- Water Quality: The proposed road drainage discharge may lead to siltation and indirect impacts on freshwater habitats. Potential decreased water quality resulting from road runoff carrying sediment load, soluble and insoluble pollution may occur and potential increased risk from accidental spillage. Low dilution capacity of watercourse. Due to the low sensitivity assigned to Linn Mill Burn, impacts on water quality have been assessed as high magnitude and therefore Moderate significance.

South Corridor Option 1

8.4.48 See Table 8.15 below for an assessment of potential impacts to affected watercourses during the operational phase of South Corridor Option 1.

South Corridor Option 2

8.4.49 See Table 8.16 below for an assessment of potential impacts to affected watercourses during the operational phase of South Corridor Option 2.

Table 8.15: Summary of Potential Impacts During Operation – South Corridor Option 1

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Swine Burn	**Hydrology / Flood Risk**: Medium **Fluvial Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: There would be a greater impermeable area in the catchment area with the potential for more and faster runoff than baseline. Flood plain will be affected. **Fluvial Geomorphology**: Two additional crossings and one modified crossing structure. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Low **Geomorphology**: High **Water Quality**: Low	**Hydrology / Flood Risk**: Slight **Geomorphology**: Moderate / Substantial **Water Quality**: Slight
Dolphington Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There would be a greater impermeable area in the catchment area with the potential for more and faster runoff than baseline. **Fluvial Geomorphology**: One additional crossing. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Negligible
Niddry Burn	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: High	**Hydrology and Flood Risk**: There would be a greater impermeable area with potential for more and faster runoff. **Fluvial Geomorphology**: Modified crossing structure. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Moderate

Table 8.16: Summary of Potential Impacts During Operation – South Corridor Option 2

Water Feature	Sensitivity	Impact Description Summary	Potential Impact (unmitigated)	
			Magnitude	Significance
Swine Burn at M9	**Hydrology / Flood Risk**: Medium **Fluvial Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: Diversion could result in a different flow regime at the crossing of the M9. Greater impermeable area with the potential for more and faster runoff than baseline. The route runs through a large part of the catchment area of the Swine Burn and could interfere with existing runoff routes and flooding. **Fluvial Geomorphology**: Construction of two additional crossings and modifications to one existing crossing. **Water Quality**: Potential road drainage discharge may lead to siltation and indirect impacts on freshwater habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage. Low / medium dilution capacity of watercourse.	**Hydrology / Flood Risk**: Medium **Geomorphology**: High **Water Quality**: High	**Hydrology / Flood Risk**: Moderate **Geomorphology**: Moderate / Substantial **Water Quality**: Moderate / Substantial
Swine Burn upstream of Humbie Reservoir	**Hydrology / Flood Risk**: Medium **Fluvial Geomorphology**: Medium **Water Quality**: Medium	**Hydrology and Flood Risk**: There is a greater impermeable area in the catchment area with the potential for more and faster runoff than baseline. **Fluvial Geomorphology**: Construction of one additional crossing and modifications to one existing crossing. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Low	**Hydrology / Flood Risk**: Slight **Geomorphology**: Moderate **Water Quality**: Slight
Unnamed tributary of Swine Burn	**Hydrology / Flood Risk**: Medium **Fluvial Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There is a greater impermeable area in the catchment area with the potential for more and faster runoff than baseline. **Fluvial Geomorphology**: Construction of one additional crossing and modifications to one additional crossing. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Low **Geomorphology**: Medium **Water Quality**: Negligible	**Hydrology / Flood Risk**: Slight **Geomorphology**: Slight **Water Quality**: Negligible
Niddry Burn	**Hydrology / Flood Risk**: Low **Fluvial Geomorphology**: Medium **Water Quality**: High	**Hydrology and Flood Risk**: There is a greater impermeable area in the catchment area with the potential for more and faster runoff than baseline. **Fluvial Geomorphology**: One modified crossing structure. **Water Quality**: Potential road drainage discharge may lead to siltation and indirect impacts on freshwater habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage. Low / medium dilution capacity of watercourse.	**Hydrology / Flood Risk**: Low **Geomorphology**: Low **Water Quality**: High	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Slight **Water Quality**: Substantial
Dolphington Burn	**Hydrology / Flood Risk**: Low **Fluvial Geomorphology**: Low **Water Quality**: Low	**Hydrology and Flood Risk**: There would be a greater impermeable area in the catchment area with the potential for more and faster runoff than baseline. **Fluvial Geomorphology**: Construction of two additional crossings and modification of one existing crossing. **Water Quality**: Impacts from diffuse pollution sources likely to be negligible.	**Hydrology / Flood Risk**: Low **Geomorphology**: High **Water Quality**: Low	**Hydrology / Flood Risk**: Negligible **Geomorphology**: Moderate **Water Quality**: Negligible

8.5 Potential Mitigation

8.5.1 The objectives of the mitigation measures outlined in this section are to prevent, reduce or offset the potential impacts described above. At this DMRB Stage 2 assessment of route corridor options, the detailed design (including watercourse crossings) has not been developed, and mitigation detail therefore cannot be accurately defined. The objective of this section is therefore to identify 'standard' or 'anticipated' mitigation taking cognisance of best practice, legislation and guidance. This mitigation is taken into account in the subsequent identification of residual impacts in Section 8.6 (Summary of Route Corridor Options Assessment), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to DMRB Stage 3.

8.5.2 Adverse environmental effects are most likely to be experienced during the construction phase, as this is the period when there is most activity on site. However there is also potential for pollution and spillage events from vehicles during the operational phase through the everyday use of the road.

8.5.3 The objective of mitigation is to prevent, reduce or offset potential impacts. Mitigation would include those measures to convey surface water runoff from the road to receiving watercourses without detrimental effect on water quality, water quantity, associated ecosystems or the underlying groundwater (Chapter 7: Geology, Contaminated Land and Groundwater). It also includes measures to reduce impacts on geomorphological features that may arise from the installation of bridge piers, culverts and realignments, as well as those to be implemented to avoid impacts during the construction phase.

Potential Mitigation (Construction)

8.5.4 Measures to avoid, reduce or control pollution of surface water (and groundwater) would incorporate SEPA requirements and best practice on site to help avoid pollution release to watercourses. In particular, relevant SEPA Pollution Prevention Guidelines (PPGs) would be implemented and a Construction Environmental Management Plan (CEMP) would be produced.

8.5.5 Mitigation requirements for works in the vicinity of water features, incorporating SEPA PPG guidance, are summarised below:

- control of suspended solid release using appropriate runoff and erosion controls;
- appropriate storage of oils, fuels and chemicals, and identification of contingency plans for any accidental pollution incidents (such as spills);
- undertaking potentially polluting activities (e.g. concrete batching and mixing) away from watercourses, ditches and surface water drains;
- watercourse crossing works to be undertaken using appropriate methods to reduce the risk of pollution to the watercourse;
- appropriate method of working for outfall construction including adherence to SEPA (2007) SG-28 Good Practice Guide: Construction of Outfalls; and
- site sewage disposal to follow good practice and any service diversions to be carried out using good engineering practices.

8.5.6 Avoidance and reduction of construction impacts on watercourses would be achieved through best practice, which may include some or all of the following:

- minimising the duration and spatial extent of works in the vicinity of watercourses and ensuring adequate sediment control measures are in place around the works;

- progressive rehabilitation of exposed areas throughout the construction period as soon as possible after the work has been completed to reduce the risk of sediment release into the channel;
- installation of temporary treatment ponds, where required, to ensure the protection of water quality throughout construction. Details regarding any temporary construction treatment ponds would be agreed with SEPA prior to commencement of construction. Guidance detailed in CIRIA C697 (2007) would be followed relating to temporary Sustainable Urban Drainage Systems (SUDS);
- inspection and maintenance of all erosion controls weekly and after heavy rainfall; and
- adherence to CIRIA C648 (2006) – Control of Water Pollution From Linear Construction Projects: Technical Guidance.

8.5.7 Groundwater Protection Zones (GPZ) can require specific mitigation requirements with regard to control of surface water pollution. However, as noted in Chapter 7: Geology, Contaminated Land and Groundwater), there are no GPZs established in the study area.

Potential Mitigation (Operation)

8.5.8 The drainage design for the proposed scheme would include mitigation measures in the form of SUDS to convey, attenuate, store and treat surface road runoff. SUDS measures would be used where appropriate and could include some or all of the following; filter drains, catch pits, swales, retention basins and treatment ponds (up to three in series which may include wet or dry ponds or a mixture). The design would be progressed at DMRB Stage 3, following detailed pollution and spillage calculations as part of the EIA.

8.5.9 Where SUDS are proposed, these would be designed in accordance with 'The SUDS Manual' CIRIA C697 (CIRIA, 2007); 'Treatment of Highway Runoff using Constructed Wetlands' (Environment Agency, 1998), and 'Road Drainage and the Water Environment', Volume 11, Section 3, Part 10 (The Highways Agency et al., 2006).

8.5.10 Outfall structures would be correctly positioned to limit the potential for scour around the culverts and designed with the aim of avoiding significant alteration to flow patterns. The outfall would not project out into the channel and would not be located where flow converges with river banks. Outfall design would comply with best practice, including CIRIA 697 (CIRIA, 2007) and SEPA (2007) SG-28 Good Practice Guide: Construction of Outfalls.

8.5.11 Water crossings would be in the form of bridges or culverts, designed to convey at least the 0.5% AEP event.

8.5.12 Where culverts are provided, the design would follow relevant good practice and guidance such as CIRIA (1997) Culvert Design Manual: Report 168; and SEPA (2007) SG-25 Best Management Practice: River Crossings. Where applicable, the proposed crossings would accommodate fish passage following guidance from 'River Crossings and Migratory Fish: Design Guidance: A Consultation Paper for the Scottish Executive' (SEERAD, 2000). The design of the proposed crossings would aim to ensure that there is minimal disruption to the existing flow regime of the affected watercourse.

8.5.13 Dependent on design of the proposed replacement bridge and any associated potential land claim from designated areas, there could be a need for provision of compensatory habitat.

8.6 Summary of Route Corridor Options Assessment

Northern Route Corridor Options

Hydrology and Flood Risk

8.6.1 In general there would be Negligible residual impact on flood risk due to the route corridor options. However, greater mitigation works would be required for North Corridor Option 2. Consequently, North Corridor Option 1 is the preferred route with respect to flood risk.

Geomorphology

8.6.2 For geomorphology it is difficult to determine the reduction in significance of the impact as at this stage the design is not as detailed as would be required for this determination. However, providing the proposed replacement bridge structure is sympathetically designed to consider the unique geomorphology of the estuary and, if necessary, coastal habitat compensation is provided, then it is considered that there would be only a Negligible adverse residual impact on coastal geomorphology. If land claim within the Firth of Forth is proposed as part of the scheme, the potential residual impact could be greater unless compensatory habitat is provided. The reduction in significance of impact on fluvial geomorphology would be largely dependent on the design details of proposed watercourse crossings and any proposed watercourse realignments.

8.6.3 North Corridor Option 1 would have a Slight residual impact on Pinkerton Burn, Keithing Burn and Negligible to Slight residual impact on an unnamed ditch of Keithing Burn and The Cast. North Corridor Option 2 would result in a Slight residual impact on Pinkerton Burn due to the construction of an additional crossing over this watercourse and a Negligible to Slight residual impact on Brankholm Burn and an unnamed ditch (south of Masterton Junction). Overall, geomorphological impact on watercourses would be similar for either northern route corridor option.

Water Quality

8.6.4 Due to the similarities of design between the two options, their associated risks and potential impacts on water quality would be similar. The risk of impacts however, can be considered to increase with the scale and complexity of construction works and operational road drainage. For example, a longer route with more crossings and road drainage is assessed as having a higher potential risk of impact on water quality.

8.6.5 North Corridor Option 1 and North Corridor Option 2 are both considered to have a Negligible to Slight residual impact during construction. Although North Corridor Option 1 crosses more watercourses (due to junction configuration), it is still considered on balance to have the lowest likely residual impact during construction as it is an online upgrade. Although North Corridor Option 2 would cross fewer watercourses, it has the potential to have indirect impacts on watercourses due to construction works associated with an offline alignment.

8.6.6 Similarly during operation, both northern route corridor options are considered to have a Negligible to Slight significance as, at this stage, they both have two road drainage discharges proposed. North Corridor Option 1 however, is a shorter route and as an online upgrade there may be the potential to improve existing road drainage discharges. North Corridor Option 1 is considered on balance to have the lowest likely residual impact during operation.

Southern Route Corridor Options

Hydrology and Flood Risk

8.6.7 From the assessments during both construction and operation for southern route corridor options, the residual impacts would be of Negligible significance. Slightly greater mitigation would be required for South Corridor Option 2. In terms of flood risk, therefore, South Corridor Option 1 is preferred.

Geomorphology

8.6.8 South Corridor Option 1 would have a Moderate residual impact on Swine Burn due to the requirement for two additional crossings, and a Negligible to Slight residual impact on other watercourses. South Corridor Option 2 would have a Moderate residual impact on Swine Burn due to the requirement for three additional crossings and a Slight residual impact on Dolphington Burn also due to a requirement for three additional crossings. In terms of geomorphology, South Corridor Option 1 has the lowest overall impacts.

Water Quality

8.6.9 Of the two southern route corridor options, South Corridor Option 1 is considered to have the lowest residual impact during construction (Negligible to Slight) as it would have impacts on the least number of watercourses. South Corridor Option 2 would require greater mitigation in order to achieve a Negligible to Slight impact on the water environment.

8.6.10 Similarly, during operation South Corridor Option 1 is considered to have the lowest residual impact (Negligible to Slight significance) as it has the least number of watercourses potentially impacted and one proposed road drainage discharge. South Corridor Option 2 would necessitate greater mitigation in order to give residual impacts of Negligible to Moderate significance.

8.7 Scope of Stage 3 Assessment

8.7.1 During the Stage 3 Assessment further baseline information will be collected. A more detailed assessment will be carried out using DMRB Volume 11 methodology unless otherwise agreed with statutory consultees. An outline of the scope of the assessments for hydrology and flood risk, coastal and fluvial geomorphology and water quality is given below.

Hydrology and Flood Risk

- an assessment of the capacity of each crossing structure for the maximum design flow of 0.5% Annual Exceedance Probability (AEP) i.e. 1 in 200 year event;
- assessment of the effects of crossing structures on water levels;
- assessment of the impact on water levels of any road embankments within functional floodplains; and
- proposals for mitigation measures and identifying where opportunities may exist to offset impacts.

Coastal Geomorphology

- detailed desk study reviewing relevant literature, historic maps and aerial photography and other data sources;
- detailed field survey; and
- assessment of impacts and identification of mitigation measures and, where practicable, opportunities to offset the impacts of the proposed scheme.

Fluvial Geomorphology

- detailed assessment of baseline characteristics of each watercourse including sediment regime, channel morphology and continuity of fluvial processes; and
- assessment of impacts and proposals for mitigation measures and where practicable, opportunities to offset impacts.

Water Quality

- assessment of the potential impact from suspended solids and accidental spillage (e.g. of oils or concrete) during construction;
- estimation using methods based on DMRB, of copper and zinc concentrations within receiving watercourses immediately downstream of proposed highway discharge points;
- calculation of risk of serious pollution from spillage of liquids from heavy good vehicles as a result of vehicular collision during operation; and
- development of mitigation measures including appropriate pollution control facilities within the drainage design.

8.8 References

CIRIA (2006). Control of Water Pollution from Linear Construction Projects: Technical Guidance. CIRIA C648. Murnane, E., Heap, A. and Swain, A. ISBN 0-86-17-648-7.

CIRIA (2007). The SUDS Manual, CIRIA C697 Woods-Ballard, B., Kellagher, R., Martin, P., Jefferies, C., Bray, R. and Shaffer, P. ISBN 0-86017-697-5.

Institute of Hydrology (1999). Flood Estimation Handbook (FEH).

SEPA (2002). The Future for Scotland's Water: Guiding principles on the technical requirements of the Water Framework Directive.

SEPA (2007).WAT-SG-25 Good Practice Guide: Construction of River Crossings

SEPA (2007b). WAT-SG-21 Environmental Standards for River Morphology

The Highways Agency et al. (2006). Design Manual for Roads and Bridges (DMRB). Volume 11, Section 3, Part 10. The Highways Agency, Scottish Executive Development Department, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

The Water Environment (Oil Storage) (Scotland) Regulations 2006.

Water Framework Directive (2000/60/EC).

9 Ecology and Nature Conservation

9.1 Introduction

9.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of ecology and nature conservation issues within the study area. Potential impacts associated with the different proposed route corridor options on habitats, flora and fauna are compared and discussed.

Aims

9.1.2 The purposes of the Stage 2 assessment are to:

- identify the presence and status of habitats, flora and fauna of conservation significance within the study area;
- carry out a preliminary evaluation of key habitats and the associated flora and fauna within the study area;
- identify anticipated potential impacts on habitats, flora and fauna of conservation significance associated with the different route corridor options;
- present potential mitigation strategies for the identified impacts; and
- provide a summary of the route corridor option assessment, identifying residual impacts taking into account likely mitigation.

Overview of Legislation

9.1.3 Features of ecological value are protected to varying degrees by a range of designations implemented through statute, international convention and local authority planning controls. Non-designated sites can also be important to nature conservation, for example, providing links between other habitats and allowing the wider countryside to support a wide range of species in addition to those present in specifically designated areas.

Legal Protection of Habitats and Species

9.1.4 The EU Birds and Habitats Directives allow for the protection of 'Natura 2000 Sites', which have been identified as Special Areas of Conservation (SACs) designated under the Habitats Directive (EEC, 1992), and Special Protection Areas (SPAs) designated under the Birds Directive (EEC, 1979). The protection of such sites is achieved through a combination of the provisions within the Conservation (Natural Habitats, & c) Regulations 1994 (the Habitats Regulations) and Section 28 of the Wildlife and Countryside Act (WCA; 1981, as amended), as amended by the Nature Conservation (Scotland) Act 2004. Where European Sites occur above mean low water they will have already been notified as Sites of Special Scientific Interest (SSSIs).

9.1.5 Ramsar Sites, an additional international designation, are identified under the Convention on Wetlands of International Importance (especially as waterfowl habitat). As a matter of policy, the UK Government has chosen to apply the procedures for the protection of European Sites to Ramsar Sites.

9.1.6 The WCA and the Habitats Regulations are the principle mechanisms for the legislative protection of wildlife in Great Britain. Section 28 of the WCA 1981 as amended by the Nature Conservation (Scotland) Act 2004 allows for the notification, protection and management of SSSIs. The WCA and the Habitats Regulations also allows for the protection of breeding birds, other animals and plants. This legislation requires that the presence of protected species be regarded as a material consideration by a planning authority. This, therefore, requires that the presence, or otherwise of such species, and the extent to which they would be affected by any development is established before planning permission could be granted.

Biodiversity Action Plan

9.1.7 The UK Biodiversity Action Plan (BAP) was published in January 1994 in response to Article 6 of the Biodiversity Convention, to develop national strategies for the conservation of biological diversity and the sustainable use of biological resources. The Nature Conservation (Scotland) Act 2004 placed new duties on all public bodies in respect of the conservation of biodiversity.

Other Guidance

9.1.8 National Planning Policy Guidance 14: Natural Heritage, in Scotland provides guidance on the protection of biodiversity and geological conservation through the planning system.

9.1.9 Local Planning Authorities or Wildlife Trusts will often identify locally important sites of nature conservation value as Sites of Biological Importance (SBIs), Sites of Importance for Nature Conservation (SINCs) or Sites of Wildlife Importance (SWIs) for planning purposes. These are often identified in the local development plan and are usually afforded a degree of protection through the planning process.

9.2 Approach and Methods

Overview of Approach

9.2.1 The assessment has been undertaken in accordance with the requirements of the DMRB (The Highways Agency et al., 1993), STAG and best practice guidance for ecological assessment including the Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM, 2006).

9.2.2 The study area is shown on Figure 5.1. Although route corridor options to be considered at DMRB Stage 2 had not been confirmed at the commencement of baseline ecological surveys, a wide study area was established to ensure that adequate survey coverage would be available to inform the assessment of the emerging route corridor options.

Baseline Conditions

Consultation and Literature Review

9.2.3 A full list of consultees contacted as part of the Stage 2 consultation process can be found in Chapter 5 (Overview of Environmental Assessment). Table 9.1 lists individuals and organisations consulted during the course of the desk study in order to collate any existing information on the distribution and status of species and habitats within the study area.

Table 9.1: Ecology and Nature Conservation Consultees

Consultees	
Bat Conservation Trust	Lothian Bat Group
British Herpetological Society	Lothian Wildlife Information Centre
Botanical Society of British Isles	National Biodiversity Network
British Trust for Ornithology	North Lanarkshire Council
Buglife Scotland	Perth and Kinross Council
Centre of Ecology and Hydrology	Raptor Study Group, Lothian and Borders
City of Edinburgh Council	Royal Society for the Protection of Birds
Echoes Ecology	Scottish Badgers
Edinburgh Biodiversity Partnership	Scottish Fisheries Protection Agency
Edinburgh and Lothian Badger Group	Scottish Fisherman's Federation
Fife Bat Group	Scottish Government Rural Directorate
Fife Bird Club	Scottish Natural Heritage
Fife Coast and Countryside Trust	Scottish Ornithological Club
Forestry Commission	Take Pride in Fife Environmental Information Centre
Forth District Salmon Fisheries Board	University of Edinburgh
Forth Estuary Forum	University of Glasgow
Forth Seabird Group	University of Stirling
Institute of Freshwater Biology	West Lothian Council
Local Community Councils	Wildfowl and Wetlands Trust
Lothian Amphibian and Reptile Group	

9.2.4 A review of relevant literature was undertaken to obtain information on species and habitat abundance, distribution and susceptibility to impacts. These documents include:

- ERM (1996). Setting Forth: Environmental Statement. Draft Report.
- Transport Scotland (2007a) Strategic Transport Projects Review, Report 4, Appendix D – Environment. Jacobs UK Ltd.

9.2.5 Aerial photographs (taken in April 2007 and provided by Transport Scotland) and Ordnance Survey maps were also studied to identify potential habitat areas of nature conservation importance within the study area.

<u>Field Survey Methods</u>

9.2.6 A walkover survey of the full study area was conducted between 25 – 26 February 2008. The objective of the survey was to confirm or otherwise the information collected during consultation and provide a preliminary review of the ecological characteristics of the survey area.

9.2.7 A Phase 1 Habitat Survey has been previously undertaken for the majority of the study area as part of work undertaken for the STAG Report (Transport Scotland, 2007a). To ensure a complete dataset, the results of the previous Phase 1 Habitat Survey were reviewed and any locations within the study area not covered by this were then subject to Phase 1 Habitat Survey between 24 – 28 March 2008 to inform the Stage 2 assessment – no target notes were required for these relatively small areas. Further detailed Phase 1 Habitat Survey to confirm earlier results was undertaken in June 2008 and this will inform Stage 3.

9.2.8 Habitats were identified and mapped in accordance with Phase 1 Habitat Survey methodology (JNCC, 1993). Plant species lists were compiled for each habitat area and an initial evaluation of the nature conservation value of each habitat was made. Habitats were also assessed for the presence of and/or their potential to support protected species, BAP Priority Species and other species of conservation concern.

9.2.9 For each habitat type within the study area, dominant and readily identified species were noted to provide a basic habitat description and to indicate the likely nature conservation value of each habitat type.

9.2.10 Protected species surveys are not required at Stage 2, although DMRB requires that desk-based assessment should include the presence of protected species where this info is available, that this should be verified through the preliminary walkover survey, and that this may need to confirm the suspected presence or absence of protected/endangered species. Habitat information and results of the walkover survey were therefore used in the assessment of protected species, and in addition, where information from consultation or preliminary results of Stage 3 surveys were available these were taken into account as appropriate (i.e. where already underway due to seasonal constraints; refer to Chapter 5, paragraph 5.2.9).

Impact Assessment

9.2.11 Impact significance was determined with respect to the sensitivity/importance of the baseline conditions and the magnitude of potential impact, following DMRB guidance. This is described in detail below.

Sensitivity

9.2.12 The sensitivity of ecological receptors has been defined with reference to the potential 'value' of individual features or locations to populations of protected species. The evaluation of ecological features has been undertaken within a geographical frame of reference (rather than as 'High', 'Medium', 'Low') and has been evaluated at one of the following levels:

- international (European);
- national;
- regional or authority area;
- local; and
- less than local (i.e. any geographic scale smaller than local authority district).

9.2.13 The value of each site or feature of nature conservation interest has been determined by reference to any designations and by the results of consultations, literature review and field surveys. The criteria used is based on the Ratcliffe Criteria (Ratcliffe, 1977), which are used in the selection of biological SSSIs.

Impact Magnitude

9.2.14 The magnitude of each impact has been assessed independently of the affected site or feature's value or statutory status. Magnitude is essentially a scale of the change caused, which was assessed as detailed in Table 9.2.

Table 9.2: Definition of Impact Magnitude Categories

Magnitude	Criteria
High Negative	The change is likely to permanently affect the integrity of an ecological receptor in terms of the coherence of its ecological structure and function across its whole area, thus altering its ability to sustain the habitat/s and/or the population levels of species of interest at a regional or higher level.
Medium Negative	The change is not likely to permanently affect the ecological receptor's integrity but the effect on the receptor is likely to be substantial in terms of its ecological structure and function and may change its evaluation. Likely to result in changes in the local distribution of a species but not affect its population status at a regional level.
Low Negative	The change may affect the ecological receptor in the short term, but there will probably be no permanent effect on its integrity and/or key attributes and is unlikely to change its evaluation.
Neutral	There will be changes to the receptor, but they will cause no short-term or long-term affects on its integrity, key attributes or species populations.
No change	There will be no observable impact on the ecological receptor.

<u>Impact Significance</u>

9.2.15 The significance of impacts has been determined according to the matrix of value/sensitivity and magnitude as illustrated in Table 9.3.

Table 9.3: Matrix for Assessment of Ecological Impacts

Magnitude / Importance	Neutral	Low	Medium	High
International	Neutral	Moderate	Major	Major
National	Neutral	Moderate	Major	Major
Regional/Authority Area	Neutral	Minor	Moderate	Moderate
Local	Neutral	Minor	Minor	Minor
Less than Local	Neutral	Negligible	Negligible	Minor

9.2.16 This preliminary evaluation of significance has been made on the basis of the consultation and literature review, site walkover and Phase 1 Habitat Survey results. A precautionary approach has been adopted, however, further species-specific surveys will be required at DMRB Stage 3 to fully evaluate the nature conservation value of features within the study area.

Limitations to Assessment

9.2.17 Although considerable data are available for the study area, the level of detail varies between species and groups. The designated site information however, allied with the Phase 1 Habitat information and the consultation responses have allowed for a robust comparative assessment to be undertaken between the route corridor options, and this assessment fulfils the guidance presented in DMRB for a Stage 2 assessment.

9.2.18 Although the additional Phase 1 Habitat Survey was undertaken at a sub-optimal time of year (outside of the prescribed period of April – September), sufficient information was gathered to allow for the robust identification of habitat types. In addition, the field data collected were reviewed in the context of previous Phase 1 Habitat Survey information available.

9.3 Baseline Conditions

Consultation Information

9.3.1 This section is based on consultation responses received during the Stage 2 assessment and desk based review of existing information.

Designated Sites

9.3.2 Designated sites are shown on Figure 9.2.

9.3.3 There are three SPAs within the study area: the Firth of Forth, the Forth Islands and the Leith Docks SPA. All are designated as such due to the breeding bird populations of European importance they support e.g. sandwich tern (*Sterna sandvicensis*), Slavonian grebe (*Podiceps auritus*) and pink-footed goose (*Anser brachyrhynchus*).

9.3.4 The Firth of Forth SPA is also designated as a Ramsar site, and regularly supports over 20,000 waterfowl in the winter. This site is underpinned by the Firth of Forth SSSI, which is considered to be of special interest due to a number of habitats and species. Habitats of interest within this SSSI are fens, lagoons, heathland, salt marshes/sand dunes, extensive reed beds and the most diverse coastal grassland in west Fife (SNH, 2008). Species of special interest include eel grasses (*Zostera sp.*), sea wormwood (*Artemisia maritima*), and pyramidal orchid (*Anacamptis pyramidalis*). Furthermore, this SSSI supports a large number and density of waders and wildfowl and represents the second most important estuarine area for wintering bird species in Scotland.

9.3.5 The River Teith SAC lies outside of the study area but due to the migratory nature of the site's qualifying species (sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra planeri*), river lamprey (*L. fluviatilis*) and Atlantic salmon (*Salmo salar*)), is identified within this assessment.

9.3.6 There are nine other SSSIs located within the study area. Otterston Loch SSSI, to the northeast of Dalgety Bay in the eastern periphery of the Northern study area, is designated as it supports several regionally scarce habitat types (e.g. swamp woodland) and floral species including cowbane (*Cicuta virosa*) and the aquatic rigid hornwort (*Ceratophyllum demersum*). Additionally, it is of local importance for breeding and wintering wildfowl (SNH 2008).

9.3.7 Philipstoun Muir SSSI lies approximately 2km northeast of Winchburgh and in the far western periphery of the Southern study area and encompasses mixed deciduous woodland which supports several plant species uncommon in the Lothians such as sanicle (*Sanicula europaea*), twayblade (*Listera ovata*) and oak fern (*Gymnocarpium dryopteris*).

9.3.8 St Margaret's Marsh SSSI lies on the northern shore of the Firth of Forth, adjacent and to the west of the A90. The SSSI comprises one of the largest expanses of reed bed in Fife which provides important habitat for breeding birds such as sedge warbler (*Acrocephalus schoenobaenus*), reed bunting (*Emberiza schoeniclus*) and water rail (*Rallus aquaticus*). This SSSI also supports areas of herb-rich grassland which includes nationally uncommon species such as northern marsh-orchid (*Dactylorhiza purpurella*), as well as communities of breeding birds, including whitethroat (*Sylvia communis*) linnet (*Carduelis cannabina*), green woodpecker (*Picus viridis*) and willow warbler (*Phylloscopus trochilus*) (SNH, 2008).

9.3.9 Carlingnose SSSI lies to the east of North Queensferry and within the eastern periphery of the Northern study area, with North Queensferry, the Forth Road Bridge and the Forth Rail Bridge between them. The SSSI contains areas of herb-rich calcareous grassland and dwarf-shrub heath; this combination of habitats is scarce and declining in Fife. Carlingnose SSSI supports a variety of vascular plant species, including one species rare in Scotland, as well as a few which are locally rare or scarce e.g. dropwort (*Filipendula vulgaris*), bird's-foot-trefoil (*Lotus corniculatus*) and field gentian (*Gentianella campestris*). Carlingnose Point Scottish Wildlife Trust (SWT) Reserve encompasses the SSSI and extends to the north of it.

9.3.10 Ferry Hills SSSI lies northwest of North Queensferry and immediately adjacent to the A90. It contains scarce and declining habitats of unimproved calcareous and neutral grassland. Like Carlingnose SSSI, this site supports a wide variety of vascular plants including several which are locally scarce.

9.3.11 Seven local plan designated SINCs lie within the survey area: Port Edgar, Dundas Hill/Barrencraig Wood, Back Braes Weir, Lindsay's Craigs, River Almond, Disused Railway Line and Jock's Hole SINCs. In addition, two Wildlife Sites are present at Jamestown Pond and Clais Muir Wood. There are also four Local Nature Reserves (LNR) located at Port Laing, North Queensferry/Ferry Hills, St. Margaret's Marsh and Jamestown Jetty. Although these sites receive no statutory protection, they are considered important at the authority area/local level.

Habitats and Vegetation

9.3.12 This section is based on the Phase 1 Habitat Survey information presented on Figure 9.1.

9.3.13 Figure 9.1 utilises Annex D5.3 of the Strategic Transport Projects Review – Report 4 – Appendix D – Environment (Transport Scotland, 2007a) as a data source. These data were based on information provided by Lothian Wildlife Trust and the Forests and the European Union Resource Network (FERN) (2001/2) with ground-truthing undertaken from public rights of way by Faber Maunsell for the above report. Surveys undertaken by Jacobs Arup of areas outside of the original survey boundary but required to provide coverage of the Forth Replacement Crossing study area also inform this section.

9.3.14 Additional information has been supplied by the local Botanical Society of the British Isles (BSBI) recorder regarding locally rare plants all of which were recorded from within statutorily and non-statutorily protected sites. Information regarding habitats present within statutory and non-statutory sites has also been utilised in this section.

9.3.15 The predominant habitat within the survey area comprises arable land. Such habitats are generally intensively managed and therefore of limited ecological value.

9.3.16 Much of the semi-natural habitats within the study area are contained within the aforementioned statutorily and non-statutorily protected sites.

9.3.17 The most extensive semi-natural habitat present within the study area is woodland. A large number of woodlands are listed as Ancient Woodland sites with additional areas identified as Semi-natural Ancient Woodland. Ancient Woodland comprises areas that appear as wooded on 1750 maps and are considered likely to have been continuously wooded since then. Semi-natural Ancient Woodland comprises areas that appear as wooded on 1860 maps but not on the 1750 maps and have therefore appeared between these dates. These woodlands are recorded on the Phase 1 habitat maps as a mix of semi-natural broadleaved woodland, broadleaved woodland plantation, coniferous and mixed plantation.

9.3.18 Other semi-natural habitats present within the survey area include coastal reedbeds and salt marsh and areas of small and fragmented unimproved and semi-improved neutral grasslands. Riparian habitats are also present alongside watercourses and other water bodies.

Species of Conservation Concern

9.3.19 Species of conservation concern comprise those species that are afforded statutory protection, are identified on the Biodiversity Action Plans (BAPs) or are otherwise identified as being of concern due to a decline in numbers and/or distribution as described in paragraphs 9.1.3-9.1.9.

9.3.20 The UK Biodiversity Action Plan (BAP) was published in response to the Convention on Biological Diversity. The main objective of the BAP is to preserve and enhance the biological diversity of the UK through implementation of Habitat Action Plans (HAPs) and Species Action Plans (SAPs).

9.3.21 The presence of a HAP or SAP reflects the fact that the habitat or species to which it relates is in a sub-optimal state and requires conservation action. It does not imply any specific designation or level of importance, but establishes a framework for the conservation of the habitat and identifies current factors causing loss and decline of that feature.

9.3.22 In 2007, SNH published a Species Action Framework that identified 32 species where new, focused effort and resources over the next five years could make the most difference to biodiversity.

9.3.23 In addition to having national priorities and targets, action for biodiversity is also taken at a local level. Within the study area, this is achieved through the implementation of Local BAPs. The implementation of BAPs, whether at the UK or local level, is perceived as a fundamental requirement for public bodies to meet their obligations under the relevant national legislation.

Amphibians

9.3.24 A search on the National Biodiversity Network (NBN) gateway website reveals positive records for the following amphibian species within the study area:

- common toad (*Bufo bufo*);
- common frog (*Rana temporaria*);
- smooth newt (*Lissotriton vulgaris*);
- palmate newt (*L. helveticus*); and
- great crested newt (*Triturus cristatus*).

9.3.25 Great crested newts are a European protected species and have been recorded south of the Firth of Forth at Dundas Castle and Dalmeny (Transport Scotland, 2007a). Great crested newts are widespread across the UK although in Scotland they are close to the northern extent of their range (Oldham et al., 2000). However where great crested newts are present they are likely to be locally abundant and could potentially use any terrestrial habitat within 500m of their breeding ponds. Therefore for the purposes of this assessment great crested newts are assumed to be potentially present in all ponds and terrestrial habitats within 500m of the route corridor options.

9.3.26 Common species of amphibian (common frog, common toad, smooth and palmate newt) are only protected from sale under statute (WCA, 1981). However they are listed as priority species under the United Kingdom (UK) BAP and as such should be considered as species of conservation concern.

Badgers

9.3.27 Records of badger (*Meles meles*) setts have been received from Edinburgh and Lothians Badger Group. These records highlight that badgers are widespread throughout the study area. As badgers are still subject to persecution, records for setts and their locations will not be reported in this document. Badger records will be reported at DMRB Stage 3 in a separate confidential report in conjunction with the result of targeted badger surveys carried out for the northern and southern route corridor options.

9.3.28 Although badgers are protected under national legislation, it is one of most common and widespread British mammals and therefore for the purposes of this assessment, it is assumed that badgers are present throughout the study area and utilise all suitable habitat.

Bats

9.3.29 Data returned from Echoes Ecology consisted of nine bat records dating between May 2001 and September 2007. All of these records related to the Southern study area. Three species were recorded in this area: common or bandit pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*P.pygmaeus*), and Daubenton's bat (*Myotis daubentonii*). One record comprised of foraging and commuting activity, three of field captures and the remaining five of roosts in trees or buildings. The majority of these records are located outside of the study area but are located on its western periphery. The most significant record was for a maternity colony of 100+ soprano pipistrelles at Hopetoun Estates (NT070060) which was recorded in July 2007.

9.3.30 All bats are listed as European Protected Species.

Birds

9.3.31 At the coastal edge of the Northern study area, St. Margaret's Marsh supports regionally important breeding and wintering bird species such as blackcap (*Sylvia atricapilla*), whitethroat, garden warbler (*S. borin*), redwing (*Turdus iliacus*), curlew (*Numenius arquata*) and marsh harrier (*Circus aeruginosus*). Other notable bird species recorded at St. Margaret's Marsh include water rail (*Rallus aquaticus*), dunlin (*Calidris alpine*), snipe (*Gallinago gallinago*), sedge warbler, linnet, corn bunting (*Miliaria calandra*), redshank (*Tringa tetanus*), green woodpecker, skylark (*Alauda arvensis*), fieldfare (*Turdus pilaris*) and oystercatcher (*Haematopus ostralegus*) (ERM, 1996).

9.3.32 Castlandhill Wood, which is also within the Northern study area supports bird species such as goldcrest (*Regulus regulus*), wren (*Troglodytes troglodytes*), robin (*Erithacus rubecula*), blackbird (*Turdus merula*), chaffinch (*Fringilla coelebs*) and tits (*Parus spp.*). Dales Wood, in the middle of the Northern study area, also supports common bird species such as long-tailed tit (*Aegithalos caudatus*), willow warbler, robin, chaffinch (ERM, 1996).

9.3.33 Notable species recorded in the Southern study area include buzzard (*Buteo buteo*) in Duddingston Wood, grey partridge (*Perdix perdix*) at the River Almond Oxbow, linnet at Duddingston Wood, Pinkerton Wood and Burn Craig Wood; black-necked grebe (*Podiceps nigricollis*), whooper swan (*Cygnus cygnus*), kingfisher (*Alcedo atthis*), sand martin (*Riparia riparia*), dipper (*Cinclus cinclus*), sedge warbler, linnet, teal (*Anas crecca*) and goldeneye (*Bucephala clangula*) along the River Almond corridor (ERM, 1996).

9.3.34 In the Southern study area, woodland such as Duddingston Wood and Burn Craig Wood support a range of common bird species such as the robin, dunnock (*Prunella modularis*), great-spotted woodpecker (*Dendrocopos major*), blue tit (*Cyanistes caeruleus*), woodpigeon (*Columba palumbus*), blackbird, starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*) (ERM, 1996).

9.3.35 The River Almond (in the Southern study area) and its banks support a wide range of breeding and wintering bird species. Survey visits south of the River Almond at an old oxbow recorded presence of grey partridge, reed bunting, grey heron (*Ardea cinerea*), mallard (*Anas platyrhynchos*) and dunnock. Fields inland of Port Edgar are reported to support wintering and breeding flocks of lapwing (*Vanellus vanellus*) as well as species such as barn owls (*Tyto alba*), kestrels (*Falco tinnunculus*) and pheasants (*Phasianus colchicus*) which are known to use farmland. Tawny owls (*Strix aluco*) are known to inhabit Burn Craigs Wood (ERM, 1996).

9.3.36 The Forth Islands SPA regularly supports breeding populations of European importance: sandwich terns and common terns (*Sterna hirundo*), as well as the most northerly colony of roseate terns (*S. dougallii*). This SPA also supports internationally important populations of migratory species such as shags (*Phalacrocorax aristotelis*), cormorants (*Phalacrocorax carbo*), gannets (*Morus bassanus*), puffins (*Fratercula arctica*), razorbills (*Alca torda*), lesser black-backed gulls (*Larus fuscus*), kittiwake (*Rissa tridactyla*) and guillemots (*Uria aalge*) (SNH, 2004).

9.3.37 The Firth of Forth Ramsar site regularly supports approximately 20,000 waterfowl over winter (SNH, 2001a).

9.3.38 The Firth of Forth SPA supports an internationally important post-breeding population of sandwich tern. This SPA also regularly supports wintering populations of European and International importance of migratory bird species such as the pink-footed goose, shelduck (*Tadorna tadorna*), goldeneye, turnstone (*Arenaria interpres*), knot (*Calidris canutus*), Slavonian grebe (*Podiceps auritus*), redshank, bar-tailed godwit (*Limosa lapponica*) (SNH, 2001a), red-throated diver (*Gavia stellata*), red-breasted merganser (*Mergus serrator*), oystercatcher, great crested grebe (*Podiceps cristatus*), common scoter (*Melanitta nigra*), scaup (*Aythya marila*), long-tailed duck (*Clangula hyemalis*), curlew and golden plover (*Pluvialis apricaria*) (SNH, 2001b).

9.3.39 The Firth of Forth SSSI encompasses mudflats which are important feeding grounds for waders and wildfowl in the Firth of Forth. This SSSI is particularly important for its wintering bird species and is consequently the second most important estuarine area for wintering birds in Scotland and eleventh in the UK. There are internationally important populations of shelduck, and nationally important populations of redshank, great crested grebe and wintering knot. In the inner Firth of Forth, important populations of goldeneye and teal are present. Regionally important species which use the shoreline, intertidal area and offshore waters of the Firth of Forth include wigeon (*Anas Penelope*), golden plover, mallard (*Anas platyrhynchos*), pintail (*Anus acuta*), pochard (*Aythya farina*) and lapwing (SNH, 2008).

9.3.40 Long Craig Island SSSI supports a nationally important colony of roseate terns.

9.3.41 Inchmickery SSSI maintains important breeding colonies of four species of tern - common, arctic, sandwich and roseate; the numbers of roseate and sandwich terns here are of national importance (SNH, 2008).

9.3.42 Otterston Loch SSSI contains locally important populations of wintering and breeding wildfowl, as well as containing a small heronry and a large rookery.

9.3.43 St. Margaret's Marsh SSSI (described in paragraph 9.3.30 in terms of its bird assemblage) contains a number of habitats important for breeding birds including reedbeds important for water rails (*Rallus aquaticus*), sedge warblers and reed buntings; and scrub and grassland important for whitethroat, linnet, green woodpecker and snipe.

9.3.44 All birds, their nests and eggs with certain exceptions are protected under national law.

Invertebrates

9.3.45 The National Biodiversity Network (NBN) records the presence of a number of marine and terrestrial invertebrate species listed on the UK BAP within and adjacent to the study area. For example, SEPA (2006) records the presence of the cranefly (*Lipsothrix ecucullata*) at numerous points within and surrounding the study area such as at Keithing Burn, Linn Burn, Dour Burn, Murray Burn, Niddry Burn, Brox Burn and Dolphington Burn.

9.3.46 Other UKBAP invertebrate species recorded within and adjacent to the study area are as follows:

- rove beetle (*Staphylinidae fortunatarum*) at Faucheldean (Lothian Wildlife Information Centre, 1996) and Dalmeny Park (SNH, 1982);
- European tarnished plant bug (*Lygus rugulipennis*) at Faucheldean, Drumbrae South (Lothian Wildlife Information Centre, 1996), and the Hopetoun Estate (Highland Biological Recording Group, 1983);
- small pearl-bordered fritillary (*Boloria selene*) at Roscobie Hills SSSI (Scottish Natural Heritage 1989) and Blairdam Forest (Highland Biological Recording Group 1993);
- sea squirt (*Tunicata clava*) at Hound Point and approximately 300m from Rosyth Castle on the north shore (JNCC 1992); and
- sea whip (*Virgularia mirabilis*) at Kingston Hudds (Marine Biological Association 1993) and in the Firth of Forth estuary (SEPA 2006).

9.3.47 Previous desk studies by Faber Maunsell recorded the presence of additional notable terrestrial species near to the study area. Species listed as ‘Noteable’ include the leafhopper (*Aphrodes albiger*) at Hopetoun Estate (NT088739; LWIC, 1996), and the leaf beetles (*Apteropeda globosa* and *Tropiphorus terricola*) at Hopetoun Estate (NT088789; Ranger Service Recording). ‘Nationally Notable’ species recorded in 1995 are the planthoppers (*Stiroma bicarinata* and *Dicranotropis divergens*) in Faucheldean which is just outside of the southern study area.

9.3.48 The Firth of Forth Ramsar site and SPA includes extensive invertebrate-rich intertidal flats (SNH, 2001). The Firth of Forth SSSI supports a wide range of invertebrate species which reflects the wide range of habitats present within it. A number of nationally scarce invertebrate species occur in this area e.g. the northern brown argus butterfly (*Aricia artaxerxes*) and the sand dart moth (*Agrotis ripae*). Also present within this SSSI are a number of rare or very local beetle species (including *Lebia chlorocephala*, *Scymnus schmidti*, *Ceutorhynchus rugulosus* and *Cleonus piger* (SNH, 2008)).

9.3.49 Certain species of invertebrate are protected to a degree by national and European legislation.

Fish

9.3.50 Longannet Power Station (west of the study area, on the northern shore of the Firth of Forth) records fish species which are swept into the station with cooling water intakes. The most common species sampled recently (in 2006) were cod (*Gadus morhua)*, flounder (*Platicthyes flesus)*, (*gadidae juv)*, goby (*Gobius spp)*, herring *Clupea harengus*, plaice (*Pleuronectes platessa)*, snake pipefish (*Entelurus aequoreus)*, sprat (*Sprattus sprattus)* and whiting (*Merlangius merlangus)*. Other species trapped include salmon and river lamprey. The latter is a species of conservation concern, listed for freshwater habitats only under Annex II of the Habitats Directive (CEC, 1992). It is reasonable to assume that species found at this point of the Firth of Forth are also found within the study area.

9.3.51 A number of watercourses in the study area (such as Swine Burn, Niddry Burn, the River Almond, Dolphington Burn and Keithing Burn) are likely to host fish species of conservation concern.

9.3.52 Certain species of fish are protected to a degree by national and European legislation.

Red Squirrels

9.3.53 The consultation responses yielded no records of red squirrels (*Sciurus vulgaris*) within the study area. Sparse historical red squirrel records do however exist outside the study area. South of the Firth of Forth, red squirrels have been recorded from outside of the study area although these records date from 1994 or earlier. Records of red squirrels to the north of the Firth of Forth date from 1993-1996 and occur within woodlands west of Fordell Castle which lie partly within the study area.

9.3.54 Red squirrels are protected under national legislation.

Reptiles

9.3.55 The consultation request for reptile records within the study area had returned no results at the time of writing this report. NBN Gateway holds a record of a slow worm (*Anguis fragilis*) from Cairney Hill in 1991, approximately 10km east of the Northern study area. Other anecdotal sightings of common lizards (*Zootoca vivpara*) have been recorded in 2003 in areas to the north and south of the Forth Replacement Crossing but these records are in excess of 10km outside of the study area. These species of reptile are afforded limited protection under national legislation.

Riparian Mammals

9.3.56 Preliminary otter (*Lutra lutra*) surveys conducted by Faber Maunsell in January 2007 reported positive signs of otters (i.e. spraint) at Port Edgar and Hill End. There are (undated) sightings of otters reported by the Scottish Wildlife Trust (SWT) and the Vincent Wildlife Trust (VWT) on the River Almond and its tributaries (Swine Burn, Brox Burn and Niddry Burn) which are within the Southern study area.

9.3.57 The NBN reports no records of otter or water vole (*Arvicola terrestris*) within 250m of any of the proposed route corridor options (north and south). However, the NBN records otter presence at Fordell-Inverkeithing (grid reference: NT146873) which is approximately 1km outside of the Northern study area, and at Boathouse Bridge on the River Almond at NT143743 near Kirkliston which is at the southern extent of the Southern study area.

9.3.58 The Atlas of Mammals (Arnold, 1993) reports presence of water voles in Old Philipstoun (NT0778) which is just outside the Southern study area, however these records date back to 1967. The Lothian Wildlife Information Centre reports more recent sightings of water vole between October 1999 and March 2000 in Faucheldean, near Winchburgh (which is just southwest of the Southern study area).

9.3.59 Otters are a European protected species while water vole habitat, access to it and disturbance of the water vole is illegal under national legislation.

Cetaceans

9.3.60 Cetaceans such as the bottlenose dolphin (*Tursiops truncactus*) are regularly recorded in the Firth of Forth (Transport Scotland, 2007b). Incidental records indicate that the Firth of Forth is regularly used by killer whale (*Orcinus orca*) and records have also provided evidence that solitary animals lie-up beneath the Forth Road Bridge, while a pod of whales has been recorded feeding on seal pups in the estuary over the last two years. On the basis of the above and the known importance of the estuary to other cetaceans, the Firth of Forth is considered to be of regional or national importance. All cetaceans are European protected species.

Other Marine Mammals

9.3.61 The Isle of May SAC is located in the north of the outer Forth of Forth approximately 8km from the coast and approximately 55km from the location of the proposed replacement bridge. This SAC is designated in recognition of grey seal (*Halichoerus grypus*) populations. The site is the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of annual UK pup production.

Field Survey Results

Habitats and Flora

9.3.62 As previously stated, additional Phase 1 Habitat Survey was undertaken to provide complete mapping of the habitats within the study area as this extended further than that considered in earlier assessments.

9.3.63 Phase 1 Habitat maps are shown as Figure 9.1.

Fauna

Amphibians

9.3.64 The Phase 1 Habitat Survey and walkover of the study area identified numerous ponds and terrestrial habitat such as woodland, which could support breeding amphibian populations. Surveys currently underway for Stage 3 have confirmed the presence of great crested newts within the Southern study area at Dundas Hill and an additional population was recorded from within the southern element of Ferry Hills SSSI in the Northern study area. Great crested newt populations are considered to be of national importance within the study area whereas other amphibian species present are assessed to be of local importance.

Badgers

9.3.65 No badger field signs were identified during the Phase 1 Habitat Survey or walkover surveys. However the mosaic of habitats in the study area includes woodland and arable/pastoral farmland that is likely to support badgers. Badgers are assessed to be of local importance within the study area.

Bats

9.3.66 No specific surveys were undertaken for bats to inform DMRB Stage 2 assessment, but the landscape structure and overall quality of habitat suggests that bats are likely to be present across the study area and surveys are therefore underway to inform more detailed assessment at Stage 3. It would, however, be expected for their distribution to be concentrated along river and stream corridors, wooded areas, hedgerows and smaller enclosed fields as these habitat types offer suitable roosting sites and/or foraging opportunities and allow connectivity between habitat areas.

9.3.67 The study area comprises a mixture of urban and semi-natural habitats. Broadleaved woodland blocks provide optimal foraging habitat and a variety of different types of buildings within close proximity of each other provide a range of different potential roosting conditions. Furthermore, the hedgerows and watercourses within the study area are likely to facilitate the movement of bats throughout the landscape. Given the location of the study area and the habitats available it is probable that common pipistrelle, Daubenton's and brown long-eared bats (*Plecotus auritus*) are present. In light of the above, the study area is likely to be of Authority Area importance in relation to bats, although this largely depends on the numbers and types of roosts actually present.

Birds

9.3.68 The walkover survey and the Phase 1 Habitat Survey confirmed that the study area provides a mixture of urban and semi-urban habitats, intensively managed farmland and blocks of broadleaved, mixed and coniferous plantation woodland. This mixture of habitats and the proximity of the Firth of Forth indicate that the area could support significant populations of woodland breeding birds and may be of importance for waders and wildfowl that use the estuary in winter.

Invertebrates

9.3.69 The walkover survey and the Phase 1 Habitat Survey information identified areas of semi-natural vegetation and fresh, still and running waters from within the study area which may support invertebrate species of note. Invertebrates are considered to be of local importance although this assessment is likely to alter should the presence of UKBAP species and/or important assemblages be identified.

Fish

9.3.70 A number of rivers and streams observed to be of variable water quality during the walkover surveys are present in the study area and have the potential to support fish populations.

Red Squirrel

9.3.71 Red squirrels were not recorded within the study area during the walkover and Phase 1 surveys, although several woodland areas provide potential to support populations of this species. Large woodland areas with high connectivity, diverse age structure and a favourable species mix (e.g. Scots pine (*Pinus sylvestris*), spruce (*Picea spp.*), hawthorn (*Crataegus monogyna*), yew (*Taxus baccata*) are present within the study area. There are, however, relatively few large blocks of connected coniferous woodland within the study area. Grey squirrels (*Sciruis carolinensis*) were observed during the walkover survey within Dundas Estate and are likely to be present throughout the study area. It is considered unlikely that red squirrels are present within the study area and this opinion was supported by SNH.

Reptiles

9.3.72 No specific reptile surveys were undertaken for DMRB Stage 2 but preliminary assessment of the available habitat area, their extent and connectivity indicate that reptiles are likely to be present within the study area.

9.3.73 Reptiles have fairly broad habitat requirements but do require key areas such as scrub, rough grass, heath and features such as log/stone piles and south facing slopes. Linear features such as hedgerows and drystone walls provide suitable corridors for them to move and maintain links with different habitat areas. The species most likely to be present in the predominantly agricultural landscape are the common lizard and slow worm.

9.3.74 The population size and status of reptiles within the local area is unknown but based on their declining numbers throughout Britain and the recent inclusion of all UK reptiles on the UK BAP, they are considered of local importance.

Riparian Mammals

9.3.75 Although no signs of otter or water vole were found during the walkover survey or Phase 1 Habitat Survey, they are likely to be present throughout the study area. Habitats observed offer potential to support these species e.g. slow-moving rivers and streams suitable for water vole with good fish habitat providing foraging opportunities for otters. In addition, areas of grassland and woodland/scrub offer refuge/breeding sites for water voles and otters respectively.

9.3.76 As otters are generally widespread throughout Scotland (Green & Green, 1997), the study area is likely to be of authority area importance in relation to this species. However, water voles are rare especially in lowland Scotland (Strachan & Jeffries, 2003); therefore the study area is likely to be of regional importance in relation to water voles.

Summary of Baseline Assessment

9.3.77 The baseline assessment is based primarily on the review and interpretation of previously prepared reports, consultation information and surveys (walkover and Phase 1 Habitat). This review has indicated the likely presence of the following species and groups:

- amphibians;
- badgers;
- bats;
- breeding birds (terrestrial and marine habitats);
- wintering birds (terrestrial and marine habitats);
- terrestrial and freshwater invertebrates;
- freshwater and marine fish;
- reptiles;
- water voles and otters; and
- marine mammals (cetaceans and seals (family *phocidae*).

9.3.78 Due to the lack of recent records of red squirrels, no signs of red squirrels noted during surveys currently underway to inform Stage 3, and the presence of grey squirrels, it is considered unlikely that they are present within the study area and they are not therefore considered further in this assessment.

9.4 Potential Impacts

9.4.1 This assessment is based on potential impacts (i.e. without mitigation), and based on the intrinsic value of habitats encountered during the walkover and Phase 1 Habitat Surveys and their potential value to support plant and animal species of conservation concern.

9.4.2 The different route corridor options have been considered against a ‘do minimum’ scenario i.e. the scenario of what could happen if the scheme does not go ahead. This therefore serves as a baseline for the impact assessment.

9.4.3 The range of potential impacts of road schemes and their significance on nature conservation will depend on the individual circumstances of each scheme. However, it is possible to identify a number of main areas of concern, which have general applicability (Highways Agency et al., 1993). These include:

- direct mortality;
- habitat loss;
- habitat fragmentation and isolation;
- disturbance; and
- pollution and other indirect impacts (where applicable).

9.4.4 As indicated in Chapter 5 (paragraph 5.3.5) construction impacts are considered as temporary and operational impacts to be long term or permanent.

Nature Conservation Sites

9.4.5 A simple comparison of the potential impacts on nature conservation resulting from the different route corridor options is presented in Table 9.4 below. This comparative assessment includes the estuarine protected sites associated with construction and operation of the proposed replacement bridge. This basic assessment is based on the number of times a site of each level of nature conservation value (i.e. international national, regional, authority area or local) could be directly affected by each route corridor option.

Table 9.4: Number of Sites Potentially Directly Affected without Mitigation

Ecological Value	Number of Areas Potentially Directly Affected (Includes Multiple Designations on Individual Sites)			
	North		South	
	Corridor Option 1	Corridor Option 2	Corridor Option 1B	Corridor Option 2
International	1[1]	1[1]	1[1]	1[1]
National	1[2]	2	0	0
Regional	0	0	0	0
Authority Area/Local	1	2	3	3

[1] The Firth of Forth is only counted once as an International site, despite the fact that it maintains two International designations (SPA and Ramsar and one National Designation (SSSI).

[2] Does not include impacts to Ferry Hills SSSI as this corridor option only affects the geological element of this site.

Proposed Replacement Bridge

Designated Sites

9.4.6 Without mitigation, the construction of the proposed replacement bridge is likely to cause disturbance to the wintering bird assemblages of the Firth of Forth SPA, causing disturbance within the SPA boundary to birds feeding at low tide, birds roosting at high tide and disturbance to open water species. WeBS low tide data for the winter of 2003/04 indicates redshank, cormorant, curlew and red breasted merganser all occur in significant numbers in this corridor (above 1% of SPA designated threshold level). There are also potential impacts associated with disturbance of roosting areas adjacent to the coast.

9.4.7 The Forth Islands SPA is designated for its breeding common, roseate, sandwich and arctic tern colonies and breeding seabird assemblages. Most of this composite SPA is located in the outer Firth of Forth, however Long Craig Island is situated beneath the Forth Road Bridge and supports important tern colonies. Disturbance impacts on this site will be dependent on the timing and type of construction activities.

9.4.8 Leith Docks SPA holds the largest breeding common tern colony on the Firth of Forth and is designated for 558 pairs, which is estimated to be 5% of the British population. Terns are very mobile, and would readily move between colonies and birds are unlikely to breed only in one colony or another. There is therefore an ecological link between these two SPAs. Potential disturbance to the breeding tern populations on Long Craig Island may, therefore, result in increased numbers within these colonies. It is anticipated that any impacts would be restricted to this construction period.

9.4.9 The qualifying features of the River Teith SAC rely upon the successful migration through the Firth of Forth of salmon, sea lamprey and river lamprey. There is potential for this migration to be interrupted by indirect impacts of construction such as increased turbidity. The acoustic impact of pile driving, in particular can create a barrier for migrating fish. Any such disturbance impacts will be dependent upon the timing and type of impact and it is anticipated that any impacts would be restricted to the construction period.

9.4.10 As noted in paragraph 9.5.5, further assessment will be undertaken to provide information to inform an Appropriate Assessment of potential impacts on Natura 2000 sites (SPAs and SACs). The scope of this assessment is currently being developed in consultation with SNH.

Amphibians

9.4.11 Potential impacts on amphibians may occur during the construction of the bridge abutments on the north and south shores of the Firth of Forth. Any such impacts are discussed in the impacts common to all route corridor options section.

Badgers

9.4.12 Potential impacts on badgers may occur during the construction of the bridge abutments on the north and south shores of the Firth of Forth. Any such impacts are discussed in the impacts common to all route corridor options section.

Bats

9.4.13 The proposed replacement bridge is unlikely to impact on bat populations in the area since it predominantly passes over the Firth of Forth. There may be negligible disturbance impacts associated with construction and operation of the scheme if lighting is used. For instance, some bats, such as pipistrelles, may forage over beaches, and thus foraging and commuting activity could be modified (Halcrow, 2006; Sheil et al., 1999).

Birds

9.4.14 Due to the extensive nature of the Natura 2000 sites designated for their ornithological interest, potential impacts are addressed in the Nature Conservation Sites section above. It is however not possible to confirm the magnitude and significance of these impacts at this stage, and assessment is therefore necessarily preliminary and qualitative.

Invertebrates

9.4.15 The Firth of Forth Ramsar and SPA include extensive invertebrate-rich intertidal flats (SNH, 2001a and b). Construction and operation of the proposed replacement bridge could result in the temporary and permanent loss of habitat and there could therefore be a consequent minor loss of invertebrate biomass and potential loss of habitats important for the above species. It is likely that any habitat loss would be restricted to those areas affected by construction and impacts are again assessed as of low magnitude and Moderate significance.

Fish

9.4.16 This assessment is based on the assumption that species trapped at Longannet Power Station are representative of fish species in the Firth of Forth (paragraph 9.3.42). Potential impacts that may affect fish species include habitat disturbance and acoustic disturbance which may cause fish species to temporarily avoid areas of construction. Loss of subtidal and intertidal habitat may also occur as a result of construction; however impacts on fish are expected to be of low magnitude due to the extensive areas of habitat within the area but may result in impacts of Moderate/Minor significance.

Reptiles

9.4.17 Impacts where the bridge joins the north and south shore are predicted and are discussed as part of the northern and southern route corridor options.

Riparian Mammals

9.4.18 In the Northern study area, no impacts upon otters or water voles are predicted. In the Southern study area, the construction and operation of the proposed replacement bridge could affect otters through impacts upon the northern end of Linn Mill Burn. Consultation information provided evidence that otters are present at the mouth of the Linn Mill Burn, which strongly implies use of the foreshore for feeding and/or travelling between rivers to good food sources such as ponds in the upper reaches of these small tributaries of the Firth of Forth. Construction could cause disturbance, may increase risk of pollution, and result in fragmentation/loss of important otter habitats. With respect to otters, the impacts described would be likely to be of medium magnitude and Moderate significance whereas for water voles, the impact would be of neutral magnitude and Neutral significance.

Cetaceans

9.4.19 Potential impacts that may affect cetaceans include potential disruption of movement up and down the Firth of Forth and acoustic disturbance during construction which may cause cetaceans to temporarily leave such areas. Impacts associated with the proposed replacement bridge would be restricted to the construction period and are considered to be of low magnitude and Moderate significance.

Other Marine Mammals

9.4.20 SNH advised during consultation that seals may swim as far as the proposed replacement bridge, but did not consider that the conservation objectives of the Isle of May SAC would be undermined. The SAC is a considerable distance (approximately 55km) from the proposed replacement bridge and therefore is not considered further at Stage 2. Any disturbance to individuals within proximity of the proposed scheme will be considered during Stage 3.

Summary of Potential Impacts (Proposed Replacement Bridge)

9.4.21 Table 9.5 provides a summary of potential impacts associated with the construction and operation of the proposed replacement bridge.

Table 9.5: Summary of Potential Impacts – Proposed Replacement Bridge

Ecological Receptor	Value	Potential Impact (unmitigated)	
		Magnitude	Significance
Terrestrial Habitat	Local	Medium	Minor
Intertidal Habitat	International	Low	Moderate
Amphibians	National/local	Neutral	Neutral
Bats	Authority Area	Low	Minor
Badgers	Local	Neutral	Neutral
Birds	International – Local	Unknown	Not confirmed *
Invertebrates	International - Local	Low	Moderate
Fish	International – Local	Low	Moderate
Reptiles	Local	Neutral	Neutral
Otters	Authority Area	Medium	Moderate
Water Voles	Regional	Low	Minor
Cetaceans	National - Regional	Low	Moderate

* refer to paragraphs 9.4.13 and 9.4.14

Northern Route Corridor Options

Impacts Common to Both Northern Route Corridor Options

Designated Sites

9.4.22 Both of the northern route corridor options could result in impacts to the Firth of Forth SPA, Ramsar Site and SSSI. Impacts would be restricted to a small area from the launching point of the bridge and may result in the loss of small areas of intertidal and coastal habitats, disturbance, shading and potential pollution.

Invertebrates

9.4.23 There is insufficient information available at this stage to determine potential differences between impacts on species, and only qualitative assessment is therefore provided for each of the northern route corridor options.

Reptiles

9.4.24 Immediately north of St Margaret's Wood on the northern shore is an open area of scrub, bare ground and rough grass that appears to be suitable for reptiles. This area could be almost completely lost during the construction of the Forth Replacement Crossing for both of the northern route corridor options, but impacts associated with this habitat loss are considered to be Neutral magnitude and of Neutral significance due to its small size and its good connection to the extensive area of alternative suitable habitat in St Margaret's Marsh SSSI.

North Corridor Option 1

Designated Sites

9.4.25 Impacts to St Margaret's Marsh could result from loss of habitat within the eastern area of the site as well as indirect impacts associated with disturbance, potential pollution, shading and changes to hydrology of the remaining site. Impacts are assessed as of medium magnitude and Moderate significance.

9.4.26 Ferry Hills SSSI is associated with the cuttings and hilltop grasslands alongside the M90. Based on the citation, it appears that the cuttings affected by North Corridor Option 1 represent the geological component of the designation (and that the grassland element of the SSSI comprises the circular area at Fairy Kirk (an old quarry tip) and the area to the east of the Forth Road Bridge), there should be no direct or indirect ecological impacts on this feature as a result of North Corridor Option 1.

Habitats and Vegetation

9.4.27 This corridor option could result in significant impacts to St Margaret's Wood, listed on the semi-natural woodland inventory as a Long Established Woodland of Plantation Origin, adjacent to the bridgehead. It is anticipated that approximately 20% of the woodland could be lost and additional impacts to the remaining woodland may occur as a result of disturbance, localised hydrological changes due to changes to groundwater flows and drainage, as well as changes to the micro-climatic conditions of the wood. Impacts are therefore assessed as being of high magnitude which on a feature of Authority Area importance results in an impact of Moderate significance.

9.4.28 Apart from the above impacts, due to the predominant online nature of this corridor option, it is not anticipated that significant additional impacts to habitats and vegetation could occur.

Amphibians

9.4.29 North Corridor Option 1 could result in the loss of terrestrial habitat that may support amphibians, notably St. Margaret's Wood; however at the time of writing, there were no records of amphibians in this area. The construction and subsequent operational phase of this corridor option may increase the likelihood of adverse impacts such as loss and degradation of habitats, mortality and fragmentation/severance of habitats. As great crested newts were only recorded remotely from this corridor option during the Stage 3 surveys, no impacts are predicted on this species. Impacts are therefore predicted to constitute a medium adverse impact of Minor significance.

Badgers

9.4.30 North Corridor Option 1 involves primarily online widening to the existing A90/M90 carriageway. Badgers regularly use road embankments as commuting corridors, for sett building (although no such use was recorded during the walkover survey or consultation) and for foraging. Therefore online improvements on this section could potentially cause the disruption of commuting corridors, loss of setts and suitable foraging habitat. Also disturbance to active setts adjacent to working areas may occur. Where North Corridor Option 1 ties into the proposed replacement bridge, it is offline for approximately 200m and would result in the loss of areas of St. Margaret's Wood, although impacts are slightly reduced in this corridor option when compared to Northern Corridor Option 2. Although no records of badger were forthcoming, these impacts have the potential to result in impacts of low magnitude and Minor significance.

Bats

9.4.31 Where severance of hedgerows, watercourses and other linear features occurs there is the potential for disruption of bat flightlines and commuting corridors. Due to a lack of records, the scale of these impacts cannot be predicted until the importance of the relative flightlines has been determined. Due to the predominant online nature of this option, impacts are assessed as being of negligible magnitude and Slight significance. Equally, potential impacts to any features used as maternity roosts cannot be fully assessed but due to the online nature of this option impacts are assessed as being of low magnitude and Minor significance.

Birds

9.4.32 Construction and operation of this option could result in losses of eastern areas of St Margaret's Marsh, which is known as an important area for bird species all year round.

9.4.33 As this option is substantially online, potential impacts on bird populations of this option are considered to be lower than for North Corridor Option 2. Potential impacts are assessed as being of low magnitude resulting in impacts of Minor significance.

Invertebrates

9.4.34 Invertebrates are scoped out for the purposes of Stage 2 comparative assessment as there is insufficient information available at this stage to determine potential differences between impacts associated with the different options. However, construction and operation of this option could result in losses of eastern areas of St Margaret's Marsh which is potentially of value for invertebrates.

9.4.35 As this option is substantially online, potential impacts on invertebrates elsewhere in the study area would be likely to be lower than for North Corridor Option 2.

Fish

9.4.36 There are a number of waterbodies/courses suitable for fish species close to the proposed road: Ferry Loch (NT127811), Inverkeithing North Junction Pond (NT125839), Pinkerton Burn (NT133845), Brankholm Burn (NT119838), Balbougie Burn (NT139845) and North Duloch Burn (NT139867). However this corridor could mean that little additional fragmentation of these water courses could occur as the proposed corridor is largely online with the existing A90/M90. It is possible that construction could have impacts on fish species via changes in culverting, water flow and realignment. Despite this, the majority of impacts upon fish could be temporary i.e. disturbance associated with the construction of the road such as acoustic disturbance. These impacts would be likely to be of low magnitude and Minor significance.

Reptiles

9.4.37 This route corridor option is online with the existing A90/M90 for the majority of its length and would therefore require upgrading of the existing carriageway, resulting in the loss of and disturbance to suitable verge habitat. Road verges can represent good reptile habitat and play an important role in maintaining links between different populations and habitats. Suitable reptile habitat has been identified around the Ferrytoll junction and further north where the improvements to the existing road could result in the loss of this habitat and potentially the direct mortality of reptiles present. The temporary loss of the verge habitat during construction and subsequent re-establishment of vegetation on new earthworks may also reduce the connectivity between areas of suitable habitat. These impacts are considered to be of neutral magnitude and Neutral significance.

Riparian Mammals

9.4.38 This route corridor option could mean that little additional fragmentation of suitable habitat for otters/water voles would occur as the proposed corridor is largely online with the existing A90/M90. Although there is potential for pollution events associated with construction activities, it is anticipated that the adoption of appropriate best-practice will preclude the occurrence of any such events. Consequently, the majority of impacts upon otters and water voles could be temporary i.e. disturbance associated with the construction of the road such as noise disturbance, and disturbance associated with temporary roads and traffic diversions.

9.4.39 Waterbodies/courses within 250m of the route corridor option are: Ferry Loch (NT127811), Inverkeithing North Junction Pond (NT125839), Pinkerton Burn (NT133845), Brankholm Burn (NT119838), Balbougie Burn (NT139845) and North Duloch Burn (NT139867). However these are also within 250m of the existing road and therefore new and permanent impacts on otters and water voles are expected to be minimal. With respect to otters and water voles, the impacts described would likely be of low magnitude and Minor significance.

Summary of Potential Impacts (North Corridor Option 1)

9.4.40 Table 9.6 provides a summary of potential impacts associated with the construction and operation of North Corridor Option 1.

Table 9.6: Summary of Potential Impacts - North Corridor Option 1

Ecological Receptor	Value	Potential Impact (unmitigated)	
		Magnitude	**Significance**
Designated Sites - St Margaret's Marsh SSSI	National	Medium	Moderate
Habitat and Vegetation	Authority Area	High	Moderate
Amphibians	Local	Medium	Minor
Badgers	Local	Low	Minor
Bats*	Authority Area	Low	Minor
Birds	National/Authority Area	Low	Minor
Invertebrates	Local	Unknown	Unknown
Fish	Local	Low	Minor
Reptiles	Local	Neutral	Neutral
Otters*	Authority Area	Low	Minor
Water Voles	Regional	Low	Minor

*Group or species protected under European legislation.

North Corridor Option 2

Designated Sites

9.4.41 Increased impacts to St Margaret's Marsh from North Corridor Option 2 compared to North Corridor Option 1 could result from loss of habitat within the eastern area of the site as well as indirect impacts associated with disturbance, potential pollution, shading and changes to hydrology of the remaining site. Mitigation options are restricted and it may be necessary to consider off-site habitat creation to compensate for the impacts. Impacts are assessed as being of medium magnitude and Major significance.

9.4.42 This corridor option could result in the potential loss of approximately 50% of the area of grassland within the northern, circular area at Fairy Kirk (an old quarry tip) of Ferry Hills SSSI. Impacts could result from direct habitat loss, disturbance, potential pollution, localised hydrological changes and loss of appropriate management regimes. Impacts to the Ferry Hills SSSI are therefore assessed as being of medium magnitude and Major significance for this corridor option.

Habitats and Vegetation

9.4.43 Similar to North Corridor Option 1, this corridor option could result in significant impacts to St Margaret's Wood which is listed on the semi-natural woodland inventory as a long-established woodland of plantation origin and lies adjacent to the bridgehead. It should, however be noted that North Corridor Option 2 has the greatest impact resulting in the loss of approximately 27% of the woodland. Additional impacts to the remaining woodland may occur as a result of disturbance, localised hydrological changes due to changes to groundwater flows and drainage, and changes to the micro-climatic conditions of the wood. Impacts are therefore assessed as being of high magnitude which on a feature of authority area importance results in an impact of Major significance.

9.4.44 The northeastern areas of Castlandhill Woods could be lost as a result of this corridor option. Additional impacts to the remaining woodland may occur as a result of disturbance, localised hydrological changes and changes to the micro-climatic conditions of the wood. Impacts are therefore assessed as being of low magnitude which on a feature of authority area importance results in an impact of Minor significance.

9.4.45 This corridor option would pass close to an area of broadleaved woodland to the northeast of Junction 2 which is listed on the Semi-natural Woodland Inventory as Long Established Woodland of Plantation Origin. Impacts are restricted to increased disturbance and are assessed as being of neutral magnitude resulting in impacts of Neutral significance.

Amphibians

9.4.46 North Corridor Option 2 could result in the loss of additional areas of terrestrial habitat that have the potential to support amphibian populations compared to North Corridor Option 1, notably St. Margaret's Wood. The construction and subsequent operational phase of this corridor option may increase the likelihood of the adverse impacts such as loss and degradation of habitats, mortality and fragmentation/severance of habitats. As great crested newts were only recorded remotely from this corridor option, no impacts are predicted on this species and impacts are therefore predicted to constitute a medium adverse impact of Minor significance.

Badger

9.4.47 North Corridor Option 2 is mainly offline and passes through arable farmland and woodland (St. Margaret's Wood and Castlandhill Woods) prior to the replacement road bridge. Although no records have been forthcoming, this corridor option could result in the loss of badger setts, reduce the amount of available foraging habitat and fragment badger territories/commuting routes. Although the existing M90 already acts as a barrier to movement, this corridor option could result in the isolation of an area between the existing M90 and this route. These impacts would be likely to constitute a medium adverse impact of Minor significance.

Bats

9.4.48 Although no there are no records of the presence of bats within the study area, low adverse impacts of Minor significance could be likely at Castlandhill Woods due to habitat loss, fragmentation and disturbance associated with this route corridor option.

9.4.49 Where severance of hedgerows, watercourses and other linear features occurs there is the potential for disruption of bat flightlines and commuting corridors. The scale of these impacts cannot be predicted until the importance of the relative flightlines has been determined but due to the predominant offline nature of this corridor option and the relative paucity of such features north of the Firth of Forth, impacts are assessed as being of low magnitude and Minor significance. Potential impacts to features used as maternity roosts cannot be fully assessed but due to the apparent lack of suitable structures impacts are assessed as being of neutral magnitude and Neutral significance.

Birds

9.4.50 Increased impacts to St Margaret's Marsh SSSI and the extensive offline nature of this corridor option means that this is likely to have higher ornithological impacts than North Corridor Option 1. Potential impacts are however still assessed as being of low magnitude resulting in impacts of Minor significance.

Invertebrates

9.4.51 Increased impacts to St Margaret's Marsh and Ferry Hills SSSI and the extensive offline nature of this corridor option means that this is likely to have higher impacts than for North Corridor Option 1.

Fish

9.4.52 This corridor option would require crossings over the unnamed ditch south of Masterton Junction (NT130840) and Pinkerton Burn (NT133845). The latter was reported as being heavily polluted. The unnamed ditch south of Masterton Junction may provide suitable habitat for many fish species and construction of the new route may impact upon fish populations if they occur in these areas. Further changes to watercourses fragmented by the existing road during new road construction may affect fish species via changes in culverting, water flow, and realignment. Impacts on fish species would be of medium magnitude and Minor significance.

Reptiles

9.4.53 This route corridor option is offline from the existing A90 and M90 and cuts across a predominantly arable landscape. Although there are no records for reptiles within the vicinity of this corridor option, there are areas of potential suitable reptile habitat that could be negatively impacted as part of the scheme. Suitable habitat around the Ferrytoll junction and a larger area to the southeast and northeast of the existing A90/A921 Admiralty Road junction could be impacted through habitat loss, disturbance fragmentation and direct mortality. These impacts are considered to be of low adverse magnitude and Minor significance.

Riparian Mammals

9.4.54 This route corridor option would require a crossing over the unnamed ditch south of Masterton Junction (NT130840) which may currently provide suitable habitat in terms of shelter and food for otter and water vole populations. In the absence of mitigation, this crossing could increase the risk of direct mortality due to otters attempting to cross the carriageway. Additionally, this proposed corridor lies within 250m of the Cast (NT136836), Balbougie Burn (NT139845), North Duloch Burn (NT139867), Brankholm Burn (NT119838), Ferry Loch (NT127811) and Inverkeithing North Junction Pond (NT125839). The construction of this corridor option may therefore impact upon otter and water vole populations if they occur in these areas. Assuming these species are indeed present, impacts would be likely to be of low magnitude and Minor significance.

Summary of Potential Impacts (North Corridor Option 2)

9.4.55 Table 9.7 provides a summary of potential impacts associated with the construction and operation of North Corridor Option 2.

Table 9.7: Summary of Potential Impacts - North Corridor Option 2

Ecological Receptor	Value	Potential Impact (unmitigated)	
		Magnitude	Significance
Designated Sites - St Margaret's Marsh SSSI - Ferry Hill SSSI	 National National	 Medium Medium	 Major Major
Terrestrial habitat - Castlandhill Woods - St Margarets Wood	Authority Area	Low	Minor
Amphibians	Local	Medium	Minor
Badgers	Local	Medium	Minor
Bats*	Authority Area	Low	Minor
Birds	National/Authority Area	Low	Minor

Ecological Receptor	Value	Potential Impact (unmitigated)	
		Magnitude	Significance
Invertebrates	Local	unknown	unknown
Fish	Local	Medium	Minor
Reptiles	Local	Low	Minor
Otters*	Authority Area	Low	Minor
Water Voles	Regional	Low	Minor

*Group or species protected under European legislation.

Southern Route Corridor Options

<u>Impacts Common to Both Southern Route Corridor Options</u>

Designated Sites

9.4.56 Both southern route corridor options would result in impacts to the Port Edgar SINC. Construction of the proposed scheme would result in the loss and severance of areas of intertidal, coastal and terrestrial woodland habitats, disturbance, shading and potential pollution to freshwater and marine environs. Mitigation options are restricted and impacts are therefore assessed as being of low to high magnitude and Moderate to Major significance.

Bats

9.4.57 Potential impacts associated with the proposed launching structures may result in the loss of bat roosts but cannot be assessed at this stage due to a lack of information but would be common to both corridor options.

Birds

9.4.58 The two southern route corridor options link to the proposed replacement bridge via a structure from west of South Queensferry. Birds move freely between this section of the foreshore and the Blackness Bay SSSI to the west. Construction is therefore likely to impact upon waders and wildfowl via disturbance to their feeding habitats and disturbance to flight lines; many of the species using this area are of national and international importance.

Invertebrates

9.4.59 The two southern route corridor options pass predominantly through areas of intensively managed farmland considered to be of limited value for invertebrate species. Impacts are, therefore, assessed as being of negligible magnitude and Neutral significance due to the extensive nature and poor quality of the affected habitats. There is, however, variability regarding the extent of losses of semi-natural habitat between the two route corridor options and this has been identified where appropriate.

Fish

9.4.60 Both route corridor options would result in direct impacts to fish populations which inhabit/migrate through the north of Linn Mill Burn due to fragmentation and loss of suitable habitats; Linn Mill Burn is a tributary of the Firth of Forth.

Reptiles

9.4.61 Both proposed southern route corridor options follow the same corridor heading south between the proposed replacement bridge and A904 before diverging after this point. In this common section, the impacts of the route corridor options are predicted to be the same. Immediately south of the proposed crossing is a small area of potential reptile habitat that appears to comprise of rough grassland, scrub and woodland planting. Both southern route corridor options could result in the loss of habitat, fragmentation of habitat, disturbance and potential direct mortality of reptiles in this area during the construction of the scheme. Furthermore, the operational road could create a barrier to reptile dispersal. These impacts are considered to be of negligible magnitude and Neutral significance as suitable reptile habitat would remain to the west.

South Corridor Option 1

Designated Sites

9.4.62 This corridor option could result in direct habitat loss and fragmentation to Dundas Hill SINC as it will clip the top of the area. Impacts resulting from habitat loss, in addition to disturbance and pollution could occur and therefore are assessed as being of low magnitude and Minor significance.

9.4.63 This corridor option may also result in increased disturbance to Lindsay's Craigs SINC with impacts assessed as being of low magnitude and Minor significance.

Habitats and Vegetation

9.4.64 Both southern route corridor options would pass predominantly through arable fields with species poor and fragmented hedgerows. The offline section of South Corridor Option 1 is shorter than that for South Corridor Option 2 and impacts on these features are reduced in terms of scale when compared to South Corridor Option 2 and are assessed as being of low magnitude and Minor significance.

Amphibians

9.4.65 South Corridor Option 1 could result in the loss of small areas of woodland and hedgerows that may support amphibians, although to date no great crested newts have been recorded within 500m of South Corridor Option 1 as part of Stage 3 surveys currently underway. The construction and subsequent unmitigated operational phase of this option may increase the likelihood of adverse impacts such as loss and degradation of habitats, mortality and fragmentation/severance of habitats. Impacts are therefore predicted to constitute a medium adverse impact of Minor significance.

Badgers

9.4.66 This option could result in the loss of arable farmland and associated features such as hedgerows to the west and south of South Queensferry. These areas may provide suitable habitat for foraging and sett building. Additionally, this route corridor option unmitigated may cause severance to badger territories, which could increase competition between neighbouring badger clans and increase the frequency of badger road traffic accident. These impacts could constitute a medium adverse impact of Minor significance.

Bats

9.4.67 The offline section of this route corridor option is shorter than that for South Corridor Option 2 but would result in direct habitat loss and potential fragmentation issues associated with Dundas Hill woodlands. Although no records are available the loss and potential fragmentation associated with the woodlands and adjacent fields to foraging and commuting bats is assessed as being of low magnitude and Minor significance.

Birds

9.4.68 There is insufficient information available at this stage to determine potential impacts associated with this corridor option. However, the offline section of this route corridor option is shorter than that for South Corridor Option 2 which would result in limited impacts to intensively farmed arable fields although there would be direct losses of woodland at Dundas Hill.

Invertebrates

9.4.69 As above there would be limited impacts to areas of semi-natural habitat due to the impacts being predominantly restricted to poor quality habitat.

Fish

9.4.70 Potential impacts are likely to be those associated with Linn Mill Burn and impacts are assessed as being of medium magnitude and Minor significance.

Reptiles

9.4.71 South of the A904, this route corridor option turns east and links up with the existing A90. The habitat here does not appear to be suitable for reptiles as it is predominantly open arable fields with few features of potential value to reptiles. Therefore impacts associated with this route corridor option are considered to have a magnitude of no change when compared to the 'do minimum' scenario and be of Neutral significance.

Riparian Mammals

9.4.72 Construction of the road is likely to directly impact upon otter populations at the north of Linn Mill Burn due to the fragmentation and loss of suitable habitats. Echline/Scotstoun Junction lies within 250m of two waterbodies, less than 100m from an unnamed pond on the outskirts of Kirkliston and an unnamed watercourse which runs parallel to the existing road. Consequently, construction of this junction may cause disturbance to otter and water vole populations but is not expected to fragment existing habitats. With respect to otters and water voles, impacts of the construction of this route corridor option are likely to be of medium magnitude and Moderate significance.

Summary of Potential Impacts (South Corridor Option 1)

9.4.73 Table 9.8 provides a summary of potential impacts associated with the construction and operation of South Corridor Option 1.

Table 9.8: Summary of Potential Impacts - South Corridor Option 1

Ecological Receptor	Value	Potential Impact (unmitigated)	
		Magnitude	Significance
Designated Sites - Port Edgar SINC - Dundas Hil SINC - Lindsay's Craigs SINC	 Authority Area Authority Area Authority Area	 High Low Low	 Major Minor Minor
Terrestrial Habitat	Local	Low	Minor
Amphibians	Local	Medium	Minor
Badgers	Local	Medium	Minor
Bats*	Authority Area	Low	Minor
Birds	International/local	Unknown	Unknown
Invertebrates	Local	Unknown	Unknown

Ecological Receptor	Value	Potential Impact (unmitigated)	
		Magnitude	Significance
Fish	Local	Medium	Minor
Reptiles	Local	Neutral	Neutral
Otters*	Authority Area	Medium	Moderate
Water Voles	Regional	Medium	Moderate

*Group or species protected under European legislation.

<u>South Corridor Option 2</u>

Habitat and Vegetation

9.4.74 South Corridor Option 2 passes predominantly through arable fields with species-poor and fragmented hedgerows. It would, however, pass between Swineburn/Muiriehall Wood complex and Carmelhill Wood and there may be limited direct habitat impacts to these areas as well as indirect impacts including fragmentation, disturbance, localised hydrological changes and changes to the micro-climatic conditions of the wood. Parts of the woodland areas are identified on the Ancient Woodland Inventory as Long Established Woodland of Plantation Origin and comprises broadleaved woodland plantation. This option may also result in losses of open water and associated habitats in this area. Impacts are assessed as being of low magnitude and Minor significance.

9.4.75 Ross's Plantation could be affected by the proposed junction associated with this option. There may be limited direct habitat impacts to this feature as well as indirect impacts including disturbance, localised hydrological changes due to changes to surface water drainage and the water table and changes to the micro-climatic conditions of the wood. The woodland is identified on the Ancient Woodland Inventory with the affected area recorded as coniferous plantation with adjacent areas recorded as broadleaved woodland plantation by the previously undertaken Phase 1 Habitat Survey. Impacts are assessed as being of low magnitude and Minor significance.

Amphibians

9.4.76 South Corridor Option 2 could result in the loss of terrestrial habitat that may support amphibians, notably Muiriehall Wood and Ross Plantation. In addition, there is a great crested newt population approximately 500m to the east of the route corridor near Dundas Castle which has been confirmed during Stage 3 surveys currently underway. Due to the distance of this corridor option from the recorded great crested newt population, impacts are assessed as constituting a low adverse impact of Minor significance.

Badgers

9.4.77 South Corridor Option 2 is offline to the west of South Queensferry travelling southwards to where it connects with the M9 near Junction 1A. The footprint of the corridor could result in the loss of arable farmland and associated features such as hedgerows. In addition, the M9 junction could result in adverse impacts in relation to Swineburn Wood, Muiriehall Wood and Ross's Plantation. These areas may be suitable badger foraging and sett building habitat. Additionally the route corridor option may potentially cause severance to badger territories, which could increase competition between neighbouring badger clans and increase the frequency of badger road traffic accidents (RTAs). These impacts could be likely to constitute medium magnitude impacts of Minor significance.

Bats

9.4.78 Although no records have been obtained relating to bats within these areas, the fragmentation of Swineburn and Muiriehall Woods from Carmelhill Wood is likely to be a moderate magnitude impact of Moderate significance, due to the severance of foraging and potential roosting habitat. Fragmentation of possible roost sites at Westfield Farm and Westmuir Riding Centre from potential foraging areas to the east is considered to be of low adverse magnitude and Minor significance since suitable alternative foraging areas to the west remain. This route corridor option could also result in the fragmentation of Swine Burn, which has the potential to serve as an important commuting corridor/foraging route for bats, in particular Daubenton's.

Birds

9.4.79 There is insufficient information available at this stage to confirm differences between impacts associated with the different route corridor options although when compared to South Corridor Option 1, this corridor option would result in increased impacts to woodland and open water, open field and hedgerow habitats potentially supporting breeding and wintering birds.

Invertebrates

9.4.80 There is insufficient information available at this stage to determine potential differences between impacts associated with the different route corridor options. As above, however there would be increased impacts to areas of semi-natural habitat due to the predominant offline nature of this corridor option.

Fish

9.4.81 In addition to the impacts predicted to Linn Mill Burn, this route corridor option crosses Swine Burn in two places which could result in habitat loss and fragmentation as well as other potential impacts such as changes in flow and, pollution incidents. Impacts on fish for this corridor option are assessed as being of medium magnitude and Minor significance.

Reptiles

9.4.82 This corridor option would link the proposed replacement bridge with the existing M9 to the west of M9 Junction 1A. No impacts that could adversely affect local reptile populations are predicted from the A904 south to Swineburn, as the habitat crossed by South Corridor Option 2 in this section is heavily arable with no suitable field edges or hedgerows that might support reptiles. South of Swineburn, the route corridor passes adjacent to Humbie Reservoir, before crossing a railway and minor road and then joining the existing M9. This could result in the loss of suitable habitat along the M9 verge as it is modified to accommodate the new route. This option could also increase fragmentation in the area by creating a barrier between suitable habitat to the immediate east and west. The magnitude of impacts in this area are predicted to be low and of Minor significance.

Riparian Mammals

9.4.83 The proposed corridor runs parallel to Linn Mill Burn (NT107774), which at some points could be approximately 100m from the road cuttings. At the mouth of the burn, the proposed embankments could directly affect the burn, which may impact upon otter and water vole populations through habitat loss and noise disturbance during construction.

9.4.84 Swineburn disused quarry (NT097759) is immediately adjacent to South Corridor Option 2. This area is a commercial fishery so it is likely that otters could be present. South Corridor Option 2 also passes directly through Swine Burn in two places which could mean loss of bankside vegetation as well as habitat fragmentation. Construction noise may also affect otters (especially during the breeding season) and mortalities on the new section of road may also occur. The proposed corridor is also less than 100m from an unnamed pond on the outskirts of Kirkliston; this pond is already less than 100m from the existing road therefore only impacts associated with the construction of the proposed road are expected. With respect to otters, the impacts described for South Corridor Option 2 could be likely to be of medium magnitude and Moderate significance. For water voles, impacts of low magnitude and Minor significance are predicted.

Summary of Potential Impacts (South Corridor Option 2)

9.4.85 The following table provides a summary of potential impacts associated with the construction and operation of South Corridor Option 2.

Table 9.9: Summary of Potential Impacts - South Corridor Option 2

Ecological Receptor	Value	Potential Impact (unmitigated)	
		Magnitude	Significance
Designated Sites - Port Edgar SINC	 Authority Area	 High	 Moderate
Terrestrial Habitat - Swineburn/Muiriehall Wood complex and Carmelhill Wood - Ross's Plantation	Local Local Local	Low Low Low	Minor Minor Minor
Amphibians	National/local	Low	Minor
Badgers	Local	Medium	Minor
Bats*	Authority Area	Low	Minor
Birds	International-local	Unknown	Unknown
Invertebrates	Local	Unknown	Unknown
Fish	Local	Medium	Minor
Reptiles	Local	Low	Minor
Otters*	Authority Area	Medium	Moderate
Water Voles	Regional	Low	Minor

*Group or species protected under European legislation.

9.5 Potential Mitigation

9.5.1 Where potential adverse impacts have been identified, measures may be required to avoid the impacts or to mitigate for their effects (i.e. reduce the impact significance). The nature and scale of mitigation works required could be appropriate to the significance of the impact concerned.

9.5.2 At DMRB Stage 2 assessment of route corridor options, the detailed design has not been developed, and mitigation detail therefore cannot be confirmed. The objective of this section is therefore to identify anticipated 'standard' or 'generic' mitigation taking into account best practice, legislation and guidance. This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 9.6, to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

9.5.3 Generic mitigation for adverse impacts associated with the proposed scheme is likely to include:

- creation of woodland areas to mitigate for habitat loss using locally-sourced native species where possible;
- creation of species-rich grasslands on new verges and embankments and the instigation of appropriate management regimes;

- sympathetic design of culverts, underpasses and bridges to allow passage by fauna and thus reduce fragmentation impacts;
- installation of mammal fencing where necessary to help prevent mortality due to traffic; and
- new attenuation ponds and drainage ditches designed to treat road runoff and as such reduce ecological impacts.

9.5.4 All ecological mitigation measures will be proposed and designed in accordance with DMRB guidance, Volume 10 (The Highways Agency et al., 1993).

9.6 Summary of Route Corridor Options Assessment

Northern Route Corridor Options

<u>North Corridor Option 1</u>

9.6.1 The northern corridor option with least ecological impact is North Corridor Option 1. This corridor option is predominantly online and although there may be limited impacts to Ferry Hills SSSI, these are associated with the geological rather than the ecological element of it. Impacts resulting from both corridor options could occur at St Margaret's SSSI although this option could result in the least direct impact. As previously discussed, impacts to other species and groups would be limited due to the online nature of North Corridor Option 1.

<u>North Corridor Option 2</u>

9.6.2 North Corridor Option 2 results in greater direct habitat loss within St Margaret's Marsh SSSI and through the northern component of the Ferry Hills SSSI and would result in the loss of grassland within this area. In addition, the predominantly offline nature of much of this option increases the potential for impacts on species such as reptiles for which there are little available data.

9.6.3 Impacts on the Ferry Hills SSSI are assessed as being of Major significance for North Corridor Option 2. Impacts to Castlandhill Woods could result in the loss of woodland habitats of potential value for bats and breeding birds. Impacts on this feature have been evaluated as being of Minor significance for this option.

9.6.4 Impacts to watercourses from North Corridor Option 2 may result in fragmentation and direct habitat loss as well as consequent impacts on riparian mammals. These impacts are assessed as being of Moderate significance.

Southern Route Corridor Options

<u>South Corridor Option 1</u>

9.6.5 The southern corridor option with lowest overall ecological impact is South Corridor Option 1 as it is offline for a relatively shorter length than South Corridor Option 2 although it would result in impacts to Dundas Hill SINC. This option would also result in reduced fragmentation issues. Disturbance to Dundas Hill SINC and Lindsay's Craigs SINC could also result from this option, however these impacts are assessed as being of Minor significance.

9.6.6 The offline sections of South Corridor Option 1 could pass through large arable fields with species-poor and fragmented hedgerows of low ecological value and impacts could therefore be of limited significance to habitat and associated species such as breeding birds, reptiles and red squirrels.

South Corridor Option 2

9.6.7 South Corridor Option 2 could result in the fragmentation of the Swineburn, Muiriehall and Carmelhill woodland complex with potential impacts to bats and birds. These impacts have been assessed as being of Minor significance. Disturbance to Lindsay's Craigs SINC and potential impacts to Ross's Plantation could also result from this option and are assessed as being of Minor and Neutral significance, respectively.

