- Princes Street / South Charlotte Street
- Princes Street / The Mound / Hanover Street
- North St. David's Street / Queen Street / York Place / North St. Andrew's Street
- St. Andrew's Square North
- St. Andrew's Square South
- South St. David's Street / Princes Street / South St. Andrew's Street
- Picardy Place / Broughton Street / York Place / Leith Street / Leith Walk

*Leith Walk – Granton Section*

- Leith Walk / London Road / Elm Row
- Leith Walk / Duke Street / Great Junction Street / Constitution Street
- Constitution Street / Bernard Street / Baltic Street
- Newhaven Place / Pier Road / Lindsay Road
- Pier Place / Starbank Road / Craighall Road
- Trinity Crescent / Lower Granton Road
- West Harbour Road / West Granton Road

Further re-signalling and new signalling is proposed at other locations around the route, to promote road safety and the requirements of Her Majesty's Railway Inspectorate.

### 6.1.4 Route Alignment Parameters

The proposed route takes account of the following design parameters and constraints:

- Topography – based upon the updated OS 1:1250 mapping provided as at October 2003 and topographical survey work undertaken specifically for the scheme during Autumn 2003;
- Vehicle parameters – the ability of the proposed light rail vehicle to negotiate the alignment, based upon parameters given in Section 6.2; and
- Proposed new developments – the alignment takes account of proposed planned development and wherever possible is aligned to integrate with detailed planning proposals.

### 6.1.5 Route Description

The scheme is described, as follows, commencing in the City Centre and following an anti-clockwise direction around the loop:

*City centre*

The city centre is an essential component of the loop, as the largest trip generator for the scheme, the service it would provide to this section is most significant. It provides convenient, on street access to shops and businesses and integration with bus and rail (at Waverley station).

Within the city centre, two option alignments are considered: one via Princes Street and the other via Charlotte Square and George street.

For the Princes Street option the route passes from Shandwick Place through the World Heritage Site on Princes Street. Overall the introduction of the tram to Princes Street, including the committed mitigation, will have a negative townscape effect, primarily arising from the OLE (overhead line equipment) and the tram stop. The site, Edinburgh's principal street and a formally laid out part of the World Heritage site, has a very high public profile. Its designation and location would make it highly sensitive to change, although it can be argued that the degree of change wrought on the street in post-war developments is such that it is now only moderately sensitive. However, this section of the route will be afforded specific attention with respect to its townscape design.

The tram will run on-street from Rutland Place centrally onto and in a straight line along Princes Street, as far as South St David Street for eastbound trams and South St Andrew for westbound trams. A stop is proposed just east of the junction with Castle Street.

Between Lothian Road and South Charlotte Street the there are three lanes in either direction, occupying the entire current road width to accommodate vehicle flows in this busy junction.

The main part of Princes Street will have a layout broadly similar to the existing but with reduced road space. It will consist of a dual carriageway as at present but the centre strip will be increased to approximately 1.6m width. There will be one continuous lane of mixed tram and bus traffic and a discontinuous second lane in each direction. The discontinuous second lane accommodates bus stopping and limited amounts of bus running, allows for the tram stop, reduced length pedestrian crossings and increased pedestrian circulation space at key points, all as outlined below.

At the junction with South Charlotte Street the north footway is widened for a length of approximately 20 metres. At Castle Street both the north and south footways are widened over a length of approximately 100m including the Princes Street tram stop. At the mound the north side footway is widened over approximately 50m west and 20 m east of the junction and the south footway over approximately 100m east of the junction, including the current pedestrian pinch-point at the steps to the Royal Scottish Academy. At South St David Street the north side footway is widened over approximately 60m in front of Jenners and the Mount Royal Hotel.

Between Princes Street and Queen Street the tram will run on-street with single-track alignments. The northbound trams will run up South St David Street in a straight line along the edge of the square and down North St David Street, turning east on to Queen Street. Southbound trams will turn off York Place and follow the equivalent route on North and South St Andrew Street.

Stops are proposed on South St David and South St Andrew Streets, between St Andrew Square and Meuse Lane.

For the Charlotte Square and George Street option, the key features of the route, lie in three main areas: St Andrew Square, George Street and Charlotte Square.

In St. Andrew square a city bound tram (west bound) follows the line of the preferred alignment along York Place before turning onto North St Andrew Street. This section of the alignment would require the removal of parking/servicing, the cutting back of the steps on the south kerb line, the modification of the junctions at North St Andrew Street and Broughton Street along with the junction to accommodate the right turning traffic into the St James Centre car park and the Bus station. Once in the square the alignment runs on the east face before deviating from the preferred alignment to run along the south face of the square, where a stop would be located, and then runs onto George Street via the west face of the square. Within St Andrew Square there is a requirement to modify all the junctions to accommodate the tram along with a loss of parking on both the east and west faces. A tram leaving the city (east bound) would exit George Street and join the preferred alignment which runs north onto North St David Street then head east on Queen Street (kerb running on the north). This leg requires the modification of two signalised junctions and the removal of parking along Queen Street. With this option along both Queen Street and York Place there will be four dedicated traffic lanes.

On George Street, the alignment was developed to maintain a straight segregated alignment centrally on George Street adjacent to a single traffic lane kerbside in both directions. This option requires the removal of the on street parking and servicing from Hanover Street to Castle Street both kerbside and centrally although limited parking would remain kerbside from Hanover Street east and Castle Street west. The three main junctions along George Street all operate as roundabouts at present with incorporated zebra crossings, however, there would be a requirement to signalise these junctions and incorporate pedestrian crossings. It is anticipated that the level of priority at these junctions will be tram, pedestrian then road traffic. At present there is no designated cycleway along George Street although it is part of the National Cycle Network and under this option there would be no allocated cycleway along George Street.

The stop location is staggered either side of the Fredrick Street junction with central island platforms.

In Charlotte Square the alignment is the result of early consultations and is principally designed to minimise visual impact on the Square. The route runs from the end of George Street south round Charlotte Square onto the southern face where it is expected that the tram will run with the traffic. The alignment then turns south into Hope Street where it runs with traffic through to Rutland Place. The alignment then runs across Rutland Place to Shandwick Place then heads west to the West End Stop location. This option will have serious impacts on the traffic operations in the Square. There could also be a requirement to run general traffic around the northern face of Charlotte Square and reopen the northern end of Glenfinlas Street to general traffic, however, further work is required to develop the traffic operations and model the flows. There would not be a requirement to remove any of the on-street parking currently provided within Charlotte Square for this option, although the taxi rank currently at the southern end of Hope Street would require to be relocated further north.

North of St Andrew square, the northbound tram will run on-street single-track on Queen Street and both north and southbound trams will run twin-track along the centre of York Place.

In order to accommodate the heavy vehicular flows along York Place and Queen Street, two general traffic lanes are maintained in each direction. The result is a requirement to widen York Place slightly. It is recognised that this arrangement changes with the likely introduction of CETM which will alleviate this impact.

*Leith Walk to Constitution Street*

Whilst the extent of tram boarding along this section is relatively low for the loop, it forms an essential link for ridership between the City Centre and key locations and areas of new development in Leith and Newhaven.

The junctions at the top of Leith Walk will be entirely reorganised. The roundabouts at Picardy Place and London Road will both be replaced by T-junctions and a stop introduced in the reorganised junction at Picardy Place. The tram will then run the full length of Leith Walk along the centre of the road, with stops at MacDonald Road, Balfour Street and the Foot of the Walk. The tramline will be shared with bus throughout this length, offering a high degree of priority of movement through junctions to both tram and bus. Buses will leave the shared centre-running alignment to stop at a number of locations along Leith Walk approximately in line with existing bus stop provision (subject to limited rationalisation).

The tram lines will run on-street out of the centre of York Place into Picardy Place, swinging slightly south to allow two lanes of general traffic along Picardy Place on the line of the current access lane. Through the new junction and tram stop at Picardy Place there will be a short section of fully segregated running. Down Leith Walk the tracks will generally follow the alignment of the street, along the centre of the road, deviating occasionally to allow for right turn lanes.

Tram stops are proposed at Picardy Place, MacDonald Road, Balfour Street and the Foot of Leith Walk. All these stops are currently envisaged as island stops, located centrally between tram lanes, with Picardy Place linked to a large pedestrian traffic island. Stops located at Picardy Place and, more significantly, at the Foot of the Walk are also located to provide potential for integration with possible bus services.

*Constitution Street to Ocean Terminal & Chancelot Mill*

Moving north from Leith Walk, Line 1 will run on-street, sharing road space with all other traffic through Leith from the Foot of Leith Walk along Constitution Street to the dock gates at Constitution Place, with a staggered stop in the old town centre between Queen Charlotte and Bernard Streets. This would take the form of a north bound stop (Kerbside) immediately to the south of Maritime Lane and a south bound stop close to the south side of the junction with Bernard Street. Both stops would be designed to appear as well-detailed slightly raised areas of footpath. Apart from the area of the stop and minor junction alterations at Bernard Street, the alterations to the streetscape will be minimal.

Tram Line 1 will run through the Port of Leith from Constitution Street through an area of new development (by Cala Homes) off-street on the north side line of a realigned section Ocean Drive to a realigned newly signalised junction with Tower Place. A stop is proposed to the west of the junction between Constitution Street and Ocean Drive to serve this area including the new development. The tram road will continue west following the alignment of the existing, privately owned, section of Ocean Drive to Ocean Terminal. A stop at Ocean Terminal is proposed providing access for passengers within this area of extensive redevelopment (including the new Skyliner and Ocean Point Developments). From there the route will proceed along the dock road past the entrance to Chancelot Mill and then ramp up to join Lindsay Road at Anchorfield.

The tram depot will be located just inside the port area, on the east side of the route, immediately north of the dock gates on Constitution Street. There will be two stops, one at Ocean Terminal and one on Ocean Drive, between Constitution Street and Tower Place.

From Ocean Terminal to Lindsay Road the tram will run on-street for a short section (to avoid the sewage pumping station) then segregated parallel to the street. A new ramp structure, approximately on the line of the existing pedestrian ramp, will provide access from the dock road to Lindsay Road. This will cut the end off a lightly used piece of public open space but allows the opportunity to reinstate the area to a higher quality and provide better public access.

*Newhaven to Wardie Bay*

The tram will run from Newhaven to Granton along the waterfront – Lindsay Road, Pier Place, Starbank Road, Trinity Crescent and Lower Granton Road. Stops are proposed at Newhaven, adjacent Great Michael Square, and at the east end of Lower Granton Road.