9.6.8 South Corridor Option 2 would pass predominantly through large arable fields with species-poor and fragmented hedgerows of low ecological value and impacts could therefore be of limited significance to habitat and associated species such as breeding birds, reptiles and red squirrels. In addition to the impacts to Linn Mill Burn, Swine Burn could be crossed twice by this corridor option with potential impacts to otters and water voles.

9.7 Scope of Stage 3 Assessment

9.7.1 The Stage 3 Assessment of ecological impacts of the preferred corridor will be undertaken according to DMRB, Volume 11, Section 3, Part 4 taking cognisance of publications / best practice standards including seasonal constraints, in addition to sources of survey methods as prescribed by the Institute of Ecology and Environmental Management. The assessment will be based on the following steps:

- Further consultations with statutory and non-statutory bodies to establish the existence of new and/or updated ecological data relating to the survey area and, where appropriate to confirm acceptance the approach being undertaken (e.g. SNH).
- Review and assessment of the results of field surveys undertaken for the following:
  - i. bat roost potential and activity;
  - ii. badgers;
  - iii. breeding and wintering birds;
  - iv. detailed botanical surveys;
  - v. fish;
  - vi. great crested newts;
  - vii. hedgerow surveys;
  - viii. invertebrates – aquatic and terrestrial;
  - ix. red squirrels;
  - x. reptiles;
  - xi. otters; and
  - xii. water voles.
- Input to the design of the proposed scheme including incorporation of mitigation as required, such as specification of culverts, mammal fencing, and requirements for replacement habitat

9.7.2 In addition to Stage 3 assessment, the potential impacts on the Firth of Forth SPA and Forth Islands SPA will need to be considered under the terms of Regulation 48(1) of 'The Conservation (Natural Habitats & c.) Regulations 1994'. An 'Information to Inform an Appropriate Assessment' (IIAA) document will therefore be prepared and submitted to the competent authority.

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10 Landscape

10.1 Introduction

10.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of potential impacts on the surrounding landscape.

10.1.2 Within the northern study area, settlement and industry dominate the coastal terrace of Fife between the steep wooded cliffs and braes through which the M90 sweeps in extensive cuttings towards the Forth.

10.1.3 The Firth of Forth is a maritime landscape with extensive intertidal shores, islands and harbours. The sea, sky and the prevailing weather and light conditions provide a dramatic setting for the iconic road and rail bridges.

10.1.4 South of the Firth of Forth, the historic town of South Queensferry sprawls into the surrounding arable farmland, which itself slopes towards the mudflats and rocky outcrops of the shore and is contained by the wooded estates at Dalmeny, Hopetoun and Dundas.

10.1.5 Impacts assessed as being of Moderate or greater significance are considered to represent changes to the fabric, character and quality of the landscape and mitigation would generally be required to reduce these where possible.

10.1.6 The likely mitigation is considered and taken into account to summarise the residual impacts for each route corridor option and identify the northern and southern route corridor options with the lowest overall landscape impact.

10.1.7 The impact on the character of views and visual amenity is addressed separately in Chapter 11 (Visual). Landscape impacts during construction are addressed in Chapter 17 (Disruption Due to Construction).

10.2 Approach and Methods

10.2.1 The landscape assessment was undertaken in accordance with DMRB (The Highways Agency et al., 1993), Landscape & Visual Assessment and Supplementary Guidance (Scottish Executive, 2002) and Guidelines for Landscape and Visual Impact Assessment (Landscape Institute and Institute of Environmental Management & Assessment, 2002).

10.2.2 The initial stage of landscape assessment involves the collection of baseline data relating to the individual elements and characteristics of the landscape.

10.2.3 SNH has published two Landscape Character Assessments covering the study area, namely Fife Landscape Character Assessment (FLCA) (David Tyldesdale and Associates, 1999) and The Lothians Landscape Character Assessment (TLLCA) (ASH Consulting, 1998). These were used as the basis for the Landscape Character Assessment. These documents divide the study area into various Landscape Character Areas (LCAs) of particular Landscape Character Type (LCT). Detailed desk based and field assessment were undertaken to allow the boundaries of landscape character types and areas to be refined and considered at a more local scale. This provided a level of detail that enabled the evaluation of sensitivity and impact assessment. In some cases, this has meant the subdivision of land which is identified in the SNH assessments as being of a single landscape character type into smaller scale units, or Local Landscape Character Areas (LLCAs) to better reflect local variations in character.

10.2.4 An overview of the LLCAs is shown on Figure 10.1. Photographs which portray the character of the LLCAs are shown on Figure 10.2. Photographs from identified viewpoints will be produced for the Stage 3 report.

10.2.5 The information provided in the FLCA and TLLCA was supplemented by data collected through both desk based study and field assessment. The field surveys were carried out by car and by site walkovers from the surrounding minor roads, tracks and footpaths, and were undertaken by teams of at least two landscape architects. In addition, baseline data contained in the Scottish Transport Appraisal Guidance (STAG) Assessment for the Forth Replacement Crossing Study and Strategic Environmental Assessment (SEA) (Jacobs et al., 2006 – 2007) were utilised, where relevant. Reference was also made to the Setting Forth Environmental Statement (ERM, 1996). Data related to built-up areas, identified simply as 'Urban' in the FLCA were gathered in order to provide a meaningful baseline against which to assess potential impacts on their character and setting, (for example through noise and visual impacts). As the landscape and visual impact assessments are closely related, the data collected were used for both, as appropriate.

Desk Study

10.2.6 The desk study entailed the following:

- Structure and local plans, aerial photographs of the study area, and current 1:25,000 scale and 1:50,000 scale Ordnance Survey maps were studied to help identify the presence of areas of statutory designation and protection, and landscape elements and patterns.
- Consultations were undertaken with statutory and other bodies as discussed in Chapter 5 (Overview of Environmental Assessment) to supplement the desk study data collection.

10.2.7 Information of relevance to the Forth Replacement Crossing was extracted from these sources and the following topics were explored:

- pattern and scale of landform, land cover and built development; and
- special values including national and local landscape designations, Conservation Areas and historical, cultural and associations.

Field Survey

10.2.8 The study area was visited to conduct an up-to-date field survey that included identification of specific landscape constraints and verification/supplementation of data collected in the desk assessment.

Evaluation of Sensitivity to Change, Magnitude of Change and Impact Significance

10.2.9 Once the LLCAs were identified, the sensitivity of each area to change due to development was assessed in accordance with Landscape & Visual Assessment Supplementary Guidance (Scottish Executive, 2002). Table 10.1 outlines the criteria used to define the overall evaluation of landscape sensitivity.

Table 10.1: Landscape Sensitivity Criteria

Sensitivity	Criteria
High	Landscape or landscape elements of particular distinctive character, highly valued and considered susceptible to relatively small changes.
Medium	A landscape of moderately valued characteristics considered reasonably tolerant of change.
Low	A landscape of generally low valued characteristics considered potentially tolerant of substantial change.

10.2.10 Evaluation of the magnitude of the proposed changes upon the landscape, brought about by the proposed northern and southern route corridor options used the criteria in Table 10.2. The results of this evaluation are presented in Section 10.4 (Potential Impacts).

Table 10.2: Landscape Magnitude of Change Criteria

Magnitude	Criteria
High	Notable change in landscape characteristics over an extensive area ranging to very intensive change over a more limited area.
Medium	Minor changes in landscape characteristics over a wide area ranging to notable changes in a more limited area.
Low	Minor or virtually imperceptible change in any area or landscape components.

10.2.11 An initial indication of impact significance of each of the northern and southern route corridor options was obtained by combining the sensitivity to change and magnitude of change assessments using the framework shown in Table 10.3. This initial assessment of impact significance using the above criteria was supplemented by professional judgement based on experience and awareness of the relative balance of importance between sensitivity and magnitude.

Table 10.3: Landscape Impact Significance

Magnitude / Sensitivity	Negligible	Low	Medium	High
High	Slight	Moderate	Substantial	Severe
Medium	Negligible to Slight	Slight	Moderate	Substantial
Low	Negligible	Negligible to Slight	Slight	Moderate

10.2.12 As stated in paragraph 10.1.5, impacts assessed as being of Moderate or greater are considered to represent key landscape changes and mitigation would generally be required to reduce these where possible.

10.2.13 It should be noted that the matrix provided in Table 10.3 provides an initial guide and significance assigned may be adjusted using professional judgement. The categories and range of impact significance, which accord with DMRB, are explained in Table 10.4.

Table 10.4: Impact Significance Criteria

Impact	Criteria
Negligible	No noticeable deterioration or improvement in the existing landscape resource.
Negligible to Slight adverse	Barely perceptible variance with the landform, scale or pattern of the landscape resulting in very limited degradation or diminution of the integrity of an area of recognised character; and would change a landscape of low sensitivity.
Slight adverse	At barely perceptible variance with the landform, scale or pattern of the landscape resulting in very minor degradation or diminution of the integrity of an area of recognised character; and would change a landscape of medium sensitivity; or At minor variance with the landform, scale or pattern of the landscape resulting in limited degradation or diminution of the integrity of an area of recognised character; and would change a landscape of low sensitivity.
Slight to Moderate adverse	At barely perceptible variance with the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of valued characteristic features and/or elements and/or their settings; and would cause a landscape of high sensitivity to be permanently changed; or At minor variance with the landform, scale or pattern of the landscape resulting in very minor degradation or diminution of the integrity of an area of recognised character; and would change a landscape of medium sensitivity; or At considerable variance with the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of valued characteristic features and/or

Impact	Criteria
	elements and/or their settings; and would cause a landscape of low sensitivity to be permanently changed.
Moderate adverse	At minor variance with the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of highly valued characteristic features and/or elements and/or their settings; and would cause a landscape of high sensitivity to be changed; or At considerable variance with the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of valued characteristic features and/or elements and/or their settings; and would cause a landscape of medium sensitivity to be permanently changed; or At very considerable variance with the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of highly valued characteristic features and/or elements and/or their settings; and would cause a landscape of low sensitivity to be permanently changed.
Moderate to Substantial adverse	At considerable variance to the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of highly valued characteristic features and/or elements and/or their settings; and would cause a landscape of high sensitivity to be permanently changed; or At very considerable variance to the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of highly valued characteristic features and/or elements and/or their settings; and would cause a landscape of medium sensitivity to be permanently changed.
Substantial adverse	At very considerable variance to the landform, scale and pattern of the landscape resulting in permanent degradation or diminution of the integrity of highly valued characteristic features and/or elements and/or their settings; and would cause a landscape of high sensitivity to be permanently changed; or At extreme variance with the landform, scale and pattern of the landscape resulting in permanent degradation, diminution or destruction of the integrity of highly valued characteristic features and/or elements and/or their settings; and would cause a medium sensitive landscape to be permanently changed.
Severe adverse	At extreme variance with the landform, scale and pattern of the landscape resulting in permanent degradation, diminution or destruction of the integrity of highly valued characteristic features and/or elements and/or their settings; and would cause a highly sensitive landscape to be permanently changed.
Slight beneficial	Minor improvement in the landscape character with proposals fitting in with the scale, landform and pattern of the landscape and enabling limited introduction or restoration of valued landscape characteristics which may have been diminished or lost.
Moderate beneficial	Considerable improvement in the landscape character with proposals fitting in very well with the scale, landform and pattern of the landscape and enabling significant introduction or restoration of valued landscape characteristics which may have been diminished or lost.

10.2.14 As indicated in Table 10.3, landscape impacts can be either beneficial or adverse. However, it should be noted that to provide consistency with the assessment of other environmental parameters within this Stage 2 report, stated impacts are considered to be adverse unless otherwise stated.

Limitations to Assessment

10.2.15 The assessment of potential impacts for the two Local Landscape Character Areas (LLCAs) listed below are desk-based due to access issues, using information from maps and aerial photography:

- Dundas Designed Wooded Landscape; and
- Newliston Designed Wooded Landscape.

10.2.16 It should be noted, however, that the information available from the desk-based assessment was considered sufficient for the purposes of Stage 2 assessment.

10.3 Baseline Conditions

10.3.1 This section classifies and evaluates the landscape resource of the Northern and Southern study areas and the Firth of Forth taking account of the geological, cultural and historical influences as well as identifying any designated or protected areas.

Regional Context

10.3.2 The study area is located in the broad Midland Valley between the Grampian Hills and the Southern Uplands, where the Firth of Forth forms a major water body.

10.3.3 To the north of the Firth of Forth, the Fife lowland and upland landscape is characterised by hills, valleys and urban settlements, of which Dunfermline is the largest. Lothian's lowland plains and hills, south of the Firth of Forth, form an undulating agricultural landscape, with a small settlement at South Queensferry.

10.3.4 The Firth of Forth, central to the study area, forms a large horizontal expanse of intertidal and maritime landscape features.

Landscape and other Designations

10.3.5 Landscape designations are illustrated on Figure 10.3. The level of protection afforded to sites of landscape value and importance varies according to their designation as described below.

<u>Nationally Protected Sites</u>

Historic Landscapes and Designed Gardens

10.3.6 Within the study area there are a number of sites included on the Inventory of Gardens and Designed Landscapes designated by Historic Scotland and SNH.

10.3.7 The following Gardens and Designed Landscapes are located within or close to the Northern and Southern study areas:

- Fordell Castle (Figure 10.3a);
- Donibristle (Figure 10.3a);
- House of Binns (west of Hopetoun House and not shown on a figure);
- Hopetoun House (Figure 10.3b and c);
- Dundas Castle (Figure 10.3c);
- Dalmeny (Figure 10.3c); and
- Newliston (Figure 10.3c).

<u>Locally Protected Areas</u>

Area of Outstanding Landscape Quality – Edinburgh City Council

10.3.8 The specific location and extent of the Areas of Outstanding Landscape Quality (AOLQ) within the study area are shown in the Adopted Rural West Edinburgh Local Plan and on Figure 10.3.

Area of Great Landscape Value – West Lothian Council

10.3.9 The Finalised West Lothian Plan 2005 identifies an Area of Great Landscape Value (AGLV) along the shore of the Firth of Forth between Blackness and South Queensferry including the managed woodlands of Hopetoun House and the setting of several other historic buildings surrounding the Hopetoun Estate (Figure 10.1). The AGLV is within the Southern study area.

Green Belt – Edinburgh City Council

10.3.10 Green Belt, identified in the Rural West Edinburgh Local Plan (adopted June 2006), and in Edinburgh and Lothians Structure Plan 2015, extends into the Southern study area as shown on Figure 10.3c).

Protection of Open Space – Edinburgh City Council

10.3.11 Rural West Edinburgh Local Plan (adopted June 2006) outlines policy for the protection of public and private open space of recreational, amenity or nature conservation value.

10.3.12 There are several areas of open space, as defined above, within the Southern study area as shown on Figure 6.2c.

<u>Tree Preservation Orders</u>

10.3.13 A Tree Preservation Order (TPO) is made by a local planning authority to protect specific trees or a particular area, group or woodland from deliberate damage and destruction. TPOs can prevent the felling, lopping, topping, uprooting or otherwise willful damaging of trees without permission.

10.3.14 There are several TPO areas to the north of the study area:

- North Queensferry – Wooded brae south of Ferry Loch;
- Rosyth – Wooded area round the dovecot, north of the castle;
- Rosyth – 'The Wilderness' north of the town;
- Letham – Letham Hill Wood; and
- Dunfermline – 'North Wood' adjacent to Pitreavie Golf Course.

10.3.15 There are three TPO areas in the study area to the south of the Firth of Forth:

- Dalmeny – Single tree immediately north of the A90 on Standingstane Road;
- South Queensferry – Block of trees to the east of St. Margaret's Primary School; and
- Kirkliston – Wooded grounds surrounding dwelling on Manse Road.

Landform and Drainage

10.3.16 There is a varied landform north of the Firth of Forth, including a flat coastal area, minor hills, gently undulating slopes steeper coastal braes and inland valleys. The major hills in the area include the Ferry Hills at North Queensferry, Whinny Hill / Castlandhill to the west of Inverkeithing, Letham Hill to the west of Dalgety Bay and Clinthill Top to the north of Dalgety Bay. Ridge lines occur in several places in a roughly east-west formation along the south facing slopes.

10.3.17 The Firth of Forth is the main water catchment in the area and flows from the Grampian Mountains in the west to the North Sea in the east with several rivers discharging into it along its length. In the north, the generally south facing slopes drain southwards into the

Firth of Forth. There are several burns in the area that converge at Inverkeithing and discharge into Inverkeithing Bay and the Firth of Forth.

10.3.18 In the Southern study area, burns along the north facing slopes (north of the ridge line) discharge northwards into the Firth of Forth. The main example being Midhope Burn on the Hopetoun Estate. South facing slopes form the catchment for the River Almond which discharges into the Firth of Forth at Cramond to the east of the study area.

10.3.19 The drainage of the study area is illustrated on Figures 8.1 and 8.2 of Chapter 8 (Water Environment).

Vegetation

10.3.20 Vegetation cover in the study area varies to reflect the natural influences of local geology, landform, microclimate, drainage, soil, colonisation and biodiversity and the influence of man upon land use and management. The resulting vegetation pattern is intrinsic to the integrity of regional and local distinctiveness.

10.3.21 The majority of mature broadleaf and coniferous woodlands and shelterbelts occur on country estates scattered throughout the study area, with several of the older, extensive woodland areas such as those at Dalmeny, Dundas, Hopetoun, Fordell and Newliston originating from designed landscapes dating back to the 17^{th} century as shown on Figures 10.3.

10.3.22 Broadleaf and mixed woodland is also found on isolated hills such as Letham Hill and Craigie Hill, along areas of the Union Canal and distributed elsewhere as shown on Figure 9.1.

10.3.23 The majority of agricultural land within the Northern and Southern study areas is arable, with shelterbelts and hedges used extensively to reflect the exposed nature of the broad valley setting. The topography also provides large flat areas such as St. Margaret's Hope adjacent to the water providing a distinctive marshland area.

SNH Landscape Character Assessments

10.3.24 Collective LCTs, based on those outlined in the TLLCA and FLCA, are applied throughout the Northern and Southern study areas, as detailed below. The LCTs have been further classified in this assessment as LLCAs, as shown on Figures 10.1, to take account of the local landscape features. Detailed descriptions of the LLCAs and evaluation of the sensitivity to change due to development are contained in Appendix A10.1.

Lowland Hill and Valley Farmland

10.3.25 The Lowland Hill and Valley Farmland LCT comprises a variety of undulating landforms with open regular farmland patterns of medium-scale fields of arable and grasslands. Field boundaries consist of fencing and hedges with hedgerow trees. Roads within the area relate well to the landform and contribute to the generally well maintained, safe, quiet, balanced and calm landscape (based on extract from SNH, 1999). LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Table 10.5.

Table 10.5: Lowland Hill and Valley Farmland LLCAs

LLCA	Figure Number	Overall Sensitivity
Woodlee	10.1a	Medium
Duloch	10.1a and b	Low
Inverkeithing Farmland	10.1a and b	Medium
Duddingston	10.1c	Medium
Craigbrae	10.1c	Medium

Wooded Lowland Hill and Valley

10.3.26 This LCT contains undulating landforms, often valley slopes and hills, that feature extensive areas of plantations, shelter planting and other dominant linear and point features of plantations and tree groups (based on extract from SNH, 1999). LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Table 10.6.

Table 10.6: Wooded Lowland Hill and Valley LLCAs

LLCA	Figure Number	Overall Sensitivity
Craigie	10.1c	Medium to High
Humbie	10.1c	High
North Inverkeithing	10.1b	Low to Medium

Coastal Hills

10.3.27 Coastal Hills LCTs have a strong association with the coast through views, sounds, smells and other coastal experiences. Features also include large open undulating fields with fences, low hedges or drystone dykes and hillsides with scrub woodland or rough grazing. Settlement is in exposed, isolated farms often with converted outbuildings (adapted from SNH, 1999). LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Table 10.7.

Table 10.7: Coastal Hill LLCAs

LLCA	Figure Number	Overall Sensitivity
Letham Hill	10.1b	Medium to High
Castlandhill	10.1b	Medium
Ferry Hills	10.1b	Medium

Coastal Flats

10.3.28 Coastal Flats are low-lying, open, exposed, large-scale coastal landscapes at sea level encroached by industry and other built developments. Land cover also includes open grassland expanses. A coastal landscape where the character is always influenced by the sea and can be particularly affected by the weather conditions and views of the sky and the sea (adapted from SNH, 1999). LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Table 10.8.

Table 10.8: Coastal Flats LLCAs

LLCA	Figure Number	Overall Sensitivity
North Queensferry	10.1b	Medium to High

Designed Wooded Landscape

10.3.29 These landscape character types are formed around large country houses and estates. Features include large woodland blocks and shelterbelts which surround arable fields, tree clumps and isolated trees. There are often artificial and natural ponds and water features, as well as other features of a designed landscape such as ha-ha's and tree lined access roads. Well maintained stone walls mark estate boundaries and dwellings range from stately manor houses to simple vernacular estate cottages within extensive grounds. LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Table 10.9.

Table 10.9: Designed Wooded Landscape LLCAs

LLCA	Figure Number	Overall Sensitivity
Fordell	10.1a	Medium to High
Hopetoun	10.1c	High
Dalmeny	10.1c	High
Dundas	10.1c	Medium to High
Newliston	10.1c	High

Disturbed Farmland

10.3.30 The Disturbed Farmland character type is characterised by rolling lowland fields featuring large hills formed from mining spoils. The spoil heaps dominate the surrounding landscape and are highly visible. Other features include manmade elements such as landfill sites, canals and rail lines forming a distinctive post industrial landscape. Settlements include scattered farms. LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Table 10.10.

Table 10.10: Disturbed Farmland LLCAs

LLCA	Figure Number	Overall Sensitivity
Craigton	10.1c	Low to Medium

Lowland Plain

10.3.31 The Lowland Plain character type is a flat or gently undulating landform with a rural matrix of predominantly arable farmland. Field edges include small hedges with mature trees and stone walls (adapted from SNH, 1998). LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Table 10.11.

Table 10.11: Lowland Plain LLCAs

LLCA	Figure Number	Overall Sensitivity
River Almond	10.1c	Medium to High
Overton	10.1c	Medium

Firth of Forth

10.3.32 This character area is a large scale, exposed, horizontal landscape dominated by the weather conditions and the sky. It is generally calm and colourful with extensive views. Features include off-shore islands, slow moving vessels and changing coastline features influenced by the tide. Dominant structures in the landscape are the Forth Road Bridge and Forth Rail Bridge. The LLCA classified under this type, figure location and evaluation of sensitivity to change due to development are listed in Table 10.12.

Table 10.12: Firth of Forth LLCAs

LLCA	Figure Number	Overall Sensitivity
Firth of Forth	10.1b and c	High

Urban / Industrial

10.3.33 Urban and Industrial areas are a feature of the landscape adding colour and texture. Negative attributes however include fragmentation of the natural landscape. LLCAs classified under this type, their figure location and evaluation of sensitivity to change due to development are listed in Tables 10.13 and10.14.

Table 10.13: Urban LLCAs

LLCA	Figure Number	Overall Sensitivity
Dunfermline	10.1a	Low
Rosyth	10.1a and b	Low
Dalgety Bay	10.1b	Medium
Inverkeithing	10.1b	Medium
North Queensferry	10.1b	Medium to High
South Queensferry	10.1b and c	Medium to High
Kirkliston	10.1c	Medium

Table 10.14: Industrial LLCAs

LLCA	Figure Number	Overall Sensitivity
Inverkeithing Industrial Estate	10.1b	Low
South Inverkeithing Bay	10.1b	Low
Rosyth Industrial Area	10.1b	Low

Existing Road Corridor

10.3.34 The M9, A90 and M90 form large linear elements in the landscape that are distinct from the surrounding landscape features. They are characterised by cuttings through hills and large embankments with scrub woodland planting in places. They are also areas of intense activity in contrast to the relative tranquillity of the rural surroundings. The LLCA classified under this type, figure location and evaluation of sensitivity to change due to development are listed in Table 10.15.

Table 10.15: Existing Road Corridor LLCAs

LLCA	Figure Number	Overall Sensitivity
M9, A90 and M90	10.1a-c	Low

10.4 Potential Impacts

10.4.1 Without appropriate mitigation, landscape impacts may include the following:

- alteration of the regional and local character of the landscape, or the special qualities of designated areas, due to loss of landscape elements and introduction of infrastructure elements associated with a new bridge and adjoining motorways; and
- alteration of the surrounding landform, land use, pattern, boundaries, vegetation and watercourses.

10.4.2 The proposed replacement bridge and the northern and southern route corridor options are assessed separately.

10.4.3 For the purpose of consistency, potential impacts are assessed for each LLCA, as they occur from north to south within the study area. As previously stated, descriptions of the LLCAs and the sensitivity of each area to change due to development are contained in Appendix A10.1.

10.4.4 The sensitivity of each LLCA is justified on the first occasion that the LLCA is discussed and remains unchanged throughout the report.

10.4.5 Potential impacts considered not to be common to both corridor options within the Northern or Southern study areas are identified separately.

Proposed Replacement Bridge

10.4.6 The imposing scale of the proposed replacement bridge would have an impact on a number of LLCAs. Affected LLCAs with direct impacts are outlined below and summarised in Table 10.16.

10.4.7 The Existing Road Corridor LLCA has a low sensitivity to change. The introduction of the proposed replacement bridge would produce a medium magnitude of change and an impact of Slight to Medium significance.

10.4.8 Rosyth Urban LLCA has a low sensitivity to change due to industry and continued development to the south and intrusion from the M90 to the east. The magnitude of change would be low and the overall impact of Negligible significance.

10.4.9 The prominent Castlandhill LLCA with intermittent views over the Firth of Forth, has a medium sensitivity to change. Indirect impacts from the proposed replacement bridge would be limited by distance, with a low magnitude of change and an impact of Negligible significance.

10.4.10 Rosyth Industrial LLCA would be indirectly impacted by the proposed replacement bridge. However, this LLCA is heavily developed, with low sensitivity and a high tolerance for change. The proposed replacement bridge would produce a low magnitude of change to the character of the LLCA with the overall impact limited to Negligible significance.

10.4.11 North Queensferry Coastal Flat LLCA is a valued part of the coastal landscape with a sensitivity of medium to high. The proximity of the proposed replacement bridge would give a magnitude of change as low to medium and an impact of Slight to Moderate significance.

10.4.12 Ferry Hills is an attractive but fragmented LLCA where the sensitivity is assessed as medium. The proposed replacement bridge would directly impact on the western side of the LLCA, with a high magnitude of change and an overall impact of Moderate to Substantial significance.

10.4.13 North Queensferry LLCA, a historic town penetrated by the northern section of the two existing bridge structures has a sensitivity of medium to high. The proposed replacement bridge would impose a medium magnitude of change and an impact of Moderate significance.

10.4.14 The sensitivity of the open, reflective Firth of Forth LLCA is high. The proposed replacement bridge would further alter this marine landscape, with a medium to high magnitude of change in the context of the existing bridges. The overall impact would be of Moderate to Substantial significance.

10.4.15 Hopetoun LLCA, with a Garden and Designed Landscape designation, has a high sensitivity to change but the presence of the existing bridges would limit the magnitude of change to low to medium and the significance of impact to Slight to Moderate.

10.4.16 Duddingston LLCA, a rural landscape edged by settlement, has a medium sensitivity to change. The proposed replacement bridge would directly impact upon fields to the north east beside urban development. The magnitude of change will be medium and the overall impact significance will be Moderate.

10.4.17 South Queensferry LLCA, where the Forth Road and Rail Bridges tie in to the east and west of the town, has a sensitivity of medium to high. The magnitude of change is predicted as medium to high due to the removed location of the proposed replacement bridge to Port Edgar with an impact of Moderate to Substantial significance.

10.4.18 Dalmeny is a highly valued LLCA with a Garden and Designed Landscape designation. This gives the area a high sensitivity to change. However, the proposed replacement bridge would have no direct impacts on the features or quality of the area, so that the magnitude of change would be low and the overall impact would be of Negligible to Slight significance.

Table 10.16: Summary of Potential Impacts – Proposed Replacement Bridge

LLCA Receptor	Sensitivity	Potential Impact (unmitigated)		
		Direct/Indirect	Magnitude	Significance
Existing Road Corridor	Low	Indirect	Medium	Slight to Moderate
Rosyth Urban	Low	Indirect	Low	Negligible
Castlandhill Coastal Hill	Medium	Indirect	Low	Negligible
Rosyth Industrial Area	Low	Indirect	Low	Negligible
North Queensferry Coastal Flat	Medium to High	Indirect	Low to Medium	Slight to Moderate
Ferry Hills Coastal Hill	Medium	Direct	High	Moderate to Substantial
North Queensferry Urban Area	Medium to High	Indirect	Medium	Moderate adverse
Firth of Forth	High	Direct	Medium to High	Moderate to Substantial
Hopetoun Designed Wooded Landscape	High	Indirect	Low to Medium	Slight to Moderate
Duddingston Lowland Hill and Valley Farmland	Medium	Direct	Medium	Moderate adverse
South Queensferry Urban	Medium to High	Indirect	Medium to High	Moderate to Substantial
Dalmeny Designed Wooded Landscape	High	Indirect	Low	Negligible to Slight

Northern Route Corridor Options

Impacts Common to Both Northern Route Corridor Options

10.4.19 Impacts on LLCAs which would be common to both Northern route corridor options are described below and summarised in Table 10.17.

10.4.20 The introduction of a new junction at Masterton and a tie in at North Queensferry Hill would produce a low magnitude of change for the Existing Road Corridor LLCA. This would result in an impact of Slight significance.

10.4.21 Woodlee is an undulating rural landscape influenced by the existing M90 to the west, with medium sensitivity. Distant views of Masterton provide low magnitude of change and would result in an impact of Slight significance. These potential impacts are not significant and common to both northern route corridor options.

10.4.22 Dunfermline is a large dense town with low sensitivity. The replacement Masterton Junction would produce a low magnitude of change of Negligible significance.

10.4.23 Potential impacts for Letham Hill are not significant and common to both northern route corridor options. Although Letham Hill has high sensitivity, due to attractive ancient woodland, coastal location and productive agricultural land, the distance of the proposed Masterton Junction from this area would produce impacts of low magnitude and Negligible significance.

10.4.24 Dalgety Bay is a densely developed urban area, assessed as having a medium sensitivity. Both options would have a low magnitude and an impact of Negligible significance.

10.4.25 The sensitivity for South Inverkeithing Bay is low due to a large working quarry and other industry. Despite its close proximity to the North Corridor Option 1, the magnitude of change would be low and the overall impact would be of Negligible significance.

10.4.26 A low magnitude of change reflects the existing industry and infrastructure at Rosyth Industrial Area. Potential impacts would be indirect and of Negligible significance.

10.4.27 North Corridor Options 1 and 2 would pass through the western edge of Ferry Hills on embankment at the top of a prominent hill, altering its topography and vegetation. Both will introduce major cuttings in the hill where the existing A90 ties in with the proposed route corridor. This would result in a high magnitude of change of Substantial significance.

10.4.28 Potential impacts for North Queensferry would be indirect, not significant and common to both northern route corridor options. The magnitude would therefore be low and the impact significance assessed to be Negligible.

10.4.29 Both the northern route corridor options would indirectly alter the character of the Firth of Forth with a low magnitude of change. The overall adverse impact would be of Slight significance.

Table 10.17: Summary of Potential Impacts Common to Both Northern Route Corridor Options

LLCA Receptor	Sensitivity	Potential Impact (unmitigated)		
		Direct/Indirect	Magnitude	Significance
Existing Road Corridor	Low	Direct	Low	Slight
Woodlee Lowland Hill and Valley Farmland	Medium	Direct	Low	Slight
Dunfermline Urban Area	Low	Direct	Low	Negligible
Letham Hill Coastal Hill	Medium to High	Indirect	Low	Negligible
Dalgety Bay Urban	Medium	Indirect	Low	Negligible
South Inverkeithing Bay Industrial	Low	Direct (North Corridor Option 1) Indirect (North Corridor Option 2)	Low	Negligible
Rosyth Industrial Area	Low	Direct	Low	Negligible
Ferry Hills Coastal Hill	Medium	Direct	High	Substantial
North Queensferry Urban Area	Medium to High	Indirect	Low	Negligible
Firth of Forth	High	Indirect	Low	Slight

<u>North Corridor Option 1</u>

10.4.30 North Corridor Option 1 utilises the existing A90 / M90 carriageway and introduces a new section of road to the south where the proposed replacement bridge ties in with the existing A90 road and a slightly altered junction at Masterton. Additional embankments and cuttings may have to be widened as the road is upgraded in places. Potential impacts on LLCAs from North Corridor Option 1 are described below and summarised in Table 10.18.

10.4.31 Fordell has a valued wooded character and medium to high sensitivity to change. The new Masterton Junction coincides with the existing junction so that the magnitude of change would be low to medium and the impact significance would be Slight to Moderate.

10.4.32 Duloch is semi-rural and bounded by the existing M90 and Dunfermline. The sensitivity is assessed as low and the proposed Masterton Junction would create a medium magnitude of change and an impact of Slight to Moderate significance.

10.4.33 Inverkeithing Farmland has medium sensitivity due to attractive rural features and south facing high quality farmland. The magnitude of change would be medium to high since the Masterton Junction and link road directly impacts the west of the LLCA and the overall impact would be of Moderate to Substantial significance.

10.4.34 Inverkeithing Industrial Estate also has a low sensitivity to change. The proposed change at Masterton Junction would be visible but will only produce a low magnitude of change and an impact of Negligible significance.

10.4.35 The route corridor and new Masterton Junction would indirectly detract from the character of Rosyth settlement. The magnitude of change would be low to medium with an impact of Slight significance.

10.4.36 North Inverkeithing is surrounded by infrastructure and settlement. It has a low to medium sensitivity and low magnitude of change. The impact will be of Slight significance.

10.4.37 Inverkeithing town’s sensitivity is assessed as medium. Masterton Junction would represent a low magnitude of change and an impact of Negligible significance.

10.4.38 Most of North Corridor Option 1 follows the existing A90 at Castlandhill, with the exception of a new roundabout and access road at the southeast corner of the character area. These additions to the existing infrastructure would produce a low magnitude of change and an impact of Negligible to Slight significance.

10.4.39 At North Queensferry Coastal Flat, North Corridor Option 1 cuts through the east edge of the LLCA on a wide embankment disturbing the flat character of the area which would consequently result in a high magnitude of change and an impact of Substantial significance.

Table 10.18: Summary of Potential Impacts - North Corridor Option 1

LLCA Receptor	Sensitivity	Potential Impact (unmitigated)		
		Direct/Indirect	Magnitude	Significance
Fordell Designed Wooded Landscape	Medium to High	Direct	Low to Medium	Slight to Moderate
Duloch Lowland Hill and Valley Farmland	Low	Direct	Medium	Slight to Moderate
Inverkeithing Lowland Hill and Valley Farmland	Medium	Direct	Medium to High	Moderate to Substantial
Inverkeithing Industrial Estate	Low	Direct	Low	Negligible
Rosyth Urban Area	Low	Direct	Low to Medium	Slight
North Inverkeithing Lowland Hill	Low to Medium	Direct	Low	Slight
Inverkeithing Urban Area	Medium	Indirect	Low	Negligible
Castlandhill Coastal Hill	Medium	Direct	Low	Negligible to slight
North Queensferry Coastal Flat	Medium to High	Direct	High	Substantial

North Corridor Option 2

10.4.40 North Corridor Option 2 is online before branching to the east of the existing M90, across the southwest corner of Fordell and returning southwest to dissect Inverkeithing Industrial Estate, cross the corridor of the existing motorway and cut through the east side of Castlandhill using a cut-and-cover solution. It continues south to the north coast of the Firth of Forth, immediately west of the Forth Road Bridge approach. Potential impacts on LLCAs from North Corridor Option 2 are described below and summarised in Table 10.19.

10.4.41 North Corridor Option 2 would directly impact the southwest of Fordell as it passes through on embankment, at grade and in cutting, severing two fields and permanently changing the landform and mature woodland. The magnitude of change is assessed as high and the impact significance would be Moderate to Substantial.

10.4.42 Duloch is semi-rural and bounded by the existing M90 and Dunfermline. The sensitivity is assessed as low and the proposed route corridor option would create low magnitude of change and an impact of Negligible to Slight significance.

10.4.43 Inverkeithing Farmland would experience a high magnitude of change as North Corridor Option 2 crosses the area on high embankment, severing and isolating fields. The overall impact significance would be greater than for North Corridor Option 1 at Moderate to Substantial.

10.4.44 North Corridor Option 2 would directly affect Inverkeithing Industrial Estate. The magnitude of change would be high and the overall impact would therefore be of Moderate to Substantial significant, which is a more significant impact than for North Corridor Option 1.

10.4.45 The proximity of North Corridor Option 2 to Rosyth Urban Area would impose a medium magnitude of change and overall impact significance of Moderate, which is greater than for North Corridor Option 1.

10.4.46 North Corridor Option 2 would directly impact North Inverkeithing Lowland Hill as it passes through in a large cutting. The magnitude of change would therefore be high and the impact, which is greater than for North Corridor Option 1 would be of Substantial significance.

10.4.47 North Corridor Option 2 would pass very close to the western and northern extremities of Inverkeithing Urban Area, with the potential demolition of housing. Impacts would be greater than for North Corridor Option 1, with a medium to high magnitude of change and an overall impact of Moderate to Substantial significance.

10.4.48 The proposed road forms substantial cuttings to the east side of both hills at Castlandhill, via a cut-and-cover solution on the northern hill. The magnitude of change would therefore be high and the impact significance is greater than North Corridor Option 1 at Severe.

10.4.49 At North Queensferry Coastal Flat, the additional slip road to the west of the mainline further encroaches on the area to a greater extent than for North Corridor Option 1 and consequently would result in a high magnitude of change and with an impact significance of Severe.

Table 10.19: Summary of Potential Impacts - North Corridor Option 2

LLCA Receptor	Sensitivity	Potential Impact (unmitigated)		
		Direct/Indirect	Magnitude	Significance
Fordell Designed Wooded Landscape	Medium to High	Direct	High	Moderate to Substantial
Duloch Lowland Hill and Valley Farmland	Low	Indirect	Low	Negligible to Slight
Inverkeithing Lowland Hill and Valley Farmland	Medium	Direct	High	Moderate to Substantial
Inverkeithing Industrial Estate	Low	Direct	High	Moderate to Substantial
Rosyth Urban Area	Low	Indirect	Medium	Moderate
North Inverkeithing Lowland Hill	Low to Medium	Direct	High	Substantial
Inverkeithing Urban Area	Medium	Indirect	Medium to High	Moderate to Substantial
Castlandhill Coastal Hill	Medium	Direct	High	Severe
North Queensferry Coastal Flat	Medium to High	Direct	High	Severe

Southern Route Corridor Options

<u>Impacts Common to Both Southern Route Corridor Options</u>

10.4.50 Impacts on LLCAs which would be common to both southern route corridor options are described below and summarised in Table 10.20.

10.4.51 Neither of the southern route corridor options would directly alter the Firth of Forth and would have only a limited effect on the quality of the area and a low magnitude of change. The overall impact would be of Slight significance.

10.4.52 The majority of this route corridor would be separated from Hopetoun by extensive woodland. The magnitude of change would be low and the overall impact significance would therefore be Slight.

10.4.53 The proposed route corridor would not alter the character of Dalmeny, so the magnitude of change would be low and the overall impact significance would be Negligible.

10.4.54 Craigie is a significant feature in the landscape with ancient woodland and medium to high sensitivity. Neither southern route corridor option would detract from the quality of this area, with a low magnitude of change and an impact of Negligible significance.

10.4.55 Craigton has a low to medium sensitivity due to the presence of bings and proximity of the M9. The magnitude of change from the route corridor would be low and the impact would be of Slight significance.

10.4.56 The sensitivity of Overton is medium reflecting the existing disturbance from infrastructure. The re-modelling of M9 Junction 1A in a cutting to the east and embankment with bridge to the west would have a medium magnitude of change. The overall impact would be of Moderate significance.

10.4.57 Kirkliston is a small scale town with medium sensitivity. South Corridor Option 1 would change the junction layout to the southwest of the town. The magnitude of change would be low to medium and the impact would be of Slight significance.

10.4.58 Newliston is a valued character area with a high sensitivity to change. South Corridor Option 1 will run close to the north of the LLCA mainly in cutting and separated from Newliston by woodland. The magnitude of change would be low and the overall impact would be of Slight significance

10.4.59 River Almond is a relatively flat rural area adjacent to Edinburgh Airport. It has a medium to high sensitivity reflecting the openness of the area and the sensitivity of the River Almond which flows through the area. The magnitude of change from the proposed corridor and alterations to the M9 Spur would be low and the overall impact would be of Negligible significance.

Table 10.20: Summary of Potential Impacts Common to Both Southern Route Corridor Options

LLCA Receptor	Sensitivity	Potential Impact (unmitigated)		
		Direct/Indirect	**Magnitude**	**Significance**
Firth of Forth	High	Indirect	Low	Slight
Hopetoun Designed Wooded Landscape	High	Indirect	Low	Slight
Dalmeny	High	Indirect	Low	Negligible
Craigie Wooded Lowland Hill and Valley	Medium to High	Indirect	Low	Negligible
Craigton Disturbed Farmland	Low to Medium	Direct (South Corridor Option 1) Indirect (South Corridor Option 2)	Low	Slight
Overton Lowland Plain	Medium	Direct	Medium	Moderate
Kirkliston Urban Area	Medium	Direct	Low to Medium	Slight
Newliston Designed Wooded Landscape	High	Direct	Low	Slight
River Almond	Medium to High	Indirect	Low	Negligible

South Corridor Option 1

10.4.60 This route corridor option utilises the existing M9 Spur and proposes an additional extension of the A90 running to the south and west of South Queensferry. M9 Junction 1A is remodelled with sliproads passing through adjacent fields and additional slip roads are used to connect the M9 Spur to the existing A90. The A90 extension cuts through open agricultural land. Potential impacts on LLCAs from South Corridor Option 1 are described below and summarised in Table 10.21.

10.4.61 The fabric of the existing Road Corridor LLCA has a low to medium sensitivity to change. South Corridor Option 1 would replace the existing M9 Junction 1A with a remodelled junction and additional bridge structure and would also create a new road link to the north with slip roads from the existing A90. The magnitude of change would be low to medium with an impact of Slight significance.

10.4.62 South Corridor Option 1 would directly impact the Duddingston LLCA as it circumnavigates South Queensferry in the northeast of the area. The scale of the road and Echline Junction in the landscape will be large and will permanently alter field patterns. The magnitude of change would be high and the overall impact would be of Substantial significance.

10.4.63 For South Queensferry, the route corridor and Echline Junction would result in a magnitude of change that would be medium to high. The impacts would be of Moderate to Substantial significance.

10.4.64 Dundas is a highly valued LLCA character area assessed as having medium to high sensitivity to change. The magnitude of change would be high since the route corridor would cut through existing woodland and fields to the north and east. The overall impact would be of Substantial significance.

10.4.65 The sensitivity to change for Craigbrae is medium due to the area's open aspect and small scale. South Corridor Option 1 would have a low magnitude of change on the LLCA as it passes to the west and would result in an impact of Slight significance.

10.4.66 Humbie has been designated an AOLQ and has a high sensitivity to change. South Corridor Option 1 would result in a low magnitude of change since there would be no direct effects on the area and the overall impact would be of Negligible significance.

Table 10.21: Summary of Potential Impacts - South Corridor Option 1

LLCA Receptor	Sensitivity	Potential Impact (unmitigated)		
		Direct/Indirect	Magnitude	Significance
Existing Road Corridor	Low to Medium	Direct	Low to Medium	Slight
Duddingston Lowland Hill and Valley Farmland	Medium	Direct	High	Substantial
South Queensferry Urban	Medium to High	Direct	Medium to High	Moderate to Substantial
Dundas Designed Wooded Landscape	Medium to High	Direct	High	Substantial
Craigbrae Lowland Hill and Valley Farmland	Medium	Direct	Low	Slight
Humbie Wooded Lowland Hill and Valley	High	Indirect	Low	Negligible

South Corridor Option 2

10.4.67 South Corridor Option 2 follows a direct line from the proposed replacement bridge to the M9 in the south. The proposed road is in cutting for most of this route corridor, with large embankments along some of the slip roads where it connects to the M9. The M9 Spur is also utilised to connect to the existing A90 and M9 Junction 1A is remodelled as in South Corridor Option 1. There are further realignment and connecting slip roads where the M9 Spur meets the A90 in the north. Potential impacts on LLCAs from South Corridor Option 2 are described below and summarised in Table 10.22.

10.4.68 For the Existing Road Corridor LLCA, South Corridor Option 2 would replace the existing M9 Junction 1A with a remodelled junction and additional bridge structures and would also create a further junction from the M9 Spur to the A90 with slip roads and bridges. The magnitude of change would be medium to high with an impact of Moderate significance. This impact is greater than for South Corridor Option 1.

10.4.69 South Corridor Option 2 would directly impact Duddingston, as it crosses from north to south, mainly in cutting, with embankment to the far north and south. The scale of the road and junction in the landscape would be large and permanently alter field patterns. The magnitude of change would be high and the overall impact would be of Substantial to Severe significance. This impact is greater than for South Corridor Option 1.

10.4.70 For South Queensferry, the route corridor would be contained by cuttings to produce a magnitude of change that will be low to medium. The impacts would be of Slight to Moderate significance.

10.4.71 The magnitude of change at Dundas would be medium to high due to reduced tranquillity to the west and east of the LLCA. The impact would be of Substantial significance.

10.4.72 South Corridor Option 2 would have a medium to high magnitude of change for Craigbrae due to junction infrastructure and the introduction of large embankments and bridges severing fields to the northwest. The overall impact significance would be considerably greater than for South Corridor Option 1 at Moderate to Substantial.

10.4.73 The magnitude of change for Humbie LLCA would be high for this route corridor option since South Corridor Option 2 passes directly through the area on embankment with elevated slip roads and bridges. The overall impact to the character of the area would therefore be of Severe significance, which is considerably more significant than for South Corridor Option 1.

Table 10.22: Summary of Potential Impacts - South Corridor Option 2

LLCA Receptor	Sensitivity	Potential Impact (unmitigated)		
		Direct/Indirect	Magnitude	Significance
Existing Road Corridor	Low to Medium	Direct	Medium to High	Moderate
Duddingston Lowland Hill and Valley Farmland	Medium	Direct	High	Substantial to Severe
South Queensferry Urban	Medium to High	Indirect	Low to Medium	Slight to Moderate
Dundas Designed Wooded Landscape	Medium to High	Direct	Medium to High	Moderate to Substantial
Craigbrae Lowland Hill and Valley Farmland	Medium	Direct	Medium to High	Moderate to Substantial
Humbie Wooded Lowland Hill and Valley	High	Direct	High	Severe

10.5 Potential Mitigation

10.5.1 At DMRB Stage 2 assessment of route corridor options, the detailed design has not been developed and mitigation detail therefore cannot be accurately defined. The objective of this section is therefore to identify 'standard' or 'anticipated' mitigation measures, in accordance with best practice, legislation and guidance.

10.5.2 This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 10.6 (Summary of Route Corridor Options Assessment), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

10.5.3 Mitigation measures are proposed as follows:

Respect integrity of surrounding landscape character

- uphold regional and local distinctiveness;
- develop landscape design for earthworks, walls, planting and seeding to reflect, reinstate and endorse the adjacent landform, land use, pattern and vegetation; and
- retain woodland, hedgerows, water bodies, stone walls and other intrinsic elements.

Conserve designated areas

- Select route corridor which avoids direct impacts and minimal indirect impacts on the following:
  1. Historic Garden and Designed Landscapes;
  2. semi-natural Woodland/Long-Established/Ancient Woodland; and
  3. Areas of Great Landscape Value.

Promote aesthetic cohesion

- ensure built elements and earthworks are keyed into surrounding landform;
- integrate alignment, earthworks and attenuation (SUDS) ponds with the surrounding topography;
- form rock cuttings to produce naturalistic appearance; and
- reinforce the sense of place with locally sourced materials, vegetation and design elements.

10.5.4 Initial assessment of the northern and southern corridor options has highlighted areas which, in general terms, could be used for landscape mitigation. These are outlined below.

Northern Route Corridor Options

<u>North Corridor Option 1</u>

- woodland planting on embankments at North Queensferry Coastal Flat to replace woodland lost in the cutting at Ferry Hills and extend the remaining woodland north; and
- woodland planting in severed section of field between slip road and mainline to the north of the Masterton Junction to reduce impacts on Fordell Designed Wooded Landscape.

<u>North Corridor Option 2</u>

- woodland planting on embankments at North Queensferry Coastal Flat to replace woodland lost in the cutting at Ferry Hills and extend the remaining woodland north;

- cut-and cover solution through Castlandhill to reduce impact of cutting through the wooded hillside; and
- woodland planting to assist landscape integration of the large embankment at Dales Farm Cottages.

Southern Route Corridor Options

South Corridor Option 1

- revegetation of cuttings to integrate with surrounding open farmland in Duddingston;
- woodland screen planting to the north of Dundas Castle to tie in with the existing woodland at the A904 Echline Junction; and
- woodland screen planting at M9 Junction 1A to tie in with existing surrounding woodland.

South Corridor Option 2

- revegetation of cuttings to integrate with surrounding open farmland in Duddingston;
- woodland planting at Humbie for screening and integration and to mitigate against loss of ancient woodland block at fragmented fields between the proposed scheme and existing infrastructure south of the LLCA; and
- woodland screen planting at M9 Junction 1A to tie in with existing surrounding woodland.

10.6 Summary of Route Corridor Options Assessment

10.6.1 This section takes the likely mitigation measures into account and summarises the residual impacts associated with each route corridor option.

Northern Route Corridor Options

10.6.2 North Corridor Option 1 is predominantly online and as a result, the overall impacts on landscape would generally be lower than for North Corridor Option 2.

North Corridor Option 1

10.6.3 North Corridor Option 1 is predominantly online so that the effects on the landscape of the area as a whole and impacts on LLCAs represent only a slight additional encroachment on the immediate rural surroundings north of Masterton and the urban and industrial edges of Rosyth and Inverkeithing to the existing M90 corridor. The significance of these effects is lower than for North Corridor Option 2.

10.6.4 Closer to the replacement crossing, the new route corridor will cut through wooded coastal braes, changing the topography and vegetation of the few remaining ‘islands’ of undeveloped land with impacts to LLCAs as detailed below.

10.6.5 North Corridor Option 1 would pass through the western edge of Ferry Hills on embankment at the top of a prominent hill, altering its topography and vegetation, with impacts of Substantial significance anticipated.

10.6.6 Proposed alterations to Masterton Junction would produce Moderate significance impacts for Inverkeithing farmland as the upgraded junction and link road will directly impact the west of this attractive rural area of high quality farmland.

10.6.7 Impacts of Moderate to Substantial significance are assessed at North Queensferry Coastal Flat where the new section of road between the proposed replacement bridge and existing A90 corridor would cut through the east edge of the LLCA on a wide embankment.

North Corridor Option 2

10.6.8 The majority of North Corridor Option 2 is offline so that overall impacts on the landscape character and LLCAs are significant for more LLCAs and greater than for North Corridor Option 1.

10.6.9 As with North Corridor Option 1, North Corridor Option 2 would pass through the western edge of Ferry Hills on embankment with Substantial significance impacts anticipated.

10.6.10 Where North Corridor Option 2 branches east of Masterton junction, woodland at Fordell and fields at Inverkeithing farmland would be severed and residual impacts for this attractive area of rolling farmland would be greater than for North Corridor Option 1 at Moderate to Substantial significance. Residual impacts from the large cutting through North Inverkeithing Lowland Hill would also be greater than for North Corridor Option 1.

10.6.11 The proximity of this corridor option to the west and north edge of Inverkeithing Urban Area, with the potential demolition of housing, would produce greater impacts than for North Corridor Option 1, with Moderate to Substantial significance.

10.6.12 Approaching the replacement crossing, the substantial cuttings through both wooded hills at Castlandhill, via a cut-and-cover solution on the northern hill and the additional slip road at North Queensferry coastal flat, to the west of the mainline, would sever woodland and significantly alter the coastal topography, with higher impact significance than for North Corridor Option 1 for both LLCAs of Severe.

Southern Route Corridor Options

10.6.13 South Corridor Option 1 would have a lower impact on the landscape than South Corridor Option 2. South Corridor Option 2 cuts through an open, rural landscape and in addition would impact on Humbie Area of Outstanding Landscape Quality (AOLQ) and increase isolation of Dundas Estate due to encircling by roads infrastructure.

South Corridor Option 1

10.6.14 South Corridor Option 1 is limited to linking existing roads, with limited additional roads and upgrading to junctions. The introduction of a motorway to the west and south of South Queensferry would effectively introduce a by-pass around the town, extending the existing area of development into farmland with a peripheral loss of rural character. Impacts on LLCAs are generally not significant, except where detailed below, and lower than for South Corridor Option 2.

10.6.15 The re-modelling of M9 Junction 1A would have overall residual impacts of Moderate to Slight significance for Overton.

10.6.16 This route corridor option utilises the existing M9 Spur and proposes an additional extension of the A90 running to the south and west of South Queensferry. This would directly impact the northeast of Duddingston LLCA, permanently altering field patterns with overall residual impact of Moderate to Substantial significance. It would also indirectly impact on South Queensferry with Moderate residual impact significance.

10.6.17 Moderate to Substantial significance residual impact is assessed for Dundas as this route corridor would cut through existing woodland and fields to the north and east of this LLCA.

South Corridor Option 2

10.6.18 South Corridor Option 2 follows a direct line from the proposed replacement bridge to the M9 in the south. The rigid alignment of this route corridor is unsympathetic to the rural expanse of open, undulating farmland which it crosses and although the woodland of Dundas' designed landscape is not directly affected, this corridor option would create a further boundary to isolate the charm and character of this historic area. Impacts on LLCAs would be significant for more LLCAs and greater than for South Corridor Option 1.

10.6.19 South Corridor Option 2 is in cutting for most of this route corridor, with large embankments along some of the slip roads where it connects to the M9. The M9 Spur is also utilised to connect to the existing A90 and M9 Junction 1A is remodelled as in South Corridor Option 1. There are further realignment and connecting slip roads where the M9 Spur meets the A90 in the north.

10.6.20 As with South Corridor Option 1, the re-modelling of M9 Junction 1A as part of South Corridor Option 2 would have overall residual impacts of Moderate to Slight significance for Overton.

10.6.21 For the Existing Road Corridor LLCA, the remodelled junction at M9 Junction 1A would have a residual impact of Moderate significance, which is greater than for South Corridor Option 1.

10.6.22 The large-scale cutting across Duddingston would produce residual impacts of Substantial significance, which is greater than for South Corridor Option 1.

10.6.23 Residual impacts of Moderate to Substantial significance would result from the reduced tranquillity to the west and east of Dundas LLCA. Similar impacts would occur at Craigbrae due to the introduction of large embankments and bridges, severing fields to the northwest. These impacts are the same as for South Corridor Option 1 for Dundas but considerably greater than South Corridor Option 1 for Craigbrae.

10.6.24 South Corridor Option 2 passes directly through Humbie on embankment with elevated slip roads and bridges. A residual impact of Substantial to Severe significance, which is considerably greater than for South Corridor Option 1 would accrue.

10.7 Scope of Stage 3 Assessment

10.7.1 The Stage 3 assessment will be based on the following tasks as set out in DMRB Volume 11, Section 3, Part 5:

- updated/supplementary baseline landscape assessment, if necessary, for consistency with relevant information from other subject areas;
- consultation with SNH regarding approach to and development of detailed mitigation and viewpoints for photomontages;
- identification of detailed mitigation and CPO land required, incorporating agricultural, surface water, ecological and noise mitigation;
- updated impact assessment to take account of detailed mitigation proposals; and
- preparation of photomontages.

10.8 References

ASH Consulting Group (1998). The Lothians Landscape Character Assessment. Scottish Natural Heritage Review No 91

David Tyldesley and Associates (1999). Fife Landscape Character Assessment. Scottish Natural Heritage Review No 113

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Landscape Institute and the Institute for Environmental Management and Assessment (2002). Guidelines for Landscape and Visual Impact Assessment, 2nd edition. Spon Press.

Scottish Executive (2002). DMRB Vol.11, Landscape & Visual Assessment, Section 3, Part 5, Supplementary Guidance. Scottish Executive Development Department.

The Highways Agency et al. (1993). DMRB Vol.11, Landscape & Visual Assessment. Section 3, Part 5. The Highways Agency, Scottish Executive Development Department, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

11 Visual

11.1 Introduction

11.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of impacts on the buildings, viewpoints, footpaths and transport routes (collectively referred to as receptors) that would notice a discernible change to the character and visual amenity of their views.

11.1.2 Impacts assessed as being of Moderate or greater are considered to represent clearly perceptible changes to views and mitigation would generally be required to reduce these where possible.

11.1.3 The likely mitigation is considered and taken into account to summarise the residual impacts for each route corridor and identify the northern and southern route corridors with the lowest overall visual impact.

11.1.4 Visual impacts relating specifically to views from the road are considered in Chapter 16 (Vehicle Travellers). Visual impacts during construction are addressed in Chapter 17 (Disruption Due to Construction).

11.2 Approach and Methods

Study Area

11.2.1 The indicative study area for the visual assessment was identified through a combination of desk based assessment and site survey. The assessment identified the locations of property areas likely to experience a visual change related to the project for each route corridor option. For the purposes of comparative assessment at Stage 2, the study area has been limited to an approximate 3km distance from the route corridor options (considered to be the approximate distance when elements of this infrastructure could have a discernible visual impact on a receptor and a robust comparison made) subject to screening by surrounding topography and woodland.

11.2.2 Due to the anticipated height of the proposed replacement bridge structure, it would be visible from locations to the west along the Firth of Forth and viewpoints throughout Edinburgh City, beyond the study area. At this stage it is considered that potential impacts beyond the study area would not be significant, due to distance, the proximity of the existing Forth Road Bridge and Forth Rail Bridge and effective integration of the Forth Replacement Crossing. However, as explained in Section 11.7, the use of separate assessments for the replacement bridge and approach roads, with separate study areas and Visual Envelope Maps will be undertaken at Stage 3, in consultation with SNH. This will ensure that potential visual impacts upon the wider landscape are considered as part of the detailed assessment.

Guidance and Approach

11.2.3 The visual assessment follows guidance provided in DMRB Volume 11 Section 3 Part 5, Landscape & Visual Assessment and Supplementary Guidance (Highways Agency et al., 1993; Scottish Executive, 2002) and Guidelines for Landscape and Visual Impact Assessment (Landscape Institute and Institute of Environmental Management & Assessment, 2002).

11.2.4 The assessment has been carried out through:

- review of proposed route corridor options and replacement bridge design to ascertain the likely visually intrusive elements of the proposals; and

- field studies to identify receptor areas likely to experience a change of visual amenity in relation to each route corridor option.

Impact Assessment

11.2.5 The assessment considers both built (dwellings, workplaces and recreational buildings) and outdoor (major and well-used minor roads, the Edinburgh to Dundee railway, outdoor recreational spaces, rights of way, footpaths (in accordance with the Scottish Paths Record), cycleways and equestrian routes) receptors. Groups of built and outdoor receptors within the study area which would gain views of the Forth Replacement Crossing were identified through assessment by teams of two or more landscape architects in the field, and the degree of change to their visual amenity surveyed. Receptors likely to be affected by the proposed corridor options are identified on Figures 11.1 to 11.5.

11.2.6 The significance of visual impacts was determined through consideration of both the sensitivity of the visual receptors and the predicted magnitude of change as a result of the proposed scheme.

Sensitivity of Receptors

11.2.7 The sensitivity of visual receptors to changes in their views was evaluated in accordance with the criteria provided in Table 11.1 based on the following factors:

- nature and context of the viewpoint;
- expectations of users/receptors; and
- importance and value of the view to the receptor.

Table 11.1: Sensitivity of Visual Receptor

Sensitivity	Criteria
High	Receptors where the changed view is of high value and importance and/or where the receptor will notice any change to visual amenity by reason of the nature of use and their expectations, (particularly remote dwellings situated to take advantage of panoramic scenic views or outdoor receptors where the view is important to users will be considered to be of high sensitivity).
Medium	Receptors where the changed view is incidental but not critical to amenity and/or the nature of the view is not a primary consideration of the users (the majority of dwellings have been assessed as being of medium sensitivity, as well as outdoor receptors where users are likely to spend time outside of participation in their activity looking at the view and industrial receptors that have offices with windows that take advantage of views).
Low	Receptors where the changed view is unimportant/irrelevant and/or users are not sensitive to change (the majority of industrial receptors are considered to be of low sensitivity unless they have a significant number of windows, which may raise their sensitivity to low/medium; outdoor receptors where users are unlikely to consider the views an important element of their usage of the site will generally be assessed to be of low sensitivity).

Magnitude of Visual Change

11.2.8 Evaluation of the magnitude of visual change affecting receptors was carried out by considering the scale of change in the view due to the addition or loss of features, change in character and the amount/extent of the view affected.

11.2.9 The main elements taken into account in the evaluation of magnitude of change included:

- the extent of the receptor's available view affected by the development (including the distance from the scheme);
- the angle of view relative to the main activity of the receptor; and
- the level of integration or contrast created by the road and its associated elements within the view.

11.2.10 The criteria used to determine the magnitude of visual change are shown in Table 11.2.

Table 11.2: Magnitude of Visual Change

Magnitude	Criteria
High	Where the Forth Replacement Crossing or elements of it will dominate the view and fundamentally change its character and components.
Medium	Where the Forth Replacement Crossing or elements of it will be noticeable in the view, affecting its character and altering some of its components and features.
Low	Where the Forth Replacement Crossing or elements of it will be only a minor element of the overall view that are likely to be missed by the casual observer and/or scarcely appreciated.

Impact Significance

11.2.11 Table 11.3 was used to help determine the thresholds of adverse or beneficial impact significance using a matrix of sensitivity and magnitude. It should be noted, however, that the use of this matrix was supplemented by professional judgement and awareness of the relative balance of importance between sensitivity and magnitude.

Table 11.3: Visual Impact Significance Criteria

Magnitude / Sensitivity	Negligible	Low	Medium	High
High	Slight	Moderate	Substantial	Severe
Medium	Negligible to Slight	Slight	Moderate	Substantial
Low	Negligible	Negligible to Slight	Slight	Moderate

11.2.12 As stated in 11.1.4, impacts of Moderate or greater are considered to be significant such that they should be mitigated where possible, as this is the level at which changes would be clearly perceived.

11.2.13 It should be noted that to provide consistency with the assessment of other environmental parameters within this Stage 2 report, stated impacts are considered to be adverse unless otherwise qualified. However, this distinction is inherently subjective in visual terms, particularly with regard to large and potentially 'iconic' bridge structures.

Limitations to Assessment

11.2.14 At this stage the assessment was limited to a general survey to provide an indicative visual envelope for each of the northern and southern route corridor options as part of the identification of a preferred corridor. The existing bridges are visible from a great distance along the Firth of Forth and parts of Edinburgh. The structure of the proposed replacement bridge is anticipated to be similarly visible, but the study area for the visual impacts will not extend to cover all areas as beyond a distance of approximately 3km, the visual change will be so minimal as to be considered insignificant. A detailed survey to identify specific receptors and assess impacts will be carried out at DMRB Stage 3, following the selection of a preferred route corridor option.

11.3 Baseline Conditions

11.3.1 The 'Guidelines for Landscape and Visual Impact Assessment' (IEMA, 2002), states that '*landscape and visual assessments are separate, although linked, procedures. The landscape baseline, its analysis, and the assessment of landscape effects all contribute to the baseline for visual assessment studies*'. The visual context and baseline description of the study area is therefore incorporated to a considerable extent in Chapter 10 (Landscape) and supporting Appendix A10.1.

11.3.2 Baseline visual conditions around the northern and southern study areas are summarised below. Sensitivity is described generally in this section for areas and for key features to provide an overview of baseline visual sensitivity, however the sensitivity of specific individual receptors is identified within the impact assessment (Section 11.4: Potential Impacts) to avoid unnecessary repetition.

Northern Study Area

11.3.3 Much of the northern study area is urban development. The largest settlement, Dunfermline, has significantly expanded in recent years, with housing development on-going at the eastern side of the town. The town is built across a number of hills, which provide several areas (such as Garvock Hill and Brucefield) with views to the south across Rosyth and the M90 towards the existing bridges. The majority of properties are generally considered to be of medium sensitivity.

11.3.4 Views across the Firth of Forth from Rosyth, to the south of Dunfermline, are restricted by Castlandhill, the Naval Base, ferry terminal and industry in Roysth Europarc at the southern edge of the town. The A90/M90 separates Rosyth from Inverkeithing, situated on a hillside with views to the south-east across Inverkeithing Bay. The northern side of the town has views across rolling farmland towards the M90 and Fordell Estate, which are adversely affected by the presence of the industrial estate at the edge of the settlement. Further east, the settlement of Dalgety Bay is also situated on the coastal hillside, with the Forth Rail Bridge prominent in views to the west. The topography of the surrounding area, in particular the wooded ridgeline of Letham Hill, limits views elsewhere, although the Hillend community at the northern edge of the town has attractive, rural views to the south of Fordell Estate.

11.3.5 Outwith the settlements, the majority of the study area is open farmland of medium sensitivity with views towards the Firth of Forth featuring both countryside and urban development. Rolling topography and woodland, particularly within Fordell Estate, provides screening for many rural areas.

11.3.6 Views from many of the existing roads are contained by development, while the M90/A90 is visually enclosed throughout much of the study area by cuttings and vegetation, so that sensitivity is limited to low. The B981 road and associated footpath to North Queensferry have attractive, intermittent views across the Firth of Forth which afford this receptor medium sensitivity to change.

11.3.7 The Fife Coastal Path and the footpaths across Castlandhill are medium sensitivity, with attractive views across the Firth of Forth and limited views of the Forth rail bridge, the surrounding farmland and the settlements to the north, dominated by the existing bridges.

Firth of Forth

11.3.8 The Forth Road Bridge and Forth Rail Bridge across the Firth of Forth are significant features within the landscape, with an extensive visual envelope from northern Edinburgh to Dunfermline and west along the river to Bo'ness. Views from the Firth of Forth itself are also important as it is extensively used by leisure craft as well as commercial and defence vessels. Despite the heavy industry at Rosyth Europarc and Grangemouth, the scenic value of the area is high and potentially sensitive to change.

Southern Study Area

11.3.9 South Queensferry is the largest settlement in the southern study area. The context of the historic harbour area affords the majority of properties medium/high sensitivity while properties elsewhere are considered to be of medium sensitivity. Views are focussed towards the Firth of Forth by the rolling topography of the surrounding farmland. The other significant settlement is the village of Kirkliston, situated to the north of Edinburgh Airport between the River Almond and the M9 and M9 Spur. Properties here have medium sensitivity due to the intrusive development in the area. The adjacent motorway embankments and rising landform to the north of the village screen views to the north and west.

11.3.10 There are several historic estates across the study area at Hopetoun, Dundas, Dalmeny and Newliston. The properties and grounds are generally enclosed by woodland although Hopetoun House Estate, which is situated on the lower slopes of the estuary, has intermittent views to the east along the Firth of Forth towards the existing bridges and there are famous views from the top of Dundas Castle.

11.3.11 Between the M9 and the Firth of Forth, there are numerous isolated farms and dwellings. The rolling nature of the surrounding landform and a number of woodland plantations limit views for most of these properties.

11.3.12 The majority of the existing roads have open views across the surrounding farmland and medium sensitivity, in particular the M9 and M9 Spur, which are generally situated on high embankments. The rolling topography of the farmland limits views of the Firth of Forth from many of the roads, but the tops of the existing bridges are visible from northbound sections of the M9 Spur, A90 and A8000. Open views across the Firth of Forth are available from the A904 to the west of South Queensferry, with a designated viewpoint of medium to high sensitivity situated at the edge of the small settlement at Newton.

11.4 Potential Impacts

11.4.1 Without appropriate mitigation, visual impacts may include the following:

- alteration to the character of views due to loss of landscape elements and introduction of infrastructure elements associated with a new bridge and connecting roads, including lighting in previously unlit areas; and
- alteration and obstruction of views by the introduction of significant cuttings or embankments into the landform and reduced screening where woodland is lost.

11.4.2 The proposed replacement bridge, the northern and southern route corridor options are assessed separately.

11.4.3 The sensitivity of each receptor is justified on the first occasion that the receptor is discussed and remains unchanged throughout the chapter.

11.4.4 If potential impacts are considered to be common to both route corridor options in the northern or southern study areas, these are identified separately.

Proposed Replacement Bridge

11.4.5 Due to the height of the proposed replacement bridge, it is anticipated to be the most visible element of the Forth Replacement Crossing, and would have the same impacts for all of the route corridor options.

11.4.6 Potential receptors are indicated on Figure 11.1 and impacts on receptors are described below and summarised in Table 11.4.

<u>Built Receptors</u>

11.4.7 The towers of the proposed replacement bridge would be visible from elevated locations in Dunfermline at Abbey Parks, Garvock Hill and Brucefield and the new development at the southeastern edge of the town. Due to the distance involved and the proximity of the towers to the existing bridges, the impacts would not be considered to be significant. Similar views are predicted for the northern part of Rosyth and the eastern side of Inverkeithing.

11.4.8 The proximity of the A90 to properties at Muckle Hill and southwest Inverkeithing affects the setting of the dwellings and reduces their sensitivity to medium. The proposed replacement bridge would represent a low magnitude of change and an impact of Slight to Negligible significance.

11.4.9 Castlandhill Cottages would have open views of the new crossing. Despite the existing A90 and mobile phone masts on the hill, these properties have medium to high sensitivity. The proximity of the proposed replacement bridge to the existing crossings would represent a low magnitude of change which would result in a Slight to Moderate significance impact.

11.4.10 Housing on Ferry Toll Road would have views towards the proposed replacement bridge, partially screened by the woodland on the other side of the road. The adjacent industry limits sensitivity to medium and the proposed replacement bridge would not be considered a significant change to views. The impact on the housing would therefore be of Slight to Negligible significance.

11.4.11 The proposed replacement bridge would be visible from the majority of North Queensferry where receptors have medium to high sensitivity. The proposed replacement bridge would represent a medium magnitude of change, with Moderate significance impacts.

11.4.12 The proposed replacement bridge would pass very close to the Queensferry Hotel (Figure 11.1a) which is assessed as having medium sensitivity. The new bridge would affect the only remaining open aspect, with high magnitude of change and Substantial significance impacts.

11.4.13 Admiralty House, Ferry Craig House and Tigh-na-Grian are situated on the coast of the Firth of Forth with attractive views, which give the properties high sensitivity. The introduction of the proposed replacement bridge to their views would represent a high magnitude of change with Severe significance impacts.

11.4.14 The nature of the Naval Base, Rosyth Europarc, ferry terminal and sewage works at the southern edge of Rosyth limits them to low sensitivity, despite their coastal locations. Although highly visible from the facilities, the backdrop of the existing bridges would limit the magnitude of change to low, and impact significance to Slight to Negligible.

11.4.15 South of the Firth of Forth, approximately half of South Queensferry, where sensitivity of receptors is medium, would notice a medium change to views of the Firth of Forth and the existing bridges, with Moderate significance impacts. The historic waterfront has medium to high sensitivity due to available views and also medium magnitude of change and Moderate significance impacts.

11.4.16 To the west of South Queensferry, Inchgarvie House and houses at Linn Mill overlook the Firth of Forth where woodland at East Shore Wood permits. These receptors have medium to high sensitivity. The proposed replacement bridge would pass immediately east of the properties, set against the backdrop of the existing bridges, so that a medium magnitude of change and Moderate to Substantial significance impacts would be predicted.

11.4.17 Further west along the coast, Hopetoun House, the Lodge and the Society houses at the edge of the estate have attractive views across the Firth of Forth and therefore high sensitivity. The addition of a third bridge would produce a medium visual change and Moderate significance impacts.

11.4.18 Industrial units at the edge of Hopetoun Estate have low sensitivity as the available views are not important to these receptors and are partially screened by existing woodland around the site. The magnitude of change for the facility would be low resulting in Slight to Negligible significance impacts.

11.4.19 Duddingston, Lawflat, and White Gate Lodge are farms and dwellings scattered across the farmland around Dundas Estate, which are considered to be of medium to high sensitivity due to their attractive rural views. The proposed replacement bridge would cause a low magnitude of change to the views of the existing bridges, which would have a Slight significance impact on the properties.

11.4.20 Dundas Castle is noted for its panoramic view from the top of the castle and is assessed as being of high sensitivity. The new bridge would produce a low to medium magnitude of change, with Moderate significance of impact.

11.4.21 Dundas Home Farm, situated beside the A90 at the edge of Dundas Estate, would also have a low change to views but the reduced sensitivity of medium would limit significance of impacts to Slight to Negligible.

Outdoor Receptors

11.4.22 Between the small settlement at Newton and South Queensferry, sections of the eastbound A904 would have views across the Firth of Forth towards the proposed replacement bridge. The receptor is considered to be of medium sensitivity due to the available views, but would only notice a low to medium magnitude of change to views of the existing bridges, which would have Slight to Moderate significance impacts on the visual amenity of the route.

11.4.23 A designated viewpoint for the existing bridges is situated on the A904 east of Newton. The purpose of this receptor justifies medium to high sensitivity. The proposed replacement bridge would cause a medium magnitude of change to the existing views resulting in Moderate to Substantial significance impacts.

11.4.24 A coastal footpath to Hopetoun House, which overlooks the Firth of Forth and existing bridges has medium to high sensitivity. The proposed replacement bridge, set against the backdrop of the existing bridges would represent a low to medium magnitude of change and Moderate significance impact.

11.4.25 The footpath along the waterfront of South Queensferry is also considered to be of medium to high sensitivity. From this receptor, the proposed replacement crossing would be seen behind the Forth Road Bridge, representing a low magnitude of change to the views and Slight to Moderate significance impact. The proposed replacement bridge would also be visible from the path as it continues to the east around Dalmeny Estate, but impacts would be of Negligible significance as it would not represent a significant change to the existing view in the context of the existing bridges.

11.4.26 Port Edgar marina, at the edge of South Queensferry, has panoramic views across the Firth of Forth, dominated to the east by the existing bridges giving the facility medium to high sensitivity to change. The proposed replacement bridge would be located immediately west of the marina, with medium to high magnitude of change and Substantial significance impact for these views.

11.4.27 North of the Firth of Forth, there would be low magnitude of change and Negligible significance impacts for all existing roads except the B981 road and associated footpath to North Queensferry, where medium magnitude of change and Moderate significance impacts are assessed. However, only low magnitude of change and Negligble significance impacts would occur for the Fife Coastal Path and the footpaths across Castlandhill.

11.4.28 The attractive views available from the Firth of Forth itself are currently impacted by the industry and urbanisation of the shoreline, which limit the sensitivity of the receptor to medium to high. The close proximity of the proposed replacement bridge to the existing bridges would bring about a low to medium change for the majority of views.

Table 11.4: Summary of Potential Impacts – Proposed Replacement Bridge

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Muckle Hill dwellings – SW Inverkeithing	Medium	Low	Slight to Negligible
Castlandhill Cottages	Medium to High	Low	Slight to Moderate
Ferry Toll Road housing estate, Rosyth	Medium	Low	Slight to Negligible
North Queensferry	Medium to High	Medium	Moderate
The Queensferry Hotel	Medium	High	Substantial
Admiralty House, Ferry Craig House & Tigh-na-Grian	High	High	Severe
HM Naval Base, Rosyth Europarc & sewage works	Low	Low	Slight to Negligible
South Queensferry	Medium	Medium	Moderate
South Queensferry waterfront buildings	Medium to High	Medium	Moderate
Inchgarvie House & Linn Mill	Medium to High	Medium	Moderate to Substantial
Hopetoun House, Lodge & Society Houses	High	Medium	Moderate
Hopetoun Estate industrial area	Low	Low	Slight to Negligible
Duddingston, Lawflat, White Gate	Medium to High	Low	Slight
Dundas Castle	High	Low to Medium	Moderate
Dundas Home Farm	Medium	Low	Slight to Negligible
A904	Medium	Low to Medium	Slight to Moderate
A904 viewpoint	Medium to High	Medium	Moderate to Substantial
Coastal path to Hopetoun House	Medium to High	Low to Medium	Moderate
South Queensferry waterfront footpath	Medium to High	Low	Slight to Moderate
Existing roads in Northern study area	Low	Low	Negligible
B981 to North Queensferry	Medium	Medium	Moderate
Fife Coastal Path and footpath across Castlandhill	Medium	Low	Negligible
Port Edgar marina	Medium to High	Medium to High	Substantial
Firth of Forth	Medium to High	Low to Medium	Moderate

Northern Route Corridor Options

<u>Impacts Common to Both Northern Route Corridor Options</u>

11.4.29 Impacts on receptors which would be common to both Northern route corridor options are described below and summarised in Table 11.5. Potential receptors are indicated on Figures 11.2 and 11.3.

11.4.30 The park and ride at Inverkeithing and the sewage works at North Queensferry have low sensitivity. Changes to the Ferrytoll junction for both options would cause a low degree of change to their views and Slight to Negligible significance visual impacts.

11.4.31 Views from the lodge for Admiralty House and Welldean Cottages, north of North Queensferry, are screened by local vegetation and topography, which limit their sensitivity to medium. The new roads would be close to the properties, dominating their views and causing a high magnitude of change and Substantial significance.

Table 11.5: Summary of Potential Impacts Common to Both Northern Route Corridor Options

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Inverkeithing Park & Ride and North Queensferry Sewage Works	Low	Low	Slight to Negligible
Admiralty House Lodge & Welldean Cottages	Medium	High	Substantial

<u>North Corridor Option 1</u>

11.4.32 The majority of North Corridor Option 1 would be online with the existing A90/M90 and unlikely to represent a discernible visual change to that caused by the existing road network for the majority of receptors.

11.4.33 Potential receptors are indicated on Figures 11.2 and impacts on receptors are described below and summarised in Table 11.6.

11.4.34 At the southeastern corner of Dunfermline, new housing being built north of the existing M90, near Mastertown and Middlebank farms, has open views south. The urban setting of the receptors limits their sensitivity to medium. Changes to the Masterton Junction with the removal of vegetation that currently screens the M90 and the new road connecting to the A921 would cause a low to negligible change and Slight significance impacts.

11.4.35 To the south of Fordell Estate, Balbougie Farm and Cottages are considered to be of medium to high sensitivity with attractive rural views to Letham Hill. The revised Masterton Junction would introduce new slip roads and overbridges and a link to the A921 to their views, which would cause a low change to views and Slight significance impacts.

11.4.36 The small Hillend community to the east of Inverkeithing has medium sensitivity due to the intrusion of the railway line. The slip roads and structures for the revised Masterton Junction would cause a low change to their views which would result in Slight significance impacts.

11.4.37 To the north of Inverkeithing, The Dales and its associated Cottages and Steadings have attractive views south and east across the surrounding farmland, which affords the properties medium to high sensitivity. The earthworks required for the link road from the A921 to the revised slip roads would cause a medium magnitude of change with Moderate significance impacts.

11.4.38 The new link roads to the A921 and structures for the slip roads would cause a medium change to views from Inverkeithing Industrial Estate, but the low sensitivity of the receptor would only have a Slight significance impact.

11.4.39 To the east of the main estate, a small group of business units and houses on North Road (B981), with medium sensitivity, would notice a medium magnitude of change with Moderate significance impacts.

11.4.40 Inverkeithing High School has an elevated location above the A921, with open views across the farmland to the north that afford it low to medium sensitivity. The embankments for the new link road around the industrial estate and slip roads would represent a low to medium change to the views and a Slight significance impact.

11.4.41 Properties at Burleigh Crescent in Inverkeithing have medium sensitivity, would have a low to medium change to views that would result in Slight to Moderate impacts.

11.4.42 Housing at Struan Place and Struan Drive at the northern edge of Inverkeithing is situated on slightly higher ground with wider views over the valley. The slip roads and link roads for the revised Masterton Junction would have a medium magnitude of change on views from the properties which would result in Moderate significance impacts.

11.4.43 Dwellings on Castlandhill have attractive views across the Firth of Forth and the surrounding settlements that give the properties medium to high sensitivity. The changes to the main carriageway would have minimal impact on the receptors, but the new Ferrytoll junction would be visible to the south, producing a low to medium change and Moderate significance impact.

11.4.44 To the east of the A90, more densely clustered properties on Muckle Hill have similar views across the area but reduced sensitivity of medium. The new junction would bring about a low to medium change to the views and a Slight to Moderate significance impact.

Table 11.6: Summary of Potential Impacts – North Corridor Option 1

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Southeastern edge of Dunfermline	Medium	Low to Negligible	Slight
Balbougie Farm & Cottages	Medium to High	Low	Slight
The Dales	Medium to High	Medium	Moderate
Hillend	Medium	Low	Slight
Inverkeithing Industrial Estate	Low	Medium	Slight
North Road	Medium	Medium	Moderate
Inverkeithing High School	Low to Medium	Low to Medium	Slight
Burleigh Crescent, Inverkeithing	Medium	Low to Medium	Slight to Moderate
Struan Place & Struan Drive, Inverkeithing	Medium	Medium	Moderate
Castlandhill	Medium to High	Low to Medium	Moderate
Muckle Hill	Medium	Low to Medium	Slight to Moderate

<u>North Corridor Option 2</u>

11.4.45 North Corridor Option 2 would require a significant cutting through Castlandhill and the adjacent hillside at the northern edge of Inverkeithing, with a new bridge to cross the existing A90/M90. The route would then be on significant structure as it crosses the industrial estate at Inverkeithing and railway line before moving onto embankment and into cutting as it runs up the hill to tie-in with the existing M90.

11.4.46 Potential receptors are indicated on Figure 11.3 and impacts on receptors are described below and summarised in Table 11.7.

11.4.47 Cuttings at Castlandhill and the adjacent hillside would be visible in the distance from parts of the Garvock Hill, Brucefield and Pitcorthie housing areas of Dunfermline. The magnitude of change would be considered to be medium, with Moderate significance impact predicted for the affected properties. The housing and business units around Castle Brae and the new housing at the south-eastern edge of the town near Mastertown and Middlebank farms and to the east of Annfield House also have medium sensitivity, but clearer views of the route corridor. This would result in a medium to high change and Substantial significance impacts upon their views.

11.4.48 At the eastern edge of Dunfermline, Duloch, Duloch Home Farm and Old Duloch, situated adjacent to the M90, would be affected by the proposed motorway split near Fordell Estate, where trees would be removed and a flyover constructed. These receptors have medium sensitivity. Duloch would experience a medium to high change to views and Moderate to Substantial impacts. Duloch Home Farm and Old Duloch would only notice a low change due to screening by retained vegetation and Slight significance impacts.

11.4.49 Impacts would be more significant for the medium to high sensitivity Balbougie Cottages than those caused by North Corridor Option 1, but the existing woodland around Balbougie Farm would help to screen the property from impacts. The cutting at the northern edge of Inverkeithing and the structures required to cross the industrial estate and railway would be visible, which would cause a low to medium change to views and Moderate significance impacts.

11.4.50 Receptors at the edge of Hillend, which have medium sensitivity, would have views of the road crossing the hillside north of the railway. This option would cause a medium to high magnitude of change and Moderate to Substantial significance impacts to the receptors.

11.4.51 As noted in North Corridor Option 1, The Dales and its associated Cottages and Steadings to the north of Inverkeithing are considered to have medium to high sensitivity due to the available views. The proximity of the scheme to the receptors and the felling of part of the adjacent mature woodland would represent a high magnitude of change with Severe significance impacts.

11.4.52 Inverkeithing Industrial Estate has low sensitivity, so that a high magnitude of change from the route corridor crossing the eastern side of the estate would only have Moderate significance impacts.

11.4.53 The houses and business units on the B981 to the east of the main estate are considered to have medium sensitivity. The structures for the route corridor as it crosses the estate would cause a medium to high magnitude of change which would have Moderate to Substantial significance impacts.

11.4.54 As with North Corridor Option 1, Inverkeithing High School is considered to have low to medium sensitivity due to its elevated position. The route corridor through the industrial estate and across the hillside would represent a medium to high change to the views, and Moderate significance impacts.

11.4.55 At the northern edge of Inverkeithing, properties on Burleigh Crescent and Niven Road have medium sensitivity. The road would cause a medium to high change to views with Moderate to Substantial significance impacts.

11.4.56 Impacts on the medium sensitivity housing on Struan Place, Struan Drive and Cameron Grove at the northern edge of Inverkeithing would be more significant, with a high magnitude of change and Substantial significance impacts.

11.4.57 The cuttings through Castlandhill and the northern edge of Inverkeithing would be visible from much of Rosyth, but would not cause significant impacts. Exceptions occur at the northern end of Queensferry Road, where properties near the railway station are elevated with views to the south. The cuttings would cause a medium change to the views, with Moderate significance impacts.

11.4.58 At the eastern edge of Rosyth, housing at Park Lea, Harley Street and Craig Street would experience a medium to high magnitude of change, with Moderate to Substantial significance impacts.

11.4.59 Receptors in south Rosyth, at Hillwood Terrace, Alexander Place and Hudson Road, would have open views of the cutting and proposed replacement bridge that would cause high magnitude of change to views and Substantial significance impacts.

11.4.60 In west Rosyth, new housing at Sherbrooke Road and Peasehill Brae would have limited views of the Castlandhill cutting, causing a low magnitude of change and Slight significance impacts.

11.4.61 On Castlandhill, the context for the farm and adjacent row of housing is considered to be of medium to high sensitivity. The nearby cuttings through Castlandhill Woods and through the hillside at the northern edge of Inverkeithing, the new bridge across the existing A90/M90 and the new Ferrytoll junction would represent a high magnitude of change to the views with Severe significance impacts.

11.4.62 The Forth Replacement Crossing would cause a high magnitude of change to views from dwellings on Muckle Hill, which would be considered to have Substantial significance impacts.

Table 11.7: Summary of Potential Impacts - North Corridor Option 2

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Garvock Hill, Brucefield & Pitcorthie, Dunfermline	Medium	Medium	Moderate
Southeastern edge of Dunfermline	Medium	Medium to High	Substantial
Duloch	Medium	Medium to High	Moderate to Substantial
Duloch Home Farm & Old Duloch	Medium	Low	Slight
Balbougie Farm Cottages	Medium to High	Low to Medium	Moderate
Hillend	Medium	Medium to High	Moderate to Substantial
The Dales & Dales Farm Cottages	Medium to High	High	Severe
Inverkeithing Industrial Estate	Low	High	Moderate
North Road	Medium	Medium to High	Moderate to Substantial
Inverkeithing High School	Low to Medium	Medium to High	Moderate
Burleigh Crescent & Niven Road, Inverkeithing	Medium	Medium to High	Moderate to Substantial
Struan Place, Struan Drive & Cameron Grove, Inverkeithing	Medium	High	Substantial
Northern end of Queensferry Road, Rosyth	Medium	Medium	Moderate
Park Lea, Harley Street & Craig Street, Rosyth	Medium	Medium to High	Moderate to Substantial
Hillwood Terrace, Alexander Place & Hudson Road, Rosyth	Medium	High	Substantial
Sherbrooke Road & Peasehill Brae, Rosyth	Medium	Low	Slight
Castlandhill	Medium to High	High	Severe
Muckle Hill	Medium	High	Substantial

Southern Route Corridor Options

Impacts Common to Both Southern Route Corridor Options

11.4.63 Impacts on receptors which would be common to both southern route corridor options are described below and summarised in Table 11.8. Potential receptors are indicated on Figures 11.4 and 11.5.

11.4.64 At the southern end of the proposed replacement bridge, the road would cross fields adjacent to the western edge of South Queensferry and the more sensitive Linn Mill on embankment. The high magnitude of change would produce Substantial and Substantial to Severe significance impacts respectively.

11.4.65 The proposed A904 crossing would be visible from properties at the southwestern corner of South Queensferry with a medium to high change to views and Moderate to Substantial significance impacts.

11.4.66 As stated previously, Dundas Castle has high sensitivity. Both route corridor options would sever fields in middle-distant views. The magnitude of change would be medium and the significance of impact Moderate to Substantial.

11.4.67 The upgraded M9 Junction 1A would introduce a major interchange on embankments into views from Humbie Home Farm and Steadings, causing a medium to high magnitude of change and Moderate to Substantial significance impacts upon the properties.

11.4.68 Views from Bedlam Paintball, east of Dundas Estate, have low sensitivity. Modifications to the Echline/Scotstoun Junction would have a low to medium change to views and Slight significance impacts.

11.4.69 Despite their proximity to the proposed revisions to the Echline/Scotstoun Junction, the magnitude of change for the industrial units at Royal Elizabeth Yard would be low, resulting in Slight to Negligible significance impacts.

11.4.70 Harribrae Kennels and Cattery, at the southern edge of Dalmeny, is considered to have low to medium sensitivity. The proposed Echline/Scotstoun Junction would represent a low to medium change and Slight significance impact.

Table 11.8: Summary of Potential Impacts Common to Both Southern Route Corridor Options

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	**Significance**
Western edge of South Queensferry	Medium	High	Substantial
Linn Mill	Medium to High	High	Substantial to Severe
Southwestern corner of South Queensferry	Medium	Medium to High	Moderate to Substantial
Dundas Castle	High	Medium	Moderate to Substantial
Humbie Farm and Steadings	Medium	Medium to High	Moderate to Substantial
Bedlam Paintball HQ	Low	Low to Medium	Slight
Royal Elizabeth Yard	Low	Low	Slight to Negligible
Harribrae Kennels & Cattery, Dalmeny	Low to Medium	Low to Medium	Slight

South Corridor Option 1

11.4.71 This route corridor option would utilise the existing M9 Spur and proposes an additional extension of the A90 running to the south and west of South Queensferry. M9 Junction 1A would be remodelled and additional slip roads used to connect the Spur to the existing A90.

11.4.72 Potential receptors are indicated on Figure 11.4 and impacts on receptors are described below and summarised in Table 11.9.

11.4.73 The Echline/Scotstoun Junction would be visible from dwellings and commercial properties on the A904 near the existing junction with the A90. These receptors, considered to be of medium sensitivity, would experience a medium to high change to their views and Moderate to Substantial significance impacts.

11.4.74 The Ferry Muir retail estate has low sensitivity changes in its visual context. The merging of the Echline/Scotstoun Junction would not noticeably degrade views, so the magnitude of change would be low, with Slight to Negligible significance impacts.

11.4.75 Housing on the southern edge of the Scotstoun area in South Queensferry has medium sensitivity. The magnitude of change to their views from the additional slip road at the new Echline/Scotstoun Junction would be low to medium, with a Moderate to Slight significance impact.

11.4.76 The new Echline/Scotstoun Junction would represent a medium to high magnitude of change for Dundas Home Farm and adjacent properties and Moderate to Substantial significance impacts.

11.4.77 The magnitude of change for Duddingston, Lawflat and White Gate would be limited to low to medium by distance, topography, vegetation and the road cutting, resulting in Moderate significance impacts to views. Higher impacts for these receptors are assessed for South Corridor Option 2.

11.4.78 South of the M9, Overton and Burbank Cottages have medium sensitivity. The new junction would have a medium magnitude of change to their views and a Moderate significance impact, which would be less significant than the impacts resulting for South Corridor Option 2.

Table 11.9: Summary of Potential Impacts - South Corridor Option 1

Receptor	Sensitivity	Potential Impact (unmitigated)	
		Magnitude	Significance
Dwellings and commercial properties on the A904	Medium	Medium to High	Moderate to Substantial
Ferry Muir retail estate	Low	Low	Slight to Negligible
Dwellings on southern edge of Scotstoun area in South Queensferry	Medium	Low to Medium	Moderate to Slight
Dundas Home Farm	Medium	Medium to High	Moderate to Substantial
Duddingston, Lawflat and White Gate	Medium to High	Low to Medium	Moderate
Overton and Burbank Cottages	Medium	Medium	Moderate

<u>South Corridor Option 2</u>

11.4.79 South Corridor Option 2 would follow a direct line from the proposed replacement bridge to the M9 in the south. The proposed road would be in cutting for most of this route corridor, with large embankments along some of the slip roads where it would connect to the M9. The M9 Spur would also be utilised to connect to the existing A90 and M9 Junction 1A would be remodelled as in South Corridor Option 1. There would be further realignment and connecting slip roads where the M9 Spur connects with the A90 in the north.

11.4.80 Potential receptors are indicated on Figure 11.5 and impacts on receptors are described below and summarised in Table 11.10.

11.4.81 For South Corridor Option 2, the predicted change to views from the A904 would be high, with Substantial significance impacts.

11.4.82 For Dundas Home Farm and adjacent properties, which are considered to have medium sensitivity to change, the revised Scotstoun junction would represent a low magnitude of change and Slight significance impact upon the receptors.

11.4.83 A medium change to views from Duddingston, which is partially screened by topography and vegetation, would have a Moderate to Substantial significance impact on the property. Lawflat and White Gate would be nearer to the route corridor and Substantial and Substantial to Severe significance impacts would be expected respectively. These impacts would be greater than for South Corridor Option 1.

11.4.84 The new M9 Junction 1A would have a medium to high magnitude of change to views from Overton and Burbank Cottages, resulting in Moderate to Substantial significance impacts, which would be more significant than for South Corridor Option 1.

11.4.85 Dundas Mains would not be affected by South Corridor Option 1, but Moderate to Substantial significance impacts would be predicted for this receptor from South Corridor Option 2.

11.4.86 Westfield Farm, Baronscraig Cottage and Holly Cottage are considered to have medium to high sensitivity. The nearby route corridor would represent a medium to high magnitude of change to their views, with Substantial significance impacts.

11.4.87 Westmuir Riding Centre and Totley Wells Grange would notice a medium to high change to views but medium sensitivity, due to visual containment by local vegetation, would reduce the impacts to of Moderate to Substantial significance.

11.4.88 Swineburn’s remote, rural location affords the property medium to high sensitivity to change. The road would be visible in close proximity, with a high magnitude of change and Substantial to Severe significance impacts.

11.4.89 The predicted impacts upon the Bedlam Paintball facility to the east of Dundas Estate, the industrial units in the Royal Elizabeth Yard and for the Harribrae Kennels and Cattery would be the same for South Corridor Options 1 and 2.

11.4.90 North of Humbie Reservoir, Humbie Cottage and Carmelhill have medium to high sensitivity. However, topography and woodland would screen the road west of the reservoir so that a low magnitude of change and Slight to Moderate significance impacts would be predicted.

11.4.91 Pentland View and Muiriehall are west of Humbie Reservoir, close to the motorway and a large bing, restricting their sensitivity to low to medium. The modified M9 Junction 1A would produce a low to medium change to their views and Slight significance impacts. Similar criteria and adverse impact would be predicted for Niddry Mains.