From the top of the ramp at Anchorfield to the junction at Newhaven Place, the tram will run on-street in segregated on the north (dock) side of the road. Detailed alterations to the road alignment will be required along much of the length and new traffic islands will be introduced

From Newhaven Place to Trinity Road it will run on-street, entirely integrated with other traffic.

At Newhaven Place and at the junction between Craighall Road and Starbank Road, the junctions will be reorganised, within the existing road area, and signalised.

The junction at the foot of Trinity Road will be realigned, taking up some of the existing open space but providing a layout that is more visually logical as well as functional.

Starbank Road is particularly narrow with restricted pavement widths. Frontages access and informal parking will be impacted upon by the tram alignment and this in turn could have an impact on the operations of the timetable. A new 3 metre wide combined footway and cyclepath is proposed on the seaward side of the existing sea wall to mitigate this. However, environmental issues associated with the site's protected status and impacts on natural habitats will have to be carefully examined (see Section 7.2.1). This will be the subject of more detailed discussion with the Council Planners to promote a sympathetic solution.

Where the tram runs on-street, the track-bed will be finished in bitumen macadam with granite chips rolled in, to integrate it visually with the existing road.

Realignment of kerblines will be undertaken over much of this length. Some islands and tie-ins will be constructed with concrete kerbs where necessary to match the existing to ensure visual integration.

The route between Trinity Crescent towards Granton Square will be segregated, on street. The arrangement will be one of segregated running to the north of a revised alignment for Lower Granton Road. The revised arrangement offers better provision for parking by residents and improvement in noise and vibration levels caused by traffic, which currently runs close to residential properties. This alignment also addresses the issues associated with right turns and the aspects of loading points for buses. The tram road alignment to the north also provides the opportunity to use grass track and therefore improve the aspects of urban space being provided.

The alterations to the road between Anchorfield and Trinity Road will generally have an effect on the townscape of low magnitude. The alterations at the Trinity Road junction and along Lower Granton Road will have an effect of medium magnitude.

Stops, currently envisaged as a pair of kerbside stops opposite each other, are proposed at Newhaven, adjacent Great Michael Square, and at the east end of Lower Granton Road.

*Granton to Ferry Road*

The tram runs through the Granton Waterfront development area from Granton Square to the junction of West Granton Access and West Granton Road, at the northern edge of Pilton. The area is currently undergoing comprehensive redevelopment and the tram alignment through the area has been determined primarily through the development master-planning process. A stop is envisaged at Granton Square and two others at key locations within the new development.

From Granton Square to the junction with the main development spine road just west of the lighthouse on West Harbour road, the tram will run on a segregated alignment along the north side of the road. The stop envisaged at Granton Square has a potential positive effect on the townscape by reinforcing what is currently a rather neglected nodal point in the urban fabric.

Through much of the main development area, the tram will form part of a transport boulevard, with a short section of roadside segregated track along the northern extension of West Granton Access.

The design for this area will be developed in conjunction with the masterplanners and developers so that the tram forms an integral part of the development. In particular the materials used will reflect the design intentions of the masterplan.

The extent of redevelopment of the Granton Waterfront area is so extensive that its character is primarily one of change, so it is only slightly sensitive to further change. The introduction of the tram system has already been designed in the masterplan.

The tram route through Pilton is along a reserved corridor on the west verge of the newly constructed West Granton Access from West Granton Road to Ferry Road, with a stop envisaged approximately mid-way.

The construction of the tram will involve the loss of the broad grass verge to the new road and some areas of semi-decorative shrub planting, and the opening up of the temporary infill under part of the span of the bridge carrying West Pilton Place across the road.

To reduce the effect on what is currently a fairly bleak townscape it is envisaged that the track-bed will be infilled with grass and that, wherever the room is available, a hedge will be planted immediately in front of the existing and any new barrier fencing.

The stop is currently envisaged as an island stop, with the northbound track diverging into an additional area of land to the rear of 4 to 6 Pilton Place. The stop would take the form of an extended traffic island designed to appear as a well-detailed slightly raised area of pavement. Pedestrian access to West Pilton is envisaged to be via a new road as part of a new housing development.

*Ferry Road to Haymarket*

This section provides for residential areas through Craigleith and Roseburn and offers a connection for the rapidly expanding transport needs of the major development area in Granton to the major modal interchange at Haymarket and to the City Centre. Much of this section makes use of the former railway corridor, providing a rapid, segregated section of route, which has very little impact upon and from other modes of transport. Unsurprisingly, this section of the route offers the fastest journeys and consistently carries the highest passenger loading for the scheme, particularly during the a.m. peak.

The tram will follow the former railway solum from Ferry Road to the point where it meets the existing heavy rail just west of Haymarket. Stops are envisaged at Ferry Road, Telford Road, Craigleith and Ravelston Dykes.

Close to Crewe Toll there are two options: one option continues along the former railway alignment with stops located at Craigleith (just north of Queensferry Road), Crewe Toll (south of Ferry Road) and West Granton (north of West Granton Road).

The other option leaves the former rail corridor at the Craigleith stop and runs along South Groathill Avenue, Groathill Avenue and Telford Road. A stop is located at the Western General Hospital. The route leaves Telford Road just south of Crewe Toll where it swings west through the Fire Training Centre car park to rejoin the former railway at Ferry Road. From here it continues along the former railway to the West Granton stop.

Alterations will be required to all the smaller bridges that the tram runs over, including the bridge over the A8 at Roseburn. Works will be required to the Coltbridge viaduct. This will be the subject of more detailed design considerations and approval in order to promote a sympathetic solution within this conservation area.

At both ends of the corridor, the existing railway corridor is on embankment some five metres above the surrounding land. Significant regrading will be required to ramp the tram line up to and down from this level over a length of about 150 metres.

The former railway solum was converted to a cycleway and footpath in the 1980s and is now a well used and popular recreational resource. The embankment and cutting slopes have become very dense with many mature and semi-mature trees which are predominately self seeded, forming a lush enclosed landscape that is distinctly separate from the surrounding primarily residential areas. The area has been maintained against the background of the route being reserved as a public transport corridor.

The tram and the replacement cycleway and footpath will be constructed on the line of the old track-bed, with a fence and, where space is available, a hedge separating them. The tram will run on the east side of the track-bed and the cycle and foot path to the west, with formal crossings as required to allow public accesses to the east.

The combined width of the tram tracks and the cycleway and footpath will be approximately 11 metres, compared to the original railway of 8 metres and the current cycle-track of 3 metres. In parts of the existing cutting and embankments retaining structures will be required to allow for widening.

Where the railway corridor passes under narrow and low arched bridges, the track bed will be lowered to allow the tram tracks to be offset from the bridge centre-line and thus allow room for a narrow cycleway and footpath.

The safety clearances required for the OLE, combined with the increased width of track, mean that extensive tree clearance will be required, opening up the current enclosed nature of the railway corridor.

The cycleway and footpath will be surfaced in a fine grade black-top as existing, while the tram track, except at crossings, is envisaged as grasscrete or "grasstrack"

Stops are envisaged at Ferry Road, Telford Road, Craigleith and Ravelston Dykes.

The stops at Telford Road, Craigleith and Ravelston Dykes are entirely within the railway corridor and will be designed as well-detailed low platform height suburban railway halts, with the shelters, seating, signage and other equipment designed as an integrated whole. Level difference between these stops and the adjacent roads and footways will be dealt with by the incorporation of ramps and steps with commensurate lighting and security measures.

*Haymarket to Princes Street*

This section of the route offers the opportunity for major multi-modal interchange between Tram, rail, bus and taxi and represents a significant service demand for the tram.

The tram enters the Haymarket area parallel to the existing heavy railway to the south of Balbirnie Place, where a strip of existing screen planting will be replaced by twin tram tracks, opening up further an area where spaces are currently weakly defined by the built form. A possible substation site has been identified in an unobtrusive location at the rear of the yard to the warehouse at 15 Devon Place.

East of Balbirnie Place, the tram will turn north, away from the heavy rail, passing between the new office developments of Haymarket Yards and the rear of the warehouses on Devon Place and the rear of the offices and tenements of Haymarket Terrace and emerging onto the top section of Haymarket Yards alongside Rosebery House. The tram track will replace some areas of car parking and small areas of landscaping and larger areas of derelict land.

At the top of Haymarket Yards, the tram lines will turn east, at street level, onto a viaduct structure to be built up over the current station car park and run parallel to Haymarket Terrace, where a tram stop is proposed. They will then move onto to the street in a reverse curve at the end of Haymarket Terrace at the location of the current Caledonian Ale House, requiring the demolition of this B listed building. The line will cross the Haymarket junction following the curve of Haymarket Terrace into Clifton Terrace and continuing straight along West Maitland Street towards the West End.

To accommodate the tram running in a segregated lane, the junction at Haymarket will be reorganised. The junction design as frozen for the purposes of this assessment includes the widening of Morrison Street by 3 to 6 metres, flaring out between Morrison Link and Dalry Road.

The tram will run straight through the West End, on road from West Maitland Street to Shandwick Place, with a stop proposed between Coates and Atholl Crescents. This would take the form of an extended island designed as a well-detailed slightly raised area of pavement. To the west of the stop a crossover is proposed to offer turnback facility for east bound vehicles during closure for events in the City centre.

To accommodate the two lanes of traffic that have to pass the island stop in either direction (a tram lane and a general traffic lane) the footways along the front of the garden areas will have to be set back, giving the opportunity to redesigning the edges of the gardens along Shandwick Place.

The design as currently envisaged entails the reconstruction and making good of the edges of the gardens generally matching the existing design, but set back by up to 2m to accommodate the island stop. The trees would be replaced by semi-mature specimen trees of a minimum 30cm girth aligned to suit the revised design, which itself would respect the formality of alignment of the New Town. The area will be subject to further liaison and design consideration with the City planners in order to promote the best use of the space.

Traffic movements are proposed to be controlled by new traffic signals at the east end of Coates and Atholl Crescents. Subject to the detailed design alignment, a realignment of the kerbs may be required at Rutland Place.