Table 11.10: Summary of Potential Impacts - South Corridor Option 2

Receptor	Sensitivity	Potential Impact (umitigated)	
		Magnitude	Significance
A904	Medium	High	Substantial
Dundas Home Farm	Medium	Low	Slight
Duddingston	Medium to High	Medium	Moderate to Substantial
Lawflat	Medium to High	Medium to High	Substantial
White Gate	Medium to High	High	Substantial to Severe
Overton and Burbank Cottages	Medium	Medium to High	Moderate to Substantial
Dundas Mains	Medium	Medium to High	Moderate to Substantial
Westfield Farm, Baronscraig Cottage & Holly Cottage	Medium to High	Medium to High	Substantial
Westmuir Riding Centre & Totley Wells Grange	Medium	Medium to High	Moderate to Substantial
Swineburn	Medium to High	High	Substantial to Severe
Humbie Cottage & Carmelhill	Medium to High	Low	Slight to Moderate
Pentland View, Muriehall & Niddry Mains	Low to Medium	Low to Medium	Slight

11.5 Potential Mitigation

11.5.1 At DMRB Stage 2 assessment of route corridor options, the detailed design has not been developed and mitigation detail therefore cannot be accurately defined. The objective of this section is therefore to identify ‘standard’ or ‘anticipated’ mitigation measures, in accordance with best practice, legislation and guidance.

11.5.2 This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 10.6 (Summary of Route Corridor Options Assessment), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

11.5.3 Mitigation measures are proposed as follows:

<u>To respect integrity of views</u>

- retain elements which are important to the visual quality of regional and local distinctiveness;
- avoid obstruction of valued views by proposed embankments and built elements;
- introduce and/or reinstate screening of visually intrusive infrastructure elements with earthworks, walls and woodland planting which reflect and endorse the adjacent landform, land use, pattern and vegetation; and
- ensure that the minimum amount of lighting is used, without compromising safety.

<u>To promote aesthetic cohesion</u>

- ensure built elements and earthworks are keyed into surrounding landform;
- integrate alignment, earthworks and attenuation (SUDS) ponds with the surrounding topography;
- form rock cuttings to produce naturalistic appearance; and

- reinforce the sense of place with locally sourced materials, vegetation and design elements.

11.5.4 Initial assessment of the northern and southern route corridor options has highlighted areas which, in general terms, could be used for visual mitigation. These are outlined below.

Northern Route Corridor Options

North Corridor Option 1

- screen planting around the Ferrytoll junction to reduce impacts on views from the surrounding receptors;
- woodland planting on embankments at North Queensferry Coastal Flat to reduce visual impacts of woodland lost in the cutting at Ferry Hills; and
- woodland planting to the north of the Masterton Junction to reduce visual impacts of upgraded junction and false cuttings along the link roads from the Masterton Junction to the A921 to screen views of the road.

North Corridor Option 2

- woodland planting on embankments to reduce appearance of the cutting at Ferry Hills and along the M90 at the motorway split;
- cut-and cover solution through Castlandhill to reduce impact of cutting through the wooded hillside; and
- woodland planting to assist visual integration of the large embankment at Dales Farm Cottages and at North Queensferry Coastal Flat.

Southern Route Corridor Options

South Corridor Option 1

- revegetation of cuttings to visually integrate with surrounding open farmland in Duddingston;
- woodland screen planting to the north of Dundas Castle and false cuttings to tie-in to natural rolling landform and screen carriageway from views; and
- woodland screen planting at M9 Junction 1A to screen views and tie in with existing surrounding woodland.

South Corridor Option 2

- revegetation of cuttings to integrate with appearance of surrounding open farmland in Duddingston;
- woodland planting at Humbie for screening and integration;
- woodland screen planting at M9 Junction 1A to tie in with existing surrounding woodland;
- false cuttings to tie-in to natural rolling landform and screen carriageway as the road crosses farmland to the west of Dundas Estate;
- replacement woodland planting south of Swineburn to provide screening of embankments for slip roads.

11.6 Summary of Route Corridor Options Assessment

11.6.1 This section takes the likely mitigation into account to summarise the residual impacts for each of the route corridor options.

Northern Route Corridor Options

North Corridor Option 1

11.6.2 North Corridor Option 1 is predominantly online and the impacts on receptors are generally not significant, except where detailed below, and lower than for North Corridor Option 2.

11.6.3 Admiralty House and Welldean Cottages, north of North Queensferry would experience Substantial significance residual impacts.

11.6.4 Moderate significance residual impacts are predicted for the Dales Cottages and Steadings, business units and houses on North Road and housing on the northern edge of Inverkeithing and Castlandhill.

North Corridor Option 2

11.6.5 The majority of North Corridor Option 2 is offline and the impacts on receptors are significant for more receptors and greater than for North Corridor Option 1.

11.6.6 As with North Corridor Option 1, Admiralty House and Welldean Cottages, north of North Queensferry would experience Substantial significance residual impacts.

11.6.7 The Dales Cottages and Steadings and the context for the farm and adjacent row of housing at Castlandhill will experience Substantial significance residual impacts.

11.6.8 Areas of Dunfermline, Castle Brae, Mastertown, south Rosyth, the northern edge of Inverkeithing, Muckle Hill and Middlebank farms are all predicted to experience Moderate to Substantial significance residual impacts on their views.

11.6.9 Moderate to Substantial significance residual impacts for receptors on the B981, the eastern edge of Rosyth and the northern edge of Inverkeithing are assessed and Slight to Moderate significance residual impacts would accrue for Inverkeithing High School and Balbougie Cottages.

Southern Route Corridor Options

South Corridor Option 1

11.6.10 South Corridor Option 1 is limited to linking existing roads, with limited additional roads and upgrading to junctions. Impacts on receptors are generally not significant, except where detailed below, and lower than for South Corridor Option 2.

11.6.11 The western edge of South Queensferry and Dundas Castle would experience Moderate to Substantial significance residual impacts while Substantial significance residual impacts would accrue for Linn Mill.

11.6.12 Moderate significance residual impacts are assessed for properties at the southwestern corner of South Queensferry from views of the proposed A904 crossing and the same residual impact significance is predicted for Humbie Home Farm and Steadings from views of the upgraded M9 Junction 1A.

11.6.13 Moderate significance residual impacts would also accrue for receptors on the A904, while residual impacts for Dundas Home Farm and adjacent properties are predicted to remain of Moderate to Substantial significance.

11.6.14 Duddingston, Lawflat and White Gate would experience Moderate significance residual impacts to views, which are higher than those assessed for South Corridor Option 2, while residual impacts for Overton and Burbank Cottages, south of the M9, would be less significant than the impacts resulting for South Corridor Option 2 at Slight to Moderate significance.

South Corridor Option 2

11.6.15 South Corridor Option 2 follows a direct line from the proposed replacement bridge to the M9 in the south. Impacts on receptors would be significant for more receptors and greater than for South Corridor Option 1.

11.6.16 As with South Corridor Option 1, the western edge of South Queensferry and Dundas Castle would experience Moderate to Substantial significance residual impacts while Substantial to Severe significance residual impacts would accrue for Linn Mill.

11.6.17 Moderate to Substantial significance residual impacts are assessed for properties at the south-western corner of South Queensferry from views of the proposed A904 crossing and the same residual impact significance is predicted for Humbie Home Farm and Steadings from views of the upgraded M9 Junction 1A.

11.6.18 For White Gate, Substantial significance residual impacts are predicted.

11.6.19 Substantial significance residual impacts are assessed for receptors on the A904, Lawflat, Westfield Farm, Baronscraig Cottage and Holly Cottage, with Moderate to Substantial significance residual impacts for Duddingston, Overton and Burbank Cottages, Dundas Mains, Westmuir Riding Centre and Totley Wells Grange.

11.7 Scope of Stage 3 Assessment

11.7.1 The Stage 3 assessment will follow guidance set out in DMRB, Volume 11, Section 3, Part 5 and will include the following:

- updated/supplementary baseline visual assessment, if necessary, for consistency with relevant information from other subject areas;
- more detailed identification of receptors within existing receptor 'clusters' and assessment thereafter;
- consultation with SNH regarding the following:
  - i. the use of separate assessments for the replacement bridge and approach roads, with separate study areas and Visual Envelope Maps (the extent of which are to be determined);
  - ii. approach to and development of detailed mitigation;
- identification of detailed mitigation, incorporating agricultural, ecological and noise mitigation, which have screening implications;
- updated impact assessment to take account of detailed mitigation proposals; and
- preparation of day and night Visual Envelope Maps for the Design Year.

11.8 References

Landscape Institute and the Institute for Environmental Management and Assessment (2002). Guidelines for Landscape and Visual Impact Assessment, 2nd edition. Spon Press.

Scottish Executive (2002). DMRB Vol.11, Landscape & Visual Assessment. Section 3, Part 5, Supplementary Guidance. Scottish Executive Development Department.

The Highways Agency et al. (1993). DMRB Vol.11, Landscape & Visual Assessment. Section 3, Part 5. The Highways Agency, Scottish Executive Development Department, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

12 Cultural Heritage

12.1 Introduction

12.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of the following three sub-topics, in accordance with the guidance provided in Volume 11, Section 3, Part 2 of the Design Manual for Roads and Bridges (The Highways Agency et el., 2007):

- archaeology;
- historic buildings; and
- the historic landscape.

12.1.2 Other policy documents taken into account include:

- Dunfermline and the Coast Adopted Local Plan 2002 - 2006;
- Edinburgh and the Lothians Structure Plan (ELSP) 2015;
- Fife Structure Plan 2001 – 2011;
- Memorandum of Guidance on Listed Buildings and Conservation Areas (Historic Scotland, 1998);
- National Planning Policy Guideline (NPPG) 5: Archaeology and Planning (Scottish Office, 1994a);
- NPPG 18: Planning and the Historic Environment (Scottish Office 1999);
- Policy Advice Note (PAN) 42: Archaeology – The Planning Process and Scheduled Monuments Procedures (Scottish Office, 1994b);
- Scottish Historic Environment Policy (SHEP) 2: Scheduling: protecting Scotland's nationally important monuments (Historic Scotland, 2006);
- SHEP 3: Gardens and Designed Landscapes (Historic Scotland 2008);
- Standard and Guidance on Archaeological Desk-Based Assessments (The Institute of Field Archaeologists, 1994); and
- West Lothian Local Plan 2005.

12.1.3 Some archaeological sites are afforded statutory protection as Scheduled Ancient Monuments (SAMs), protected under the Ancient Monuments and Archaeological Areas Act 1979, and are by definition of National importance. Without the prior written consent of the Scottish Ministers, known as Scheduled Monument Consent (SMC), it is an offence to undertake any works which would have the effect of demolishing, destroying, damaging, removing, repairing, altering, adding to, flooding or covering up a SAM. Under article 15 (1) of the Town and Country Planning (General Development Procedure) (Scotland) Order 1992 notification to Historic Scotland of any planning application affecting a SAM is also required.

12.1.4 Buildings of special architectural or historic interest may be afforded statutory protection as Listed Buildings (Graded A, B or C(S)) under the terms of the Town and Country Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 and Listed Building consent must be obtained where proposals will alter the character of the Listed Building. The criteria by which the Scottish Ministers define the necessary quality and character under the planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 are broadly: Age and rarity, Architectural Interest and close historical association. It is a criminal offence to undertake such works without this consent. Any object or structure which is fixed to a listed building, or which falls within the curtilage of such building and, although not fixed to the building, has formed part of the land since before 1 July 1948, is treated as part of the building and also listed. Some buildings of lesser interest may be protected under Local Plan policies (see below).

12.1.5 The Town and Country Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 imposes a duty of local planning authorities to designate and protect the historic character and appearance of some areas through their designation as Conservation Areas. These are areas of special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance, and along with the main implication of designation is that consent will be required for specific types of development that would not otherwise require it, 'conservation area consent' is used for applications to demolish unlisted buildings in conservation areas.

12.1.6 Parks and gardens included on the Inventory of Gardens and Designed Landscapes in Scotland are protected under Section 15(1)(j)(iv) of the Town and Country Planning (General Development Procedure) (Scotland) Order 1992 (the GDPO) which requires planning authorities, prior to granting planning permission, to consult Scottish Ministers on 'development which may affect a historic garden or designed landscape'. The Scottish Minister's policies for gardens and designed landscapes are set out in Scottish Historic Environment Policy 3: Gardens and Designed Landscapes (Historic Scotland 2008).

12.1.7 NPPG 18, Planning and the Historic Environment outlines the Government's advice to developers and local authorities in their consideration of development proposals affecting amongst others Listed Buildings and their setting, Conservation Areas and other historic buildings. Paragraph 12 of NPPG 18 states that *"In the determination of an application for listed building consent or for planning permission for development affecting a listed building or its setting, the planning authority is required to have special regard to the desirability of preserving the building, or its setting, or any features of special architectural or historic interest which it possesses"*. In addition prior consideration should be given to the scope for recycling buildings which have clear historic or architectural significance.

12.1.8 For trunk road, Historic Scotland is responsible for providing policy advice and commenting on the implications of a trunk road scheme for the historic environment.

12.1.9 The heritage policies of City of Edinburgh Council, Fife Council and West Lothian Council are set out in the Local Plans and Structure Plans for these local authorities (Chapter 18: Policies and Plans). Generally, these promote the preservation, enhancement and conservation of archaeological sites, historic buildings and historic garden and designed landscapes and their settings. In general, there is a presumption against developments which would adversely affect such sites and their settings and a presumption of preserving important archaeological remains *in situ* where feasible.

12.2 Approach and Methods

Baseline Conditions

12.2.1 A study area was defined extending at least 200m in all directions from the edge of each of the connecting road corridor options. The extent of the study area is shown on Figure 12.1. Additional information was gathered from the wider surrounding area to place the cultural heritage in its local and regional context. Historic buildings and any other sites within the wider surrounding area where setting was considered to contribute to the importance or sensitivity of the site have also been taken into account.

12.2.2 The information used in this chapter has been gathered from the following sources:

- Aerial Photograph Collection of the Royal Commission on Ancient and Historical Monuments of Scotland (RCAHMS);
- Fife Council Sites and Monuments Record;

- National Monuments Record of Scotland (NMRS);
- Ordnance Survey and pre-Ordnance Survey mapping held by the Map Library of the National Library of Scotland and the National Archives of Scotland;
- published and unpublished archaeological reports, articles, journals and books;
- Historic Landscape Assessment (HLA) undertaken by RCAHMS. Data were obtained from the RCAHMS for a 10km x10km tile surrounding the study area;
- UK Hydrographic Office information regarding sea wreck locations; and
- West of Scotland Archaeological Service (WoSAS) Sites and Monuments Record.

12.2.3 Walkover surveys were also undertaken between 31 March and 04 June 2008 to verify the information gathered from the sources listed above and to identify previously unrecorded sites of cultural heritage sensitivity which survive above ground.

Impact Assessment

12.2.4 DMRB, Volume 11, Section 3 (as modified by HA208/07), states that impacts are assessed in relation to the change to the 'historic legibility' of the cultural heritage resource, defined as '*…the way in which a historic monument or landscape can be 'read' through an understanding of the development of its features, character, setting and context through time'*.

12.2.5 Physical impacts and impacts on the cultural heritage setting are considered in this assessment:

- Physical damage to a site will affect its historic legibility through destruction or disturbance of archaeological remains, demolition of buildings or severance of related features. More rarely, remains can be indirectly effected by vibration, dewatering or other direct impacts.
- Effects on the historic legibility of sites, in association with, or in the absence of, physical impacts may also result from changes to the settings of sites, where the setting of a site makes a significant contribution to our understanding and appreciation of that site.

12.2.6 Physical impacts and impacts on setting resulting from major infrastructure projects are generally long-term or permanent, starting or occurring during construction and persisting through the operational phase. As such, impacts as assessed within this assessment are not separated into construction and operation impacts, and are all considered to be long-term or permanent unless otherwise stated.

<u>Sensitivity</u>

12.2.7 An assessment of the degree of sensitivity to change of each cultural heritage receptor within the study area has been made on a five-point scale of Very High, High, Medium, Low, Negligible and Unknown, according to the criteria given in Table 12.1 below.

Table 12.1 Criteria to Assess Sensitivity of Archaeological and Built Heritage Sites

Sensitivity	Criteria
Very High	• World Heritage Sites or other sites of acknowledged international importance.
High	• Scheduled Ancient Monuments (SAM) • Category A Listed Buildings • Sites proposed for Scheduling or Listing. • Conservation Areas containing very important buildings. • Gardens and Designed Landscapes recorded on the Inventory of Gardens and Designed Landscapes. • Some undesignated sites assessed as of high sensitivity using paragraph 12.2.8 methodology.
Medium	• Category B Listed Buildings • Conservation Areas containing buildings that contribute significantly to its historic character. • Historic Townscape or built-up areas with important historic integrity in their buildings or built settings. • Undesignated sites assessed as of medium sensitivity using paragraph 12.2.8 methodology.
Low	• Undesignated sites assessed as of low sensitivity using paragraph 12.2.8 methodology. • Category C(S) Listed Buildings
Negligible	• Site is a non-statutory archaeological site with no surviving remains. • Buildings of no architectural or historical note.
Unknown	• The sensitivity of the site cannot be ascertained.

12.2.8 For the purposes of assessment, undesignated sites were assigned a level of sensitivity using professional judgement based on the criteria set out in the following documents:

- criteria used in SHEP 2 for the designation of SAMs (Historic Scotland 2008); and
- non-statutory criteria used in their designation of Listed Building categories (Memorandum of Guidance on Listed Buildings and Conservation Areas, Historic Scotland 1998).

12.2.9 For each site, the elements which contribute to its setting were identified against the following criteria:

- physical relationship with or characteristics of the site;
- demonstrable former relationship; or
- perceptual non-physical relationship (e.g. public perceptions of the site, historical associations etc).

12.2.10 The sensitivity of each element was then assessed on a three point scale of low, medium and high in order to define its level of contribution to the setting of the site as a whole, and the contribution of setting to a site's overall sensitivity.

12.2.11 Historic Landscape units were defined based on the Historic Landscape Assessment (HLA) undertaken by RCAHMS. The sensitivity of the each of the historic landscape units was based on the criteria set out in Table 12.2.

Table 12.2: Criteria to Assess Sensitivity of Historic Landscape Units

Sensitivity	Criteria
Very High	• World Heritage Sites inscribed for their historic landscape qualities. • Historic landscapes of international sensitivity, whether designated or not. • Extremely well preserved historic landscapes with exceptional coherence, time-depth, or other critical factor(s).
High	• Parks and gardens included on the Inventory of Gardens and Designed Landscapes in Scotland. • Areas of Outstanding Natural Beauty (AONB), National Parks or other designated historic landscapes of outstanding interest. • Undesignated landscapes of outstanding interest. • Undesignated landscapes of high quality and importance, and of demonstrable national importance. • Well preserved historic landscapes, exhibiting considerable coherence, time-depth or other critical factor(s).
Medium	• Designated special historic landscapes. • Undesignated historic landscapes that would justify special historic landscape designation, landscapes of regional importance. • Averagely well-preserved historic landscapes with reasonable coherence, time-depth or other critical factor(s).
Low	• Robust undesignated historic landscapes. • Historic landscapes with specific and substantial importance to local interest groups, but with limited sensitivity. • Historic landscapes whose sensitivity is limited by poor preservation and/or poor survival of contextual associations.
Negligible	• Landscapes with little or no significant historical interest.
Unknown	• The sensitivity of the landscape cannot be ascertained.

Impact Magnitude

12.2.12 Criteria for the assessment of the magnitude of impact are set out in Table 12.3 and Table 12.4.

Table 12.3 Criteria to Assess Magnitude of Impact for Archaeology and Historic Buildings

Magnitude	Criteria
Major	• Change to most or all key archaeological or historic building elements so that resource is totally altered. • Comprehensive changes to setting.
Moderate	• Changes to many key archaeological or historic building elements, such that the resource is clearly modified. • Considerable changes to setting that affect the character of the asset.
Minor	• Changes to the key archaeological or historic building elements, such that the resource is clearly modified. • Slight changes to setting.
Negligible	• Very minor changes to archaeological or historic building elements or setting.
No Change	• No observable loss of archaeological or historic building elements or setting elements.

Table 12.4 Criteria to Assess Magnitude of Impact for Historic Landscape Units

Magnitude	Criteria
Major	• Change to most or all key historic landscape features; extreme visual effects; gross change of noise levels or change to sound quality; fundamental change to use or access; resulting in total change to historic landscape unit.
Moderate	• Change to many key historic landscape features, visual change to many key aspects of historic landscape, noticeable differences in noise levels or sound quality, considerable change to use or access; resulting in moderate change to historic landscape unit.
Minor	• Change to few key historic landscape features, slight visual change to few key aspects of historic landscape, limited changes in noise levels or sound quality, slight change to use or access; resulting in a limited change to historic landscape unit.
Negligible	• Very minor changes to key historic landscape features, virtually unchanged visual effects, very slight changes in noise levels or sound quality, very slight change to use or access; resulting in a very small change to historic landscape unit.
No Change	• No change to key historic landscape features; no visual or audible changes; no changes arising from amenity or community factors.

Impact Significance

12.2.13 Significance of effect is determined as a combination of the site importance and impact magnitude. Five levels of significance were defined which apply equally to beneficial and adverse impacts. To provide consistency with other environmental assessments presented within this Stage 2 report, the significance terms used in the Table 5.4 of HA 208/07 have been substituted in this the cultural heritage assessment with the following terms, which are the same as those used in Chapter 10 (Landscape) and Chapter 11 (Visual):

- Negligible (‘Neutral/Slight’ in HA 208/07);
- Slight (unchanged);
- Moderate (unchanged);
- Substantial (‘Large’ in HA 208/07); and
- Severe (‘Very Large’ in HA 208/07).

12.2.14 Table 12.5 shows how the sensitivity of the heritage assets and magnitude of impact are combined to assess the significance of impact:

Table 12.5: Significance of Impacts Matrix

Magnitude / Sensitivity	No Change	Negligible	Minor	Moderate	Major
Very High	Neutral	Slight	Moderate or Substantial	Substantial or Severe	Severe
High	Neutral	Slight	Moderate or Slight	Moderate or Substantial	Substantial or Severe
Medium	Neutral	Negligible	Slight	Moderate	Moderate or Substantial
Low	Neutral	Negligible	Negligible	Slight	Slight or Moderate
Negligible	Neutral	Neutral	Negligible	Negligible	Slight

12.3 Baseline Conditions

12.3.1 A total of 244 sites of cultural heritage interest were identified within the study area. While located outside the study area, possible impacts on a complex of sites associated with Dundas Castle (Sites 819, 822, 828, 839, 847, 849, 855, 874, 876, 877, 891, 898) were also assessed, bringing the total number of sites considered to 256. Of these, 214 sites are undesignated, while Table 12.6 provides a break-down of the remaining 42 sites by their designation.

Table 12.6: Summary of Designated Sites within the Study Area

Designation	Site Number	Total Sites
Category A Listed Building	30, 427, 847, 855	4
Category B Listed Building	89, 267, 279, 300, 303, 323, 358, 484, 721, 808, 814, 819, 817, 839, 876 ,877, 891, 898, 904	19
Category C (S) Listed Building	334, 336, 439, 482, 532, 815, 822, 828, 830, 834, 874, 907, 909	13
Conservation Area	1250	1
Inventory of Gardens and Designed Landscapes	1096, 1111, 1112	3
Scheduled Ancient Monument	82, 849	2
Total		**42**

12.3.2 Table 12.7 provides a breakdown of identified sites by archaeological/historical period.

Table 12.7: Summary of All Sites within the Study Area (by period)

Period	Total Sites
Prehistoric (7000 – AD 43)	12
Roman (AD 43 – 410)	4
Early Medieval (AD 410 – 1066)	1
Medieval (AD 410 – 1603)	5
Post-Medieval (AD 1603 – 1901)	150
Modern (AD 1901 onwards)	31
Uncertain	53
Total	**256**

Topography and Landscape

12.3.3 While the Royal Burghs of North and South Queensferry and Inverkeithing have had a significant role in shaping the character of the study area, especially with regard to settlement based on trade and the passage of goods and people north and south across the Firth of Forth, the present landscape is largely a product of estate improvements of the 17th, 18th and 19th centuries. More recent influences have included a steadily increasing industrial and military presence on either side of the Firth of Forth with extractive industries such as coal, quarrying and shale oil mining followed by the construction of large Naval complexes such as Rosyth and Port Edgar Barracks. In addition, extensive defences were constructed during both World War I (WWI) and World War II (WWII).

Prehistoric Period

12.3.4 Prehistoric human activity within the wider area includes the earliest dated human settlement ever found in Scotland. Evidence for a Mesolithic camp in the form of stone tools, tool waste and hazelnut shells have been recovered from Cramond just east of the Forth Rail Bridge. Activity in this camp has been dated to about 8500 BC. Two stone axes (Sites 234 and 818) recovered from inside the study area are likely to be Neolithic in date and it is possible that the stone axe heads found in a field beside the farmhouse of Ferry Barns (Site 346) also date to this period. The large stone cairn at Cromwell's Mount, Craigdhu (Site 344; now destroyed) may have been constructed in the Neolithic period.

12.3.5 Evidence for Bronze Age activity comprises two short cists excavated in advance of the construction of the Forth Road Bridge (Sites 87 and 743). Finds recovered from the former included a bronze dagger and a jet necklace. The finds recovered from the cists inserted into the stone cairn at Cromwell's Mount, Craigdhu (Site 344) indicate a Bronze Age date for these.

12.3.6 Evidence for later prehistoric activity is scant and comprises a Late Bronze Age socketed bronze axe was found near Kirkliston (Site 1003) and Middlebank Souterrain (Site 82; a Scheduled Ancient Monument), which is likely to date to the Iron Age. Souterrains are curving, underground passageways which are usually lined with stone. Such sites are known across all of Scotland but particularly, north of the Firth of Forth with a large concentration on Tayside. The function of such sites is not known but it has been suggested that they were associated with either storage of valuable commodities or alternatively had an important ritual function. Most souterrains were deliberately filled in and ritually closed towards the end of the Roman occupation of Lowland Scotland.

12.3.7 Other sites possibly dating to the prehistoric period include Middlebank ring ditch (Site 90), flints (Site 244), human graves in the vicinity of Inchgarvie House (Site 543) and 'Sentry Knowe' Barrow (Site 526; now destroyed) which was also located in the vicinity of Inchgarvie House.

Roman

12.3.8 To the west of the study area, the presence of the Antonine Wall and to the east the fort at Cramond attest to a substantial presence in the area during the Roman period. There are however few known Roman sites within the study area. Urns recovered from Middlebank in the 19th century (Site 94) have been attributed to the Roman period although this date is not secure. Roman material, including a patera handle and a possible building was noted in the 19th century close to Inchgarvie House (Site 534). Excavation has demonstrated that the possible Roman enclosure at Inchgarvie visible on aerial photographs (Site 706) was a misinterpretation of geological features while evaluation excavation also revealed no trace of the proposed Cramond to Antonine Wall Roman Road at South Queensferry (Site 745).

Early Medieval

12.3.9 A pre-12th century AD sculptured stone (Site 26) was previously located close to the old mansion house of Duloch and the west lodge of Fordell. This stone was broken up for road metal. Although there is little in the way of known Early Medieval sites within the area, the presence of sites in the wider area (particularly towards the upper reaches of the Firth of Forth) indicates that there is good potential for the presence of previously unknown sites.

Medieval

12.3.10 The Royal Burghs of North and South Queensferry and Inverkeithing have their origins in the Medieval period. The presence of great houses such as at Abercorn, Dundas and Niddry Castle are likely to have had associations with the Carmelite friary at South Queensferry. While the present keep of Dundas Castle dates to the 15th century, the castle may have its origins in the 12th century. It is possible that cultivation terraces located to the west of Inverkeithing Cemetery (Site 265) date to the medieval period; no trace of these was located by the evaluation excavations undertaken to the south (Site 262). It is also known that there was a medieval hospital at North Queensferry (Site 425) although the exact location of this site is unknown. Greig's Hill to the west of Kirkliston, now the site of a modern housing development, is traditionally the site of an encampment of Edward I (Site 1002) while a now destroyed area of rig and furrow at Dalmeny Junction (Site 1234) may have dated to the medieval period.

Post Medieval and Modern (Industrial) Period

12.3.11 The cultural heritage of the study area is characterised by sites dating to the Post Medieval and modern periods, with 181 sites dating to this period identified within the study area.

12.3.12 The present landscape of the study area was shaped by the formation of country estates, all with substantial designed landscapes and organised parkland including Fordell Castle Designed Landscape (Site 1096), Dundas Castle Designed Landscape (Site 1111) and Newliston Designed Landscape (Site 1112) all of which are recorded on the Inventory of Gardens and Designed Landscapes. All of these estates retain several Category A and B Listed Buildings and/or Scheduled Ancient Monuments within their grounds. The influence of these large estates extended beyond their present boundaries with the creation of planned villages such as Dalmeny and the sponsorship of industrial and extractive industries also had a large influence on the wider landscape.

12.3.13 The area around the Forth Rail Bridge became an increasingly important location for the Royal Navy during the period following the construction of the Rosyth Naval Dockyard in 1906. As a result, the requirement for air and sea defences within the area, particularly during WWII, led to the construction of numerous and varied defence installations. There are a number of air defence batteries, pill boxes and barrage balloon mooring sites as well as the Category B listed former admiralty headquarters at St Margaret's Hope (Sites 300 and 303). Notable amongst the military built heritage sites for its excellent preservation and quality is the Category B Listed former Royal Naval hospital, prison, hospital, air raid shelter and boiler room and barrack complex at Port Edgar (Site 484). Port Edgar was a training base for motor torpedo boats prior to WWI. During WWII it was renamed HMS Lochinvar and was later the training base for minesweeping and fishery patrol work until 1975 when the base was decommissioned.

12.3.14 The Firth of Forth became the focus for increasing industrial activity from the 18th century onwards with the advent of coal mining and associated salt panning, thus beginning a long history of industrial activity along the shores of the Forth, particularly around Inverkeithing upon construction of the railway bridge. The presence of the large country estates precluded larger scale industrial activity in these areas which have since been preserved as designed landscapes.

12.3.15 A number of wrecks have also been identified in the Firth of Forth (Figure 12.1f). The majority of these are 19th century cargo ships which sank after striking Beamer Rock.

Historic Landscape Assessment

12.3.16 Based on the Historic Landscape Characterisation data provided by RCAHMS, a total of 176 separate character areas have been identified, grouped into the 27 historic landscape types. The table below provides a summary of the historic landscape character types identified within the study area along with an assessment of their sensitivity. The locations of the character areas are shown on Figure 12.3.

Table 12.8: Summary of Historic Landscape Character Types within the Study Area

Historic Landscape Character Type	Number of Character Areas	Sensitivity
17th-19th Century Country Estate	1	High
17th-19th Century Designed Landscape	4	High
17th-19th Century Policies and Parkland	8	Medium
18th Century-Present Cemetery	1	Medium
18th-19th Century Planned Village: Agricultural	1	Medium
18th-19th Century Rectilinear Fields	27	Negligible
18th-20th Century Managed Woodland	19	Negligible
19th Century Rail Bridge	1	High
19th Century-Present Amalgamated Fields	24	Negligible
19th Century-Present Industrial and Commercial Area	12	Negligible
19th Century-Present Maritime Installation	2	Medium
19th Century-Present Quarry	1	Medium
19th Century-Present Railway	4	Negligible
19th Century-Present Recreation Area	13	Low
19th Century-Present Reservoir	2	Low
19th Century-Present Urban Area	14	Negligible
20th Century Road Bridge	1	High
20th Century Coniferous Plantation	1	Negligible
20th Century Holdings	3	Negligible
Late 20th Century-Present New Fields	3	Negligible
Late 20th Century-Present Power Station	1	Negligible
Late 20th Century-Present Restored Agricultural Land	1	Negligible
Late 20th Century-Present Roads	5	Negligible
Late 20th Century-Present Woodland Plantation	1	Negligible
Medieval Urban Core	1	High
Medieval Village Core	1	High
Rough Grazing	24	Negligible

12.4 Potential Impacts

12.4.1 The tables below list all sites that could experience impacts due to the Forth Replacement Crossing project and provides a provisional assessment of the significance of potential impacts on each known site, in line with the methodology described above. It should be noted that this section reports potential impacts in the absence of mitigation, which would be developed as part of Stage 3 assessment.

12.4.2 The proposed replacement bridge is common to all corridor options and it is therefore assumed that the magnitude and significance of potential impacts resulting from the river crossing would be the same for any combination of alignments. Potential impacts from the proposed replacement bridge are therefore only assessed once and separately from the connecting road corridor options.

12.4.3 With the exception of potential impacts on Designed Landscapes (Sites 1096, 1111, 1112), the impacts on the historic landscape character areas were not significant. This assessment was based on the proposed impacts when compared to present the existing and landscape character areas. These were therefore not taken into consideration in the assessment and comparison of the route corridor options.

Proposed Replacement Bridge

12.4.4 The construction of a bridge pier on Beamer Rock is likely to have a direct physical impact on Beamer Rock Lighthouse (Site 426), a site of low sensitivity. The magnitude of this impact has been assessed as major and the significance of impact as Moderate.

12.4.5 One of the bridge piers may also have a direct impact on St Margaret's Hope Relict Country Estate (Site 1102), a site of medium sensitivity. The magnitude of this impact has been assessed as minor and significance of this impact has been assessed as Slight.

12.4.6 Based on the locations provided by NMRS and the UK Hydrographic Office, no impacts on any known shipwrecks are predicted. There is however potential for direct physical impacts on unknown shipwrecks and other marine archaeological sites and impacts on their setting.

12.4.7 The complexes of Listed Buildings at St Margaret's Hope (Sites 300 and 303) and at Port Edgar Harbour (Site 484) will be spanned or partially spanned by the proposed replacement bridge, introducing a new element into the setting of these sites. The significance of impact on the setting of these sites has been assessed as Substantial. The proposed bridge will also have an impact on views from and to Inchgarvie House (Site 532; a Category C(S) Listed building) and its associated gate lodge (Site 530). The significance of impact on the setting of these sites has been assessed as Moderate.

12.4.8 The location of the houses, principal facades, driveway and gate lodges would suggest that Hopetoun House (Site 452), Society House (Site 446) and the associated Designed Landscape (Site 1103) were constructed to take advantage of views eastwards along the Firth of Forth and that these views, which now include the Forth Rail Bridge (Site 435) and Forth Road Bridge (Site 427), form an important element in the setting of the Hopetoun Estate on which the proposed replacement bridge would have an impact. The significance of this impact has been assessed as Slight.

Table 12.9: Summary of Potential Impacts on Setting – Proposed Replacement Bridge

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
300	St Margaret's Hope, Including Boundary Walls, Walled Garden To South And Archway On Drive To North	Category B Listed Building	Medium	Major	Substantial
334	Ferry Craig, South Queensferry	Category C(S) Listed Building	Low	Major	Moderate
446	Hopetoun House, Society House	Category A Listed Building	High	Minor	Slight
452	Hopetoun House	Category A Listed Building	High	Minor	Slight
474	Hopetoun House, East Lodge And Gate	Category B Listed Building	Medium	Minor	Slight
482	Port Edgar West Pier	Category C(S) Listed Building	Low	Moderate	Slight
484	Port Edgar Harbour Barrack Complex	Category B Listed Buildings	Medium	Major	Substantial
530	Inchgarvie House Lodge	None	Low	Major	Moderate
532	Inchgarvie House	Category C(S) Listed Building	Low	Major	Moderate
1102	St Margaret's Hope Relict Country Estate	None	Medium	Major	Moderate
1103	Hopetoun House Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Minor	Slight

12.4.9 In addition to those sites assessed above, there are a large number of Listed Buildings located in North Queensferry and South Queensferry and parts of both towns are Conservation Areas. As the settings of these buildings and Conservation Areas are dominated by the existing bridges, the significance of impact on the setting of these sites by a similar element has been assessed as Slight.

Northern Route Corridor Options

Impacts Common to Both Northern Route Corridor Options

12.4.10 There are a number of Listed Buildings located in Inverkeithing, Jamestown, and North Queensferry, and part of North Queensferry is also a Conservation Area. To the west of Inverkeithing, there is recent residential development between both of the corridor options and the town’s historic core. Further to the south, both the Jamestown Viaduct and the Forth Road Bridge are likely to reduce the views of both corridor options eastwards from Jamestown and North Queensferry. The significance of impact on Listed Buildings in these towns, and North Queensferry Conservation Area of either northern route corridor options has therefore been assessed as Neutral.

North Corridor Option 1

12.4.11 Potential physical impacts on 11 sites have been identified, as detailed in Table 12.10 below. These impacts are all permanent and direct. Middlebank Souterrain SAM (Site 82) will be removed by this option and the significance of this impact has been assessed as Severe. This option will also have an impact on the approach ramps of the existing Forth Road Bridge (Site 427; Category A Listed Building). The significance of impact on this site has been assessed as being Slight. The potential impact on St Margaret's Hope Relict Country Estate (Site 1102) has been assessed as of Moderate significance.

12.4.12 While located within the footprint of this corridor option, Sites 94, 260, 297 and 1091 have been destroyed. The impact on these sites has been assessed as being of Neutral significance.

Table 12.10: Summary of Potential Physical Impacts - North Corridor Option 1

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
82	Middlebank Souterrain	SAM	High	Major	Severe
256	Inverkeithing Cemetery, Cultivation Terraces	None	Low	Minor	Negligible
289	St Margaret's Hope Rosyth	None	Low	Major	Slight
427	Forth Road Bridge	Category A Listed Building	High	Negligible	Slight
1060	Middlebank Quarry Tramline	None	Negligible	Major	Slight
1062	Middlebank Coal Level	None	Negligible	Moderate	Negligible
1078	Middlebank Cropmarks	None	Unknown	Moderate	Unknown
1094	St Margaret's, Quarry	None	Negligible	Moderate	Negligible
1097	Duloch House Designed Landscape	None	Low	Negligible	Negligible
1100	Middlebank Relict County Estate	None	Low	Moderate	Slight
1102	St Margaret's Hope Relict Country Estate	None	Medium	Minor	Slight

12.4.13 As detailed in Table 12.11 below, potential impacts on the setting of 16 sites have been identified. While the northern end of this corridor option is located close to the Fordell Castle

Designed Landscape (Site 1096) and Old Duloch House (Site 30; Category A Listed Building), it is mostly on the line of the existing A90 and in a cutting, reducing the visibility of this option. The significance of impact of the setting of these sites therefore been assessed as Slight. To the northwest of The Dales (Site 89; Category B Listed Building), this option follows the line of the A90, an existing element in the views which form part of the setting of this Listed Building. The significance of the impact on the setting of this has been assessed as Slight.

Table 12.11: Summary of Potential Impacts on Setting - North Corridor Option 1

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
22	Duloch House South Gate	None	Low	Negligible	Negligible
30	Old Duloch House, Walled Garden and Boundary Walls and Gatepiers	Category A Listed Building	High	Minor	Slight
89	The Dales, Inverkeithing, Farmhouse and Steading	Category B Listed Building	Medium	Minor	Slight
226	Inverkeithing, Dunfermline Wynd, 'Selvage' Manor House	None	Low	Negligible	Negligible
267	Inverkeithing, Jamestown Viaduct	Category B Listed Building	Medium	Negligible	Negligible
279	Jamestown, Ferryhills Road, Naval Base Mansions	Category B Listed Building	Medium	Negligible	Negligible
282	Jamestown, General	None	Low	Negligible	Negligible
323	North Queensferry, Northcliff House, Gatepiers, Gates and Railings	Category B Listed Building	Medium	Negligible	Negligible
337	North Queensferry, Main Road, Fernbank, Outbuilding	Category C(S) Listed Building	Low	Negligible	Negligible
358	North Queensferry, Craigdhu	Category B Listed Building	Medium	Negligible	Negligible
1056	Middlebank House	None	Low	Negligible	Negligible
1057	Middlebank House and Walled Garden	None	Low	Negligible	Negligible
1069	Castle Hill, Lodge House	None	Low	Negligible	Negligible
1096	Fordell Castle Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Negligible	Slight
1097	Duloch House Designed Landscape	None	Low	Moderate	Slight
1100	Middlebank Designed Landscape	None	Low	Moderate	Slight

North Corridor Option 2

12.4.14 Potential physical impacts on 15 sites have been identified, as detailed in Table 12.12 below. Of these, the significance of eight impacts have been assessed as Slight while there is also the potential for an impact of Moderate significance on the non-designated designed landscape at Castlandhill (Site 1101).

12.4.15 While located within the footprint of this option, Sites 297, 299 and 1091 have been destroyed. The impact on these sites has been assessed as Neutral and these are not considered in Table 12.12.

Table 12.12: Summary of Potential Physical Impacts - North Corridor Option 2

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
22	Duloch House South Gate	None	Low	Moderate	Slight
36	Bridge over Pinkerton Burn	None	Low	Major	Slight
96	Greens Park Building (Site of)	None	Negligible	Major	Negligible
112	Inverkeithing, Belleknowes Industrial Estate	None	Negligible	Major	Negligible
121	Castlandhill Boundary Wall	None	Negligible	Major	Negligible
287	Stone and Earth Wall	None	Negligible	Major	Negligible
289	St Margaret's Hope Wharf Rosyth	None	Low	Moderate	Slight
292	St Margaret's Hope Cults Ness; Rosyth	None	Negligible	Major	Slight
304	Quarry	None	Negligible	Major	Slight
318	Stone and Earth Wall	None	Negligible	Major	Slight
1074	The Dales, Track/Road	None	Negligible	Minor	Negligible
1081	Castlandhill, WW2 Military Buildings	None	Low	Major	Slight
1082	Castlandhill, Circular Cropmarks and Building	None	Medium	Negligible	Negligible
1097	Duloch House Designed Landscape	None	Low	Moderate	Slight
1101	Castlandhill Designed Landscape	None	Medium	Moderate	Moderate

12.4.16 Potential impacts on the setting of 11 sites have been identified in Table 12.13. Construction of the road would introduce a new element into essentially rural views north-westwards from The Dales Farmhouse and Steading at Inverkeithing (Site 89; Category B Listed Building) and the significance of this impact has been assessed as being Moderate. While the northern end of this option is located close to Old Duloch House (Site 30; Category A Listed Building) and the Fordell Castle Designed Landscape (Site 1096), it is mostly on the line of the existing A90 and in cutting, reducing the visibility of this option in the landscape. The significance of impacts on these sites has been assessed as Slight.

Table 12.13: Summary of Potential Impacts on Setting - North Corridor Option 2

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
30	Old Duloch House, Walled Garden and Boundary Walls and Gatepiers	Category A Listed Building	High	Minor	Slight
89	Inverkeithing, The Dales, Farmhouse and Steading	Category B Listed Building	Medium	Major	Moderate
226	Inverkeithing, Dunfermline Wynd, 'Selvage' Manor House	None	Low	Negligible	Negligible
238	Castlandhill Cottages	None	Low	Negligible	Negligible
267	Inverkeithing, Jamestown Viaduct	Category B Listed Building	Medium	Negligible	Negligible
1069	Castle Hill, Lodge House	None	Low	Negligible	Negligible
1079	Castlandhill, Pillbox	None	Low	Negligible	Negligible
1096	Fordell Castle Designed Landscape	Designed Landscape	High	Negligible	Slight

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
1097	Duloch House Designed Landscape	None	Low	Moderate	Slight
1100	Middlebank Designed Landscape	None	Low	Negligible	Negligible
1101	Castlandhill Designed Landscape	None	Medium	Moderate	Moderate

Southern Route Corridor Options

Impacts Common to Both Southern Route Corridor Options

12.4.17 A number of sites recorded in the area of Inchgarvie House (Site 532), including a possible barrow (Site 526), graves (Site 543) and Roman finds (Site 534) suggest activity in this area dating to the prehistoric and Roman periods. This area is therefore considered to have a high potential for the presence of unknown archaeological remains on which either of the proposed southern corridor options may have an impact.

12.4.18 There are a large number of Listed Buildings located within South Queensferry, the northeastern part of which is a Conservation Area. However the existing embankment for the Forth Road Bridge will reduce the visibility of both South Corridor Option 1 and South Corridor Option 2 in views west from South Queensferry. The potential impact on the setting of Listed Buildings and the Conservation Area within South Queensferry has been assessed as Slight.

12.4.19 The existing M9 Spur has already partially urbanised the setting of Humbie Dovecot (Site 907), Humbie Cottages (Site 909), Humbie Steading (Site 914) and Humbie Farmhouse (Site 919). Humbie Steading is a Category B Listed Building while the others are Category C(S) Listed Buildings. While a new link road is proposed, both South Corridor Option 1 and South Corridor Option 2 are on line in this area. The significance of impact on the setting of these sites has therefore been assessed as Neutral.

South Corridor Option 1

12.4.20 Potential physical impacts on 14 sites have been identified, as detailed in Table 12.14 below. These impacts are all direct and permanent. The impact on Dundas Castle Designed Landscape (Site 1111) has been assessed as of being of Substantial significance and there is potential for a Slight significance of impact on the northeastern corner the Newliston Designed Landscape (Site 1112). The significance of the impacts on other sites has been assessed as ranging from Neutral to Moderate.

Table 12.14: Summary of Potential Physical Impacts - South Corridor Option 1

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
150	Newbigging Cobbled Surface	None	Low	Major	Slight
561	Linn Burn Cropmark	None	Medium	Negligible	Negligible
811	Inchgarvie House Linear Cropmarks	None	Low	Moderate	Slight
1111	Dundas Castle Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Moderate	Substantial
1112	Newliston Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Negligible	Slight

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
1118	South Queensferry, Linear Cropmark	None	Unknown	Moderate	Unknown
1122	Possible Quarry Pit	None	Negligible	Major	Slight
1145	Newbigging Roadway	None	Low	Minor	Negligible
1146	Newbigging Cropmark Pit Alignment	None	Medium	Major	Moderate
1147	Echline Strip Clearance Cairns	None	Negligible	Major	Slight
1148	Newbigging Clearance Cairns	None	Negligible	Negligible	Neutral
1149	Newbigging Tank/Spring	None	Negligible	Major	Slight
1197	Milton Cropmark Pit Alignment	None	Medium	Minor	Slight
1200	Newbigging Road	None	Low	Minor	Negligible

12.4.21 Potential impacts on the setting of eight sites or site groups have been identified, as detailed in Table 12.15 below. The significance of the potential impact on the setting of Dundas Castle Designed Landscape (Site 1111) has been assessed as Moderate. The potential impacts on Echline Farmhouse (Site 721; Category B Listed Building), Echline Cottages (Sites 723-730; Category B Listed), Newbigging Steading (Site 814; Category B Listed) and Newbigging Farmhouse (Site 815; Category C(S) Listed Building) have all been assessed as being of Slight significance.

Table 12.15: Summary of Potential Impacts on Setting - South Corridor Option 1

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
721	Echline Farmhouse	Category B Listed Building	High	Minor	Slight
723-730	Echline Cottages	Category B Listed Buildings (group)	High	Minor	Slight
802, 807 & 808	Scotstoun House, 1 and 2, Offices & Garden Walls	Category B Listed Buildings complex	High	No Change	Neutral
814	Newbigging Steading 6-18	Category B Listed Building	High	Minor	Slight
815	Newbigging Farmhouse	Category C (S) Listed Building	Medium	Minor	Slight
817, 828, 839, 847, 849, 855, 876, 879, 877, 891, 898, 904	Dundas Castle Complex	SAM and Category A, B and C (S) Listed Buildings	High	No Change	Neutral
1111	Dundas Castle designed Landscape	Designed Landscape	High	Moderate	Moderate
1112	Newliston Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Negligible	Slight

<u>South Corridor Option 2</u>

12.4.22 Potential physical impacts on seven sites or groups of sites have been identified, as detailed in Table 12.16 below. While the significance of the impact on Milton Cropmark Pit Alignment (Site 1197) has been assessed as Moderate, the significance of the impacts on the other sites have been assessed as Negligible or Slight.

Table 12.16 Summary of Potential Physical Impacts - South Corridor Option 2

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
561	Linn Mill Burn	None	Medium	Negligible	Negligible
811	Inchgarvie Cropmark	None	Medium	Minor	Slight
896	Swineburn Wood Linear Cropmark	None	Medium	Negligible	Negligible
945	Overton, Charles Bridge	None	Low	Moderate	Slight
1112	Newliston Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Minor	Slight
1118	Cropmark	None	Medium	Minor	Slight
1197	Milton Cropmark Pit Alignment	None	Medium	Moderate	Moderate

12.4.23 Potential impacts on the setting of five sites or groups of sites have been identified in Table 12.17. The potential impacts on the Category B Listed Dundas Mains Cottages (Sites 819-823) and the Westfield Steading complex (Sites 830, 834-6 & 842-844; all Category C(S) Listed Buildings) have been assessed as being of Slight significance. To the west of the Dundas Castle Designed Landscape (Site 1112), recorded on the Inventory of Gardens and Designed Landscapes, South Corridor Option 2 would be in a road cutting, reducing its visibility in the landscape. The significance of this impact on this site has been assessed as Slight.

Table 12.17: Summary of Potential Impacts on Setting - South Corridor Option 2

Site	Site Name	Designation	Sensitivity	Potential Impact (unmitigated)	
				Magnitude	Significance
819-823	Dundas Mains	Category B Listed Building	High	Minor	Slight
817, 828, 839, 847, 849, 855, 876, 879, 877, 891, 898, 904	Dundas Castle Complex	Scheduled Ancient Monument and Category A, Band C(S) Listed Buildings	High	No Change	Neutral
830, 834-6 & 842-844	Westfield Steading Complex	Category C (S) Listed Buildings	Medium	Minor	Slight
1111	Dundas Castle Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Minor	Slight
1112	Newliston Designed Landscape	Inventory of Gardens and Designed Landscapes	High	Minor	Slight

12.5 Potential Mitigation

12.5.1 At DMRB Stage 2 assessment of route corridor options, the detailed design has not been developed and mitigation detail therefore cannot be accurately defined. The objective of this section is therefore to identify ‘standard’ or ‘anticipated’ mitigation taking into account best practice, legislation and guidance. This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 12.6 (Summary of Corridor Options Assessment), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

12.5.2 Generic mitigation options available include:

- design solutions to avoid or reduce impacts, so as to achieve 'preservation *in situ*', for instance by altering the vertical or horizontal alignment;
- archaeological and architectural recording works in advance of construction, including set-piece archaeological excavations, and the dissemination of the results of these works to offset the impact by recording the site ('preservation by record'); and
- archaeological recording work during construction, including watching briefs, and the dissemination of the results, to offset the impact by recording any surviving remains.

12.5.3 Where mitigation works are required for impacts on the setting of sites of cultural heritage interest, they are most likely to take the form of landscape design measures, including the provision of false cuttings and or vegetation planting.

12.6 Summary of Route Corridor Options Assessment

12.6.1 This section takes the likely mitigation into account to summarise the residual impacts for each of the route corridor options.

Northern Route Corridor Options

12.6.2 The significance of the impact of North Corridor Option 1 on Middlebank Souterrain SAM (Site 82) has been assessed as Severe. While it may be possible to offset this impact through recording works, including set piece excavations and dissemination of results, the residual significance of impact on this site been assessed as Substantial until this can be confirmed. As North Corridor Option 2 avoids a direct physical impact on Middlebank Souterrain SAM (Site 82), this option is the preferred northern route corridor option. It is Historic Scotland's expectation that all new roads are planned to avoid damage to the site and setting of statutorily protected scheduled monuments (The Highways Agency et al., 2007). This is in accordance with the guidance provided by NPPG 5 (Paragraph 17), SHEP 2 (Historic Scotland, 2008) and the Dunfermline and the Coast Adopted Local Plan (Policy BE15).

12.6.3 With the exception of Site 82, it is likely that the significance of the other direct physical impacts which may result from North Corridor Option 1 and North Corridor Option 2 can be reduced to Neutral through recording works in advance of construction. It is also likely that the impacts on setting identified can also be mitigated by recording in advance of highway and landscape construction.

12.6.4 Overall, whilst both North Corridor Options 1 and 2 have the potential to impact on Middlebank Souterrain SAM, North Corridor Option 2 is marginally preferred as it would be further away from this SAM.

Southern Route Corridor Options

12.6.5 A direct impact of Slight significance by both southern route corridor options on Newliston Designed Landscape (Site 1112) has been identified although it may be possible to mitigate this impact by recording works in advance of construction. In addition a direct physical impact of Moderate significance on Dundas Castle Designed Landscape (Site 1111) by South Corridor Option 1 is predicted, which would be difficult to fully mitigate. South Corridor Option 2 avoids this impact and is therefore the preferred southern corridor option. It is Historic Scotland's policy to seek to prevent any intrusive development which would detract from the integrity and historic landscape character of gardens and designed landscapes (The Highways Agency et al., 2007).

12.6.6 It is likely that the other direct physical impacts predicted for the southern corridor options, assessed as ranging from Slight to Moderate, can be reduced to Neutral through recording works in advance of construction.

12.6.7 South Corridor Option 2 is predicted to have impacts on the setting of four sites, the significance of which has been assessed as Slight with the remaining impact being assessed as Neutral. Slight impacts on the setting of five sites by South Corridor Option 1 are predicted, along with two Moderate significance impacts.

12.6.8 In terms of number and significance of impacts on setting, South Corridor Option 2 would have less impact to South Corridor Option 1. With the exception of impacts on the setting of Dundas Castle Designed Landscape (Site 1111), it is likely that the other impacts on setting by the southern corridor options can be fully mitigated through landscape works.

12.6.9 Overall, South Corridor Option 2 is the preferred option as it would have less impact on Dundas Castle Designed Landscape and other impacts are generally similar.

12.7 Scope of Stage 3 Assessment

12.7.1 The Stage 3 assessment will be based on DMRB Volume 11, Section 3, Part 2 and will provide the following information:

- a description of the archaeological/historic background of the area surrounding the preferred route corridor including a compiled of known sites;
- a description of the archaeology, historic buildings and historic landscape character in the area surrounding the preferred route corridor;
- an assessment of the cultural heritage value of each site, structure and area identified within the survey area;
- an assessment of the potential of the survey area for unknown archaeological remains;
- recommendations for further evaluation and mitigation works; and
- an assessment of the magnitude of the un-mitigated scheme on all sites, structures and areas.

12.8 References

City of Edinburgh Council (2006). Rural West Edinburgh Local Plan, Adopted June 2006.

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13 Air Quality

13.1 Introduction

13.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of air quality.

13.1.2 Air quality studies are concerned with the presence or absence of airborne pollutants. This chapter outlines the relevant air quality management policy and legislation, describes the existing or 'baseline' air quality situation and identifies and compares the anticipated operational air quality impacts of each of the route corridor options. Potential air quality impacts during construction are considered separately in Chapter 17 (Disruption Due to Construction).

13.1.3 In the area surrounding the Forth Replacement Crossing, vehicle emissions are the dominant source of air pollution. For this reason and also because of the nature of the development, the assessment only considers those air pollutants emitted by vehicular traffic and which have been identified as being of most concern by the UK Government's Air Quality Strategy and by UK and EU legislation.

13.1.4 The main pollutants that are produced by road traffic and which can lead to poor air quality include oxides of nitrogen (NO_x), comprising mainly nitric oxide (NO) and nitrogen dioxide (NO_2), carbon monoxide (CO), volatile organic compounds (VOCs), particularly benzene and 1,3-butadiene and fine particulate matter ($PM_{2.5}$, PM_{10}). However, for the purpose of the local air quality assessment presented in this chapter only NO_2, NO_x and PM_{10} are assessed. Local authorities have identified NO_2 and PM_{10}, emitted by road traffic as the key pollutants of concern within this area of Scotland (refer to Section 13.3: Local Authority Review and Assessment of Air Quality). Other motor vehicle related pollutants are sufficiently controlled to have negligible impact in terms of local air quality. NOx concentrations are included due to the fact that local atmospheric chemistry determines related NO_2 concentrations.

13.1.5 Nitrogen deposition is also considered within the Stage 2 assessment as per DMRB guidance.

13.1.6 Scottish Transport Appraisal Guidance (STAG) (Transport Scotland, 2008) also identifies carbon dioxide (CO_2) as a pollutant of concern on a global level. Concentrations of CO_2 generated as a result of the Forth Replacement Crossing are therefore considered in the regional level assessment. In addition, concentrations of NO_x and PM_{10} are considered in terms of total emissions as part of the regional level assessment.

13.2 Approach and Methods

Study Area

13.2.1 The study area considered for this Stage 2 assessment comprises an area covering the Forth Replacement Crossing corridor as well as areas to the north and south of the proposed replacement bridge. Figures 13.2a-c show the extent of the modelled road network and thus the extent of the study area for the air quality assessment.

Overall Approach

13.2.2 The assessment of air quality is made in terms of the difference between the air quality that would be likely with the proposed scheme (the Do-Something scenario) and without the proposed scheme (the 'do-minimum scenario) for both the anticipated year of opening (2017) and the design year 15 years after opening (2032). The future 'do minimum' scenario assumes that the existing Forth Road Bridge is still in operation.

13.2.3 The Stage 2 air quality assessment of the route corridor options consists of the following components:

- a review of the existing air quality situation;
- collation of road traffic data and scoping out of local road links with changes in traffic flows or speeds too small to influence local air quality under each of the route corridor options;
- an assessment of the changes in air quality at representative receptors arising from the operation of the Forth Replacement Crossing, as a result of the changing traffic flows on the proposed replacement bridge and adjoining road network for each of the route corridor options;
- an assessment of the changes in nitrogen deposition at representative receptors arising from the operation of the Forth Replacement Crossing as a result of the changing traffic flows on the new replacement crossing and adjoining road network for each of the route corridor options; and
- a comparison of changes in local population exposure to road traffic related air pollution for the current configuration and each of the route corridor options.

Assessment Methodology

13.2.4 The methodology used for the Stage 2 air quality assessment is based on DMRB Volume 11, Section 3, Part 1: HA207/07 (The Highways Agency et al., 2007). This document provides a three-stage appraisal methodology, using scoping, screening and detailed modelling techniques where appropriate to allow comparison of pollutant concentrations with the relevant European Union (EU) limit values and Scotland air quality objectives (see Table 13.3). The quantitative comparison of the route corridor options is based on the methodology included in STAG.

13.2.5 An assessment has been made of the concentrations of NO_2 and PM_{10} at receptors near to the roads and junctions for the various route corridor options. Receptors were selected as those in closest proximity to the road, at junctions where congestion or a reduction in speed may be expected and at identified sensitive areas such as the designated Firth of Forth Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI), St Margaret's Marsh SSSI and Ferry Hills SSSI (see paragraph 13.3.31 for more information on these designated sites).

Modelling Methodology

Road Traffic Data and Scoping

13.2.6 Road traffic data were collated in terms of annual average daily (24 hour) traffic flows (AADT), daily average speed and percentage of heavy duty vehicles for the proposed replacement bridge and associated access road links and junctions for the base year (2005) and future assessment scenarios years 2017 and 2032. The data were firstly interrogated to scope out sections of road (links) where potential changes in traffic flows would not influence local air quality significantly using the DMRB thresholds:

- road alignment will change by 5 m or more; or
- daily traffic flows will change by 1,000 AADT or more or 10% change on road links; or
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more; or
- daily average speed will change by 10 km/hr or more; or
- peak hour speed will change by 20 km/hr or more.

Changes in Local Population Exposure

13.2.7 For each scoped in link for each northern and southern route corridor option, residential receptor counts were made for distance bandings 0-50m, 50-100m, 100-150m and 150-200m on either side of the road.

13.2.8 ArcGIS was used to generate buffer zones (0-50m; 0-100m; 0-150m; 0-200m) around the scoped in links and to count properties within each buffer zone. Figure 3.2 shows the four buffer zones for one scenario (North Corridor Option 1 in combination with South Corridor Option in 2032) and properties within the 200m buffer as an example.

13.2.9 The DMRB calculation procedure was then used to determine NO_2 and PM_{10} concentrations within these distance bandings and, using weighting factors included in STAG, a population exposure score was derived for each scenario. These scores are relative and provide a means of comparing the effect of each route corridor option in terms of population exposure to road traffic related air pollution. It should be noted that STAG scores are based on average concentration net change per assessed property.

Changes in Air Quality and Nitrogen Deposition

13.2.10 Representative receptors were identified within the study area. The criteria for receptor selection included:

- residential properties and other sensitive receptors, such as schools or locations within designated nature reserves which are closest to affected road links and where the greatest change in local air quality would be expected as a result of the Forth Replacement Crossing (i.e. where greatest change in traffic flows is predicted to occur); and
- residential properties or locations within designated nature reserves where the highest concentrations of road traffic pollutants would be expected (e.g. around junctions).

13.2.11 DMRB HA207/07 includes a calculation procedure combining background air quality data with road traffic emissions to derive concentrations of NO_x, NO_2 and PM_{10} and nitrogen deposition rates at each representative receptor. The background air quality concentrations were obtained from the National Air Quality Archive; this is further discussed in paragraphs 13.3.27 to 13.3.29. The years of assessment were for the baseline situation in 2005 (based on 2005 traffic survey data), 2017 and 2032 both with and without the proposed replacement bridge. It should be noted that DMRB emission factors only go as far as 2025 and therefore 2025 emission factors have been used for the 2032 scenarios. The results are compared directly to the air quality limit values and objectives as well as the critical load for calcareous grassland, saltmarsh fens, and neutral grassland which are the predominant habitats found in the SSSIs in the study area (see Table 13.8).

13.2.12 Assessment of designated sites within 200m either side of each route corridor option was carried out in accordance with the methodology outlined in Annex F of the DMRB HA207/07 which assesses the traffic related dry deposition of nitrogen (in kilograms per hectare per year). This requires that annual mean NO_2 concentrations are calculated for a transect up to 200m away from each of the affected roads (roads that have been scoped in) within or near a designated site. The calculations were carried out for 2017 and 2032 with and without the proposed replacement bridge at 20m intervals starting from the closest point from the road that lies within or in close proximity to the SSSI. When predicting future deposition rates, background nitrogen deposition rates (as presented in Table 13.10) were reduced by 2% per year in accordance with DMRB. This is because of predicted improvements in vehicle technologies and abatement equipment.

Total Pollutant Emissions

13.2.13 Total emissions of NO_x, PM_{10} and CO_2 were calculated within the study area. All road links independent of whether or not they meet the DMRB criteria were included in the total emissions calculations. Total vehicle kilometres travelled along each road link were established using ArcGIS and available traffic data. Emission factors were derived using the dataset incorporated in the DMRB worksheets version 1.03c (July 2007). For each road link total pollutant emissions per year were calculated. Emissions established for each link were then added to generate the total mass of emissions for each assessed corridor option.

Baseline Conditions

13.2.14 Baseline conditions were assessed using the desk study based approach. Air Quality Review and Assessment documents from relevant local authorities have been reviewed and existing local air quality established using information from the reviewed reports and the national air quality archive.

13.2.15 Estimates of background air quality for pollutants NO_x, NO_2 and PM_{10} have also been obtained from the national air quality archive. This is in the form of annual mean estimates aggregated for each one km grid square for 2004 and projections for future years from national mapping studies (www.airquality.co.uk).

13.2.16 In line with current guidance, background concentrations for future years (2017, 2032) were calculated using the netcen year adjustment calculator available on www.airquality.co.uk. The calculator includes factors for years up to 2020. As a consequence, the 2020 factor has been used to calculate background concentrations for 2032.

13.2.17 These mapping studies consider local sources, such as roads and industry, as well as sources from elsewhere in the UK and continental Europe.

Impact Assessment

13.2.18 The National Society for Clean Air (NSCA) guidance (NCSA, 2006) provides an example approach for assessing the significance of air quality impacts associated with a given development. These significance criteria have been used to quantify traffic effects for the individual sensitive receptors modelled. The significance of the impacts is then assessed through a series of questions with closed (yes and no) answers. Each question is addressed in descending order until the arrow points to one of the outcomes in the right hand column. This gives the relative priority which air quality considerations should be afforded with respect to the development proposal.

13.2.19 The NSCA guidance also provides further guidance on how to describe the significance of the impacts predicted from the air quality modelling for the pollutants NO_2 and PM_{10}. Two tables are presented that set out examples of descriptors for magnitude of change and significance (as shown below in Tables 13.1 and 13.2). The first step is to identify the descriptor of change in ambient concentrations for NO_2 and PM_{10} (Table 13.1) according to the percentage change in annual mean concentrations (for both NO_2 and PM_{10}). The descriptor can then be used to assess the impact significance for the two pollutants in relation to changes in the absolute concentration forecast from the modelling with the Forth Replacement Crossing in place (Table 13.2).

Sensitivity

13.2.20 As described above, the sensitivity of certain receptors has been considered by applying screening criteria to road links affected by the Forth Replacement Crossing. Receptor points within 200m of links that meet the DMRB criteria are considered as being potentially 'susceptible' to resulting changes in local air quality and are therefore included in the quantitative assessment.

Impact Magnitude

13.2.21 Table 13.1 below shows descriptors of magnitude of change.

Table 13.1: Examples of Descriptors for Changes in Ambient Concentrations of NO_2 and PM_{10} (Source: NSCA, 2006)

Magnitude of Change	Annual Mean NO_2/PM_{10}
Very Large	Increase/decrease > 25%
Large	Increase/decrease 15-25%
Medium	Increase/decrease 10-15%
Small	Increase/decrease 5-10%
Very Small	Increase/decrease 1-5%
Extremely Small	Increase/decrease <1%

Impact Significance

13.2.22 The significance of impacts was determined according to a matrix of sensitivity and magnitude as illustrated in Table 13.2, in accordance with NSCA guidance.

Table 13.2: Examples of Descriptors for Impact Significance for NO_2 and PM_{10} (Source NSCA, 2006)

Absolute Concentration in Relation to Standard	Extremely Small	Very Small	Small	Medium	Large	Very Large
Decrease with scheme						
Above Standard with scheme	Slight beneficial	Slight beneficial	Substantial beneficial	Substantial beneficial	Very substantial beneficial	Very substantial beneficial
Above Standard without scheme Below with scheme	Slight beneficial	Moderate beneficial	Substantial beneficial	Substantial beneficial	Very substantial beneficial	Very substantial beneficial
Below Standard without scheme, but not Well Below	Negligible	Slight beneficial	Slight beneficial	Moderate beneficial	Moderate beneficial	Substantial beneficial
Well Below Standard without scheme	Negligible	Negligible	Slight beneficial	Slight beneficial	Slight beneficial	Moderate beneficial
Increase with scheme						
Above Standard without scheme	Slight adverse	Slight adverse	Substantial adverse	Substantial adverse	Very substantial adverse	Very substantial adverse
Below Standard without scheme Above with scheme	Slight adverse	Moderate adverse	Substantial adverse	Substantial adverse	Very substantial adverse	Very substantial adverse
Below Standard with scheme, but not Well Below	Negligible	Slight adverse	Slight adverse	Moderate adverse	Moderate adverse	Substantial adverse
Well Below Standard with scheme	Negligible	Negligible	Slight adverse	Slight adverse	Slight adverse	Moderate adverse
Well Below standard = <75% of the standard level. 'Standard' in the context of this table relates to specific air quality objective or Limit Value in question						

Limitations to Assessment

13.2.23 The base year in terms of traffic was taken to be 2005, using Transport Model for Scotland (TMfS05a) data. A later version is currently in preparation by MVA Consultancy on behalf of Transport Scotland, to include changes such as more recent alterations to the road network and anticipated major developments. However, TMfS05a represents the best data currently available and it is considered that these provide an acceptable proxy for the baseline traffic situation for the purposes of this assessment.

13.2.24 As described in paragraph 13.2.2, the years of assessment include future years of 2017 and 2032. There is an inherent limitation in the accuracy of background concentrations and vehicle emission factors projections so far into the future. However, the approach followed is consistent with current best practice and government guidance.

13.3 Baseline Conditions

Air Quality Policies, Legislation and Standards

Air Quality Limit Values and Objectives

13.3.1 Air quality limit values and objectives are quality standards for clean air. They can be used as assessment criteria for determining the significance of any potential changes in local air quality resulting from the development proposals.

13.3.2 EU air quality policy sets the scene for national policy. The 'framework' EU Directive on Ambient Air Quality Assessment and Management came into force in September 1996 (Directive 96/62/EC) and is intended as a strategic framework for tackling air quality consistently, through setting European-wide air quality limit values in a series of daughter directives, superseding and extending existing European legislation. The first four daughter directives have been placed into national legislation. These EU limit values have recently been consolidated in the Air Quality Standards (Scotland) Regulations 2007. A new EU Directive (Directive 2008/50/EC) has recently been announced that merges the four daughter directives and one Council decision into a single directive on air quality. The new Directive introduces a new limit value for fine particulate matter ($PM_{2.5}$) but does not change the existing air quality standards. This is yet to be transposed into UK policy.

13.3.3 In a parallel national process, the Environment Act was published in 1995. The Act required the preparation of a national air quality strategy setting air quality standards and objectives for specified pollutants and outlining measures to be taken by local authorities (through the system of Local Air Quality Management ('LAQM')) and by others 'to work in pursuit of the achievement' of these objectives. A National Air Quality Strategy (NAQS) was published in 1997 and subsequently reviewed and revised in 2000, and an addendum to the Strategy published in 2002. The current Strategy is that published in July 2007; (The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, 2007). The objectives which are relevant to local air quality management have been set into Regulations (Air Quality (Scotland) Regulations 2000 and Air Quality (Scotland) Amendment Regulations 2002).

13.3.4 Table 13.3 sets out the EU air quality limit values and national air quality objectives for the pollutants of relevance to this study.

Table 13.3: EU Air Quality Limit Values and National Air Quality Objectives for Relevant Pollutants

Pollutant	Averaging Period	Objective/Limit Value	Compliance Date	Basis
Nitrogen dioxide (NO_2)	1 hour mean	200 µg/m^3, not to be exceeded more than 18 times a year (99.8th percentile)	31 Dec 2005	National
			01 Jan 2010	EU
	Annual mean	40 µg/m^3	31 Dec 2005	National
			01 Jan 2010	EU
Particulate matter (PM_{10})	Daily mean	50 µg/m^3, not to be exceeded more than 35 times a year (90.4th percentile)	01 Dec 2004	National
			Not specified	EU
Measurement technique: Gravimetric	Annual mean	40 µg/m^3	31 Dec 2004	National
			Not specified	EU
		18 µg/m^3	31 Dec 2010	National

Planning Policy

13.3.5 The key links between planning and air quality are with transport, industry and energy, since these are the main sources of air pollution. National planning policy is set out in Scottish Planning Policies (SPP), with SPP 17 'Planning for Transport' being relevant to air quality assessments of new transport infrastructure. The Scottish Government has also published Planning Advice Notes (PANs) of which PAN75 'Planning for Transport' is of relevance to this air quality assessment.

13.3.6 SPP17 (accompanied by PAN75) highlights the need to provide better integration between transport and land-use planning, as well as with other Government policies. SPP17 outlines a framework encouraging key travel generating uses to be in locations that support sustainable transport options, a move towards maximum car parking standards and broader transport assessments covering all modes of access, and the use of green travel plans and planning agreements to promote sustainable transport solutions. Sustainable transport options and green travel plans contribute to integrating transport and air quality such that air quality does not deteriorate as a result of new development.

Air Pollution Sources

Industrial Processes

13.3.7 Industrial air pollution sources are regulated through a system of operating permits or authorisations, requiring stringent emission limits to be met and ensuring that any releases are minimised or rendered harmless. Regulated (or prescribed) industrial processes are classified as Part A or Part B processes. Part A processes, regulated through the Integrated Pollution Prevention and Control (IPPC) system (EC Directive 96/91/EC on Integrated Pollution Prevention and Control) are regulated by SEPA. Part A processes have the potential for release of prescribed substances to air, land and water, and as such require an IPPC permit to operate. Part B processes are those regulated by the local authority through the Pollution Prevention and Control (PPC) system under the Pollution Prevention and Control (Scotland) Regulations 2000. Part B processes are smaller in scale than Part A processes and have the potential for release of prescribed substances to air only, requiring a PPC authorisation or permit to operate. Given the extent of the study area, it is likely that there are several Part B processes within the assessed area. However, due to the fact that they are controlled, it is considered unlikely that such processes would lead to a breach of air quality objectives.

13.3.8 There are a number of industrial processes regulated through the IPPC system within approximately 2km of the Forth Replacement Crossing, including, Dalmeny Tank Farm, South Queensferry (part of BP Exploration Co. Ltd), Shanks Chemical Services, several Sewage Treatment Works, Rosyth Royal Dockyards Ltd and the Grampian County Food Group Ltd. However, as these processes are controlled by SEPA and potential releases to air are tightly regulated it is considered that such processes would not lead to a breach of air quality objectives.

13.3.9 In addition to the processes in the immediate vicinity of the proposed replacement bridge, there are industrial sources which contribute to releases to air in Grangemouth, approximately 20km to the west of the proposed replacement bridge.

Local Authority Review and Assessment of Air Quality

13.3.10 Under the requirements of the Environment Act 1995 Part IV, local authorities are required to periodically review and assess air quality in their areas. If it is predicted that air quality concentrations will exceed national air quality objectives the local authority is required to declare an Air Quality Management Area (AQMA) around the area where the exceedance is predicted to occur.

City of Edinburgh Council

13.3.11 City of Edinburgh Council (CEC) undertook the first and second stages of the review and assessment which concluded that NO_2 required further investigation at Stage 3 review and assessment (CEC, 2000). This concluded that the annual mean NO_2 objective was predicted to be exceeded in 2005 in eight locations in Edinburgh. On this basis CEC subsequently designated an Air Quality Management Area (AQMA) for NO_2 covering the city centre, including the main roads into the city centre.

13.3.12 CEC produced an Air Quality Action Plan in July 2003 (CEC, 2003) which detailed measures to reduce NOx emissions in the AQMA in pursuit of the annual mean NO_2 objective.

13.3.13 A further Updating and Screening Assessment (USA) was carried out in 2006 which concluded that a second AQMA should be declared for the area around St Johns Road, west Edinburgh city centre. As a result, an AQMA for NO_2 was declared on 31 December 2006.

13.3.14 The study area does not include the centre of Edinburgh or any of the designated AQMAs due to the fact that road links do not meet the DMRB criteria as listed in paragraph 13.2.6. As a result, it is considered unlikely that any of the route corridor options would have a significant impact on the AQMAs in Edinburgh.

West Lothian Council

13.3.15 West Lothian Council (WLC) undertook the first and second stages of the review and assessment which concluded that all pollutants of concern would meet the relevant air quality objectives in the relevant years and hence no further assessment work was required.

13.3.16 The USA submitted in July 2006 concluded that all pollutants would continue to meet the relevant air quality objectives and therefore no further assessment would be required. For PM_{10}, however, it was indicated that there is a risk of exceeding the annual objective of $18\mu g/m^3$ in Linlithgow High Street. As a result it was recommended to continue the PM_{10} monitoring at Linlithgow High Street.

13.3.17 The Progress Report submitted in April 2007 states that Linlithgow High Street would potentially have to be declared an AQMA due to a number of exceedances of the PM_{10} standard and the closeness to the annual mean objective. With regards to NO_2, the report concludes that there were no exceedances of relevant national objectives and therefore no further Detailed Assessment is required.

13.3.18 The study area does not include Linlithgow High Street due to the fact that road links outside the boundary of the study area do not meet the DMRB criteria as listed in paragraph 13.2.6. As a result, it is considered unlikely that any of the route corridor options would have a significant impact on the AQMA in Linlithgow.

Fife Council

13.3.19 Fife Council (FC) completed the second round of air quality review and assessment in 2003 with subsequent Progress Reports following in 2004 and 2005. The 2003 USA identified that high NO_2 concentrations were recorded at several kerbside locations within the Fife area. The 2004 Progress Report recommended to undertaking monitoring at the façade of buildings rather than kerbside locations to allow a better assessment of likely exposure. A revised monitoring programme was carried out in 2004 and automatic monitoring of NO_2 has been undertaken at two locations (Rosyth and Kincardine) in Fife.

13.3.20 In 2006 FC submitted an USA as part of the third round of air quality assessment. The USA concluded that it is unlikely that the air quality objective for NO_2 would be exceeded.

13.3.21 With regards to PM_{10}, the 2006 USA concluded that the 2004 air quality objective is unlikely to be exceeded but that the 2010 objective might be closely approached. It was recommended to continue automatic monitoring for a period covering at least one full year.

13.3.22 The 2007 Progress Report concluded that there is a risk of exceeding the NO_2 and PM_{10} air quality objectives in Bonnygate, Cupar and a Detailed Assessment has been carried out during 2007. If the Detailed Assessment confirms the exceedance of relevant objectives, an Air Quality Management Area will have to be designated.

13.3.23 As Bonnygate is located more than 40km to the northeast of the proposed replacement bridge, it is very unlikely that any of the assessed corridor options will have an adverse impact on the existing air quality hotspot.

Local Air Quality Monitoring

13.3.24 There are a number of continuous monitoring stations within the areas of Edinburgh, Fife and West Lothian, however, only one of them is located within 5km of the proposed replacement bridge. The Council of Fife operates a mobile monitoring station in Rosyth at NGR 311752, 683515. In their 2007 Progress Report, Fife Council reports a NO_2 concentration of 26µg/m^3 at this location for a six month period (October 2006 – March 2007).

13.3.25 City of Edinburgh, Fife and West Lothian Councils also operate extensive networks of diffusion tubes. However, only a limited number of tubes are located in the vicinity of the proposed replacement bridge. Table 13.4 lists diffusion tubes located in Rosyth, Fife, approximately 2km northwest of the proposed replacement bridge and associated measured NO_2 concentrations.

Table 13.4: Diffusion Tube Results for Rosyth, Fife

Diffusion Tube	Monitoring Type*	NGR	NO_2 Concentration		
			2004	2005	2006
Admiralty Rd	KS	312103, 683439	37	31	36
Admiralty Rd 1	RS (F)	312103, 683439	19	26	32
Admiralty Rd 2	RS (F)	312103, 683439	20	26	33

Diffusion Tube	Monitoring Type*	NGR	NO_2 Concentration		
			2004	2005	2006
Admiralty Rd 3	RS (F)	312103, 683439	20	23	32

* KS – Kerbside; RS (F) – Roadside on building facade

13.3.26 The results in Table 13.4 show that for all monitored years the annual mean NO_2 air quality objective as shown in Table 13.3 was met.

Background Pollution Concentration

13.3.27 Estimated pollutant background concentrations from the national air quality archive for Edinburgh, Fife and West Lothian in 2005 (Baseline year for the assessment) are summarised in Tables 13.5, 13.6 and 13.7 below.

Table 13.5: Edinburgh Background Concentrations

Pollutant	2005 Annual Mean, µg/m^3		
	CEC Area Mean	CEC Area Maximum	CEC Area Minimum
NO_x	18.5	41.6	6.4
NO_2	14.2	26.1	5.0
PM_{10}	14.4	20.3	11.6

Note: The data presented are nationally mapped annual means for each 1km grid square aggregated over the Edinburgh area.

Table 13.6: Fife Background Concentrations

Pollutant	2005 Annual Mean, µg/m^3		
	Fife Area Mean	Fife Area Maximum	Fife Area Minimum
NO_x	7.3	21.7	3.9
NO_2	5.7	17.1	3.1
PM_{10}	11.8	16.8	10.3

Note: The data presented are nationally mapped annual means for each 1km grid square aggregated over the Fife area.

Table 13.7: West Lothian Background Concentrations

Pollutant	2005 Annual Mean, µg/m^3		
	West Lothian Area Mean	West Lothian Area Maximum	West Lothian Area Minimum
NOx	10.6	26.5	4.8
NO_2	8.4	19.4	3.8
PM_{10}	13.7	21.9	11.3

The data presented are nationally mapped annual means for each 1km grid square aggregated over the West Lothian area.

13.3.28 The results indicate background concentrations of NO_2 and PM_{10} are within applicable air quality standards (Table 13.3) although the maximum NO_x concentration in the CEC area exceeds the limit for the protection of ecosystems. The results do not take account of exposure or receptor location. It should also be noted that as these are background concentrations, levels would be expected to be higher at locations nearer to busy roads.

13.3.29 Industrial and vehicular emissions control has reduced ambient concentrations of NO_x and PM_{10} over recent years and it is predicted that this trend will continue.

Nitrogen Deposition Rates

13.3.30 DMRB states that any nature conservation sites ('designated sites') and their characteristics should be identified as part of the air quality assessment. The designated sites that should be considered for an assessment are those for which the designated features are sensitive to air pollutants, either directly or indirectly, and which could be adversely affected by the effect of air pollution on vegetation within the nature conservation sites.

13.3.31 High levels of NO_x can have an adverse effect on vegetation, including leaf or needle damage and reduced growth. Deposition of pollutants derived from nitrogen oxide emissions contribute to acidification and/or eutrophication of sensitive habitats leading to loss of biodiversity.

13.3.32 Table 13.8 shows SSSIs within the study area, the reasons for their designation and critical loads for the features of special interest. The background nitrogen deposition rate (in kg/ha/yr) was taken from the APIS website (www.apis.co.uk) for grid references 312029, 678687 (Firth of Forth SPA & SSSI), 312070, 681475 (St Margaret's Mash SSSI), 312545, 681673 (Ferry Hills SSSI). In accordance with the DMRB guidance, the total estimated background deposition rates are reduced by 2% per future year. Figure 13.1a-c shows the locations of assessed SSSIs within the study area.

Table 13.8: Nitrogen Critical Loads and Background Deposition Rates (2004)

SSSI Name	Features of Special Interest	Critical Load (kg N ha^{-1} yr^{-1})	Nitrogen Deposition (kg N ha^{-1} yr^{-1})
Firth of Forth	Neutral grassland	10-20	12.7
	Fen, marsh and swamp	10-35	12.7
St Margaret's Marsh	Saltmarsh fen; marsh and swamp	10-35	12.3
Ferry Hills	Calcareous grassland	15-25	12.3

DMRB Receptors

13.3.33 Thirty discrete receptor locations have been chosen to assess potential impacts of the route corridor options at various sensitive locations. Criteria as described in paragraph 13.2.4 were used to determine the most representative receptor locations. The same receptors have been used for all assessed route corridor options in order to allow comparison of impacts. Figure 13.2a-c and Table 13.9 show receptor locations in the northern (N) and southern (S) study areas.

Table 13.9: Individual Receptor Locations

Receptor	Grid Ref	Location Details
R1 (N)	NT 2987 8495	16 Sandybank, Halbeath
R2 (N)	NT2743 4645	The Bungalow; Dunfermline
R3 (N)	NT2334 4161	65 Park Lea, Rosyth
R4 (N)	NT3630 3508	Inverkeithing High School; Hillend Road
R5 (N)	NT3252 3467	Burleigh Cresent; Inverkeithing
R6 (N)	NT2259 3577	127 Parkside Street, Rosyth
R7 (N)	NT2190 3088	102 Castlandhill Road, Rosyth
R8 (N)	NT1940 3413	10 Castlandhill Road, Rosyth
R9 (N)	NT2436 2725	4 Mucklehill Park, Inverkeithing
R10 (N)	NT 2331 1036	St Margarets Hope; North Queensferry
R11 (N)	NT2630 0720	15 Ferry Barns Court, North Queensferry
R12 (S)	NT2400 8418	14 Farquhar Terrace, South Queensferry

Receptor	Grid Ref	Location Details
R13 (S)	NT2866 8382	15 Hopetoun Road, South Queensferry
R14 (S)	NT2398 7919	41 Stoneyflats Cresent, South Queensferry
R15 (S)	NT2998 7509	2 Scotstoun Green, South Queensferry
R16 (S)	NT1542 7947	66 Echline Drive, South Queensferry
R17 (S)	NT1327 8475	7 Linnmill, South Queensferry
R18 (S)	NT2621 7176	12 Dundas Home Farm, South Queensferry
R19 (S)	NT9175 7629	9 Main Street, Newton
R20 (S)	NT1900 4112	95 King Edwards Way, Kirkliston
R21 (S)	NT9246 5067	2 Beatly Road, Winchburgh
R22 (S)	NT1927 3546	2 Millrig Cottages, Kirkliston
R23 (S)	NT2449 4934	2 Newmains Road, Kirkliston
R24 (S)	NT2559 4547	76 Main Street, Kirkliston
R25 (S)	NT1674 8150	14 Springfield Terrace, South Queensferry
R26 (S)	NT8799 7443	1 Winchburgh Road, Winchburgh
R27 (N)	NT1221 4467	239 Queensferry Road; Rosyth
R28 (N)	NT3999 8926	23 Westfield Grove, Crossgates
R29 (N)	NT4537 8685	Inverkeithing Road, Crossgates
R30 (N)	NT4478 3830	6 Letham Hill Avenue, Hillend

2005 – Base Year

13.3.34 In the year 2005, calculated NO_2 and PM_{10} concentrations are well within the air quality objectives at all receptor locations. The highest concentration of NO_2 was calculated as 28.1µg/m^3 at receptor R15, which is 70% of the air quality objective. The lowest concentration of NO_2 in 2005 was calculated as 10.4µg/m^3 (26% of the air quality objective) at receptor R10. The highest concentration of PM_{10} was established to be 21.3µg/m^3 at receptor R15 and the lowest concentration was calculated as 13.44µg/m^3 at receptor R17, which, in terms of percentage of the 2004 air quality objective represents, 54% and 34% respectively. A full list of results is presented in Appendix A13.1.

13.3.35 Forecast concentrations for both NO_2 and PM_{10} in 2017 and 2032 are lower than those experienced in the base year (2005). This is to be expected due to predicted improvements in vehicle technology.

13.3.36 With regards to nitrogen deposition, Table 13.10 shows the existing nitrogen deposition rates in 2005 for the five assessed SSSIs.

Table 13.10: Nitrogen Deposition Rates in 2005

Receptor Name	Dry Deposition in 2005 (Kg/N/ha/yr)	Total Deposition Rate in 2005 (Kg/N/ha/yr)	Critical Load (Kg/N/ha/yr)
Firth of Forth SPA & SSSI 1	1.07	12.49	10-35
Firth of Forth SPA & SSSI 2	2.03	13.30	10-35
St Margaret's Marsh SSSI	1.54	12.69	10-35
Ferry Hills SSSI 1	2.29	12.68	15-25
Ferry Hills SSSI 2	1.96	12.89	15-25

13.3.37 Table 13.10 shows that in 2005 the lower levels of critical load bands are exceeded for all assessed SSSIs, with the exception of Ferry Hills SSSI.

13.4 Potential Impacts

13.4.1 The results of the assessment of local air quality impacts associated with the Forth Replacement Crossing are presented below in terms of predicted air quality at local receptors, changes in local population exposure to air pollution and changes in nitrogen deposition at sensitive receptor sites. The results are presented by providing a baseline concentration (2005) and comparing the do minimum and do something scenarios for the years 2017 and 2032.

13.4.2 For consistency with the other environmental assessments, this chapter reports air quality separately for each of the northern and southern route corridor options. However, it is acknowledged that there may be slight variations in traffic flows depending on the combinations of options (e.g. North Corridor Option 1 when combined with either South Corridor Option 1 or South Corridor Option 2) and this could have consequent implications in terms of air quality. These combinations were therefore modelled, but with the exception of a small number of receptors the magnitude of change and significance categories for each option was unaffected by the different combinations. Where the magnitude or significance varies this is identified within this chapter, and the source pollution calculations for the combinations assessment are provided in Appendix A13.1. Population exposure differed between combinations and is therefore not reported for each route corridor option separately.

13.4.3 Tables showing percentages of change of pollutant concentrations between the do minimum and do something scenarios are presented in Appendix A13.1 for 2017 and 2032 and described below in terms of magnitude of change and significance.

Northern Route Corridor Options

<u>North Corridor Option 1</u>

Assessment of Residential Receptors - NO_2

13.4.4 For North Corridor Option 1, at all locations and for both do minimum and do something scenarios in 2017 and 2032 the predicted NO_2 concentrations are less than 45% of the air quality objective. These concentrations are considered to be well within the air quality objective.

13.4.5 Percentage changes for NO_2 vary between 0 and 37.6% in 2017 and between 0 and 42.1% in 2032. Receptors in the vicinity of roads which are predicted to undergo reductions in traffic as a result of the proposed scheme are likely to experience an improvement of air quality and receptors in the vicinity of new proposed road links are likely to experience deterioration as summarised in Table 13.11.

13.4.6 With reference to Table 13.2, the majority of concentration increases and decreases can be described as of Negligible significance for NO_2 in 2017 and 2032.

13.4.7 There is one receptor (R10) that is predicted to experience Moderate Adverse significance impacts with regards to NO_2 concentrations as a result of the proposed Forth Replacement Crossing for both assessed years. In 2017, one out of the 15 assessed receptor locations (R11) is predicted to experience Moderate Beneficial significance impacts. One receptor location (R9) is likely to experience Slight Adverse significance impacts as a result of the Forth Replacement Crossing. In 2032 one receptor location (R7) is predicted to experience Slight Adverse significance impacts and the impact significance of the Forth Replacement Crossing at one receptor (R29) can be described as Sight Beneficial.

13.4.8 Receptor R10 would be located along a new section of carriageway, which explains the larger deterioration at this receptor. Receptor R11 is located in the immediate vicinity of the existing Forth Road Bridge. It is predicted that traffic flows would be diverted to the proposed Forth Replacement Crossing, hence traffic flows are significantly reduced and air quality improved along the existing links.

Table 13.11: Annual Mean NO_2 Magnitude of Change and Significance (in accordance with NSCA guidance) – North Corridor Option 1

Magnitude	Significance		
	Improvement	Deterioration	No Change
Year of Opening (2017)			
Very Large	R11 (Moderate Beneficial)	R10 (Moderate Adverse)	
Large			
Medium			
Small		R9 (Slight Adverse)	
Very Small	R3 (Negligible)	R5 (Negligible) R7 (Negligible)	
Extremely Small	R8 (Negligible) R29 (Negligible)	R4 (Negligible) R6 (Negligible) R27 (Negligible)	R1, R2, R28, R30
Design Year (2032)			
Very Large	R11 (Moderate Beneficial)	R10 (Moderate Adverse)	
Large			
Medium			
Small	R29 (Slight Beneficial)	R7 (Slight Adverse)	
Very Small	R1 (Negligible) R4 (Negligible) R8 (Negligible) R30 (Negligible)	R2 (Negligible) R3 (Negligible) R9 (Negligible)	
Extremely Small	R27 (Negligible)	R6 (Negligible) R28 (Negligible)	R5

13.4.9 There are slight variations in annual mean NO_2 magnitude of change at receptors R3 (in 2032), R8 (in 2017) and R29 (in 2017) depending on what combination of route corridor options is selected. However, the overall significance is not affected by these variations.

Assessment of Residential Receptors - PM_{10}

13.4.10 Predicted concentrations for PM_{10} for both the do minimum and do something scenario in 2017 and 2032 are less 90% of the 2010 air quality objective. These concentrations are within but not well within the air quality objective.

13.4.11 Percentages changes for PM_{10} vary between 0 and 11.7% in 2017 and between 0 and 14.2% in 2032. Table 13.12 shows which receptors are predicted to experience improvement and deterioration with respect to local PM_{10} concentrations.

13.4.12 With regards to PM_{10}, the impact on the majority of receptors can be described as Negligible for both assessed years. In 2017, there are three locations where the impact is Slight Adverse (R7, R9, R10) and one location which is likely to experience a Slight Beneficial impact (R11). In 2032, two receptor locations (R7, R10) are likely to experience Slight Adverse impacts and the PM_{10} concentration change at two receptors (R8, R11) is predicted to be Slight Beneficial.

13.4.13 As with $N0_2$, deterioration at R10 and improvement at R11 can be explained due to proximity to a new section of carriageway and to the existing Forth Crossing respectively.

Table 13.12: Annual Mean PM_{10} Magnitude of Change and Significance (in accordance with NSCA guidance) – North Corridor Option 1

Magnitude	Significance		
	Improvement	Deterioration	No Change
Year of Opening (2017)			
Very Large			
Large			
Medium			
Small	R11 (Slight Beneficial)	R10 (Slight Adverse)	
Very Small		R7 (Slight Adverse) R9 (Slight Adverse)	
Extremely Small	R1 (Negligible) R8 (Negligible) R29 (Negligible)	R5 (Negligible) R6 (Negligible)	R2, R3, R4, R27 - R30
Design Year (2032)			
Very Large			
Large			
Medium	R11 (Slight Beneficial)		
Small		R10 (Slight Adverse)	
Very Small	R8 (Slight Beneficial) R29 (Negligible) R30 (Negligible)	R7 (Slight Adverse)	
Extremely Small	R4 (Negligible) R5 (Negligible) R27 (Negligible) R28 (Negligible)	R2 (Negligible) R3 (Negligible) R6 (Negligible) R9 (Negligible)	R1

Changes in Local Population Exposure (NO_2 and PM_{10})

13.4.14 The results of comparing predicted concentrations of NO_2 and PM_{10} using the STAG methodology are presented in Appendix A13.2 for years 2017 and 2032. STAG assessment scores provide a useful indication of change in local population exposure to air pollution.

13.4.15 For North Corridor Option 1, results using the STAG assessment show that there would be virtually no change in local population exposure to air pollution for either NO_2 or PM_{10} in 2017 or 2032 compared to the do minimum. Population exposure is illustrated below in Table 13.13.

Table 13.13: Local Population Exposure of NO_2 and PM_{10}– North Corridor Option 1

Route Corridor Combination	NO_2			PM_{10}		
	Deterioration	Improvement	STAG Score	Deterioration	Improvement	STAG Score
2017						
North Corridor Option 1 (with South Corridor Option 1)	3692	3316	-0.004	3923	3085	-0.0013
North Corridor Option 1 (with South Corridor Option 2)	2847	3969	-0.082	3174	3642	-0.014
2032						
North Corridor Option 1 (with South Corridor	3708	5472	-0.022	3494	5686	-0.011

Route Corridor Combination	NO_2			PM_{10}		
	Deterioration	Improvement	STAG Score	Deterioration	Improvement	STAG Score
Option 1)						
North Corridor Option 1 (with South Corridor Option 2)	3026	6275	-0.082	2825	6476	-0.021

13.4.16 A total of 7008 properties are located within 200m of road links affected by the N1S1 option in 2017, with 9180 affected by 2032.

13.4.17 A total of 6816 properties are located within 200m of road links affected by North Corridor Option 1 / South Corridor Option 2 in 2017, with 9301 properties affected by North Corridor Option 1 / South Corridor Option 2 in 2032.

Changes in Nitrogen Deposition

13.4.18 The results of estimating nitrogen deposition at identified SSSIs (St Margarets Marsh; Ferry Hills 1 and 2) for North Corridor Option 1 are presented in Tables 13.14 to 13.16. Figure 13.1 shows the location of these SSSIs.