## 6.2 Technology

### 6.2.1 Vehicle

*Introduction*

A range of vehicle types and systems were examined at feasibility stage (see Appendix C9). The selection of a tram system for the Edinburgh Loop was agreed in principle based upon the economics of the scheme, which showed that the level and type of passenger service required was more suited to this type of mass transit system. Trams also satisfied a number of other criteria including environmental aspects, speed, safety, reliability and quality. Such qualities are believed to have been found to provide a more attractive form of public transport than other forms (to the extent that they are able to attract passengers away from their cars), and providing accessibility for all members of the community including the Mobility Impaired. These aspects are clearly in line with the Objectives of the City of Edinburgh Council.

A variety of types and characteristics of tram vehicles are available as detailed below. The selection of a preferred vehicle has not been made, as yet, and vehicle parameters (established for the purposes of design) have been adopted such that the selection is not unduly restricted during the procurement stages of the scheme.

There are three main categories of LRVs/trams currently available which are based upon the height of the tram floor relative to the running surface: *High Floor, Partial Low Floor and Low Floor*. These descriptions also reflect the evolution of tram design, although none of these categories are obsolete and each has its own relative merits which are set out below. All three of these types can be further classified as single or articulated. The articulated vehicles can be single-, double-, triple- or multiple-articulated. Both single and articulated trams can be operated as single units or assembled into pairs or trains according to the required capacity and stop facilities.

*High floor trams*

High floor trams are mainly suited for use in segregated corridors, in sub-urban areas, on disused heavy rail lines or on lines used commonly by trains and trams, where high speed is required. They require high boarding platforms, typically 850-1000mm and therefore on lines not already equipped with high platforms the civils works required to accommodate these trams are usually more expensive than trams with lower floors.

The advantages of these vehicles come from their simple construction, high riding quality, speed (90-120km/h is attainable), easy equipment inspections, easy passenger accessibility and low purchasing costs.

If it is necessary to provide step wells for boarding the tram from low level tram stops this results in poor accessibility for mobility impaired travellers. These factors mean that high floor trams are not generally suited to the urban environment where high platforms cause physical obstacle and strong visual impact.

*Partial low floor trams*

These trams offer high and low floor sections with the principal aim of improving accessibility, especially for mobility impaired travellers. They are mainly suited for use in urban and sub-urban areas where high speed is also required. They provide a good riding quality and can attain speeds of up to 80-100 km/h. The low floor sections usually make up approximately 50-70% of the floor area and are generally at the doors. Internal access to high floor sections of the tram must be negotiated by steps.

*Continuous low floor trams*

These are the most modern of available trams and provide the most accessible passenger vehicles, facilitating kerb boarding for users of all levels of mobility and age. These trams are mainly suited for use in urban environments where low visual impact is required. These vehicles offer fewer limitations on operations and can be easily customised internally to accommodate special requirements, for example, cycles and wheel chairs. Some are capable of negotiating very tight curves (radii 18m). On straight segregated track they can operate at speeds of 70-80km/h.

The disadvantage of low floor trams is that the on-board auxiliary equipment must be accommodated on the body roof. At present they are more expensive than the partly low floor types.

*General LRV specification*

Currently no particular light rail vehicle (LRV) or tram has been chosen for use on the Edinburgh system. However, it is understood that **tie** is seeking to implement a high quality low floor system. The following, therefore, sets out to provide a guide on the range of vehicle characteristics currently available on the market and to define an outline vehicle specification to be adopted for design. It is the intention that within the specification the interior ergonomics are optimised.

Table 6.1 provides indicative performance parameters for a typical modern tram.

**Table 6.1 Indicative Tram Performance Parameters**

| Characteristic | Typical Street Running LRV | Comments |
|---|---|---|
| Overall length | 22m - 35m (up to 48m modular) | Envelope of vehicle lengths available |
| Vehicle width | 2.30m - 2.65m | Envelope of vehicle widths available |
| Vehicle height | 3.20m -3.40m | Envelope of vehicle heights available |
| Floor height (above top of rail) | 300mm - 350mm (low floor) up to 915 mm | Envelope of vehicle floor heights available |
| Track gauge | 1435mm | Standard track gauge |
| Doorway width | 1,200mm - 1,300mm | Envelope of vehicle Doorway widths available |
| Seating capacity (including tip ups) | 65 - 80 | Envelope of seating capacities available |
| Passenger capacity ($4/m^2$) normal load | 100 - 230 | Envelope of passenger capacities available (normal load) |
| Passenger capacity ($6/m^2$) max service load | 200 - 320 | Envelope of passenger capacities available (max service load) |
| Line voltage | 750V d.c. | Standard Line voltage |
| Maximum speed | 70km/h – 100km/h | Envelope of maximum speeds available |
| Absolute minimum horizontal radius | 18m | Absolute minimum horizontal radius available. |
| Usual minimum horizontal radius | 25m | Usual minimum horizontal radius available. |
| Minimum vertical radius | 400m - 500m | Envelope of minimum vertical radii available |
| Expandable vehicle (modular) | Yes | Most tram vehicles considered are expandable |
| Multiple unit operation | Yes | All tram vehicles considered are capable of multiple unit operation |
| Single-ended* or double-ended | Either type | For Edinburgh double-ended more practical, although single-ended possible. |
| Maximum gradient | 6% - 10% | Envelope of maximum gradients available |
| Maximum acceleration rate (crush load on straight & level track) | $1.00m/s^2$ - $1.30m/s^2$ | Envelope of maximum acceleration rates available |
| Maximum service braking rate | $1.00m/s^2$ - $1.30m/s^2$ | Envelope of maximum service braking rates available |
| Maximum emergency braking rate | $2.50m/s^2$ - $3.00m/s^2$ (note: HMRI requirement is $3.00m/s^2$) | Envelope of maximum emergency braking rates available |
| Design life (body structure) | 30 years | Design life of all vehicles |

| | | |
|---|---|---|
| | | considered |
| Braking systems | Mechanical, electrical, electro-magnetic (track) | Braking systems employed by the vehicles considered. |

Note: * Normal operation unidirectional, in emergency can be operated in reverse.

## 6.3 Tram Design Specification

### 6.3.1 Characteristics of Tram Systems

*Vehicle characteristics*

A number of tram vehicles have been considered in compiling the following assumptions, including the Ansaldo Transporti, Firema T68, the Alstom Citadis tram and the Adtranz Incentro tram vehicle. A further review of other possible tram vehicle types has been undertaken in summary to confirm the validity of the following assumptions.

It has been assumed that geometric design will comply fully with the requirements of Railway Safety Principles and Guidance 1996 published by HMSO.

It is assumed for the purposes of STAG 2 alignment development that the trams will be semi-low floor or total low floor vehicles. This implies a floor height of between 300 and 400mm. This type of vehicle has been adopted in order to ensure that the alignment characteristics will cater for *most* currently available rolling stock. It should be noted however, that as trams are frequently variations on a basic vehicle derivative, no guarantee could be given in relation to the ability to accommodate any particular vehicle in the future.

The key characteristics of a typical street running light rail vehicle are illustrated in Table 6.2.

**Table 6.2 Characteristics of a Typical Street Running Light Rail Vehicle**

| Indicator | Characteristic |
|---|---|
| Overall length | 40m inclusive |
| Vehicle width | 2.65m |
| Vehicle height, excluding pantograph | 3.365m (from top of rail to roof) |
| Floor height (above top of rail) | 350mm |
| Track gauge | 1435mm |
| Doorway width | 1200 - 1300 mm |
| Seating capacity (including tip ups) | 65 – 80 |
| Passenger capacity (4/m²) normal load | 100 – 230 |
| Passenger capacity (6/m²) max service load | 200 – 320 |
| Line voltage | 750V d.c. |
| Maximum operating speed | 80km/h |
| Maximum design speed | 85km/h |
| Absolute minimum horizontal radius | 25m |
| Desirable minimum horizontal radius | 30m |
| Minimum vertical radius (sag or hog) | 500m |

| | |
|---|---|
| Desirable vertical radius (sag or hog) | 1000m |
| Expandable vehicle (modular) | Yes |
| Multiple unit operation | Only in case of breakdown and emergency (see note) |
| Bi-directional | Yes |
| Maximum gradient | 6.5% |
| Maximum acceleration rate (crush load on straight & level track) | 1.00m/s² - 1.30m/s² |
| Maximum service braking rate | 1.10m/s² - 1.30m/s² |
| Minimum emergency braking rate | 3.0m/s² |
| Operational acceleration and braking rate | 0.9m/s² (for use in run time and operational assessments) |
| Design life (body structure) | 30 years |

**Note:** It is presently assumed that vehicles will not require to be coupled together during normal operation. This assumes that single units will be capable of providing the required capacity to meet patronage demands during the design life of the system. Early confirmation of the likely patronage demand and hence this assumption is required.

*Traction system specifications*

Approximately 97% of the 400, or so, tram systems operating currently throughout the world are powered by electricity supplied via overhead wires. The environmental impact of such wires within the Edinburgh streetscape is significant, particularly within the New Town, World Heritage Site. Whilst the use of overhead wires (OLE) is proposed, for Edinburgh for a number of reasons (not least the proven technology of OLE) a review of alternative traction systems has been undertaken and will merit further review prior to implementation (see Appendix C10).

### 6.3.2 Tram Infrastructure

*Rails, trackslab and surfacing*

The nature of tramline surfacing (track, swept path, affected roads and footpaths) is dependent upon its environment. On street, trackslab construction (reinforced concrete) must provide strength to support the traffic / tram loads (including risk of voids beneath) together with appropriate stray current protection. Steel rails are fixed within the trackslab using a no-shrink medium. The trackslab may also be designed for specific circumstances to mitigate ground borne vibrations and noise. Off-street the rails may be fixed within trackslab, "grasstrack" (usually a crasscrete type slab or unit construction) or traditional ballast and sleeper type arrangement. Current details for line 1 do not include ballast type track due the impact of its appearance and the risk of misuse of ballast material by members of the public.

Outwith the street environment unpaved surfacing can be provided such as ballast or grass track. The extent of ballast that is proposed for Line 1 is currently confined to the depot. Within the streets hard surfacing is proposed. This section focuses on this type of surfacing.

The extent of surfacing works will address:

- Typically the tramline width will be a minimum of around 3.5m per lane within street-running sections;
- Increased lane width and centre line separation will be required on bends;
- Increased centre line to accommodate centre poles;

- The full width of the carriageway should be resurfaced were the tram construction and ancillary works (including service diversions) disturbs the existing;
- Surface finishes to reflect the location and design manual within the swept path, opportunities outside the swept path to provide betterment and/or upgrade finishes to existing to be considered;
- Carriageway and footpath width provision should include for the necessary street furniture including signage & signalling, poles, barriers, etc;
- Where no existing pavement offers space or access for specific maintenance purposes, additional surfaced pavement may be required; and
- Footpaths will generally not be less than 2.0m wide.