Table 13.14: St Margaret's Marsh SSSI (NGR312467 681432) – North Corridor Option 1

Transect Distance	Dry deposition on Transect in 2017 (Kg/N/ha/yr)		Total deposition rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
5m (closest to road link)	-	1.73	-	10.49	10-35
25m	-	1.40	-	10.16	
45m	1.10	1.18	9.85	9.93	

13.4.19 The predicted contribution from local traffic to nitrogen deposition rates at St Margaret's SSSI varies between 1.10 Kg/N/ha/yr for the do minimum scenario (at 45 m distance) and 1.73 Kg/N/ha/yr for the do something scenario (at 5m distance). The closest road to the SSSI is located at 5m distance but only exists in the do something scenario. The lower value of the critical load band is exceeded at up to 45m from the closest road in the do something scenario. In the do minimum scenario, the critical load level would be met at all distances from the road. The impact of the Forth Replacement Crossing would increase the nitrogen deposition by 0.08 Kg/N/ha/yr at 45m distance.

Table 13.15: Ferry Hills 1 SSSI (NGR 312493 683361) – North Corridor Option 1

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
15m (closest to road link)	1.58	1.59	9.92	9.93	15-25

13.4.20 The predicted contribution from local traffic to nitrogen deposition rates at the Ferry Hills 1 SSSI differs between 1.58 Kg/N/ha/yr for the do minimum scenario and 1.59 Kg/N/ha/yr for the do something scenario. The nitrogen deposition increase resulting from North Corridor Option 1 / South Corridor Option 1 is 0.01 Kg/N/ha/yr. At the closest point to the road the critical load for calcareous grassland is met for scenarios with and without the development.

Table 13.16: Ferry Hills 2 SSSI (NGR 312615 681202) – North Corridor Option 1

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
0m	1.23	-	9.98	-	15-25
20m	1.22	-	9.97	-	
40m	1.01	-	9.76	-	
60m	0.84	-	9.60	-	
80m	0.76	-	9.51	-	
100m	0.71	-	9.46	-	
120m	0.68	-	9.43	-	
140m (closest to road link)	0.66	0.68	9.41	9.43	

13.4.21 The predicted contribution from local traffic to nitrogen deposition rates at the Ferry Hills 2 SSSI at 140m distance ranges between 0.66 Kg/N/ha/yr for the do minimum and 0.68 Kg/N/ha/yr for the do something scenario. The closest road in the do something scenario is located at 140m distance from the SSSI. The nitrogen deposition increase resulting from route corridor option N1S1 is 0.02 Kg/N/ha/yr. The critical load for calcareous grassland is met for scenarios with and without the development.

North Corridor Option 2

Assessment of Residential Receptors - NO_2

13.4.22 For North Corridor Option 2, at all locations and for both do minimum and do something scenarios in 2017 and 2032 the predicted NO_2 concentrations were less than 43% of the air quality objective. These concentrations are considered to be well within the air quality objective.

13.4.23 Percentages of change for NO_2 vary between 0 and 37.6% in 2017 and between 0 and 42.1% in 2032 respectively. Receptors in the vicinity of roads which are predicted to undergo reductions in traffic as a result of the proposed scheme are likely to experience an improvement of air quality and receptors in the vicinity of new proposed road links are likely to experience as shown in Table 13.17 below.

13.4.24 With reference to Table 13.2, the majority of concentration increases and decreases can be described as Negligible in significance for both NO_2 and PM_{10} in 2017 and 2032.

13.4.25 There is one receptor (R10) that is predicted to experience Moderate Adverse significance impacts with regards to NO_2 concentrations as a result of the Forth Replacement Crossing in both assessed years 2017 and 2032. In 2017 one out of the 15 assessed receptor locations (R11) is predicted to experience Moderate Beneficial significance impacts. The impact of the Forth Replacement Crossing at two receptor locations (R2, R9) can be described as Slight Beneficial. In 2032, one receptor (R7) is likely to experience Slight Adverse significance impacts as a result of the Forth Replacement Crossing and three receptors (R2, R9, R29) are predicted to experience Slight Beneficial significance impacts.

Table 13.17: Annual Mean NO_2 Magnitude of Change and Significance (in accordance to NSCA guidance) – North Corridor Option 2

Magnitude	Significance		
	Improvement	Deterioration	No Change
Year of Opening (2017)			
Very Large	R11 (Moderate Beneficial)	R10 (Moderate Adverse)	
Large			
Medium			
Small	R2 (Slight Beneficial) R9 (Slight Beneficial)		
Very Small	R3 (Negligible) R6 (Negligible) R7 (Negligible)	R4 (Negligible) R5 (Negligible)	
Extremely Small	R8 (Negligible) R30 (Negligible)		R1, R27, R28, R29
Design Year (2032)			
Very Large	R11 (Moderate Beneficial)	R10 (Moderate Adverse)	
Large			
Medium			
Small	R2 (Slight Beneficial) R9 (Slight Beneficial) R29 (Slight Beneficial)	R7 (Slight Adverse)	
Very Small	R1 (Negligible) R3 (Negligible) R6 (Negligible) R8 (Negligible) R27 (Negligible) R30 (Negligible)	R5 (Negligible)	
Extremely Small	R4 (Negligible)		R28

13.4.26 As explained in paragraph 13.4.2, Table 13.17 presents North Corridor Option 2 in combination with South Corridor Option 1. There are slight variations in magnitude of change at receptors R3 (in 2032), R4 (in 2017 and 2032), R5 (in 2017), R27 (in 2032) and R30 (in 2017) if North Corridor Option 2 is instead combined with South Corridor Option 2, however, the overall significance is not affected by these variations.

Assessment of Residential Receptors – PM_{10}

Predicted concentrations for PM_{10} for both the do minimum and do something scenario in 2017 and 2032 were less than 90% of the 2010 air quality objective. These concentrations are within but not well within the air quality objective.

13.4.27 Percentages of change for PM_{10} vary between 0 and 11.7% in 2017 and between 0 and 14.2% in 2032. Table 13.18 shows which receptors are predicted to experience improvement and deterioration with respect to local PM_{10} concentrations.

13.4.28 With regards to PM_{10}, the impact on the vast majority of receptors can be described as Negligible. In 2017 there are two locations where the impact is Slight Adverse (R5, R10) and three locations (R2, R3, R11) which are likely to experience a Slight Beneficial effect. In 2032, two receptor locations (R7, R10) are predicted to experience Slight Adverse impacts as a result of the Forth Replacement Crossing and the number of receptors predicted to be Slight Beneficial increases to five.

13.4.29 As with NO_2, deterioration at Receptor R10 and improvement at Receptor R11 can be explained due to proximity to a new section of carriageway and to the existing Forth Crossing respectively.

Table 13.18: Annual Mean PM_{10} Magnitude of Change and Significance (in accordance with NSCA guidance) – North Corridor Option 2

Magnitude	Significance		
	Improvement	Deterioration	No Change
Year of Opening (2017)			
Very Large			
Large			
Medium			
Small	R11 (Slight Beneficial)	R10 (Slight Adverse)	
Very Small	R2 (Slight Beneficial) R3 (Slight Beneficial)	R5 (Slight Adverse)	
Extremely Small	R1 (Negligible) R6 (Negligible)	R7 (Negligible)	R4, R8, R9, R27-R30
Design Year (2032)			
Very Large			
Large			
Medium	R11 (Slight Beneficial)		
Small		R10 (Slight Adverse)	
Very Small	R2 (Slight Beneficial) R6 (Slight Beneficial) R8 (Slight Beneficial) R9 (Slight Beneficial) R29 (Negligible) R30 (Negligible)	R7 (Slight Adverse)	
Extremely Small	R1 (Negligible) R3 (Negligible) R4 (Negligible) R27 (Negligible) R28 (Negligible)		R5

13.4.30 There are slight variations in annual mean PM_{10} magnitude of change at receptor R5 in 2017 and 2032 depending on which combination of route corridor options is selected. As explained in paragraph 13.4.2, Table 13.18 presents North Corridor Option 1 in combination with South Corridor Option 1. However, if this was combined with South Corridor Option 2, the significance of impact would be lower (Negligible in 2017 and Slight Beneficial in 2032).

Changes in Local Population Exposure (NO_2 and PM_{10})

13.4.31 The results of comparing predicted concentrations of NO_2 and PM_{10} using the STAG methodology are presented in Appendix A13.2 for years 2017 and 2032. The STAG assessment scores provide a useful indication of change in local population exposure to air pollution.

13.4.32 For North Corridor Option 1, results using the STAG assessment show that there would be virtually no change in local population exposure to air pollution for either NO_2 or PM_{10} in 2017 or 2032 compared to the do minimum. Population exposure is illustrated below in Table 13.19.

Table 13.19: Local Population Exposure of NO_2 and PM_{10}– North Corridor Option 2

Route Corridor Combination	NO2			PM10		
	Deterioration	Improvement	STAG Score	Deterioration	Improvement	STAG Score
2017						
North Corridor Option 2 (with South Corridor Option 1)	2742	4035	-0.093	2747	4030	-0.021
North Corridor Option 2 (with South Corridor Option 2)	1891	4493	-0.149	2137	4247	-0.030
2032						
North Corridor Option 2 (with South Corridor Option 1)	2412	7202	-0.090	2312	7302	-0.027
North Corridor Option 2 (with South Corridor Option 2)	2159	6770	-0.120	2077	6852	-0.031

13.4.33 A total of 6777 properties are located within 200m of road links affected by N2S1 route corridor option in 2017, with 9614 affected by 2032.

13.4.34 A total of 6384 properties are located within 200m of road links affected by N2S2 route corridor option in 2017, with 8929 affected by 2032.

<u>Changes in Nitrogen Deposition</u>

13.4.35 The results of estimating nitrogen deposition at identified SSSI for North Corridor Option 2 are presented in Tables 13.20 to 13.22. This presents North Corridor Option 2 as combined with South Corridor Option 1, however there are no significant changes in nitrogen deposition between this and the alternative combination with South Corridor Option 2.

Table 13.20: St Margaret's Marsh SSSI (NGR 312467 681432) – North Corridor Option 2

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
5m (closest distance to road link)	-	1.71	-	10.45	10-35
25m	-	1.84	-	10.60	
45m	1.10	1.78	9.85	10.55	
85m	0.90	1.32	9.65	10.07	
105m	0.85	1.12	9.60	9.87	

13.4.36 The maximum contributions from local traffic to nitrogen deposition rates at the St Margaret's Marsh SSSI unit was calculated to be 1.10 Kg/N/ha/yr for the do minimum scenario (at 45m distance) and 1.84 Kg/N/ha/yr (at 25m) for the do something scenario. The resulting increase of nitrogen deposition rates equates to 0.68 Kg/N/ha/yr at 45m distance. Critical loads for neutral grassland, fen marsh and swamp would be met at a distance of 105m from North Corridor Option 2 in the do something scenario.

Table 13.21: Ferry Hills 1 SSSI (NGR 312615 681202) – North Corridor Option 2

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
15m (closest distance to road link)	1.58	1.52	9.92	9.86	15-25
35m	1.44	1.49	9.77	9.82	
55m	1.34	1.53	9.68	9.87	
75m	1.28	1.64	9.61	9.97	
95m	1.24	1.84	9.58	10.18	
115m	1.22	2.12	9.56	10.46	
135m	1.21	1.98	9.55	10.32	
155m	1.19	1.69	9.52	10.02	
175m	1.18	1.50	9.51	9.84	
195m	1.17	1.39	9.51	9.72	

13.4.37 The maximum predicted contribution from local traffic to nitrogen deposition rates at the Ferry Hills 1 SSSI in the do minimum scenario equates to 1.58 Kg/N/ha/yr (at 15m distance) and is decreasing with distance from the road. The contribution from local road traffic for the do something scenario is 1.52 Kg/N/ha/yr (at 15m distance). The increase in nitrogen deposition with increasing distance to the road link in the do something scenario is caused by another road link in the vicinity of the SSSI unit. The SSSI is located between the existing A90 and a new proposed road which forms part of corridor option North 2 / South 1. At the closest point (15m distance) to either of the road links the critical load for calcareous grassland is met for scenarios with and without the development.

Table 13.22: Ferry Hills 2 SSSI (NGR 312493 683361) – North Corridor Option 2

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
0m	1.23	-	9.98	-	15-25
20m	1.22	-	9.97	-	
40m	1.01	-	9.76	-	
60m	0.84	-	9.60	-	
80m	0.76	-	9.51	-	
100m	0.71	-	9.46	-	
120m	0.68	-	9.43	-	
140m	0.66	-	9.41	-	
160m	0.64	0.65	9.39	9.40	

13.4.38 The contribution from local traffic to nitrogen deposition rates at the Ferry Hills 2 SSSI is predicted to be 0.64 Kg/N/ha/yr for the do minimum scenario and 0.65 Kg/N/ha/yr for the do something scenario at 160m distance (closest road distance to the SSSI in the do something scenario). The nitrogen deposition increase resulting North Corridor Option 2 / South Corridor Option 1 is 0.01 Kg/N/ha/yr. The critical load for calcareous grassland is met for scenarios with and without the development.

Southern Route Corridor Options

South Corridor Option 1

Assessment of Residential Receptors - NO_2

13.4.39 For South Corridor Option 1, at all locations and for both do minimum and do something scenarios in 2017 and 2032 the predicted NO_2 concentrations are less than 43% of the air quality objective. These concentrations are considered to be well within the air quality objective.

13.4.40 Percentages changes for NO_2 vary between 0 and 37.6% in 2017 and between 0 and 42.1% in 2032. Receptors in the vicinity of roads which are predicted to undergo reductions in traffic as a result of the proposed scheme are likely to experience a change in air quality are summarised in Table 13.23.

13.4.41 In 2017, two out of the 15 assessed receptor locations (R12, R14) are predicted to experience Moderate Beneficial impacts. Three receptor locations are likely to experience Slight Adverse significance impacts as a result of the Forth Replacement Crossing. In 2032 five receptor locations are predicted to experience Slight Adverse significance impacts and the impact of the Forth Replacement Crossing at four receptors can be described as Moderate to Sight Beneficial significance.

Table 13.23: Annual Mean NO_2 Magnitude of Change and Significance (in accordance with NSCA guidance) – South Corridor Option 1

Magnitude	Significance		
	Improvement	Deterioration	No Change
Year of Opening (2017)			
Very Large	R12 (Moderate Beneficial) R14 (Moderate Beneficial)		
Large		R17 (Slight Adverse) R18 (Slight Adverse)	
Medium			
Small		R21 (Slight Adverse)	
Very Small	R13 (Negligible) R19 (Negligible)	R15 (Negligible) R16 (Negligible) R20 (Negligible) R22 (Negligible) R23 (Negligible) R24 (Negligible) R25 (Negligible)	
Extremely Small		R26 (Negligible)	
Design Year (2032)			
Very Large	R12 (Moderate Beneficial) R14 (Moderate Beneficial)		
Large		R17 (Slight Adverse) R18 (Slight Adverse)	
Medium			
Small	R13 (Slight Beneficial) R15 (Slight Beneficial)	R16 (Slight Adverse) R20 (Slight Adverse) R22 (Slight Adverse)	
Very Small	R23 (Negligible) R24 (Negligible)	R25 (Negligible) R26 (Negligible)	

Magnitude	**Significance**		
	Improvement	**Deterioration**	**No Change**
Extremely Small		R21 (Negligible)	R19

13.4.42 There are slight variations in magnitude of change if South Corridor Option 1 is combined with North Corridor Option 2 instead of North Corridor Option 1. However, the significance of impacts as listed in Table 13.23 would be unchanged except for the following minor shifts:

- 2017: R15 (to Negligible), R20 and R22 (to Slight Adverse) and R23 (to No Change).
- 2032: R13 (to Slight Beneficial), R19 (to No Change), R22 (to Slight Adverse), and R24 to Negligible).

Assessment of Residential Receptors – PM_{10}

13.4.43 Percentages changes for PM_{10} vary between 0 and 11.7% in 2017 and between 0 and 14.2% in 2032. Table 13.24 shows which receptors are predicted to experience improvement and deterioration with respect to local PM_{10} concentrations.

13.4.44 Predicted concentrations for PM_{10} for both the do minimum and do something scenario in 2017 and 2032 are less than 89% of the 2010 air quality objective. These concentrations are within but not well within the air quality objective.

13.4.45 The impact on the vast majority of receptors can be described as Negligible significance for both assessed years. In 2017, there are two locations where the impact is Slight Beneficial (R12, R14). In 2032, two receptor locations (R20, R18) are likely to experience Slight Adverse significance impacts and the PM_{10} impact significance at three receptors is predicted to be Slight Beneficial (R12, R14, R15).

Table 13.24: Annual Mean PM_{10} Magnitude of Change and Significance (in accordance with NSCA guidance) – South Corridor Option 1

Magnitude	**Significance**		
	Improvement	**Deterioration**	**No Change**
Year of Opening (2017)			
Very Large			
Large			
Medium	R14 (Slight Beneficial)		
Small	R12 (Slight Beneficial)		
Very Small	R13 (Negligible)	R17 (Negligible) R18 (Negligible) R21 (Negligible)	
Extremely Small	R19 (Negligible)	R15 (Negligible) R16 (Negligible) R22 (Negligible)	R20, R23-R26
Design Year (2032)			
Very Large			
Large			
Medium	R12 (Slight Beneficial) R14 (Slight Beneficial)		
Small		R18 (Slight Adverse)	
Very Small	R13 (Negligible) R15 (Slight Beneficial) R23 (Negligible) R24 (Negligible)	R16 (Negligible) R17 (Negligible) R20 (Slight Adverse)	

Magnitude	Significance		
	Improvement	**Deterioration**	**No Change**
Extremely Small		R19 (Negligible) R22 (Negligible)	R21, R25, R26

13.4.46 There are slight variations in magnitude of change if South Corridor Option 1 is combined with North Corridor Option 2 instead of North Corridor Option 1. However, the significance of impacts as listed in Table 13.24 would be unchanged except for the following minor shifts:

- 2017: R20; R24 and R26 (to Negligible), R22 (to Slight Adverse) and R15 and R21 (to No Change).
- 2032: R19 and R22 (to Negligible), R18 (to Slight Adverse) and R21 and R26 (to No Change).

Changes in Local Population Exposure (NO_2 and PM_{10})

13.4.47 The results of comparing predicted concentrations of NO_2 and PM_{10} using the STAG methodology are presented in Appendix A13.2 for years 2017 and 2032. The STAG assessment scores provide a useful indication of change in local population exposure to air pollution.

13.4.48 For South Corridor Option 1, results using the STAG assessment show that there would be virtually no change in local population exposure to air pollution for either NO_2 or PM_{10} in 2017 or 2032 compared to the do minimum. Population exposure is illustrated below in Table 13.25.

Table 13.25: Local Population Exposure of NO_2 and PM_{10} – South Corridor Option 1

Route Corridor Combination	NO2			PM10		
	Deterioration	**Improvement**	**STAG Score**	**Deterioration**	**Improvement**	**STAG Score**
2017						
South Corridor Option 1 (with North Corridor Option 1)	3692	3316	-0.004	3923	3085	-0.0013
South Corridor Option 1 (with North Corridor Option 2)	2742	4035	-0.093	2747	4030	-0.021
2032						
South Corridor Option 1 (with North Corridor Option 1)	3708	5472	-0.022	3494	5686	-0.011
South Corridor Option 1 (with North Corridor Option 2)	2412	7202	-0.090	2312	7302	-0.027

13.4.49 A total of 7008 properties are located within 200m of road links affected by the N1S1 route corridor option in 2017, with 9180 affected by 2032.

13.4.50 A total of 6777 properties are located within 200m of road links affected by N2S1 route corridor option in 2017, with 9614 affected by 2032.

Changes in Nitrogen Deposition

13.4.51 The results of estimating nitrogen deposition at identified SPAs and SSSIs (Firth of Forth 1 and 2) for South Corridor Option 1 are presented in Tables 13.26 and 13.27. Figure 13.1 shows the location of assessed sensitive SSSIs.

Table 13.26: Firth of Forth SPA & SSSI 1 (NGR 311783 678806) – South Corridor Option 1

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
10m (closest distance to road link)	1.78	0.88	10.75	9.85	10-20
20m	1.58	-	10.55	-	
40m	1.30	-	10.27	-	
60m	1.12	-	10.08	-	
80m	0.99	-	9.96	-	

13.4.52 At a distance of 10m from the road, the predicted contribution from local traffic to nitrogen deposition rates at the Firth of Forth 1 SPA & SSSI ranges between 1.78 Kg/N/ha/yr for the do minimum scenario and 0.88 Kg/N/ha/yr for the do something scenario. At 10m distance from the SSSI the Forth Replacement Crossing would decrease nitrogen deposition rates by 0.9 Kg/N/ha/yr. Critical loads for neutral grassland, fen marsh and swamp would be met at any distance from the road with the Forth Replacement Crossing in place.

Table 13.27: Firth of Forth SPA & SSSI 2 (NGR 312546 678691) – South Corridor Option 1

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
180m (closest distance to road link)	0.77	0.80	9.85	9.88	10-20

13.4.53 The predicted contribution from local traffic to nitrogen deposition rates at the closest point between the Firth of Forth SPA and SSSI and the road varies between 0.77 Kg/N/ha/yr and 0.8 Kg/N/ha/yr in the do minimum and do something scenarios. The impact of the Forth Replacement Crossing would increase nitrogen deposition by 0.03 Kg/N/ha/yr. The total deposition rate shows that with or without the Forth Replacement Crossing, the lower end of the critical load for neutral grassland, fen marsh and swamps would be met.

South Corridor Option 2

Assessment of Residential Receptors - NO_2

13.4.54 At all locations and for both do minimum and do something scenarios in 2017 and 2032 the predicted NO_2 concentrations are less than 45% of the air quality objective. These concentrations are considered to be well within the air quality objective (in accordance with the definition provided in Table 13.2).

13.4.55 Percentages of change for NO_2 vary between 0 and 37.6% in 2017 and between 0 and 42.1% in 2032 respectively. Receptors in the vicinity of roads which are predicted to undergo reductions in traffic as a result of the proposed scheme are likely to experience an improvement of air quality and receptors in the vicinity of new proposed road links are likely to experience deterioration as shown in Table 13.28.

13.4.56 In 2017, two out of the 15 assessed receptor locations (R12, R14) are predicted to experience Moderate Beneficial significance impacts. Three receptor locations are predicted to experience Slight Adverse significance impacts and the impact of the Forth Replacement Crossing at five receptors can be described as Slight Beneficial. In 2032, eight receptor locations can be described as either Moderate Beneficial or Slight Beneficial in terms of impacts from the Forth Replacement Crossing, one receptor (R17) is predicted to experience Slight Adverse significance impacts.

Table 13.28: Annual Mean NO_2 Magnitude of Change and Significance (in accordance with NSCA guidance) – South Corridor Option 2

Magnitude	Significance		
	Improvement	Deterioration	No Change
Year of Opening (2017)			
Very Large	R12 (Moderate Beneficial) R14 (Moderate Beneficial)		
Large	R15 (Slight Beneficial)	R17 (Slight Adverse)	
Medium	R21 (Slight Beneficial) R23 (Slight Beneficial) R24 (Slight Beneficial)	R20 (Slight Adverse)	
Small	R19 (Slight Beneficial)	R22 (Slight Adverse)	
Very Small		R13 (Negligible) R16 (Negligible) R25 (Negligible)	
Extremely Small			R18, R26
Design Year (2032)			
Very Large	R12 (Moderate Beneficial) R14 (Moderate Beneficial) R15 (Moderate Beneficial)		
Large	R23 (Slight Beneficial)	R17 (Slight Adverse)	
Medium	R21 (Slight Beneficial) R22 (Slight Beneficial) R24 (Slight Beneficial)		
Small	R19 (Slight Beneficial)	R20 (Slight Adverse)	
Very Small		R13 (Negligible) R16 (Negligible) R25 (Negligible) R26 (Negligible)	
Extremely Small		R18 (Negligible)	

13.4.57 There are slight variations in magnitude of change at receptors R20 (in 2017) and R26 (in 2032) if South Corridor Option 2 is combined with North Corridor Option 2. However, the significance of impact would be lower (R20 - Negligible in 2017) or the same (R26 - Negligible in 2032).

Assessment of Residential Receptors – PM_{10}

13.4.58 Predicted concentrations for PM_{10} for both the do minimum and do something scenario in 2017 and 2032 are less than 90% of the 2010 air quality objective. These concentrations are within but not well within the air quality objective.

13.4.59 Percentages of change for PM_{10} vary between 0 and 11.7% in 2017 and between 0 and 14.2% in 2032. Table 13.29 shows which receptors are predicted to experience improvement and deterioration with respect to local PM_{10} concentrations.

13.4.60 With regards to PM_{10}, the impact on the vast majority of receptors can be described as Negligible significance in both 2017 and 2032. In 2017 there are three locations (R17, R20, R22) where the impact is Slight Adverse significance and four locations which are likely to experience a Slight Beneficial effect (R12, R14, R15, R24). The significance at two receptor locations (R17, R20) ranges between Slight Adverse and Negligible depending on which northern route corridor option combination is assessed. In 2032, the number of receptors with a Slight Adverse effect is two (R17, R20) and five receptor locations are predicted to experience Slight Beneficial impacts. A summary of significance for all receptors is provided in Appendix A13.1.

Table 13.29: Annual Mean PM_{10} Magnitude of Change and Significance (in accordance with NSCA guidance) – South Corridor Option 2

Magnitude	Significance		
	Improvement	Deterioration	No Change
Year of Opening (2017)			
Very Large			
Large			
Medium	R14 (Slight Beneficial)		
Small	R12 (Slight Beneficial) R15 (Slight Beneficial) R24 (Slight Beneficial)		
Very Small	R19 (Negligible) R21 (Negligible) R23 (Negligible)	R17 (Slight Adverse) R20 (Slight Adverse) R22 (Slight Adverse)	
Extremely Small		R16 (Negligible) R25 (Negligible)	R13, R18, R26
Design Year (2032)			
Very Large			
Large			
Medium	R12 (Slight Beneficial) R14 (Slight Beneficial)		
Small	R15 (Slight Beneficial) R24 (Slight Beneficial)	R17 (Slight Adverse)	
Very Small	R19 (Negligible) R21 (Negligible) R22 (Slight Beneficial)	R20 (Slight Adverse)	
Extremely Small		R16 (Negligible) R25 (Negligible)	R13, R18, R26

Changes in Local Population Exposure (NO_2 and PM_{10})

13.4.61 The results of comparing predicted concentrations of NO_2 and PM_{10} using the STAG methodology are presented in Appendix A13.2 for years 2017 and 2032. The STAG assessment scores provide a useful indication of change in local population exposure to air pollution.

13.4.62 For South Corridor Option 2, results using the STAG assessment show that there would be virtually no change in local population exposure to air pollution for either NO_2 or PM_{10} in 2017 or 2032 compared to the do minimum. Population exposure is illustrated below in Table 13.30.

Table 13.30: Local Population Exposure of NO_2 and PM_{10} – South Corridor Option 2

Route Corridor Combination	NO2			PM10		
	Deterioration	Improvement	STAG Score	Deterioration	Improvement	STAG Score
Year of Opening (2017)						
South Corridor Option 2 (with North Corridor Option 1)	2847	3969	-0.082	3174	3642	-0.014
South Corridor Option 2 (with North Corridor Option 2)	1891	4493	-0.149	2137	4247	-0.030
Design Year (2032)						
South Corridor Option 2 (with North Corridor Option 1)	3026	6275	-0.082	2825	6476	-0.021
South Corridor Option 2 (with North Corridor Option 2)	2159	6770	-0.120	2077	6852	-0.031

13.4.63 A total of 6816 properties are located within 200m of road links affected by South Corridor Option 2 / North Corridor Option 1 in 2017, with 9301 properties affected by South Corridor Option 2 / North Corridor Option 1 in 2032.

13.4.64 A total of 6384 properties are located within 200m of road links affected by N2S2 route corridor option in 2017, with 8929 affected by 2032.

Changes in Nitrogen Deposition

13.4.65 The results of estimating nitrogen deposition at identified SPAs and SSSIs (Firth of Forth 1 and 2) for South Corridor Option 2 are presented in Tables 13.31 and 13.32. Figure 13.1 shows the location of assessed sensitive SSSIs.

Table 13.31: Firth of Forth SPA & SSSI 1 (NGR 311783 678806) – South Corridor Option 2

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
10m (closest distance to road link)	1.78	0.88	10.75	9.85	10-20
20m	1.58	-	10.55	-	
40m	1.30	-	10.27	-	
60m	1.12	-	10.08	-	
80m	0.99	-	9.96	-	

13.4.66 At a distance of 10m from the road, the predicted contribution from local traffic to nitrogen deposition rates at the Firth of Forth SPA and SSSI 1 ranges between 1.78 Kg/N/ha/yr for the do minimum scenario and 0.88 Kg/N/ha/yr for the do something scenario. At 10m distance from the SSSI the Forth Replacement Crossing would decrease nitrogen deposition rates by 0.9 Kg/N/ha/yr. Critical loads for neutral grassland, fen marsh and swamp would be met at any distance from the road with the Forth Replacement Crossing in place.

Table 13.32: Firth of Forth SPA & SSSI 2 (NGR 312546 678691) – South Corridor Option 2

Transect Distance	Dry Deposition on Transect in 2017 (Kg/N/ha/yr)		Total Deposition Rate in 2017 (Kg/N/ha/yr)		Critical Load (Kg/N/ha/yr)
	Do Minimum	Do Something	Do Minimum	Do Something	
180m (closest distance to road link)	0.77	0.80	9.85	9.88	10-20

13.4.67 The predicted contribution from local traffic to nitrogen deposition rates at the closest point between the Firth of Forth SPA and SSSI and the road varies between 0.77 Kg/N/ha/yr and 0.8 Kg/N/ha/yr in the do minimum and do something scenarios. The impact of the Forth Replacement Crossing would increase nitrogen deposition by 0.03 Kg/N/ha/yr. The total deposition rate shows that with or without the Forth Replacement Crossing, the lower end of the critical load for neutral grassland, fen marsh and swamps would be met.

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13.4.68 In order to assess the wider impact of the northern and southern route corridor options, total emissions of NOx, PM10 and CO_2 have been calculated within the study area for route corridor combinations and results are shown in Table 13.33. Total vehicle kilometres travelled (vkt) under each of the route corridor options are also shown in Table 13.33.

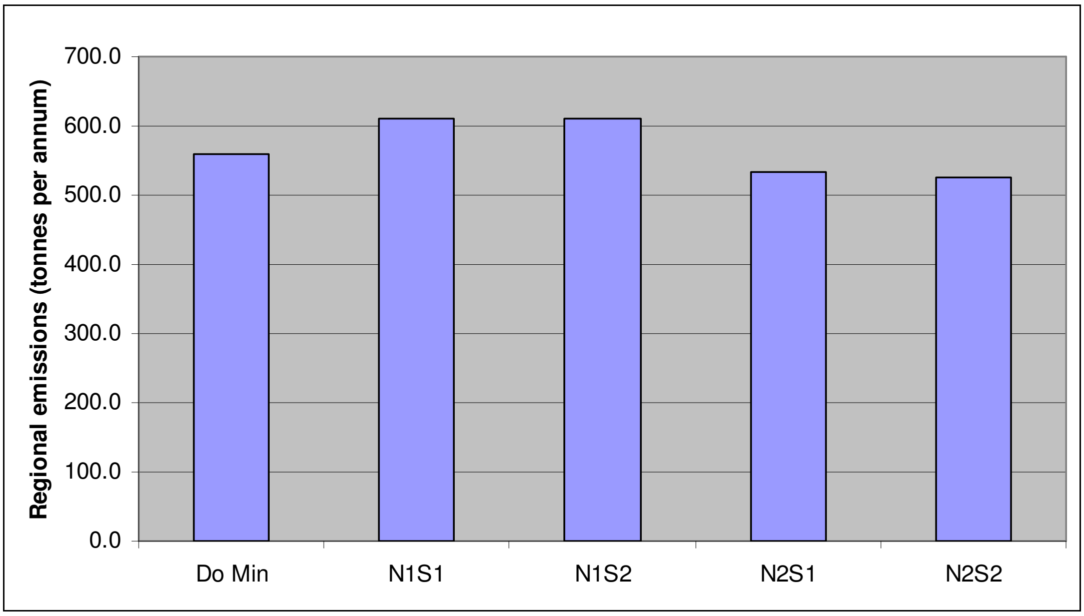
Table 13.33: Total Emissions (tonnes/annum)

Pollutant	Do Minimum	North Corridor Option 1 / South Corridor Option 1	North Corridor Option 1 / South Corridor Option 2	North Corridor Option 2 / South Corridor Option1	North Corridor Option 2 / South Corridor Option 2
Year of Opening (2017)					
Total vkt	3,724,156	3,950,763	3,830,672	3,514,829	3,351,925
NO_x	559.5	611.3	610.7	533.9	526.6
PM_{10}	18.8	20.1	19.9	17.0	16.7
CO_2	274975.9	290549.3	286910.5	254033.8	247466.3
Design Year (2032)					
Total vkt	5,142,239	4,883,780	4,673,525	4,347,951	4,082,016
NO_x	664.8	735.0	723.3	638.7	621.2
PM_{10}	24.6	24.9	24.2	21.6	20.5
CO_2	365547.8	352682.8	344049.1	307424.9	296013.9

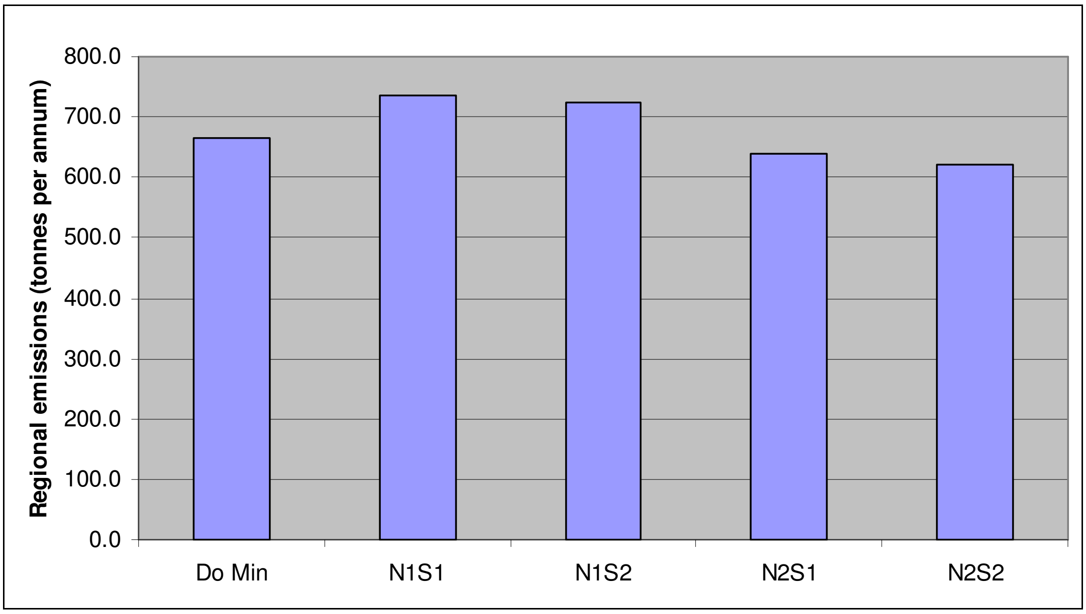
13.4.69 Graphs 13.1 to 13.6 visualise the data presented in Table 13.33. The lowest overall NO_x, PM_{10} and CO_2 emissions for both 2017 and 2032 are predicted to occur in North Corridor Option 2 / South Corridor Option 2.

13.4.70 Graph 13.6 shows a decrease in 2032 CO_2 emissions for all route corridor options relative to the do minimum. This is likely to be a result of decreased congestion and decreasing total vehicle kilometres travelled. In 2017 (Graph 13.5) there is a slight increase in emissions between the do minimum and route corridor options North Corridor Option 1 / South Corridor Option 1 and North Corridor Option 1 / South Corridor Option 2. This trend is also reflected in the total vehicle kilometres travelled.

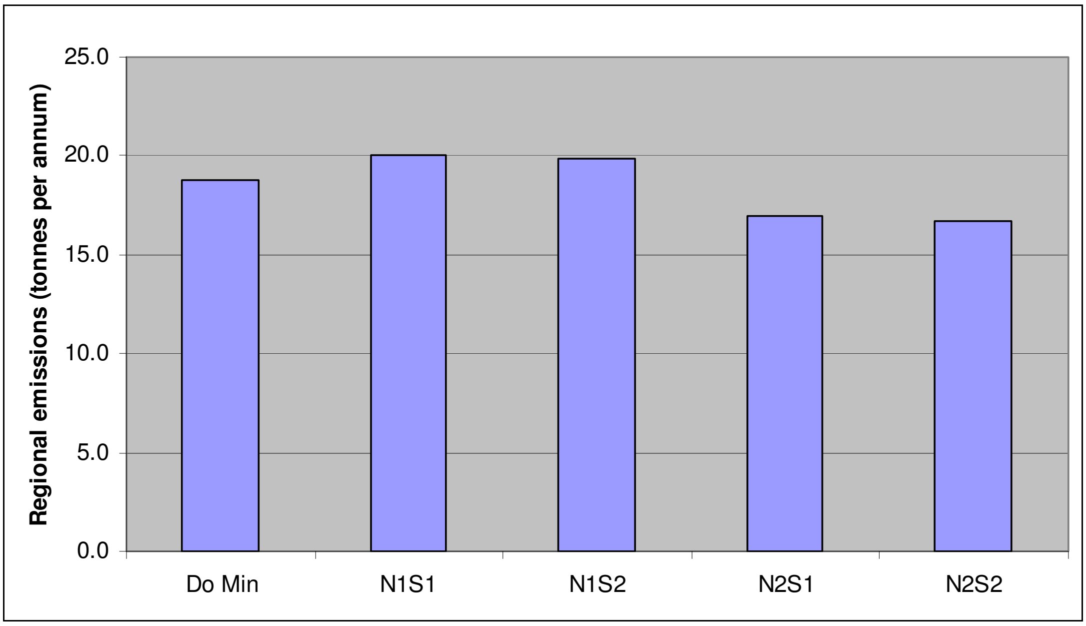
Graph 13.1: Total NOx emissions – 2017



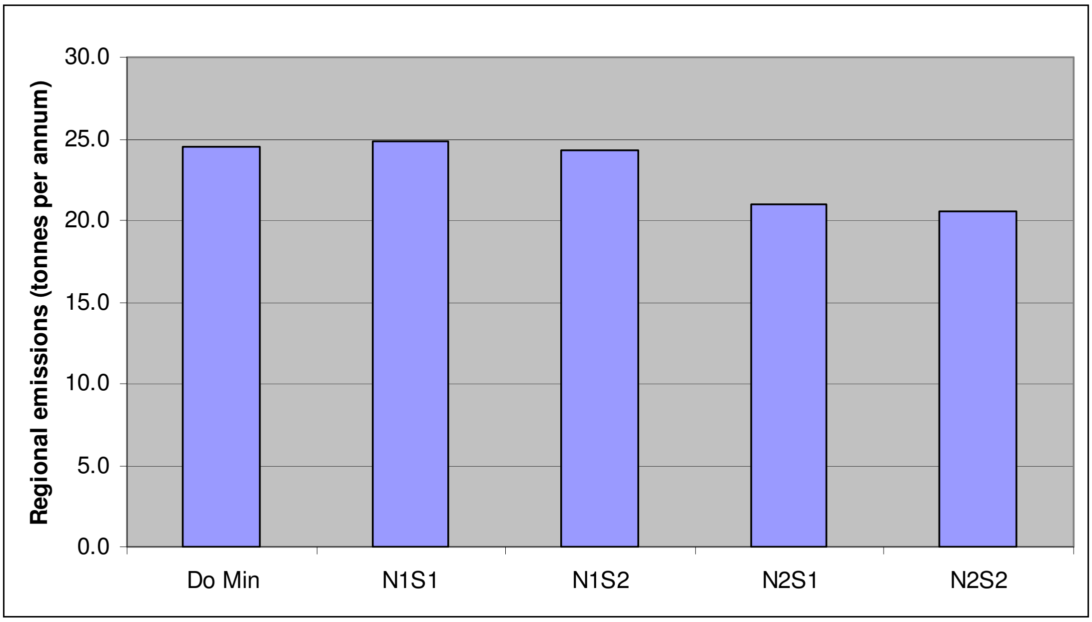
Graph 13.2: Total NOx emissions – 2032



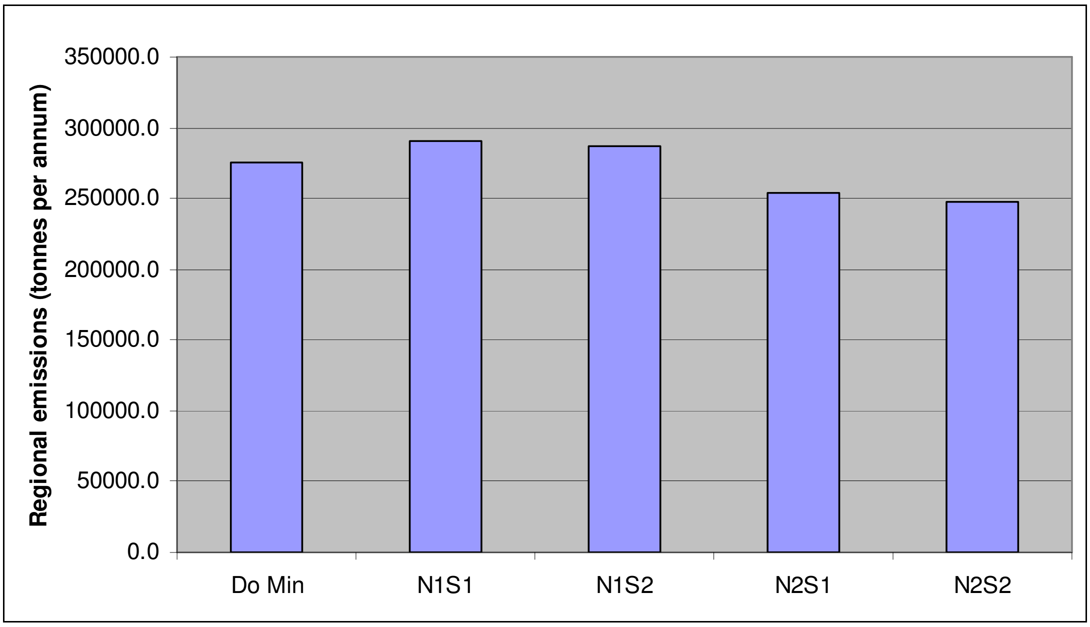
Graph 13.3: Total PM_{10} emissions – 2017



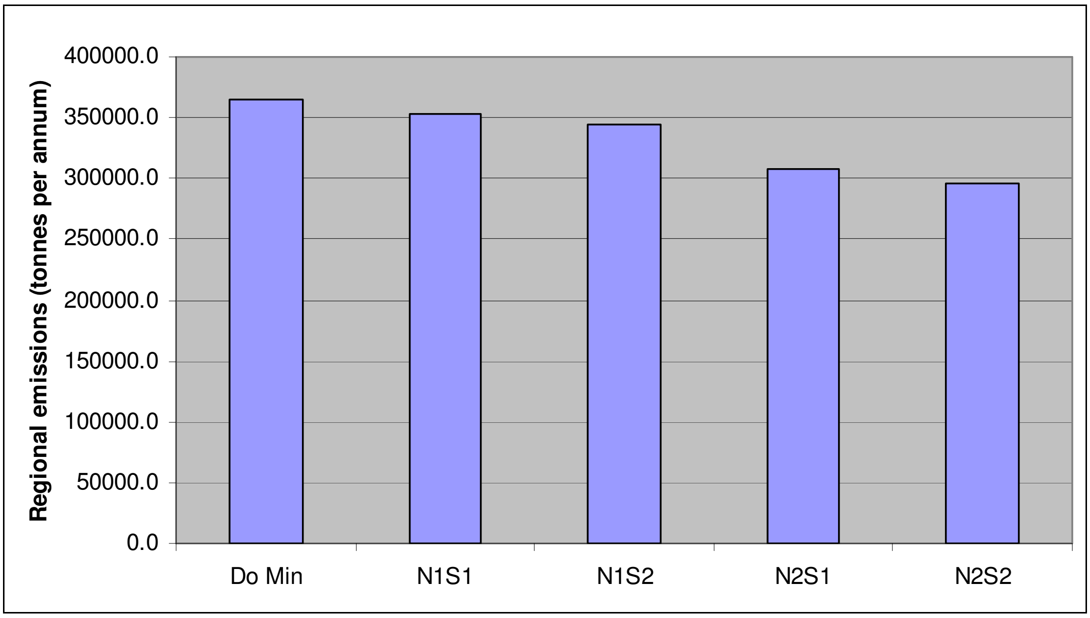
Graph 13.4: Total PM_{10} emissions – 2032



Graph 13.5: Total CO_2 emissions – 2017



Graph 13.6: Total CO_2 emissions - 2032



13.4.71 The assessment described above provides an indication of total emissions within the study area and allows a comparison of the different corridor options in terms of total emissions. However, the study area is relatively small in terms of regional or global emissions.

13.4.72 The Transport Model for Scotland (TMfS05a) includes an environmental appraisal module (ENEVAL) which provides information on pollutants associated with transport. ENEVAL data on CO_2 emissions was produced for an extended area covering the South East of Scotland Transport Partnership (SESTran) area which includes the Scottish Borders, East Lothian, Midlothian, City of Edinburgh, West Lothian, Falkirk, Clackmannanshire and Fife.

13.4.73 The 2017 ENEVAL emissions calculated for this wider study area do not quite follow the trend shown in Graph 13.5, as ENEVAL shows small increases in CO_2 emissions (<0.4%) for all assessed corridor options when compared to the do minimum. However, these increases fall within the expected variability of the modelling process. 2032 ENEVAL data were not available at the time of assessment.

13.4.74 The wider study area CO_2 data are therefore considered to be broadly similar for all corridor options, including the do-minimum. As they do not assist in differentiating between corridor options, ENEVAL data are not reproduced in this report.

13.5 Potential Mitigation

13.5.1 The results of the Stage 2 assessment indicate that it is unlikely that exceedances of relevant air quality objectives and limit values would occur as a result of the proposed Forth Replacement Crossing. However, it is not feasible at DMRB Stage 2 to identify requirements for mitigation for either local air quality or the impacts of air quality on vegetation at designated sites (other than avoiding these areas where possible; refer to Chapter 9: Ecology and Nature Conservation). The requirement for mitigation will be reviewed during DMRB Stage 3.

13.5.2 Generic measures in relation to air quality during construction are outlined in Chapter 17 (Disruption Due to Construction).

13.6 Summary of Route Corridor Options Assessment

Northern Route Corridor Options

Changes in Population Exposure

13.6.1 Assessment scores represent differences in overall pollutant concentrations averaged over the number of properties affected and are calculated by subtracting the overall do minimum scenario score from the overall do something scenario score. A negative score therefore represents an improvement from the do minimum to the do something and a positive score represents a worsening of local air quality.

13.6.2 In terms of overall air quality, Table 13.34 (summarising from the STAG calculations) shows that under all of the route corridor options, there is predicted to be virtually no change in local population exposure to air pollution as a result of the Forth Replacement Crossing. Of the four route corridor options, North Corridor Option 2 / South Corridor Option 2 is predicted to result in the greatest change in air quality showing a very slight improvement (compared to the do minimum scenario) but these changes remain very small.

Table 13.34: Assessment Scores for 2017 and 2032 for Route Corridor Options

Route Corridor Option	2017		2032	
	NO_2	PM_{10}	NO_2	PM_{10}
North Corridor Option 1 / South Corridor Option 1	-0.004	-0.0013	-0.022	-0.011
North Corridor Option 2 / South Corridor Option 1	-0.093	-0.021	-0.090	-0.027
North Corridor Option 1 / South Corridor Option 2	-0.082	-0.0143	-0.082	-0.021
North Corridor Option 2 / South Corridor Option 2	-0.149	-0.0296	-0.120	-0.031

Note: The assessment scores are based on average concentration change per assessed property and comparative to the do minimum scenario.

13.6.3 When comparing North Corridor Option 1 with North Corridor Option 2, it can be concluded that North Corridor Option 2 is predicted to result in a slightly higher improvement of local air quality when combined with both, South Corridor Option 1 and South Corridor Option 2, but again the changes are very small.

Changes in Air Quality and Nitrogen Deposition

Assessment of Designated Sites

13.6.4 The traffic related nitrogen deposition rates show that for the Firth of Forth SPA and SSSI 2 and both assessed Ferry Hill SSSI units critical loads of nitrogen will not be exceeded with or without the development.

13.6.5 The assessed Firth of Forth SPA and SSSI 1 in vicinity to the existing Forth Road Bridge will experience an improvement of equal scale for all assessed route corridor options.

13.6.6 It is predicted that critical loads for St Margaret's Marsh SSSI will be exceeded for all do something route corridor options. It has been calculated that North Corridor Option 1 / South Corridor Option 2 route corridor option will have the least detrimental impact on the St Margaret's Marsh SSSI.

Assessment of Residential Receptors

13.6.7 The assessment of individual residential receptors has shown that NO_2 concentrations modelled at all receptors are forecast to remain well within the air quality objectives and EU limit values. There is one receptor (R10) that is likely to experience Moderate Adverse impacts in all the assessed route corridor options.

13.6.8 The assessment has shown that PM_{10} concentrations are predicted to remain below but not well below the air quality objective and EU limit value. The majority of receptors will experience Negligible impacts as a result of the Forth Replacement Crossing independent of which route corridor option is taken forward.

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13.6.9 Total vehicle kilometres travelled are smaller for North Corridor Option 2 compared to North Corridor Option 1 in both assessment years 2017 and 2032.

13.6.10 In 2017, North Corridor Option 2 is predicted to result in a decrease of NO_x, PM_{10} and CO_2 emissions compared to the do minimum whilst North Corridor Option 1 is predicted to result in an increase.

13.6.11 In 2032, CO_2 emissions are predicted to decrease compared to the do minimum for both northern route orridor options. The higher decrease is predicted to occur as a result of North Corridor Option 2. NO_x concentrations in 2032 are predicted to increase for North Corridor Option 1 when compared to the do minimum but decrease for North Corridor Option 2. In 2032, PM_{10} concentrations are predicted to be higher for North Corridor Option 1 compared to North Corridor Option 2 and decrease for North Corridor Option 2 compared to the do minimum scenario. PM_{10} concentrations for North Corridor Option 1 decrease or increase compared to the do minimum depending on which South Corridor Option it is combined with.

13.6.12 It should be noted that 2017 CO_2 data produced by ENEVAL for the wider area show no significant difference between emission levels for all assessed route corridor options and the do minimum.

Southern Route Corridor Options

Changes in Population Exposure

13.6.13 When comparing South Corridor Option 1 with South Corridor Option 2 with regards to population exposure, South Corridor Option 2 is predicted to result in the greater change in air quality showing a slightly higher improvement (compared to the do minimum), as shown in Table 13.35 below.

Table 13.35: Assessment Scores for 2017 and 2032 for Route Corridor Options

Route Corridor Option	2017		2032	
	NO_2	PM_{10}		NO_2
South Corridor Option 1/ North Corridor Option 1	-0.004	-0.0013	-0.022	-0.011
South Corridor Option 2/ North Corridor Option 1	-0.082	-0.0143	-0.082	-0.021
South Corridor Option 1/ North Corridor Option 2	-0.093	-0.021	-0.090	-0.027
South Corridor Option 2/ North Corridor Option 2	-0.149	-0.0296	-0.120	-0.031

Note: The assessment scores are based on average concentration change per assessed property and comparative to the do minimum scenario.

Changes in Air Quality and Nitrogen Deposition

Assessment of Designated Sites

13.6.14 The traffic related nitrogen deposition rates show that for the Firth of Forth SPA and SSSI 2 and both assessed Ferry Hill SSSI units critical loads of nitrogen will not be exceeded with or without the development.

13.6.15 The assessed Firth of Forth SPA and SSSI 1 in the vicinity of the Forth Road Bridge will experience an improvement of equal scale for all assessed route corridor options.

13.6.16 It is predicted that critical loads for St Margaret's Marsh SSSI will be exceeded for all do something route corridor options. It has been calculated that South Corridor Option 2 / North Corridor Option 1 will have the least detrimental impact on the St Margaret's Marsh SSSI.

Assessment of Residential Receptors

13.6.17 The assessment of individual residential receptors has shown that NO_2 concentrations modelled at all receptors are forecast to remain well within the air quality objectives and EU limit values.

13.6.18 The assessment has shown that PM_{10} concentrations are predicted to remain below but not well below the air quality objective and EU limit value. The majority of receptors will experience Negligible impacts as a result of the Forth Replacement Crossing independent of which route corridor option is taken forward.

Regional Assessment

13.6.19 Table 13.36 shows that total vehicle kilometres travelled are smaller for South Corridor Option 2 compared to South Corridor Option 1 in both assessment years 2017 and 2032.

13.6.20 Emissions for all assessed pollutants are lower for South Corridor Option 2 compared to South Corridor Option 1. However, depending on which northern corridor option is combined with South Corridor Option 2, concentrations of NO_x, PM_{10} and CO_2 decrease (South Corridor Option 2 / North Corridor Option 2) or increase (South Corridor Option 2 / North Corridor Option 1) compared to the concentrations calculated for the do minimum scenario, with the exception of PM_{10} and CO_2 in the 2032 scenario. Similarly, depending on which northern corridor option is combined with South Corridor Option 1, pollutant concentrations decrease (South Corridor Option1 / North Corridor Option 2) or increase (South Corridor Option 1 / North Corridor Option 1) compared to the do minimum scenario.

13.6.21 In 2032, CO_2 emissions for all scenarios are lower than the calculated emissions in the do minimum scenario.

13.6.22 It should be noted that 2017 CO_2 data produced by ENEVAL for the wider area show no significant difference between emission levels for all assessed route corridor options and the do minimum.

13.7 Scope of Stage 3 Assessment

13.7.1 The Stage 3 assessment will be undertaken in accordance with DMRB Volume 11, Section 3, Part 1: HA207/07 which requires at assessment of local air quality effects using a suitable model.

13.7.2 Dispersion modelling using ADMS-Roads (or similar model) will be carried out for the operational phase, covering an area similar to the study area used in the Stage 2 assessment. The dispersion model will be used to calculate concentrations of NO_2 and PM_{10} at sensitive receptors and contour plots of pollutant concentrations will also be prepared.

13.7.3 The results for the different years will be evaluated against the relevant air quality criteria in that year for the situations with and without the scheme. The significance of these effects will then be assessed using NSCA guidance. Additionally, regional air quality impacts due to the total emissions anticipated as a result of the scheme will be assessed.

13.7.4 A qualitative assessment of an alternative do minimum assessment will be carried out. The approach and degree of assessment will depend on traffic data availability.

13.7.5 Construction effects will be assessed through a qualitative assessment of potential sources of air pollutant emissions from construction activities and through the formulation of appropriate mitigation and control measures to be placed within a formal Code of Construction Practice (CoCP).

13.8 References

Air Quality (Scotland) Regulations 2000 and Air Quality (Scotland) Amendment Regulations 2002.

City of Edinburgh Council (2000). Review and Assessment of Air Quality Stage 3.

City of Edinburgh Council (2002). Review and Assessment of Air Quality Stage 4.

City of Edinburgh Council (2003). Air Quality Action Plan: NO_2 Air Pollution.

City of Edinburgh Council (2003). Updating and Screening Assessment, Local Air Quality Management Phase 2.

Directive 2008/50/EC - Ambient Air Quality and Cleaner Air for Europe.

Directive 96/62/EC - Ambient Air Quality Assessment and Management

NSCA (2006). Development Control: Planning for Air Quality. Environmental Protection UK. National Society for Clean Air.

The Air Quality Standards (Scotland) Regulations 2007, HMSO.

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department of Environment, Food and Rural Affairs, The Stationery Office, July 2007.

The Highways Agency et al. (2007). Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 1 Air Quality, HA207/07. The Highways Agency, Scottish Executive, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

The Scottish Executive (2002). Scottish Planning Policy 2 (SPP2) – Economic Development.

The Scottish Executive (2005). Planning Advice Note 75 (PAN 75) – Planning for Transport.

The Scottish Executive (2005). Scottish Planning Policy 17 (SPP17) – Transport & Planning.

Transport Scotland (2008). Scottish Transport Appraisal Guidance. The Scottish Government.

14 Traffic Noise and Vibration

14.1 Introduction

14.1.1 This section presents the DMRB Stage 2 assessment of the potential noise and vibration impacts of the Forth Replacement Crossing.

14.1.2 The assessment builds on the Strategic Environmental Assessment (Jacobs et al., 2007) that considered noise and vibration and informed the decision by the Scottish Ministers to progress a new crossing by bridge in the location currently proposed.

14.1.3 Appendix A14.1 presents an introduction to noise and vibration as well as standard noise terms.

14.2 Approach and Methods

Legislative Framework

Road Traffic Noise and Vibration

14.2.1 The assessment and mitigation of road traffic noise is carried out according to established prediction and assessment methodologies governed by various regulatory standards. Key documents include:

- Calculation of Road Traffic Noise (CRTN). The UK calculation method for predicting road traffic noise levels. Department of Transport (1988).
- Design Manual for Roads and Bridges (DMRB), Volume 11, Part 7. Includes guidance and assessment methods for noise and vibration. DMRB is adopted by Transport Scotland for new trunk road schemes.
- The Environmental Impact Assessment (Scotland) Regulations 1999 (as amended).
- Noise Insulation (Scotland) Regulations 1975. The Noise Insulation Regulations define the conditions under which dwellings are eligible for noise insulation to control internal noise levels. The number of properties that are likely to be eligible for statutory insulation would be indicated as part of a Stage 3 level assessment. Noise mitigation measures would be applied, if practicable, to ensure that noise exposure at dwellings alongside the Forth Replacement Crossing is controlled below the qualifying threshold for The Noise Insulation (Scotland) Regulations.

Construction Noise and Vibration

14.2.2 Construction noise and vibration is temporary and, as is accepted practice, should not be assessed in the same way as permanent operational impacts such as traffic noise. It is recognised that this must be judged against local needs and conditions. The impact of construction noise and vibration is usually assessed with reference to the following guidance and statutes:

- BS 5228: Noise and Vibration Control on Construction and Open Sites (British Standards Institution, 1997). BS 5228 provides guidance on the assessment and control of noise from construction operations to minimise the impact on local residents and construction workers.
- Environmental Protection Act (1990). The EPA describes the duty of the Local Authority to take steps to identify and abate any noise, including that from a construction site, deemed to be causing a statutory nuisance.

- Control of Pollution Act (1974). CoPA gives the Local Authority powers to serve a notice requiring the control of site noise and the mechanism by which persons responsible for premises can seek advance approval for construction activities and the associated steps to minimise noise.
- Local Policies. Local requirements for construction noise and vibration control are often set by Local Authorities. Identification of local policies would be pursued as part of the ongoing consultation process and developed in further detail during Stage 3 assessment. Noise limit targets are often based on recognised limits published many years ago in advisory documents such as DoE Advisory Leaflet (AL) 72 (1976). Advisory Leaflet (AL) 72 recommends that daytime construction noise levels at the facades of noise sensitive receivers should not exceed:

  i. 75 dB $L_{Aeq,12h}$ in urban areas near to main roads or in heavy industrial areas; or

  ii. 70 dB $L_{Aeq,12h}$ in rural, suburban and urban areas away from road traffic and industrial noise.

14.2.3 It is also proposed in AL 72 that noise limits should be 10 dB(A) lower for the evening period.

14.2.4 Chapter 17 (Disruption Due to Construction) provides more information on the construction process and its effects in terms of other environmental parameters.

Identification of Noise Sensitive Locations

14.2.5 It is a requirement of the Stage 2 DMRB procedure for the noise assessment to determine the numbers of noise sensitive properties in distance bands of 0-50m, 50-100m, 100-200m, and 200-300m from each of the route corridor options. To provide additional information, these property counts were extended to include 300-400m, 400-500m and 500-600m. A 600m area will also be considered during detailed assessment at Stage 3.

14.2.6 Potentially noise sensitive properties include residential properties, care homes, schools and hospitals. These were identified through review of existing information from previous studies and from review of Ordnance Survey plans. The distance bands are shown on Figures 14.2 to 14.9.

Assessment Methodology for Road Traffic Noise and Vibration

Road Traffic Noise

14.2.7 This assessment has been undertaken in accordance with DMRB (1994) guidance of comparing the noise levels for the Do Something scenario (with Forth Replacement Crossing) against noise levels for the Do Minimum scenario (continued use of the Forth Road Bridge). The method requires that comparisons are made between the ambient noise situation (before the change produced by the Forth Replacement Crossing) and the noise level in the worst-case year in the first 15 years after opening (i.e. generally the design year which would have the maximum traffic flow 15 years after opening). The DMRB (1994) methodology was current guidance at the time of the study but an updated (2008) version was issued in August (HA 213/08) and this will be used for the next stage of assessment.

14.2.8 For the purposes of this assessment, the ambient and design years are taken as 2017 (i.e. the proposed year of opening) and 2032 respectively.

14.2.9 The calculations are carried out according to the CRTN methodology using proprietary software. Traffic noise levels are calculated across a grid of receiver positions over the study area, which includes traffic flows from the bridge itself, and contours of noise level exposure are established.

14.2.10 The current DMRB defines a study area of 300m either side of the route corridor options for Stage 2 assessment. However this chapter presents information for a wider area to provide additional information. The absolute noise levels (as mapped on Figures 14.1 to 14.5) extend to 500m either side of each route corridor. Potential impacts on noise sensitive receptors are reported in terms of predicted noise level changes (as mapped on Figures 14.6 to 14.9).

14.2.11 Noise levels are calculated in terms of the $L_{A10,18h}$ index as specified in CRTN. This represents the A-weighted noise level exceeded for 10% of the time between the hours of 06:00 and 00:00. For this study, annual average weekday traffic (AAWT) flows have been used as specified by CRTN. The traffic flow predictions on which the noise calculations are derived have been provided by traffic engineers for the different route corridor options.

14.2.12 In addition to traffic flow information, the traffic noise calculations are determined from digital mapping data detailing topographical and landscaping information including man-made features; positions of noise sensitive receivers such as houses, schools and hospitals; type of ground cover; and type of road surface used.

14.2.13 Based on the assessed effects, the likely requirement for noise mitigation associated with each route corridor option would be compared as required by the DMRB Stage 2 methodology.

Road Traffic Vibration

14.2.14 DMRB recommends that in addition to an assessment of noise, the effects of vibration should also be considered where possible. In the case of ground-borne vibration, the likelihood of perceptible vibration being caused is particularly dependent upon the smoothness of the road surface. Research has shown that vibration levels caused by heavy goods vehicles travelling at 110kph over a 25mm hump could cause perceptible vibration at up to 40m from the road. This would infer, therefore, that it is unlikely that significant levels of vibration would be generated at distances greater than this.

14.2.15 The DMRB method for estimating the likelihood of airborne noise causing vibration nuisance is based upon studies close to main roads where such problems can occur. These studies were limited to receivers within 40m of the road without screening. As an indication of the scale of impact relative to noise effects, the guidance in DMRB states that for a given level of traffic noise exposure the percentage of people bothered very much or quite a lot by airborne vibration is 10% lower than the corresponding amount for noise nuisance. Also, the significance of any change in airborne traffic vibration can be considered proportional to the significance of changes in traffic noise, as described above for each area.

14.2.16 The impact of vibration effects has been examined within the constraints of the assessment methodology as defined above.

Assessment Methodology for Construction Noise and Vibration

14.2.17 At this stage of the project (route corridor options assessment), detailed construction methodologies have not been developed. Therefore, for the Stage 2 assessment, the construction noise and vibration effects for the Forth Replacement Crossing have been assessed by considering the likely range of construction processes associated with the Forth Replacement Crossing works and their typical durations.

14.2.18 The noise effects associated with construction works for the mainline are estimated from a detailed predictive study that has recently been undertaken by Arup for another major highway scheme (M1 J21-30 widening; Highways Agency, 2006).

Mainline Construction

14.2.19 For the purposes of the noise assessment, the mainline construction activities (i.e. proposed new and upgraded roads) are categorised into four major phases as follows:

- site clearance;
- earthworks (and piling);
- drainage / lighting;
- pavement construction.

14.2.20 As part of the M1 J21-30 Widening referred to in paragraph 14.2.15, a range of noise levels was calculated across representative receivers closest to each route corridor option for each of these phases. The noise sensitive receivers alongside the route corridor were selected within a distance range typically 20 – 50m from the scheme (i.e. those potentially the worst affected). Piling operations were also considered as a separate activity, as might take place during retaining wall constructions, as this is known to be a potentially noisy operation. This would only occur for a limited number of situations along the mainline.

14.2.21 The calculations carried out for the M1 J21-30 Widening study were based on the plant machinery typically involved for these operations (as agreed with the engineers for that scheme) and the rate of progress past each receiver location along the route corridor. The results represent a worst-case day when the particular operation is passing directly alongside the receiver. The daily noise levels would be lower as each phase of works approaches and also passes beyond the receiver. Table 14.1 gives the highest noise levels calculated for each operation at the closest nearby receivers (approximately 20m).

14.2.22 The data provide an illustration of the highest daily noise levels at a reference distance during highway construction. Although these results are not specific to the construction of the Forth Replacement Crossing, the data can be used as an indication of noise levels at receivers close to the northern and southern route corridor options.

Table 14.1: Example 'Worst-case Day' Noise Level from Construction Phases

Example Noise Levels from Construction Phases dB $L_{Aeq,10h\ façade\ corrected}$ **Receiver Locations approx 20m from Highway Scheme** (first floor noise level without screening potentially provided by early installation of operational mitigation) (Taken from: Highways Agency (2006) Widening the M1 J21-30 Environmental Statement of Contract 1 works (Junctions 25-28))				
Site Clearance	**Piling**	**Earthworks**	**Drainage and Lighting**	**Pavement**
76	82	76	72	82

14.2.23 Based on the assessed effects, the appropriate best practicable means mitigation has been proposed.

Evaluation and Significance Criteria

Road Traffic Noise

14.2.24 There is no established UK guidance which clearly defines significance criteria for the assessment of changes in road traffic noise. The response of people to noise is highly subjective and sensitivity to changes in traffic noise change is therefore variable across the population. Part 7, Volume 11 of DMRB (The Highways Agency et al., 1994) notes that 'attitudes to traffic noise are also related to satisfaction with the neighbourhood in general'. Given the variability of response and the potential for non-acoustical factors to influence perceptions of noise, any assessment of significance can only represent an average community response to traffic noise. Many of the guidance documents (past and present) relating to traffic noise assessment note that a change of less than 3dB(A) is not generally perceptible and it would follow that a significant effect cannot occur if the change is not perceptible. Further to this, just because a change is perceptible does not necessarily mean that this change is sufficient to cause a significant effect. Nevertheless, a change threshold of 3dB(A) has commonly been used in traffic noise assessments in the UK to approximate the threshold of significance.

14.2.25 For reference, the guidance citing the 3dB(A) threshold includes:

- Transport Scotland (2008), Scottish Transport Appraisal Guidance – The Noise Objective, STAG Unit 3.3.2, HMSO
- Department For Transport (1998), A New Deal For Trunk Roads In England: Guidance On The New Approach To Appraisal, HMSO
- Department Of The Environment (1990), Report Of The Noise Review Working Party, HMSO
- Institute Of Environmental Assessment (1992), Guidelines For The Environmental Assessment Of Road Traffic. IEA
- The Scottish Office, Development Department (1999), Planning Advice Note 56, Planning and Noise

14.2.26 However, DMRB states that, following a change in traffic flow, benefits or disbenefits have been reported for traffic noise changes as small as 1dB(A). This is based on research of community response to noise indicating that people would be more sensitive to the abrupt noise change soon after opening of the Forth Replacement Crossing and for a number of years afterwards.

14.2.27 DMRB describes a procedure for assessing noise nuisance experienced alongside the highway. Noise changes of 1dB(A) or more are related to the estimated change in the 'percentage of people bothered very much or quite a lot by traffic noise'. Although the DMRB method does not rate the noise change in terms of the significance of the effect, it suggests that a proportion of the community may report a change in nuisance level following noise changes as small as 1dB(A). DMRB states that this heightened sensitivity is a temporary effect and the longer-term noise nuisance level after a number of years is assumed to revert to the 'steady state' level.

14.2.28 When considering appropriate significance criteria for changes in traffic noise, it is widely accepted that changes of 3dB(A) or more would generally be noticeable, whilst the research cited in DMRB indicates that some individuals would respond to changes less than this, particularly soon after opening of the road. In the case of small changes in noise levels considerably less than 3dB, which would not generally be regarded as perceptible, it could be argued that the rating of nuisance changes may be coloured by factors other than noise (Baughan & Huddart, 1993).

14.2.29 For the purposes of this assessment it is assumed that significant effects would be generally experienced for changes of 3dB(A) or more at residential properties. Clearly this threshold cannot represent an absolute step-change in people's response and it follows that for some proportion of the community noise changes less than 3dB(A) could be perceptible. It would be recognised, therefore, that for some people there could be an onset of significant change for changes between 2 and 3dB(A). Significance of noise change at non-residential receptors would be based on these same criteria, although other factors may affect the assessment, such as the exact nature of use, the times of use and the sensitivity of the occupants (eg special educational needs). Due to the complexity of the various issues a qualitative judgement on the significance of noise change was made for these non-residential receptors. The effects on non-residential receptors will be considered in more detail at the next assessment stage.

14.2.30 The following semantic scale is commonly used in traffic noise assessment to broadly rate the magnitude of the noise effects.

Table 14.2: Significance Criteria for Changes in Traffic Noise

Change in Noise Level	Magnitude of Effect	Significance of Effect
>10	Major adverse	Significant increase
5 to <10	Moderate adverse	
3 to <5	Minor adverse	
1 to <3	Slight adverse	Not significant
<1 to >-1	No effect	
-1 to >-3	Slight beneficial	
-3 to >-5	Minor beneficial	Significant decrease
-5 to >-10	Moderate beneficial	
<-10	Major beneficial	

14.2.31 Section 14.4 will primarily consider noise changes based on the change between the ambient noise situation and the noise level in the worst-case year in the first 15 years after opening (i.e. 2032) as required by DMRB.

<u>Construction Noise</u>

14.2.32 There are no nationally accepted criteria by which to assess the significance of effects caused by exposure to construction noise. The guidance documents available do not propose any specific criteria for the setting of noise limits or significance criteria for construction works. When assessing construction noise the guidance in BS 5228 identifies a number of key factors in relation to the acceptability of noise (and vibration) to people living and working around the site. Because the noise changes are temporary, the duration of the noise exposure is an important factor as well as the actual noise level.

14.2.33 An initial assessment of the significance of the effects has been made based on the predicted noise levels relative to the ambient levels and the duration of exposure.

14.2.34 As a basic indicator of temporary significant effects for the purpose of the Stage 2 assessment, an outline significance criteria would be defined as an increase in the LAeq,10h at affected dwellings as a result of construction by at least 3dB (i.e. perceptible) for a period of at least 8 weeks.

Limitations to Assessment

14.2.35 The assessment of road traffic noise effects is based on the data and information provided by others, i.e. traffic model, road design details and topography. However, it is considered that all data inputs required for the Stage 2 assessment have been obtained to an adequate level of detail.

14.2.36 The assessment of construction noise has been based on the anticipated construction stages to complete the required works. It is possible that the exact plant and duration of activities would vary slightly from the assumptions made although it is considered that the assumptions made are representative of the likely works. The level of information currently available for the assessment of construction noise for the Forth Replacement Crossing is limited. However, at this outline design stage it is considered that the examination of the intensity and likely duration of works would be sufficient to identify the potential for significant effects. Construction noise and vibration impacts would be considered in greater depth at the detailed assessment stage.

14.3 Baseline Conditions

Ambient Noise Climate

14.3.1 For the purposes of the noise assessment, the baseline situation is represented by the predicted ambient noise levels before the change produced by the Forth Replacement Crossing as required by DMRB. This is taken as the noise levels from the existing roads in the year 2017. Figure 14.1 shows noise levels at 5dB intervals to represent the ambient situation in 2017, illustrating noise contour maps for the existing roads. The contour maps (Figure 14.1) show the noise exposures within the study area from which the effects of distance, topography, the presence of noise barriers and other screening structures can be seen.

Distribution of Noise Sensitive Locations

14.3.2 Table 14.3 presents the numbers of noise sensitive receptors (this includes residential, care homes, schools and hospitals) identified within distance bands from each of the route corridor options.

Table 14.3: Numbers of Noise Sensitive Receptors in Different Distance Bands from the Forth Replacement Crossing Route Corridor Options

Forth Replacement Crossing	Number of noise sensitive receptors								
	0 – 50m	50-100m	100-200m	200-300m	300-400m	400-500m	500-600m	0-300m Total	0-600m Total
North Do-Minimum	47	171	508	496	631	737	889	1222	3479
North Corridor Option 1	12	131	491	608	882	983	1059	1242	4166
North Corridor Option 2	3	11	161	414	522	665	752	589	2528
South Do-Minimum	92	167	549	843	790	689	657	1651	3787
South Corridor Option 1	8	90	397	811	890	727	573	1306	3496
South Corridor Option 2	17	70	205	534	665	586	537	826	2614

14.3.3 This table gives numbers of noise sensitive receptors up to 600m from the Forth Replacement Crossing route corridor options. As the current DMRB specifies that properties in bands up to 300m should be considered, it is the 300m results which would primarily be considered in this report as the noise effects would be expected to be greatest within this distance.

14.3.4 It must be noted that property counts of this nature cannot be taken as a definitive indication of noise impact, as they represent only the numbers of properties in close proximity to the route corridor options and cannot therefore take account of actual noise exposure or noise sources elsewhere in the study area which may affect the assessment.

14.3.5 It should be assumed that, unless otherwise stated, all properties in the study area are already subject to road traffic noise, which is likely to lessen noise change, and hence impact, arising from the Forth Replacement Crossing.

14.3.6 For the two northern route corridor options under consideration, there is a reduction of properties within both route corridors relative to the existing alignment (both route corridor options are further from North Queensferry). North Corridor Option 2 provides the greatest reduction in numbers of properties affected. Of the two, North Corridor Option 2 minimises the numbers of properties in the closest bands i.e. 0-100m and 100-200m.

14.3.7 For the southern route corridor options, again, both of the corridor options show a reduction of properties within the route corridor relative to the existing alignment. South Corridor Option 2 provides the greatest reduction in numbers of properties affected, as the route corridor takes the M90 southward, away from the southern South Queensferry residential areas, whilst at the same time, traffic along the A904 (Builyeon Road) is also reduced.

Do-Minimum North

14.3.8 There are six schools within the vicinity of the Do-Minimum route: one (Inverkeithing High School) in the 0-50m band; one in the 50-100m band (Park Road Primary School); one (Inverkeithing Nursey) in the 100-200m band; one (Inverkeithing Primary School) in the 200-300m band; one (Careshare Nursery) in the 300-400m band and one (North Queensferry Primary School) in the 500-600m band as shown on Figure 14.1.

Do-Minimum South

14.3.9 There are four schools within the vicinity of the existing route: one (Dalmeny Primary School) in the 50-100m band; two (Echline Primary School and Kirkliston Primary School) in the 300-400m band; and one (Queensferry Primary School) in the 500-600m band. There is also one care home (Leonard Cheshire Home, Kirkliston) within the 300-400m band.

14.4 Potential Impacts

14.4.1 This section describes the changes in noise levels predicted at representative locations as a result of the construction works and the operation of the Forth Replacement Crossing route corridor options. Representative noise sensitive receptors are identified on Figures 14.1 to 14.9 and discussed in this section. It should be noted that potential impacts are reported (i.e. with no mitigation). Mitigation is then considered in Section 14.5 for both construction and operational noise to address potential noise impacts.

14.4.2 Figures 14.1 to 14.5 show predicted absolute noise levels for the do minimum (ambient) situation in 2017 and with the operation of the Forth Replacement Crossing in the opening (2017) and design years (2032). Figures 14.6 to 14.9 show those locations where there are predicted to be noise changes of 1dB(A) or more at noise sensitive receivers. Based on the significance criteria set out earlier, it would be assumed that significant effects would be generally experienced for changes of 3dB(A) or more.

14.4.3 It should be noted that the noise contour results shown in these figures do not take into account the effect of façade reflections which result in a localised increase of 2.5dB(A) at one metre in front of a building's façade.

14.4.4 With regard to ground-borne vibration, it is considered that no properties are sufficiently close to the Forth Replacement Crossing for significant ground-borne vibration impacts to occur. This is because the surface of the proposed new and upgraded roads would be smooth, with no surface irregularities of sufficient size to generate significant levels of ground-borne vibration. The size of irregularities necessary to cause perceptible ground-borne vibration is discussed in the assessment methodology described in Section 14.2.

14.4.5 In the case of airborne vibration, the guidance suggests that the percentage of people bothered very much or quite a lot by airborne vibration is 10% lower than the corresponding amount for noise nuisance. It can be assumed then that significant effects associated with airborne vibration would be approximately equivalent to, but no greater than those effects reported for noise.

14.4.6 For the reasons set out in paragraphs 14.4.4 and 14.4.5, air-borne and ground-borne vibration effects are not considered further in this Stage 2 assessment.

Northern Route Corridor Options

<u>North Corridor Option 1</u>

14.4.7 North Corridor Option 1 is very similar to the present route corridor, making only one significant departure from the existing M90 mainline alignment for the proposed replacement bridge.

14.4.8 North Corridor Option 1 runs south from where the M90 crosses the B916. Southwards from this point, the M90 mainline widening remains contained within the present highway corridor until it reaches St Margaret's Marsh. Significant earthwork alterations occur through Masterton Junction, just south of Fairy Kirk and through Castlandhill, west of Muckle Hill. At Ferrytoll Junction, the M90 mainline deviates west of the Forth Road Bridge alignment, taking it approximately 250m further to the west, to the eastern side of Queensferry Lodge Hotel.

14.4.9 As North Corridor Option 1 is largely an upgrading and widening of the existing route corridor, any noise impact is likely to be relatively small when compared with the Do-Minimum Option. The existing houses affected by the route corridor would receive a noise increase due largely to the predicted rise in traffic volume along the M90. Smaller increases in noise occur where the alignment is shifted slightly closer to residential and other noise sensitive properties, due to the widening.

14.4.10 One exception to this would be the proposed link road from Masterton Junction to the A921, just to the west of Inverkeithing High School. This new road would pass to the east of properties along the B981, becoming a major new noise source in this particular area. The east facing facades of these properties currently overlook open fields.

14.4.11 As with the do-minimum scenario, there are schools that would be within the vicinity of this route corridor: one (Inverkeithing High School) in the 0-50m band; one (Park Road Primary School) in the 50-100m band; and;three (Careshare Nursery, Inverkeithing Nursery and Inverkeithing Primary School) in the 300-400m band; and one (North Queensferry Primary School) in the 500-600m band.

Construction

14.4.12 The proposed road links at the Ferrytoll Junction are not close to residential areas and the construction works here would not be expected to give rise to significant effects. The carriageway alterations and cuttings works further north alongside Castlandhill are not estimated to exceed construction noise limit values although the noise increases relative to ambient noise levels would be estimated to be temporarily significant.

14.4.13 To the north of Rosyth, this route corridor option proposes a number of new links at the junction of the M90 and A823(M). There are no residential areas close enough here for there to be a likelihood of the noise limit values being exceeded. Also, given the relatively high ambient noise levels, the junction and structures works would not be expected to give rise to significant effects on the northeast edge of Rosyth. No further significant effects are expected north of the junction.

Operation

14.4.14 Around Masterton Junction, there would be Slight to Minor beneficial effects (-1 to >-5dB(A)). The new road from the A921 linking into the new junction at M90 would have a Slight Adverse effect (1-<3dB(A)) at North Road (B981) at those properties closest to road.

14.4.15 The results indicate a slight to Moderate Adverse effect of 3 to 10dB(A) along parts of the B980/B981 to Rosyth and the south link between Inverkeithing and the proposed replacement bridge.

14.4.16 St Margaret's Hope to the west of the proposed replacement bridge would have a Moderate Adverse effect of 5-<10dB(A). The Queensferry Lodge Hotel noise effect changes from the east façade to west façade with an overall Major Adverse effect (>10dB(A)).

14.4.17 Properties in North Queensferry would be subject to Slight to Major Beneficial effects, i.e. -1 to <-10dB(A).

<u>North Corridor Option 2</u>

14.4.18 In comparison to North Corridor Option 1, North Corridor Option 2 makes significant departures from the existing M90 mainline alignment. North Corridor Option 2 begins where the M90 crosses the B916. However, soon after this point, the M90 mainline corridor diverts across to the east into deep cutting, whilst new slips take traffic back onto the existing M90 alignment to Masterton Junction. North Corridor Option 2 then rises back to level ground at Dales Steading / Dales Farm Cottage, before going onto high embankment down alongside the B981, until it crosses over the new Inverkeithing North Junction and the Edinburgh to Aberdeen and Fife Circle Railway lines. Properties along the B981 would have a clear line of sight to this new road due to its elevated position, with an associated noise.

14.4.19 At this point the road remains elevated on a section of bridge down to the A921 (Admiralty Road). Further embankment earthworks carry the M90 east of Inverkeithing, down to and over the existing A90, just south of Admiralty Junction and the B980.

14.4.20 At this point it drops below ground level into a cut and cover tunnel, just east of Castlandhill Farm Steadings, where it continues south towards Castlandhill Woods in shallow embankment. A new slip road feeds northbound traffic from the M90, across high embankment over and onto the existing A90. This embankment would provide beneficial screening of M90 traffic noise to Castlandhill Woods. North Corridor Option 2 would also relieve traffic noise currently impacting upon the cemetery south of Muckle Hill, by reducing traffic upon the existing A90. South of this point, the North Corridor Option 2 becomes the same as in North Corridor Option 1.

14.4.21 This route corridor option would relieve traffic along the existing A90 which would provide beneficial noise reductions for properties within the Admiralty Junction area. Whilst North Corridor Option 2 shifts traffic away from Admiralty Junction, because it is elevated, noise from this new road would not be as attenuated as if it were at grade level.

14.4.22 Properties in the northwest of Inverkeithing would be affected by the new elevated road source, and are likely to experience increased traffic noise.

14.4.23 The reduction in numbers of properties affected by North Corridor Option 2 compared with the current route is mainly due to the redirection of traffic away from the housing estate bounded by the M90 to the east, the A985 to the south and the A823(M) to the north.

14.4.24 North Corridor Option 2 would reduce the number of schools within the vicinity of the route to one (Park Road Primary School) in the 400-500m band.

Construction

14.4.25 North Corridor Option 2 proposes a new route alignment to the west of the A90 around the Castlandhill area; unlike North Corridor Option 1, temporarily significant effects are not expected here as the works would be more distant from noise sensitive receptors. North Corridor Option 2 would pass approximately 100m from the northwest edge of Inverkeithing and the cutting works here could give rise to temporarily significant effects. The section of new route corridor continuing north is not close to any residential locations and no significant effects are anticipated for the remainder of this route corridor option.

14.4.26 Although there could be some effects at Inverkeithing for North Option 2 , there would be less likelihood of noise effects at Muckle Hill and northeast Rosyth. Of the two northern route corridor options, North Corridor Option 2 is therefore considered marginally preferable in terms of construction noise.

Operation

14.4.27 The new road to the east of Masterton Junction would have Minor Adverse effects at some properties on Struan Place and Struan Drive (3-<5dB(A)) in Inverkeithing. Properties along the existing M90 and Park Road Primary School would be subject to a minor beneficial effect (-3 to >-5dB(A)). Properties along Castlandhill Road in Rosyth and Whinny Hill Crescent in Inverkeithing would be subject to a Moderate Beneficial effect (-5 to >-10dB(A)). Properties along Dunfermline Wynd/Hill Street in Inverkeithing would be subject to a major beneficial effect (<-10dB(A)).

14.4.28 Along the road connecting B980/B981 and Rosyth, there would be a Minor Adverse effect (3-<5dB(A)) at Castlandhill House.

14.4.29 St Margaret’s Hope to the west of the proposed replacement bridge would be subject to a Moderate Adverse effect (5-<10dB(A)). The Queensferry Lodge Hotel noise effect changes from the east façade to west façade with an overall Moderate Adverse effect (5-<10dB(A)).

14.4.30 Along the southern link between Inverkeithing and the bridge over the B981, there would be Moderate Adverse effects at properties (5-<10dB(A)). Some properties in North Queensferry would be subject to Slight to Major Beneficial effects, i.e. -1 to <-10dB(A).

Southern Route Corridor Options

<u>South Corridor Option 1</u>

14.4.31 Under South Corridor Option 1, the route corridor to the proposed replacement bridge remains broadly the same as the current alignmenr along the M9 spur until south of South Queensferry, where the road crosses Dolphington Burn, level with and west of the Royal Elizabeth Yard. At this point new slip roads join, taking traffic back to the existing northbound A90, whilst South Corridor Option 1 takes traffic further to the west before turning northbound, towards the proposed replacement bridge. This is the start of the new junction called Echline/Scotstoun Junction, which stretches from Dolphington Culvert to the east, to Dundas Home Farm and Ferry Muir to the west. The new slip roads join onto the A90 at Queens Crossing, whilst a smaller junction slightly west of this point feeds traffic to the A904 (Builyeon Road).

14.4.32 From here South Corridor Option 1 progresses west, past Echline Strip and the property White Lodge Dundas, before heading north, and going into cutting to take it under the A904/B924 ‘Y’ junction. From here it is supported by an embankment before joining onto the proposed replacement bridge, passing Inchgarvie House and other scattered properties within 300m on the western side.

14.4.33 There are three schools within the vicinity of South Corridor Option 1: one (Dalmeny Primary School) in the 100-200m band; one (Kirkliston Primary School) in the 300-400m band; and one (Echline Primary School) in the 400-500m band. There is also one (Leonard Cheshire Home) care home within the 300-400m band.

Construction

14.4.34 Widening or other alteration works on the M9 spur approximately 50m to the west of Kirkliston would involve some of the standard processes listed in Table 14.1. Calculations indicate that the worst-case daily noise levels for some of the phases would be estimated to be below 75dB(A) which is typically adopted by local authorities as the daily construction noise limit in urban areas. However, pavement and any piling operations would possibly be close to, or in exceedance of this limit, and therefore may require particular attention to mitigate this disturbance in accordance with best practicable means. Relative to the ambient noise levels which are dominated by the existing road traffic, the increase in noise level would be sufficient to be rated as a temporary significant effect if the works along this section continued over a period of two or more months.

14.4.35 Further north, South Corridor Option 1 would be aligned approximately 200-400m to the south of South Queensferry and the resulting noise levels would be well below the 75dB(A) limit value at residential properties here. As South Corridor Option 1 turns north along the west side of South Queensferry, it passes within approximately 150m of residential areas. Noise levels from the generic construction processes would still be less than the noise limit value (75dB(A)). The increase in noise level relative to ambient noise levels to the southwest and west of South Queensferry is estimated to be temporarily significant during the noisier phases given the likely duration of the works (i.e. assumed to raise noise levels by at least 3dB for longer than 8 weeks).

Operation

14.4.36 Along the B924, a number of properties and Echline Primary School would be exposed to a Minor Adverse effect (3–<5dB(A)). South Corridor Option 1, from the approach viaduct down to the A904, brings Major Adverse effects in noise to some residential properties at Inchgarvie House, Linn Mill, Cluflat Brae, Springfield Brae, Terrace and Crescent of >10dB(A).

14.4.37 On the north side of the A90 is the village of Dalmeny. Noise level changes in this area would be Negligible including those effects at Dalmeny Primary School. To the south is Dundas Home Farm that would be subject to increases of between 1 to <5dB(A), ie Slight to Minor Adverse. There are Moderate to Major Beneficial effects predicted in South Queensferry of between -5 to <-10dB(A) in the area around the existing bridge link road.

14.4.38 Kirkliston would be subject to Minor Beneficial effects (-3 to >-5dB(A)) in the northwest and western outskirts with no significant changes further into the centre of Kirkliston.

14.4.39 The relative benefits and disbenefits of the various route corridor options with respect to operational noise are compared in Section 14.6.

<u>South Corridor Option 2</u>

14.4.40 South Corridor Option 2 would comprise a new road branching off from the M9 via a new junction, between Humble Reservoir and Muiriehall Wood, directly to the proposed replacement bridge. There would also be a new eastbound slip road from the spur to A90 and a new slip road at M9 Junction 1A.

14.4.41 As the new road traverses northward, it passes between a number of isolated properties both to the east and west of the route corridor. To the east lie Dundas Castle and its grounds, including Castleloch Dundas and The Chalet Dundas, as well other isolated properties of Carmel Hill cottage, Dundas Mains, Rose-acre and Lilac Cottage, Brown-acre Dundas, Green-acre Dundas, Blue-acre Dundas and Chapel-acre Dundas. Other properties to the west of South Corridor Option 2 include Swineburn, Totleywells Grange, Westfield, Holly Cottage, Baroncraig, Gillerhill and Lawflat Duddingston. All these areas would be subject to a noise increase due to the locality of the new road, although this would be mitigated to a certain degree as the new road would be in cutting along most of its length.

14.4.42 The potential noise increases that the closest properties would be exposed to for South Corridor Option 2, would be more severe than for South Corridor Option 1, due to the low ambient noise climate in this very rural area. The topography in this area is fairly undulating and complex, and would therefore have a significant bearing on the potential for noise impact that the new road could have on the various scattered properties in this area.

14.4.43 Under this route corridor option, traffic along the M9 spur would be significantly reduced, providing noise reductions to properties along this existing section of road.

14.4.44 There are three schools within the vicinity of South Corridor Option 2: one (Dalmeny Primary School) in the 50-100m band; and two (Echline Primary School and Kirkliston Primary School) in the 300-400m band. There is also one (Leonard Cheshire Home) care home within the 300-400m band.

Construction

14.4.45 The construction noise effects to the west of Kirkliston would be the same as those described above for South Corridor Option 1. Alterations associated with South Corridor Option 2 at the Scotstoun Junction would bring the works close to Dalmeny, but it is not expected that the noise levels would be high enough to exceed the 75dB(A) limit here according to the construction noise prediction approach set out in Section 14.2 (Approach and Methods). This corridor option incorporates a new section of highway from the M9 northeast to the west of South Queensferry. This would pass through a relatively unpopulated area. The closest residential property to this route corridor is Westfield Farm approximately midway between the M9 and the A904. However, this property would not be expected to receive construction noise levels in excess of the limit value. The construction noise effects would be expected to be rated as temporarily significant, however, given the ambient noise levels and the likely duration of the excavation works for the cutting here (i.e. assumed to raise noise levels by at least 3dB for longer than 8 weeks).

14.4.46 Further north, the effects to the west side of South Queensferry would be as described above for South Corridor Option 1, i.e. estimated to be temporarily significant relative to ambient noise levels.

14.4.47 Compared to South Corridor Option 1, South Corridor Option 2 is likely to result in less construction noise effects as there would be less new highway works to the south of South Queensferry.

Operation

14.4.48 From the proposed replacement bridge south towards the A904, residential properties at Inchgarvie House, Linn Mill, Cluflat Brae, Springfield Brae, Terrace and Crescent would experience Major Adverse effects (>10dB(A)).

14.4.49 There is very little change in noise at properties along Builyeon Road (A904) closest to the South Corridor Option 2, but properties further along this road to the east would be subject to a noise reduction of between 2-<3dB(A), i.e. onset of Significant Beneficial effect.

14.4.50 White Lodge Dundas at Westfield, Totleywells Grange, Baroncraig and Holly Cottage would be subject to a Major Adverse effect (>10dB(A)). Moderate Adverse effects (5 to <10dB(A)) are predicted at Dundas Castle, Dundas Mains and Swineburn.

14.4.51 Properties at Dundas Home Farm and Newbigging would be subject to a Moderate Beneficial effect (-5 to >-10dB(A)). There are Moderate to Major Beneficial effects predicted in South Queensferry of between -5 to <-10dB(A) in the area around the existing bridge link road.

14.4.52 Kirkliston would have Minor Beneficial effects (-3 to >-5dB(A)) in the northern outskirts, with a Moderate Beneficial effect (-5 to >-10dB(A)) in the southeast outskirts. There is predicted Insignificant to onset of Significant Beneficial effect toward the centre of Kirkliston.

14.5 Potential Mitigation

14.5.1 At DMRB Stage 2 assessment of route corridor options, the detailed design has not been developed, and mitigation detail therefore cannot be accurately defined. The objective of this section is therefore to identify 'standard' or 'anticipated' mitigation taking into account best practice, legislation and guidance. This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 14.6 (Summary of Route Corridor Options Assessment), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

14.5.2 Proposals for the mitigation of construction and operational noise are described in the following section. An estimate has been made of the approximate lengths of screening required for each route corridor option based on the locations alongside the route corridor options where significant effects have been identified.

<u>Construction Noise and Vibration</u>

14.5.3 The potential noise and vibration effects of the construction works would be addressed to reduce disturbance at all stages of the work. Working with the best practice guidance, opportunities would be sought to minimise the level and duration of noise exposure from construction according to established best practicable means. It is also intended that local residents should be kept informed of the possibility of disturbance and information made available regarding the nature and duration of the works likely to affect them. The measures taken to control potential disturbance would also be described as part of the public liaison exercise.

14.5.4 For all of the construction processes, all reasonable measures would be taken to minimise noise impact during these operations to protect residential properties and other noise sensitive areas from excessive noise exposure. This would be achieved using best practicable means according to measures described in BS 5228. In the case of the potential for vibration effects, reference would also be made to BS 6472 and BS 7385-2 which contain advice on the evaluation and measurement of vibration.

14.5.5 Those areas where temporary significant effects were identified for the construction works would receive particular attention to minimise noise effects. Similarly, areas where there is the potential for noise levels to exceed the 75dB(A) daily noise limit generally adopted for construction work would also be considered for mitigation to keep noise below this limit.

14.5.6 Locations closest to the Forth Replacement Crossing would be subject to the highest construction noise levels although many of these may also benefit from screening as part of the traffic noise mitigation plan. It is proposed that, where practicable, these screening measures should be installed before the construction works which would reduce the construction noise levels considerably.

14.5.7 The Contractor would liaise with the relevant Local Authorities for each area and specific local requirements would be agreed regarding working hours and prohibited activities. Specific noise control practices could be written into prior consents set out under Section 61 agreements (Control of Pollution Act) between the Contractor and the Local Authority. Concessions might be negotiated for exceptional specific activities such as working outside of standard hours.

14.5.8 The Contractor would work with the local authorities to ensure local policy requirements are addressed and to satisfy the local authorities that construction noise and vibration effects are minimised. The likely requirements will be identified during consultation as part of Stage 3 assessment.

14.5.9 General measures would include the selection of appropriate plant, construction methods and programming. Plant would be required to conform to the relevant national or international standards on noise emission (refer to British Standard 5228). If practicable, dedicated acoustic screening would be used in optimal positions if considered to be of particular benefit.

14.5.10 Strict adherence to working time limits would be operated to ensure that any noise disturbance is only likely to occur within agreed hours, unless exceptional working has been agreed in advance with the relevant local authority.

14.5.11 Monitoring of noise levels may be required during the construction works to ensure that any action levels agreed between the Contractor and the local authority are not exceeded at established monitoring positions.

14.5.12 Where piling is necessary, non-impactive piling would be used at positions closest to noise sensitive properties if it is possible to do so. The choice of piling technique would be reviewed once the construction programme is finalised.

14.5.13 Plant machinery such as generators or compressors would be positioned as far from noise sensitive locations as possible and ideally in naturally screened positions. All plant equipment would be adequately maintained to minimise noise emission. HGV traffic delivering and removing materials or plant to and from the site would access the works area via the most suitable route corridor.

<u>Operational Noise</u>

14.5.14 The significance criteria adopted for the purposes of this study have been described above in terms of the degree of traffic noise increase likely to cause significant effects. For the Forth Replacement Crossing, the use of mitigation would be considered, where practicable, at residential locations identified as being subject to significant effects (i.e. increases of 3dB or more). Figures 14.1 and 14.9 provide noise bands based on available traffic data, and indicate areas where noise levels may increase by 3dB or more and hence mitigation (such as noise barriers or false cuttings) may be appropriate.

14.5.15 The Stage 2 DMRB methodology requires that those options requiring ‘particularly extensive mitigation’ are identified.

14.5.16 Mitigation requirements have been based on the noise mitigation criteria defined earlier in the chapter, i.e. those residential areas where noise increases are 3dB or more, or that meet the criteria of the Noise Insulation (Scotland) Regulations. These estimates of mitigation requirement are based solely on areas meeting the criteria above with no consideration (at this stage) of other factors such as landscaping. The requirement for mitigation is based on the noise map predictions that take into account topography and actual traffic flow information, as this is considered to be more accurate than only using the separation distance between source and receptor (Table 14.3). The northern route corridor option requiring the most mitigation would be North Corridor Option 2 (potentially just over 1km of screening), although the requirement for North Corridor Option 1 would be only marginally less (potentially 1km of screening). The southern route corridor option requiring most mitigation would be South Corridor Option 2 (potentially 5km of screening), as compared with South Corridor Option 1 (potentially 3km of screening).

Residual Impacts & Effects

Construction Noise

14.5.17 The mitigation measures described above to control construction noise effects would ensure that disturbance from construction activities would be reduced at sensitive locations. Also, residents would be kept informed of the likely nature and duration of any disturbance in their area.

Operational Noise

14.5.18 A detailed noise mitigation plan has not been made as part of this Stage 2 assessment, hence it is not possible to precisely assess the residual effects. However, it can be assumed that in most locations, significant effects would be prevented. In some locations subject to large noise increases, the effects would be diminished although effects may still be rated as significant. It is also considered that the mitigation plan would be effective at reducing noise levels below 68dB(A) (NIR threshold) at most locations.

14.5.19 It should be noted that a detailed mitigation plan would be developed as part of the Stage 3 assessment.

Cumulative Impacts & Effects

14.5.20 The noise effects reported as part of this study of the Forth Replacement Crossing route corridor options could be potentially affected by other new noise sources within the study corridor that could not be considered as part of this assessment. For example this might include nearby highway alterations for other road schemes, airfields, industrial installations, or construction of buildings that could provide additional screening from the road. On the basis of information available at the time of this assessment, there appear to be no such major noise sources or construction projects which are of a scale that would be identified as having a cumulative noise effect when combined with the Forth Replacement Crossing.

14.5.21 Schemes that may be under construction at the same time as Forth Replacement Crossing are identified in Chapter 18 (Policies and Plans). The scheme known at this time as of potential relevance in the vicinity of the Forth Replacement Crossing is the anticipated redevelopment at Port Edgar on the southern side of the Firth of Forth, although this is likely to be of a relatively small scale.

14.5.22 It is possible, of course, that there would be proposals which are yet to be registered in the planning system that could result in localised noise effects due to the introduction of a new noise source or a screening structure.

14.6 Summary of Route Corridor Options Assessment

14.6.1 Noise and vibration effects have been considered for the construction works and the operation of the Forth Replacement Crossing. The range of construction noise levels has been approximated based on typical highway construction processes. The operational noise levels have been estimated using the appropriate noise prediction methodologies. The operational assessment has compared the ambient noise levels before opening (2017), against the design year noise levels (2032).

14.6.2 Comparing the construction noise effects estimated for the different route corridor options, it is considered that South Corridor Option 2 and North Corridor Option 2 would be marginally preferable to the alternatives with respect to construction noise effects.

14.6.3 For all of the construction processes, all reasonable measures would be taken to reduce noise impact during these operations to protect residential properties and other noise sensitive areas from excessive noise exposure. This would be achieved using best practicable means according to the relevant guidance. Those areas where significant effects have been estimated, or noise limits are likely to be exceeded, would be subject to particular attention.

14.6.4 Mitigation requirements have been based on the noise mitigation criteria defined earlier in the chapter, i.e. those residential areas where noise increases are 3dB or more, or that meet the criteria of the Noise Insulation (Scotland) Regulations.

Northern Route Corridor Options

14.6.5 North Corridor Option 2 would give rise to significant benefits northeast of Rosyth although there would be some significant adverse effects on the northwest edge of Inverkeithing. It would be expected that the noise increases could be mitigated to lessen the adverse effects. North Corridor Option 1 would give rise to very few adverse effects in residential areas although the noise benefits at Rosyth would be smaller.

14.6.6 Comparing the northern route corridor options, the overall balance of positive and negative noise effects is marginal. However, it may be considered preferable to avoid the potential for adverse effects at the northwest of Inverkeithing (despite the significant benefits elsewhere), in which case North Corridor Option 1 would be rated as preferable.

Southern Route Corridor Options

14.6.7 From the assessment of operational noise effects associated with the southern route corridor options, it is considered that South Corridor Option 2 is favourable in terms of overall noise effects. This is due to the diversion of traffic away from the A90 south of South Queensferry which would result in significant noise reductions to a large number of properties in this area. Conversely, the South Corridor Option 2 between the M9 and the A904 would result in large noise increases affecting a small number of rural properties. South Corridor Option 1 does not afford the same degree of noise reduction in South Queensferry, although the rural areas to the southwest of South Queensferry would remain unaffected.

14.6.8 On balance, South Corridor Option 2 is considered to have lower overall noise effects.

14.7 Scope of Stage 3 Assessment

14.7.1 The Stage 3 assessment will build upon the Stage 2 assessment but will use the latest version of DMRB published in August 2008 (The Highways Agency et al., 2008) and will include the following tasks:

- A baseline noise survey to establish ambient noise levels, particularly in areas not currently dominated by road traffic noise, where predicted baseline traffic noise levels may be less reliable.
- Dwelling façade noise calculations to 600m either side of the alignment for Do-Minimum and Do-Something conditions in the baseline and future years (2017 and 2032) will be undertaken; dwellings will be classified in 3dB noise exposure bands between 47.5 and 83.5dB(A). Tables will be produced showing the results of property counts in different noise change bands occurring between the following scenarios:

  a) Do-Minimum 2017 vs Do-Minimum 2032.

b) Do-Minimum 2017 vs Do-Something 2032.

- A qualitative assessment for dwellings and other sensitive receptors located between 600-2000m from the route.
- A simple assessment of the affected route (i.e 1dB change in opening year) within the study area that are outside the noise calculation area for Do-Minimum and Do-Something in 2017 and 2032.
- An assessment of the number of dwellings and other noise sensitive dwellings affected by temporary impacts will be made. Construction operations that may have a significant impact will be identified and appropriate mitigation proposed.

14.8 References

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15 Pedestrians, Cyclists, Equestrians and Community Effects

15.1 Introduction

15.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in terms of potential impacts on local communities and the journeys made by pedestrians, cyclists and equestrians. For ease of reference the terms 'pedestrians and others' and 'Non-Motorised Users' (NMUs) are used to describe this group. Impacts on local vehicular journeys are also considered where relevant.

15.1.2 In accordance with DMRB (The Highways Agency et al., 1993), the assessment of impacts on pedestrians and others focuses on three main aspects:

- changes in journey lengths and times;
- changes in the amenity value of journeys; and
- changes in links between communities and their facilities.

15.1.3 Paths used by pedestrians and others are important because they can provide:

- access to local countryside and more remote areas on foot, bike or horse;
- opportunities for long-distance travelling;
- safe, non-motorised access to shops, work and school; and
- opportunities to integrate access and land management.

15.1.4 The use of paths can help to improve health, reduce social exclusion, and unlike other modes of transport generally has few associated costs (i.e. fuel, travel tickets etc). A good path network can also encourage visitors to enjoy the outdoors and to visit places of landscape, historical and wildlife interest, therefore encouraging financial expenditure which supports the local rural economy. Well planned paths can potentially assist landowners and farmers to successfully integrate recreational use with land management operations.

15.1.5 In accordance with SNH guidance on EIA (SNH, 2006), an assessment specifically considering the impacts of the route corridor options on outdoor access has been undertaken and is included in this section. This draws on the findings of this DMRB assessment of impacts on NMUs and community access.

15.1.6 Impacts during construction are considered in Chapter 17 (Disruption Due to Construction).

Land Reform (Scotland) Act 2003

15.1.7 The Land Reform (Scotland) Act 2003 Part 1 came into effect in February 2005 and establishes statutory rights of responsible access on and over most land, including inland water. The legislation offers a general framework of responsible conduct for both those exercising rights of access and for landowners.

15.1.8 Local authorities are granted new powers and duties to uphold and facilitate responsible access rights. There is a duty on local authorities to prepare a plan for a path network and to keep a list of 'Core Paths' (paragraph 15.3.4). Sections 13 and 19 of the Act state: '*It is the duty of the local authority to assert, protect and keep open and free from obstruction or encroachment any route, waterway or other means by which access rights may reasonably be exercised*'; and '*The local authority may do anything which they consider appropriate for the purposes of maintaining a Core Path and keeping a Core Path free from obstruction or encroachment*'.

15.1.9 Section 10 of the Act states that it is the duty of SNH to draw up and issue a Scottish Outdoor Access Code which sets out guidance in relation to access rights and responsibilities. It is the duty of SNH and local authorities to publicise the Code and for SNH to promote understanding of it. The Scottish Outdoor Access Code was subsequently prepared by SNH and approved by the Scottish Parliament in July 2004.

15.2 Approach and Methods

15.2.1 The assessment of impacts on Pedestrians, Cyclists, Equestrians and Community effects has been undertaken taking into account guidance provided in DMRB Volume 11, Section 3, Part 8 (The Highways Agency et al., 1993) and SNH's Handbook on Environmental Impact Assessment (SNH, 2006).

Baseline Conditions

15.2.2 The study area for the assessment of impacts on NMUs extends beyond the general study area shown in Figure 5.1. This extension allowed inclusion of key community facilities accessed by paths which may be affected by the route corridor options. All baseline data are shown on Figures 15.1 to 15.5. Consideration of the wider area is particularly important in identifying potential community effects.

15.2.3 Baseline data have been collected through:

- Desk study including a review of Ordnance Survey Maps, Jacobs Arup GIS Database, relevant Local Plans and strategies, Core Path Plans, and a web based search to identify:
  i. existing and proposed paths (recreational and functional), and rights of way used by pedestrians, cyclists, equestrians;
  ii. key community facilities within and in close vicinity to the survey area, including doctors' surgeries, hospitals, schools, shops, post offices, churches, parks and sport centres;
  iii. community catchment areas represented by non-denominational primary school catchments (denominational primary school catchments are unlikely to represent the whole of the local community and are therefore not considered relevant);
  iv. outdoor access facilities as specified in Appendix 5, Table 2 of 'A Handbook on Environmental Impact Assessment' (SNH, 2006) – e.g. parks, National and Local Nature Reserves (NNRs and LNRs), local open spaces and reservoirs, and linear facilities e.g. paths, rights of way, cycleways; and
  v. bus routes / stops in the survey area.
- Consultation responses from City of Edinburgh Council, Fife Council, SNH, the Ramblers Association, Scotways, and Sustrans. A number of other bodies have been consulted but have not responded to date.
- Site survey of key community facilities and paths used by pedestrians and others.

Counts

15.2.4 DMRB guidance advises the use of origin/destination surveys where '…*travel patterns* [of pedestrian and other users] *are complex and a scheme could have a major impact*'. These surveys could include the use of 'counts'. Counts would be employed to provide information including numbers and types of user. For this assessment, the type of user has been determined from information provided in the local authority Core Path plans (adopted and draft) and site visits.

15.2.5 In Scotland, under the Land Reform (Scotland) Act 2003, '…*it is the duty of the local* *authority to assert, protect and keep open and free from obstruction or encroachme*nt any route, waterway or other means by which access rights may reasonably be exercised' (paragraphs 15.1.7 to 15.1.9). It is therefore considered that regardless of levels of use and types of user, all routes should be maintained and/or improved where practicable.

15.2.6 In addition to the Land Reform (Scotland) Act 2003, National Planning Policy Guideline (NPPG) 11 Sport, Physical Recreation and Open Space and Scottish Planning Policy (SPP) 17, Planning for Transport all aim to increase travel by NMUs and improve access even where usage levels are low.

15.2.7 Therefore for the purposes of this assessment it is considered that the use of counts will add little value, because all paths will be considered as being of equal importance, regardless of user type or levels of usage.

Impact Assessment

15.2.8 As specified by DMRB, the Stage 2 assessment objective is to assess the changes to NMU journeys within the survey area, and access to community facilities.

15.2.9 For each route corridor option, the number of paths to be affected by the operation of the Forth Replacement Crossing was reported. Changes to journeys made by pedestrians and others were described qualitatively, i.e. where there will either be an increase, decrease, or no change to journey lengths. Further detail on the degree of these changes will be identified as part of Stage 3 assessment.

15.2.10 Any changes in the amenity value and safety of paths were also considered. An assessment of amenity value includes any potential changes in air quality, traffic flows, noise levels and views from the path. The effects were described qualitatively for each route corridor option i.e. where there will be an increase, decrease, or no change in amenity value. Further detail on the degree of these changes will be provided for the Stage 3 assessment.

15.2.11 For the purposes of the Stage 2 assessment, potential impacts were considered to be either significant or not. Where a route corridor option would result in a change in journey length and/or amenity value, the potential impact on the paths is considered to be significant. Significance criteria will be defined in the Stage 3 assessment for the purposes of identifying level of impact significance.

15.2.12 The assessment on communities assesses the degree of potential severance experienced by the community i.e. the degree to which communities are separated from facilities and services they use within their community. Non–denominational primary school catchment areas are illustrated on Figures 15.5a-b to show indicative boundaries of the areas served by the local facilities. Using the assessment of the paths identified above, the effect on current journey patterns (including pedestrians and others, bus routes and local vehicles) to community facilities within these catchment areas was assessed. For each of the route corridor options, any potential relief from existing severance was also identified.

15.2.13 The objective of the outdoor access impact assessment (Appendix 5, SNH 2006) is to determine any likely significant effects on outdoor access features and sites. Access (the ability to make use of a site or path) and accessibility (ease with which access can be taken) will be considered using the changes and significance on linear and area based facilities identified in the DMRB assessment as outlined above.

Mitigation

15.2.14 Where impacts on paths are identified as significant (refer to paragraph 15.2.11 for criteria), it is considered that mitigation will be necessary in order to reduce the impact. Mitigation would be likely to include new overbridges and underbridges to maintain the path link across the route corridor option and the creation of new lengths of pathway to link existing paths and maintain access.

15.2.15 Due to the preliminary nature of the route corridor options design, details of minor crossings/junctions and proposed structures are not currently available. The assessment includes identification of locations where crossing points would be required in order to reduce impacts on NMUs.

Disability Discrimination Act (1995)

15.2.16 Under the Disability Discrimination Act (1995), it is unlawful for service providers to treat disabled people less favourably than they would treat other people, for a reason related to their disability, when offering public services and facilities, thereby including paths and trails. With reference to this assessment therefore, any access structures which could potentially be used in mitigation to maintain existing paths e.g. overbridges and underpasses, need to take into account potential barriers to disabled people such as gradient, verge width, radius of bends and surfacing.

Limitations to Assessment

15.2.17 It should be noted that the rights of way baseline data provided by Scotways/SNH was compiled in 1995 and was digitised at a scale of 1:50,000, which is less accurate than the scales used in this assessment (1:10,000 and 1:25,000). Scotways relies on members of the public and organisations to provide any information on possible amendments to their database. Updates are therefore infrequent and do not necessarily include all rights of way which are sometimes only locally known. In some instances rights of way are identified which are no longer usable pathways e.g. restricted by security fences or routed through buildings. However as they have not been formally extinguished or diverted, Scotways has requested these are still included within the assessment (Scotways, pers. comm.). For the rights of way to be shown as accurately as possible on the larger scale maps used in this assessment, some of the digitised path lines have been re-positioned to match with the OS base mapping in consultation with Scotways and using, where available, descriptions of the rights of way. Due to the poor scale of the digital data and infrequent updates the accuracy of the location of rights of way cannot be guaranteed.

15.2.18 Fife Council provided its proposed Core Path network baseline data in a GIS shapefile, which has been used for the purposes of this assessment and is shown on Figures 15.1 and 15.2. The Edinburgh Core Path Plan Final Draft (2008) and the West Lothian Draft Core Path Plan (2008) were used to determine the locations of Edinburgh and West Lothian Council's proposed Core Paths. During this assessment (in June 2008), City of Edinburgh Council adopted its Core Path Plan. As the other Core Path Plans are currently in draft and undergoing consultation, they may be subject to change.

15.2.19 Indicative community catchment areas have been identified using non-denominational primary school catchment area boundaries. These boundaries were provided by City of Edinburgh Council, West Lothian Council and Fife Council and digitised for the inclusion on figures by Jacobs Arup. It should be noted that the boundaries have been used as an indication of the likely 'catchment areas' i.e. areas which people will travel within local communities to access facilities. Catchment areas will be further refined at Stage 3 through consultation and site visits.

15.3 Baseline Conditions

Rights of Way

15.3.1 A public right of way is a defined route which has been used by the general public for at least 20 years and which links two public places (usually public roads). Rights of way have been recognised in Scots Law for centuries, i.e. common law. The time period of 20 years stems from the Prescription and Limitation (Scotland) Act 1973 s3(3). Rights of way vary from long hill routes (often historical drove or kirk roads) to local routes used for walking the dog or as short cuts to shops, schools and other local amenities.

15.3.2 ScotWays maintains the National Catalogue of Rights of Way (CROW), in partnership with SNH. In addition, many local authorities also have their own records. Access along rights of way are protected by the Countryside (Scotland) Act 1967 requiring the local authority to 'assert, protect and keep open and free from obstruction or encroachment any public rights of way', though diversions can be considered if the proposed diversion is deemed suitable by the planning authority.

15.3.3 The 24 rights of way listed in Table 15.1 are located in part or fully within the survey area and are illustrated on Figures 15.1 to 15.4.

Core Path Network

15.3.4 The local authorities responsible for access within the survey area are Fife Council, City of Edinburgh Council, and West Lothian Council. The City of Edinburgh Council Core Path Plan was adopted in June 2008, however, all other plans are currently in draft and are therefore referred to as the 'Proposed Core Path Network'. Local authorities have a duty to make the Core Paths Plan publicly available for inspection under the Land Reform (Scotland) Act 2003 (paragraphs 15.1.7 to 15.1.9).

15.3.5 Core Paths may include the following: rights of way; footpaths; tracks; cycle tracks; paths which are, or may be, covered by path agreements or path orders under the Land Reform (Scotland) Act Sections 20 and 21; waterways; or other means by which persons may cross land. The Core Path Plan will have regard to the likely usage and desirability of paths, and a balance with landowner interests. The majority of Core Paths are existing well-established paths, and the Core Paths system represents a basic 'backbone' of key paths throughout the local authority boundaries.

15.3.6 The 23 proposed Core Paths located in part or fully within the survey area are listed in Table 15.1 and illustrated on Figures 15.1 to 15.4. Where applicable, Core Paths are identified by reference numbers as assigned by the local authorities: CEC - City of Edinburgh Council; and WL - West Lothian Council. Fife Council's proposed Core Paths are not currently identified by reference numbers.

National Cycle Network

15.3.7 The National Cycle Network is a UK network of cycle routes, created by SUSTRANS. The routes are a combination of pedestrian routes, disused railways, minor roads, canal towpaths and traffic calmed routes; therefore, routes can also be designated as Core Paths or rights of way (Table 15.1). Sections of both National Cycle Routes (NCR) 1 and 76 fall within the survey area. The routes are described in Table 15.1 and shown on Figures 15.1 to 15.4.

Other Paths

15.3.8 Other local paths located within the survey area that are not designated rights of way, part of the Core Path network or cycleways are also listed in Table 15.1.

Table 15.1: Paths within Stage 2 Assessment Survey Area

Path Ref.	Type (including CROW or Core Path ref where applicable)	Users	Description	Community Link	Local Authority / Governing Body
A	NCR 1	Cyclists	Traffic-free shared use roadside path along the A90 from the Forth Road Bridge to Inverkeithing.	North Queensferry / Forth Road Bridge to Inverkeithing	Sustrans / Fife Council
A1	NCR 1	Cyclists	On road cycleway through Inverkeithing.	To / From Inverkeithing	Sustrans / Fife Council
A2	NCR 1	Cyclists	On road (B981 and Masterton Road) cycleway from Inverkeithing to Pitreavie.	Inverkeithing to Pitreavie, Dunfermline	Sustrans / Fife Council
B	Core Path	Pedestrians, Cyclists	Roadside path along the B981 linking North Queensferry to Rosyth and Forth Road Bridge.	North Queensferry to Forth Road Bridge and Rosyth	Fife Council
C	Core Path; Right of Way (FD89)	Pedestrians	Ferry Loch Route along track, from A90 to North Queensferry coastal path (F). Part of Ferry Loch Route Core Path, along path from A90 to Brock Street, North Queensferry.	n/a	Fife Council
D	Core Path	Pedestrians, Cyclists	Path through St. Margaret's Marsh.	n/a	Fife Council
E	NCR 76	Cyclists	On road cycleway from Rosyth Dock, linking with National Cycle Route 1.	n/a – Round the Forth route.	Sustrans / Fife Council
F	Core Path; Right of Way (FD183 and FD180)	Pedestrians, Cyclists	Coastal path linking North Queensferry to Hope St, Inverkeithing.	North Queensferry to Inverkeithing	Fife Council
G	Core Path; Right of Way (FD179)	Pedestrians, Cyclists	Caldwells Mill route along Hope Street linking the coastal path (F) with Inverkeithing.	North Queensferry to Inverkeithing	Fife Council
H	Right of Way (FD88)	Pedestrians	Track from Ferry Toll Place, running west to east, to the north of Castlandhill Woods, to meet the B980.	n/a	Fife Council
I	Core Path; Right of Way (FD87)	Pedestrians, Cyclists, Equestrians	Route through Castlandhill, from Ferry Toll Road to the B980.	n/a	Fife Council
J	Core Path	Pedestrians, Cyclists	Quiet access Castlandhill Link route along Dunfermline Wynd between Castleandhill (from I) and Inverkeithing.	Castleandhill to Inverkeithing	Fife Council
K	Core Path	Pedestrians, Cyclists, Equestrians	Quiet access Inverkeithing Reservoir Links Route from Dunfermline Wynd to Chapel Place.	Inverkeithing	Fife Council
L	Core Path	Pedestrians	Roadside path along urban Rosyth streets linking with Inverkeithing Reservoir Links Route (K).	Rosyth to Inverkeithing	Fife Council

Path Ref.	Type (including CROW or Core Path ref where applicable)	Users	Description	Community Link	Local Authority / Governing Body
M	Other path	Pedestrians, Cyclists	Traffic-free shared use roadside path along A921 linking NCR 1 with Rosyth.	Inverkeithing to Rosyth	Fife Council
N	Other path	Pedestrians, Cyclists	On road cycleway and roadside footway to Harley Street and traffic-free shared use path through Rosyth to Parkgate along the south side of recreation ground.	Inverkeithing to Rosyth	Fife Council
O	Core Path	Pedestrians (incl. vulnerable), Cyclists, Equestrians	Rosyth to Pitreavie link path from the Wilderness open space to Castle Brae and Carnegie Avenue, crossing the A823 on an overbridge.	Rosyth to Pitreavie, Dunfermline	Fife Council
P	Right of Way (FD163)	Pedestrians	Rural track from Masterton Road to the B916 linking path A2 with Q.	n/a	Fife Council
Q	Core Path	Pedestrians, Cyclists	Traffic-free shared use roadside path along B916 from Dunfermline to Fordell with links to Inverkeithing and Dalgety Bay.	Dunfermline to Fordell, Inverkeithing & Dalgety Bay	Fife Council
R	Core Path	Pedestrians (incl. vulnerable), Cyclists, Equestrians	Traffic-free shared use path from Fordell to Hillend.	Fordell to Hillend	Fife Council
S	Right of Way (FD168)	Pedestrians	Overgrown path running alongside a tributary to the Keithing Burn.	n/a	Fife Council
T	Core Path	Pedestrians (incl. vulnerable), Cyclists, Equestrians	Quiet access route along track from Calaisburn Cotts to M90, linking to North Duloch Loop (U) and Fordell Circuit.	n/a	Fife Council
U	Core Path; Right of Way (FD84)	Pedestrians (incl. vulnerable), Cyclists, Equestrians	North Duloch Loop off-road track from B916 to North Duloch.	n/a	Fife Council
V	Core Path; Right of Way (FD82 and FD83)	Pedestrians (incl. vulnerable), Cyclists, Equestrians	Traffic-free shared use path from Gipsy Lane, Dunfermline, north of Calais Muir Wood, to North Duloch, linking with the North Duloch Loop route (U).	n/a	Fife Council
W	Core Path	Pedestrians, Cyclists	Traffic-free shared use roadside path along Sandpiper Drive.	Dunfermline	Fife Council
XA	Core Path; NCR 1	Pedestrians (including vulnerable), Cyclists	Traffic free shared use roadside path crossing the Forth Road Bridge, part of NCR1.	Lothian to Fife and beyond	Fife Council / City of Edinburgh Council / Sustrans
X	Core Path (Part of CEC10); NCR 1	Pedestrians (incl. vulnerable), Cyclists	Part of Newbridge to South Queensferry and Kirkliston Core Path. Traffic free shared use roadside path along the A90 from the Forth Road Bridge, via subway to Ferrymuir Gait, part of NCR1.	Forth Road Bridge to South Queensferry	City of Edinburgh Council / Sustrans
X1	Core Path (Part of CEC10); NCR 1	Pedestrians (incl. vulnerable), Cyclists	Part of Newbridge to South Queensferry and Kirkliston Core Path. Off road path from Ferrymuir Gait to Viewforth Road with access to Queensferry High School, then roadside path along Roseberry Avenue, part of NCR1.	South Queensferry	City of Edinburgh Council / Sustrans

Path Ref.	Type (including CROW or Core Path ref where applicable)	Users	Description	Community Link	Local Authority / Governing Body
X2	Core Path (Part of CEC10); NCR 1	Pedestrians (including vulnerable), Cyclists	Part of Newbridge to South Queensferry and Kirkliston Core Path. On road cycleway and roadside footpath from South Queensferry to Wester Dalmeny, part of NCR1.	South Queensferry to Wester Dalmeny	City of Edinburgh Council / Sustrans
Y	Core Path (Part of CEC 6 and WL34); NCR 76	Pedestrians (incl. vulnerable), Cyclists, Equestrians	On road Firth of Forth route along Society Road and Hopetoun Road, forming part of the NCR76, from Hopetoun to South Queensferry, linking with the Newbridge to South Queensferry Core Path.	Hopetoun to South Queensferry	City of Edinburgh Council / West Lothian Council / Sustrans
Y1	Core Path (Part of CEC 6); NCR 76	Pedestrians (incl. vulnerable), Cyclists, Equestrians	On road Firth of Forth route through South Queensferry along Hopetoun Road and High Street to the coastline path under the Forth Rail Bridge.	South Queensferry	City of Edinburgh Council / Sustrans
Z	Core Path (Part of CEC10); Right of Way (LC118); NCR 76	Pedestrians (incl. vulnerable), Cyclists, Equestrians	Part of Newbridge to South Queensferry and Kirkliston Core Path. Off road path follows a disused railway line through South Queensferry to Dalmeny which forms part of NCR76 to Edinburgh.	South Queensferry to Wester Dalmeny	City of Edinburgh Council / Sustrans
Z1	Core Path (Part of CEC10); Right of Way (Part of LC114)	Pedestrians (incl. vulnerable), Cyclists, Equestrians	Part of Newbridge to South Queensferry and Kirkliston Core Path. Off road path follows a disused railway line from Dalmeny to Kirkliston.	Dalmeny to Kirkliston	City of Edinburgh Council
Z2	Core Path (Part of CEC10 and WL11)	Pedestrians (incl. vulnerable), Cyclists, Equestrians	Part of Newbridge to South Queensferry and Kirkliston and Winchburgh to Kirkliston Core Paths. Roadside path from the east of Kirkliston along B9080 to Winchburgh.	Kirkliston to Winchburgh	City of Edinburgh Council / West Lothian Council
AA	Right of Way (Part of LC114)	Pedestrians	Shared use rough track from Standingstane Road to Dolphington Cottages.	n/a	City of Edinburgh Council
AB	Right of Way (LC116)	Pedestrians	Rough track from Dolphington Cottages to Easter Dalmeny.	n/a	City of Edinburgh Council
AC	Core Path (Part of CEC 11); Right of Way (Part of LC130)	Pedestrians	Path alongside the River Almond.	n/a	City of Edinburgh Council
AD	Right of Way (LC117)	Pedestrians	Path via Scotstoun Avenue, South Queensferry, through Lovers Lane to Kirkliston Road.	South Queensferry	City of Edinburgh Council
AE	Right of Way (LW2)	Pedestrians	Path from Linn Mill to the north of Hedrig Hill Factory.	n/a	West Lothian Council
AF	Right of Way (LW8)	Pedestrians, Cyclists	Track from Icehouse Hill to Duddingston and Newton.	n/a	West Lothian Council
AG	Other Path	Cyclists, Equestrians	Minor road to the west of Westmuir Riding Centre.	n/a	City of Edinburgh Council
AH	Right of Way (LW16)	Pedestrians	Footpath from South Niddry Castle to Hawk Hill Wood.	n/a	West Lothian Council

Path Ref.	Type (including CROW or Core Path ref where applicable)	Users	Description	Community Link	Local Authority / Governing Body
AI	Right of Way (LW10)	Pedestrians, Cyclists, Equestrians	Path from Newton to Swineburn Woods and south linking to Core Path Z2.	n/a	West Lothian Council
AJ	Other Path	Pedestrians	Track through fields from Duntarvie to Myre.	n/a	West Lothian Council
AK	Core Path (Part of WL2b); Right of Way (LW18)	Pedestrians, Cyclists	Part of tow path alongside the Union Canal.	Philipstoun to Winchburgh to Edinburgh	West Lothian Council
AL	Right of Way (LW13)	Pedestrians	Footpath along Swineburn from Winchburgh Road to the Union Canal.	n/a	West Lothian Council
AM	Right of Way (LW10)	Pedestrians	Footpath linking Dalmeny train station to Core Path along Firth of Forth coastline (Y1).	South Queensferry	City of Edinburgh Council
AN	Core Path (Part of CEC 9); NCR 1	Pedestrians, Cyclists	Part of South Queensferry to Craigleith Core Path. On road route along the B924 from South Queensferry to Craigleith, Edinburgh. NCR 1 follows part of this route from Dalmeny to Craigleith, Edinburgh.	South Queensferry to Craigleith, Edinburgh. Dalmeny to Craigleith, Edinburgh.	City of Edinburgh Council
AO	Right of Way (LW12)	Pedestrians	Footpath linking Niddry Mains to Winchburgh Road.	n/a	West Lothian Council
AP	Right of Way (LW15)	Pedestrians	Footpath from Hawk Hill Wood to Ross's Plantation.	n/a	West Lothian Council
AQ	Right of Way (LW14)	Pedestrians	Footpath from Hawk Hill Wood to Ross's Plantation.	n/a	West Lothian Council

Community Facilities

15.3.9 Tables 15.2 and 15.3 list the key community facilities north and south of the Firth of Forth, respectively. Facilities listed include all that are accessed by the identified paths (Table 15.1), located within the study area. All identified community facilities and the indicative community catchment areas are shown on Figures 15.1 to 15.5. Facility types include doctors' surgeries, hospitals, schools, shops, post offices, churches, parks and leisure centres.

Local Communities – Northern Study Area

15.3.10 The indicative community catchment areas to the north of the Firth of Forth are shown on Figure 15.5a. The existing A90/M90 appears to define the boundaries of some of these catchment areas with most located areas either wholly east or west of the road. Only North Queensferry and Park Road primary school catchments have areas to the east and west of the M90.

Table 15.2: Community Facilities - Northern Study Area

Community Facility Type	Community							
	Crossgates	Dalgety Bay	Dunfermline (East)	Halbeath	Hillend	Inverkeithing	North Queensferry	Rosyth
Church						✓✓✓✓		✓✓✓✓
Civic Centre						✓		
College				✓				
Community Centre			✓✓✓✓			✓✓	✓	✓
Community Leisure Centre	✓		✓✓✓	✓				✓
Doctors	✓					✓		✓✓
Fire Station								✓
Golf Course			✓					
Hospital			✓	✓				
Leisure Park				✓				
Library	✓		✓			✓		✓
Police Station								✓
Post Office	✓		✓	✓	✓			✓✓
Public Park								✓
Retail Park				✓				
School – Primary	✓		✓✓✓✓ ✓✓✓			✓	✓	✓✓✓
School – Secondary			✓			✓		
Train Station		✓	✓✓			✓	✓	✓

Local Communities – Southern Study Area

15.3.11 The indicative community catchment areas to the south of the Firth of Forth are shown on Figure 15.5b.

Table 15.3: Community Facilities - Southern Study Area

Community Facility Type	Community						
	Dalmeny	Dundas	Kirkliston	Newton	South Queensferry	Westmuir	Winchburgh
Church	✓		✓		✓✓✓		✓✓
Community Centre				✓	✓✓		
Community Leisure Centre					✓		
Doctors			✓		✓		✓
Golf Course		✓					
Fire Station					✓		
Library			✓		✓		
Nursery			✓				
Post Office	✓		✓	✓	✓		✓
Police Station					✓		
Public Park			✓✓		✓✓✓✓ ✓✓		
Riding Centre						✓	
School – Primary	✓		✓		✓✓		✓
School – Secondary					✓		
Train Station	✓						

Public Transport

Public Bus Services

15.3.12 Within the survey area there are a number of services that provide access to the local shops and facilities within the main urban centres as well as to surrounding towns and villages. These include important links to key facilities such as Queen Margaret Hospital, Western General Hospital, Edinburgh Airport, Fife Leisure Park, higher education colleges, and park and ride facilities. A high proportion of these bus services travel across the Forth Road Bridge. A summary of the key public transport services within the survey area are listed in Table 15.4.

Table 15.4: Key Bus Services within the Study Area

Community Link	Bus No.	Route	Service Provider
Dalgety Bay – Edinburgh	53	Via Inverkeithing Square, Forth Road Bridge, Ferrytoll Park & Ride, Barton Queensferry Road.	Stagecoach
Dalgety Bay/ Dunfermline – Edinburgh	X50	Via Rosyth, Inverkeithing, Ferrytoll Park & Ride, Forth Road Bridge, Barnton Hotel, Telford College.	Stagecoach
Dunfermline – Dalgety Bay	80	Tesco (Duloch), Calais Muir Estate.	Stagecoach
Dunfermline – Edinburgh	55	Via Rosyth, Inverkeithing, Ferrytoll Park & Ride, Forth Road Bridge.	Stagecoach
	154	Via Duloch Park (Tesco), Rosyth, Inverkeithing, Forth Road Bridge.	Stagecoach
Dunfermline – Glenrothes	30	Via Dunfermline, Queen Margaret Hospital, Fife Leisure Park.	Stagecoach
Dunfermline – Inverkeithing	71	Via Rosyth, Ferrytoll Park & Ride.	Stagecoach
Dunfermline – Kirkcaldy	133	Via Halbeath, Fife Leisure Park, Crossgates.	Stagecoach
Dunfermline – Leven	7	Via Rosyth, Castleandhill Road, Inverkeithing.	Stagecoach
Dunfermline – Queen Margaret Hospital	D8	Via Duloch Park (Tesco).	Stagecoach
	15	Via Halbeath, Fife Leisure Park.	Stagecoach
Edinburgh – Dundee	n/a	Via Forth Road Bridge, Ferry Toll Park & Ride, Dunfermline (Lauder College).	City Link
Edinburgh – Falkirk	44N	Via Kirkliston, Winchburgh, Linlithgow, Bo'ness, Grangemouth.	First
Glasgow – Dunfermline	126	Fife Leisure Park, Dunfermline Fire Station.	Stagecoach
Inverkeithing – Dalgety Bay	83	Inverkeithing and Dalgety Bay rail stations.	Stagecoach
Inverkeithing – Edinburgh Airport	747	Ferrytoll Park & Ride, Forth Road Bridge.	Stagecoach
Kelty – Dalgety Bay	79/79A	Via Dunfermline, Rosyth, Inverkeithing.	Stagecoach
Kirkcaldy – Dunfermline	33	Via Hill of Beath School, Halbeath, Queen Margaret Hospital.	Stagecoach
Kirkcaldy – Edinburgh	159	Inverkeithing, Forth Road Bridge.	Stagecoach
South Queensferry – Bathgate	474	Via Newton, Linlithgow.	Davidson Buses
South Queensferry – Edinburgh	43	Via Dalmeny, Newton.	First
	X43	Via Dalmeny, Newton (Limited Stop).	First
	X4	Via Barnton, Newton (Limited Stop).	First
South Queensferry – Fauldhouse	6	Via Kirkliston, Winchburgh, Broxburn, Livingston.	First
South Queensferry – Gyle Shopping Centre	63	Via Newton, Kirkliston, Newbridge - Ratho.	Waverley Travel
Rosyth – Balingry	19	Via Dunfermline bus depot, Halbeath.	Stagecoach
St Andrews – Edinburgh	X58, X59 X60	Via Barnton Queensferry Road, Ferrytoll Park and Ride, Forth Road Bridge.	Stagecoach
St Andrews – Glasgow	X26/X27	Via Dunfermline, Halbeath (Carnegie College).	Stagecoach
Stirling – Edinburgh	38, 38A	Via Falkirk, Linlithgow, Winchburgh, Kirkliston.	First
Townhill – North Queensferry	D7	Via Duloch Park (Tesco), Calais Muir Estate, Fife Leisure Park, Hillend, Masterton Rd, Castle Brae, Rosyth, Inverkeithing (Rail Station), Ferry Toll, North Queensferry.	Stagecoach

Public Rail Services

15.3.13 Within the survey area there are a number of rail services connecting Edinburgh to Fife and beyond:

- The East Coast Main Line provides services between the North East of Scotland and London, via Edinburgh and Fife.
- The Strathclyde North East Line passes through the southern part of the survey area linking Edinburgh to Stirling.
- The Fife Circle Line links the Fife towns within the survey area (Dalmeny, North Queensferry, Rosyth and Inverkeithing) to Edinburgh.

15.3.14 The location of the railway stations within the survey area are shown on Figures 15.1 to 15.4.

Outdoor Access Facilities

15.3.15 The key outdoor access facilities located within the survey area and surrounding communities (Figures 15.1 to 15.4) are as follows:

- Area based facilities:
  - i. All public parks as identified in Tables 15.2 and 15.3.
  - ii. Inland waterbodies including Ferry Loch at North Queensferry and Humbie Reservoir.
  - iii. Woodlands including Calais Muir Wood, Fordell Firs, Fairy Kirk Wood, Castlandhill Wood, St Margaret's Wood, East Shore Wood, Swineburn Wood, Muiriehall Wood, and Ross's Plantation.
  - iv. St Margaret's Marsh on the northern shore of Firth of Forth.
  - v. Other community land as identified in Chapter 6 (Land Use).
- Linear access facilities:
  - i. All rights of way as identified in Table 15.1.
  - ii. All Core Paths as identified in Table 15.1.
  - iii. National Cycle Routes 1 and 76 as identified in Table 15.1.
  - iv. All other paths as identified in Table 15.1.
  - v. River Almond.
  - vi. Union Canal.

15.4 Potential Impacts

15.4.1 Potential impacts of the route corridor options on pedestrians, cyclists, equestrians and communities are described in this section. It should be noted that potential impacts identified are prior to the implementation of mitigation. Impacts on paths and links to communities can be reduced through the provision of suitable mitigation measures as outlined in Section 15.5 (Potential Mitigation).

Proposed Replacement Bridge

15.4.2 As indicated in the baseline section (Table 15.1), path XA provides a traffic free link across the Forth Road Bridge for pedestrians and cyclists. Current proposals are for the proposed replacement bridge to be multi-modal and incorporate provisions for public transport and NMUs. Although the Forth Road Bridge would be closed to motorised vehicles, it is assumed that it would not be demolished and would remain available for use by NMUs. Therefore by incorporating suitable provision for NMUs, the proposed replacement bridge would offer an alternative and additional crossing and provide significant benefits for pedestrians and others.

15.4.3 The diversion of road traffic onto the proposed replacement bridge could potentially have an impact on links between settlements to the north and south of the Firth of Forth. However, all bus services across the Firth of Forth are anticipated to be maintained and therefore no significant new severance from any changes to transport links between communities is anticipated.

Northern Route Corridor Options

Impacts Common to Both Northern Route Corridor Options

Paths (Existing Crossing Points)

15.4.4 On the northern side of the Firth of Forth, the existing A90/M90 crosses NMU paths which are maintained through the provision of overbridges/underbridges. Some sections of North Corridor Option 1 and North Corridor Option 2 follow the existing alignment of the A90/M90 and would therefore cross the NMU paths in the same manner as the existing A90/M90. The two locations at which both northern route corridor options would cross NMU paths at existing crossing points are shown on Figures 15.1 and 15.2 and the paths identified in Table 15.5. It is assumed that the road improvements along these stretches would incorporate the existing crossing points and no permanent diversions would be necessary. In which case, impacts on journey length and amenity value of these paths are assessed as not being significant.

Table 15.5: Existing Crossing Points of NMU Paths Assumed to be Maintained by Both Northern Route Corridor Options

Path Ref.	Path Type	Existing Crossing	Change in Journey Length	Change in Amenity Value	Significant
E	NCR 76	The existing B981 underbridge will be maintained linking NCR 76 with NCR 1.	None	None	No
Q	Core Path	The existing B916 overbridge will be maintained.	None	None	No

Paths (New Conflicts)

15.4.5 Paths B and D would be affected by both northern route corridor options, although the two route corridor options would affect the NMU paths to differing degrees. The potential impacts on these paths are therefore described separately in Tables 15.7 and 15.8 below. These tables discuss all potential impacts of any new conflicts with NMU paths resulting from the northern route corridor options.

Community Severance (Relief from Existing Severance)

15.4.6 To the north of the Firth of Forth, communities are currently separated by the A90/M90 creating a north-south divide along the carriageway alignment. Rosyth and Dunfermline are located to the west, and Inverkeithing and North Queensferry to the east of the road. The northern route corridor options are proposed within a similar corridor to the existing A90/M90 (trending broadly north-south) and therefore it is unlikely that any relief from existing severance would result.

Community Severance (New Severance)

15.4.7 To the north of the Firth of Forth, neither of the route corridor options would directly sever any communities nor result in the loss of any community facilities. However, both route corridor options would impact on path linkages between settlements, and without mitigation, some new community severance may result where several paths which access community facilities are severed.

15.4.8 There are a number of bus services that cross existing junctions of the M90. Bus services 7, X50, 55, 71, 79, 79A, 154 and D7 provide public transport connections to community facilities between settlements located to the east and west of the M90 such as Rosyth, Inverkeithing and Dunfermline. However, vehicle access across the M90 is expected to be maintained by both route corridor options and therefore no significant new severance on bus links is anticipated in this area.

15.4.9 Both northern route corridor options would cross the railway line at the Inverkeithing Junction, although, it is anticipated that the new road would be routed over the line. None of the railway stations would be affected by either northern route corridor option since no new severance of the communities would result. Neither northern route corridor option would therefore directly affect the railway line or its services.

Outdoor Access

15.4.10 North of the Firth of Forth, the accessibility to public parks, woodlands and Ferry Loch is likely to be reduced without mitigation. Where pathways would be severed, pedestrians and others would have to choose alternative routes on existing paths to access facilities. For both northern route corridor options, access would still be possible to St Margaret's Marsh and St Margaret's Wood as the new road would be raised on viaduct over this area.

<u>North Corridor Option 1</u>

Paths (Existing Crossing Points)

15.4.11 In addition to the two existing crossing points identified in Table 15.5, North Corridor Option 1 would cross four further NMU paths in the same manner as the existing A90/M90, as shown on Figure 15.1 and identified in Table 15.6. It is assumed that the road improvements along these stretches would incorporate the existing crossing points and no permanent diversions would be necessary. In which case, impacts on journey length and amenity value of these paths are assessed as not being significant.

Table 15.6: Existing Crossing Points of NMU Paths Assumed to be Maintained by North Corridor Option 1

Path Ref.	Path Type	Existing Crossing	Change in Journey Length	Change in Amenity Value	Significant
A2	NCR 1	The existing Masterton Road overbridge will be maintained and allow for the new slip road of North Corridor Option 1 to the Masterton Junction to be routed beneath the cycle route.	None	None	No
J	Core Path	The existing Dunfermline Wynd overbridge will be maintained.	None	None	No
L	Core Path	The existing A921 underbridge will be maintained.	None	None	No
M	Footpath / Cycleway	The existing A921 underbridge will be maintained.	None	None	No

Paths (New Conflicts)

15.4.12 Table 15.7 details the potential impacts which would result on NMU paths from North Corridor Option 1. In the absence of mitigation significant impacts would potentially result on two Core Paths (B and D) and part of NCR 1. Two rights of way (H and I) are located in close vicinity to the west of North Corridor Option 1 and it is assumed access to these would be unaffected by the route corridor option.

Table 15.7: Potential Impacts of North Corridor Option 1 on NMU Paths

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
A	NCR 1	Path may be impacted by the new slip road to North Corridor Option 1 and improvement works to the existing A90 link with the B981 to Inverkeithing. The cycle route will be maintained through the provision of a slip road to the B981.	None	None	No
A2	NCR 1	The on-road section of the National Cycle Route would be severed by the Masterton Junction slip road of North Corridor Option 1. Without mitigation, cyclists would probably divert via the A985 to the south. The amenity value would be lower due to the decreased safety resulting from being on a busier road route.	Increase	Decrease	Yes
B	Core Path	Path would be severed by North Corridor Option 1 and the slip road leading from the Forth Road Bridge to North Corridor Option 1. Without mitigation, NMUs would probably divert via Core Paths C and F. The amenity value of this alternative route is likely to be higher than the existing route due to improved air quality and increased safety as a result of being away from the A90.	Increase	Increase	Yes
D	Core Path	The eastern section of the recreational path, which currently links with path B, is crossed by North Corridor Option 1 on viaduct. It is assumed that this path can be retained underneath the viaduct structure. The amenity value would be lower due to the visual impact of the proposed replacement bridge.	None	Decrease	Yes
H	Right of Way	Path is located in close vicinity to the west of the proposed North Corridor Option 1. The amenity value is unlikely to be affected as the path is in close proximity to the A90/M90.	None	None	No
I	Right of Way / Core Path	Path is located in close vicinity to the west of the proposed North Corridor Option 1. The amenity value is unlikely to be affected as the path is in close proximity to the A90/M90.	None	None	No

Community Severance

15.4.13 For North Corridor Option 1, only one community link between Rosyth and North Queensferry would be severed. Without mitigation, NMUs would need to choose an alternative route and divert via existing paths to maintain access between these communities. The online alignment of North Corridor Option 1 will not create any new severance of community catchment areas as indicated on Figure 15.5a.

Outdoor Access

15.4.14 North Corridor Option 1 would potentially sever one Core Path and NCR1. Without mitigation this route corridor option could prevent some access to the outdoors, and significantly impact the continued use of NCR1.

North Corridor Option 2

Paths (Existing Crossing Points)

15.4.15 Existing crossing points which would be crossed by North Corridor Option 2 are discussed in paragraph 15.4.4 and identified in Table 15.5.

Paths (New Conflicts)

15.4.16 Table 15.8 details the potential impacts which would result on NMU paths from North Corridor Option 2 in the absence of mitigation. Significant impacts would potentially result on seven pathways, including the National Cycle Network Route 1 at two locations (A and A2), two rights of way (H and I) and four Core Paths (B, D, I and L).

Table 15.8: Potential Impacts of North Corridor Option 2 on NMU Paths

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
A	NCR 1	Path would be severed by the new slip road leading to the existing A90 and B981 to Inverkeithing. Without mitigation, cyclists would probably divert via Core Paths B and F. The amenity value of this alternative route is likely to be higher than the existing route due to improved air quality and safety resulting from being away from the A90.	Increase	Increase	Yes
A2	NCR 1	The on-road section of the National Cycle Route would be severed by North Corridor Option 2. Without mitigation, cyclists would probably divert via the B981 to the north. The amenity value would be lower due to the decreased safety resulting from being on a busier road route.	Increase	Decrease	Yes
B	Core Path	Path would be severed by North Corridor Option 2. A greater length of path B would be affected by North Corridor Option 2 than by North Corridor Option 1. Without mitigation, NMUs would probably divert via Core Paths C and F. The amenity value of this alternative route is likely to be higher than the existing route due to improved air quality and safety resulting from being away from the A90.	Increase	Increase	Yes
D	Core Path	The eastern section of the recreational path, which currently links with path B, is crossed by North Corridor Option 2 on viaduct. It is assumed that this path can be retained underneath the viaduct structure, although the length of path which would be crossed is greater than for North Corridor Option 1. The amenity value would be lower due to the visual impact of the proposed replacement bridge.	None	Decrease	Yes
H	Right of Way	This recreational path would be severed by North Corridor Option 2. No alternative	Decrease	Decrease	Yes

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
		route would be possible. The amenity value would be lower due to the visual impact of the proposed replacement bridge and road infrastructure.			
I	Right of Way / Core Path	Path would be severed by North Corridor Option 2. Without mitigation NMUs would probably divert via Ferry Toll Road to connect with the Core Path network to the east of the A90. The amenity value would be lower due to the visual impact of the proposed replacement bridge and road infrastructure.	Increase	Decrease	Yes
L	Core Path	Path would be severed by North Corridor Option 2. Without mitigation NMUs would probably divert via the B980 to the south to maintain links with the Core Path network. The amenity value would be lower due to the visual impact of the road infrastructure.	Increase	Decrease	Yes
M	Footpath / Cycleway	Path along the A985 would be severed by North Corridor Option 2. Without mitigation NMUs would probably divert north via the B981 or south via the B980. The amenity value would be lower due to the decreased safety resulting from the on-road sections of the proposed diversion route.	Increase	Decrease	Yes

Community Severance

15.4.17 North Corridor Option 2 would impact on access between communities by severing one link between Rosyth and North Queensferry, two links between Rosyth and Inverkeithing and one link between Inverkeithing and Dunfermline. Without mitigation, NMUs would need to choose alternative routes and divert via existing paths to maintain access between these communities. North Corridor Option 2 follows the boundaries between indicative community catchment areas and therefore no new severance is anticipated.

Outdoor Access

15.4.18 Impacts on access to outdoor facilities to the north of the Firth of Forth would be most significant for North Corridor Option 2, due to the potential severance of seven pathways, including NCR1 at two locations, two rights of way and three Core Paths. As a result of some of these severed pathways, it is likely that access would be restricted to public parks, woodlands (including Castlandhill Wood) and Ferry Loch without appropriate mitigation provision. A reduction in amenity of paths and sites is also likely for North Corridor Option 2.

Southern Route Corridor Options

<u>Impacts Common to Both Southern Route Corridor Options</u>

Paths (Existing Conflicts)

15.4.19 On the southern side of the Firth of Forth, the existing M8 and M9 spur crosses the Core Path Z2 at two locations, and access is maintained through the provision of two overbridges. Both southern route corridor options would cross the Core Path in the same manner as the existing M8 and M9 spur, as shown on Figures 15.3 and 15.4 and identified in Table 15.9. It is assumed that the road improvements along these stretches would incorporate the existing crossing points and no permanent diversions would be necessary. In which case, impacts on journey length and amenity value of this path are assessed as not being significant.

Table 15.9: Existing Crossing Points of NMU Paths Assumed to be Maintained by Both Southern Route Corridor Options

Path Ref.	Path Type	Existing Crossing	Change in Journey Length	Change in Amenity Value	Significant
Z2	Core Path	The existing M8 overbridge will be maintained.	None	None	No
Z2	Core Path	The existing M9 spur overbridge will be maintained.	None	None	No

Paths (New Conflicts)

15.4.20 On the southern side of the Firth of Forth, one Core Path (Y) and NCR 76 would be crossed by both southern route corridor options on viaduct. It is assumed that these paths can be retained beneath the new structure. However, the proximity of this Core Path to the route corridor options would likely reduce the amenity value. Similarly, the right of way (AE) which links to Core Path Y would likely experience a decrease in amenity value. Table 15.10 details potential impacts on paths Y and AE.

Table 15.10: Potential Impacts Common to Both Southern Route Corridor Options

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
Y	Core Path / NCR 76	Path assumed to be retained by both route corridor options below the new road viaduct. Potential changes in scenery, accessibility and safety.	None	Decrease	Yes
AE	Right of Way	Path is located in close vicinity to the west of the southern route corridor options. Proximity of the road is likely to lead to a decrease in amenity.	None	Decrease	Yes

Community Severance (Relief from Existing Severance)

15.4.21 To the south of the Firth of Forth, both route corridor options would divert vehicular traffic away from South Queensferry to its western periphery, reducing traffic volumes along this section of the A90 and removing vehicular traffic from the Forth Road Bridge. This would provide significant benefits for pedestrians and cyclists using NCR1 and the proposed Core Path network in the South Queensferry area. Some relief from existing severance in the community of South Queensferry may result from lower traffic volumes.

Community Severance (New Severance)

15.4.22 To the south of the Firth of Forth, neither of the route corridor options would directly sever the heart of any communities nor result in the loss of any community facilities. It should however be noted that both South Corridor Options 1 and 2 would create a divide between houses located at Linn Mill, on the western margin of South Queensferry, and the core of South Queensferry where the majority of its community facilities are located. Linkages between Linn Mill to the west of the route corridor options and South Queensferry to the east of the route corridor options would be maintained along paths AE and Y (beneath the proposed viaduct) and therefore the severance impact is considered to be negligible.

15.4.23 Both South Corridor Options 1 and 2 would impact on the Core Path (Z2) link between Winchburgh and Kirkliston, which follows a minor road (B9080). Without mitigation, changes in journey length along this path would lead to adverse impacts on pedestrians and others accessing these areas, and some new community severance may result for these communities. Bus services 6, 38, 38A, 44N, 63 also provide important public transport links along the B9080. However, this path (Z2) is already crossed twice by the M8 and provision for NMUs is provided by two overbridges. Assuming the Forth Replacement Crossing design maintains the B9080 as a transport link and new junctions of the route corridor options would not require at-grade crossings, no significant new severance is anticipated.

15.4.24 The A904 is also crossed by both route corridor options to the south of the Firth of Forth. Although this does not directly conflict with any paths, this road provides a key public transport link for the village of Newton and surrounding communities. Bus services X4, 43, X43, 63 and 474 travel along this route providing connections to locations such as South Queensferry, Edinburgh, Linlithgow, and the Gyle Shopping Centre. It is assumed that the provision of an overbridge at this location (as specified in all design route corridor options) would prevent any changes in access along the A904 therefore no significant new severance is anticipated at this location.

15.4.25 As shown in Figure 15.5b, the school catchment area for Echline would be severed by South Corridor Options 1 and 2. However, it is likely that most children living in the severed areas will travel to school by car or public transport and since all road links will be maintained with both corridor options, no significant severance would result. The community catchment of South Queensferry would be unaffected by both southern route corridor options.

15.4.26 Both southern route corridor options would cross the Strathclyde North East railway line though it is anticipated that the new road would be routed over the line. The Dalmeny railway station would not be affected by either southern route corridor option since no new severance of Dalmeny and Queensferry would result. Neither southern route corridor option would therefore directly affect the railway line or its services.

Outdoor Access

15.4.27 Impacts on outdoor access are discussed in paragraphs 15.4.31, 15.4.36 and 15.4.37 below.

<u>South Corridor Option 1</u>

Paths (Existing Conflicts)

15.4.28 Existing crossing points which would be crossed by South Corridor Option 1 are common to both southern route corridor options and as such are discussed in paragraph 15.4.19 (and identified in Table 15.9).

Paths (New Conflicts)

15.4.29 Table 15.11 details the potential impacts which would result on NMU paths from South Corridor Option 1 in the absence of mitigation. In addition to impacts on paths Y and AE which are common to both southern route corridor options (Table 15.10), South Corridor Option 1 would impact on one Core Path (Z2).

Table 15.11: Potential Impacts of South Corridor Option 1 on NMU Paths

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
Z2	Core Path	The proposed junction connections of South Corridor Option 1 would sever this route. Without mitigation, NMUs would probably divert via tracks to the northwest of Kirkliston. Junction structures and connecting roads may decrease air quality and reduce tranquillity.	Increase	Decrease	Yes

Community Severance

15.4.30 Potential community severance impacts resulting from South Corridor Option 1 are discussed in paragraphs 15.4.21 to 15.4.25 under impacts resulting from both southern route corridor options.

Outdoor Access

15.4.31 South Corridor Option 1 would result in the potential severance of only one Core Path and would not result in any direct loss of outdoor access facilities and is therefore not considered to have a significant impact on access to the outdoors.

South Corridor Option 2

Paths (Existing Conflicts)

15.4.32 Existing crossing points which would be crossed by South Corridor Option 2 that are common to both southern route corridor options are discussed in paragraph 15.4.19 (and identified in Table 15.9). South Corridor Option 2 would also cross right of way and Core Path Z1 where it is already crossed by the A90, as shown on Figure 15.4. This existing crossing point is identified in Table 15.12. It is assumed that the road improvements along this stretch would incorporate the existing crossing point and no permanent diversion would be necessary. In which case, impacts on journey length and amenity value of this path are assessed as not being significant.

Table 15.12: Existing Crossing Point of NMU Path Assumed to be Maintained by South Corridor Option 2

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
Z1	Right of Way / Core Path	South Corridor Option 2 new junction connections would sever this route. However the A90 already crosses the path at this location and there is provision for crossing the A90 using the existing dismantled railway underbridge.	None	None	No

Paths (New Conflicts)

15.4.33 Table 15.13 details the potential impacts which would result from South Corridor Option 2 in the absence of mitigation. In addition to impacts on paths Y and AE (Table 15.10) which are common to both southern route corridor options, South Corridor Option 2 would significantly impact on four paths including two rights of way (AI and AP) and one Core Path (Z2).

Table 15.13: Potential Impacts of South Corridor Option 2 on NMU Paths

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
Z2	Core Path	The proposed South Corridor Option 2 junction connections would sever this route at two new locations. Without mitigation, NMUs would probably divert via right of way AH and minor roads to the southwest of Kirkliston. The Core Path would be lost by using this alternative route. Junction structures and connecting roads may reduce air quality and reduce tranquillity. Where Z2 is currently crossed by the M9, the improvements to this road will maintain existing crossing points.	Increase	Decrease	Yes

Path Ref.	Path Type	Potential Impact (unmitigated)	Change in Journey Length	Change in Amenity Value	Significant
AG	Other Path	Minor road is located in close proximity to the west of South Corridor Option 2. Amenity value would potentially decrease due to the proximity of the road infrastructure.	None	Decrease	Yes
AI	Right of Way	Path would be severed by the proposed junction connections of South Corridor Option 2 at two locations. Without mitigation, NMUs would probably divert via the minor road at Swineburn, assuming that an underbridge is provided where South Corridor Option 2 crosses the minor road at this location. Junction structures and connecting roads may decrease air quality and reduce tranquillity.	Increase	Decrease	Yes
AP	Right of Way	Path would be severed by the proposed junction connections of South Corridor Option 2. A possible alternative route would be via the south side of Ross's Plantation along right of way AQ, resulting in the loss of AP as a recreational route. Junction structures and connecting roads may decrease air quality and reduce tranquillity.	Decrease	Decrease	Yes

Community Severance

15.4.34 Potential community severance impacts resulting from South Corridor Option 2 are discussed in paragraphs 15.4.21 to 15.4.25 under impacts resulting from both southern route corridor options.

15.4.35 In addition to potential severance of the Echline community catchment, the school catchment area for Kirkliston would be severed by South Corridor Option 2 (Figure 15.5b). However, it is likely that most children living in the severed areas will travel to school by car or public transport and since all road links will be maintained, no significant severance would result.

Outdoor Access

15.4.36 Impacts on access to outdoor facilities to the south of the Firth of Forth would be most significant for South Corridor Option 2, due to the potential severance of paths at five locations. A reduction in amenity is also likely to be significant for South Corridor Option 2.

15.4.37 The accessibility of Ross's Plantation, Swineburn Wood, Muiriehall Wood and Humbie Reservoir would be reduced by South Corridor Option 2 without mitigation. It is likely that pedestrians and others would have to divert their usual journeys to these areas via alternative existing pathways. This option would also result in the loss of some woodland at these locations (Chapter 6: Land Use).

15.5 Potential Mitigation

15.5.1 At DMRB Stage 2 assessment of route corridor options, the detailed design has not been developed and mitigation detail therefore cannot be accurately defined. The objective of this section is therefore to identify 'standard' or 'anticipated' mitigation taking into account best practice, legislation and guidance. This mitigation is taken into account in the subsequent identification of likely residual impacts in Section 15.6 (Summary of Route Corridor Options Assessment), to provide a robust basis for comparative assessment and selection of a preferred route corridor option to be taken forward to Stage 3.

15.5.2 Potential mitigation measures are listed in Tables 15.14 and 15.15 for the northern and southern route corridor options respectively.

Table 15.14: Potential Mitigation Measures – Northern Route Corridor Options

Northern Route Corridor Option (s)	Path Ref.	Path Type	Users	Significant Impact	Potential Mitigation / Recommendations
North Corridor Option 1	A	NCR 1	Cyclists	No	Cycle route will be maintained alongside the existing A90 and slip roads to the B981.
North Corridor Option 2	A	NCR 1	Cyclists	Yes	NMU access provision from existing road bridge to B981 to allow continued access along the National Cycle Route. Alternatively NCR1 could be routed over the proposed replacement bridge on a traffic free pathway, though this would create a longer route and require diversions at north and south ends of the proposed replacement bridge.
Either Northern Route Corridor Option	A2	NCR 1	Cyclists	Yes	Overbridge to allow continued cycle use along the National Cycle Route.
Either Northern Route Corridor Option	B	Core Path	Pedestrians Cyclists	Yes	Underbridge to allow continued pedestrians and others use along this Core Path.
Either Northern Route Corridor Option	D	Core Path	Pedestrians Cyclists	Yes	None required if path is maintained beneath proposed viaduct.
North Corridor Option 2	H	Right of Way	Pedestrians	Yes	Overbridge to allow continued pedestrians and others use along the right of way to the B980.
North Corridor Option 2	I	Right of Way / Core Path	Pedestrians Cyclists Equestrians	Yes	Overbridge to allow continued pedestrians and others use along the right of way and links to the Core Path network in Inverkeithing.
North Corridor Option 2	L	Core Path	Pedestrians	Yes	Overbridge to maintain community links along the Core Path network from Inverkeithing to Rosyth.
North Corridor Option 2	M	Footpath / Cycleway	Pedestrians Cyclists	Yes	Underbridge to maintain community links from Inverkeithing to Rosyth along the A985.

Table 15.15: Potential Mitigation Measures – Southern Route Corridor Options

Southern Route Corridor Option (s)	Path Ref.	Path Type	Users	Significant Impact	Potential Mitigation / Recommendations
Either Southern Route Corridor Option	Y	Core Path / NCR 76	Pedestrians (incl. vulnerable) Cyclists Equestrians	Yes	None required if path is maintained beneath the proposed viaduct.
Either Southern Route Corridor Option	AE	Right of Way	Pedestrians	Yes	Planting to screen visual impacts of the road infrastructure.
South Corridor Option 2	Z1	Core Path	Pedestrians (incl. vulnerable) Cyclists Equestrians	No	None required if proposed junction structures do not affect the existing underbridge and use by pedestrians and others along this Core Path.

Southern Route Corridor Option (s)	Path Ref.	Path Type	Users	Significant Impact	Potential Mitigation / Recommendations
Either Southern Route Corridor Option	Z2	Core Path	Pedestrians (incl. vulnerable) Cyclists Equestrians	Yes	Corridor Option 1: One overbridge to maintain community links between Kirkliston and Winchburgh along this Core Path and the B9080. Corridor Option 2: One overbridge and one underbridge to maintain community links between Kirkliston and Winchburgh along this Core Path and the B9080.
South Corridor Option 2	AI	Right of Way	Pedestrians Cyclists Equestrians	Yes	Two underbridges to maintain use by pedestrians and others along the path to link with Core Path Z2.
South Corridor Option 2	AP	Right of Way	Pedestrians	Yes	A new path to link the severed sections of the right of way through Ross's Plantation.

15.5.3 As indicated above, the main requirement for mitigation is to ensure that consideration is given to the location of any proposed junction structures and that the design of any overbridges and underbridges maintains access for NMUs. Any bridges should take into account potential barriers to disabled people such as the gradient or surfacing and should be compliant with the requirements of the Disability Discrimination Act (1995) (paragraph 15.2.16).

15.5.4 With appropriate mitigation i.e. the provision of overbridges and underbridges in the Forth Replacement Crossing design, community links would be maintained and no new community severance is likely to result.

15.5.5 All route corridor options would have an impact on some local paths and appropriate diversions would need to be provided to ensure access is maintained during construction in compliance with legislative requirements. Core paths are protected under the Land Reform (Scotland) Act 2003 (refer to paragraph 15.1.8). As noted in paragraph 15.3.2, access along rights of way is protected by the Countryside (Scotland) Act 1967, however, diversions can be considered if the proposed diversion is deemed suitable by the planning authority. In addition, under the Roads (Scotland) Act 1984, rights of ways are considered as roads, and consequently there are diversion and extinguishment procedures available under this Act.

15.6 Summary of Route Corridor Options Assessment

15.6.1 With appropriate mitigation (Section 15.5: Potential Mitigation) there would be no significant residual journey length impacts on paths. Access along all paths and to outdoor facilities would be maintained regardless of route corridor option, and therefore no community severance would result.

15.6.2 For all the options where paths would cross the route corridors via an overbridge or underbridge, it is likely that NMUs would experience a reduction in amenity value. The level of significance of the decreased amenity has not been assessed at Stage 2 but will be determined at Stage 3 taking into consideration changes in traffic flow data, the visual assessment, and proposed mitigation measures.

Northern Route Corridor Options

15.6.3 Overall, North Corridor Option 1 would result in the least number of paths being directly affected. No communities would be directly affected in terms of severance or loss of community facilities by either northern route corridor option.

North Corridor Option 1

Paths

15.6.4 Two new crossing provisions are proposed for Core Path B and path A2 (NCR1) to reduce the potential impact on journey length impact. Two rights of way (H and I) are located in close vicinity to the west of the route corridor option though no significant impacts are likely. Residual adverse amenity value impacts would remain on both Core Paths B and D due to the visual impact of the route corridor option.

Community Severance

15.6.5 With the new crossing provisions, links between Rosyth and North Queensferry would be maintained. North Corridor Option 1 would not directly sever any communities, catchment areas or result in the loss of any community facilities.

Outdoor Access

15.6.6 Access to public parks, woodlands and Ferry Loch would be maintained through the provision of new crossings. St Margaret's Marsh and St Margaret's Wood would remain accessible underneath the viaduct structure of the proposed replacement bridge.

North Corridor Option 2

Paths

15.6.7 Six new crossing provisions are proposed, for NCR1 (A2), Core Paths B, I (also right of way), L, right of way H and other path M, to reduce impacts on journey length. In addition, access to the affected section of NCR1 (A) would be reinstated, possibly through re-routing over the proposed replacement bridge which would result in an increased journey length. Residual adverse amenity value impacts would remain on all paths crossed by North Corridor Option 2 due to the visual impact of the route corridor option.

Community Severance

15.6.8 With the new crossing provisions, access between the communities of Rosyth, North Queensferry, Inverkeithing and Dunfermline would be maintained. North Corridor Option 2 would not directly sever any communities, catchment areas or result in the loss of any community facilities.

Outdoor Access

15.6.9 Access to public parks, woodlands (including Castlandhill Wood) and Ferry Loch would be maintained through the provision of new crossings. St Margaret's Marsh and St Margaret's Wood would remain accessible underneath the viaduct structure of the proposed replacement bridge.

Southern Route Corridor Options

15.6.10 Overall, South Corridor Option 1 would result in the least number of paths being directly affected and would have least impact on rights of way. No communities would be directly affected in terms of severance or loss of community facilities by either southern route corridor option.

South Corridor Option 1

Paths

15.6.11 One new crossing provision is proposed for Core Path Z2 to reduce the impact on journey length. Residual adverse amenity value impacts would remain on all paths crossed by South Corridor Option 1 due to the visual impact of the route corridor option.

Community Severance

15.6.12 With the new crossing provision on Core Path Z2, access between the communities of Winchburgh and Kirkliston would be maintained. South Corridor Option 1 would not directly sever any communities or result in the loss of any community facilities. Maintenance of paths AE and Y underneath the viaduct of the proposed replacement bridge would avoid any potential severance of Linn Mill from South Queensferry. Travel within the Echline school catchment area would be maintained along the continued road links.

Outdoor Access

15.6.13 The new crossing provision on Core Path Z2 would maintain any potential links to outdoor access facilities located in Winchburgh, Kirkliston and the surrounding area.

South Corridor Option 2

Paths

15.6.14 Four new crossing provisions are proposed for Core Path Z2 (two locations) and right of way AI (two locations) to reduce the impacts on journey length. Residual adverse amenity value impacts would remain on all paths crossed by South Corridor Option 2 due to the visual impact of this option.

Community Severance

15.6.15 With the new crossing provisions, access between the communities of Winchburgh and Kirkliston would be maintained. South Corridor Option 2 would not directly sever any communities or result in the loss of any community facilities. Maintenance of paths AE and Y underneath the viaduct of the proposed replacement bridge would avoid any potential severance of Linn Mill from South Queensferry. Travel within the Echline and Kirkliston school catchment areas would be maintained along the continued road links.

Outdoor Access

15.6.16 The new crossing provisions would maintain any potential links to outdoor access facilities located in Winchburgh, Kirkliston and the surrounding area including Ross's Plantation, Swineburn Wood, Muiriehall Wood, and Humbie Reservoir. However, while access to these areas will be maintained, there will be some loss of woodland (Chapter 6: Land Use).

15.7 Scope of Stage 3 Assessment

15.7.1 In accordance with DMRB Volume 11 Section 3, Part 8, an assessment of the preferred route corridor will be undertaken to identify any significant impacts on pedestrians, cyclists, equestrians and communities. The assessment will be based on the following steps:

- confirm information gathered from relevant statutory bodies and local councils including types of users through desk-based assessment and site visits;
- undertake additional consultation with relevant organisations e.g. SNH, local councils, Scotways and Sustrans;

- refine the Stage 2 assessment of the amenity value of paths using traffic flow data and the Stage 3 visual assessment;
- incorporate findings from the socio-economic assessment into the assessment of community effects;
- update and define level of impact significance for changes in journey length, amenity and community severance; and
- propose appropriate mitigation measures based on refined assessments.

15.8 References

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16 Vehicle Travellers

16.1 Introduction

16.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing on vehicle travellers in terms of view from the road and driver stress.

16.1.2 View from the road is defined as the extent to which vehicle travellers are exposed to different types of scenery through which the proposed scheme passes. The existence of a new road provides the opportunity for more people to view the landscape and appreciate their location in relation to distinctive landscape features. Views from a new road, or section of a road, may also help to alleviate driver stress. Conversely, where views from a road are restricted by the topography of a new construction, this may cause frustration or contribute to driver boredom.

16.1.3 Driver stress is defined as the mental and physiological effects experienced by a driver using a road network. The three main components of driver stress are frustration, fear of a potential accident, and uncertainty of the route which is being followed.

16.1.4 Impacts during construction are considered in Chapter 17 (Disruption Due to Construction).

16.2 Approach and Methods

16.2.1 The assessment of impacts on Vehicle Travellers has been undertaken following guidance provided in DMRB Volume 11, Section 3, Part 9 (The Highways Agency et al., 1993).

View from the Road

16.2.2 The assessment takes into account the types of scenery or landscape character, the extent to which travellers would be able to view the scene, the quality of the landscape and features of particular interest or the prominence of the view.

16.2.3 The extent to which travellers will be able to perceive the landscape through which they are passing will vary with the relative level of the road and its surrounding topography and vegetation. The categories used to assess this are:

- no view – road in very deep cutting or contained by earth bunds, environmental barriers or adjacent structures;
- restricted view – road in frequent cuttings, or with deep cuttings across slopes, with frequent environmental barriers or adjacent structures blocking the view;
- intermittent view – road generally at grade but with shallow cuttings, environmental barriers or structures at intervals; and
- open view – road generally at grade or on embankment with views extending over the wider landscape or only restricted by existing landscape features.

Driver Stress

16.2.4 Driver stress has been assessed using the following three point scale as recommended in DMRB:

- high;
- moderate; and
- low.

16.2.5 Driver stress levels are predicted by forecasting the average peak (peak is taken as 08h00-09h00 and 17h00-18h00) hourly flow per lane for each section of the route and the average journey speed on that section. The baseline (existing) traffic conditions have been calculated using 2005 traffic flows. In accordance with the guidance in DMRB, the assessment of Driver Stress for the Forth Replacement Crossing is based on the highest traffic flow in the first 15 years after opening, which has been taken to be 2032. The baseline / forecast traffic flows and predicted journeys speeds used for the assessment are provided in Appendix A16.1.

16.2.6 Tables 16.1 and 16.2 present the guidance on categorisation of driver stress provided by DMRB based on flow and speed for a motorway and dual carriageway respectively. The motorway categories apply to the sections of route where motorway regulations apply – namely north of Admiralty in the Northern study area and south of the A904 or Scotstoun Junction in the Southern study area. The dual carriageway category applies to the section of the A90 between Admiralty and Ferrytoll, the proposed replacement bridge and the A90 to the south of the Firth of Forth. The categories only apply to those sections of road where traffic flows and speeds are relatively constant over 1km or more of the route and are therefore only presented for the sections of the mainline between individual junctions.

Table 16.1 - Driver Stress Levels on Motorways

Average Peak Hourly Flow per Lane [1] (flow units / hour)	Average Journey speed km/hr		
	Under 75	75 - 95	Over 95
Under 1200	High	Moderate	Low
1200 – 1600	High	Moderate	Moderate
Over 1600	High	High	High

Table 16.2 - Driver Stress Levels on Dual Carriageway Roads

Average Peak Hourly Flow per Lane [1] (flow units / hour)	Average Journey speed km/hr		
	Under 60	60 – 80	Over 80
Under 1200	High[2]	Moderate	Low
1200 – 1600	High	Moderate	Moderate
Over 1600	High	High	High

[1] A car or light van equals one flow unit. A commercial vehicle over 1.5 tons unladen weight or a public service vehicle equals 3 flow units.

[2] 'Moderate' in urban areas.

16.2.7 It should be noted that the levels of driver stress predicted are relative, i.e. driver stress would be significantly affected by nationally anticipated increases in traffic volumes (i.e. increased driver stress in the do-minimum scenario) and not specifically a consequence of the Forth Replacement Crossing project.

16.3 Baseline Conditions

View from the Road

16.3.1 The descriptions of views from the existing road network around the study area have been produced based upon desk based assessment and knowledge of the roads gained through field survey and informed by the visual assessment (Chapter 11: Visual).

Firth of Forth

16.3.2 Views from the Forth Road Bridge are partially obstructed by the surrounding structure and safety barriers on the bridge which allow intermittent views. In clear weather, views west along the estuary extend to Grangemouth and Kincardine. Views east are dominated by the Forth Rail Bridge, with limited views beyond North Queensferry to Dalgety Bay and the islands in the estuary. The towers and cables of the Forth Road Bridge filter the views directly north and south along the Forth Rail Bridge, allowing only glimpses of South Queensferry, Castlandhill and Ferry Hills.

Northern Study Area

16.3.3 The A90 crosses Fife, becoming the M90 at the southern edge of Rosyth. To the south of the settlement, the views to the eastern side of the road are constrained by the rock cuttings adjacent to the carriageway. These cuttings have weathered to achieve a naturalised appearance as features in the landscape, which mitigates the sense of enclosure. Intermittent views are available to the west across coastal grassland, punctuated by roadside planting and small rock cuttings at Ferry Toll roundabout. Southbound traffic has views along the carriageway towards the Firth of Forth, with views of the Forth Road Bridge framed by rock cuttings, creating an ‘approach’ experience. Open views beyond Rosyth are across settlement to the west and over farmland and an industrial estate to the east. The road returns to cutting and with restricted or no views as it continues north past Dunfermline, although roadside planting softens the resulting sense of enclosure.

16.3.4 North of Inverkeithing, the A921 and A985 provide the main east-west route, crossing the existing M90 at Junction 1A. Inverkeithing Industrial Estate, near the M90, degrades views north from the A921, but beyond Inverkeithing there are attractive open views across farmland which rises northwards to Fordell Estate. The rising landform south of the road restricts views towards the Firth of Forth. West of the M90, the A985 has no views within Rosyth and open rural views thereafter. Views from the A823(M) to Dunfermline, which runs west from Junction 2 of the M90, are restricted by landform, vegetation and within the town, settlement.

Southern Study Area

16.3.5 Beyond the confines of Edinburgh, views from the A90 are generally restricted between Cramond Bridge and South Queensferry by woodland, topography and occasional cuttings, with intermittent views to the west across the surrounding farmland. From Dalmeny, there are intermittent views south across adjacent farmland towards Kirkliston, partially screened by the M9 Spur. At Ferry Muir, restricted views towards the Forth Road Bridge are glimpsed for northbound traffic, before more open views across the Firth of Forth become available, enhanced by the recent removal of the toll barriers.

16.3.6 The M9 Spur was completed in 2007 to cater for the volume of traffic between the Forth Road Bridge and the M9. Between the M9 Junction 1A and the new overbridge across the A8000, open views are available across Kirkliston to the east of the road, with short-range views to the west contained by the topography and woodland of Dundas Estate and Humbie Farm. Beyond Dundas Estate, the elevation of the road allows glimpses of the Forth Road Bridge and Forth Rail Bridge across rolling farmland. Southbound traffic has open views across farmland towards Edinburgh Airport, with views restricted by deep cuttings, as the road passes Royal Elizabeth Yard industrial estate. At the merge with the A90, views north are limited by South Queensferry settlement.

16.3.7 The A904 follows a sinuous route west from Ferry Muir roundabout, at the southern edge of South Queensferry, towards Linlithgow, with generally open views across the surrounding farmland. Between Newton and South Queensferry, eastbound traffic has open, scenic views across the Firth of Forth towards the Forth Road Bridge and Forth Rail Bridge, partially screened by Headrig Hill. From the A8000 from Kirkliston to South Queensferry, which until recently provided a major link to the Forth Road Bridge, travellers have intermittent rural views to the east of the road and limited views to the west into Dundas Estate, with glimpses north to the towers of the Forth Road Bridge.

Driver Stress

16.3.8 The level of driver stress on the A90 and M90 during the peak periods in 2005 was generally moderate to high. In the inter-peak period, driver stress was generally low, except for the Forth Road Bridge and A90 to the south of the Firth of Forth, where driver stress was moderate.

Limitations to Assessment

16.3.9 As part of the DMRB Stage 2 assessment, detailed mitigation proposals will not be developed. Mitigation earthworks, landscape and ecological planting, walls, fences and noise barriers would potentially affect views from the road. At this stage the residual impacts of the change to views cannot therefore be confirmed.

16.4 Potential Impacts

16.4.1 This assessment is based on potential impacts (i.e. without mitigation). As noted in paragraph 6.2.7, potential impacts in terms of driver stress are significantly affected by nationally anticipated increases in traffic volumes with or without the Forth Replacement Crossing.

Forth Replacement Bridge

View from the Road

16.4.2 Views from the proposed replacement bridge would be very similar to those from the Forth Road Bridge. As with the Forth Road Bridge, the bridge structure itself would permit only intermittent views. The alignment of the crossing would increase views of the industry in Rosyth Europarc, but travellers would still have attractive views west along the Firth of Forth, with the Forth Road Bridge and Forth Rail Bridge dominating and screening views to the east. Substantial wind deflection structures, to reduce the effects of high winds and frequency of bridge closures, would potentially interrupt views depending on the design/form used. Views along the carriageway would be limited by the towers of the proposed replacement bridge, with intermittent views north to Castlandhill and the Ferry Hills, and south to the wooded hill of Dundas Estate and surrounding farmland.

Driver Stress

16.4.3 By 2032, driver stress on the proposed replacement bridge is likely to be high during peak periods and moderate at times of lower travel demand, due to a combination of high flows and low forecast speeds.

Northern Route Corridor Options

North Corridor Option 1

View from the Road

16.4.4 This route corridor would join the existing A90 immediately north of the proposed replacement bridge. Between St Margaret’s Hope hill and the route tie-in, the road would have open views west towards the Firth of Forth. To the east, intermittent short-range views would be contained by the rock cutting through Ferry Hills and roadside planting north of The Queensferry Hotel.

16.4.5 Beyond the tie-in, views for travellers would be very similar to those from the existing A90. Between Castlandhill and Muckle Hill/Fairy Kirk hill, views would be restricted by rock cuttings, the original sections of which are weathered and would frame views of the new bridge for southbound travellers.

16.4.6 North of the cuttings, open views across Rosyth and farmland to the east would remain unchanged, although views would be partially disrupted by the structure and embankments of the revised Masterton Junction. The upgraded junction would require removal of existing trees to accommodate a more elevated carriageway, creating intermittent views to the east across the adjacent farmland. East of Duloch Home Farm there would be no views where the road enters a cutting as it passes beneath the B916.

Driver Stress

16.4.7 Driver stress on the M90 and A90 is likely to be high at peak times under North Corridor Option 1 due to the relatively high flow per lane forecast in 2032. However, driver stress may be categorised as moderate at other times, particularly on the motorway section north of Masterton Interchange, which has been assessed as low or moderate during the inter-peak period.

<u>North Corridor Option 2</u>

View from the Road

16.4.8 This route corridor would be constructed offline before tying back into the existing M90 to the south of the B916. Beyond St Margaret's Hope hill, the road would be elevated with open views west towards the Firth of Forth. Intermittent views to the east would overlook the B981 to North Queensferry and the existing A90 towards the rock cutting through Ferry Hills.

16.4.9 After Ferry Toll Junction, there would be no views from the road as it cuts through Whinny Hill, Castlandhill and Fairy Kirk hill. The alignment would limit the opportunity for an approach experience prior to reaching the proposed replacement bridge.

16.4.10 North of Fairy Kirk hill, the elevated road would enable open views west across Inverkeithing Industrial Estate to Dunfermline. More attractive open views to the east would be anticipated across the farmland valley between Fordell Estate to the north and Letham Hill to the south.

16.4.11 The approach to the final merge with the M90 would be in cutting, which would restrict the views available to the side of the road, while the rising landform would restrict views north. Southbound travellers would have views along the carriageway towards the Forth Rail Bridge.

Driver Stress

16.4.12 Driver stress is forecast to be high on the new offline section of dual two lane motorway and on the proposed replacement bridge. From the northern extent of the proposed scheme and the start of the offline section of new carriageway, driver stress is likely to be moderate to high during peak periods and moderate at other times. Drivers on the existing M90 / A90 carriageway connecting Masterton Interchange, Admiralty and Ferrytoll would be expected to experience low levels of driver stress due to the reduction in traffic on these sections of network as a consequence of constructing North Corridor Option 2.

Southern Route Corridor Options

South Corridor Option 1

View from the Road

16.4.13 The initial section of road to the south of the proposed replacement bridge would be situated on a small embankment as it diverges from the A90, with open views to either side and views north towards the Forth Road Bridge.

16.4.14 The road would be in cutting as it continues to the west towards the A904 and passes beneath the new junction with the A904, with no views available due to the surrounding landform. Southbound traffic would have intermittent views along the carriageway towards the southern edge of South Queensferry and the adjacent farmland, while views along the road for northbound travellers would be restricted by cuttings.

16.4.15 North of the A904, the road would move onto embankment, with open views west for northbound traffic across farmland towards Hopetoun Estate, and north across the Firth of Forth. From the southbound carriageway, intermittent views would be available towards South Queensferry and the woodland of Dundas Estate, interrupted by the A904 Junction overbridges.

16.4.16 The changes to the Echline / Scotstoun Junction would not represent a significant change to existing intermittent views, while the new M9 Junction 1A would require the majority of vegetation on the western side of the junction to be removed, enabling open views across farmland towards Dundas Estate, although the scenic quality of the views would be degraded by the bings near Niddry Mains.

Driver Stress

16.4.17 Driver stress on the section of dual carriageway between the proposed replacement bridge and the revised Echline / Scotstoun Junction is likely to be high during peak periods due to the combination of high flows and low speeds that are forecast in 2032. Driver stress will be moderate at times of lower travel demand. However, on the A90 to the west of Scotstoun, driver stress has been assessed as moderate at all times and on the M9 Spur to the south of Scotstoun, driver stress has been assessed as moderate at peak times and low in the inter-peak period.

South Corridor Option 2

View from the Road

16.4.18 The embankments for the new carriageway between the M9 and Humbie Reservoir would provide travellers with open views east across farmland and west towards the large bing near Niddry Mains. Beside the reservoir, views would be restricted by the structures and embankments of the new slip roads. Open views would be available from the elevated slip roads across the reservoir and adjacent woodland areas. Northbound views along the carriageway would be restricted by local topography and overbridges, while southbound travellers would have attractive open views across farmland.

16.4.19 Beyond Swineburn, the road would be briefly at grade, with open views to both sides of the road across farmland. The road would then move into deep cutting, which would restrict views for travellers, with occasional glimpses of isolated woodland to the west and Dundas Estate to the east. The route corridor would remain in cutting until it had passed the proposed junction with the A904.

16.4.20 In the vicinity of Westfield Farm, intermittent views north along the carriageway to the towers of the new bridge would be anticipated, with localised screening by landform and the overbridges for the local road and the A904 Junction. Southbound views directly ahead would be to Swineburn Wood and the bings near Niddry Mains.

16.4.21 Views from the final stretch road to the south of the proposed replacement bridge would be the same as for South Corridor Option 1.

16.4.22 The extended straight alignment south of the proposed replacement bridge would potentially provide travellers with a longer approach experience than South Corridor Option 1, dependent on topography and overbridges.

16.4.23 This option would include a revised layout for the Scotstoun Junction, where the M9 Spur merges with the A90. However, this change would be unlikely to cause a discernible change to the existing views for travellers.

Driver Stress

16.4.24 By 2032, driver stress between the proposed replacement bridge and the M9 to the north of M9 Junction 1A has been assessed as high at peak periods and moderate at other times. The rerouting of traffic from the M9 Spur to the new motorway link would result in driver stress on the M9 Spur being low at all times. Driver stress on the A90 to the east of Scotstoun would remain moderate.

16.5 Potential Mitigation

View from the Road

16.5.1 At this stage of the assessment, detailed mitigation measures have not been developed, so it is not possible to assess to what extent views would be altered by mitigation earthworks, landscape and ecological planting, walls, fences and noise barriers. However, for each route corridor option, areas where potential mitigation could be introduced to enhance the journey experience for drivers have been identified.

16.5.2 Without appropriate mitigation, the source of adverse impacts for travellers are likely to include the following:

- journeys through deep cuttings causing a distressing sense of enclosure for drivers;
- lack of distant views ahead along the carriageway causing lack of certainty about the route; and
- change to existing route to reveal or increase views of unattractive features.

16.5.3 Mitigation measures include the prevention of impacts through the selection of a route corridor option that provides the most varied journey experience, maximising opportunities to appreciate scenic and valued views and providing adequate stretches of long-distance views ahead along the carriageway. The best fit within the landscape and the reduction / offsetting of impacts is also sought through the use of:

- elevation - construct the road at grade where possible;
- earthworks - tie in cuttings and embankments with the natural landform;
- rock cuttings - create naturalistic looking rock faces; and
- planting and seeding - integrate with surrounding ground cover, scrub or woodland, replace lost vegetation, provide screening and soften/vary the sense of enclosure.

16.5.4 Potential mitigation measures for each option are outlined below.

North Corridor Option 1

- minimise the extent of new rock cutting through Castlandhill / Muckle Hill section and retain the weathered existing rock cuts to reduce the sense of enclosure; and
- retain the existing vegetation beside the road to the north of the Masterton Junction where possible to soften the sense of enclosure.

North Corridor Option 2

- grade out the cutting slopes through Castlandhill and Fairy Kirk hill to enhance the fit with the landscape and ensure the rock cutting method achieves a naturalistic appearance;
- replace planting around the cutting through Fairy Kirk hill to soften the appearance and offset the loss of existing vegetation; and
- replace planting at the M90 split where possible, to soften the appearance of the cutting.

South Corridor Option 1

- grade out the cutting slopes to improve the landscape fit and reduce the sense of enclosure at the A904 junction;
- replace woodland lost at the edge of Dundas Estate to improve the appearance of the severed woodland edge; and
- introduce roadside planting where appropriate, such as adjacent to Dundas Estate, to vary and soften the sense of enclosure.

South Corridor Option 2

- replace woodland lost at the edge of Swineburn Wood to improve the appearance of the severed woodland edge and improve the fit of embankments within the landscape;
- grade out the cutting slopes to improve the landscape fit and reduce the sense of enclosure at the A904 junction;
- introduce roadside planting, where appropriate, to vary and soften the sense of enclosure; and
- promote views towards the proposed replacement bridge to enhance the approach experience.

Driver Stress

16.5.5 The Forth Replacement Crossing will be designed to appropriate road design standards in accordance with DMRB. The objective is to ensure that the design (including aspects such as gradients, junctions, lane change requirements) enables traffic to flow freely and are able to manoeuvre within the traffic stream with relative ease. Driver stress will be highest where a driver's ability to manoeuvre is constrained by a combination of high traffic flows or a high proportion of large vehicles and constrained road capacity.

16.5.6 Fear can be reduced by ensuring that sight distances generally comply with the current standards, giving a clear view of the carriageway ahead. The provision of adequate lighting at junctions may also help to reduce fear in vehicle travellers undertaking their journey at night. Current design standards do not require road lighting for the full length of the Forth Replacement Crossing.

16.5.7 Driver stress in terms of route uncertainty can be minimised by the provision of signs designed and sited in accordance with the appropriate standards.

16.6 Summary of Route Corridor Options Assessment

Northern Route Corridor Options

16.6.1 Overall, North Corridor Option 1 would offer the most benefits in terms of views for travellers and woukld be likely to result in comparatively less driver stress.

<u>North Corridor Option 1</u>

View from the Road

16.6.2 North Corridor Option 1 would offer the most open and varied views for travellers, with views across farmland to the north of Inverkeithing and a view, framed by weathered rock cuttings, of the approach to the new bridge.

Driver Stress

16.6.3 Driver stress has been assessed as high during peak times and moderate at other times for North Corridor Option 1.

<u>North Corridor Option 2</u>

View from the Road

16.6.4 The route corridor for North Corridor Option 2 would be likely to require substantial new rock cuttings, which could appear conspicuous and unweathered for several years.

16.6.5 North of Fairy Kirk hill, North Corridor Option 2 would provide travellers with attractive open views across the rolling farmland to the east and views southwards from the higher ground towards the Forth. However, the cuttings through Whinny Hill, Castlandhill and Fairy Kirk hill and the sinuous alignment would severely restrict the views and minimise opportunities for drivers to gain an approach experience to the new bridge.

16.6.6 Overall North Corridor Option 2 would provide the most enclosure and least variety in views for travellers.

Driver Stress

16.6.7 North Corridor Option 2 is likely to result in high levels of driver stress during most periods as a result of the lesser carriageway provision on the offline section compared to North Corridor Option 1. However, drivers using the existing section of M90 / A90 that is bypassed by the offline section are likely to experience low levels of driver stress.

Southern Route Corridor Options

16.6.8 Overall, it is considered that impacts on vehicle travellers would be of similar significance for either of the southern route corridor options.

<u>South Corridor Option 1</u>

View from the Road

16.6.9 Views from South Corridor Option 1 would be generally intermittent since the majority of the route corridor would be in cutting. This short route would provide a very brief approach experience in terms of view of the new bridge, although the short distance that would need to be travelled would reduce the amount of time that travellers would be enclosed.

Driver Stress

16.6.10 Levels of driver stress are likely to be high at peak times and moderate during the inter-peak period for South Corridor Option 1 on the proposed replacement crossing, similar to those anticipated for South Corridor Option 2. Under South Corridor Option 1, drivers are likely to experience moderate driver stress for the remainder of their journeys on the A90 or M9 Spur east or south of the reconfigured Echline / Scotstoun Interchange.

<u>South Corridor Option 2</u>

View from the Road

16.6.11 South Corridor Option 2 would provide a long approach to the crossing, maximising the opportunity to appreciate a view of the Forth Road Bridge, the Forth Rail Bridge as well as the proposed replacement bridge. However, the majority of this route corridor would be in cutting, with restricted rural views to either side of the road. Although the elevated approach to M9 Junction 1A would provide drivers with an open view to the south, it would be dominated by the large bing near Niddry Mains, which would have an adverse impact on the scenic quality of the view.

Driver Stress

16.6.12 As with South Corridor Option 1, driver stress is likely to be high at peak times and moderate during the inter-peak period. However, with South Corridor Option 2, a greater proportion of bridge traffic would remain on the proposed motorway link between the A904 and M9, resulting in high driver stress on this section at peak times. However, driver stress would be low on the M9 Spur throughout the day.