*Cycleways*

Where possible, cycleways and cycle lanes will be provided as segregated routes for cyclists, with the aim of reducing perceived and actual danger from other road users, thus improving the user experience and encouraging their use. Their provision has been an important factor in the design of the Edinburgh Trams route and it is necessary that the layout features and finishes of the pavements and roads along the route should also, whenever possible, take into account use by cyclists.

*Parking bays*

Parking bays will be provided, where possible, as described in the 1:500 scale drawings (to be included in the Figures Supplement) along the Edinburgh Trams route for the purposes of loading, residential parking, drop off points, taxi ranks and bus stops, when appropriate.

*Trackside equipment*

The provision of trackside equipment, required for the safe and effective operation and maintenance of the tram scheme, will be designed to achieve the appropriate balance between operational use and impact on the setting.

Trackside equipment may be divided into various categories:

- Power supply sub-stations, overhead line equipment, trackside isolators and return circuits for OLE;
- Stop equipment rooms;
- Communications and signalling, including telephones and emergency call buttons;
- Track controls;
- Signage;
- Lighting;
- Fare collection mechanisms;
- Closed circuit television systems (security) and PA;
- Shelters and seating;
- Cycle facilities; and
- Rubbish collection/disposal (cleansing).

*Substations*

A number of new substations will be built along the route to accommodate the infrastructure's power supply.

Sub-station sites will be spaced along the route as dictated by the needs to supply power to the system. Nine sub-stations will be required along the route at approximately 2km spacing. In addition, a switch-room is required to be located in the vicinity of each sub-station. Each proposed sub-station location has been identified on the 1:500 drawings for Line 1 (to be included in the Figures Supplement).

The size of the sub-station has been estimated, at this stage, from first principles by Mott MacDonald based on experience of other system requirements. Power simulation and liaison with the local electricity supply company will be required to develop the proposals further.

*Stop equipment rooms*

Each stop will be provided with a Stop Equipment Room (SER), this can be in the form of a cabinet or multiple of and this will house the majority of the control equipment such as communication and signalling equipment. Where possible this could also be co-located with a sub-station. A number of options, particularly in the city centre, are possible.

Typically these equipment rooms are smaller building units, similar to substations, approximately 3x3m in plan area. The alternative to these buildings is to have the control boxes situated within the vicinity of the stop, but in the open. Such control boxes are generally metal units with a 1-2m frontage, up to 1m depth and 1.5m high.

*Communications and signalling*

Small control cabinets will be required close to all signals (including telephones and emergency call buttons) for power supply controls. SERs will house all other control equipment. The tramline will be signalled using road type signals. The road signals will interface with the urban traffic controls and will require small pillars or cabinets to house the vehicle recognition system.

A PA system will be provided at each stop and will be controlled from the Operations Centre.

All communication equipment will be sited on the platforms or where the tram crosses roads in the usual position to warn tram and other vehicles of the right of way at a given junction.

*Track controls*

A small power supply pillar will normally be sited close to these to isolate the supply should it be required. An emergency point lever is also sited near to the points and is housed in a locked pole.

Points and turnouts will be electrically activated either from track circuits, vehicle recognition system or transponders relaying from the control centre. A small power supply pillar will normally be sited close to these to isolate the supply should it be required. An emergency point lever is also sited near to the points and is housed in a locked pole, this could be combined with the isolator or even supplied to each vehicle.

Where points (switches) are provided, at the delta junction or for turnbacks along the route, point controls can generally be housed in the stop equipment room, if a SER is not sited near a switch a small housing will be required, this can also contain the emergency point handle. The point motor is to be located in a pit within the road.

*Signage*

Typical signage at a stop will be stop name boards (perhaps illuminated, usually two per platform), direction signs and local map information, real time information boards, destination signs, timetable, disabled boarding point sign, braille information panel and Edinburgh Tram Logo.

*Lighting*

Typically, lighting at the stop should differentiate it from the local street scene and provide adequate levels of illumination for safety.

*Fare collection equipment*

It is currently the policy of **tie** and CEC to use conductors for fare collection in addition to two ticket vending machines at all stops. The level of redundancy will be subject to review.

Equipment at or near stops and at all road crossings will be needed to facilitate traffic controls, this will include poles and signs, a small supply pillar or control box which will enable the supply to be isolated.

*Closed circuit television systems (security) and PA*

Closed circuit television cameras are normally mounted on poles for this purpose only, strong enough to resist vibrations etc. A public address system and emergency call buttons can be attached to other poles such as street lighting columns.

The cameras will have a point, tilt and zoom facility and will be interface to the emergency call button, such that camera will turn to the location of the call button. All controls will be contained within the stop equipment room.

A public address system and emergency call buttons can be attached to other poles such as street lighting columns.

*Shelters and seating*

The type and style of shelters and seating will be determined from the design guide. Their location may vary from stop to stop.