16.7 Scope of Stage 3 Assessment

16.7.1 The Stage 3 assessment for Vehicle Travellers will be undertaken in accordance with the DMRB Volume 11, Section 9 and will include the following:

- assessment of impacts on driver stress, using updated traffic data based on the proposed scheme;
- review of the Stage 3 visual assessment to inform the view from the road, taking account of landscape and visual mitigation during winter year of opening and summer 15 years after opening; and
- identification of any further mitigation, including input where appropriate into aspects such as signage and lighting.

16.8 References

The Highways Agency et al. (1993).DMRB, Volume 11, Vehicle Travellers, Section 3, Part 9, June 1993. The Highways Agency, Scottish Executive Development Department, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

17 Disruption Due to Construction

17.1 Introduction

17.1.1 This chapter provides an initial assessment of the potential disruption impacts during to construction of the Forth Replacement Crossing.

17.1.2 As defined by DMRB, 'disruption due to construction' is a term which covers the effects on people, properties and the natural environment that can occur between the start of pre-construction works and the end of the contract maintenance period. Potential disruption due to construction impacts can include nuisance arising from noise, vibration, dust, and loss of amenity. Construction activities can also impact routes utilised by different types of users including vehicular, pedestrian and cyclist. There is also the potential for impacts on the natural environment through disturbance to wildlife, pollution of watercourses or by storage of materials on ecologically valuable land.

17.1.3 For the purposes of Stage 2, the objective of the assessment is to identify factors and effects associated with disruption due to construction to enable refinement of the route corridor options. This assessment contains the following:

- the estimated number of properties within 100m of each northern and southern route corridor option, specifically highlighting any properties which are particularly sensitive to disruption (e.g. schools, hospitals, aged person homes and libraries);
- identification of any areas or features of ecological or cultural heritage value within 100m of the route corridor options which may require protection from adverse construction impacts;
- an estimation and comparison between route corridor options of the approximate quantities of excavation and fill material requirements for earthworks;
- identification of potential impacts resulting from the construction of the Forth Replacement Crossing in terms of agricultural land use, landscape, visual, non-motorised users (NMUs) and vehicle travellers; and
- potential mitigation measures to address these impacts.

17.1.4 At Stage 2 detailed information on construction programme and methods are not available and as such potential impacts and mitigation in this chapter are described generally. However, qualitative comparative assessment of the route corridor options is provided in Section 17.6 (Summary of Route Corridor Options Assessment).

17.2 Approach and Methods

17.2.1 The Stage 2 assessment has been undertaken in accordance with the guidelines outlined in DMRB Volume 11, Section 3, Part 3 (The Highways Agency et al., 1994).

17.2.2 For the purposes of Stage 2 assessment, construction impacts are considered temporary and occur either prior to (e.g. diversion of utilities) or during construction. Operational impacts are considered as long term or permanent impacts. As indicated in paragraph 17.1.3, this chapter focuses on disruption due to construction in terms of land use, air quality, landscape, visual, NMUs (i.e. pedestrians, equestrians, cyclists and community effects) and vehicle travellers. Construction impacts in relation to other Stage 2 environmental parameters are provided within the potential impacts sections of respective chapters, due to construction impacts and operational impacts being interlinked or due to the requirement to interpret detailed and/or technical baseline or impact data. Compliance with policies and plans (Chapter 18) is not considered likely to be affected by construction works and is therefore omitted from assessment.

17.2.3 In accordance with DMRB, this chapter also provides an estimate of the number of areas or features of ecological or cultural heritage value within 100m of each route corridor option, although this is provided as baseline context only, with construction impacts considered in sections 9.4 and 12.4 (potential impacts) of the respective chapters for the reasons stated above.

17.2.4 The Jacobs Arup GIS database uses Ordnance Survey (OS) information and was used to identify numbers and types of properties within 100m of northern and southern route corridor options. An estimate of the volume of excavated and fill quantities required for each corridor option was also calculated. This enabled a preliminary assessment of the potential disruption resulting from earthworks construction to be undertaken, based on the assumption that, all other aspects being equal, the more earthworks required and the greater the quantity of material to be excavated and filled, the longer potentially disruptive works are likely to take to complete, and the greater the cumulative potential for disruption impacts.

Limitations to Assessment

17.2.5 As the precise details of the construction programme and approach have not yet been determined, assessment has been made qualitatively, except where reliable quantitative data were available.

17.2.6 Potential disruption impacts arising from construction of the proposed replacement bridge (e.g. commercial and recreational use of and navigation on the Firth of Forth) are common to all route corridor options and as such have not been assessed at this stage.

17.2.7 The number of cultural heritage and ecological designations within 100m of the options is provided in Section 17.3 (Baseline Conditions). It should be noted that counts for each route corridor option should not be summed, as certain features are subject to more than one designation or designations relate to more then one distinct area. Examples are as follows:

- Firth of Forth SPA is also notified as a SSSI and Ramsar site; and
- Ferry Hills SSSI is a single designation (and recorded as such in Section 17.3) but has several geographically distinct component areas.

17.3 Baseline Conditions

17.3.1 The purpose of this section is to outline key sensitivities within 100m of the route corridor options and also provide an indication of the likely earthwork requirements. Detailed baseline information concerning NMUs, land use, landscape, visual and vehicle travellers is presented in the baseline sections of Chapter 6 (Land Use), Chapter 10 (Landscape), Chapter 11 (Visual) and Chapter 16 (Vehicle Travellers) and not restated here.

Proximity to Properties

17.3.2 Tables 17.1 and 17.2 provide an estimate of the number and type of properties within 100m of each of the northern and southern route corridor options (inclusive of any properties abutting the northern and southern landfalls of the proposed replacement bridge).

17.3.3 There are no hospitals, aged persons homes, churches, libraries, or medical clinics within 100m of any of the northern or southern route corridor options.

Northern Route Corridor Options

Table 17.1: Estimated Number of Properties within 100m of North Corridor Options 1 and 2

Property Type	North Corridor Option 1	North Corridor Option 2
Residential	413	357
Commercial	35	34
School	1	1

Southern Route Corridor Options

Table 17.2: Estimated Number of Properties within 100m of South Corridor Options 1 and 2

Property Type	South Corridor Option 1	South Corridor Option 2
Residential	344	337
Commercial	6	7
School	None	1

Cultural Heritage

17.3.4 There are a number of sites of cultural heritage value in close proximity to northern and southern route corridor options. Tables 17.3 to 17.4 provide a summary of the numbers within 100m.

Northern Route Corridor Options

Table 17.3: Estimated Number Cultural Heritage Sites within 100m of North Corridor Options 1 and 2

Cultural Heritage Designation		North Corridor Option 1	North Corridor Option 2
Scheduled Ancient Monuments		1	None
Conservation Areas		None	None
Listed Buildings	Category A	None	None
	Category B	4	6
	Category C	1	None

Southern Route Corridor Options

Table 17.4: Estimated Number of Cultural Heritage Sites within 100m of South Corridor Options 1 and 2

Cultural Heritage Designation		North Corridor Option 1	North Corridor Option 2
Scheduled Ancient Monuments		None	None
Conservation Areas		None	1
Listed Buildings	Category A	None	None
	Category B	None	None
	Category C	1	2

Ecological Designations

17.3.5 There are a number of designated sites of ecological value in close proximity to the northern and southern route corridor options. Tables 17.5 to 17.6 provide a summary of the numbers of designated sites within 100m.

Northern Route Corridor Options

Table 17.5: Estimated Number of Ecological Designations within 100m of North Corridor Options 1 and 2

Ecological Designation	North Corridor Option 1	North Corridor Option 2
Ramsar Sites	1	1
Special Protection Areas	1	1
Sites of Special Scientific Interest	3	3
Sites of Importance for Nature Conservation	None	None
Wildlife Sites	None	None
Ancient Woodland (of Semi Natural Origin)	None	None
Long-Established Woodland (of Plantation Origin)	4	3

Southern Route Corridor Options

Table 17.6: Estimated Number of Ecological Designations within 100m of South Corridor Options 1 and 2

Ecological Designation	South Corridor Option 1	South Corridor Option 2
Ramsar Sites	None	None
Special Protection Areas	None	None
Sites of Special Scientific Interest	None	None
Sites of Importance for Nature Conservation	4	4
Wildlife Sites	2	2
Ancient Woodland (of Semi Natural Origin)	1	1
Long-Established Woodland (of Plantation Origin)	4	8

Earthworks Requirement (Cut and Fill Volume Estimates)

17.3.6 For all northern and southern route corridor options, the estimated amount of fill material required for engineering and landscape earthworks exceeds the amount of reusable material that will be excavated in the course of engineering works, as shown in Table 17.7. This may mean that additional fill material will be outsourced from locations away from construction sites (e.g. from quarries), and this could potentially exacerbate disruption impacts through transport and haulage to site requirements. Note that the specific locations of borrow sites have not been identified at this stage, and local planning authorities have not been contacted in this regard.

Table 17.7: Estimated Earthworks Requirements for All Route Corridor Options

Route Corridor Option	Excavation Quantity (m^3)	Fill Quantity (m^3)	Total Borrow (m^3)
North Corridor Option 1	534,219	1,583,605	1,049,386
North Corridor Option 2	934,291	1,285,048	350,757
South Corridor Option 1	770,306	1,057,908	287,602
South Corridor Option 2	2,349,889	2,792,063	442,174

17.4 Potential Impacts

17.4.1 Potential impacts of the route corridor options on land use (agricultural only), landscape and visual, air quality, NMUs and vehicle travellers are detailed below. Earthworks requirements are also considered. It should be noted that potential impacts identified are prior to the implementation of mitigation.

Land Use

- damage to land (e.g. movement of machinery, storage of materials, access routes);
- temporary access restrictions to properties including businesses and farm buildings;
- reduced soil quality, which can cause long term damage including reduced agricultural capability of the soils;
- disruption to existing drainage system and changes in flood risk; and
- temporary severance of land causing disruption to farming practices, including preventing movement of machinery or livestock.

Landscape and Visual

- vehicles moving machinery and materials to and from the site;
- on-site machinery including heavy excavators, earth moving plant, concrete batching plant, pile drivers, cranes etc;
- exposed bare earth over the extent of the proposed works;
- structures, earthworks, road surfacing and ancillary construction works;
- temporary site compound areas including site accommodation and parking;
- temporary soil storage heaps and construction materials stockpiles;
- lighting associated with night-time working and site accommodation; and
- demolition operations.

Air Quality

- soiling of cars, windows, painted surfaces etc by deposited dust;
- damage to vegetation from deposited dust;
- damage to crops or commercial operations from deposited dust; and
- health effects from exposure to air pollution.

NMUs

- restriction or prevention of access in areas used by the community;
- diversion or restriction of routes such as footpaths and cycleways; and
- noise, dust and reduction in visual amenity.

Vehicle Travellers

- delays to journeys due to restricted traffic flows;
- increase to driver stress due to road diversions and other temporary measures; and
- negative impacts on drivers view from the road due to construction works.

17.5 Potential Mitigation

17.5.1 Detailed mitigation will be developed as part of DMRB Stage 3 assessment when additional construction information is known and can be assessed in further detail. Typical mitigation measures are provided below.

Land Use

- restriction of construction activities to a working corridor;
- reduction of temporary land loss to agriculture through construction programming, consultation with land interests, and reinstatement of agricultural land post construction;
- maintenance of agricultural land capability through best practice techniques for handling and storage of soils;
- avoidance of flood issues through pre-construction drainage works and reinstatement/provision of new drainage as required; and
- maintenance of vehicular access to farm buildings.

Landscape and Visual

- programming of works to reduce disruption, including keeping the construction programme to the minimum practicable time;
- avoidance of night-time working where possible. Where necessary, directed lighting used to minimise light pollution/glare;
- sensitive locating of site compounds to minimise their landscape and visual impact; and
- construction sites to be kept tidy (e.g. free of litter and debris).

Air Quality

- careful storage of materials including topsoil, movement of plant and other activities during construction away from potentially sensitive receptors;
- maintaining equipment as per manufacturers specifications to reduce emissions;
- switching off machinery and vehicles when not in use;
- covering trucks transporting dust-reducing material leaving or entering the construction site; and
- conforming with all relevant local authority requirements for dust control.

NMUs

- programming to reduce the length of closures or restrictions of access;
- routes used by pedestrians and others maintained or re-routed where possible;
- any closure or re-routing of routes used by pedestrians and others agreed in advance with the local Councils;
- minimise air quality and noise impacts as far as practicable; and
- keep the local community informed with regard to construction activities.

Vehicle Travellers

- scheduling where possible to minimise disruption to the road traffic, including the timing of works vehicles using public roads and delivery/removal of site materials;
- minimise import/export of material;
- avoidance of road closures where possible;
- temporary traffic management to minimise disruption and delays; and
- road diversions clearly indicated with road markings and signage as appropriate.

17.6 Summary of Route Corridor Options Assessment

17.6.1 It is anticipated that mitigation measures identified can be implemented to reduce potential impacts. However, disruption during construction will be unavoidable on such a large infrastructure project, and the following section provides a comparison of route corridor options in terms of the likely extent of such disruption.

Northern Route Corridor Options

17.6.2 In terms of earthworks balance, the anticipated fill requirements for North Corridor Options 1 and 2 are broadly similar however, the excavation requirement for North Corridor Option 1 is expected to be 43% lower than for North Corridor Option 2. As a result, the level of borrow requirements would be approximately three times higher for North Corridor Option 1, requiring the movement of 698,629m^2 more material than North Corridor Option 2. Consequently, potential for disruption impacts from earthworks is likely to be considerably more significant for North Corridor Option 1.

17.6.3 North Corridor Option 1 is within 100m of slightly more properties overall than North Corridor Option 2. The proportional difference between the overall numbers of properties within 100m potentially affected is approximately 15% greater for North Corridor Option 1 than North Corridor Option 2. This presents a slight increase in potential for impacts to aspects such as landscape and visual amenity and air quality.

17.6.4 Total agricultural land take estimate for North Corridor Option 1 is 7.6ha compared to 9.5ha for North Corridor Option 2, although severance of land is also likely to be comparable. Some potential severance issues have been identified for businesses within Belleknowes Industrial Estate for North Corridor Option 2. Overall, North Corridor Option 2 is expected to have a higher potential for temporary impacts on land use.

17.6.5 North Corridor Option 1 would cross fewer routes identified as used by pedestrians and there is therefore less potential for disruption to NMUs than for North Corridor Option 2. However, in terms of vehicle travellers, North Corridor Option 2 has less potential for disruption as it is largely offline so there would be less disruption on the existing carriageway.

17.6.6 Overall as North Corridor Option 1 is mainly online, the magnitude of disruption in relation to earth movements and traffic interruptions would be comparatively high. The number of properties within close proximity of North Corridor Option 1 is also comparatively high. Land use impacts however would be reduced compared to North Corridor Option 2 due to less land take.

Southern Route Corridor Options

17.6.7 In terms of earthworks balance, South Corridor Option 2 would require the movement of approximately 54% (154,572m^3) more material than South Corridor Option 1. Consequently, potential for disruption impacts from earthworks is likely to be more significant for South Corridor Option 2.

17.6.8 The number of properties within 100m of South Corridor Option 1 is marginally (1.5%) greater than South Corridor Option 2. Although the number of properties within 100m is similar, South Corridor Option 2 is within 100m of Dalmeny Primary School and impacts on areas of countryside with properties that are more likely to be sensitive to changes in aspects such as landscape and visual amenity and air quality.

17.6.9 Total agricultural land take estimate for South Corridor Option 2 is 56.4ha compared to 30.8ha for South Corridor Option 1, and severance of land is also likely to be higher. On this basis, South Corridor Option 2 is also expected to have a higher potential for temporary impacts on agricultural land use.

17.6.10 Both southern route corridor options are considered similar in terms of potential for disruption to vehicle travellers during construction. However, South Corridor Option 1 would cross fewer routes identified as being used by pedestrians than South Corridor Option 2.

17.6.11 South Corridor Option 2 would require a higher level of junction/road construction and overall the magnitude of disruption in relation to earth movements and land take requirements would be comparatively greater. Although the number of receptors within close proximity of South Corridor Option 1 is slightly higher than for South Corridor Option 2, properties within 100m of South Corridor Option 2 may be more sensitive to change due to their rural location.

17.7 Scope of Stage 3 Assessment

17.7.1 The Stage 3 assessment of disruption due to construction will follow the approach set out in DMRB, Volume 11, Section 3, Part 3 (The Highways Agency et al. 1994) and will include the following steps:

- verification of the properties identified within 100m of the route at Stage 2;
- verification of the ecology and cultural heritage features identified within 100m of the route at Stage 2;
- description of any construction operations with potentially significant impacts;
- assessment of the extent of potential impacts arising during construction, taking into account proposed mitigation;
- estimate of the likely quantities of surplus/borrow material associated with the scheme and details of the size and locations of borrow pits and disposal sites where appropriate; and
- identification of mitigation as appropriate.

17.8 References

The Highways Agency et al. (1994). DMRB Volume 11 Disruption Due to Construction, Section 3, Part 3, August 1994. The Highways Agency, Scottish Executive Development Department, The National Assembly for Wales and The Department of Regional Development Northern Ireland.

18 Policies and Plans

18.1 Introduction

18.1.1 This chapter presents the assessment of the Stage 2 route corridor options for the Forth Replacement Crossing in the context of national, regional and local planning policies. This includes a review of national, regional and local planning policy and guidance documents, and consideration of the project in terms of potential policy conflicts or compliance.

18.1.2 The Scottish planning policy framework is at present provided by the 'Town and Country Planning (Scotland) Act 1997' and the 'Planning and Compensation Act 1991', and is underpinned by the general principle that decisions on development and land use planning should be taken at the most local administrative level wherever possible. The 'Planning etc. (Scotland) Act 2006' received Royal Assent in December 2006 (not implemented) and once enacted will update the 2006 Act and other primary legislation. The National Planning Framework 2 (NPF 2) will be a statutory document under the new 2006 Act once adopted, replacing the current, non-statutory, National Planning Framework (NPF).

18.1.3 The Scottish Government influences the planning system through legislation, White Papers, Scottish Planning Policy documents (SPPs), Circulars, Planning Advice Notes (PANs), approval of strategic planning documents and through powers to call in planning applications SPPs are new policy documents that replace National Planning Policy Guidelines (NPPGs). Existing National Planning Policy Guidance (NPPG) documents have continued relevance to decision making, until such time as they are replaced by an SPP. These policy documents identify key priorities for the planning system in respect of various aspects of land use. These documents may, so far as relevant, be material considerations to be taken into account in the consideration of planning applications or development proposals which do not require planning permission.

18.1.4 Sections 25 and 37 (2) of the Town and Country Planning (Scotland) Act 1997 as amended by the Planning etc. (Scotland) Act 2006 require that planning decisions be made in accordance with the Development Plan (regional and local planning policy as described in paragraphs 18.3.12-18.3.14) unless material considerations indicate otherwise. Therefore, if a proposal accords with the Development Plan and there are no material considerations indicating that it should be refused, permission should be granted and vice versa.

18.2 Approach and Methods

18.2.1 The assessment was undertaken in accordance with DMRB Volume 11, Section 3, Part 12 (The Highways Agency et al., 1994). This chapter therefore:

- describes the existing and, where appropriate, emerging planning policy guidance framework as applicable to the Forth Replacement Crossing;
- describes the existing, and where appropriate, emerging development plan framework as applicable to the Forth Replacement Crossing; and
- considers the likely conflicts or compliance of the Forth Replacement Crossing with key strategic and local planning policy objectives.

18.2.2 An assessment of potential impacts on identified development land (based on development plan allocations, proposals and current planning consents) is provided in Chapter 6 (Land Use).

18.2.3 In-confidence views of local authorities regarding the potential impact on local development policies were not specifically obtained as part of the environmental assessment. However, the project team (including Traffic and Roads Teams) and Transport Scotland have held meetings with the local authorities to obtain views and these have been taken into account as appropriate during development of the Stage 2 route corridor options.

Summary of Plans and Policies

18.2.4 Baseline information has been obtained via a desk study in which relevant policies and plans at national, regional and local level were identified and reviewed. Section 18.3 (Summary of Plans and Policies) contains a brief overview of all the relevant policies and plans and Figure 6.2 shows relevant land use allocations and planned developments.

18.2.5 A summary of the theme and objectives of each relevant policy is presented in Appendix A18.1.

Assessment of Route Corridor Options Compliance

18.2.6 The methodology used for this Stage 2 assessment was derived from DMRB and included the following:

- reviewing information gathered for the STAG and SEA assessments;
- obtaining copies of local plans for all of the areas affected;
- reviewing and updating, where required, the schedule of policies produced at Stage 1;
- assessing the likely impacts of the route corridor options on the achievement of the objectives and policies listed; and
- reporting the likely effects of the route corridor options on plans and policies.

18.2.7 The assessment of policies and plans was undertaken through an appraisal of policy objectives and whether the development of the route corridor would comply or conflict with these policy objectives.

Limitations to Assessment

18.2.8 The route corridor option designs do not provide access to the site of a proposed 352ha mixed-used development (up to 5500 homes and 40ha for employment land) at Winchburgh. However, the assessment assumes that neither southern route corridor options would preclude this access, with access gained either by the later installation of a dedicated junction on the M9 (for South Corridor Option 1) or a slip road from the M9 junction under South Corridor Option 2.

18.3 Summary of Plans and Policies

National Policies

18.3.1 National land use planning policy in Scotland is provided through a series of documents (SPPs and NPPGs) that are material considerations in the assessment of planning applications. These documents also direct the form and content of structure plans and local plans. An overview of NPPGs and SPPs is provided in Table 18.1, with a brief summary of each of these documents in Appendix A18.1.

<u>Scotland's Transport Future</u>

18.3.2 The Scottish Executive White Paper, 'Scotland's Transport Future' (2004) establishes the policy framework for transport in Scotland with a clear overall aim to '*promote economic growth, social inclusion, health and protection of our environment through a safe, integrated, effective and efficient transport system*'.

18.3.3 Paragraph 71 of the White Paper states that '*in order to enhance Scotland's global competitiveness and to enable Scotland's economy to maximise its productivity, Scotland needs to ensure that it has a well-connected, sustainable transport network. Transport needs to support major Scottish industries. Transport can help unlock the economic and regeneration potential of particular places. It can also ensure connections for people who live and work in more remote and rural areas*'.

<u>National Planning Framework</u>

18.3.4 The first NPF was published by the Scottish Executive in April 2004. It is a framework to guide the spatial development of Scotland to 2025 and it is intended to complement the Executive's Framework for Economic Development in Scotland (2004). The NPF identifies priorities for investment in strategic infrastructure to reach goals set in relation to competitiveness, fairness and sustainability. This document is a material consideration in policy and is to be taken into account for decisions on planning applications, appeals and spending decisions by the Scottish Government and its agencies.

18.3.5 Paragraph 71 of the current NPF states that '[economic] *success will bring more planning challenges than failure, with a growing economy generating increased traffic and transport capacity problems*'. Paragraph 72 states that '…*the trunk road network and public transport systems require investment to address problems of congestion and unreliability*'. In particular, Paragraph 98 recognises the importance of long term transport options as a key element of the spatial strategy to 2025.

<u>National Planning Framework 2</u>

18.3.6 NPF 2 will become statutory under the Planning etc. (Scotland) Act 2006 once it is approved by the Scottish Parliament. Paragraph 4 of the document states that *'It* [NPF 2] *will guide Scotland's spatial development to 2030, setting out strategic development priorities to support the Scottish Government's central purpose - to promote sustainable economic growth.*' The document reviewed for this assessment is the consultation draft which was published in January 2008 and is expected to be adopted at the end of 2008.

18.3.7 In relation to east central Scotland, NPF 2 states that there will be a need to accommodate a substantial growth in the number of households in the Edinburgh City region and the Upper Forth area over the next 25 years. Investment will be needed in transport and environmental infrastructure to support planned development to the east of the city. Priority is being given to developing the complementary locations which make up the Lothian Science Zone and improving the connectivity of the gateway facilities at Edinburgh Airport, Grangemouth and Rosyth.

18.3.8 The action programme for NPF 2 will specify how, when and by whom national developments will be taken forward. The Forth Replacement Crossing is listed as a national development and the need for this project is described as follows: '*The Forth Road Bridge has been an essential part of the national road infrastructure for over 40 years. It is vital to the economy of Fife, an essential link for the East Coast Corridor and crucial to the connectivity of Perth and the Highlands and Islands. The main suspension cables of the bridge are showing significant signs of deterioration as a result of corrosion. While a programme of works has been identified to dry out the cables and thus prolong the life of the bridge, there is a considerable risk that this work will not be successful. If that proves to be the case, restrictions to heavy goods vehicles may be needed as early as 2013, with the bridge closing to all traffic by 2019. Complete loss of the road crossing would have very significant adverse economic impacts, both nationally and regionally'.* Therefore the Forth Replacement Crossing is designated as '*an essential element of national infrastructure*'.

18.3.9 Finally, NPF 2 requires that the combined effects of the Forth Replacement Crossing and the developments at Rosyth and Grangemouth will need to be considered under the terms of the

Habitats Directive, effects on the historic environment and cultural heritage. The historic environment and cultural heritage will be considered through DMRB Stage 3 assessment, and Information to Inform an Appropriate Assessment reports will be prepared under the terms of the Habitats Directive in the context of the Firth of Forth and Forth Islands SPAs (Council Directive 92/43/EEC; refer to Chapter 9: Ecology and Nature Conservation). The Forth Replacement Crossing proposal was borne out of Scotland's Transport Future, NPF and NPF 2. As the goals and objectives of these government policies have been described in some detail above, additional assessment has been included in Appendix A18.1.

18.3.10 Other relevant national planning policies and guidance, such as Scottish Historic Environment Policies (SHEP), SPPs and NPPGs have been considered as part of this assessment, as listed in Table 18.1 below. An overview has been provided in this report, with details of the assessment provided in Appendix A18.1.

Table 18.1: Relevant National Planning Guidance

Policy	Title	Date
SHEP 1	Scotland's Historic Environment	2008
SHEP 2	Scheduling: protecting Scotland's nationally important monuments	2008
SHEP 3	Gardens and Designed Landscapes	2008
SPP 1	The Planning System	November 2002
SPP 2	Economic Development (2002)	November 2000
NPPG 5	Archaeology and Planning (1994)	October 1998
SPP 7	Planning and Flooding (2004)	February 2004
SPP 11	Open Space and Physical Activity	November 2007
NPPG 13	Coastal Planning	August 1997
NPPG 14	Natural Heritage (1999)	January 1999
SPP 17	Planning for Transport	August 2005
NPPG 18	Planning and the Historic Environment	April 1999
SPP 20	Role of Architecture and Design Scotland	February 2005
SPP 21	Green Belts	April 2006

18.3.11 In addition, PANs support respective NPPGs and SPPs and provide advice on good practice and other relevant information to planning authorities. An overview of relevant PANs is provided in Table 18.2 and a summary of each is provided in Appendix A18.1.

Table 18.2: Relevant Planning Advice Notes

Policy	Title	Date
PAN 40	Development Control	Revised 2001
PAN 42	Archaeology- the Planning Process and Scheduled Monument Procedures	1994
PAN 47	Community Councils and Planning	1996
PAN 50	Controlling The Environmental Effects Of Surface Mineral Workings	1996
PAN 51	Planning and Environmental Protection	Revised 2006
PAN 53	Classifying the coast for planning	1998
PAN 56	Planning and Noise	1999
PAN 58	Environmental Impact Assessment	1999
PAN 60	Planning for Natural Heritage	2000
PAN 65	Planning and Open Space	2003
PAN 69	Planning and Building Standards Advice on Flooding	2004
PAN 75	Planning for Transport	2005

Regional and Local Policies

18.3.12 The development plan consists of structure and local plans. Together they form the basis on which decisions about development and future land uses are made and effectively incorporates national, regional and strategic policies within a local development framework.

18.3.13 Structure Plans can be prepared by a single planning authority or by a collaboration of neighbouring authorities. These documents set out the strategic policies and major proposals for the development and use of land, and incorporate the principles of European and UK legislation and national planning policies.

18.3.14 Each planning authority is also required to prepare one or more local plans. These create a framework of policies and proposals for land use to provide guidance and promote change in the locality, and to apply national and strategic planning policies at a local level.

18.3.15 In this regard, the route corridor options for the Forth Replacement Crossing intersect the administrative boundaries of three local authorities: City of Edinburgh Council and West Lothian Council to the south of the Firth of Forth; and Fife Council to the north. Table 18.3 lists the documents that comprise the development plan covering these local authority areas.

Table 18.3: Development Plan Documents

Document	Title	Status
Structure Plans	Edinburgh and the Lothians Structure Plan (ELSP) 2015	Adopted 17 June 2004
	Fife Structure Plan (FSP) 2001 – 2011	Adopted 8 July 2002
	Finalised Fife Structure Plan (FFSP) 2006 - 2026	Finalised April 2006
Local Plans	Rural West Edinburgh Local Plan (RWELP)	Adopted June 2006
	Finalised West Lothian Local Plan (FWLLP) 2005	Finalised 2005, anticipated for adoption in late 2008
	Linlithgow Area Local Plan	Adopted December 1994
	Broxburn Local Plan	Adopted 1989
	Dunfermline and the Coast Local Plan (DCLP)	Adopted April 2002
Development Briefs	Port Edgar, Consultation Draft	Consultation period ended 29 May 2008
	North Kirkliston	Approved October 2006

Transportation Proposals

18.3.16 There are a number of proposals relating to transportation included in various policy documents and government framework documents. The key documents are NPF 2, Scotland's National Transport Strategy and various transportation proposals contained within the Structure and Local Plans. A list of all relevant plans is provided in table 18.4.

Table 18.4: Strategic Transport Policy

Document	Title	Published
National Transport Policy	Scotland's National Transport Strategy	December 2006
	Scotland's Transport Future	2004
	Second National Planning Framework	January 2008
	SEStran Regional Transport Strategy 2008-2023	2005
Local Transport Strategies	Edinburgh Local Transport Policy 2007-2011	Adopted March 2007
	Fife West Area Transport Plan 2005 - 2010	2005
	Local Transport Strategy for Fife 2006-2026	2007
	West Lothian Local Transport Strategy	Adopted 2000
Corporate Strategies	Edinburgh Airport Surface Access Strategy 2007-2011	2007

18.3.17 The Regional Transport Strategy covering the SEStran (South East Scotland Transport Partnership) area indicates that at present very few significant trunk road schemes are being progressed. The main proposals include the A68 Dalkeith bypass, the A876 Upper Forth Crossing at Kincardine and schemes addressing problems on the A68, A7, A8 and M80, none of these schemes will have a direct impact on the Forth Replacement Crossing. The key transportation proposals contained within the relevant documents, as listed in Table 18.4, include the following:

- Forth Replacement Crossing: national transport scheme, supported by NPF2, Scotland's National Transport Strategy and SEStran Regional Transport Strategy.
- Park and Ride schemes at Halbeath and Rosyth: identified at Halbeath and Rosyth. The site at Rosyth is currently subject to a planning application. The Park and Ride proposal at Ferrytol has been abandoned following the completion of the extension of facilities at Inverkeithing Station.
- Rosyth bypass: identified in the Fife Local Transport Strategy and the Fife Structure Plan.
- Edinburgh Tram Project: delivery of tram project serving the urban area Edinburgh, linking the airport to the city centre and Leith.
- Edinburgh Airport Surface access: development of rail access to Edinburgh Airport through the introduction of the Dalmeny chord supported in the Regional Transport Strategy (RTS).
- M9 Junction at Winchburgh: significant investment in roads will be needed to support the Core Development Area (CDA) strategy. The key requirements anticipated are set out in the CDA Action Plan (Appendix 7.1of the Finalised West Lothian Local Plan (FWLLP).Proposals include new railway station at Winchburgh and associated park and ride and public transport interchange, new four way junction on M9 with associated park and ride and new distributor road network linking new housing at Winchburgh with new housing at East Broxburn. Proposals supported in FWLLP and RTS.

18.4 Potential Mitigation

18.4.1 Mitigation will be developed, where necessary, in accordance with the relevant policies and guidance during the detailed design of the Forth Replacement Crossing at DMRB Stage 3. At DMRB Stage 2 a preferred route corridor has not been selected. The assessment for each environmental topic area reported at Stage 2 therefore takes into account 'standard' or 'anticipated' mitigation to ensure that the options assessment is robust. Section 18.5 (Assessment of Options Compliance) considers compliance or conflict with policy taking into account the anticipated mitigation as described in the relevant chapters of this report.

18.4.2 Specific issues relating to plans and policies which should be considered during the development of the detailed design are as follows:

- access provision for the proposed Winchburgh development;
- access provision for the Rosyth dockyard and Ferrytoll park and ride site; and
- impact on established employment area at Belleknowes Industrial Estate.

18.4.3 In addition, the landing site for the bridgehead on the southern shore is likely to affect land zoned for housing. However, it may be possible to find alternative sites within the South Queensferry area to mitigate for this.

18.5 Assessment of Route Corridor Options Compliance

18.5.1 The assessment against national, regional and local development planning policies for the development as a whole, the bridge structure and each route corridor option is summarised in this section. Any potential conflicts with the objectives of the land use policies relevant to each corridor option are identified. The general acceptability of the development as a whole is assessed highlighting any issues that would be common to all elements of the scheme.

The Principle of Development

National Policy

18.5.2 The Forth Replacement Crossing meets national planning objectives regarding economic development and maintaining and improving accessibility. The bridge would maintain the current trunk road network and improve the connectivity of gateway facilities at Edinburgh Airport, Grangemouth and Rosyth. It meets the Scottish Government objectives for economic development and improvement to the national transport network.

18.5.3 Safety zones, hazard consultation zones and consultation zones associated with Edinburgh Airport, the Ministry of Defence base at Rosyth and high pressure gas pipelines would also be taken into consideration.

Regional Policy

18.5.4 The primary objective of the ELSP is to protect and enhance the region's environmental assets whilst promoting beneficial development. The policies within the structure plan aim to achieve a more sustainable pattern of development by providing a framework within which the key elements of the built and natural environment can be protected and enhanced. The key elements are the coast, the Green Belt, the landscape and the countryside.

18.5.5 In terms of transport policy, the ELSP identifies Edinburgh as an area of restraint because of its Green Belt designation, its high quality landscapes, environmental objectives and existing traffic problems. The exceptions are the Newbridge/Kirkliston/Ratho core development area, where allocations are made for substantial residential and business development, Edinburgh Airport and the Royal Highland Showground areas which are established Green Belt uses. The Transport Strategy set out in the structure plan aims to reduce the need to travel by car and maximise accessibility by foot, cycle and public transport. As no land has been safeguarded with reference to a second Forth Crossing, the plan strongly advocates against development in the Green Belt. Assessment of significant adverse effects on the qualities for which the area has been designated must be weighed against potential social and economic benefits of national importance.

18.5.6 The Forth Replacement Crossing falls within areas designated as developed coast (ENV5 of the ELSP, N5 and N6 of the FSP) as well as the undeveloped coast. The policy for the undeveloped coast would normally not support any development unless the development requires a coastal location, outweighs environmental impact and that no other site is available. Previous studies have shown that the proposed location of the bridge structure is the most suitable location in terms impact, viability and access. It could therefore be considered that no other site can be considered to be available. Obviously the bridge would need a coastal location. Finally, detailed mitigation measures will be developed during Stage 3 to avoid or reduce environmental impacts. It can therefore be considered that the Forth Replacement Crossing is broadly compliant with the coastal policies.

18.5.7 The prime objective of the FSP is based on the need to locate new development for job creation and housing in the most sustainable locations. It focuses development within the Dunfermline Eastern Expansion Area for residential and business development. Port and port related development and industrial, business and environmental regeneration is planned at the Rosyth Military Estate, it is also proposed to create a deep water port facility with good connection to road and rail links.

18.5.8 There are also some transport schemes for which land has been safeguarded, for example, land safeguarded for the Rosyth Eastern bypass and new park and ride schemes at Ferrytoll and Halbeath. These transport schemes will link in with the A90 infrastructure with the aim to improve links with the Edinburgh City Region.

18.5.9 Policy T2 of the FFSP 2006-2026 acknowledges the implications of the Forth Replacement Crossing and safeguards land for a new multi modal crossing and associated approach infrastructure. Within the Fife context, the principle of a multi-modal crossing is considered vitally important for Fife's economic and social inclusion agendas.

Local Policy

Transport Policies

18.5.10 The RWELP area is a key location in the transport network of east-central Scotland. A number of major roads pass through it as do four passenger railway lines. A network of local roads supplements the major roads. The RWELP refers in paragraph 7.10 to the possibility of a replacement bridge across the Firth of Forth as a project of national importance. Further, the policy states that a feasibility study with potential for a new bridge would be required within the plan period (which is assumed to be the statutory 5 year review period). When the local plan was adopted (June 2006), a feasibility study had not yet been undertaken and the plan does not safeguard any land for the bridge and associated approach networks.

18.5.11 The thrust of transport policies contained within the RWELP relate to the A8 corridor and improving access to and from the City of Edinburgh and Edinburgh Airport by road and public transport. The schedule of transport proposals includes the West Edinburgh tram, the Edinburgh Airport rail link, park and ride facilities at Hermiston and Gogar, Edinburgh Airport road links and the A8000 road improvement scheme.

18.5.12 The local plan requires that the impact of transport proposals on the environment must be minimised. Policy TRA9 states that '*careful consideration will be given to the proposed alignment, noise mitigation, siting, and design and adequate levels of high quality screening and landscaping must be provided*'.

18.5.13 The DCLP identifies the Firth of Forth bridgehead as being located within one of the most important transport corridors in Scotland. The 'bridgehead' is where road and rail routes from Fife and eastern Scotland converge and bisect the area. The locational benefits and ease of access to this area are essential to the major development opportunities in East Dunfermline, Rosyth and Dalgety Bay. It is noted that central to these developments and the long term sustainable development of the local plan areas is for an integrated transport network that minimises road use by promoting shorter journeys as well as journeys on public transport or on foot or bicycle.

18.5.14 Policies and proposals concerning transport in the DCLP mainly relate to proposals to improve accessibility and increase the use of public transport such as the Ferrytoll and Rosyth Station park and ride facility (Policy T7 and T8) and proposals relating the Rosyth Waterfront development (Policy PR22 and T6).

18.5.15 The relevant transport policies in the WLLP are related to the Winchburgh development which has been planned to include a junction providing direct access onto the M9, park and ride facilities and public transport proposals including a interchange facility with access to rail and bus services (Policies CDA9 and TRAN29).

Environmental Policies

18.5.16 The focus of the local policy documents is on environmental protection of the landscape, the Green Belt and countryside policy areas, biodiversity (in particular the Firth of Forth Special Protection Area (SPA)), and open space. A number of environmental policies may be affected, with potential effects relating to visual impact and impact on species within the Firth of Forth SPA. Therefore, mitigation may be required.

18.5.17 The setting of designed landscapes of Hopetoun House and Dundas Estate, and North Queensferry, South Queensferry and Inverkeithing town centre Conservation Areas may be affected by the Forth Replacement Crossing. However, the extent of the impact on these areas would be limited due to the existing Forth rail and road bridges which dominate the Forth skyline. The Forth Replacement Crossing would not in itself significantly alter the setting of the designed landscapes and conservation areas (refer to Chapter 12: Cultural Heritage, Chapter 10: Landscape and Chapter 11: Visual). The purpose of the policies contained within the RWELP (E14) and the WLLP (HER22-23) are to protect these areas and their setting. Development affecting the setting of these areas is subject to consultation with Historic Scotland and SNH. . Proposed development would only be permitted if it would not adversely affect the artistic merit, historical, arboricultural, archaeological, architectural, nature conservation or scenic value of the landscape unless '*the adverse effect is outweighed by public benefits arising from the development*'. Mitigation proposals addressing the particular cultural heritage, landscape and visual impacts will be developed during Stage 3 assessment.

Development Briefs

18.5.18 A development comprising of residential development and business development associated with the marina, has been planned at Port Edgar. This proposal is subject to a planning brief which will carry the status of supplementary planning guidance once approved. It is expected that the planning brief will be approved by City of Edinburgh Council in September 2008. Supplementary planning guidance, once approved, becomes a material consideration and carries the same weight as a land use allocation in the local plan. For the avoidance of doubt, at present no planning applications have been submitted in relation to this proposal. If approved, there may be cumulative impacts on the environment which would need to be taken into account. The Forth Replacement Crossing may also impact on the planned development in terms of noise, dust and visual impact, but this would be subject to further and more detailed assessment.

18.5.19 Within South Queensferry, the bridgehead landing would cut through two additional sites that have been allocated for residential development. These sites are located at Springfield and at Society Road (planning policy allocations HSG2 and HSG7 of the RWELP respectively).

Proposed Replacement Bridge

National Policy

18.5.20 The proposed replacement bridge meets national planning objectives regarding economic development and maintaining and improving accessibility as stated previously. However, the bridge and bridgehead landing sites will need further consideration to avoid conflicts with national policies that aim to protect landscape and environmental designations. The Firth of Forth coastline is a nationally and internationally designated site and is part of the Firth of Forth SPA, Forth Islands SPA, Ramsar site and Site of Special Scientific Interest (SSSI). Assessment of significant adverse effects on the qualities for which the area has been designated must be weighed against potential social and economic benefits of national importance.

Regional Policy

18.5.21 In the ELSP, no land has been safeguarded for the development of a second Forth Crossing. Policies relating to development of the coastline support development of the 'developed coastline' if a coastal location is required. Development of the undeveloped coast will only be permitted where the benefits outweigh any detrimental environmental impact and that there is no alternative site. The Forth Replacement Crossing falls within an area designated as 'developed coast', it can therefore be considered that the Forth Replacement Crossing is broadly compliant with the coastal policies.

18.5.22 Policy T2 of the FFSP 2006-2026 recognises the implications of the Forth Replacement Crossing and safeguards land for a new multi modal crossing and associated approach infrastructure. Within the Fife context, the principle of a multi-modal crossing is considered vitally important for Fife's economic and social inclusion agendas.

Local Policy

Transport Policies

18.5.23 The RWELP refers in paragraph 7.10 to the possibility of a replacement bridge across the Firth of Forth as a project of national importance. Further, the policy states that a feasibility study with potential for a new bridge would be required. At the time when the local plan was adopted (June 2006), a feasibility study had not yet been undertaken and the plan does not safeguard any land for the bridge and associated approach networks.

18.5.24 The DCLP identifies the Firth of Forth bridgehead as being located within one of the most important transport corridors in Scotland. The 'bridgehead' is where road and rail routes from Fife and eastern Scotland converge and bisect the area. The proposed replacement bridge is not included in the adopted local plan, however in May 2008 Fife Council published the Dunfermline and West Fife Local Plan Issues and Options report in preparation for the replacement plan. This report states Fife Council's support the multi-modal Forth Replacement Crossing as an infrastructure project of national importance and strategic importance to the economy of Fife.

18.5.25 The WLLP does not contain any policies with specific reference to the proposed replacement bridge.

Environmental Policies

18.5.26 Impacts on listed buildings primarily relate to the Forth Road Bridge and Forth Rail Bridge, both of which are Category A listed structures. Mitigation measures may be required. Listed Building Consent may be required where a development affects the setting or any section of the listed fabric of a listed building. Further discussion with Historic Scotland would need to clarify if Listed Building Consent would be required and which authority would determine such application.

Planned Development

18.5.27 Within South Queensferry, the bridgehead landing would cut through two additional sites that have been allocated for residential development. These sites are located at Springfield and at Society Road (planning policy allocations HSG2 and HSG7 of the RWELP respectively). The development of these sites is supported by Policy H1 which relates to housing sites. The preamble to Policy H1 however states that 'HSG 2 was acquired by the Scottish Executive to facilitate the second Forth Crossing'. As such any use for this acquired land for housing is unlikely.

Northern Route Corridor Options

<u>Impacts Common to Both Northern Route Corridor Options</u>

18.5.28 The main policy designations of importance to all route corridor options relate to international nature conservation sites and policies relating to the undeveloped coast. The coastal zone is substantially developed but still retains important landscape, ecological, historical and recreational attractions which are protected by Areas of Great Landscape Value (AGLV), SSSI, Conservation Areas and other heritage designations. The majority of the coastal area of the Firth of Forth is designated as a SPA and a Ramsar site under European and International Convention and also as a SSSI. Policies in the DCLP in the north and the RWELP and the WLLP in the south have a presumption against adverse effects on these designations.

18.5.29 The DCLP states that there are only a few remaining stretches of undeveloped coast and these require protection from further development. Any coastal development must bring benefits to the coastal zone which may be in the form of pollutant clearance or habitat creation, recreational opportunities, public access, coastal defence and enhanced environmental quality.

18.5.30 Policy COU9 of the DCLP is relevant to the replacement bridge and all of the northern route corridor options. It seeks to protect the various SSSIs and requires that mitigation measures should be put in place to reduce the impact on these sites. The area to the east of the Forth Road Bridge and North Queensferry contains three SSSIs namely Firth of Forth, Carlingnose and Long Craig Island, a section covered by policies related to the undeveloped coast and a Natura 2000 site. The Firth of Forth is also a Ramsar site and an SPA (Policies COU8 and COU17). Two further SSSIs are located at Ferry Hills (Policy COU9) and on a disused tip northeast of the woodland at Fairy Kirk (Policy COU9). There are no Historic Gardens or Designed Landscapes that would be affected on the northern side of the Firth of Forth.

18.5.31 Fife Council is committed through national, regional and local policies to safeguard the 42ha site at Calais Muir South at Dunfermline (Figures 6.2a-b) as a large, single user high amenity site of national importance for employment and economic development (proposal PR20). The Rosyth 2000 partnership will develop the Rosyth Waterfront in accordance with the land uses supported by Policy BIT1 which identifies undeveloped employment land to meet demand for employment land within the DCLP area. The proposed Rosyth International Container Terminal is identified in NPF and the NPF 2 (consultation draft) as a development of national economic importance. The Rosyth Waterfront Area extends from the RD57 Dry Dock to the Forth Road Bridge and incorporates:

- Rosyth Dockyard;
- Rosyth Europarc;
- Port of Rosyth;

- the Oil Fuel Depot and East tip;
- Orchardhead Wood; and
- St. Margaret's Marsh SSSI.

18.5.32 The proposed replacement bridge and the northern route corridor options are within the Rosyth Waterfront regeneration area and will need to take into account both NPF and Fife Council's Proposal 22 requirements regarding the proposals for the Rosyth Waterfront Regeneration Project.

18.5.33 The northern route corridor options do not cross over and are not adjacent to any active mineral extraction areas, however, continued access to the major opencast sites found north of Dunfermline at Colton and St Ninians and Cruicks Quarry, Jamestown, Lochead Quarry, north of Wellwood and Prestonhill Quarry, east of Inverkeithing will be required during construction.

18.5.34 At Rosyth, the Health and Safety Executive (HSE) has established a consultation zone around the Naval Dockyard. The consultation procedure requires certain categories of planning application, which lie within 2.5km of the dockyard, to be referred to the HSE. All of the northern route corridor options just fall within the safeguard consultation zone between Whinny Hill and Hillwood Terrace and therefore the HSE will be consulted.

North Corridor Option 1

18.5.35 All northern route corridor options cross some town and village envelopes as designated in the DCLP. North Corridor Option 1 may affect the envelopes at Rosyth and possibly at East Dunfermline. The policies related to the protection of the town and village envelopes require that development will have to be integrated into the built and natural environment. North Corridor Option 1 is online at these locations and no significant conflict has been identified.

18.5.36 North Corridor Option 1 online upgrade of the M90 is immediately adjacent to Middlebank Souterrain, located at NT 131846 and designated as a Scheduled Ancient Monument (SAM) under the prehistoric domestic and defensive category. Policy BE15 of the DCLP states that support will not be given to development affecting SAMs unless under exceptional circumstances. The alignment and earthworks at this location would require further consideration at Stage 3 to avoid impacts on the SAM and to prevent conflict with this policy.

18.5.37 Fife Council recognises open space as a major urban land use and an essential part of the townscape requiring protection from development. It can act as an amenity buffer between developments and between housing and traffic, and allows views of surrounding features. North Corridor Option 1 skirts an area designated under policy CLR6 of the DCLP for open space, just north of the Masterton Junction to the east of Dunfermline, and this would require to be taken into account in terms of policy compliance. The allocation has been shown on Figure 6.2a.

North Corridor Option 2

18.5.38 North Corridor Option 2 crosses the town and village envelopes of North Queensferry, Inverkeithing and Rosyth as designated in the DCLP. The policies related to the protection of the town and village envelopes require that development will have to be integrated into the built and natural environment. The envelope will primarily be breached at Belleknowes Industrial Estate and the policy would thus be affected.

18.5.39 With regard to transportation policies, the DCLP notes that the Ferrytoll park and ride (adjacent to the west of North Corridor Option 2) is used by commuters and shoppers travelling into Edinburgh and is therefore an important part of the measures being implemented by the local authority to relieve pressure on the Forth Road Bridge. The DCLP therefore safeguards the field directly west of Ferrytoll to enable this service to be extended and both northern route corridor options would clip the allocated site. However, Fife Council has subsequently decided to extend the park and ride facility at Inverkeithing station to the east of the M90 and therefore the Ferrytoll site will now not be required and the proposal has been abandoned.

18.5.40 North Corridor Option 2 would not comply with policies protecting the employment area designated at Belleknowes Industrial Estate. The industrial estate is identified in DCLP as an established employment area (Policy BIT3) and brownfield site (Policy BE7); these policies protect this area from development that would restrict the range of uses that can be carried out by businesses or that would affect their amenity. North Corridor Option 2 crosses the town and village envelopes of North Queensferry, Inverkeithing and Rosyth as designated in the DCLP. The policies related to the protection of the town and village envelopes require that development will have to be integrated into the built and natural environment. The envelope will primarily be breached at Belleknowes Industrial Estate and the policy would thus be affected.

18.5.41 Junction modification at Whinny Hill, as shown on Figure 6.2b, may impact on proposal PR22 in the DCLP which relates to the Rosyth Waterfront Regeneration Area, as access to and from the new M90 may be affected.

18.5.42 Assuming that the existing M90 is no longer in use, North Corridor Option 2 would have a slightly beneficial impact on the development at the Eastern Dunfermline Expansion Area due to the slightly increased distance between the planned mixed use development and the route corridor. The actual level of benefit would depend on forecast traffic volumes and associated noise levels.

Southern Route Corridor Options

<u>Impacts Common to Both Southern Route Corridor Options</u>

18.5.43 Landscape quality and the rural character and amenity of rural west Edinburgh will need to be protected and this should be achieved through mitigation measures taking into account design, landscaping and appropriate screening in order to integrate the development into the existing landscape.

18.5.44 The proposed junction to serve the Forth Replacement Crossing runs along the northern boundary of the proposed mixed use development at Winchburgh. Policies CDA9 and TRAN29 of the WLLP allocate a motorway junction near Duntarvie Castle to be developed to support the development of the Winchburgh Core Development Area for 40ha employment land and up to 5500 homes. The assessment assumes that neither route corridor option would preclude this access. Therefore the proposed development would comply with CDA9 and TRAN29.

<u>South Corridor Option 1</u>

18.5.45 The proposal for South Corridor Option 1 would not comply with policies protecting the Green Belt and the countryside (Policies E5-E6, E23, E24 of the RWELP) to the west of Edinburgh, and the Forth Replacement Crossing and associated infrastructure may compromise the policy's function to maintain a defensible boundary to the City of Edinburgh. RWELP Policy E5 would only permit development in the Green Belt related to and within the defined boundaries of Edinburgh Airport, Royal Highland Showground and Heriot Watt University's Riccarton Campus which are recognised as areas of strategic economic importance. The areas of countryside not covered by the Green Belt policies are considered of equal environmental importance even though they do not fulfil Green Belt objectives. Therefore, the same level of protection will be accorded to countryside areas within the plan area. Infrastructure development is not identified as an acceptable use of the Green Belt and countryside areas within the RWELP. South Corridor Option 1 requires the least amount of land for development and also has the least impact on the Green Belt and countryside designations. There may be some loss of amenity for the residents of the Echline area of South Queensferry due to increased levels of noise as a result of the proximity to the route corridor. However, as most of the route corridor runs online with the existing route the impacts are not significantly greater than the current situation.

South Corridor Option 2

18.5.46 The proposal for South Corridor Option 2 would not comply with policies protecting the Green Belt and the countryside (Policies E5-E6, E23, E24 of the RWELP) to the west of Edinburgh, and its function as a defensible boundary to the city may be compromised as a result of the Forth Replacement Crossing. RWELP Policy E5 would only permit development in the Green Belt related to and within the defined boundaries of Edinburgh Airport, Royal Highland Showground and Heriot Watt University's Riccarton Campus which have a status of strategic economic importance. The areas of countryside not covered by the Green Belt policies are considered of equal environmental importance even though they do not fulfil Green Belt objectives. Therefore, the same level of protection will be accorded to countryside areas within the plan area. South Corridor Option 2 requires a greater amount of land to be developed compared to South Corridor Option 1. It also runs through a substantial area protected by countryside policy and an Area of Outstanding Landscape Quality (AOLQ) at Muiriehall Wood. AOLQs are protected through policy E8 of the RWELP which states that development proposals will be considered against those landscape features which contribute to landscape quality.

18.6 Summary of Policy Assessment

Northern Route Corridor Options

North Corridor Option 1

18.6.1 The northern route corridor option with the least conflict with policy is North Corridor Option 1. This option is predominantly online and would therefore present the least impact on future development patterns and planning allocations and would broadly comply with planning policies. Some land take may be required at St Margaret's Marsh SSSI though it would be less than that required for North Corridor Option 2. There are some impacts in relation to listed buildings, cultural heritage and the developed coast, all of which conflict with planning policy to a greater or lesser extend. Of particular importance is Middlebank Souterrain SAM, which is in closer proximity to North Corridor Option 1 than on North Corridor Option 2.

North Corridor Option 2

18.6.2 North Corridor Option 2 is less compliant with policies and plans compared to North Corridor Option 1. North Corridor Option 2 would lead to a loss of employment land and breach of settlement envelope at Belleknowes Industrial Estate in Rosyth. Following landfall the route corridor runs west of the current alignment up towards Belleknowes Industrial Estate and would therefore have a greater impact on St. Margaret's Marsh SSSI as some land take may be required in this location. Similarly to North Corridor Option 1, there are some impacts in relation to listed buildings, cultural heritage and the developed coast, all of which conflict with planning policy to a greater or lesser extent.

Southern Route Corridor Options

South Corridor Option 1

18.6.3 The southern route corridor option with the least conflict with policy is South Corridor Option 1. It would have some impact on Dundas Estate in terms of conflict with designed landscape, Site of Importance to Nature Conservation (SINC), SAMs and Green Belt planning policies. The impacts are mainly confined to the area north of Dundas Estate where the route corridor clips the SINC.

18.6.4 South Corridor Option 1 runs offline for a shorter distance than South Corridor Option 2 and therefore has the slightest impact on the current development pattern. However, as discussed previously two allocations for residential and one allocation for open space development are affected in South Queensferry.

South Corridor Option 2

18.6.5 South Corridor Option 2 would have more potential for planning policy conflict than South Corridor Option 1. This corridor option has a substantially higher amount of land take. The route corridor would cut through a substantial area of land which is currently protected by policies relating to the countryside and the AOLQ. The western section of the route corridor runs primarily offline. Two allocations for residential and one allocation for open space development are affected in South Queensferry as discussed previously.

18.7 Scope of Stage 3 Assessment

18.7.1 The Stage 3 assessment will include the following components as set out in DMRB Volume 11, Section 3, Part 12:

- update on status of policies and plans obtained for Stage 2 assessment;
- assessment of the impact of the preferred route corridor on policies and plans;
- review of compliance or non-compliance of policies by the preferred route corridor;
- consultation with City of Edinburgh Council, Fife Council and West Lothian Council on the preferred route corridor and its implications on the preferred route corridor on planning policy objectives;
- review of the effects of mitigation proposals on any identified potential conflicts with policies and plans.

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Forth Replacement Crossing

DMRB Stage 2 Corridor Report

Part 4: Traffic and Economic Assessment

Report on Scheme Development Work: May to August 2008

Contents: Volume 1 (Main Report and Appendices)

19 Modelling

19.1 Introduction

19.1.1 The traffic and economic assessment of the alternative options proposed for the connecting road network required in conjunction with the proposed replacement bridge has been undertaken using the Transport Model for Scotland (TMfS:05A). This is a strategic, four stage, multi-modal forecasting model with a 2005 base year that translates output from the Transport and Economic Land Use Model of Scotland (TELMoS) into forecasts of travel demand on both the road and public transport networks.

19.1.2 TMfS:05A was used to compare alternative options in terms of performance indicators such as changes to traffic flows, speeds, journey times and travel distances. These outputs are then input to the Transport Users Benefit Appraisal (TUBA, v1.7) software to identify the economic benefits of each option compared to a do-minimum scenario. Output from TMfS:05A was also used in the environmental appraisal of options as discussed in Chapter 13 (Air Quality) and Chapter 14 (Traffic Noise and Vibration).

19.1.3 This section of the report describes the operation of the transport model and a review of its accuracy with regard to cross-Forth travel and future year forecasting. Chapter 20 (Effects of Route Corridor Options) summarises the primary effects of the corridor options considered. The economic performance of the various corridor options are presented in Chapter 21 (Economic Performance of Route Corridor Options).

19.2 Transport Model for Scotland

19.2.1 The Transport Model for Scotland (TMfS:05A) is an enhanced version of TMfS:05, as used in the Forth Replacement Crossing Study as part of the Strategic Transport Projects Review (STPR) and reported in 2007. Both have a base year of 2005, and cover a geographical area that encompasses 95 per cent of the population of Scotland. They also include all of the principal urban centres (except Inverness), all Trunk Roads and a large proportion of non-Trunk principal roads. The model has been developed and maintained by MVA Consultancy (MVA) for Transport Scotland, for use as a planning and forecasting tool for projects such as this.

19.2.2 The main difference between these two versions of the transport model was the inclusion of modelled zones and public transport networks across the Highlands and Islands, alongside the incorporation of additional Origin – Destination travel data obtained through Roadside Interview (RSI) data in Ayrshire and around Dundee into the model calibration and validation process. Full details of TMfS model development and operation are available from www.tmfs.org.uk.

19.2.3 Road based travel demand is assigned to the highway network using a volume averaged all-or-nothing assignment, in passenger car units (pcu) for each of the following four vehicle classes:

- Cars (travelling in work time);
- Cars (travelling in non-work time);
- Light Goods Vehicles (LGV); and
- Other Goods Vehicles (OGV).

19.2.4 In addition, scheduled bus and coach services are coded to follow predefined routes based on operator timetables.

19.2.5 Model vehicle speeds are derived from speed-flow curves for each link type in the TMfS model. Junction delays are calculated for each movement at each modelled junction. Figures showing the extent of junctions that have been modelled are provided in the model calibration and validation reports on the TMfS website.

19.2.6 Three distinct one hour time periods are modelled. These are:

- 08:00 – 09:00 (AM);
- 1/6 of 10:00 – 16:00 (inter-peak); and
- 17:00 – 18:00 (PM).

19.2.7 Across the network as a whole, the 08:00 – 09:00 modelled hour is considered broadly representative of the morning 'peak' hour, while the 17:00 – 18:00 modelled hour is considered broadly representative of the evening 'peak' hour.

19.2.8 To assess traffic flows over other time periods (for example 18 hour average weekday and Annual Average Daily Traffic (AADT)), AM, inter-peak and PM flows are combined as follows:

- 18 hour weekday flow = 2.21 x AM flow + 8.61 x inter-peak flow + 2.58 x PM flow
- AADT flow = (560 x AM flow + 3419 x inter-peak flow + 651 x PM flow) / 365

19.2.9 These conversion factors were provided by MVA based on their analysis of Scottish Household Survey data. Factors were provided for both Scotland as a whole and disaggregated by Regional Transport Partnership (RTP) area. Resulting flow estimates, based on factors for the South East Scotland Transport Partnership (SEStran) area, were used in the environmental appraisal and for defining the proposed mainline carriageway standards.

19.2.10 Economic assessments required the use of default national factors (from TUBA guidance) to annualise the data as trips to and from other parts of Scotland were included in the assessment. The relevant factors are:

- Annual flow = (559 x AM flow) + (3596 x inter-peak flow) + (650 x PM flow)

19.2.11 The economic appraisal of options is discussed in Chapter 21 (Economic Performance of Route Corridor Options).

19.3 TMfS Representation of Baseline Conditions

19.3.1 The TMfS:05A is designed to replicate 2005 flows across the modelled area as closely as possible. Consequently, baseline conditions in the model are broadly as per the existing traffic conditions set out in Chapter 3 (Existing Conditions). The accuracy of the model nationwide is addressed in the model calibration and validation reports on the TMfS website.

19.3.2 Two highway only model tests were undertaken to review the sensitivity of the model response to the opening of the M9 Spur Extension in September 2007 and the removal of bridge tolls in February 2008. These sensitivity tests assumed no change in travel demand from the calibrated base model and allow only for change in route choice arising from these interventions. This approach best represents the short term route choice effects of the changes modelled, without the influence of longer term travel behaviour choices, which are represented in the full demand model. This was considered the best approach in the limited time available since these events occurred.

19.3.3 These sensitivity tests indicate that construction of the M9 Spur Extension would contribute to a decrease in traffic using the A90 between Scotstoun and Barnton of around two percent, with a corresponding marginal increase in traffic on the M9 Spur south of the former Humbie Roundabout. These changes are broadly consistent with observed changes in traffic demand in this area.

19.3.4 These sensitivity tests also indicate that removal of the tolls from the Forth Road Bridge would lead to an increase in northbound flows across the Forth Road Bridge, particularly in the morning and evening modelled hours, but little change in southbound flows. The additional northbound traffic forecast to use the bridge is consistent with a modest increase in traffic using the extended M9 Spur in the northbound direction and increased traffic flows on the A90 between Barnton and Scotstoun; to a level similar to that which existed prior to the opening of the M9 Spur Extension.

19.3.5 Taken together, these tests provide confidence that the model adequately represents baseline conditions across the study area and is therefore suitable for the testing and appraisal of the alternative connecting road options considered in this DMRB Stage 2 assessment.

19.4 Population and Employment Forecasting

19.4.1 As highlighted earlier, TMfS:05A is a strategic four stage multi-modal forecasting model with a 2005 base year that translates output from the Transport and Economic Land Use Model of Scotland (TELMoS) into forecasts of travel demand on both the road and public transport networks.

19.4.2 TELMoS is a land use model that forecasts future changes in population and employment, based on data from the 2001 census and more recent population forecasts made by the General Register Office for Scotland (GROS), forecast planning allocations provided by the local authorities, and relative travel costs obtained from TMfS:05A, taking account of committed future transport interventions.

19.4.3 TELMoS produces three future year forecasts of population, number of households and employment: 2012, 2017 and 2022. These forecasts are then used within TMfS:05A to generate travel demand forecasts in the years 2012, 2017 and 2022.

19.4.4 Figures 19.1 to 19.4 (Volume 2) show the most significant changes in population and employment forecast by TELMoS (scenario I) in 2017 and 2022 (compared to a base year of 2005). Shaded areas show areas where significant changes are forecast to occur, defined in the context of this Chapter as an increase or decrease of more than 1,500 people or jobs compared with the 2005 base. Darker colours indicate the areas with the most significant changes.

19.4.5 Figure 19.1 indicates the principal areas where TELMoS forecasts a significant change in population between 2005 and 2017. Within the City of Edinburgh, the population is forecast to increase in a number of parts of the city, with forecast growth being strongest in the Leith area. No areas of the city are forecast to see a significant reduction in population. Growth is also forecast in southeast Edinburgh and Midlothian with the forecast growth in population being strongest to the south of Dalkeith in the Newtongrange and Gorebridge area reflecting land release in the ‘A7 / A68 / Waverley Line Corridor’.

19.4.6 Within West Lothian, the population is forecast to grow in several areas, primarily in the M8 Corridor. This growth in population is forecast to be greatest in Bathgate, Livingston and Uphall and Broxburn. It is also significant in Winchburgh, Armadale, Fauldhouse / Whitburn, and to a lesser extent at Pumpherston and East Calder. No areas of West Lothian are forecast to see a significant reduction in population. Grangemouth, within the Falkirk Council area is forecast to see a significant reduction in population, as is the Harthill and Shotts area within North Lanarkshire.

19.4.7 North of the Firth of Forth, significant population growth is forecast in the Halbeath / Duloch Park area of Dunfermline, but a significant reduction in population is forecast in other areas of Fife including central Dunfermline, Dalgety Bay and Aberdour, the Templehall area of Kirkcaldy and the south of Glenrothes.

19.4.8 Figure 19.2 indicates the areas where TELMoS forecasts a significant change in employment between 2005 and 2017. To the south of the Firth of Forth, employment growth is forecast to be strongest in Midlothian and southeast Edinburgh. The growth in jobs is forecast to be greatest at Edmondstone: the area surrounding the Edinburgh Royal Infirmary; and in the Roslin and Bilston area of Midlothian. Both of these locations are designated Economic Clusters of National Importance in the Edinburgh and Lothians Structure Plan 2015 (ELSP). Significant growth is also forecast at other parts of the 'South East Wedge', namely around Millerhill and Todhills. This represents the take up of land for proposed development in the 'A7 / A68 / Waverley Line Corridor' and 'A701 Corridor' Core Development Areas as set out in the ELSP. No significant declines in employment opportunities are forecast in this area, although a slight decrease is forecast in the Penicuik area.

19.4.9 Within Edinburgh, employment opportunities are expected to increase most along the waterfront at Granton and Leith. Growth in employment is also forecast in parts of southwest central Edinburgh, particularly around Haymarket, Fountainbridge, Tollcross and the Meadows. Significant employment growth is also forecast in West Edinburgh at Newbridge, Gogarburn, Edinburgh Park and South Gyle and in the area around Heriot Watt University's Riccarton Campus. Again, this development is forecast to occur within areas set out as Core Development Areas in the ELSP. No significant declines in employment are forecast within Edinburgh, although there is a slight decrease in employment opportunities forecast in some areas of the city.

19.4.10 Substantial growth in employment is also forecast in West Lothian, particularly in the West Calder area to the southwest of Livingston and in Bathgate. A significant increase in employment opportunities is also forecast in the Blackburn / Boghall, Almondvale, Fauldhouse / Whitburn and Broxburn / Uphall areas. Significant employment growth in the Winchburgh and Hopetoun areas is also forecast. Some of this employment growth is forecast within two of the specified Core Development Areas of the ELSP: 'Livingston and the Almond Valley' and 'Winchburgh, East Broxburn and Uphall'. TELMoS also forecasts growth outside of these Core Development Areas, as highlighted above, in preference to the Armadale Core Development Area. However, some growth in employment is forecast to occur in Armadale, as well as at East Calder and Stoneyburn by 2017. No areas of West Lothian are forecast to see a significant decrease in employment opportunities, although a slight reduction in employment opportunities in central Livingston and the Pumpherston areas is forecast.

19.4.11 Further west, Grangemouth, within the Falkirk Council area, is forecast to see a significant reduction in employment, and an increase in the Larbert and High Bonnybridge area is forecast.

19.4.12 To the north of the Firth of Forth, employment opportunities are forecast to increase in the Kirkcaldy Templehall and Halbeath / Duloch Park areas, indicating a forecast expansion of Dunfermline, principally to the east. This growth is forecast to occur within areas designated for economic development in the Fife Structure Plan 2006-2026. Some reductions in central Dunfermline and to a lesser extent in some other areas are forecast. Significant growth in employment is forecast further north in the area around Kinross.

19.4.13 Traffic is likely to increase most within and between areas where a significant increase in population is forecast and areas where a significant increase in employment is forecast, particularly for movements that are not well served by public transport. Traffic growth will generally be lowest between areas where population and employment opportunities are both forecast to decline. On this basis, traffic growth is likely to be most significant between West Lothian and Midlothian / southeast Edinburgh. Consequently, the underlying demand for travel between West Lothian, Midlothian and southeast Edinburgh is likely to create significant pressures on the connecting road network, in particular the M8, A89 / A8 and A71 routes through rural west Edinburgh and the A720 Edinburgh City Bypass.

19.4.14 Growth in traffic movements within south Fife is likely to be lower as a result of a small decline in population in parts of south Fife and substantially less employment growth than is forecast in West Lothian. However, some growth in cross-Forth traffic would be expected as Fife residents may look to take up employment in growth areas south of the Firth of Forth. As direct public transport links between Fife and West Lothian and between Fife and Midlothian / southeast Edinburgh are limited, much of this demand is likely to translate into road based transport. The growth in traffic across the Forth is likely to be strongest to these new areas of employment, for which the preferred route is likely to be via the M9 Spur or alternative connection towards the M8 at Claylands, with the additional traffic flows splitting at this point between West Lothian and Midlothian / southeast Edinburgh.

19.4.15 Figure 19.3 indicates the principal areas where TELMoS forecasts a significant change in population between 2005 and 2022. The pattern of growth is similar to 2017. Within the City of Edinburgh, TELMoS forecasts further growth in the population in Leith and also continuing growth to the southeast of the city and the expansion of the urban area into Midlothian, with growth forecast to continue at settlements south of Dalkeith. No significant reductions in population are forecast in this area.

19.4.16 Within West Lothian, the population is forecast continue to grow, with growth being strongest in the Winchburgh area. As in 2017, no areas of West Lothian are forecast to see a significant reduction in population. However, the population in the Harthill and Shotts area within North Lanarkshire is forecast to continue to decline beyond 2017.

19.4.17 North of the Firth of Forth, the forecast pattern of population change is little changed between 2017 and 2022, although a significant increase in population is forecast at Forestmill in Clackmannanshire by 2022.

19.4.18 Figure 19.4 indicates the principal areas where TELMoS forecasts a significant increase in employment between 2005 and 2022. The pattern of growth forecast is similar to 2017, but with most of the land allocation in Edinburgh and Midlothian being taken up in full by 2017, growth in employment between 2017 and 2022 is forecast to be strongest in West Lothian. In particular, further growth is forecast in the West Calder area, at Blackburn / Boghall, Almondvale and in the Uphall and Broxburn area. TELMoS also indicates significant growth in the Armadale Core Development Area by 2022, reflecting take up of the majority of zoned land at potentially more desirable locations further east. Within West Lothian, the only area likely to experience a significant reduction in employment opportunities by 2022 is central Livingston.

19.4.19 Within Midlothian and southeast Edinburgh, further growth in employment opportunities is forecast in the Bonnyrigg and Rosewell area of Midlothian and the Greendykes area of southeast Edinburgh. Within the City of Edinburgh itself, there is little additional employment growth forecast between 2017 and 2022, although a significant reduction in employment opportunities is forecast by 2022 in Craigleith and parts of central Edinburgh. Further growth in employment is forecast at Edinburgh Park and at Newbridge on the west of the city. In southern Fife and the Falkirk area, little change in employment is forecast between 2017 and 2022.

19.4.20 The anticipated year of opening for the replacement crossing is 2017 and therefore the design year (15 years after scheme opening) is 2032. The TMfS05a does not forecast this far into the future, primarily due to uncertainty in the location of future development beyond 2022 and the consequent impact of traffic arising from any potential developments. Therefore, it was necessary for design and appraisal purposes to derive potential 2032 traffic matrices and then undertake a highway only assignment using 2022 cost equations and other parameters to create a pseudo 2032 forecast. The derivation of these 2032 matrices is discussed more fully in the following section.

19.5 Future Year Matrices

19.5.1 Highway model assignment matrices for 2017 and 2022, were derived from full model runs of TMfS:05A. The full model run reflects changes in the choice of destination, travel mode, trip frequency, and route travelled. However, for comparative purposes between connecting link road options, it is also possible to assign the same fixed pattern of demand to all appraisal options using a highway only assignment. This approach was undertaken for this DMRB Stage 2 comparative assessment.

19.5.2 Consequently, each of the options discussed in Chapter 20 (Effects of Route Corridor Options) was appraised using the same highway matrices in each of the years 2017, 2022 and 2032.

19.5.3 To produce estimates for 2032, traffic forecast to cross the Forth Road Bridge in the 2022 Reference Case was separated from other traffic in the highway assignment matrices so that different traffic growth forecasts could be applied to each.

19.5.4 Bridge traffic was factored by the rate of growth of bridge traffic observed over the most recent 10 years (20%) to estimate growth from 2022 to 2032. The remaining traffic was factored by National Road Traffic Forecasts (NRTF, 1997) central all vehicle growth for the same period (8.4%).

19.5.5 As the rate of traffic growth tends to reduce over time, the use of the full rate of growth over the last 10 years, applied to 2022 forecast levels for bridge traffic is considered to tend towards a ‘worst case’ in terms of both engineering design and environmental appraisal.

19.6 Do-Minimum Network

19.6.1 The TMfS:05A is intended to assess the impact of large scale strategic interventions by comparing the intervention scenario with a do-minimum or reference case scenario, such that the difference between the two identifies the impacts.

19.6.2 It is therefore necessary to define the committed and most likely changes that will be made to the transport network between 2005 and each of the appraisal years (2012, 2017 and 2022) to obtain the most representative appraisal results. These committed and likely interventions form the TMfS:05A ‘Do-minimum’ and ‘Reference Case’ scenarios respectively and were defined by Transport Scotland in August 2007 and subsequently incorporated into TMfS:05A by MVA.

19.6.3 The 'Do-minimum' interventions included within TMfS:05A (source: www.tmfs.org.uk), are listed in Table 19.1.

Table 19.1: Interventions in TMfS:05A Do-minimum scenario

Appraisal Years	Interventions incorporated in TMfS:05A Do-minimum
2017 & 2022	As 2005 Base Scenario plus: M74 Completion; M9 Spur Extension; Finnieston Bridge; A68 Dalkeith Northern Bypass; Ferrytoll Link Road; Second Upper Forth Crossing at Kincardine; Alloa - Stirling - Glasgow Rail Service; Airdrie - Bathgate Rail Reopening; Edinburgh Tram Project (Phase 1a); Glasgow Airport Rail Link; Borders Rail Service; M80 Upgrade; Aberdeen Western Peripheral Route; M8 Baillieston to Newhouse Upgrade (including Raith Interchange and Associated Network Improvements); Larkhall to Milngavie rail project; Edinburgh Waverley station upgrade; A830 Arisaig to Loch Nan Uahm; A96 Fochabers to Mostodloch Bypass; A90 Balmeddie to Tipperty Dualling; Removal of Forth Road Bridge tolls; Removal of Tay Road Bridge tolls; Heartlands development; Pollock development; A68 Roundabout at Newton St Boswells; A90 New Interchange at Portlethan; A82 Strathleven Roundabout; Cross-Forth rail scenarios: • Larbert – Stirling re-signalling; • Forth Rail Bridge re-signalling; • Additional park and ride capacity at Kirkcaldy, Markinch, Rosyth and Perth; • Edinburgh - Aberdeen express services; • Edinburgh - Dundee services stopping at Fife stations; • Hourly Edinburgh - Perth service; • Newcraighall services extended to Fife (instead of Bathgate / Dunblane); and Scotland's Railway short-term Infrastructure • Laurencekirk station (2 hourly service); • Bishopbriggs platform extension (6-car services between Glasgow - Dunblane); • Elgin & Insch platform extensions (6-car services between Aberdeen – Inverness); • Lugton to Stewarton Loop – ½ hour Kilmarnock to Glasgow service; • Haymarket station (no model impact); • Gourock Transport Interchange (no model impact).

19.6.4 In addition to the TMfS:05A do-minimum interventions, a number of non-contentious interventions are considered likely to progress, but are not yet committed. These interventions form the TMfS:05A Reference Case and are listed in Table 19.2.

Table 19.2: Interventions in TMfS:05A Reference Case scenario

Appraisal years	Interventions incorporated in TMfS:05A Reference Case
2012	As TMfS:05A Do-minimum plus: Bishopton; Glasgow East End Regeneration Route; A77 South of Whitlett duelling; and Cross-Forth rail scenarios: Additional park and ride capacity at Cupar, Dunfermline Town, Leuchars, Markinch and Dunfermline Queen Margaret.
2017	As 2012 Reference Case plus: Cross-Forth rail scenarios: Hourly Edinburgh - Inverness service; Remove Dalmeny / North Queensferry stops from Fife Circle; and Borders rail service to Inverkeithing stopping all stations.
2022	As 2017 Reference Case plus: Cross-Forth rail scenarios: All Edinburgh - Dundee services operated as 6-car sets.

19.6.5 For appraisal purposes on the proposed replacement bridge, the TMfS:05A Reference Case has been adopted as the do-minimum case for environmental appraisal and is therefore referred to as the Environmental Do-minimum.

19.6.6 The TMfS:05A Reference Case assumes that the Forth Road Bridge will remain open in 2012, 2017 and 2022 with the existing capacity maintained. The structural information currently available from the Forth Estuary Transport Authority (FETA) suggests that this is unlikely, and that complete or partial closure to traffic (or certain classes of traffic) may be required, either temporarily while repair work is undertaken, or permanently. Consequently, the previous Forth Replacement Crossing Study undertaken as part of the Strategic Transport Projects Review assumed a do-minimum scenario with no bridge in place; that is assuming that the Forth Road Bridge closes to all traffic in 2017. This would result in a substantial reduction in cross-Forth trips as work and leisure trip patterns would change. The remaining cross-Forth traffic would generally re-route via Kincardine or Stirling. This is referred to as a 'No Bridge' scenario in this assessment, which is as per the TMfS:05A Reference Case but with the Forth Road Bridge closed.

19.7 Do-Minimum Forecasts

19.7.1 Figure 19.5 indicates Annual Average Daily Traffic (AADT) flows on the wider road network in 2005, while Figure 19.6 indicates forecast AADT flows over the same area in 2017 representing the two potential minimum intervention scenarios referred to in Section 19.6. The first of these is the TMfS:05A Reference Case or Environmental Do-minimum scenario, which assumes that the Forth Road Bridge remains open to traffic. The second set of forecasts assumes a 'No Bridge' scenario, which is the do-minimum for economic appraisal. The 'No Bridge' scenario assumes closure of the Forth Road Bridge with no replacement crossing constructed, but is otherwise the same as the Environmental do-minimum. Under this scenario, cross-Forth traffic must use one of the bridges at Kincardine or in the Stirling area.

'No Bridge' Scenario

19.7.2 The impact of a scenario where the Forth Road Bridge were to close in 2017 with no replacement crossing provided in the Queensferry area, would have a substantial impact on traffic flows across a wide area of east central Scotland. To the north of the Firth of Forth, traffic flows would decline most significantly on the M90 / A90 to well below existing levels of traffic. The strategic nature of the corridor means that a significant proportion of the traffic flow would divert towards Stirling or Kincardine from a significant distance north of the Firth of Forth, generally at Perth, following the A9 towards Dunblane, or at Kinross, following the A91 westwards.

19.7.3 Traffic would also drop on the A92 East Fife Regional Road, although the forecast decline in traffic would only be to current levels, with the lesser decline reflecting the reduced route choice for travel to and from the areas of Fife served by this road. A marginal decline in traffic on the A921 coast road would also be expected, although as this route mainly carries local traffic, the impact would be significantly less than the declines forecast on the trunk road network.

19.7.4 To the west of Dunfermline, traffic would be anticipated to double on the main routes towards Kincardine: the A985 trunk road and the A994 through Crossford as a result of the bridge closure. Traffic would also be expected to double on the A977 north of Gartarry Roundabout, principally as result of traffic diverting from the M90 at Kinross via the A91. Taken together, these flows would result in a significant increase in traffic on both the existing Kincardine Bridge and the Upper Forth Crossing, currently under construction to the west of Kincardine. The forecast increase in traffic would be greatest on the existing Kincardine Bridge because it is best placed to serve the demand to and from Dunfermline and the south Fife coast. The Upper Forth Crossing is better placed to cater for longer distance traffic from the north or northeast of Scotland travelling via the A91 and A977. Forecast traffic flows on the existing Kincardine Bridge under a 'No Bridge' scenario would be more than 50 per cent above existing levels and therefore significant delays would be likely.

19.7.5 To the south of the Firth of Forth, the additional cross-Forth traffic around Kincardine would result in a significant increase in traffic flows on the M9 (particularly to the east of Junction 7). Forecast traffic levels would be more than twice existing flows between Junction 7 and Junction 1a. A small increase in traffic using north south routes from the M9, such as the A801 and B8046 would be expected, but most of the additional traffic would remain on the M9 as far as Junction 1a.

19.7.6 Within the southern bridgehead area, flows on the A904 through Newton village would be expected to increase to more than twice existing levels. Flows on the A90 east of Echline would be expected to drop by up to fifty per cent. Traffic on the M9 Spur would be expected to drop significantly, as this would become little more than a local access route to South Queensferry This also contributes to a reduction in traffic on the M9 between Junction 1a and Newbridge. Forecast traffic flows on the A8 between Newbridge and Gogar and the M8 between Claylands and Hermiston Gait would be broadly similar with and without a crossing at Queensferry.

19.7.7 The adverse impact on traffic flows across east central Scotland, particularly in the vicinity of Kincardine and Falkirk, is substantial enough to imply that closure of the Forth Road Bridge, with no infrastructure improvements on the many diversionary routes, is not a desirable option. Prolonged closure of the Forth Road Bridge, for any reason, would likely necessitate either substantial capacity enhancements on these diversionary routes, or a replacement crossing close to the site of the existing bridge. The findings of the Forth Replacement Crossing Study undertaken as part of the Strategic Transport Projects Review justified the need for a proposed replacement bridge on this basis.

19.8 Summary

19.8.1 The Transport Model for Scotland (TMfS:05A) has been used to provide existing and future forecast traffic flows. Details of the model development, operation, calibration and validation of the model are set out in reports available on the TMfS website (www.tmfs.org.uk). The model validates well against observed data on the Forth Road Bridge and responded as expected to sensitivity tests undertaken to identify the effects of the opening of the M9 Spur Extension in September 2007 and the removal of bridge tolls from the Forth Road Bridge in February 2008.

19.8.2 Future changes in land use, population and employment are forecast using the Transport Economic Land-use Model of Scotland (TELMoS) for the period until 2022. This is then used within the Transport Model for Scotland (TMfS:05A) to create travel demand forecasts for 2017 (the opening year of the proposed replacement bridge) and 2022. Traffic forecasts for the design year (2032) for engineering design purposes and environmental appraisal have been derived by factoring the 2022 forecast matrices using a combination of historic growth for cross-Forth trips, and National Road Traffic Forecasts (NRTF) Central Growth for other traffic. These revised matrices were used to create 2032 forecasts.

19.8.3 Do-minimum and reference case infrastructure was defined by Transport Scotland in August 2007 and incorporated in TMfS:05A by MVA. For the purposes of DMRB Stage 2 assessment, the TMfS:05A Reference Case has been taken as the do-minimum for Environmental Appraisal, while a ‘No Bridge’ scenario has been taken as the proposed replacement bridge do-minimum for economic elements of scheme appraisal.

19.9 References

The City of Edinburgh Council, East Lothian Council, Midlothian Council, West Lothian Council. Edinburgh and Lothians Structure Plan 2015

Fife Council. Fife Structure Plan 2006 - 2026

20 Effects of Route Corridor Options

20.1 Introduction

20.1.1 Following the route corridor option sifting discussed in Chapter 3 (Description of Route Corridor Options), four route corridor options (two on each side of the Forth) were selected for further assessment as summarised below.

- North Corridor Option 1 is an online upgrade of the A90 / M90 between the northern bridgehead and the A92 at Halbeath Interchange.
- North Corridor Option 2 is an offline upgrade of the A90 / M90 between the northern bridgehead and the A92 at Halbeath Interchange.
- South Corridor Option 1 is a new dual three lane carriageway between the proposed southern bridgehead and the A90 west of Scotstoun Junction with connections to Echline Junction and the A904. The existing Scotstoun Junction is retained with additional links providing interaction between the M9 Spur, A90 and the local road network. No links are provided between the M9 Spur and the A90 to the east. M9 Junction 1a is to be reconstructed to incorporate new west facing links within a free-flow junction arrangement.
- South Corridor Option 2 is a new dual three lane motorway between the M9 west of M9 Junction 1a and the A904. A new free-flow junction is to be provided to M9 providing full connectivity between the proposed mainline, the M9 and the M9 Spur. A new junction is also proposed between the mainline and the A904 with north facing slip roads only. This junction shall provide local and non-motorway access to the proposed replacement bridge, motorway restrictions on the mainline being terminated through the junction area. At Scotstoun, the existing junction arrangement is to be reconstructed, priority being given to the new M9 Spur to A90 eastbound connection.

20.1.2 For traffic and economic appraisal, it is necessary to combine the corridor option alternatives that are subject to more detailed appraisal to create four do-something scenarios. It is assumed that the existing Forth Road Bridge is not open to traffic, under each scenario. The do-something scenarios that are discussed in this section of the report are defined below (with their TMfS:05A test identifiers):

- North Corridor Option 1 and South Corridor Option 1
- North Corridor Option 2 and South Corridor Option 1
- North Corridor Option 1 and South Corridor Option 2 and
- South Corridor Option 2 and North Corridor Option 2

20.2 Northern Route Corridor Options

20.2.1 Figures 20.1 and 20.2 (Volume 2) indicate forecast Annual Average Daily Traffic (AADT) flows on key links in the network north of the Forth Road Bridge in both the opening year (2017) and the consequent design year (2032). Two sets of flows are presented for each year reflecting the forecasts for each option paired with both options at the southern bridgehead. Assignments are based on a fixed demand matrix for each highway model assignment.

20.2.2 Figure 20.1 indicates the forecast AADT flows for North Corridor Option 1 in 2017 and 2032. The forecast flows vary slightly depending on the connecting infrastructure to the south of the Firth of Forth, with flows on the M90 forecast to be slightly higher when this option is paired with South Corridor Option 2.

20.2.3 Figure 20.2 indicates the forecast AADT flows for North Corridor Option 2 in 2017 and 2032. The forecast flows again vary slightly depending on the connecting infrastructure to the south of the Firth of Forth, with flows on the M90 forecast to be slightly higher when this option is paired with South Corridor Option 2.

20.2.4 Comparing the forecast flows on the road network surrounding the proposed new infrastructure indicates little difference between the two northern route corridor options. Forecast flows on the offline section in North Corridor Option 2 are lower than the equivalent on-line sections because the existing road infrastructure remains to cater for local traffic, resulting in greater segregation between longer and shorter distance flows. Both options appear to be capable of accommodating anticipated traffic volumes.

20.3 Southern Route Corridor Options

20.3.1 Figures 20.3 and 20.4 (Volume 2) indicate forecast Annual Average Daily Traffic (AADT) flows on key links in the network south of the Forth Road Bridge in both the opening year (2017) and the consequent design year (2032). Two sets of flows are presented for each year reflecting the forecasts for each option paired with both options at the northern bridgehead.

20.3.2 Figure 20.3 indicates the forecast AADT flows for South Corridor Option 1 in 2017 and 2032. The forecast flows vary slightly depending on the connecting infrastructure to the north of the Firth of Forth.

20.3.3 Figure 20.4 indicates the forecast AADT flows for South Corridor Option 2 in 2017 and 2032. The AADT forecasts for South Corridor Option 2 are largely independent of the northern route corridor option selected.

20.3.4 Comparison of the forecast flows on the road network surrounding the scheme indicates a number of small differences between the options. South Corridor Option 2 (irrespective of which option is selected to the north of the Firth of Forth) is forecast to result in more traffic on the proposed replacement bridge and the M9, both west of M9 Junction 1a towards Linlithgow and south of M9 Junction 1a towards Newbridge Roundabout and Claylands Junction. Traffic flows on the M8 east of Claylands Junction and to a lesser extent the A8 east of Newbridge Roundabout are also forecast to be higher under South Corridor Option 2. However, the higher traffic flows forecast under South Corridor Option 2 are countered by lower flows on the A90 east of Scotstoun Junction, the M9 Spur, A8000 / B800 between South Queensferry and Kirkliston and on the A904 west of South Queensferry. The lower flows forecast on the A904 and A8000 indicate that South Corridor Option 2 is a more attractive alternative for the cross-Forth movements to and from the west of the southern bridgehead due to the slightly shorter travel distance for such trips when compared to South Corridor Option 1.

20.3.5 South Corridor Option 2 assigns significantly more traffic along the A904 to the east of the proposed replacement bridge, compared with South Corridor Option 1. This traffic is effectively rat running between the bridge and the A90 east of Echline Junction. As a strategic model, TMfS05a does not fully replicate the extensive congestion and deterioration of traffic conditions that this level of traffic volume is likely to cause. This routing of strategic traffic is inappropriate and unacceptable on a local road.

20.4 Summary

20.4.1 This chapter and its accompanying figures, has set out the forecast traffic flows using each element of the proposed northern and southern route corridor options.

20.4.2 South Corridor Option 2 provides better and more direct access to the M9. However, connection to the A90, east of Echline junction is not as good as with South Corridor Option 1. Less connectivity to the A90 results in a propensity for traffic to use the A904 rather than the mainline, which in turn would be likely to result in unacceptable traffic conditions and high levels of congestion.

21 Economic Performance of Route Corridor Options

21.1 Introduction

21.1.1 The economic evaluation of the route corridor options has been carried out using a program developed by the Department for Transport (DfT), called Transport User Benefits Appraisal (TUBA). This software was developed for the appraisal of transport schemes.

21.2 Method of Appraisal

21.2.1 Inputs to TUBA are zone-to-zone trips, time, distance and tolls for the “do-minimum” and “do-something” options. These data were obtained from TMfS:05A. The scheme benefits are calculated by comparing, for each pair of zones, the total costs of travel (including travel time, fares, vehicle operating costs and tolls) for the “Do-minimum” and “Do-Something” scenarios.

21.2.2 The analysis described in this report is based on road transport only. So although the effects of the different road scenarios will cause the distribution of private trips to change, there will be no transfers between public and private transport. The trip matrices for goods vehicles (heavy and light) have been kept constant for all scenarios. This is a suitable basis for comparison between options.

21.2.3 In accordance with Her Majesty’s Treasury ‘Green Book’ guidance and DMRB guidance, the benefit stream is calculated for a 60 year period between years 2017 (the planned opening year) and 2076 inclusive. The summed monetised units of benefit are expressed in 2002 prices and discounted to 2002 at 3.5% per annum for the first 30 years and at 3.0% per annum for the next 30 years.

21.2.4 The summed benefits and costs are denoted by PVB (Present Value of Benefits) and PVC (Present Value of Costs); from these are calculated the NPV (Net Present Value = PVB-PVC) and the BCR (Benefit to Cost Ratio = PVB/PVC). Where an option produces a positive NPV (i.e. a future stream of forecast benefits in excess of scheme costs) and a BCR>1 then it will be considered more favourable than the do-minimum subject to affordability of the proposal.

21.3 Basic Data

21.3.1 For these initial assessments, the do-minimum scenario against which the benefits of the options were measured was taken to be the complete closure of the existing bridge (TMfS:05A). No mitigation measures were taken into account. The do-something scenarios also assumed that the existing bridge would be closed to all traffic.

21.3.2 The do-minimum assignment was carried out using the full demand model, so the trips in the forecast year matrices were adjusted to reflect travel costs by private and public transport. For the option tests, the matrix used was the output demand from an earlier full demand model run of a generic scheme combination of North Corridor Option 1 combined with South Corridor Option 1.

21.4 Scheme Specific Data

21.4.1 TMfS:05A was run for the AM, PM and Inter-peak periods. Modelled runs were undertaken for the appraisal years 2017 and 2022. For intermediate years, benefits were obtained by interpolation. No traffic growth is assumed after 2022, as agreed with Transport Scotland. Consequently, travel costs and, hence, route corridor choices will remain unchanged. However, economic parameters, and therefore scheme benefits, are assumed to continue to change beyond 2022, as set out in WebTAG (www.webtag.org.uk). These parameters include;

- Value of Time
- Cost of Fuel
- Proportion of transport fleet using diesel or petrol

21.4.2 Whilst this approach offers a conservative valuation of scheme benefits, it was felt that this was a suitable basis for comparison of corridor options.

21.4.3 The following factors were used to factor road traffic demand outputs from the three modelled time periods to annual benefits as output by TUBA. The factors have been taken from the MVA Information Note 'Regional Annualisation Factors', number 1 version 3, 01 April 2008:

- AM – 559
- Inter peak – 3596
- PM - 650

21.5 Construction Costs

21.5.1 The four combinations of northern and southern route corridor options tested are defined in Chapter 20. The cost of each option was estimated, comprising the proposed replacement bridge and the connecting road systems north and south of the Firth of Forth. Following the production of initial estimates, adjustments are required for the excess of construction cost inflation over general inflation, for risk and for optimism bias, as set out in STAG (Scottish Transport Appraisal Guidance, available at www.transportscotland.gov.uk/stag/home).

- Construction Cost Inflation (9.5.2) No adjustment at this stage
- Risk (13.2) 10% added (9.4% for bridge)
- Optimism Bias (13.3.3) Motorways 25% added, Bridges 45% added

21.5.2 Construction was assumed to take place over 5 years (2012 to 2016) with the annual percentage being 10%, 15%, 15%, 30% and 30%.

21.5.3 The construction cost estimates (£M, 2006 Q4 prices) are as presented in Table 21.1. These exclude VAT, Costs are input to TUBA exclusive of VAT. Costs of the do-minimum scenario, complete closure of the Forth Road Bridge, have been taken as zero.

Table 21.1: Construction Cost Estimates

Option	1N + 1S	1N + 2S	2N + 2S	2N + 1S
Connecting roads North	£518.8	£518.8	£671.5	£671.5
Connecting Roads South	£318.3	£454.2	£454.2	£318.3
Main Crossing	£1,144.9	£1,144.9	£1,144.9	£1,144.9
Total	£1,982.0	£2,117.9	£2,270.6	£2,134.7

21.6 Delays During Construction

21.6.1 No assessment of the economic impacts of delays during construction has been undertaken at this stage of assessment.

21.7 Accidents

21.7.1 It is not expected that the cost of accidents will vary significantly between the options. Detailed calculations regarding the change in accidents for each route corridor option have not yet been carried out, so the same value, as calculated for North Corridor Option 1 combined with South Corridor Option 1 has been added to the traffic benefits for each option.

21.8 Removal of Model "Noise"

21.8.1 In areas remote from the scheme, where traffic is unlikely to be significantly influenced by the scheme, there is a degree of background 'noise' in the modelled calculations of flows and delays. To reduce errors in the benefit calculations, areas considered likely to be unaffected by the scheme, but with high traffic volumes and so possible sources of error, were identified. All changes to costs in and between those areas were then removed. The areas were;

- South Lanarkshire
- East Ayrshire
- South Ayrshire
- North Ayrshire
- East Renfrewshire
- Glasgow City
- North Lanarkshire
- East Dumbartonshire
- Renfrewshire
- Inverclyde
- West Dumbartonshire

21.8.2 The majority of TUBA benefits therefore came from the areas that would be directly affected by the tested scenarios; i.e. within or between the four council areas; City of Edinburgh, West Lothian, Fife and Perth & Kinross.

21.9 Results

21.9.1 The Economic Performance for each option is set out in Table 21.2, for comparison. They are expressed in 2002 prices, discounted to 2002.

Table 21.2: Economic Performance

	1N + 1S	1N + 2S	2N + 1S	2N + 2S
Present Value of Benefits	**£5,225,947**	**£5,571,062**	**£5,162,019**	**£5,641,019**
Present Value of Costs	**£1,150,117**	**£1,224,283**	**£1,236,505**	**£1,316,490**
Net Present Value (NPV)	**£4,075,830**	**£4,346,779**	**£3,926,291**	**£4,324,529**
Benefit to Cost Ratio (BCR)	**4.54**	**4.55**	**4.18**	**4.28**

21.9.2 Benefit to Cost Ratios (BCRs) for North Corridor Option 1 are higher than their North Corridor Option 2 equivalents. Therefore, North Corridor Option 1 appears to be the most economically efficient option.

21.9.3 In comparing the economic evaluation of Corridor Option combinations, under South Corridor Option 2 it is noted that a proportion of Edinburgh bound traffic would assign to the A904 as a more direct route from the Forth Replacement Crossing to Scotstoun Junction and Edinburgh via the A90, leaking from the new strategic network linking to the M9 and M9 Spur. The attributed traffic cost benefits, including the benefits attributed to the traffic from Fife using the A904, results in a higher Net Present Value (NPV). However, South Corridor Option 2 also comes with a substantial additional cost and therefore a broadly equivalent Benefit to Cost Ratio (BCR) in comparison to those option combinations containing South Corridor Option 1.

21.9.4 In the consideration of the North Corridor Option 1 combinations, the similarity in BCRs suggests that there is little to justify the additional expenditure associated with South Corridor Option 2.

21.10 Summary

21.10.1 This section reports an evaluation of the economic costs and benefits of the northern and southern route corridor options associated with the proposed replacement bridge. In each case the modelled scenario assumed the closure of the Forth Road Bridge as the do-minimum scenario against which the options were tested.

21.10.2 The economic evaluation program TUBA was used for the evaluation, as it is able to assess the economic effects of redistribution of trips due to journey cost changes resulting from the introduction of a road scheme. Traffic data for input to TUBA was derived from the Transport Model for Scotland (TMfS:05A).

21.10.3 A summary of the Net Present Values (NPV) and Benefit to Cost Ratios (BCR) is presented in Table 21.2.

21.10.4 It is clear that North Corridor Option 1 offers a better return for lower cost, than North Corridor Option 2.

21.10.5 For the southern route corridor options, there is little difference in the BCRs between the options (coupled with North Corridor Option 1). Consequently, there seems little to be gained from the additional investment required for South Corridor Option 2.

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Part 5: Sustainability Assessment

Report on Scheme Development Work: May to August 2008

Contents: Volume 1 (Main Report and Appendices)

22 Sustainability Assessment Overview

22.1 Introduction

22.1.1 Scotland signed up to the UK shared framework for sustainable development – *One future – different paths* - in 2005, and this framework set out a common goal for sustainable development across the UK:

" to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations"

The framework commits the Scottish Government to promoting a clear understanding of, and commitment to, sustainable development in all that it does so that everyone can contribute to the overall goal.

22.1.2 The UK Framework sets out five key principles for delivering sustainable development - living within environmental limits and ensuring a strong healthy and just society, by means of a sustainable economy, good governance and sound science. These five principles form the basis of all sustainable development policy in the UK.

22.1.3 The importance of including sustainable development principles in civil engineering projects has long been widely recognised. Scottish Planning Policy 1 (SPP 1) emphasised the fact that sustainable development was a key objective of the planning system: *"Planning decisions should favour the most sustainable option, promoting development that safeguards and enhances the long term needs of the economy, society and the environment."* The more recent Scottish Planning Policy (SPP) updates the Government's position and emphasises the focus that planning will have on helping to deliver the central purpose of sustainable economic growth.

22.1.4 Transport Scotland are committed to ensuring that sustainability is integrated into all the key stages of the project throughout the lifecycle of the Forth Replacement Crossing (see Section 1.4) and so this section of the report describes how sustainability considerations have been included in this options appraisal stage of the project.

22.2 Methodology

22.2.1 A sustainability framework has been developed to assist with testing the sustainability of the various stages in the project. This framework consists of a matrix of sustainability objectives, that nest within the scheme objectives, and which are derived from the sustainable development policy objectives (refer to Part 1, Chapter 1, Section 1.4), together with associated targets and indicators. The overarching scheme sustainability objectives are listed within this section of the DMRB Stage 2 Corridor Report.

22.2.2 This framework has been used in the DMRB Stage 2 assessment making use of those objectives that are relevant to assessing the road connections and arriving at a preferred corridor. For the DMRB Stage 2 assessment the objectives used in the framework were primarily the suites of environmental and social objectives.

22.2.3 Reference has been made to relevant chapters of the DMRB Stage 2 Environmental Assessment (Part 3) and the Engineering Assessment (Part 2) to consider the route corridor options against the key sustainability objectives.

Sustainability Objectives

22.2.4 The following sustainability objectives have been used in assessing alternatives in the DMRB Stage 2 design process:

Economic Objectives

1. To design, build and operate a reliable crossing
2. To improve cross-Forth access to economic opportunities
3. To improve cross-Forth transport integration
4. To minimise land take and severance of land holdings
5. To adopt sustainable resource management in design and construction
6. To optimise balance between environmental and economic costs

Social Objectives

7. To ensure that community engagement takes place at all the key stages in the FRC project process
8. To improve local accessibility and reduce community severance
9. To provide a scheme that accommodates those with special needs
10. To promote healthy lifestyles and minimise health and social exclusion impacts of the scheme
11. To provide a safe design for both road users and non-motorised users

Environmental Objectives

12. To reduce, reuse and recycle materials
13. To minimise embodied and in-use carbon
14. To minimise operational carbon in line with carbon efficiency commitments
15. To protect and enhance the natural heritage including local biodiversity
16. To protect the landscape, historic environment and cultural heritage
17. To reduce noise and air emissions
18. To protect water quality and maximise the use of sustainable drainage systems for environmental and hydrological benefit

22.3 Key Findings

22.3.1 From a sustainability perspective the key issues and objectives with regard to the various options related to consideration of:

- ecology and biodiversity – in particular sites designated for their nature conservation value and protected species (refer to Objective 15);
- communities – in particular community severance and local accessibility (refer to Objective 8);

- materials/resources – in particular the volume and balance between cut and fill in the earthworks and the environmental implications (including carbon emissions) of this (refer to Objectives 5 and 13).

Ecology

22.3.2 Due to being mostly online, North Corridor Option 1 would result in less impact on sites of nature conservation value compared to North Corridor Option 2. There is little difference between the northern route corridor options in terms of potential impacts on protected species.

22.3.3 In reviewing the southern route corridor options it is clear that the shorter route corridor option (South Corridor Option 1) would result in fewer impacts on the natural environment including potential impacts on designated sites and protected species.

Communities

22.3.4 The northern route corridor options would not directly sever any communities, catchment areas or result in the loss of any community facilities.

22.3.5 In the south, South Corridor Option 1 would result in the least number of paths being directly affected and would have least impact on rights of way. However, no communities would be directly affected in terms of severance or loss of community facilities by either southern route corridor option.

Materials/Resources

22.3.6 To the north, the generally online nature of North Corridor Option 1 means that there should be reduced earthworks and less requirement for materials compared to North Corridor Option 2.

22.3.7 In the south the shorter length of South Corridor Option 1 means that there should be reduced earthworks and less demand for materials compared to South Corridor Option 2.

22.3.8 Minimising the total volume of earthworks and demand for materials both mean that there are likely to be less transportation journeys and therefore less use of fossil fuels, contributing to reducing carbon emissions.

Sustainability Summary

22.3.9 The high level evaluation of the north and south route corridor options against the key DMRB Stage 2 sustainability objectives is summarised in the Table 5.1.

Table 22.1: Summary of Route Corridor Options against Sustainability Objectives

Sustainability Objective	North Corridor Options		South Corridor Options	
	North Corridor Option 1	North Corridor Option 2	South Corridor Option 1	South Corridor Option 2
15. To protect and enhance the natural heritage including local biodiversity	Preferred		Preferred	
8. To improve local accessibility and reduce community severance	No preference	No preference	Preferred	
5. To adopt sustainable resource management in design and construction	Preferred		Preferred	
13. To minimise embodied and in-use carbon	Preferred		Preferred	

22.4 References

Department for Environment, Food and Rural Affairs (DEFRA). One Future Different Paths: The UK's Shared Framework for Sustainable Development, 2005

The Scottish Executive/The Scottish Government. Scottish Planning Policy 1 (SPP 1): The Planning System, 2002, Crown copyright

The Scottish Government. Scottish Planning Policy (SPP), 2008, Crown copyright

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Part 6: Southern Route Corridor - Combination Option Assessment

Report on Scheme Development Work: May to August 2008

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23 Southern Route Corridor - Combination Option Assessment

23.1 Introduction

23.1.1 As reported in paragraph 21.9.3, a proportion of Edinburgh bound traffic is assigned under South Corridor Option 2 to the A904 as a more direct route from the proposed replacement bridge to Scotstoun Junction and Edinburgh via the A90 rather than using the new strategic route. A further option, South Corridor Option 4B was therefore defined. South Corridor Option 4B is a combination of South Corridor Options 1 and 2, providing connectivity to the proposed replacement bridge from the A90 and the M9. A new connection to the A90 would be used to facilitate direct access to the north of Edinburgh from the proposed replacement bridge, relieving some of the traffic pressures which may build up on the existing road network through the implementation of South Corridor Option 2 in isolation. This was compared, as a sensitivity check, against the preferred South Corridor Option 1.

23.2 Description of South Corridor Option 4B

23.2.1 With the implementation of South Option 4B, the recently completed M9 Spur would be closed and the Scotstoun Junction removed. The existing M9 Junction 1a would also be removed, a new all movements junction being provided to the M9 northeast of Winchburgh providing direct access to the proposed replacement bridge.

23.2.2 A revised layout at Echline Junction would facilitate access between the proposed replacement bridge, South Queensferry, the A90 and A904. The new dual two lane motorway connecting to the A90 would have priority through the junction area, direct connections to the north of Edinburgh via Barton Junction being formed with the removal of Scotstoun Junction. Traffic wishing to access South Queensferry from Edinburgh would be catered for through the provision of new slip road arrangements to the A90 commencing east of the A8000. The new westbound new slip road would be carried over the new dual two lane motorway on structure, north of Dundas Home Farm, before interfacing with the A904 and A8000 at Echline Junction.

23.2.3 Traffic wishing to access the proposed replacement bridge or the A90 from the A904/A8000 would be catered for with the provision of a new at grade junction to the west of the existing Echline Junction (on the A904). The existing junction arrangement would only serve local traffic and northbound traffic from Edinburgh.

23.2.4 In facilitating connections between the proposed replacement bridge, the A90 and M9, a new junction would be required southwest of South Queensferry. Operating as a single dual two lane motorway on approach to the proposed replacement bridge, a grade separated junction would be constructed providing access to/from the A90 and the A904/A8000 via the revised Echline Junction.

23.3 Engineering Considerations

23.3.1 In the provision of South Corridor Option 4B, the following engineering constraints and technical issues discussed in Part 2 of this DMRB Stage 2 Corridor Report (Chapter 4 - Engineering Assessment) relating to South Corridor Option 1 and South Corridor Option 2 apply:

- Existing topography
- Horizontal and vertical geometry of mainline carriageway design
- Connection to existing A90
- Junction provision and side roads connectivity
- Location of BP Pipeline
- Proximity of residential areas
- Environmentally significant areas
- Ground Conditions
- Possible future multi-modal developments (LRT, BRT, guided buses or trams)

23.3.2 In terms of engineering assessment, none of the elements required in the provision of South Option 4B would preclude it from further consideration. Through the implementation of direct connections to both the A90 and the M9, this option would provide a higher level of service than the sections of existing carriageway that it would replace.

23.3.3 Considering future multi-modal requirements, any requirement for the implementation of a system such as LRT or BRT would be accommodated through the implementation of hard shoulder running, any future public transport system running in parallel to general traffic on the dual two lane motorway.

23.4 Environmental Considerations

23.4.1 Although the likely significance environmental impact differs between route corridor options, no environmental issues were identified through DMRB Stage 2 assessment that would preclude the promotion of any of the options. South Corridor Option 4B was not subject to Stage 2 assessment, but was qualitatively considered following the 25 June 2008 Route Corridor Workshop. Principal factors in relation to South Corridor Option 4B compared to the Stage 2 southern route corridor options are set out below. It should be noted that impact would depend on the mitigation strategy developed through design development at Stage 3.

23.4.2 Although it is the longest of the southern options, South Corridor Option 4B would have slightly less overall land take than South Corridor Option 2 due to the reduced extent of proposed junction arrangements.

23.4.3 In terms of potential impacts on the water environment, South Corridor Option 4B would require the fewest crossings of Swine Burn and the lowest geomorphological impacts on Swine Burn. The impacts on Humbie Reservoir would be similar to those predicted for South Corridor Option 2 (no impacts on this reservoir were predicted for South Corridor Option 1).

23.4.4 In terms of potential ecological issues, South Corridor Option 4B would impact on Swineburn Wood, Ross's Plantation, Muiriehall and Carmelhill woodland complexes. These areas of woodland would be affected by South Route Corridor Option 2 but not by South Corridor Option 1. There would also be higher potential for South Corridor Option 4B to impact on otter and water vole populations at Linn Mill Burn and Swine Burn Compared to either of the other southern route corridor options.

23.4.5 South Corridor Option 4B would have similar potential landscape impacts to South Corridor Option 2. It would cut through the open arable landscape, affect the Area of Outstanding Landscape Quality at Humbie and isolate Dundas Estate by increasing the road infrastructure effectively encircling it. The potential visual impacts on rural properties and South Queensferry would be similar to those predicted for South Corridor Option 2, which overall are higher than those predicted for South Corridor Option 1.

23.4.6 With regard to cultural heritage, South Corridor Option 4B would have the highest overall potential impact on Designed Landscapes of the southern route corridor options. As South Corridor Option 4B passes through areas with generally less development, there may also be higher likelihood of encountering previously unrecorded archaeology, although works within the main area of known archaeological potential (Inchgarvie area) would be similarly affected by all options.

23.4.7 South Corridor Option 4B would have the greatest overall potential for disruption to local residents during construction (such as potential construction noise, traffic, dust etc) due to the extent and length of this option. However, in terms of vehicle travellers there could be disturbance during construction at online works at M9 Junction 1A and in the Echline/Scotstoun area.

23.4.8 South Corridor Option 4B is considered to be the least compliant of the southern route options in terms of plans and policies. It would also have the greatest overall potential impact on core paths and rights of way.

23.4.9 Noise and air quality were not assessed for South Corridor Option 4B, as detailed traffic data was not available. However, it is not expected that air quality or noise would be route option determinants.

23.5 Transportation Considerations

23.5.1 As a combination of South Corridor Options 1 and 2, South Corridor Option 4B through the provision of a dual two lane motorway in tandem with new junctions to the M9 and A904 and a connection to the A90 is expected to provide the following:

- Improved existing levels of service for private, road-based modes of travel
- Improved network performance
- Improved journey time reliability through the provision of new route corridor options for some journeys between central Scotland and Fife.
- Minimum change to land-based travel choices and integration
- Improved general accessibility for those with access to private transport
- Minimal impact on the effective operation of the transport network during times of maintenance.
- Reduced sustainable development, but increase economic growth

23.5.2 South Corridor Option 4B provides more direct routing for southbound traffic than South Corridor Option 1, but involves a lower speed interchange between the connecting roads to the M9 and A90 with manoeuvring constraints that would impact on the comfort of the route.

23.5.3 A comparison in journey distances and cumulative vehicle kilometres is provided for the route corridor options in Table 23.1 below.

Table 23.1: Comparison of Journey Distances between Route Corridor Options

Option		**North Corridor Option 1**	**North Corridor Option 2**	**South Corridor Option 1**	**South Corridor Option 2**	**South Corridor Option 4B**
Journey.	**Approx %age of Bridge traffic**					
Halbeath to North Bridgehead	**60 %**	**8.5 Km**	**8.4 Km**			
Masterton to North Bridgehead	**15%**	**4.6 Km**	**4.4 Km**			
Admiralty to North Bridgehead	**20%**	**2.6 Km**	**2.6 Km**			
Ferrytoll to North Bridgehead	**5%**	**0.9 Km**	**0.9 Km**			
South Bridgehead to A90 at Scotstoun (bound for Barnton)	**30 %**			**4.0 Km**	**7.6 Km**	**4.0 Km**
South Bridgehead to M9 East (at Newbridge)	**35 %**			**9.4 Km**	**7.1 Km**	**7.1 Km**
South Bridgehead to M9 West (at Winchburgh)	**5 %**			**14.1 Km**	**8.4 Km**	**8.4 Km**
South Bridgehead to South Queensferry and beyond via A904.	**30%**					
Indicative Annual Cumulative Vehicle km's (2017)		**553,000**	**546,000**	**452,000**	**451,000**	**357,000**

23.6 Cost Estimate

23.6.1 The cost associated with the construction South Corridor Option 4B is estimated at £417m (excluding VAT).

23.6.2 With reference to the cost estimates provided in Part 1, Chapter 3, of this report, the cost associated with the implementation of South Corridor Option 4B would be comparable to that of South Corridor Option 2 and substantially higher than the cost estimate for South Corridor Option 1.

23.6.3 The cost comparison with South Corridor Option 2 is generated through a reduction in carriageway cross section provision from dual three lane motorway standard to dual two lane motorway standard. Furthermore, with the closure of the M9 Spur, the complexities of the junctions required are significantly reduced with no requirement to integrate Scotstoun Junction or M9 Junction 1a and a lesser requirement for structural crossings of existing roads and railway lines.

23.7 Conclusions

23.7.1 Whilst South Corridor Option 4B would be capable of providing direct access to the A90 and the M9, the land take associated with the implementation of such a scheme would be far higher than that of South Corridor Option 1 or South Corridor Option 2 in isolation. This corridor would also be expected to have higher overall delivery environmental impacts.

23.7.2 In addition, the anticipated cost associated with the implementation of this option would be comparable to that of South Corridor Option 2 and far greater than that of South Corridor Option 1.

23.7.3 Considering the environmental impacts, the cost associated with this options implementation and the amount of existing roads infrastructure made redundant through its provision, South Corridor Option 4B was not taken forward.

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Part 7: Conclusion and Recommendation

Report on Scheme Development Work: May to August 2008

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24 Conclusion and Recommendation

24.1 Introduction

24.1.1 This chapter shall identify preferred northern and southern route corridor options to be taken forward for DMRB Stage 3 assessment. The recommendation made by this DMRB Stage 2 Corridor Report is based upon the requirements of the scheme objectives and the assessment work undertaken to date from an engineering, environmental, traffic, economic and sustainability perspective. The mainline route corridor options were developed to current standards over their full length. It is recognised that shorter improvements within each corridor are feasible. The full scope of improvement within the preferred corridor will be considered at the next stage of the study.

24.2 Engineering Conclusion

24.2.1 In terms of engineering assessment there is nothing which would preclude any of the options from being promoted, however North Corridor Option 1 and South Corridor Option 1 are deemed to be the preferable corridor options.

24.2.2 North Corridor Option 1 is preferable to North Corridor Option 2 as it maximises the use of existing roads infrastructure, improves the carriageway provision to dual three lane motorway and improves connectivity with new and improved junction arrangements. The provision of North Corridor Option 1 also represents value for money.

24.2.3 Likewise, South Corridor Option 1 is preferable to South Corridor Option 2 as it requires a shorter length of construction and maximises the use existing roads infrastructure whilst making provision for junction improvements. Like North Corridor Option 1, South Corridor Option 1 represents value for money.

24.3 Environmental Conclusion

24.3.1 Although the likely significance of environmental impacts differs between route corridor options, no environmental issues which would preclude the promotion of any of the options assessed have been identified through Stage 2 assessment.

24.3.2 Overall, North Corridor Option 1 is considered preferable to North Corridor Option 2 in environmental terms as the majority of the corridor is online. North Corridor Option 1 would affect fewer land interests, cross fewer pedestrian/cyclist routes, have less ecological impact and lower potential for impacts on sites of geological importance. In terms of watercourses, there are a similar number of crossings however North Corridor Option 1 is likely to have less potential for flood risk and water quality impacts and is therefore preferred overall. Noise and air quality impacts would be similar for either northern route corridor option. There is predicted to be virtually no change in local air quality, and although both options would result in both beneficial and adverse changes in noise levels, on balance North Corridor Option 1 is considered to be preferable. The predominantly online alignment of North Corridor Option 1 would also result in lower landscape and visual change and be preferable in terms of view from the road and driver stress. Although North Corridor Option 1 is closer to a Scheduled Ancient Monument (Middlebank Souterrain) than North Corridor Option 2, it is considered that potential impacts could be mitigated through design refinement as part of the DMRB Stage 3 assessment process.

24.3.3 Overall, South Corridor Option 1 is considered preferable to South Corridor Option 2 in environmental terms as it requires less new infrastructure and passes through less sensitive areas. South Corridor Option 1 would affect fewer land interests, fewer pedestrian/cyclist routes, have less ecological impact and lower potential to encounter contaminated land during construction. In terms of watercourses, South Corridor Option 1 would also require less flood risk mitigation, result in fewer water crossings, and is considered to have the least impact on water quality. Air quality impacts would be similar for either southern route corridor option. However, South Corridor Option 2 is the preferred option in terms of overall noise effects as it would divert traffic away from the A90 south of South Queensferry, although it would result in noise increases for a small number of rural properties. South Corridor Option 1 is preferred in terms of landscape and visual impacts as it is much more contained and in contrast to South Corridor Option 2 does not cut through open, rural landscape. South Corridor Option 2 would also increase landscape isolation of Dundas Estate due to encircling by roads infrastructure although in terms of cultural heritage South Corridor Option 1 would have a slightly higher impact due to direct loss of part of the Dundas Castle Designed Landscape.

24.4 Traffic and Economic Conclusion

24.4.1 In comparing the economic evaluation of Corridor Option combinations, under South Corridor Option 2 it is noted that a proportion of Edinburgh bound traffic would assign to the A904 as a more direct route from the Forth Replacement Crossing to Scotstoun Junction and Edinburgh via the A90, leaking from the new strategic network linking to the M9 and M9 Spur. The attributed traffic cost benefits, including the benefits attributed to the traffic from Fife using the A904, results in a higher Net Present Value (NPV). However, South Corridor Option 2 also comes with a substantial additional cost and therefore a broadly equivalent Benefit to Cost Ratio (BCR) in comparison to those option combinations containing South Corridor Option 1.

24.4.2 Given the additional cost associated with South Corridor Option 2 and its similarity with South Corridor Option 1 in terms of BCR, it was concluded that North Corridor Option 1 paired with South Corridor Option 1 would offer, overall, the preferred solution.

24.5 Sustainability Conclusion

24.5.1 The high level evaluation of the northern and southern route corridor options against the key DMRB Stage 2 sustainability objectives shows that North Corridor Option 1 and South Corridor Option 1 are preferred route corridor options for further assessment.

24.6 Conformity with Scheme Objectives

- **to maintain cross-Forth transport links for all modes to at least the level of service offered in 2006**

<u>Northern Route Corridor Options</u>

24.6.1 North Corridor Option 1 and North Corridor Option 2 satisfy the requirement of maintaining cross-Forth transport links to at least the level of service offered in 2006. Each provides two general traffic lanes each direction and is capable of making provision for future transport modes. Through the online upgrade of the A90/M90, North Corridor Option 1 is deemed to be preferable as it continues to utilise junctions at Ferrytoll, Admiralty and Masterton each providing access between the local communities of west Fife and the proposed mainline carriageway. North Corridor Option 2 does not provide the same level of functionality.

Southern Route Corridor Options

24.6.2 South Corridor Option 1 and South Corridor Option 2 both satisfy this scheme objective. South Corridor Option 2 satisfies this objective through the provision of a direct motorway connection to the M9 north of Winchburgh. South Corridor Option 1 is deemed to be preferable however as it makes best use of the existing roads infrastructure associated with the Forth Road Bridge, effectively extending the A90/M9 Spur connection to the proposed replacement bridge.

- **to connect to the strategic transport network to aid optimisation of the network as a whole**

Northern Route Corridor Options

24.6.3 North Corridor Option 1 and North Corridor Option 2 meet this objective through the provision of upgrades to the existing trunk road network. Both options provide an improved level of service when compared to the existing network through the implementation of a standardised cross section. Complementary initiatives such as High Occupancy Vehicle (HOV) lanes and Intelligent Transport Systems (ITS) can be used to support capacity management. Provision is also made for future public transport initiatives. In the optimisation of the trunk road and local road network as a whole, North Corridor Option 1 is deemed preferable with direct connections maintained between the proposed mainline and the A985, A921 and A823(M).

Southern Route Corridor Options

24.6.4 South Corridor Option 1 and South Corridor Option 2 are both capable of satisfying this objective through there connections to the A90, M9 Spur and M9 respectively. Both implement standardised cross sections and are capable of optimising the road network as a whole through the provision of new and improved junction arrangements. Complementary initiatives such as HOV lanes and ITS can be used to support capacity management.

- **to improve the reliability of journey times for all modes**

Northern Route Corridor Options

24.6.5 North Corridor Option 1 and North Corridor Option 2 satisfy this objective through the provision of a new/upgraded mainline carriageway to motorway standard. The provision of ITS shall assist journey time reliability. Whilst both options are deemed to bring benefits over the existing situation for all modes, North Corridor Option 1 through the provision of direct connections to existing routes such as the A985, A921 and A823(M) is deemed preferable.

Southern Route Corridor Options

24.6.6 South Corridor Option 1 and South Corridor Option 2 satisfy this objective through the provision of a new mainline carriageway to motorway standard. The provision of new and improved junctions shall assist in the effective operation of the route corridors. The provision of ITS shall aid journey time reliability.

- **to increase travel choices and improve integration across modes to encourage modal shift of people and goods**

Northern Route Corridor Options

24.6.7 North Corridor Option 1 and North Corridor Option 2 are both capable of increasing travel choices and encouraging modal shift. Each option has been designed taking cognisance of Park and Ride/Choose facilities in west Fife whilst also providing access to local destinations such as North Queensferry, Rosyth, Rosyth Dockyard, Inverkeithing and Dunfermline. The provision within each design for complementary measures and future public transport initiatives such as LRT, BRT, guided buses or trams will also encourage modal shift and assist capacity management in the future years if implemented.

Southern Route Corridor Options

24.6.8 South Corridor Option 1 and South Corridor Option 2 are also capable of increasing travel choices and encouraging modal shift. Each is capable of providing access to local and national destinations including South Queensferry, Dalmeny, the Lothians and the west of Scotland through the provision of new/improved junctions to local and national routes. The provision of complementary measures will be of benefit in the early years of the operation. Future public transport initiatives such as LRT, BRT, guided buses or trams will further encourage modal shift and assist capacity management in the future years if implemented.

- **to improve accessibility and social inclusion**

Northern Route Corridor Options

24.6.9 North Corridor Option 1 and North Corridor Option 2 are both capable of improving accessibility and social inclusion through the provision of a standardised carriageway cross section, new/improved junction arrangements and complementary measures. Each option also makes provision for future public transport modes which might be implemented. North Corridor Option 1 is deemed to be the preferred option as it offers direct connections between the trunk road and local road network through the use of Ferrytoll, Admiralty and Masterton Junction. North Corridor Option 2 whilst providing improvements does not provide the same level of direct accessibility as North Corridor Option 1.

Southern Route Corridor Options

24.6.10 South Corridor Option 1 and South Corridor Option 2 are both capable of improving accessibility and social inclusion through their connections to existing local and national routes. The provision of a standardised carriageway cross section and new/improved junction arrangements in addition to complementary measures will improve cross-Forth accessibility. The provision made within each design for future public transport systems such as LRT, BRT, guided buses or trams shall also assist each option in meeting this objective.

- **to minimise the impacts of maintenance on the effective operation of the transport network;**

Northern Route Corridor Options

24.6.11 North Corridor Option 1 and North Corridor Option 2 both satisfy this objective through the provision of a standardised carriageway cross section and ITS. Each has the ability to maintain two lanes of general traffic in each direction at all times. North Corridor Option 1 is deemed to be preferable as the provision of a dual three lane motorway enables one trafficked lane to be closed for maintenance on each carriageway whilst maintaining two lanes for general use without the need for contra flow running. Any sustained period of maintenance required on North Corridor Option 2 would likely have a greater impact on the operation of the local road network.

Southern Route Corridor Options

24.6.12 Like North Corridor Option 1, South Corridor Option 1 and South Corridor Option 2 both satisfy this objective through the provision of a standardised cross section and ITS. Both options provide dual three lane motorway cross sections, allowing two lanes of general traffic to be maintained at all times. South Corridor Option 1 is deemed to be preferable as it provides the shortest connection to existing infrastructure, limiting the impact that any maintenance period might have.

- **to support sustainable development and growth**

Northern Route Corridor Options

24.6.13 North Corridor Option 1 and North Corridor Option 2 support sustainable development and growth through their proposed improvements to the trunk road network. The provision of mainline carriageway to motorway standard and the incorporation of complementary measures will assist the development and growth of west Fife and beyond. The functionality provided for the implementation of future transport modes also supports this objective. New/improved junction arrangements will also provide benefits, improving connectivity between local and national routes.

Southern Route Corridor Options

24.6.14 South Corridor Option 1 and South Corridor Option 2 also support sustainable development and growth through their proposed improvements to the trunk road network. The provision of mainline carriageway to motorway standard and the incorporation of complementary measures will assist the development and growth of West Lothian, the Edinburgh area and beyond. The functionality provided for the implementation of future transport modes also supports this objective. New/improved junction arrangements will also provide benefits, improving connectivity between local and national routes.

- **to minimise the impact on people, and the natural and cultural heritage of the Forth area.**

Northern Route Corridor Options

24.6.15 North Corridor Option 1 is preferable to North Corridor Option 2 as it has the least impacts. It potentially has a lower impact on sites of geomorphological/geological importance, the least ecological impact and the least impact on the existing landscape. Furthermore, when compared to North Corridor Option 2, North Corridor Option 1 will bring minimal change visually, will have the least increase in traffic noise and vibration and imposes a lower level of driver stress. In addition, North Corridor Option 1 has less of an impact on footpaths and has the least potential for conflict with policies and plans.

Southern Route Corridor Options

24.6.16 South Corridor Option 1 is preferable to South Corridor Option 2 as it has least impact on land use, requires less flood risk mitigation, has the least ecological impact, has less impact on the landscape, is less visually intrusive and has less of an impact on footpaths. Furthermore, it will cause less disruption during construction when compared to South Corridor Option 2 and has the least potential for conflict with policies and plans.

24.7 South Route Corridor Option 4B

24.7.1 With reference to Part 6: South Route Corridor – Combination Option Assessment and South Corridor Option 4B, the land take associated with the implementation of such a scheme would be far higher than that associated with South Corridor Option 1 or South Corridor Option 2 and would be expected to have higher overall delivery environmental impacts.

24.7.2 The anticipated cost associated with the implementation of South Corridor Option 4B would be comparable to that of South Corridor Option 2 and far higher than that of South Corridor Option 1.

24.7.3 Considering the environmental impacts, the cost associated with this options implementation and the amount of existing roads infrastructure made redundant through its provision, South Corridor Option 4B was not taken forward.

24.8 DMRB Stage 2 Corridor Report Recommendation

24.8.1 On the basis of the foregoing analysis, the recommendation of this DMRB Stage 2 Corridor Report is that North Corridor Option 1 and South Corridor Option 1 be taken forward as the preferred corridors.

24.8.2 For the purposes of DMRB Stage 2 assessment, the route corridor options discussed within this report have been considered over the full extents of the Forth Replacement Crossing study area. The preferred corridor identified need not be implemented in full. As a part of the next stage of design and assessment, further detailed consideration shall be given to the form and function of the junctions required and the extent of the road infrastructure improvements provided within the preferred corridors. The developing design shall also reflect future consideration of the use of the Forth Road Bridge.

JACOBS ARUP

Forth Replacement Crossing

DMRB Stage 2 Corridor Report
Part 8: Appendices

Report on Scheme Development Work: May to August 2008

Contents: Volume 1 (Main Report and Appendices)

Table 1: List of Consultees at DMRB Stage 2

Consultee	
Aberdour Community Council	Fife Bat Group
Airth Parish Community Council (Falkirk)	Fife Bird Club
Alloa Centre Community Council	Fife Coast and Countryside Trust
Alloa West Community Council	Fife Council
Area Advisory Group (Forth)	Fife Environmental Network
Association of Scottish Shellfish Growers	Fife Ornithological Atlas Group
BAA Airports	Fisheries Research Services (FRS)
Blackness Community Council	Forestry Commission Scotland
Boness Community Council	Forth & Tay Disabled Ramblers
Botanical Society of British Isles (BSBI)	Forth Bridges Visitor Centre
British Divers Marine Life Rescue (BDMLR)	Forth Canoe Club
British Geological Survey	Forth Cruising Club
British Horse Society	Forth District Salmon Fisheries Board
British Herptological Society	Forth Estuary Forum
British Oceanographic Data Centre *	Forth Fisheries Foundation (Data Managed By RAFTS)
British Waterways Scotland	Forth Ports
British Trust for Ornithology (BTO)	Forth Right Alliance
Bug Life Scotland	Forth Sea Bird Group
Centre for Ecology and Hydrology (CEH)	Forth Tunnel Action Group (Forthtag)
Central Scotland Bat Group	Friends of the Earth
Charleston, Limekilns & Pattiesmuir Community Council	Greenpeace
Civil Aviation Authority	Hawk and Owl Trust
Clackmannanshire Council	Health and Safety Executive
Council of Scottish Archaeology	Health Scotland
Cramond Community Council	Hebridean Whale and Dolphin Trust
Crombie Community Council	Heritage Railway Association
Cycling Scotland	Heriot-Watt University - School of Life Sciences
Cyclist Touring Club	Historic Scotland
Dalgety Bay & Hillend Community Council	Hopetoun Estate
Dalgety Bay Sailing Club	Institute of Freshwater Ecology (via CEH)
Deep Sea World	Institute of Terrestrial Ecology (via CEH)
Dundas Estate	Inverkeithing Community Council
East Lothian Council	Joint Nature Conservative Committee (JNCC)
Echoes Ecology Ltd.	Kincardine Community Council
Edinburgh Biodiversity Partnership	Kirkliston Community Council
Edinburgh and Lothians Badger Group	Fife Biological Records Centre
Edinburgh Natural History Society	Lothian Amphibian & Reptile Group
Falkirk Council	Lothian Bat Group
Forth Estuary Transport Authority (FETA)	Lothian Wildlife Information Centre
Fife and Kinross Badger Group (no longer in existence therefore Scottish Badgers to provide information).	Mammal Society
Mid Lothian Council	Sea Mammal Research Unit

*Not issued with Stage 2 letters and included within the formal consultation process, however, provided input to the EIA. Refer to Chapter 8 (Water Environment).

Consultee	
Mobility and Access Committee (MAC)	Sea Watch Foundation
National Biodiversity Network (NBN)	SEAZONE *
National Farmers Union	Scottish Environment Protection Agency (SEPA)
National Museum of Scotland	South East of Scotland Transport Partnership (SEStran)
National Trust for Scotland	Scottish Natural Heritage (SNH)
Network Rail (Scotland)	Scottish Confederation of University and Research Libraries (SCURL) Special Needs Group
Newton Community Council (West Lothian)	SPOKES Edinburgh
North Lanarkshire Council	Stirling Council
North Queensferry Boat and Sports Club	South Lanarkshire Council
North Queensferry Community Council	SUSTRANS
North Queensferry Heritage Trust	Tayside and Central Scotland Transport Partnership (TACTRANS)
Passenger FOCUS	Take Pride in Fife Environmental Information Centre
Perth & Kinross Council	Tay Ringing Group
Pitcorthie Community Council	The Bat Conservation Trust
Plantlife UK	The City of Edinburgh Council
Port Edgar Marina	The Cockburn Association
Proudman Oceanographic Laboratory (POL)*	The Crown Estate
Queensferry Boat Club	The Garden History Society
Queensferry & District Community Council (South)	TRANSCO
Ramblers Association	Transform
Raptor Study Group Lothian and Borders	Turnhouse Golf Club
Rosyth Community Council	University of Edinburgh
Royal Commission on the Ancient and Historical Monuments for Scotland	University of Glasgow
Royal Forth Yacht Club	University of Stirling
Royal Society for the Protection of Birds (RSPB)	Visit Scotland
Scarborough Muir	Vincent Wildlife Trust
Scottish Badgers	Waterski Scotland
Scottish Canoe Association	West Lothian Council
Scottish Civic Trust	West of Scotland Archaeological Service (WoSAS)
Scottish Fisheries Protection Agency	West Lothian and Livingston Sport and Recreation Association
Scottish Fishermen's Federation	West Lothian Bird Club
Scottish Government Rural Directorate (formerly SEERAD)	West Lothian Bridleways Association
Scottish Ornithological Club (SOC)	Wetlands Bird Survey (WeBS): Lothian Coordination
Scottish Pelagic Fisherman's Association	Whale and Dolphin Conservation Society (WDCS)
Scottish Public Health Observatory	Wildfowl and Wetlands Trust
Scottish Rural Property & Business Association (formerly SLF)	Winchburgh Community Council
Scottish Water	Winchburgh Development
Scottish Wildlife Trust	World Wide Fund for Nature (WWF)
Scotways	-

*Not issued with Stage 2 letters and included within the formal consultation process, however, provided input to the EIA. Refer to Chapter 8 (Water Environment).

Key planning applications impacted by the route corridor options are shown on Figure 6.2 (as indicated by Table 1).

Table 1: Planning Applications

Planning Reference	Proposed Development	Status of Application	Comments
City of Edinburgh Council			
04/03280/FUL, Bo'ness Road, South Queensferry (Figure 6.2c - Planning Application 5)	Construction of new Waste Water Treatment Works.	Application granted	
03/01969/FUL, Port Edgar (Figure 6.2c - Planning Application 1)	New clubhouse facility for Port Edgar Yacht club.	Application granted	
05/02163/FUL, Claylands Road, Newbridge	New distribution centre.	Application granted	
03/01971/FUL, The Steading, Burnsho,t Dalmeny Estate	Change of use to office/light industrial.	Application granted	
08/01440/FUL, Dundas Castle Estate (Figure 6.2c - Planning Application 6)	Restore semi derelict stable wing to create en-suite bedrooms and studio.	Application granted	
07/04254/FUL, Queensferry Road, Kirkliston (Figure 6.2c - Planning Application 7)	Carry out infrastructure works, for future development at North Kirkliston.	Application granted	
West Lothian Council			
Woodend Newton, 1293/FUL/06	Demolition of existing building and erection of new dwelling.		
Duntarvie Castle, 0862/03	Temporary residential accommodation.	Granted	
Auldcathie, 0033/FUL/07	Restoration of former landfill site with proposed uses including gas extraction, electricity production and recreational open space.	Awaiting determination	
Winchburgh, 1012/p/05 (Figure 6.2c - Planning Application 8)	Outline Planning Permission for 352 ha mixed use development.	Awaiting determination	CDA allocation
Whitequarries Industrial Estate, 0474/FUL/07	Erection of 300 sq m farm shop.	Awaiting determination	Within the grounds of Hopetoun Estate
Newton, 0589/03	Conversion and extension to form 2 houses.	Approved	
Fife Council			
03/00259/WARM, Frankie And Benny's Fife Leisure Park Dunfermline	Reserved matters application for the erection of a class 3 restaurant with associated service area.	Application permitted with conditions	Dunfermline East Expansion Area Employment Allocation

Planning Reference	Proposed Development	Status of Application	Comments
03/02473/WFULL, Pitreavie Business Park	Erection of class 4 office building and formation of access road with associated car parking (Unit 1).	Application permitted with conditions	Dunfermline East Expansion Area Employment Allocation
03/03308/WFULL, J3 Duloch Park Dunfermline	Erection of 200 detached 2 storey dwellinghouses with integral garages and formation of access roads.	Application permitted with conditions	Dunfermline East Expansion Area Employment Allocation
03/03359/WFULL, Crossroads Place Rosyth	Erection of 2,260 sq ft building for the purposes of a class 2 use and a licensed betting office (class 2) with associated car parking and bin store.	Application permitted with conditions	
07/03611/WFULL, Halbeath Interchange Business Park	Erection of business unit (Class 4) totalling 8000 sq ft including associated landscaping and car parking.	Application permitted with conditions	Dunfermline East Expansion Area Employment Allocation
07/03212/WFULL, Whimbrel Place Dunfermline	Formation of 18 hole miniature golf theme park with associated ticket office, storage shed, car park, 2.4 metre high fencing and landscaping, including water features and provision for erection of temporary dome structure.	Application permitted with conditions	
06/02206/WOPP, Site Adjacent To Queensferry Road Pitreavie Drive Dunfermline	Outline planning application for erection of 3 no. class 4 office buildings with associated roads and car parking.	Application permitted with conditions	Dunfermline East Expansion Area Employment Allocation
06/00525/WFULL, Whimbrel Place Dunfermline	Erection of retail garden centre, formation of roads and landscaping, restaurant, display areas and landscaping.	Application permitted with conditions	
05/02761/WARM, Lapwing Drive Dunfermline	rection of 256 dwellinghouses and 24 flats, formation of new roads, footpaths and SUDS pond and provision of open space areas, landscaping, boundary treatments and structure planting.	Application permitted with Conditions	Dunfermline East Expansion Area Housing Allocation
05/02742/WFUL, Duloch Park J3 Sandpiper Drive Dunfermline	Erection of 141 dwellinghouses, formation of open space area, roads, footpaths and boundary treatments, and associated works.	Application permitted with conditions	Dunfermline East Expansion Area Housing Allocation
05/02245/WFULL, Duloch Park Plot P4 Aberdour Road Dunfermline	Erection of 117 dwellinghouses and 36 flats, formation of access roads, footpaths, parking, open space and landscaped areas; installation of an attenuation basin.	Application permitted with conditions	Dunfermline East Expansion Area Housing Allocation
04/03741/WFULL, Kingseat Road Halbeath Dunfermline	Erection of 5, 2 storey buildings (24,000ft2) comprising 7 (class 4) office units, formation of access road and car parking with associated landscaping and other engineering works.	Application permitted with conditions	Dunfermline East Expansion Area Employment Allocation

Planning Reference	Proposed Development	Status of Application	Comments
05/01115/WARM, Masterton Park Area R3 Aberdour Road Dunfermline	Erection of 183 dwellinghouses, 18 flatted dwellings, formation of new roads, footpaths, open space area, drainage treatment pond and associated works.	Application permitted with conditions	Dunfermline East Expansion Area Housing Allocation
05/01118/WFULL, Duloch Park Plot P4 Aberdour Road Dunfermline	Erection of 48 dwellinghouses and 20 flats; formation of surface water attenuation and treatment pond; landscaping; formation of associated roads, footpaths, car parking and amenity space.	Application permitted with conditions	Dunfermline East Expansion Area Housing Allocation

Table 2: Planning Applications Awaiting Decision

Planning Application Site	Proposed Development	Status of Application	Comments
Fife Council			
08/00984/WEIA, Rosyth Railway Station (Figure 6.2a - Planning Application 2)	Construction of 500 spaces park and choose facility, and associated landscaping and works.	Pending consideration	
07/03408/WFULL, Pitreavie Way	Erection of a 2 storey fire station building with associated auxiliary building, 4 emergency POD containers, a training tower, diesel tank, bund and pump, underground tank, access, parking, landscaping and security walls, gates and fencing.	Pending consideration	
07/02683/WFULL, Land To West Of Macdonald Square Main Street Halbeath	Erection of 86 flatted dwellings, formation of access road, 105 car parking spaces, landscaping /amenity areas.	Pending decision	Dunfermline East Expansion Area Housing Allocation
07/01337/WFULL, Masterton Road Dunfermline (Figure 6.2a - Planning Application 3)	Erection of 62 dwellinghouses, 18 flats and associated roads, parking and landscaping.	Pending decision	Dunfermline East Expansion Area Housing Allocation
06/04235/WARM, Masterton Park R5 (Figure 6.2a - Planning Application 4)	Reserved matters application for the erection of 203 dwellinghouses, 24 flats, formation of new road access, footpaths, roads, open space, play areas, landscaping and drainage pond.	Pending consideration	Dunfermline East Expansion Area Housing Allocation
The City of Edinburgh Council			
08/01437/LBC, Dundas Castle Estate	Listed building consent to restore semi derelict stable wing to create en-suite bedrooms and studio.	Pending decision	
08/01268/FUL, Queensferry Road, Kirkliston	Erection of 62 detached and semi-detached houses.	Pending decision	
08/01152/FUL/LBC, Haws Pier D, Newhall Road	New I.L.B boathouse with crew facilities and attached souvenir outlet.	Pending decision	

1.1 Introduction

1.1.1 This appendix sets out the baseline landscape character using Local Landscape Character Areas (LLCA) to describe the study area. For each LLCA, the description includes location, topography, drainage, land use, settlement, views, positive and negative attributes, designations, condition, scenic quality and sensitivity to change due to development.

1.1.2 The location of the Local Landscape Character Areas and landscape designations are shown on Figures 10.1 and 10.3 respectively.

1.1.3 Photographs illustrating the characteristics of each LLCA are shown in Figure 10.2

1.2 Baseline Conditions

1.2.1 The LLCAs within the Study Area are described below for each character type as listed in Chapter 10 (Landscape) and as they occur from north to south in the study area.

Lowland Hill and Valley Farmland

Woodlee

1.2.2 This LLCA is situated 2km east of Dunfermline Urban Area and is bounded to the west by the M90 with Crossgate urban settlement to the north.

1.2.3 This area is composed of south facing rolling open farmland sloping up to the north and reaching a high point of 137m above Ordnance Survey (aOD). Settlement in the area comprises a few scattered farm dwellings and a small caravan park at Drumcooper. The area also has a history of mining which is reflected in the row of air shafts located in the east of the LLCA. The elevated position of the area allows open views towards Clinthill Top to the south.

1.2.4 In terms of hydrology, there is a lake at Windmill Knowe in the north of the area and several small burns along the edges of fields throughout the area.

1.2.5 The main access route through the area is the B916 which traverses the area north to south. In addition there are several rural roads and farm access tracks leasing from the B916. There is aural and visual intrusion from the A90 to the west. Further visual intrusion occurs in the south of the area from pylons and overhead transmission lines.

1.2.6 Drystone walls and hedges define the field boundaries within the area. Vegetation cover is mainly scrub, rough grassland and species-rich grassland with some marsh areas to the northeast of the LLCA. Farmed land is arable and rough grazing. There are small areas of mixed woodland, hedge trees and shelterbelts around some farm buildings.

Table 1: Landscape Character Summary for Woodlee

Landscape Attributes	Description
Key Characteristics	• Rolling open farmland
Positive Character Attributes	• Vernacular buildings • Rolling open farmland • Open views towards southwest
Negative Character Attributes	• Visual and aural intrusion of the M90 along west edge. • The B981 road cuts through the area. • Pylons and communication masts
Landscape Designations	• Semi-natural Woodland Inventory/ Long-Established (of plantation origin) • Ancient Woodland
Landscape Condition	• Well maintained walls • Working farmland with semi-mature woodland blocks in good condition.
Scenic Quality	• Average scenic quality due to disruptive linear elements such as M90 and pylons.
Sensitivity to Change Due to Development	• Medium

Duloch

1.2.7 This LLCA is situated to the east of Dunfermline and is bounded to the east by the M90.

1.2.8 Duloch is situated on a gentle southeast facing slope with a rolling landscape to the north. Settlement in the area consists of a cluster of smallholdings and farm buildings in the south of the LLCA. To the north of the area are fields and planted mixed woodland. The area is overlooked by the housing development to the west and affected by the Edinburgh to Aberdeen railway line, M90 and an overhead powerline with pylons.

1.2.9 Pinkerton Burn is the main hydrological feature in the area and runs north to south in the south of the LLCA. Other manmade water features exist in the north of the area.

1.2.10 The main access to the smallholdings in the south of the area is from Masterton Road. The northern section of the area is accessed by Sandpiper Drive which features roundabouts and access into the northern fields catering for future development. There are several access tracks to farm buildings and a footpath through the woodland in the north.

1.2.11 Vegetation in the area consists of arable fields and mixed woodland in the north with hedge trees, shelterbelts and clumps of trees in the south around the smallholdings and farm buildings. There is also a strip of woodland and riparian vegetation along Pinkerton Burn.

Table 2: Landscape Character Summary for Duloch

Landscape Attributes	Description
Key Characteristics	• Rural area on urban fringe • Attractive burn • Smallholdings and small scale field pattern in the south. • Open south east facing gentle slope. • Block of mixed woodland to the north.
Positive Character Attributes	• Pleasant rural vista • Pinkerton Burn
Negative Character Attributes	• Pylons and overhead powerline. • Edinburgh to Aberdeen railway line. • M90 to the east. • Intrusion from the urban expansion in the west.
Landscape Designations	• Long Established Woodland (of plantation origin) around Pinkerton Burn
Landscape Condition	• Landscape generally in fair condition.
Scenic Quality	• Average scenic quality • Views into the area present a semi-rural landscape with linear intrusions from power lines and roads.
Sensitivity to Change Due to Development	• Low

Inverkeithing Farmland

1.2.12 This LLCA is situated to the northeast of Inverkeithing and to the north of Dalgety Bay. It is bounded by the A921 and the settlement of Hillend to the south and by the Fordell Estate to the north.

1.2.13 Inverkeithing Farmland is situated on a gentle south facing slope in a shallow valley.

1.2.14 There are four small water bodies running through the area (Pinkerton Burn, Keithing Burn, Mill Lade and The Cast). All of these converge at the southwest boundary of the area and feed into the river passing through Inverkeithing to the south and finally into the Firth of Forth at Inverkeithing Bay. In addition there is also a natural spring along one of the field boundaries.

1.2.15 The Edinburgh to Aberdeen and Fife Circle railway lines pass through the area from east to west and there is a dismantled railway passing from north to south. There is also an electricity sub station and an overhead power line with pylons crossing the west of the area.

1.2.16 The fields in the area are a mixture of arable and improved grassland. Other vegetation in the area includes scrub woodland to the west of the LLCA as well as degraded hedgerows, shelterbelts, hedge trees and isolated trees.

Table 3: Landscape Character Summary for Inverkeithing Farmland

Landscape Attributes	Description
Key Characteristics	• Rural area • Open, south facing, gently sloping fields. • Shallow valley • Land rising to north and southeast.
Positive Character Attributes	• Pleasant rural vista.
Negative Character Attributes	• Pylons and overhead power line. • Electricity sub-station. • Edinburgh to Aberdeen and Fife Circle railway lines. • Noise intrusion from nearby roads (A921, B981 and M90).
Landscape Designations	• 1 semi-natural Woodland Inventory/ Long-Established (of plantation origin) Ancient Woodland • Long-Established (of plantation origin) Ancient Woodland. • Historic Garden and Designed Landscape (Scotland). • 1 Area of Great Landscape Value (Fife).
Landscape Condition	• Landscape generally in good condition but some hedgerows in need of maintenance.
Scenic Quality	• Average scenic quality. • Views into the area present a rural landscape with linear intrusions from rail lines, power lines and roads.
Sensitivity to Change Due to Development	• Medium

Duddingston

1.2.17 This LLCA is situated to the southwest of South Queensferry and to the northwest of Kirkliston between Hopetoun and Dundas Designed Wooded Landscapes.

1.2.18 Topographically, Duddingston Farmland is situated on a flat ridge with a north facing slope to the north of the area and a more gentle south facing slope to the south. The north facing slope has far reaching views overlooking the Firth of Forth to the Fife coastline beyond in contrast to the south facing slopes which have more close to medium range views. The southeastern corner is screened to the north by Dundas Hill.

1.2.19 There are a few scattered rural dwellings and farm buildings within the area with the exception of the small settlement of Newton located on the ridge in the northwest corner adjacent to the A904. There is a dominant factory building bordering the Hopetoun Designed Landscape LLCA boundary to the north of the site. The historic A listed Duntarvie Castle is located to the west adjacent to the A90 motorway. A riding centre can be found in the central area of the LLCA.

1.2.20 There are three minor burns within the area and several natural ponds with associated woodland formations.

1.2.21 Most of the roads across the site are secondary or minor rural roads, except from the main A904 road running from South Queensferry along much of the ridge to the north part of the LLCA. The M9 defines the boundary along the south and eastern edge. To the south, a local rail line crosses the area. Some of the secondary roads are very narrow and in poor condition due to heavy farming machinery traffic. Pylons and communication masts are also found within the area.

1.2.22 The predominantly farming character of the landscape is composed of arable, improved pasture, grassland and rough grazing fields divided by dry stone walls, fences and beech or hawthorn hedges. Shelterbelts are used along several field boundaries and there are several scattered blocks of mixed woodland separating the farmland.

1.2.23 The area is aesthetically balanced despite its large scale and limited diversity. Apart from Dundas Hill, there are no visual barriers and a sense of openness. The main ‘A’ road and the railway line interrupt the north and south boundaries.

Table 4: Landscape Character Summary for Duddingston

Landscape Attributes	Description
Key Characteristics	• A ridge formation with slopes to the north and south. • Rolling farmland. • Small settlement with additional rural scattered dwellings. • Scattered blocks of mixed woodland plantation within the area.
Positive Character Attributes	• North facing slopes have broad views over the Firth of Forth. • Rural vistas
Negative Character Attributes	• Poor accessibility by car to some parts within the area. • Railway line • Noise and scenic intrusion by motorway in southern boundary.
Landscape Designations	• Area of Great Landscape Value (AGLV) (West Lothian) • Green Belt, Edinburgh • Historic Garden and Designed Landscape (Scotland) • 7 Long-Established (of plantation origin) Ancient Woodland (Scotland) • Scheduled Ancient Monument (Scotland)
Landscape Condition	• Productive farmland • Scattered long established woodland plantation in good condition. • Well maintained hedgerows across the area.
Scenic Quality	• Good scenic quality with north facing slopes and ridge line have attractive views over the Firth of Forth. Attractive enclosed rural landscape to the south.
Sensitivity to Change Due to Development	• Medium

Craigbrae

1.2.24 Craigbrae LLCA is located to the southeast of South Queensferry to the west of Craigie Hill. It is bounded to the north by the A90 and follows the M9 spur road to Kirkliston which form its west and south boundaries.

1.2.25 Topographically the landscape features an undulating plateau in the north which descends in a south east direction towards the River Almond.

1.2.26 There are few hydrological features in the area with the exception of Dolphington Burn, which traverses the north of the area in an east to west direction, and a further minor burn to the south of Craigbrae Farm. In addition to this, there are two ponds to the north of the area adjacent to the A90 and railway lines.

1.2.27 Access to the area is mainly through a number of rural B roads, which run from Dalmeny in the north to Kirkliston in the south west. Scattered farm dwellings and buildings can be accessed through this route which also braches off to the west towards Dalmeny Castle and the M9. Scattered footpaths and tracks also provide access to fields and farm buildings. In addition to this, the Edinburgh to Aberdeen runs through the area in a north-south direction with a local line splitting off to the southwest and another to the southeast.

1.2.28 Aside from a few scattered farm buildings, there are extensive commercial buildings in the north and centre of the LLCA. Sewage works and an oil storage depot are located in the north surrounded by a large earth bund, with, a smaller industrial estate to the south east.

1.2.29 Agricultural land in the area consists of arable and improved grassland with fence and hedge field boundaries. Other vegetation in the area includes grassland areas, a small woodland clump south of the oil storage depot and shelterbelts.

Table 5: Landscape Character Summary for Craigbrae

Landscape Attributes	Description
Key Characteristics	• Gently undulating rural farmland. • Southeasterly slope
Positive Character Attributes	• Farmland in good condition.
Negative Character Attributes	• Major road corridor • Oil storage depot and industrial units • Communication masts • Edinburgh to Aberdeen railway
Landscape Designations	• Green Belt (Edinburgh) • Long established woodland of plantation origin • Scheduled Ancient Monument
Landscape Condition	• Well maintained farmland
Scenic Quality	• Average to poor scenic quality due to spur road and oil storage depot.
Sensitivity to Change Due to Development	• Medium

Wooded lowland hill and valley

Craigie

1.2.30 This small character area is located 2km south east of South Queensferry and approximately 1km north of Edinburgh Airport.

1.2.31 The area consists of an oval shaped hill formation running in a north south direction rising from 55m to 94m aOD. The main features of the area include a re-vegetated disused quarry at the top and far reaching views over the Firth of Forth and surrounding area. Scattered farm buildings and cottages form the settlement in the area and there are also the remains of fortification at the southern edge.

1.2.32 Within the site, some views are screened by the dense deciduous ancient woodland which covers the hilltop to the north. However, extensive views are experienced by dwellings and farm buildings below the tree line. The majority of these are to the east with the exception of one dwelling to the northwest of the hill.

1.2.33 Access to the area is provided along a B road along the east boundary. Another minor road crosses the site east west at its south corner. The Edinburgh to Aberdeen railway line passes through the area and there are several footpaths within the woodland.

1.2.34 The distinctive character of the steep wooded hill surrounded by a flatter topography makes it an interesting landmark within the broader landscape.

Table 6: Landscape Character Summary for Craigie

Landscape Attributes	Description
Key Characteristics	• Small wooded hill above open farmland to the north of Edinburgh airport.
Positive Character Attributes	• Steep hill topography provides potential views. • Naturalised quarry and well established woodland used for recreation.
Negative Character Attributes	• The Edinburgh to Aberdeen railway line passes through the area. • Defined boundaries
Landscape Designations	• Green Belt, Edinburgh. • Ancient Woodland (of semi-natural origin)/ semi-natural Woodland Inventory
Landscape Condition	• Mature well established deciduous woodland across hillside surrounded by well maintain open farmland. • Disused quarry at the top of the hill in the process of regeneration.
Scenic Quality	• Good scenic quality – distinctive and attractive formation in the landscape with attractive open views of surrounding areas. Poor ability to accommodate change.
Sensitivity to Change Due to Development	• Medium to High

North Inverkeithing

1.2.35 This LLCA is located to the southeast of Rosyth and is bordered to the north by the A921 and to the west by an industrial estate and the M90 road.

1.2.36 The area comprises partly wooded west and north facing slopes. The west face is steep and overlooks Castlandhill, Rosyth and the M90 whilst the north face has open views over Inverkeithing industrial estate and distant rolling farmland. The south boundary of the area is screened by the existing topography and high hedges belonging to the peripheral housing development.

1.2.37 The area is accessed by roads from the south and east and contains a footpath network used for recreation. Overhead power cables with wooden poles cross the site.

1.2.38 Along the western limit of the area, a shelterbelt partly screens the adjacent road to the industrial estate. At the top of the western slope, which supports a strip of deciduous woodland, there is a small, disused quarry, designated as a SSSI. The northern hillside and area to the east are occupied by small rough grazing fields. The remaining vegetation is scrub woodland.

1.2.39 The area has good views to the surrounding countryside but the adjacent roads and industrial estate are degrading to the quality of the area.

Table 7: Landscape Character Summary for North Inverkeithing

Landscape Attributes	Description
Key Characteristics	• Partly wooded north and west facing slope overlooking motorway (M90), industrial estate and surrounding countryside.
Positive Character Attributes	• Open views to north. • Existing footpaths for recreational use.
Negative Character Attributes	• Visual intrusion of adjacent M90 and industrial estate.
Landscape Designations	• None
Landscape Condition	• Rough fields and scrub are in average condition. • Series of rough footpaths across the hillside. • Well maintained trees and hedges around the adjacent housing.
Scenic Quality	• Average to poor scenic quality due to disturbance by industrial estate, adjoining roads and housing. Reasonable ability to accommodate change within the area.
Sensitivity to Change Due to Development	• Low to Medium

Humbie

1.2.40 This LLCA is placed within the major Duddingston Open Farmland character area at its south boundary bordering with the railway line to the south and the A90 motorway to the south west.

1.2.41 The area rests on a south facing slope terminating in the curved shaped Humbie Reservoir. To the south of this there is a gentle north facing slope rising to the south towards the railway line. Swine Burn feeds Humbie Reservoir from the higher ground to the northwest of the area and flows onward from the south east of the area.

1.2.42 Additional hydrological features include a lake formed in a disused quarry at the western edge of the area. This has been stocked with fish and is used as a recreational fishing site. A disused quarry is also found at the northeast corner of the LLCA and has also formed a lake. In addition to this, a covered reservoir is found adjacent to the quarry in the northeast of the area.

1.2.43 The main access to the site is through a B road that runs along its north and east limits. There is a main track running south to north across a woodland block as well as several minor footpaths along the water features.

1.2.44 Along the watercourse, there is extensive woodland, mainly deciduous to the west and east and mixed in the central area, together with shelterbelt formations.

1.2.45 The farm fields are mainly covered by improved pastured and grassland. There are existing dry stone walls, hedges and fences marking boundaries of some of the fields.

1.2.46 The intrusion from the adjacent railway is visually well screened by mitigation bordering planting, but the noise of passing trains is still evident. Due to the woodlands in the LLCA, the A90 motorway is also well screened within the site with the exception of a large arable field at the south west corner. However aural intrusion from the road does occur.

1.2.47 The diverse character of the area principally deals with naturalized water features and woodland plantations in a relatively small, enclosed and peaceful location, therefore it is perceived as interesting and pleasant as well as safe.

Table 8: Landscape Character Summary for Humbie

Landscape Attributes	Description
Key Characteristics	Plantation woodland and mature shelterbelt surrounding small fields on rolling topography around small reservoir. • Disused quarries forming water-bodies and recreational facilities.
Positive Character Attributes	• Footpath network across the area • Rural location • Attractive waterbodies
Negative Character Attributes	• Proximity to busy motorway (M9) and railway line.
Landscape Designations	• Long-Established Woodland (of plantation origin) • Area of Outstanding Landscape Quality (AOLQ) Edinburgh
Landscape Condition	• Well maintained fields • Poorly managed woodland • Well defined field boundaries • Mature shelterbelt woodland in good condition. • Well maintained reservoir and water bodies used for fishing.
Scenic Quality	• Good scenic quality despite significant noise intrusion from motorway. Some attractive views to the south. Poor ability to accommodate change.
Sensitivity to Change Due to Development	• High

Coastal Hills

Letham Hill

1.2.48 This LLCA is situated immediately north of Inverkeithing Bay. It is bounded to the north by the A921 and the Firth of Forth coastline to the south.

1.2.49 Letham Hill is situated on a predominantly west facing slope and has a distinctive wooded hill along its eastern edge. A coastal brae continues to the south, with impressive views to the Firth of Forth and features a disused quarry with steep vertical faces and some natural plant regeneration.

1.2.50 Aside from a field drain and the coastal edge the flooded quarry is the only hydrological feature in the area. A network of footpaths cross the area providing access to Inverkeithing to the west and Dalgety Bay to the east. A cycle path follows the coastline and a farmhouse and outbuildings area accessed along a private track.

1.2.51 Vegetation in the area includes scrub woodland and species rich grass to the south and along the coastal brae. Deciduous woodland covers Letham Hill to the east of the area and hedges, hedge trees and shelterbelts feature beside the farmhouse and define the field boundaries. Fields are improved grassland.

Table 9: Landscape Character Summary for Letham Hill

Landscape Attributes	Description
Key Characteristics	• Isolated farmland between two urban areas. • Wooded hill to the east. • Coastal brae to the south. • West facing gently sloping fields.
Positive Character Attributes	• Impressive views over the Firth of Forth from the southern brae. • Attractive wooded hill to the east. • Well used foot and cycle paths. National Trail / Long Distance Route / National cycle network-traffic free.
Negative Character Attributes	• Visual intrusion of housing to the west. • Disused quarry with damaged fencing.
Landscape Designations	• 1 Long-Established (of plantation origin) Ancient Woodland
Landscape Condition	• Landscape generally in good condition.
Scenic Quality	• Good scenic quality • Views from the area are excellent along the southern brae. • Attractive wooded hill
Sensitivity to Change Due to Development	• Medium to High

Castlandhill

1.2.52 Castlandhill is located between Inverkeithing and Rosyth Urban Area. It is bounded to the east by the A90.

1.2.53 The LLCA comprises two separate hill formations. A smaller wooded hill (‘Whinny Hill’) to the south rises from 25m to 63m aOD and a larger hill to the north of the area rises from 40m to 85m aOD with worked farmland fields and a small cluster of housing towards the top of the hill. The northern hill also features a cluster of three prominent communication masts.

1.2.54 The area is accessed from the east by Castlandhill road where a lay-by provides parking and access to a footpath leading between the two hills with an additional footpath to the northern side of Whinny Hill. There is also private access to a house to the south of Whinny Hill from Ferry Toll Road. Further north along Castlandhill road an access track leads to the cluster of housing on the most northerly hill.

1.2.55 The topography comprises two adjacent hills at the north and south sides of the area. The southern hill is formed from igneous rock and the northern hill by contrast is formed from sedimentary rock. Between the hills, a narrow valley has been formed.

1.2.56 There are open views over Rosyth Urban Area and the M90 alignment. Views to the east are screened by an existing ridge aligned with the M90. To the south there are views to the Firth of Forth from Whinny Hill.

1.2.57 The majority of the land coverage on the northern hill is farmland. Whinny Hill has species rich and rough grassland with small scrub areas and deciduous woodland to the south. At the top of the Whinny Hill there is a small pond with marsh type vegetation. This area also features stone walls and hedges to mark field and property boundaries.

Table 10: Landscape Character Summary for Castlandhill

Landscape Attributes	Description
Key Characteristics	• Farmland across two hills.
Positive Character Attributes	• Good access • Recreation value of Whinny Hill and valley footpath network. • Long views to the Firth of Forth from the southern hill of the area. Views to the northern hill Castlandhill.
Negative Character Attributes	• The area is disturbed by the proximity of the A90 which runs along the eastern edge. • Disturbance by masts in Castlandhill and cluster of housing.
Landscape Designations	• Semi-natural Woodland Inventory/ Long-Established (of plantation origin) Ancient Woodland
Landscape Condition	• Working farmland in good condition. • Whinny Hill in semi-natural state and in good condition. • Mature deciduous woodland in good condition.
Scenic Quality	• Good scenic quality both towards and from the area.
Sensitivity to Change Due to Development	• Medium

Ferry Hills

1.2.58 This small character area is located immediately north of North Queensferry and extends to the coast to both the east and the west with Cruicks Quarry forming a boundary to the north.

1.2.59 The area is formed by igneous rock and rises steeply from sea level to the west and east reaches an undulating plateau with a high point of 71m aOD. The main features of the area include a disused quarry to the north and far reaching views over the Firth of Forth and surrounding area. There are scattered dwellings to the east of the area and a hotel and country house to the west. A railway cutting for the Edinburgh to Aberdeen railway line forms a steep vertical intrusion through the centre of the area.

1.2.60 The area has few hydrological features with the exception of a natural loch in the centre of the LLCA and the coastal edges.

1.2.61 Access to the area is provided along a B road which follows the edge of Cruicks Quarry. The A90 also traverses the area and provides access to the west of the area before continuing into North Queensferry. The area is also crossed from north to south by a railway line. A series of formal and informal footpaths cross the area providing access to the hills and coastal path to the east and the area surrounding the loch to the west. There is no access by footpath from east to west due to the railway cutting.

1.2.62 Vegetation in the area includes areas of rough grassland with large areas of gorse and scattered scrub woodland in the centre of the LLCA. To the west is an attractive area of deciduous woodland and there are also hedges, hedge trees and clumps of deciduous woodland to the west. There is also extensive riparian vegetation around the loch.

Table 11: Landscape Character Summary for Ferry Hills

Landscape Attributes	Description
Key Characteristics	• Small hill above settlement of North Queensferry • Steep coastal hills to east and west. • Extensive views • Fragmentation due to railway and A90.
Positive Character Attributes	• Natural rugged landscape • Extensive views
Negative Character Attributes	• Edinburgh to Aberdeen railway line. • Disused quarry • Fragmentation
Landscape Designations	• Ancient Woodland (of semi-natural origin) / semi-natural Woodland Inventory.
Landscape Condition	• Landscape left in natural condition in the centre of the LLCA. • Disused quarry in the process of regeneration. • Woodlands to the east and west in good condition.
Scenic Quality	• Good scenic quality – attractive open views of surrounding areas. • Fragmentation and existing intrusion from rail and road creates an ability to accommodate change.
Sensitivity to Change Due to Development	• Medium

Coastal Flats

North Queensferry

1.2.63 This LLCA is situated east of Rosyth Industrial Area, bordered to the west by the M90 and St. Margaret's Hill and to the south by the Firth of Forth coastline. Along the north fringe of the area runs a secondary road of which embankment is included within the LLCA. At the northeast corner a water treatment plant is located.

1.2.64 North Queensferry Coastal Flat is located on the Forth floodplain. As a result, its predominant topography is flat.

1.2.65 The predominant land cover is rough grassland, scrub and some shrubs and small isolated trees along the road embankment. Close to the eastern edge, there is a natural small pond with marginal vegetation around it.

1.2.66 The main access to the site is by the secondary road along the northern edge. There are several footpaths within the site.

1.2.67 The area is open to the south but slightly enclosed to other directions due to its adjacent topography and the industrial estate. The water treatment plant is intrusive causing some fragmentation. Also the adjacent Rosyth Industrial Area breaks the character of the western edge of this LLCA. There are open views to the Firth of Forth except from the eastern side where the St. Margaret's Hill partly screens those views. The area provides an interesting scenic quality provided by the contrast between the prominent wooded hill sloping down to the sea level and the flat nature of the adjacent wetland.

Table 12: Landscape Character Summary for North Queensferry

Landscape Attributes	Description
Key Characteristics	• Marshy grassland on the Forth floodplain.
Positive Character Attributes	• Open views to the Firth of Forth. • Natural pond
Negative Character Attributes	• Views partly screened by St. Margaret Hill. • Strong contrast between this naturalised area and the adjacent industrial development.
Landscape Designations	• None
Landscape Condition	• Grassland on floodplain in good natural condition. • Scattered trees and shrubs along road embankment in average condition.
Scenic Quality	• Average scenic quality due to presence of industrial estate to west and the dominance of St. Margaret Hill to the east. • Visual and smell intrusion by water treatment sewerage work. Poor ability to accommodate change due the ecological sensitivity of the area.
Sensitivity to Change Due to Development	• Medium to High

Designed Wooded Landscape

Fordell

1.2.68 Fordell Wooded Farmland is situated to the north of Dalgety Bay and to the east of the M90. It is bordered to the south by Inverkeithing Open Farmland and to the west by Woodlee Open Farmland.

1.2.69 Much of the area is designed woodland surrounding Fordell Castle and Estate. Aside from the castle, settlement consists of a few scattered farm dwellings and associated estate buildings. In addition to this there are also a number of static caravans / holiday homes forming a separate community at Fordell Gardens. The majority of this character area has been designated as a Historic Garden and Designed Landscape with long-established ancient woodland formations (of plantation origin).

1.2.70 The topography to the north of the LLCA is undulating and there is a well defined peak at Clinthill Top to the east of the area. From the undulating plateau in the north, the land falls steeply to the south before becoming a shallow southerly slope. Also featured in the landscape is a steep ravine immediately south of the castle formed by Fordell Burn.

1.2.71 In addition to Fordell Burn other hydrological features include a lake to the north of the castle, several notable springs and wells and two sets of falls. A pond has also formed in a disused quarry in the south of the area.

1.2.72 Due to its topography there are views towards the Firth of Forth from Clinthill Top and from selected south faced locations. Elements of the area are enclosed due to ravines and the undulating land formation.

1.2.73 The land cover is mainly farmland and woodland. The farmland consists of arable fields and improved pasture, separated with stone walls, fences or hedges. There are both mixed and deciduous woodlands with the main woodland located around the Castle in wide strips running from south to north. There are two other important woodlands in the area, one of them is situated in the southeast bordering with Donibristle Industrial State and the other one is at the northeast side. Some trees are used as shelterbelts or hedges dividing different fields, others are dispersed in clumps.

1.2.74 Road communications within the area are poor but there is a pathway network through the fields and woodlands.

Table 13: Landscape Character Summary for Fordell

Landscape Attributes	Description
Key Characteristics	• Rolling farmland across wooded estate.
Positive Character Attributes	• Open views to the Firth of Forth from Clinthill Top and selected points. • Historic Garden and Designed Landscape
Negative Character Attributes	• Poor communications, only one secondary B road along part of west edge. Pylons to the west of the area. • Intrusion of static homes and water tank into woodland.
Landscape Designations	• 2 semi-natural Woodland Inventory/ Long-Established (of plantation origin) Ancient Woodland • Large area of Long-Established (of plantation origin) Ancient Woodland • Historic Garden and Designed Landscape (Scotland)
Landscape Condition	• Areas of felled woodland with natural regeneration in need of maintenance. Well maintained working farmland fields.
Scenic Quality	• High scenic quality around Fordell Castle designed landscape, ravine, waterfalls. • Medium scenic value along the B981 and B916 due to regenerating woodland and intrusion of static homes into woodland setting.
Sensitivity to Change Due to Development	• Medium to High

Hopetoun

1.2.75 Hopetoun Designed Wooded Landscape is situated to the west of South Queensferry and encompasses designed landscapes from a number of historic country houses on the southern banks of the Firth of Forth.

1.2.76 The LLCA features a north facing slope descending from a ridge at 90m aOD in the south to water level in the north. The slope is best described as gently undulating with a steeper coastal brae towards the waters edge in the north. To the west of the area, the land rises reaching a peak at Binns Hill before descending towards the Firth of Forth. A steep valley (Midhope Glen) is also formed by the Midhope Burn which runs in a north easterly direction across the area before reaching the Firth of Forth. There are extensive views to the north over the Firth of Forth.

1.2.77 In addition to Midhope Burn other hydrological features include Cornie Burn running east to west and joining with Midhope burn, artificial ponds to the west and south of Hoptoun House and three ponds formed in disused quarries. Additional small burns occur south of Hopetoun House and there are several wells scattered through the area.

1.2.78 The area is accessed through minor roads stemming from the A904 running along the southern edge of the area. It can also be accessed from a coastal road originating in South Queensferry and terminating at Hopetoun House. Various private tracks provide access to estate buildings and there are footpaths around the estate grounds, along the wooded shoreline and in Hoptoun Wood to the south of the LLCA.

1.2.79 Vegetation in the area primarily consists of farmland and woodland. The farmland consists of arable fields and improved pasture, separated with well maintained stone walls, fences or hedges. There are areas of mixed, deciduous and coniferous woodlands. A continuous strip of mixed woodland follows the coast line to the north of the LLCA with a further expanse of woodland following the Midhope and Cornie Burn valleys. Mixed woodland blocks also surround Hopetoun, Midhope and Philipstoun Houses and further large woodland blocks are located to the south of the area – most notably Hopetoun Wood. Isolated trees occur in the designed landscape surrounding The Binns House in the west of the LLCA and there are also clumps of woodland, shelterbelts and hedge trees throughout the area.

Table 14: Landscape Character Summary for Hopetoun

Landscape Attributes	Description
Key Characteristics	• North facing slope with coastal edge. • Extensive views over the Firth of Forth. • Historic and designed landscapes • Extensive woodland features with areas of farmland.
Positive Character Attributes	• Open views to the Firth of Forth at places. • Peaceful sinuous coastal setting. • Attractive woodland areas • Historic Garden and Designed Landscape
Negative Character Attributes	• Some areas not easily accessible.
Landscape Designations	• Long-Established Woodland (of plantation origin) • Ancient Woodland (of semi-natural origin) • AGLV • Historic Garden and Designed Landscape
Landscape Condition	• Woodland generally in good condition. • Well maintained working farmland fields.
Scenic Quality	• High scenic quality
Sensitivity to Change Due to Development	• High

Dalmeny

1.2.80 Dalmeny is situated to the east of South Queensferry and encompasses a designed landscape to the north and west and an area of farmed estate land to the south of the B924. The area is bounded to the south by the A90 and B924 and to the east by the River Almond. The Edinburgh to Aberdeen railway line passes through the area.

1.2.81 The LLCA features an undulating landscape with several hill formations formed from underlying igneous rock (the tallest reaching a height of 119m aOD). The northern and eastern edges of the LLCA follow the coastline which forms a distinctive pointed peninsula on the Firth of Forth. There are steep wooded coastal braes with accessible crags and beach areas in places. To the southeast, the LLCA forms the western embankment of the River Almond as it discharges into The Forth estuary.

1.2.82 The area has a history of fortified settlement with a castle to the east. However the main estate residence is a country house dating to the early 19th Century. There are also a number of listed farm buildings and cottages throughout the estate.

1.2.83 In terms of hydrology, aside from the River Almond, there are two large ponds to the west of Dalmeny House and a number of burns running through the south and east of the area including Dolphington, Cockle and Linklin Burns. There are also several minor burns to the northwest. Abstraction from the area has in the past been provided through a number of wells including the historic St. Margaret's Well.

1.2.84 The area is accessed through private roads (open to the public seasonally) and an extensive public footpath network allowing attractive coastal walks from South Queensferry to Cramond and north Edinburgh beyond.

1.2.85 Vegetation in the area primarily consists of farmland and woodland. The farmland consists of arable fields and improved pasture, separated with well maintained stone walls, fences or hedges. There are areas of mixed, deciduous and coniferous woodlands. A continuous strip of mixed woodland follows the coast line to the north of the LLCA with a further expanse of woodland following the River Almond valley and the main burns in the area. Mixed woodland blocks also surround Dalmeny House and further large woodland blocks are located on the hill tops. Parkland trees occur in the designed landscape to the south of Dalmeny House. There are also shelterbelts and hedgerow trees throughout the area.

Table 15: Landscape Character Summary for Dalmeny

Landscape Attributes	Description
Key Characteristics	• Undulating / hilly wooded country estate. • Extensive views over the Firth of Forth. • Historic and designed landscapes • Extensive woodland features with areas of farmland.
Positive Character Attributes	• Open views to the Firth of Forth at places. • Peaceful sinuous coastal setting. • Attractive woodland areas • Extensive footpath network • Access to crags and beaches
Negative Character Attributes	• The Edinburgh to Aberdeen railway line passes through the area. • Some views obscured by tree line.
Landscape Designations	• Green Belt • Long-Established Woodland (of plantation origin) • Ancient Woodland (of semi-natural origin) • AOLQ • Historic Garden and Designed Landscape
Landscape Condition	• Woodland in good condition. • Well maintained working farmland fields.
Scenic Quality	• High scenic quality. Poor ability to accommodate change.
Sensitivity to Change Due to Development	• High

Dundas (desk based)

1.2.86 Dundas is situated to the south of South Queensferry and to the west of the M9 Spur. The area encompasses a designed landscape to the west and an area of wooded farm land to the east of the A8000.

1.2.87 The LLCA features a small hill rising from 60m to 118m aOD formed from igneous rock with a steep southerly edge leading to Dundas Loch situated to the south of the area. To the east of the area is a gently undulating south and east facing slope formed from underlying sedimentary carboniferous rock.

1.2.88 Settlement in the area has historically centred on Dundas Castle. However there are also a number of other scattered dwellings and buildings in the estate grounds. Several of these are listed buildings.

1.2.89 In terms of hydrology, Dundas Loch is the main water body in the area. There is also a manmade pond to the southwest of the LLCA and Dolphington Burn running through the east of the area.

1.2.90 The estate area to the west is accessed through private roads and has a footpath network through wooded areas and along the southern edge of the loch. The area to the east of the A8000 is accessed through a rural B road with tracks allowing access to farm buildings.

1.2.91 Vegetation in the area primarily consists of farmed arable fields and improved pasture, separated with well maintained stone walls, fences or hedges. There are areas of mixed, deciduous and coniferous woodlands. Parkland trees occur in the designed landscape to the east of Dundas House. There are also clumps of woodland, shelterbelts and hedge trees throughout the area.

Table 16: Landscape Character Summary for Dundas

Landscape Attributes	Description
Key Characteristics	• Undulating / hilly wooded country estate. • Natural loch • Historic and designed landscapes • Golf course within area • Extensive woodland features with areas of farmland.
Positive Character Attributes	• Attractive woodland areas • Attractive loch • Historic Garden and Designed Landscape.
Negative Character Attributes	• Intrusion from A8000 and M9 Spur
Landscape Designations	• Green Belt (Edinburgh) • Long-Established Woodland (of plantation origin) • Ancient Woodland (of semi-natural origin) • AOLQ • Historic Garden and Designed Landscape
Landscape Condition	• Woodland in good condition. • Well maintained productive farmland fields.
Scenic Quality	• High scenic quality. Poor ability to accommodate change with exception of the area between A8000 and M9 Spur which has a medium ability to accommodate change due to existing aural and visual intrusion.
Sensitivity to Change Due to Development	• Medium to High

Newliston (desk based)

1.2.92 Newliston Designed Wooded Landscape is situated to the south west of Kirkliston and to the west of the M9. The area is bound to the south by the A89 and to the west by Broxburn industrial estate.

1.2.93 The LLCA is situated on an undulating and gently south facing slope which forms the northern slope of the River Almond Valley.

1.2.94 The designed landscape is centred on Newliston House and in addition to this the main settlement in the area consists of several estate buildings, farms and farm cottages.

1.2.95 Several burns converge to the south west of the LLCA to form one main burn that flows through the area in a south west to south east direction before discharging into the River Almond. There are also two natural ponds to the south west of the LLCA and several manmade ponds in the north of the area around Newliston House.

1.2.96 The estate area is accessed through private roads via surrounding public roads to the south, west and east. The area also has several footpaths and tracks providing access to the gardens and to farm buildings and farm land. In addition to this, the Edinburgh to Glasgow railway line crosses the west of the LLCA.

1.2.97 Vegetation in the area primarily consists of farmed arable fields and improved pasture with well maintained stone walls, fence and hedge boundaries. There are areas of mixed and deciduous woodlands with isolated trees occurring in the designed landscape to the north of Newliston House.

Table 17: Landscape Character Summary for Newliston

Landscape Attributes	Description
Key Characteristics	• South sloping wooded country estate. • Natural ponds and burn • Historic and designed landscape • Woodland features with areas of farmland.
Positive Character Attributes	• Attractive woodland areas • Historic Garden and Designed Landscape
Negative Character Attributes	• Proximity of M9 and A89 • Crossed by Edinburgh to Glasgow railway line.
Landscape Designations	• Green Belt (Edinburgh) • Long-Established Woodland (of plantation origin) • Ancient Woodland (of semi-natural origin) • AOLQ • Historic Garden and Designed Landscape
Landscape Condition	• Woodland in good condition. • Well maintained working farmland fields.
Scenic Quality	• Medium to high scenic quality. Medium ability to accommodate change on the periphery of the area.
Sensitivity to Change Due to Development	• High

Disturbed Farmland

Craigton

1.2.98 This LLCA is located immediately north of Winchburgh and extends west to Philipstoun and east towards Kirkliston following the M9 as its northern boundary.

1.2.99 Topographically the area is a gently undulating landscape which is dominated by large manmade ‘bings’ from former shale mine workings. In addition to this, the area also features two disused quarries and a disused tip to the west. Settlement in the area consists of scattered farm dwellings and the settlement of Philipstoun in the west. In addition to this development, the area includes a sewage works to the north of Philipstoun and the remains of a church.

1.2.100 The main hydrological feature in the area is the canal which runs north from Winchburgh and west to Philipstoun. Other water bodies include a large pond to the north of Winchburgh and several burns including Niddry Burn to the east, Swine Burn to the northeast and Pardovan Burn to the northwest of the area.

1.2.101 Access to the area is through a selection of rural B roads. The M9 can also be accessed from one of these roads in the north of the LLCA. In addition to this, the Edinburgh to Glasgow railway line runs through the area in an east-west direction with a local line splitting off to the south east at the eastern end of the LLCA, roughly following the line of the canal. The area can also be accessed by a footpath and cycleway along the canal and there is a network of footpaths through some woodland areas.

1.2.102 Agricultural land in the area consists of arable and improved grassland with fences, hedges and drystone walls forming the field boundaries. Other vegetation includes rough grassland and natural regeneration on the bings and deciduous and mixed woodland along the canal path. There are also areas of mixed woodland in the centre of the LLCA and a block of coniferous woodland to the south of Mounthooly.

Table 18: Landscape Character Summary for Craigton

Landscape Attributes	Description
Key Characteristics	• Gently undulating rural farmland. • Presence of large dominating 'bings'. • Canal running through the area with railway line running parallel to the north.
Positive Character Attributes	• Attractive canal with path and established vegetation.
Negative Character Attributes	• Former mine workings and shale bings. • Fragmented landscape • Crossed by Edinburgh to Glasgow railway line.
Landscape Designations	• Long established woodland of plantation origin/ semi-natural woodland inventory.
Landscape Condition	• Well maintained farmland. • Well established woodland. • Canal path well maintained and in good condition. • Well maintained hedgerows and dry stone walls.
Scenic Quality	• Average to good scenic quality. Bings add interest to the landscape. Attractive walks along the canal.
Sensitivity to Change Due to Development	• Low to Medium

Lowland Plain

River Almond

1.2.103 This LLCA is located between Kirkliston urban area and Edinburgh Airport in a predominantly flat topographic landscape featuring the winding River Almond.

1.2.104 The main hydrological feature is the River Almond which runs inside the area from southeast Kirkliston urban area boundary, meandering along Edinburgh Airport's northern boundary until Craigiehall housing development. Several tributary burns join the river from the northwest. Most of the buildings within the area are isolated farms apart from the small settlement at Craigiehall, which contains several historic buildings. There are also 2 Scheduled Ancient Monuments (Scotland) within the LLCA: 'Cat Stane' on the borders of the airport grounds; and Huly Hill tumulus in the junction between the A89 and A90 roads.

1.2.105 Despite the flat topography of the area there are wider views south towards the Pentlands.

1.2.106 Access to the site is provided by B roads that run across the area from Kirkliston and mainly cover the western half of the LLCA. The Edinburgh to Aberdeen railway line passes through the area and a network of footpaths provide access throughout and follow the River Almond. There is also a traffic free cycle route crossing the area to the west towards South Queensferry.

1.2.107 Land coverage mainly consists of open arable fields with the exception of vegetation beside the River Almond. There are a few clumps of mixed woodland and isolated trees amongst the farmland. Dry stone walls, fences, hedges and shelterbelts around the arable fields can be found at several locations. Mature trees feature in areas along the River Almond particularly where it meanders to the west and east of the airport runway.

1.2.108 The area is perceived as safe and pleasant but the proximity of the airport and the lack of diversity make it monotonous and of low interest in aesthetic terms.

Table 19: Landscape Character Summary for River Almond

Landscape Attributes	Description
Key Characteristics	• Generally flat farmland, rising gently to the northeast corner, with the river Almond running through the area to the south.
Positive Character Attributes	• Riverside area with distinctive vegetation. • Historic buildings
Negative Character Attributes	• Proximity to intrusive airport development. • Edinburgh to Aberdeen railway line passes through the area. • Flat topography restricts open views. • Suppressed vegetation along River Almond adjacent to airport runway.
Landscape Designations	• Areas of Importance for Flood Protection in Edinburgh • Green Belt (Edinburgh) • Historic Garden and Designed Landscape
Landscape Condition	• Well maintained open farmland. • Well established woodland field boundaries. • Well maintained hedgerows and dry stone walls.
Scenic Quality	• Average scenic quality. Significant disturbance from the airport detracts from the scenery. Attractive south views towards the Pentlands.
Sensitivity to Change Due to Development	• Medium to High

Overton

1.2.109 Overton LLCA is located between the settlements of Winchburgh and Kirkliston. It is bounded to the northeast by the M9 and to the west by the union canal. To the south is the Newliston estate.

1.2.110 Topographically the landscape is flat with a slight south facing slope to the southern boundary.

1.2.111 There are few hydrological features in the area with the exception of Niddry Burn which travels diagonally roughly from the northwest to the south east of the LLCA. To the west of the area is the Union Canal and there is a field drain to the south.

1.2.112 Access to the area is mainly through a minor rural road which runs from Carmelhill to Winchburgh.

1.2.113 Aside from a few scattered farm buildings, there are no buildings in the LLCA.

1.2.114 Agricultural land in the area consists of arable and improved grassland with well maintained stone wall boundaries. Other vegetation in the area includes an area of mixed woodland adjacent to the M9 and a 'manicured' golf course to the northwest.

1.2.115 The area has few landscape features, is crossed by the Edinburgh to Glasgow railway line and is further degraded by the M9 to the north and the surrounding bings.

Table 20: Landscape Character Summary for Overton

Landscape Attributes	Description
Key Characteristics	• Flat rural farmland • Arable and improved grassland fields. • Stone walls • Small burn
Positive Character Attributes	• Farmland in good condition. • Stone walls • Golf course
Negative Character Attributes	• Major road corridor and junction • Crossed by Edinburgh to Glasgow railway line. • Views to surrounding bings
Landscape Designations	• Long established woodland of plantation origin
Landscape Condition	• Well maintained farmland
Scenic Quality	• Average to poor scenic quality due to road and junction and bings.
Sensitivity to Change Due to Development	• Medium

Firth of Forth

Firth of Forth (desk based)

1.2.116 The Firth of Forth is the main water body in the southeast of Scotland flowing from the Trossachs into the North Sea. The study area focuses on the section between the settlement of Boness to the west and Dalgety Bay to the east.

1.2.117 The Firth of Forth is crossed by several bridges and features small islands and transport-related infrastructure. Along the shore line to the north are several settlements including Rosyth and North Queensferry and to the south the main settlement is South Queensferry.

1.2.118 The shore area is flat featuring small rock formations in the extensive, intertidal mud flats when the tide is low. Along the firth, the land has been formed by maritime erosion into small peninsulas, bays and sand banks over thousands of years. The vast horizontal character provides long distance views and a focus for the surrounding areas.

1.2.119 The dominant structures are the Forth Road Bridge and the Forth Rail Bridge. Development on the shores to the north and south includes housing, industry, a naval base and a marina. Piers, ports, lighthouses, military installations and forts, some of which are designated as Scheduled Ancient Monuments, are located on the shorelines and islands. Ships also feature as transitory built elements.

1.2.120 The A90, Forth Road Bridge crosses the area, linking the M90 to the north with the M9 to the south. Several local roads and paths enable local access around the north and south shore. The area is also traversed by the Forth Rail Bridge which provides national and local links via the east coast railway line. The river is well used by commercial and leisure boats, including a seasonal local ferry from South Queensferry to Inchcolm Island and year-round ferry from Rosyth to Zeebrugge. The naval base at Rosyth caters for submarines and cargo vessels sail from the Forth to other ports in Scotland and Europe.

1.2.121 The land coverage is water, mud flats and small islands, vegetated with scrub woodland, and rough grassland.

1.2.122 The area is characterised by tranquil and colourful open space, where a large range of landscape experiences are founds, dependent on tidal movement, light and weather, contrasted and balanced with the constant movement of vehicles by road, rail and sea.

Table 21: Landscape Character Summary for the Firth of Forth

Landscape Attributes	Description
Key Characteristics	• Horizontal and natural landscape influenced by tidal, light and weather conditions. Contrasting natural and artificial elements.
Positive Character Attributes	• The vast horizontal scenery provides long distance views and a focus for the surrounding areas.
Negative Character Attributes	• Intrusive manmade infrastructures (piers, ports and marina centres).
Landscape Designations	• Conservation Areas in Edinburgh • Historic Garden and Designed Landscape (shore line of the Dalmeny Designed Wooded Landscape)
Landscape Condition	• River and important intertidal mud flats are in relatively unspoilt condition overall except where industrial areas and infrastructure are dominant.
Scenic Quality	• High scenic quality and important landmark.. Medium to high ability to accommodate carefully selected change near to the existing bridges.
Sensitivity to Change Due to Development	• High

Urban

Dunfermline

1.2.123 This large urban area is situated to the north of Rosyth and to the west of the M90. Areas of dense housing are separated by green recreational spaces, historic designed landscapes and business parks. It is one of the primary towns in West Fife and has an extensive housing development programme to the east.

1.2.124 Topographically, Dunfermline is situated in an undulating landscape and is spread across several rolling hills. There are views from some south facing hills towards the Firth of Forth.

1.2.125 There are a number of artificial waterbodies to the east of the area, mainly associated with sustainable urban drainage systems situated in housing developments. Other hydrological features include several burns that run through the town (Lyne Burn, Whinny Burn and Castleblair / Broomhead Burn).

1.2.126 The main roads through the town include the A823 and the A907 with most minor roads accessed from these main routes. The area is also served by the Edinburgh to Aberdeen railway with a station in the town centre.

1.2.127 There are a number of recreation and parkland areas in the town including a golf course and playing fields at Pitreavie in the south of the area and designed parklands to the west of the palace and to the north of the train station.

Table 22: Landscape Character Summary for Dunfermline

Landscape Attributes	Description
Key Characteristics	• Large expanding urban areas. • Undulating landscape
Positive Character Attributes	• Views from some south facing hills towards the Firth of Forth. • Attractive park areas
Negative Character Attributes	• Ongoing development to the east with areas of undeveloped 'waste ground'. • Derelict industrial units in the northeast corner. • Edinburgh to Aberdeen Railway line.
Landscape Designations	• Conservation Area
Landscape Condition	• Landscape generally in good condition with the exception of undeveloped and derelict areas to the east.
Scenic Quality	• Average urban scenic quality.
Sensitivity to Change Due to Development	• Low

Rosyth

1.2.128 Rosyth LLCA is situated approximately 2km west of Inverkeithing and 1km south of Dunfermline.

1.2.129 Rosyth has several medium and low density areas of housing with further residential development occurring to the east of the town. Recreational playing fields and an area of woodland provide a break in the housing to the northeast and northern edge of the area. The area also contains two business parks.

1.2.130 The main roads through the area are the B980, which runs diagonally through the centre from north to south and the A985 which crosses from east to west. Minor roads radiate from these routes. The area is bounded to the east by the M90 and to the north by the railway line. Rosyth also has a railway station to the north of the LLCA.

1.2.131 Topographically the area is situated on a south facing slope that is surrounded by hills, which give a sense of enclosure. Predominant views are to the south west across the Forth with some views to the surrounding hills and eastwards along the A90.

1.2.132 Vegetation cover includes designed parklands and urban landscaping such us avenue trees and hedges. A small area of long-established ancient woodland ('the wilderness') is located in the north edge beside a stretch of the railway.

1.2.133 The area is diverse and colourful with high levels of activity during the day especially along the A90.

Table 23: Landscape Character Summary for Rosyth

Landscape Attributes	Description
Key Characteristics	• Urban area on a south facing slope.
Positive Character Attributes	• Good communication routes and public access. • South side has a lower housing density than the north. • Long views to the firth of Forth from the south of the area. • Views to surrounding hills.
Negative Character Attributes	• Views of industrial developments to south. • Aural disturbance from M90.
Landscape Designations	• Semi-natural Woodland Inventory/ Long-Established (of plantation origin) • Ancient Woodland
Landscape Condition	• Urban landscape with well-maintained housing. • Designed parkland, avenue trees, hedge trees, clumps and isolated trees in good condition.
Scenic Quality	• Low to average scenic quality.
Sensitivity to Change Due to Development	• Low

Dalgety Bay

1.2.134 Dalgety Bay LLCA is situated 1km east of Inverkeithing Urban Area.

1.2.135 This is a medium scale urban area built around a hill formed from igneous rock and rising from sea level to 50m aOD. To the west the area is bounded by Letham Hill Wood and to the south the area borders the Firth of Forth. The LLCA also includes the settlement of Hillend to the north of the A921. Much of the area consists of medium density housing with an industrial estate and selection of shops to the north. The elevated position allows open views to the Firth of Forth from the south facing slopes.

1.2.136 The area is served by a series of roads that are accessed from the A921 to the north. Adjacent to the A921 is the train station and Fife Circle railway and within the area there also is a National Trail / Long Distance Route / National cycle network route along the coastal edge.

1.2.137 Vegetation cover includes designed parklands, clumps of mature woodland dispersed through the housing, ancient woodlands, isolated trees and a Historic Garden and Designed Landscape at Donibristle Gardens.

1.2.138 This character area has a good aesthetic value due to its harmonious balance, unity, diversity and presence of colour. Although the area is primarily urban it covers interesting views and elements and has an intimate and enclosed feel due to the surrounding wooded hills.

Table 24: Landscape Character Summary for Dalgety Bay

Landscape Attributes	Description
Key Characteristics	• Urban development on coastal hill with views over the Firth of Forth.
Positive Character Attributes	• Historic Garden and Designed Landscape at Donibristle Gardens • Vernacular and historic buildings • Good communications and public access with National Trail / Long Distance Route/ National Cycle Network. • Views across the Firth of Forth due to housing layout and sloping topography.
Negative Character Attributes	• Medium density housing • Fife Circle railway line • Presence of Industrial Estate
Landscape Designations	• 6 Long-Established Woodland (of plantation origin) • 2 Semi-natural Woodland Inventory/ Long-Established (of plantation origin) Ancient Woodland • Historic Garden and Designed Landscape (Scotland)
Landscape Condition	• Well managed clumps of mature deciduous and conifer woodland dispersed through housing estate. • Well maintained manicured private gardens and public spaces.
Scenic Quality	• A pleasant and interesting urban area to experience. • Good scenic quality especially in the south of the area.
Sensitivity to Change Due to Development	• Medium

Inverkeithing

1.2.139 This LLCA is situated to the west of the A90 between Rosyth and Dalgety Bay.

1.2.140 Inverkeithing urban area is set in a narrow valley above an inlet of the Forth. The valley is characterised by steep slopes to the west rising from sea level to 75m aOD and gentler slopes to the east rising to 35m aOD. This gives the area a sense of enclosure and limits the town to small to medium in scale.

1.2.141 The topography also reflects the hydrological features of the LLCA. Several burns converge north of the town and form a river that flows through the valley in the middle of the town into the Forth at a small inner bay to the southern edge of the town.

1.2.142 The B981 forms the main road running through the area with a number of minor roads providing access to the rest of the town. The town is also influenced by the Edinburgh to Aberdeen railway line running roughly north to south with a station in the north of the settlement.

1.2.143 The LLCA predominantly consists of housing although elements of industry are found adjacent to the bay with larger industrial areas flanking the town to the north and south. The town centre has a number of stone and vernacular buildings and the range of housing styles and periods reflects the history of the town's development.

1.2.144 Vegetation in the area includes scrub woodland to the west of the LLCA and clusters of woodland trees to the north and south west of the area. A sports ground and park adjacent to the river and bay provide a well maintained recreation facility and visually connect the town with the bay and the Firth of Forth beyond.

Table 25: Landscape Character Summary for Inverkeithing

Landscape Attributes	Description
Key Characteristics	• Urban area dissected by a river. • Valley setting • Inlet / bay of the Firth of Forth
Positive Character Attributes	• Good communications with railway station. • Vernacular/ listed buildings • Designed riverside parkland • Recreational value of the river and bay side. • National Trail / Long Distance Route / National cycle network-traffic free.
Negative Character Attributes	• Disturbance by Industrial area in the south. • Edinburgh to Aberdeen railway cuts through the area.
Landscape Designations	• None
Landscape Condition	• Mixture of housing styles and periods. • Sports grounds and park beside the river are well maintained.
Scenic Quality	• Scenic quality is compromised by industrial areas to the south and north and A90 to the west. • Attractive open space in the south provides good scenic quality. • The housing layout provides opportunities for views over the Firth of Forth.
Sensitivity to change due to development	• Medium

North Queensferry

1.2.145 This LLCA is a small urban area on the southern tip of a peninsula to the north of the Firth of Forth. It is situated on the coast at the northern end of the existing Forth road and rail bridges.

1.2.146 The town is on a south facing slope with a distinctive historic quarter closest to the bay. North of this the land rises steeply and the town has expanded haphazardly to take advantage of the extensive views and train station built in the late 19th century. There area two disused quarries, one of which has been made into the ‘Deep Sea World’ tourist attraction. There are also attractive sandy beach areas along the coast line. In terms of structures, North Queensferry is dominated in places by the road and rail bridges that penetrate the town centre.

1.2.147 Although North Queensferry is a distinctive and attractive settlement it remains relatively small in scale, limited by the topography, small peninsula and constraints such as working quarries and rail and road structures to the north.

1.2.148 The area has convenient access to the A90 and Ferryhills Road provides local access north to Inverkeithing. The Fife Coastal Path cycle / footpath originate in the town and there are three main piers for boat access from the Forth River. There is also a train station to the north of the town where the railway provides links across the iconic rail bridge to Edinburgh in the south and Dundee and Aberdeen in the north.

1.2.149 There are deciduous woodland areas along the steep hills to the northwest of the area and on the eastern coastal brae.

Table 26: Landscape Character Summary for North Queensferry

Landscape Attributes	Description
Key Characteristics	• Urban area on the northern coast of the River Forth. • Large iconic bridge structures influencing the area. • Historic town on coastal lowland with later expansion along steep hill to the north. • Extensive views along the Forth River.
Positive Character Attributes	• Attractive historic town centre with views over the Forth. • Attractive wooded hills • Major tourist attraction (Deep Sea World) • Good road access
Negative Character Attributes	• Edinburgh to Aberdeen railway line passes through the area. • Intrusion of road bridge into the town..
Landscape Designations	• Conservation Area • Ancient Woodland (of semi-natural origin)/ semi-natural Woodland Inventory
Landscape Condition	• Well maintained community with a mixture of housing styles in good condition.
Scenic Quality	• Good scenic quality with sensitive historic town and village centres. Low ability to accommodate change.
Sensitivity to Change Due to Development	• Medium to High

South Queensferry

1.2.150 This LLCA is the main urban settlement in the south study area and is situated on the coast at the southern end of the existing Forth road and rail bridges.

1.2.151 The town is on a north facing slope which is steepest at the historic town centre beside the Firth of Forth. Along the coastal edge to the north there are rock outcrops and a natural harbour. Manmade elements along the coastal edge include a harbour, pier and marina at Port Edgar to the west of the area.

1.2.152 Much of the urban development has occurred on the more gently sloping area to the south of the town and has expanded towards the village of Dalmeny to the south east of the LLCA. There are differing styles and generations of housing which add interest to the area in South Queensferry. Industrial and commercial buildings are found at the south and south east of the area with a small selection of industrial units at Port Edgar in the west. In Dalmeny the housing is mainly vernacular and is centred around a village green with more recent housing to the south of the village. The dominant structures in the area however are the two existing bridges with the road bridge structure elevated directly above the town before reaching grade.

1.2.153 The area is well accessed by A roads and the M9 spur leading to the road bridge. The B929 also runs through the town in an east west direction and forms the High Street in the town centre. Minor roads are accessed from this and the B907 running north-south through the town. Dalmeny train station lies to the east of South Queensferry and to the west of Dalmeny village with the Edinburgh to Aberdeen rail line forming a boundary between the two areas. South Queensferry is also accessible from the River Forth by boat and there are seasonal ferry trips to Inchcolm Island.

1.2.154 South Queensferry features several recreational green spaces and a wooded coastal brae to the north and west of the High Street. Dalmeny has a village park and central green.

1.2.155 The area contains a pleasing contrast of historic and modern development and remains a major tourist destination due to views of the iconic Forth Rail Bridge and the Forth Road Bridge.

Table 27: Landscape Character Summary for South Queensferry

Landscape Attributes	Description
Key Characteristics	• Urban area on the southern coast of the River Forth. • Large iconic bridge structures influencing the area. • Historic village centred around village green.
Positive Character Attributes	• Attractive historic town centre with views north over the Forth. • Attractive historic village • Good road access
Negative Character Attributes	• Edinburgh to Aberdeen railway line divides area. • Intrusion of road bridge into the town.
Landscape Designations	• Conservation Area, Edinburgh • Protection of Open Space, Edinburgh
Landscape Condition	• Well maintained communities with a mixture of housing styles – particularly in South Queensferry.
Scenic Quality	• Good scenic quality with sensitive historic town and village centres. Medium ability to accommodate change on the edges of the town.
Sensitivity to Change Due to Development	• Medium to High

Kirkliston

1.2.156 This LLCA is situated 2.5km south of South Queensferry Urban Area and 0.5km northwest of Edinburgh Airport, bordering to the east with the River Almond, to the southwest with the M9 motorway and open farmland to the north.

1.2.157 Kirkliston Urban Area is situated in a predominantly gentle south slope with a significant level drop in the south western part where the Swine Burn forms a natural pond before joining the River Almond.

1.2.158 The River Almond is a significant hydrological feature in the area and runs along the south eastern edge of the LLCA.

1.2.159 There are several styles of housing within the area with new development situated in the north and east and historic vernacular buildings in the centre and west, along the “High Street”.

1.2.160 The area has is well-accessed by road and there is a main traffic-free cycle route from south to north along the eastern edge. A network of footpaths are associated with the river Almond and Edinburgh airport is located less than 1km to the south east.

1.2.161 The vegetation in the area includes a small deciduous woodland plantation beside the River Almond tributary stream and a range of well maintained designed landscapes and gardens at the new developments.

1.2.162 The area features a dominant leisure centre facility at the northeast corner, Kirkliston Primary School, a city library and an abandoned factory where construction works are ongoing for a new development.

1.2.163 The east boundary of the area is degraded by the M9. Within the area the views are enclosed. At the edges of the LLCA however, open surroundings offer wider and more distant views.

1.2.164 The area contains a balanced contrast of historic and modern development.although new development is detracting from the sense of place. Nevertheless the proximity of rural features such as the River Almond and its tributaries, a deciduous woodland and open farmland enhance the area.

Table 28: Landscape Character Summary for Kirkliston

Landscape Attributes	Description
Key Characteristics	• Urban development adjacent to the M90 and the River Almond.
Positive Character Attributes	• Vernacular buildings • River Almond on west edge • Open view from area boundaries. • Good communications within the site.
Negative Character Attributes	• M9 motorway degrades east boundary. • Housing density reaching its limit with new developments.
Landscape Designations	• Protection of Open Space, Edinburgh • Conservation Area in West Lothian • Areas of Importance for Flood Protection in Edinburgh
Landscape Condition	• Well maintained community with a mixture of housing estates. • New housing development around the edge of town.
Scenic Quality	• Average to low scenic quality due to disturbance by noise from two motorways and noise intrusion from Edinburgh Airport.
Sensitivity to Change Due to Development	• Medium

Industrial

Inverkeithing Industrial Estate

1.2.165 This LLCA is situated to the north of Inverkeithing and to the east of Rosyth. It is bounded by the M90 to the west and the A921 to the south.

1.2.166 Inverkeithing Industrial Estate is situated on a levelled area of the valley around the Keithing Burn, enclosed by a steep embankment along the southern edge of the area, to the A921. The area is dominated by a large, derelict building a car breaker's yard, visible from a distance. There are also a mixture of old and new industrial units and a small park and ride.

1.2.167 The area is conveniently located for links to the M90 and is accessed at two points from the south, with internal roads providing access to all the industrial units and the park and ride at the eastern end of the site. The railway line to the Fife coast runs along the northern edge of the estate and converges with the Edinburgh to Aberdeen line running north from the Forth Rail Bridge at the northeastern corner of the area, isolating a triangle of derelict land between the connections. Additional sidings for goods trains lead off the line into the estate. A separate part of the estate comprising smaller business units is situated to the east of the railway and is accessed by the B981.

1.2.168 The hydrological features of the area include a small loch at the northern edge of the estate, which enhances views from the surrounding hills and a channelled burn running west to east across the area. The farmland to the north of the estate rises towards the Fordell Estate, and also provides an attractive outlook.

1.2.169 Vegetation in the area includes scrub woodland to the west of the LLCA along the railway embankment and at the park and ride area.

1.2.170 Overall, this is a disparate, degraded landscape of poor scenic quality.

Table 29: Landscape Character Summary for Inverkeithing Industrial Estate

Landscape Attributes	Description
Key Characteristics	• Industrial area • Park and ride facility • Bordered by M90, A921 and railway. • Small loch at northern end of site. • Predominantly flat with land rising to north, west and south.
Positive Character Attributes	• Attractive views to the north across rolling farmland. • Loch is hidden from most views but helps to improve appearance of estate in views from the surrounding hills. • Good links to motorway and well used park and ride system.
Negative Character Attributes	• Largest, most prominent building in poor condition. • Surrounding local and national railway lines and road have limited available space and concentrated development. • Scrap yard within estate has tall piles of cars which are visible from a distance.
Landscape Designations	• None
Landscape Condition	• Older buildings generally in a poor condition. Estate is productive bu disparate. Park and ride is used beyond capacity leading to disorganisation in car park. Scattered vegetation around edges of site appears healthy.
Scenic Quality	• Poor scenic quality • Low-lying position limits views into the area, but settlement on surrounding hills overlook the site.
Sensitivity to Change Due to Development	• Low

South Inverkeithing Bay

1.2.171 This LLCA is situated to the west of the A90 between Inverkeithing to the north and North Queensferry to the south.

1.2.172 South Inverkeithing Bay is predominantly an industrial area enveloping the west and south of Inverkeithing inner bay. Traditional and modern industrial buildings are clustered to the north of the area and a large working quarry is prominent to the south of the bay, which generates smoke. A park and ride facility is situated at the western edge of the area adjacent to the railway.

1.2.173 The Fife Coastal Way and cycle path follows the Cruickness Road beside the bay. The area is also accessed by the B981 to the north and west and the Ferryhills Road to the south. The Edinburgh to Aberdeen railway runs through the area to the west.

1.2.174 The area immediately surrounding the bay is flat. The land rises to the west towards the park and ride facility and this slope is further augmented by a railway embankment. The area of quarried land to the south features flat elements where extraction has already occurred and vertical elements at the quarry face rising to 45m aOD. The surrounding hills to the north, west and south give the area a sense of enclosure, although there are there are views east across the attractive bay area and Firth of Forth.

1.2.175 Vegetation in the area includes scrub woodland to the west of the LLCA along the railway embankment and at the park and ride area.

1.2.176 Overall, this is a disturbed and degraded landscape of poor scenic quality.

Table 30: Landscape Character Summary for South Inverkeithing Bay

Landscape Attributes	Description
Key Characteristics	• Industrial area • Large quarry • Bordered by bay / inlet • Predominantly flat with land rising to north, west and south.
Positive Character Attributes	• Attractive bay area with views east along the Firth of Forth. • National Trail / Long Distance Route / National cycle network-traffic free.
Negative Character Attributes	• Derelict Industrial buildings • Edinburgh to Aberdeen railway cuts through the area. • Active quarry detracts from the landscape value. • Quarry activity and smoke • Stockpiles in bay area
Landscape Designations	• None
Landscape Condition	• Landscape generally in poor condition with quarry activity and derelict industrial buildings.
Scenic Quality	• Poor scenic quality • Views into the area present a disturbed and degraded landscape. • Scenic views from the area to Firth of Forth. • Potential to develop the scenic quality of the area.
Sensitivity to Change Due to Development	• Low

Rosyth Industrial Area

1.2.177 Rosyth Industrial Area is located 1.5km northwest of North Queensferry and immediately south of Rosyth Urban area. The Firth of Forth creates a coastal boundary to the south.

1.2.178 Most of the LLCA is occupied by relatively large, disparate industrial buildings, surrounded by derelict land, with the eastern side undergoing further development. Rosyth Castle is incongruously situated towards the east of the estate and Rosyth Castle Dovecot, with associated woodland, to the north of the LLCA. Along the coastal edge is an enclosed naval submarine base, a ferry port and a pier.

1.2.179 Ferry Toll Road and Barham Road connect the industrial area with the A90 and Forth Road Bridge and Millenium Road and Castle Road run northwards to Rosyth. International transport links are provided by the Rosyth – Zeebrugge ferry service and the naval base.

1.2.180 The area is at sea level, predominantly flat with gentler slopes to the northwest.

1.2.181 Vegetation is mainly scrub and marsh in undeveloped areas with urbanised lines of trees and hedges elsewhere.

1.2.182 Along the north edge of the area there are clear open views to the south except in the more northeast side where the Cult Ness Hill screens views to the southeast. Views within the estate are generally limited by the industrial buildings, except in the eastern area where long views remain open to the south.

Table 31: Landscape Character Summary for Rosyth Industrial

Landscape Attributes	Description
Key Characteristics	• Flat coastal area exposed to south and contained elsewhere by topography and buildings. • Large industrial buildings expanding eastwards.
Positive Character Attributes	• A listed buildings (Rosyth Castle ruin and Dovecot) • Good access • Long open views to south across the Firth of Forth.
Negative Character Attributes	• Disparate industrial plots. • Incongruous castle setting amongst industry. • Undeveloped wasteland and scrub. • Bland or unpleasant scenery.
Landscape Designations	• Semi-natural Woodland Inventory / Long-Established (of plantation origin) Ancient Woodland • Scheduled Ancient Monuments (Scotland)
Landscape Condition	• Heavily developed with most industrial units in good condition. • Patches of undeveloped wasteland and scrub. • Landscape disruption to the east as development progresses. • Urbanised lines of trees and hedges in average condition.
Scenic Quality	• Low scenic quality of the area itself. • Panoramic, long-range views possible in south directions from south edge but views blocked within the area. • Rosyth Industrial Area is visible from the Forth Road Bridge and in views from the land surrounding the Hopetoun Estate and South Queensferry to the south.
Sensitivity to Change Due to Development	• Low

Existing Road Corridor

A90 / M90 / M9 roads (desk based)

1.2.183 The A90 / M90 / M9 LLCA consists of the distinctive linear landscape created by these roads as they pass through the landscape to the north and south of the existing Forth Road Bridge.

1.2.184 In the south, the road crosses the River Almond Valley and continues in a northwest direction along undulating south facing slopes. The road passes to the south of Kirkliston and continues onwards immediately to the south of Duntarvie Castle towards Linlithgow and Stirling. An additional M9 Spur road has recently been constructed to connect the M9 with the A90 and the Forth Road Bridge. The junction for this is immediately southwest of Kirkliston and the road continues north towards a ridge line at 55m aOD before the landscape slopes north to the Firth of Forth.

1.2.185 To the north, where the topography is generally steep and south facing, the LLCA travels through the igneous hill formation at Ferry Hills and continues northward through a slight valley formation formed by Castlandhill and North Inverkeithing Hill. The study area to the north comprises a number of cuttings as the road travels through the steep south facing slopes. To the west side of Ferry Hills, sheer rock cuttings create large vertical elements in the landscape. A further cutting with grading out occurs as the road passes to the east of Castlandhill and smaller cuttings occur as the road passes to the east of Dunfermline.

1.2.186 The study area to the north comprises a number of cuttings as the road travels through the steep south facing slopes. To the west side of Ferry Hills, sheer rock cuttings create large vertical elements in the landscape. A further cutting with grading out occurs as the road passes to the east of Castlandhill and smaller cuttings occur as the road passes to the east of Dunfermline.

1.2.187 In the study area to the south, the road corridors comprise a series of embankments which are high in places and form a dominant feature in the gently undulating landscape. The LLCA is only in cutting where the A90 crosses the final ridge line south of the Forth before continuing to the bridge.

1.2.188 The LLCA passes close to all the settlements in the study area, providing key road transport routes for Edinburgh and the central belt, with generally scenic views to the surrounding landscape.

1.2.189 Vegetation in the LLCA primarily consists of grassland or scrub and mixed or coniferous woodland planting along cuttings and embankments.

Table 32: Landscape Character Summary for A90 / M90 /M9

Landscape Attributes	Description
Key Characteristics	• Linear landscape with cuttings and embankment.
Positive Character Attributes	• Provides views to scenic landscape features.
Negative Character Attributes	• Large cuttings and embankments dominate the landscape.
Landscape Designations	• None
Landscape Condition	• Average condition
Scenic Quality	• Low scenic quality
Sensitivity to Change Due to Development	• Low

Table 1: Receptor Locations

Receptor	Grid Ref	Location Details
R1	NT 2987 8495	16 Sandybank, Halbeath
R2	NT2743 4645	The Bungalow; Dunfermline
R3	NT2334 4161	65 Park Lea, Rosyth
R4	NT3630 3508	Inverkeithing High School; Hillend Road
R5	NT3252 3467	Burleigh Cresent; Inverkeithing
R6	NT2259 3577	127 Parkside Street, Rosyth
R7	NT2190 3088	102 Castlandhill Road, Rosyth
R8	NT1940 3413	10 Castlandhill Road, Rosyth
R9	NT2436 2725	4 Mucklehill Park, Inverkeithing
R10	NT 2331 1036	St Margarets Hope; North Queensferry
R11	NT2630 0720	15 Ferry Barns Court, North Queensferry
R12	NT2400 8418	14 Farquhar Terrace, South Queensferry
R13	NT2866 8382	15 Hopetoun Road, South Queensferry
R14	NT2398 7919	41 Stoneyflats Cresent, South Queensferry
R15	NT2998 7509	2 Scotstoun Green, South Queensferry
R16	NT1542 7947	66 Echline Drive, South Queensferry
R17	NT1327 8475	7 Linnmill, South Queensferry
R18	NT2621 7176	12 Dundas Home Farm, South Queensferry
R19	NT9175 7629	9 Main Street, Newton
R20	NT1900 4112	95 King Edwards Way, Kirkliston
R21	NT9246 5067	2 Beatly Road, Winchburgh
R22	NT1927 3546	2 Millrig Cottages, Kirkliston
R23	NT2449 4934	2 Newmains Road, Kirkliston
R24	NT2559 4547	76 Main Street, Kirkliston
R25	NT1674 8150	14 Springfield Terrace, South Queensferry
R26	NT8799 7443	1 Winchburgh Road, Winchburgh
R27	NT1221 4467	239 Queensferry Road; Rosyth
R28	NT3999 8926	23 Westfield Grove, Crossgates
R29	NT4537 8685	Inverkeithing Road, Crossgates
R30	NT4478 3830	6 Letham Hill Avenue, Hillend

Table 2: NO_2 Concentrations ($\mu g/m^3$) 2017

Receptor	2005	2017 Do Minimum	2017 N1S1	2017 N1S2	2017 N2S1	2017 N2S2
R1	23.6	15.7	15.7	15.6	15.7	15.7
R2	20.7	16.0	16.0	16.0	14.9	14.8
R3	21.5	15.2	15.0	15.0	14.7	14.7
R4	17.7	12.0	12.1	12.1	12.2	11.9
R5	18.9	12.9	13.3	13.3	13.4	12.8
R6	22.2	14.7	14.8	14.8	14.2	14.1
R7	21.1	14.1	14.3	14.3	13.9	13.9
R8	19.2	12.7	12.6	12.5	12.6	12.6
R9	19.8	12.4	13.1	13.1	11.6	11.6
R10	10.4	7.57	10.2	10.3	10.9	11.1
R11	15.3	9.9	6.2	6.2	6.2	6.2
R12	19.7	13.0	9.6	9.6	9.6	9.6
R13	14.4	10.1	9.8	10.2	9.8	10.2
R14	24.3	14.9	9.3	9.3	9.3	9.3
R15	28.1	15.0	15.6	11.5	15.1	11.5
R16	13.1	9.2	9.6	9.3	9.5	9.3
R17	10.7	7.6	9.8	9.8	9.8	9.8
R18	13.0	9.3	11.1	9.3	11.2	9.3
R19	15.0	10.4	10.2	9.6	10.1	9.6
R20	21.5	14.2	14.8	15.9	15.0	14.7
R21	14.0	10.8	11.6	9.5	10.7	9.5
R22	20.9	13.5	14.0	14.7	16.9	14.7
R23	16.4	11.6	11.8	10.3	11.6	10.3
R24	20.5	13.9	14.2	12.0	13.8	12.0
R25	11.0	7.9	8.0	8.1	8.0	8.1
R26	15.1	11.2	11.3	11.2	11.0	11.2
R27	17.8	12.0	12.1	12.0	12.0	11.9
R28	18.0	12.4	12.4	12.4	12.4	12.4
R29	15.4	11.3	11.2	11.1	11.3	11.3
R30	16.3	11.0	11.0	11.0	10.9	10.8

Table 3: PM_{10} Concentrations ($\mu g/m^3$) 2017

Receptor	2005	2017 Do Minimum	2017 N1S1	2017 N1S2	2017 N2S1	2017 N2S2
R1	19.4	15.3	15.2	15.2	15.2	15.2
R2	17.5	15.1	15.1	15.1	14.7	14.7
R3	17.9	15.5	15.5	15.5	15.3	15.3
R4	15.8	13.9	13.9	13.9	13.9	13.9
R5	16.3	14.2	14.3	14.3	14.4	14.2
R6	18.2	15.2	15.3	15.3	15.1	15.1
R7	17.5	14.9	15.1	15.1	15.0	15.0
R8	17.5	15.1	15.0	15.0	15.1	15.0
R9	18.6	15.7	16.2	16.2	15.7	15.7
R10	15.6	13.9	14.7	14.7	14.9	14.9
R11	15.3	12.8	11.6	11.6	11.6	11.6
R12	16.9	14.1	12.9	12.9	12.9	12.9
R13	15.0	13.2	13.0	13.2	13.0	13.2
R14	18.9	14.5	12.8	12.8	12.8	12.8
R15	21.3	14.1	14.2	13.3	14.1	13.3
R16	14.1	12.4	12.5	12.5	12.5	12.5
R17	13.4	12.0	12.6	12.6	12.6	12.6
R18	14.3	12.8	13.4	12.8	13.4	12.8
R19	15.0	12.6	12.5	12.4	12.5	12.4
R20	18.3	14.9	14.9	15.1	15.0	14.9
R21	14.9	13.1	13.3	12.8	13.1	12.8
R22	16.5	14.1	14.2	14.5	14.9	14.5
R23	15.2	13.2	13.2	12.9	13.2	12.9
R24	17.2	9.6	9.6	9.1	9.5	9.1
R25	13.5	12.1	12.1	12.2	12.1	12.2
R26	14.9	12.9	12.9	12.9	12.8	12.9
R27	17.1	15.2	15.2	15.2	15.2	15.2
R28	16.4	13.8	13.8	13.8	13.8	13.8
R29	15.1	13.2	13.2	13.2	13.2	13.2
R30	15.8	13.4	13.4	13.4	13.4	13.3

Table 4: NO_2 Concentrations ($\mu g/m^3$) 2032

Receptor	2005	2032 Do Minimum	2032 N1S1	2032 N1S2	2032 N2S1	2032 N2S2
R1	23.6	16.3	16.1	15.9	16.1	16.0
R2	20.7	14.2	14.4	14.4	13.2	13.0
R3	21.5	15.1	15.3	15.2	14.9	15.0
R4	17.7	12.5	12.3	12.3	12.4	12.2
R5	18.9	13.6	13.6	13.6	13.8	13.2
R6	22.2	15.0	15.1	15.1	14.4	14.3
R7	21.1	13.1	14.3	14.3	13.9	13.9
R8	19.2	13.2	12.7	12.7	12.7	12.6
R9	19.8	12.8	13.1	13.1	11.7	11.6
R10	10.4	7.5	10.3	10.4	11.4	11.7
R11	15.3	10.7	6.2	6.2	6.2	6.2
R12	19.7	13.7	9.6	9.7	9.6	9.7
R13	14.4	10.4	9.8	10.5	9.9	10.5
R14	24.3	14.9	9.2	9.2	9.2	9.2
R15	28.1	17.2	16.2	11.7	15.2	11.7
R16	13.1	9.1	10.0	9.4	9.8	9.4
R17	10.7	7.6	9.9	9.9	9.9	9.9
R18	13.0	9.3	11.1	9.3	11.1	9.3
R19	15.0	10.1	10.1	9.6	10.7	9.6
R20	21.5	14.0	15.3	14.8	15.6	14.7
R21	14.0	12.3	12.4	10.9	12.3	10.9
R22	20.9	16.9	17.8	15.0	17.0	15.1
R23	16.4	12.4	11.9	10.3	11.6	10.3
R24	20.5	15.2	14.9	13.2	14.3	13.3
R25	11.0	7.9	8.0	8.2	8.0	8.2
R26	15.1	12.5	12.8	12.7	12.6	12.6
R27	17.8	12.2	12.1	12.1	12.0	12.0
R28	18.0	12.7	12.7	12.7	12.7	12.7
R29	15.4	12.2	11.5	11.4	11.5	11.5
R30	16.3	11.7	11.3	11.3	11.2	11.2

Table 5: PM_{10} Concentrations ($\mu g/m^3$) 2032

Receptor	2005	2032 Do Minimum	2032 N1S1	2032 N1S2	2032 N2S1	2032 N2S2
R1	19.4	15.4	15.4	15.3	15.3	15.3
R2	17.5	15.0	15.1	15.0	14.6	14.5
R3	17.9	15.5	15.6	15.5	15.4	15.5
R4	15.8	14.0	13.9	13.9	13.9	13.9
R5	16.3	14.5	14.4	14.4	14.5	14.3
R6	18.2	15.3	15.4	15.4	15.1	15.1
R7	17.5	14.6	15.0	15.0	15.0	15.0
R8	17.5	15.3	15.0	15.0	15.0	15.0
R9	18.6	16.0	16.1	16.1	15.7	15.6
R10	15.6	13.8	14.6	14.7	15.0	15.1
R11	15.3	13.4	11.5	11.5	11.5	11.5
R12	16.9	14.7	12.8	12.9	12.8	12.9
R13	15.0	13.2	13.0	13.2	13.0	13.2
R14	18.9	14.5	12.7	12.7	12.7	12.7
R15	21.3	14.7	14.3	13.3	14.2	13.3
R16	14.1	12.3	12.5	12.4	12.5	12.4
R17	13.4	11.9	12.5	12.5	12.5	12.5
R18	14.3	12.7	13.4	12.7	13.3	12.7
R19	15.0	12.5	12.6	12.3	12.5	12.3
R20	18.3	14.6	15.1	15.1	15.2	14.8
R21	14.9	13.4	13.4	13.1	13.3	13.1
R22	16.5	14.9	15.0	14.5	14.9	14.5
R23	15.2	13.4	13.2	12.8	13.1	12.8
R24	17.2	14.3	13.9	13.5	13.8	13.5
R25	13.5	12.0	12.0	12.1	12.0	12.1
R26	14.9	13.2	13.2	13.2	13.1	13.2
R27	17.1	15.2	15.1	15.1	15.1	15.1
R28	16.4	13.9	13.8	13.8	13.8	13.8
R29	15.1	13.4	13.2	13.2	13.2	13.2
R30	15.8	13.6	13.4	13.5	13.4	13.4

Table 6: Significance N1S1 NO_2 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.7	0.0	Extremely Small	Negligible
R2	16.0	0.0	Extremely Small	Negligible
R3	15.0	1.3	Very Small	Negligible
R4	12.1	0.8	Extremely Small	Negligible
R5	13.3	3.0	Very Small	Negligible
R6	14.8	0.7	Extremely Small	Negligible
R7	14.3	1.4	Very Small	Negligible
R8	12.6	0.8	Extremely Small	Negligible
R9	13.1	5.3	Small	Slight adverse
R10	10.2	25.8	Very Large	Moderate adverse
R11	6.2	37.4	Very Large	Moderate beneficial
R12	9.6	26.2	Very Large	Moderate beneficial
R13	9.8	3.0	Very Small	Negligible
R14	9.3	37.6	Very Large	Moderate beneficial
R15	15.6	3.8	Very Small	Negligible
R16	9.6	4.2	Very Small	Negligible
R17	9.8	22.4	Large	Slight adverse
R18	11.1	16.2	Large	Slight adverse
R19	10.2	1.9	Very Small	Negligible
R20	14.8	4.1	Very Small	Negligible
R21	11.6	6.9	Small	Slight adverse
R22	14.0	3.6	Very Small	Negligible
R23	11.8	1.7	Very Small	Negligible
R24	14.2	2.1	Very Small	Negligible
R25	8.0	1.3	Very Small	Negligible
R26	11.3	0.9	Extremely Small	Negligible
R27	12.1	0.8	Extremely Small	Negligible
R28	12.4	0.0	Extremely Small	Negligible
R29	11.2	0.9	Extremely Small	Negligible
R30	11.0	0.0	Extremely Small	Negligible

Table 7: Significance N1S1 PM_{10} 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.2	0.7	Extremely Small	Negligible
R2	15.1	0.0	Extremely Small	Negligible
R3	15.5	0.0	Extremely Small	Negligible
R4	13.9	0.0	Extremely Small	Negligible
R5	14.3	0.7	Extremely Small	Negligible
R6	15.3	0.7	Extremely Small	Negligible
R7	15.1	1.3	Very Small	Slight adverse
R8	15.0	0.7	Extremely Small	Negligible
R9	16.2	3.1	Very Small	Slight adverse
R10	14.7	5.4	Small	Slight adverse
R11	11.6	9.4	Small	Slight beneficial
R12	12.9	8.5	Small	Slight beneficial
R13	13.0	1.5	Very Small	Negligible
R14	12.8	11.7	Medium	Slight beneficial
R15	14.2	0.7	Extremely Small	Negligible
R16	12.5	0.8	Extremely Small	Negligible
R17	12.6	4.8	Very Small	Negligible
R18	13.4	4.5	Very Small	Negligible
R19	12.5	0.8	Extremely Small	Negligible
R20	14.9	0.0	Extremely Small	Negligible
R21	13.3	1.5	Very Small	Negligible
R22	14.2	0.7	Extremely Small	Negligible
R23	13.2	0.0	Extremely Small	Negligible
R24	9.6	0.0	Extremely Small	Negligible
R25	12.1	0.0	Extremely Small	Negligible
R26	12.9	0.0	Extremely Small	Negligible
R27	15.2	0.0	Extremely Small	Negligible
R28	13.8	0.0	Extremely Small	Negligible
R29	13.2	0.0	Extremely Small	Negligible
R30	13.4	0.0	Extremely Small	Negligible

Table 8: Significance N1S1 NO_2 2032

Receptor	Concentration (μg/m^3)	Percentage change	Magnitude of change	Significance
R1	16.1	1.2	Very Small	Negligible
R2	14.4	1.4	Very Small	Negligible
R3	15.3	1.3	Very Small	Negligible
R4	12.3	1.6	Very Small	Negligible
R5	13.6	0.0	Extremely Small	Negligible
R6	15.1	0.7	Extremely Small	Negligible
R7	14.3	8.4	Small	Slight adverse
R8	12.7	3.8	Very Small	Negligible
R9	13.1	2.3	Very Small	Negligible
R10	10.3	27.2	Very Large	Moderate adverse
R11	6.2	42.1	Very Large	Moderate beneficial
R12	9.6	29.9	Very Large	Moderate beneficial
R13	9.8	5.8	Small	Slight beneficial
R14	9.2	38.3	Very Large	Moderate beneficial
R15	16.2	5.8	Small	Slight beneficial
R16	10.0	9.0	Small	Slight adverse
R17	9.9	23.2	Large	Slight adverse
R18	11.1	16.2	Large	Slight adverse
R19	10.1	0.0	Extremely Small	Negligible
R20	15.3	8.5	Small	Slight adverse
R21	12.4	0.8	Extremely Small	Negligible
R22	17.8	5.1	Small	Slight adverse
R23	11.9	4.0	Very Small	Negligible
R24	14.9	2.0	Very Small	Negligible
R25	8.0	1.3	Very Small	Negligible
R26	12.8	2.3	Very Small	Negligible
R27	12.1	0.8	Extremely Small	Negligible
R28	12.7	0.0	Extremely Small	Negligible
R29	11.5	5.7	Small	Slight beneficial
R30	11.3	3.4	Very Small	Negligible

Table 9: Significance N1S1 PM_{10} 2032

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.4	0.0	Extremely Small	Negligible
R2	15.1	0.7	Extremely Small	Negligible
R3	15.6	0.6	Extremely Small	Negligible
R4	13.9	0.7	Extremely Small	Negligible
R5	14.4	0.7	Extremely Small	Negligible
R6	15.4	0.6	Extremely Small	Negligible
R7	15.0	2.7	Very Small	Slight adverse
R8	15.0	2.0	Very Small	Slight beneficial
R9	16.1	0.6	Extremely Small	Negligible
R10	14.6	5.5	Small	Slight adverse
R11	11.5	14.2	Medium	Slight beneficial
R12	12.8	12.9	Medium	Slight beneficial
R13	13.0	1.5	Very Small	Negligible
R14	12.7	12.4	Medium	Slight beneficial
R15	14.3	2.7	Very Small	Slight beneficial
R16	12.5	1.6	Very Small	Negligible
R17	12.5	4.8	Very Small	Negligible
R18	13.4	5.2	Small	Slight adverse
R19	12.6	0.8	Extremely Small	Negligible
R20	15.1	3.3	Very Small	Slight adverse
R21	13.4	0.0	Extremely Small	Negligible
R22	15.0	0.7	Extremely Small	Negligible
R23	13.2	1.5	Very Small	Negligible
R24	13.9	2.8	Very Small	Negligible
R25	12.0	0.0	Extremely Small	Negligible
R26	13.2	0.0	Extremely Small	Negligible
R27	15.1	0.7	Extremely Small	Negligible
R28	13.8	0.7	Extremely Small	Negligible
R29	13.2	1.5	Very Small	Negligible
R30	13.4	1.5	Very Small	Negligible

Table 10: Significance N1S2 NO_2 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.6	0.6	Extremely Small	Negligible
R2	16.0	0.0	Extremely Small	Negligible
R3	15.0	1.3	Very Small	Negligible
R4	12.1	0.8	Extremely Small	Negligible
R5	13.3	3.0	Very Small	Negligible
R6	14.8	0.7	Extremely Small	Negligible
R7	14.3	1.4	Very Small	Negligible
R8	12.5	1.6	Very Small	Negligible
R9	13.1	5.3	Small	Slight adverse
R10	10.3	26.5	Very Large	Moderate adverse
R11	6.2	37.4	Very Large	Moderate beneficial
R12	9.6	26.2	Very Large	Moderate beneficial
R13	10.2	1.0	Very Small	Negligible
R14	9.3	37.6	Very Large	Moderate beneficial
R15	11.5	23.3	Large	Slight beneficial
R16	9.3	1.1	Very Small	Negligible
R17	9.8	22.4	Large	Slight adverse
R18	9.3	0.0	Extremely Small	Negligible
R19	9.6	7.7	Small	Slight beneficial
R20	15.9	10.7	Medium	Slight adverse
R21	9.5	12.0	Medium	Slight beneficial
R22	14.7	8.2	Small	Slight adverse
R23	10.3	11.2	Medium	Slight beneficial
R24	12.0	13.7	Medium	Slight beneficial
R25	8.1	2.5	Very Small	Negligible
R26	11.2	0.0	Extremely Small	Negligible
R27	12.0	0.0	Extremely Small	Negligible
R28	12.4	0.0	Extremely Small	Negligible
R29	11.1	1.8	Very Small	Negligible
R30	11.0	0.0	Extremely Small	Negligible

Table 11: Significance N1S2 PM_{10} 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.2	0.7	Extremely Small	Negligible
R2	15.1	0.0	Extremely Small	Negligible
R3	15.5	0.0	Extremely Small	Negligible
R4	13.9	0.0	Extremely Small	Negligible
R5	14.3	0.7	Extremely Small	Negligible
R6	15.3	0.7	Extremely Small	Negligible
R7	15.1	1.3	Very Small	Slight adverse
R8	15.0	0.7	Extremely Small	Negligible
R9	16.2	3.1	Very Small	Slight adverse
R10	14.7	5.4	Small	Slight adverse
R11	11.6	9.4	Small	Slight beneficial
R12	12.9	8.5	Small	Slight beneficial
R13	13.2	0.0	Extremely Small	Negligible
R14	12.8	11.7	Medium	Slight beneficial
R15	13.3	5.7	Small	Slight beneficial
R16	12.5	0.8	Extremely Small	Negligible
R17	12.6	4.8	Very Small	Slight adverse
R18	12.8	0.0	Extremely Small	Negligible
R19	12.4	1.6	Very Small	Negligible
R20	15.1	1.3	Very Small	Slight adverse
R21	12.8	2.3	Very Small	Negligible
R22	14.5	2.8	Very Small	Slight adverse
R23	12.9	2.3	Very Small	Negligible
R24	9.1	5.2	Small	Slight beneficial
R25	12.2	0.8	Extremely Small	Negligible
R26	12.9	0.0	Extremely Small	Negligible
R27	15.2	0.0	Extremely Small	Negligible
R28	13.8	0.0	Extremely Small	Negligible
R29	13.2	0.0	Extremely Small	Negligible
R30	13.4	0.0	Extremely Small	Negligible

Table 12: Significance N1S2 NO_2 2032

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.9	2.5	Very Small	Negligible
R2	14.4	1.4	Very Small	Negligible
R3	15.2	0.7	Extremely Small	Negligible
R4	12.3	1.6	Very Small	Negligible
R5	13.6	0.0	Extremely Small	Negligible
R6	15.1	0.7	Extremely Small	Negligible
R7	14.3	8.4	Small	Slight adverse
R8	12.7	3.8	Very Small	Negligible
R9	13.1	2.3	Very Small	Negligible
R10	10.4	27.9	Very Large	Moderate adverse
R11	6.2	42.1	Very Large	Moderate beneficial
R12	9.7	29.2	Very Large	Moderate beneficial
R13	10.5	1.0	Very Small	Negligible
R14	9.2	38.3	Very Large	Moderate beneficial
R15	11.7	32.0	Very Large	Moderate beneficial
R16	9.4	3.2	Very Small	Negligible
R17	9.9	23.2	Large	Slight adverse
R18	9.3	0.0	Extremely Small	Negligible
R19	9.6	5.0	Small	Slight beneficial
R20	14.8	5.4	Small	Slight adverse
R21	10.9	11.4	Medium	Slight beneficial
R22	15.0	11.2	Medium	Slight beneficial
R23	10.3	16.9	Large	Slight beneficial
R24	13.2	13.2	Medium	Slight beneficial
R25	8.2	3.7	Very Small	Negligible
R26	12.7	1.6	Very Small	Negligible
R27	12.1	0.8	Extremely Small	Negligible
R28	12.7	0.0	Extremely Small	Negligible
R29	11.4	6.6	Small	Slight beneficial
R30	11.3	3.4	Very Small	Negligible

Table 13: Significance N1S2 PM_{10} 2032

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.3	0.6	Extremely Small	Negligible
R2	15.0	0.0	Extremely Small	Negligible
R3	15.5	0.0	Extremely Small	Negligible
R4	13.9	0.7	Extremely Small	Negligible
R5	14.4	0.7	Extremely Small	Negligible
R6	15.4	0.6	Extremely Small	Negligible
R7	15.0	2.7	Very Small	Slight adverse
R8	15.0	2.0	Very Small	Slight beneficial
R9	16.1	0.6	Extremely Small	Negligible
R10	14.7	6.1	Small	Slight adverse
R11	11.5	14.2	Medium	Slight beneficial
R12	12.9	12.2	Medium	Slight beneficial
R13	13.2	0.0	Extremely Small	Negligible
R14	12.7	12.4	Medium	Slight beneficial
R15	13.3	9.5	Small	Slight beneficial
R16	12.4	0.8	Extremely Small	Negligible
R17	12.5	4.8	Small	Slight adverse
R18	12.7	0.0	Extremely Small	Negligible
R19	12.3	1.6	Very Small	Negligible
R20	15.1	3.3	Very Small	Slight adverse
R21	13.1	2.2	Very Small	Negligible
R22	14.5	2.7	Very Small	Slight beneficial
R23	12.8	4.5	Very Small	Negligible
R24	13.5	5.6	Small	Slight beneficial
R25	12.1	0.8	Extremely Small	Negligible
R26	13.2	0.0	Extremely Small	Negligible
R27	15.1	0.7	Extremely Small	Negligible
R28	13.8	0.7	Extremely Small	Negligible
R29	13.2	1.5	Very Small	Negligible
R30	13.5	0.7	Extremely Small	Negligible

Table 14: Significance N2S1 NO_2 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.7	0.0	Extremely Small	Negligible
R2	14.9	6.9	Small	Slight beneficial
R3	14.7	3.3	Very Small	Negligible
R4	12.2	1.6	Very Small	Negligible
R5	13.4	3.7	Very Small	Negligible
R6	14.2	3.4	Very Small	Negligible
R7	13.9	1.4	Very Small	Negligible
R8	12.6	0.8	Extremely Small	Negligible
R9	11.6	6.5	Small	Slight beneficial
R10	10.9	30.6	Very Large	Moderate adverse
R11	6.2	37.4	Very Large	Moderate beneficial
R12	9.6	26.2	Very Large	Moderate beneficial
R13	9.8	3.0	Very Small	Negligible
R14	9.3	37.6	Very Large	Moderate beneficial
R15	15.1	0.7	Extremely Small	Negligible
R16	9.5	3.2	Very Small	Negligible
R17	9.8	22.4	Large	Slight adverse
R18	11.2	17.0	Large	Slight adverse
R19	10.1	2.9	Very Small	Negligible
R20	15.0	5.3	Small	Slight adverse
R21	10.7	0.9	Extremely Small	Negligible
R22	16.9	20.1	Large	Slight adverse
R23	11.6	0.0	Extremely Small	Negligible
R24	13.8	0.7	Extremely Small	Negligible
R25	8.0	1.3	Very Small	Negligible
R26	11.0	1.8	Very Small	Negligible
R27	12.0	0.0	Extremely Small	Negligible
R28	12.4	0.0	Extremely Small	Negligible
R29	11.3	0.0	Extremely Small	Negligible
R30	10.9	0.9	Extremely Small	Negligible

Table 15: Significance N2S1 PM_{10} 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.2	0.7	Extremely Small	Negligible
R2	14.7	2.6	Very Small	Slight beneficial
R3	15.3	1.3	Very Small	Slight beneficial
R4	13.9	0.0	Extremely Small	Negligible
R5	14.4	1.4	Very Small	Slight adverse
R6	15.1	0.7	Extremely Small	Negligible
R7	15.0	0.7	Extremely Small	Negligible
R8	15.1	0.0	Extremely Small	Negligible
R9	15.7	0.0	Extremely Small	Negligible
R10	14.9	6.7	Small	Slight adverse
R11	11.6	9.4	Small	Slight beneficial
R12	12.9	8.5	Small	Slight beneficial
R13	13.0	1.5	Very Small	Negligible
R14	12.8	11.7	Medium	Slight beneficial
R15	14.1	0.0	Extremely Small	Negligible
R16	12.5	0.8	Extremely Small	Negligible
R17	12.6	4.8	Very Small	Negligible
R18	13.4	4.5	Very Small	Negligible
R19	12.5	0.8	Extremely Small	Negligible
R20	15.0	0.7	Extremely Small	Negligible
R21	13.1	0.0	Extremely Small	Negligible
R22	14.9	5.4	Small	Slight adverse
R23	13.2	0.0	Extremely Small	Negligible
R24	9.5	1.0	Very Small	Negligible
R25	12.1	0.0	Extremely Small	Negligible
R26	12.8	0.8	Extremely Small	Negligible
R27	15.2	0.0	Extremely Small	Negligible
R28	13.8	0.0	Extremely Small	Negligible
R29	13.2	0.0	Extremely Small	Negligible
R30	13.4	0.0	Extremely Small	Negligible

Table 16: Significance N2S1 NO_2 2032

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	16.1	1.2	Very Small	Negligible
R2	13.2	7.0	Small	Slight beneficial
R3	14.9	1.3	Very Small	Negligible
R4	12.4	0.8	Extremely Small	Negligible
R5	13.8	1.4	Very Small	Negligible
R6	14.4	4.0	Very Small	Negligible
R7	13.9	5.8	Small	Slight adverse
R8	12.7	3.8	Very Small	Negligible
R9	11.7	8.6	Small	Slight beneficial
R10	11.4	34.2	Very Large	Moderate adverse
R11	6.2	42.1	Very Large	Moderate beneficial
R12	9.6	29.9	Very Large	Moderate beneficial
R13	9.9	4.8	Very Small	Negligible
R14	9.2	38.3	Very Large	Moderate beneficial
R15	15.2	11.6	Medium	Slight beneficial
R16	9.8	7.1	Small	Slight adverse
R17	9.9	23.2	Large	Slight adverse
R18	11.1	16.2	Large	Slight adverse
R19	10.7	5.6	Small	Slight adverse
R20	15.6	10.3	Medium	Slight adverse
R21	12.3	0.0	Extremely Small	Negligible
R22	17.0	0.6	Extremely Small	Negligible
R23	11.6	6.5	Small	Slight beneficial
R24	14.3	5.9	Small	Slight beneficial
R25	8.0	1.3	Very Small	Negligible
R26	12.6	0.8	Extremely Small	Negligible
R27	12.0	1.6	Very Small	Negligible
R28	12.7	0.0	Extremely Small	Negligible
R29	11.5	5.7	Small	Slight beneficial
R30	11.2	4.3	Very Small	Negligible

Table 17: Significance N2S1 PM_{10} 2032

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.3	0.6	Extremely Small	Negligible
R2	14.6	2.7	Very Small	Slight beneficial
R3	15.4	0.6	Extremely Small	Negligible
R4	13.9	0.7	Extremely Small	Negligible
R5	14.5	0.0	Extremely Small	Negligible
R6	15.1	1.3	Very Small	Slight beneficial
R7	15.0	2.7	Very Small	Slight adverse
R8	15.0	2.0	Very Small	Slight beneficial
R9	15.7	1.9	Very Small	Slight beneficial
R10	15.0	8.0	Small	Slight adverse
R11	11.5	14.2	Medium	Slight beneficial
R12	12.8	12.9	Medium	Slight beneficial
R13	13.0	1.5	Very Small	Negligible
R14	12.7	12.4	Medium	Slight beneficial
R15	14.2	3.4	Very Small	Slight beneficial
R16	12.5	1.6	Very Small	Negligible
R17	12.5	4.8	Very Small	Negligible
R18	13.3	4.5	Very Small	Negligible
R19	12.5	0.0	Extremely Small	Negligible
R20	15.2	3.9	Very Small	Slight adverse
R21	13.3	0.7	Extremely Small	Negligible
R22	14.9	0.0	Extremely Small	Negligible
R23	13.1	2.2	Very Small	Negligible
R24	13.8	3.5	Very Small	Negligible
R25	12.0	0.0	Extremely Small	Negligible
R26	13.1	0.8	Extremely Small	Negligible
R27	15.1	0.7	Extremely Small	Negligible
R28	13.8	0.7	Extremely Small	Negligible
R29	13.2	1.5	Very Small	Negligible
R30	13.4	1.5	Very Small	Negligible

Table 18: Significance N2S2 NO_2 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.7	0.0	Extremely Small	Negligible
R2	14.8	7.5	Small	Slight beneficial
R3	14.7	3.3	Very Small	Negligible
R4	11.9	0.8	Extremely Small	Negligible
R5	12.8	0.8	Extremely Small	Negligible
R6	14.1	4.1	Very Small	Negligible
R7	13.9	1.4	Very Small	Negligible
R8	12.6	0.8	Extremely Small	Negligible
R9	11.6	6.5	Small	Slight beneficial
R10	11.1	31.8	Very Large	Moderate adverse
R11	6.2	37.4	Very Large	Moderate beneficial
R12	9.6	26.2	Very Large	Moderate beneficial
R13	10.2	1.0	Very Small	Negligible
R14	9.3	37.6	Very Large	Moderate beneficial
R15	11.5	23.3	Large	Slight beneficial
R16	9.3	1.1	Very Small	Negligible
R17	9.8	22.4	Large	Slight adverse
R18	9.3	0.0	Extremely Small	Negligible
R19	9.6	7.7	Small	Slight beneficial
R20	14.7	3.4	Very Small	Negligible
R21	9.5	12.0	Medium	Slight beneficial
R22	14.7	8.2	Small	Slight adverse
R23	10.3	11.2	Medium	Slight beneficial
R24	12.0	13.7	Medium	Slight beneficial
R25	8.1	2.5	Very Small	Negligible
R26	11.2	0.0	Extremely Small	Negligible
R27	11.9	0.8	Extremely Small	Negligible
R28	12.4	0.0	Extremely Small	Negligible
R29	11.3	0.0	Extremely Small	Negligible
R30	10.8	1.8	Very Small	Negligible

Table 19: Significance N2S2 PM_{10} 2017

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.2	0.7	Extremely Small	Negligible
R2	14.7	2.6	Very Small	Slight beneficial
R3	15.3	1.3	Very Small	Slight beneficial
R4	13.9	0.0	Extremely Small	Negligible
R5	14.2	0.0	Extremely Small	Negligible
R6	15.1	0.7	Extremely Small	Negligible
R7	15.0	0.7	Extremely Small	Negligible
R8	15.0	0.7	Extremely Small	Negligible
R9	15.7	0.0	Extremely Small	Negligible
R10	14.9	6.7	Small	Slight adverse
R11	11.6	9.4	Small	Slight beneficial
R12	12.9	8.5	Small	Slight beneficial
R13	13.2	0.0	Extremely Small	Negligible
R14	12.8	11.7	Medium	Slight beneficial
R15	13.3	5.7	Small	Slight beneficial
R16	12.5	0.8	Extremely Small	Negligible
R17	12.6	4.8	Very Small	Negligible
R18	12.8	0.0	Extremely Small	Negligible
R19	12.4	1.6	Very Small	Negligible
R20	14.9	0.0	Extremely Small	Negligible
R21	12.8	2.3	Very Small	Negligible
R22	14.5	2.8	Very Small	Slight adverse
R23	12.9	2.3	Very Small	Negligible
R24	9.1	5.2	Small	Slight beneficial
R25	12.2	0.8	Extremely Small	Negligible
R26	12.9	0.0	Extremely Small	Negligible
R27	15.2	0.0	Extremely Small	Negligible
R28	13.8	0.0	Extremely Small	Negligible
R29	13.2	0.0	Extremely Small	Negligible
R30	13.3	0.7	Extremely Small	Negligible

Table 20: Significance N2S2 NO_2 2032

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	16.0	1.8	Very Small	Negligible
R2	13.0	8.5	Small	Slight beneficial
R3	15.0	0.7	Extremely Small	Negligible
R4	12.2	2.4	Very Small	Negligible
R5	13.2	2.9	Very Small	Negligible
R6	14.3	4.7	Very Small	Negligible
R7	13.9	5.8	Small	Slight adverse
R8	12.6	4.5	Very Small	Negligible
R9	11.6	9.4	Small	Slight beneficial
R10	11.7	35.9	Very Large	Moderate adverse
R11	6.2	42.1	Very Large	Moderate beneficial
R12	9.7	29.2	Very Large	Moderate beneficial
R13	10.5	1.0	Very Small	Negligible
R14	9.2	38.3	Very Large	Moderate beneficial
R15	11.7	32.0	Very Large	Moderate beneficial
R16	9.4	3.2	Very Small	Negligible
R17	9.9	23.2	Large	Slight adverse
R18	9.3	0.0	Extremely Small	Negligible
R19	9.6	5.0	Small	Slight beneficial
R20	14.7	4.8	Very Small	Negligible
R21	10.9	11.4	Medium	Slight beneficial
R22	15.1	10.7	Medium	Slight beneficial
R23	10.3	16.9	Large	Slight beneficial
R24	13.3	12.5	Medium	Slight beneficial
R25	8.2	3.7	Very Small	Negligible
R26	12.6	0.8	Extremely Small	Negligible
R27	12.0	1.6	Very Small	Negligible
R28	12.7	0.0	Extremely Small	Negligible
R29	11.5	5.7	Small	Slight beneficial
R30	11.2	4.3	Very Small	Negligible

Table 21: Significance N2S2 PM_{10} 2032

Receptor	Concentration ($\mu g/m^3$)	Percentage change	Magnitude of change	Significance
R1	15.3	0.6	Extremely Small	Negligible
R2	14.5	3.3	Very Small	Slight beneficial
R3	15.5	0.0	Extremely Small	Negligible
R4	13.9	0.7	Extremely Small	Negligible
R5	14.3	1.4	Very Small	Slight beneficial
R6	15.1	1.3	Very Small	Slight beneficial
R7	15.0	2.7	Very Small	Slight adverse
R8	15.0	2.0	Very Small	Slight beneficial
R9	15.6	2.5	Very Small	Slight beneficial
R10	15.1	8.6	Small	Slight adverse
R11	11.5	14.2	Medium	Slight beneficial
R12	12.9	12.2	Medium	Slight beneficial
R13	13.2	0.0	Extremely Small	Negligible
R14	12.7	12.4	Medium	Slight beneficial
R15	13.3	9.5	Small	Slight beneficial
R16	12.4	0.8	Extremely Small	Negligible
R17	12.5	4.8	Very Small	Negligible
R18	12.7	0.0	Extremely Small	Negligible
R19	12.3	1.6	Very Small	Slight beneficial
R20	14.8	1.4	Very Small	Slight adverse
R21	13.1	2.2	Very Small	Negligible
R22	14.5	2.7	Very Small	Slight beneficial
R23	12.8	4.5	Very Small	Negligible
R24	13.5	5.6	Small	Slight beneficial
R25	12.1	0.8	Extremely Small	Negligible
R26	13.2	0.0	Extremely Small	Negligible
R27	15.1	0.7	Extremely Small	Negligible
R28	13.8	0.7	Extremely Small	Negligible
R29	13.2	1.5	Very Small	Negligible
R30	13.4	1.5	Very Small	Negligible

Appendix A13.2 provides the calculations and results from the assessment of local population exposure. Tables showing calculations for all assessed route corridor options and years are available on CD upon request.

1.1 Introduction

1.1.1 Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 18 Hz to 18 kHz and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear. To help understand the range of noise levels which may be encountered, an indication of the level of some common sounds on the dB(A) scale is given in the table below.

Table 1: Indication of Noise Thresholds

dB(A)	Description
140	Threshold of pain
120	Jet take off at 50 metres
100	Maximum noise levels on an underground platform
80	Kerbside of a busy urban street
60	Busy general office
40	Residential area at night
20	Background in a TV and recording studio
0	Threshold of hearing

1.1.2 Furthermore, the perception of noise may be determined by a number of other factors, both acoustic and non-acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

1.1.3 The most widely used weighting mechanism that best corresponds to the response of the human ear is the A-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90}, etc. according to the parameter being measured.

1.1.4 For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for ten per cent of the time period under consideration, has been adopted in this country for the assessment of road traffic noise. The L_{90}, the level exceeded for ninety per cent of the time, has been adopted to represent the background noise level. The L_1, the level exceeded for one per cent of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, eg $dBL_{A10,\ 5\ min}$ or $dBL_{A90,8hr}$.

1.1.5 The decibel scale is logarithmic rather than linear, and hence a 3dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3dB(A) of steady state noise is generally regarded as the minimum difference needed to perceive a change.

1.1.6 Vibration is defined as a repetitive oscillatory motion. Vibration can be transmitted to the human body through the supporting surfaces, the feet of a standing person, the buttocks, back and feet of a seated person or the supporting area of a recumbent person. In most situations, entry into the human body will be through the supporting ground or through the supporting floors of a building.

1.1.7 Vibration is often complex, containing many frequencies, occurring in many directions and changing over time. There are many factors that influence human response to vibration. Physical factors include vibration magnitude, vibration frequency, vibration axis, duration, point of entry into the human body and posture of the human body. Other factors include the exposed persons experience, expectation, arousal and activity.

1.1.8 Experience shows that disturbance or annoyance from vibration in residential situations is likely to arise when the magnitude of vibration is only slightly in excess of the threshold of perception.

1.1.9 The threshold of perception depends on the frequency of vibration. The human body is most sensitive to vibration in the frequency range 0.5-80Hz, and especially sensitive to vibration in the range 4-8Hz. As with noise, a frequency weighting mechanism is used to quantify vibration in a way that best corresponds to the frequency response of the human body. For occupants within buildings, the appropriate standard is British Standard BS6472: 2008 Guide to Evaluation of Human Exposure to Vibration in Buildings, British Standards Institution.

1.1.10 BS6472 Part 1 advises the use of the estimated vibration dose value (VDV) form frequency weighted vibration measurements. The VDV value is used is used to estimate the probability of adverse comment which might be expected from humans experiencing vibration within buildings. Consideration is given to the VDV that an occupant would receive over the course of a 16 hour day or 8 hour night-time period. The vibration dose value provides a means of specifying the frequency dependent vibration level of a given duration as a single number.

1.1.11 BS6472 Part 2 gives guidance on human exposure to blast induced vibration in buildings. It is primarily applicable to mineral extraction blasting. It may be useful in assessing blasting associated with civil engineering works and demolition activity.

Table 1: Base Year

	Northbound					Southbound				
	Vehicles per hour	**No of Lanes**	**Flow Units per hour per lane**	**Speed**	**Driver Stress**	**Vehicles per hour**	**No of Lanes**	**Flow Units per hour per lane**	**Speed**	**Driver Stress**
2005 AM										
Halbeath - Masterton	2219	2	1234	100	MODERATE	2360	2	1279	100	MODERATE
Masterton - Admiralty	2353	2	1312	100	MODERATE	2320	2	1265	100	MODERATE
Admiralty - Ferrytoll	2613	2	1438	96	MODERATE	2669	2	1425	97	MODERATE
Forth Road Bridge	2712	2	1534	65	MODERATE	2771	2	1560	62	MODERATE
M9 Spur	1033	2	540	103	LOW	1364	2	715	101	LOW
East of Scotstoun	1658	2	921	79	MODERATE	1491	2	880	79	MODERATE
2005 Inter-Peak										
Halbeath - Masterton	1629	2	940	101	LOW	1649	2	928	101	LOW
Masterton - Admiralty	1804	2	1043	100	LOW	1870	2	1050	100	LOW
Admiralty - Ferrytoll	1984	2	1124	99	LOW	2027	2	1119	100	LOW
Forth Road Bridge	1960	2	1153	80	MODERATE	2085	2	1192	80	MODERATE
M9 Spur	860	2	458	103	LOW	955	2	489	103	LOW
East of Scotstoun	1160	2	704	79	MODERATE	999	2	595	79	MODERATE
2005 PM										
Halbeath - Masterton	2903	2	1570	99	MODERATE	2157	2	1282	100	MODERATE
Masterton - Admiralty	3068	2	1654	100	HIGH	2399	2	1404	100	MODERATE
Admiralty - Ferrytoll	3463	2	1849	86	HIGH	2530	2	1466	97	MODERATE
Forth Road Bridge	3486	2	1914	37	HIGH	2685	2	1571	63	MODERATE
M9 Spur	1344	2	703	101	LOW	815	2	415	103	LOW
East of Scotstoun	2051	2	1176	79	MODERATE	1633	2	985	79	MODERATE

Table 2: North 1 / South 1

	Northbound					Southbound				
	Vehicles per hour	**No of Lanes**	**Flow Units per hour per lane**	**Speed**	**Driver Stress**	**Vehicles per hour**	**No of Lanes**	**Flow Units per hour per lane**	**Speed**	**Driver Stress**
2032 AM										
Halbeath - offline section	4220	3	1570	99	MODERATE	3487	3	1262	100	MODERATE
Offline section	3274	2	1877	63	HIGH	2381	2	1327	80	MODERATE
Offline - Masterton	944	2	478	102	LOW	1105	2	565	102	LOW
Masterton - Admiralty	960	2	500	100	LOW	1298	2	719	100	LOW
Admiralty - Ferrytoll	1251	2	647	102	LOW	2212	2	1188	100	LOW
Replacement Bridge	4833	3	1806	46	HIGH	4400	3	1615	58	HIGH
M9 Spur	3265	2	1834	87	HIGH	2734	2	1488	95	MODERATE
East of Scotstoun	1837	2	985	79	MODERATE	2229	2	1230	77	MODERATE
2032 Inter-Peak										
Halbeath - offline section	3392	3	1294	100	MODERATE	3231	3	1193	100	LOW
Offline section	2840	2	1647	76	HIGH	2650	2	1482	80	MODERATE
Offline - Masterton	553	2	295	103	LOW	582	2	308	104	LOW
Masterton - Admiralty	842	2	460	100	LOW	903	2	491	100	LOW
Admiralty - Ferrytoll	1088	2	578	102	LOW	1405	2	752	102	LOW
Replacement Bridge	4055	3	1545	64	MODERATE	3895	3	1435	69	MODERATE
M9 Spur	2355	2	1234	99	MODERATE	2393	2	1236	99	MODERATE
East of Scotstoun	1612	2	961	79	MODERATE	1441	2	829	79	MODERATE
2032 PM										
Halbeath - offline section	4142	3	1461	99	MODERATE	4232	3	1554	99	MODERATE
Offline section	3316	2	1774	65	HIGH	3028	2	1725	70	HIGH
Offline - Masterton	827	2	420	103	LOW	1204	2	606	102	LOW
Masterton - Admiralty	1323	2	672	100	LOW	1602	2	817	100	LOW
Admiralty - Ferrytoll	2083	2	1050	99	LOW	2261	2	1152	100	LOW
Replacement Bridge	5493	3	1952	33	HIGH	5289	3	1919	37	HIGH
M9 Spur	3581	2	1906	84	HIGH	2998	2	1545	93	MODERATE
East of Scotstoun	2459	2	1315	76	MODERATE	2518	2	1368	75	MODERATE

Table 3: North 1 / South 2

	Northbound					Southbound				
	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress
2032 AM										
Halbeath - Masterton	4118	3	1569	94	MODERATE	3387	3	1225	99	MODERATE
Masterton - Admiralty	4042	3	1549	95	MODERATE	3701	3	1354	100	MODERATE
Admiralty - Ferrytoll	4804	3	1807	88	HIGH	4286	3	1550	94	MODERATE
Replacement Bridge	5023	3	1910	40	HIGH	4280	3	1575	59	MODERATE
A904 - M9	4727	3	1788	89	HIGH	2433	3	893	101	LOW
M9 Spur	654	2	358	103	LOW	1528	2	782	101	LOW
East of Scotstoun	1662	2	894	79	MODERATE	1910	2	1068	79	MODERATE
2032 Inter-Peak										
Halbeath - Masterton	3469	3	1328	99	MODERATE	3196	3	1178	100	LOW
Masterton - Admiralty	3581	3	1372	100	MODERATE	3416	3	1257	100	MODERATE
Admiralty - Ferrytoll	4263	3	1624	91	HIGH	4052	3	1471	95	MODERATE
Replacement Bridge	4254	3	1620	59	HIGH	4023	3	1482	66	MODERATE
A904 - M9	3718	3	1399	98	MODERATE	2554	3	934	101	LOW
M9 Spur	441	2	243	104	LOW	1025	2	550	102	LOW
East of Scotstoun	1386	2	814	79	MODERATE	1334	2	726	79	MODERATE
2032 PM										
Halbeath - Masterton	4226	3	1517	94	MODERATE	4940	3	1791	88	HIGH
Masterton - Admiralty	4410	3	1579	95	MODERATE	4766	3	1734	90	HIGH
Admiralty - Ferrytoll	5504	3	1944	84	HIGH	5048	3	1829	87	HIGH
Replacement Bridge	5652	3	2036	29	HIGH	5226	3	1895	39	HIGH
A904 - M9	5174	3	1855	86	HIGH	3353	3	1178	99	LOW
M9 Spur	1332	2	709	102	LOW	2283	2	1166	100	LOW
East of Scotstoun	2484	2	1310	75	MODERATE	2402	2	1309	76	MODERATE

Table 4: North 2 / South 2

	Northbound					Southbound				
	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress
2032 AM										
Halbeath - offline section	4304	3	1631	99	HIGH	3536	3	1303	100	MODERATE
Offline section	3246	2	1911	62	HIGH	2504	2	1427	80	MODERATE
Offline - Masterton	1057	2	536	102	LOW	1031	2	528	102	LOW
Masterton - Admiralty	1150	2	600	100	LOW	1368	2	720	100	LOW
Admiralty - Ferrytoll	1533	2	791	102	LOW	2090	2	1063	100	LOW
Replacement Bridge	5031	3	1914	40	HIGH	4317	3	1588	59	HIGH
A904 - M9	4736	3	1793	89	HIGH	2483	3	910	101	LOW
M9 Spur	645	2	354	103	LOW	1520	2	780	101	LOW
East of Scotstoun	1655	2	892	79	MODERATE	1908	2	1067	79	MODERATE
2032 Inter-Peak										
Halbeath - offline section	3499	3	1336	100	MODERATE	3298	3	1220	100	MODERATE
Offline section	2977	2	1726	72	HIGH	2821	2	1575	79	MODERATE
Offline - Masterton	522	2	279	103	LOW	477	2	256	104	LOW
Masterton - Admiralty	866	2	473	100	LOW	942	2	510	104	LOW
Admiralty - Ferrytoll	1209	2	640	102	LOW	1323	2	710	102	LOW
Replacement Bridge	4252	3	1620	59	HIGH	3976	3	1467	68	MODERATE
A904 - M9	3730	3	1404	98	MODERATE	2518	3	922	101	LOW
M9 Spur	444	2	244	104	LOW	1027	2	550	102	LOW
East of Scotstoun	1384	2	812	79		1336	2	726	79	MODERATE
2032 PM										
Halbeath - offline section	4236	3	1521	99	MODERATE	4427	3	1620	98	HIGH
Offline section	3405	2	1861	62	HIGH	3617	2	2022	64	HIGH
Offline - Masterton	829	2	421	103	LOW	811	2	410	104	LOW
Masterton - Admiralty	1388	2	704	100	LOW	1267	2	648	100	LOW

	Northbound					Southbound				
	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress
Admiralty - Ferrytoll	2163	2	1091	99	LOW	1753	2	895	100	LOW
Replacement Bridge	5650	3	2035	29	HIGH	5342	3	1935	36	HIGH
A904 - M9	5177	3	1856	86	HIGH	3471	3	1219	99	MODERATE
M9 Spur	1325	2	706	102	LOW	2283	2	1166	100	LOW
East of Scotstoun	2487	2	1312	75	MODERATE	2401	2	1310	76	MODERATE

Table 5: North 2 / South 1

	Northbound					Southbound				
	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress	Vehicles per hour	No of Lanes	Flow Units per hour per lane	Speed	Driver Stress
2032 AM										
Halbeath - offline section	4220	3	1570	99	MODERATE	3487	3	1262	100	MODERATE
Offline section	3274	2	1877	63	HIGH	2381	2	1327	80	MODERATE
Offline - Masterton	944	2	478	102	LOW	1105	2	565	102	LOW
Masterton - Admiralty	960	2	500	100	LOW	1298	2	719	100	LOW
Admiralty - Ferrytoll	1251	2	647	102	LOW	2212	2	1188	100	LOW
Replacement Bridge	4833	3	1806	46	HIGH	4400	3	1615	58	HIGH
M9 Spur	3265	2	1834	87	HIGH	2734	2	1488	95	MODERATE
East of Scotstoun	1837	2	985	79	MODERATE	2229	2	1230	77	MODERATE
2032 IP										
Halbeath - offline section	3392	3	1294	100	MODERATE	3231	3	1193	100	LOW
Offline section	2840	2	1647	76	HIGH	2650	2	1482	80	MODERATE
Offline - Masterton	553	2	295	103	LOW	582	2	308	104	LOW
Masterton - Admiralty	842	2	460	100	LOW	903	2	491	100	LOW
Admiralty - Ferrytoll	1088	2	578	102	LOW	1405	2	752	102	LOW
Replacement Bridge	4055	3	1545	64	MODERATE	3895	3	1435	69	MODERATE
M9 Spur	2355	2	1234	99	MODERATE	2393	2	1236	99	MODERATE

	Northbound					Southbound				
	Vehicles per hour	**No of Lanes**	**Flow Units per hour per lane**	**Speed**	**Driver Stress**	**Vehicles per hour**	**No of Lanes**	**Flow Units per hour per lane**	**Speed**	**Driver Stress**
East of Scotstoun	1612	2	961	79	MODERATE	1441	2	829	79	MODERATE
2032 PM										
Halbeath - offline section	4142	3	1461	99	MODERATE	4232	3	1554	99	MODERATE
Offline section	3316	2	1774	65	HIGH	3028	2	1725	70	HIGH
Offline - Masterton	827	2	420	103	LOW	1204	2	606	102	LOW
Masterton - Admiralty	1323	2	672	100	LOW	1602	2	817	100	LOW
Admiralty - Ferrytoll	2083	2	1050	99	LOW	2261	2	1152	100	LOW
Replacement Bridge	5493	3	1952	33	HIGH	5289	3	1919	37	HIGH
M9 Spur	3581	2	1906	84	HIGH	2998	2	1545	93	MODERATE
East of Scotstoun	2459	2	1315	76	MODERATE	2518	2	1368	75	MODERATE

The table below list the key policies that may affect the development of the proposal. Route corridor options that are marked with '**X**' are of particular relevance as there may be non-compliance issues. Route corridor options that are marked with a tick '✓' are generally compliant. Route corridor options marked '**?**' indicate potential non-compliance issues that will be further assessed at Stage 3 and for which mitigation proposals may be developed where appropriate.

Table 1: Assessment of Policy Compliance

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
Edinburgh and the Lothians Structure Plan 2015					
ECON4 – Established Green Belt uses	n/a	n/a	X	X	Additional land for development may only be justified within the boundaries of Edinburgh Airport, Royal Highland Showground and Heriot Watt University at Riccarton. The scheme would represent additional land being taken within the Green Belt boundary for development and therefore the scheme is non-compliant with policy ECON 4.
ENV1G – Design of new development	n/a	n/a	✓	✓	Requires local plans to include policies to promote high quality of design in all new development.
ENV2 - Green Belt	n/a	n/a	X	X	A continuous Green Belt around Edinburgh must be maintained. There is a presumption against development but local plans may justify any exceptions to national planning policy. Both southern options cut through the Green Belt.
ENV5 - The Coast	n/a	n/a	✓	✓	Development of the undeveloped coast will only be permitted where it demonstrates a need for a coastal location, where benefits outweigh any detrimental environmental impact and where there is no alternative site.
ENV1C - International and National Historic or Built Environment Designations	n/a	n/a	?	?	Development which would harm the character, appearance and setting of World Heritage Sites, Listed Buildings, Scheduled Ancient Monuments or Sites listed in the Inventory of Gardens and Designed Landscapes and/or the specific features that justify their designation, should be resisted. Mitigation measures may be required to reduce the impact on some sites (Chapter 10: Landscape, Chapter 11: Visual and Chapter 12: Cultural Heritage).
ENV1D - Regional and Local Natural And Built Environment Interests	n/a	n/a	✓	✓	Schemes that have a direct impact or impact on the setting of Conservation Areas or sites of archaeological interest will only be permitted if the objectives or overall integrity of the site are not compromised or the social/economic benefits outweigh the conservation value.
Fife Structure Plan 2001 - 2011					
SS4 – Dunfermline Area	✓	✓	n/a	n/a	Continued phased development of the Dunfermline Eastern Expansion Area for housing, employment and ancillary land.

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
SS5, PT1 – Rosyth Military Estate	✓	✓	n/a	n/a	Proposal for development of roll-on roll-off ferry terminal, port and related facilities, industrial, business and mixed uses will be supported.
PT2 – Transport Proposals	✓	✓	n/a	n/a	Land for the following routes and facilities will be safeguarded from prejudicial development: • Bus/rail interchange at Inverkeithing. • Kincardine eastern bypass. • Rosyth bypass (A985). • Tay Bridgehead park and ride site. • New park and ride at Halbeath, Dunfermline. • A92T Preston to Balfarg junctions improvement scheme. • Rosyth Access Road, A90 Ferrytoll to port. • A92T interchange at Redhouse.
SS4 – Dunfermline Area	✓	✓	n/a	n/a	Continued phased development of the Dunfermline Eastern Expansion Area for the provision of housing, employment and ancillary land.
SS8 – Green Belts for Dunfermline	✓	✓	n/a	n/a	There is a presumption against development or changes of use in Green Belts.
N5 – Development of the Developed Coast	✓	✓	n/a	n/a	Development will be supported in principle where it demonstrates the need for a coastal location and it does not prejudice the footpath or cycle network.
N6 – Development on the Undeveloped Coast	✓	✓	n/a	n/a	Development on the undeveloped coast outwith settlements will only be permitted where it demonstrates a need for a coastal location, no alternative site is available and it meets a social and economic need of the community and it does not prejudice the footpath or cycle network.
B1 – Built Heritage	?	?	n/a	n/a	Development will be supported where it does not adversely impact on Listed Buildings, Conservation Areas, sites recorded on the Inventory of Gardens and Designed Landscapes, non-inventory gardens or designed landscapes or sites recorded in the Fife SMR. Mitigation measures where required will be provided in the Stage 3 assessment.
Finalised Fife Structure Plan 2006 - 2026					
T2 - Safeguarding of Existing and Potential Transport Routes	✓	✓	n/a	n/a	Landfall for approach infrastructure for a potential new multi-modal crossing of the Forth will be safeguarded from development that may prejudice existing or future transportation use.
PT1 - Transport Proposals	✓	✓	n/a	n/a	A new multi modal cross-forth bridge and associated approach networks at North Queensferry has been classified under the category national/international and the policy states that an initial feasibility study with potential for a new bridge within the Plan period is required.

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
Rural West Edinburgh Local Plan, Adopted 2006					
E41 - Design of New Development	n/a	n/a	✓	✓	New development will be required to promote high standards of design for all development. Special attention is also required to design quality at gateways and along arterial routes.
E42 - Quality of New Development	n/a	n/a	✓	✓	New development will be required to make a positive contribution to the overall character of its context and immediate setting.
E14 - Designed Landscapes	n/a	n/a	?	?	Proposed development which would adversely affect Designed Landscapes of national significance or their setting will only be permitted where it assists restoration and would not adversely affect the artistic merit, historical, horticultural, arboricultural, archaeological, and architectural, nature conservation or scenic value of the landscape. The impact on the scenic value of Dalmeny and Newliston has been assessed as being of Negligible to Slight significance (Chapter 10 – Landscape). Impacts on Dundas Designed Landscape have been assessed as being of Substantial to Severe for South Corridor Option 1 and Moderate to Substantial for South Corridor Option 2.
E8 - Area of Outstanding Landscape Quality and Areas of Great Landscape Value	n/a	n/a	x	x	Within designated Areas of Great Landscape Value (AGLV) and Areas of Outstanding Landscape Quality (AOLQ), the quality of the landscape will be protected and enhanced. Development will not be permitted where it would adversely affect the special scenic qualities and integrity of the AGLV or AOLQ. The landscape features include patterns of woodland, fields, hedgerows and trees; the special qualities of rivers and lochs; and skylines and hill features, including prominent views. The impact on Dalmeny and Newliston AOLQs has been assessed as being of Negligible to Slight significance (Chapter 10 – Landscape). Impacts on Dundas AOLQ have been assessed as being of Substantial to Severe for South Corridor Option 1 and Moderate to Substantial for South Corridor Option 2.
E30 - Non-Scheduled Archaeological Remains - Archaeological Evaluation	n/a	n/a	✓	✓	Archaeological evaluation required where impact on known archaeological sites or potential impact on unknown archaeological sites. Where preservation in situ is not feasible archaeological investigation and reporting is required.
E32 - Listed Buildings	n/a	n/a	✓	✓	Proposals affecting a listed building or its setting will be considered for their effect on the character of the building.
E34 - Listed Buildings - Country Houses	n/a	n/a	✓	✓	To protect the setting and character of listed country houses, development in their grounds will only be permitted where the relationship of the original buildings to their policies is not compromised.
HSP1 – North Kirkliston	n/a	n/a	✓	✓	Strategic housing allocation with estimated capacity of 610 units and associated infrastructure.
HSG2 – Springfield, South Queensferry	n/a	n/a	x	x	Housing proposal with estimated capacity of 150 units. Both southern route options run through the site shown on the proposals map.

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
ENV6 – Springfield, South Queensferry	n/a	n/a	x	x	Area proposed for environmental improvements associated with residential development identified in Policy HSG2 situated to the north of this site. Both southern route options run through the site shown on the proposals map.
HSG7 – Society Road, South Queensferry	n/a	n/a	x	x	Housing proposal with undetermined capacity. Both southern route options cut through this designated housing allocation. Both southern route options run through the site shown on the proposals map.
HSG6, ECON10 – Port Edgar	n/a	n/a	x	x	The Port Edgar area is proposed for mixed use development including Class 4 marina uses, marine businesses and residential development. The proposals are subject of a development brief prepared by the City of Edinburgh Council. Cumulative construction impacts of the scheme and the proposals at Port Edgar would need to be considered. The proximity of the scheme to proposed residential and business development at Port Edgar may result in loss of amenity. Mitigation measures would ensure that amenity is maintained.
E18-E19, E21 – Site of Interest to Nature Conservation (SINC)	n/a	n/a	x	x	Development within or affecting SINC not permitted unless mitigation measures safeguard the nature conservation interest. South Corridor Option 1 runs through the northern part of the Dundas SINC and Port Edgar SINC is affected by both South Corridor Options 1 and 2 where the bridgehead lands.
E5 - Countryside and Green Belt	n/a	n/a	x	x	To protect the landscape quality, rural character and amenity of the Green Belt and Countryside Areas, development will not be permitted except where necessary for agriculture, relating to minor extensions or change of use of existing buildings or acceptable under the policies for strategic economic importance (Policies ED5 – 7 below). The scheme is not situated within the defined areas for strategic economic development (i.e. Edinburgh Airport, The Royal Highland Showground and Heriot-Watt University) therefore the scheme is non-compliant with Policy E5.
E6 - Design and Amenity Criteria for Development in the Green Belt and Countryside	n/a	n/a	?	?	Policy ED6 provides design criteria for development in the Green Belt and Countryside with the aim to achieve high standards of design and landscaping and to safeguard local amenity. The scheme would lead to some loss of amenity in the existing rural environment in terms of traffic, noise and air. Mitigation measures will be identified in the Stage 3 assessment.
ED5-7 - Economic Development	n/a	n/a	✓	✓	Development proposals relating to the following major Established Green Belt Uses of strategic economic importance: • Edinburgh Airport • Royal Highland Showground • Heriot-Watt University Campus at Riccarton The proposals relate to development contained within the boundaries of these allocations.

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
E51 - Protection of Open Space, Port Edgar and Back Braes Weir, E51	n/a	n/a	✓	✓	Public and private open space of recreational, amenity or nature conservation value should be retained
E12 - Developed Coast	n/a	n/a	✓	✓	South Queensferry has been allocated as 'developed coast' under terms of PAN 53. Development would not be permitted unless a coastal location is required for the particular development.
E17, 21 - Nature Conservation sites	n/a	n/a	?	?	Nature conservation sites of international and national importance, SPA, Ramsar site or SSSI, where development would normally only be permitted where the designation objectives and overall integrity of the designated area will not be compromised; where any significant adverse effects on the qualities for which the area has been designated are outweighed by social or economic benefits of national importance; and it can be demonstrated that there are no alternative solutions. The Firth of Forth SPA lies directly to the east of the proposed replacement bridge. An Appropriate Assessment will be undertaken at Stage 3 in order to assess any potential impacts. The Scottish Government has demonstrated the national importance, in social and economic terms, of the scheme in NPF 2 and it therefore, generally complies with the terms of the policy.
ED10 - Birdstrike Limit - Aviation Use Consultation Zone	n/a	n/a	?	?	Height and detailed design of buildings will be controlled to ensure airport operations and aircraft movements are not inhibited. Development which would create or increase the risk of an unacceptable birdstrike hazard within the defined consultation area will not be permitted. The operator of Edinburgh Airport would also need to be consulted. The views of the airport operator will be taken into account during the design process and if required, mitigation measures will be proposed at Stage 3.
Finalised West Lothian Local Plan 2005					
ENV3 - Special Protection Area (SPA)	n/a	n/a	x	x	Development within or affecting areas classified as existing sites of international importance under the European Directives or affecting the habitats and species listed in the Habitat Directives I and II and Species Directive Annex I, will not be permitted unless there are no alternative solutions or there are imperative reasons of over-riding national public interest to allow development. The Firth of Forth SPA lies directly to the east of the proposed replacement bridge. An Appropriate Assessment will be undertaken at Stage 3 in order to assess any potential impacts. The Scottish Government has demonstrated the national importance, in social and economic terms, of the scheme in NPF 2 and it therefore, generally complies with the terms of the policy.
ENV9 – Areas of Special Agricultural Importance	n/a	n/a	✓	x	Various intensively farmed, high quality agricultural areas, within the eastern part of West Lothian are designated as Areas of Special Agricultural Importance. Within these areas there will be a presumption against large-scale development unless justified for strategic reasons. South Corridor Option 2 encroaches on Policy ENV9 land. However, the Scottish Government has demonstrated the national importance, in social and economic terms, of the scheme in NPF 2. Therefore, the scheme generally complies with the terms of the policy.

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
ENV20-21 - Areas of Great Landscape Value (AGLV)	n/a	n/a	✓	✓	Forth Shore is a designated AGLV; it is mainly covered by managed woodlands of the Hopetoun Estate and includes the shore of the Forth between Blackness and South Queensferry and the setting of several historic buildings. Development that would affect the setting of the AGLV will be subject to detailed visual appraisal.
HER12-14 - Scheduled Monuments	n/a	n/a	✓	✓	Development that would adversely affect the interest, character or setting of scheduled monuments will not be approved. Monuments include: Abercorn Castle, Hopetoun; Carved stones in session house, Abercorn Church; Fort 450m SW of West Lodge, Abercorn; Auldcathie Church, Winchburgh; Midhope Castle, Abercorn; Staneyhill Tower, Hopetoun; Faucheldean shale bing, Winchburgh.
HER22-23 - Designed Landscapes and Gardens	n/a	n/a	✓	✓	The special architectural and historic character and features of historic gardens and designed landscapes will be considered sympathetically and receive full protection in the consideration of proposals for development within or adjacent to them.
EM5 – Employment Areas	n/a	n/a	✓	✓	Area designated for employment use, within Classes 4, 5 and 6, on the former Digital/Motorola site east of South Queensferry.
CDA9 – Winchburgh and East Broxburn Core Development Area	n/a	n/a	✓	✓	Land designated for mixed use development consisting of residential development of up to 5500 units, business development of up to 40 ha, school at primary and secondary levels, community facilities, open space and leisure, town centre and retailing facilities, public transport facilities, roads and a new junction providing direct access onto the M9.
TRAN29 – New Motorway junction on M9	n/a	n/a	✓	✓	Motorway junction supported to serve planned Core Development Area at Winchburgh.
Linlithgow Area Local Plan 1994					
R1 - Development in the Countryside	n/a	n/a	✓	✓	Proposals for development in the countryside not directly related to agriculture or otherwise meriting a rural location will not normally be approved. Although generic, this policy relates primarily to the development of housing in the countryside. Larger scale developments will be assessed on locational need, minimum disturbance to agricultural management, trees, woodland and wildlife habitats and the availability of alternative sites.
R3, R5 - Area of Great Landscape Value (AGLV)	n/a	n/a	✓	✓	The Forth Shore is designated an AGLV. Within AGLVs, there will be a presumption against development unless it is of the highest standard in terms of location and design and meets the terms of policy R1 in full.
R7-8 - Areas of Special Agricultural Importance (ASAI)	n/a	n/a	?	?	The intensively farmed, high quality land located in the Craigton-Duntarvie-Duddingston area is designated an ASAI. Within theASAI, there will be a further presumption against development unless it is of the highest standard in terms of location and design and meets the terms of policy R1 in full.

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
					South Corridor Option 2 encroaches on policies R7 and R8 areas at Muiriehall Wood. However in planning decisions, the Finalised West Lothian Local Plan (FWLLP) is considered to be a material consideration. Policy ENV9 will replace policies R7 and R8 of the Linlithgow Area Local Plan once the FWLLP has been adopted and this policy would allow large-scale development if justified for strategic reasons. In NPF 2, the Scottish Government has demonstrated the national importance, in social and economic terms, of the scheme. Therefore, on balance, the scheme is considered to comply with the terms of the policy.
Broxburn Area Local Plan 1989					
E5-6 - Development in the Countryside – Policy	n/a	n/a	✓	✓	Essential services and developments of a high-quality or prestigious nature meriting a rural location will be considered favourably subject to assessment of locational need, minimum disturbance to agricultural management, trees, woodland and wildlife habitats and the availability of alternative sites.
E8-E10 - Areas of Special Agricultural Importance	n/a	n/a	?	?	The intensively farmed, high quality areas of land located to the south of Broxburn and east of Winchburgh are designated as Areas of Special Agricultural Importance (ASAIs). Within the ASAIs, there will be a presumption against development unless it is of the highest standard in terms of location and design. South Corridor Option 2 encroaches the designated area at Swineburn. However in planning decisions, the Finalised West Lothian Local Plan (FWLLP) is considered to be a material consideration. Policy ENV9 will replace policies E8 and E10 of the Broxburn Local Plan once the FWLLP has been adopted and this policy would allow large-scale development if justified for strategic reasons. In NPF 2, the Scottish Government has demonstrated the national importance, in social and economic terms, of the scheme. Therefore, on balance, the scheme is considered to comply with the terms of the policy.
Dunfermline and the Coast Local Plan 2002					
BE3 - Development Design	✓	✓	n/a	n/a	All new development is expected to make a positive contribution to its immediate environment.
BE7 - Brownfield Land	✓	✓	n/a	n/a	The objective of policy BE7 is to encourage the development of brownfield sites in order to aid regeneration and clear dereliction and eyesores, enhance decaying urban areas and relieve pressure on greenfield sites, particularly on the periphery of towns and villages.
BIT 1 and BIT 2 – Employment land	✓	✓	n/a	n/a	Employment land is concentrated at the eastern and southern approaches to Dunfermline, with major sites at Calais Muir, Dover Heights, Pitreavie and Halbeath.
BIT3 – Established Employment Area	✓	x	n/a	n/a	Proposals for uses other than business (Class 4), industrial or storage and distribution purposes within established employment areas will only be permitted where it can be demonstrated that there is no demand for such use/development or where the proposed use would not restrict the

Policy	Northern Route Corridor Options		Southern Route Corridor Options		Summary
	N1	N2	S1	S2	
					range of uses which can be carried out by businesses and where the proposed use would cause traffic or amenity problems. Belleknowes Industrial Estate would be affected by North Corridor Option 2.
H1, H2 - Housing	✓	✓	n/a	n/a	The East Dunfermline Expansion Area, which includes most of the land between Dunfermline and the M90, is identified as the main focus for growth over the next 10 to 15 years. When complete, more than 4,000 houses, 131 hectares of employment land and a commercial leisure park will be linked by an integrated transport network. At its heart is the Duloch Park District Centre which already incorporates the Tesco superstore adjacent to the new District Park. Schools and other community facilities will complement a high quality environment, including the protected Calais Muir Wood.
BE12 - Development Affecting Listed Buildings	✓	✓	n/a	n/a	Development proposals affecting listed buildings and their settings should not detract from those settings, and will be required to conform to the highest design standards, including siting, materials, landscaping and boundary enclosures.
BE15 - Ancient Monuments and Archaeological Sites	x	✓	n/a	n/a	Archaeological and historic features of significance and their settings will be protected and conserved in-situ. Unless exceptional circumstances are demonstrated, support will not be given to development which would adversely affect these sites. Without mitigation, Middlebank Souterrain SAM will be removed by North Corridor Option 1 and the significance of this impact has been assessed as Severe. Impacts on other monuments could be reduced to neutral through mitigation and recording.
H6 - Development Adjacent to Residential Areas	✓	✓	n/a	n/a	The need to protect amenity will be a material consideration in the assessment of development proposals for sites adjacent to residential areas.
T7 – Ferrytoll Park and Ride	✓	✓	n/a	n/a	Fife Council will safeguard land to the west of the A90 Ferrytoll Interchange to facilitate an extended park and ride facility. This facility has been realised through expansion of the facility at Inverkeithing station and subsequently the proposal has been abandoned.
T8 – Rosyth Station Car Park	✓	✓	n/a	n/a	Safeguarding of land to east of Rosyth Railway station to enable the future extension of park and ride services, this proposal is currently subject of a planning application.
COU4 - Areas of Great Landscape value	✓	✓	n/a	n/a	Development must maintain or enhance the character of the landscape through the highest standard of design and finish.
COU7 – Urban Green Corridors	✓	✓	n/a	n/a	Fife Council will seek to protect the urban green corridors in Dunfermline
COU8, COU9 – Nature Conservation International and National sites	?	?	n/a	n/a	Development that would affect a Natura 2000 site, or SSSI would normally only be permitted if any adverse effects on the qualities of the area are outweighed by social or economic benefits. At Stage 3, an Appropriate Assessment will be undertaken to assess the impact on the Natura 2000 sites. The Scottish Government has demonstrated the national importance, in social and

Policy	**Northern Route Corridor Options**		**Southern Route Corridor Options**		**Summary**
	N1	**N2**	**S1**	**S2**	
					economic terms, of the scheme in NPF 2. Therefore, the scheme generally complies with the terms of the policy.
COU17 - Undeveloped Coast	?	?	n/a	n/a	The policy states that the remaining undeveloped coast will be protected from further development. However, NPPG13 which provides the national context to this policy states that major development within the undeveloped coast may be considered where the proposal can be considered to yield social and economic benefits sufficient enough to outweigh any potentially detrimental impact on the coastal environment. However, the Scottish Government has demonstrated the national importance, in social and economic terms, of the scheme in NPF 2. Therefore, the scheme generally complies with the terms of the policy.

Forth Replacement Crossing

DMRB Stage 2 Corridor Report

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