*Cycle facilities*

Demand for cycle provision on trams depends on the terrain, access to adjacent attractive cycling areas and the general numbers of cyclists in the area. In Edinburgh much of the route of Tramline One follows or integrates with existing cycle routes, for example the former railway corridor between Haymarket and Granton. The cycle routes appear popular and suggest that a large local cycling population may exist. Consequently, allowing cyclists to use Tramline 1 will provide added value to the existing cycle facilities. Moreover, access from the Line One loop into the suburbs by cycle could increase patronage.

There are a variety of reasons why cyclist provision on trams will attract patronage. Provision for cyclists on trams is useful for longer routes or where the terrain is difficult, offering the possibility of breaking the journey, providing alternatives to other modes of travel. Many cyclists travelling on more secluded lines outside normal hours, also prefer to cycle at either end of their trip to offer them added security.

Much of the demand to integrate the tram with cyclists may be satisfied in alternative ways. The provision of secure cycle storage at tram stops would accommodate travellers who only require to cycle at one end of their journey and would remove the need to take bicycles on the tram. Similarly, provision of cycle hire facilities at selected tram stops (most probably major transport interchanges such as Waverley or Haymarket) also increases the systems flexibility; such schemes are common in European cities and are particularly attractive option for tourists wishing to use public transport but explore areas beyond the network.

Cycle facilities - Vehicles

In terms of the statutory position on this issue, it is our understanding that HMRI have no objection to the inclusion of cycles on trams but consider the decision to be one for the operator. It remains the responsibility of the operator to demonstrate to the Inspectorate that the cycle facilities can be implemented safely.

Allowing bicycles on trams may cause inconvenience to other passengers. Cycles can block accesses and be wet, dirty and oily. Loading cycles onto the tram has the potential to increase dwell times at stops and therefore overall journey times. This will be dependent upon actual numbers of bicycles on individual trams and in particular the number during peak periods. However, experience from other European systems suggests that actual numbers may not be large and careful design can accommodate cycles safely and efficiently.

Provision for cyclists on trams also restricts the type of tram that can be sensibly used. Ideally, cyclists require level access into trams with wide gangways and vestibules. It should be noted that level access does not mean the sole use of a low floor vehicle. DDA requirements ensure that both high and low floor varieties will in the future have boarding points suitable for the mobility impaired (which would include cyclist if they are specifically permitted to utilise the system). In many ways, partial low floor vehicles are likely to be more restrictive on cycle provision inside the vehicle as the interior layout is often restricted by the changing floor level. The width of the tram is likely to be towards the wider range of vehicles (i.e. 2650mm) to allow sufficient movement of the cycle within the vehicle. Trams typically have more doors and designated areas adjacent to them for e.g. a common low floor section for pushchairs and wheelchairs including tip up seats to give more spatial flexibility. It is these areas which would be expanded and designed to accommodate cycles, preferably with a means of securing the bicycles so as to reduce the conflict with other users.

It is of course beneficial to ensure that the tram design has sufficient flexibility to allow future conversion to accommodate bicycles, if their provision is not specifically included during initial procurement.

Where systems employ conductors there would be a clear advantage in the ways which cycles could be managed. Regulations or Bye-Laws permitting cycle use must be clear, covering for example, permitted times of use, fares, placing and securing of cycles, the hierarchy of user priorities and where cyclists must give way to the mobility impaired (i.e. disabled and families) . The penalties for misuse of the system must also be clear and enforceable.

One frequently raised concern regards the impact cycle inclusion has on safety during emergency stops since modern trams have powerful braking systems. The solution will be in the interior design of the vehicles, with the use of specified cycle bays next to entrances with provision for restraint. Alternatively, cycles could be restricted to certain sections of the vehicle and cyclists required staying with their bicycle for the journey to ensure they remain secure. As outlined above, the cycle proposals will require the approval of the HMRI.

Cycle facilities - Platforms

There are a number of design issues relating to platforms as well as the trams themselves. Cyclists have the potential to cause nuisance on platforms and around stops. The design should discourage riding of bikes onto or through the facilities. Again, this requires clear guidance, markings, signs and penalties for misuse. Where vehicles will restrict access to particular tram doors, this will need to be indicated in a similar manner to disabled access.

Cycle facilities - Control of Demand

Various tools can be used to either help control the demand or to manage cycle accommodation. The hours of use can be restricted to off peak hours, or routes can be restricted to counter the direction of peak flow of passenger traffic. Allowing bicycles on the tram is also a means of generating additional revenue during off-peak hours. The payment method and its level can be used to control the numbers of cycles on the tram. For example, some systems require cyclists to purchase travel permits in advance of using the tram. This indicates to the operator the likely demand allowing him to plan and manage operations. Monitoring the numbers of cycles, time of use, compliance with regulations, relative numbers of cyclists to wheelchairs, prams and pushchairs provides particularly useful information regarding the necessity and development of control procedures.

*Rubbish collection/disposal (cleansing)*

Refuse collection at stops will be determined from the design guidance. A number of these will be placed on or near a platform.

Signage at the platform will be fairly standard, if real time information systems are to be used; the control for this will again be in the SER.

*Overhead Line Equipment (OLE)*

It is a major objective of the design guide to minimise the number of poles/columns used. In urban areas OLE can be supported from fixings attached to existing structures, removing the need for new support poles. Where this is not possible or desirable, then combined OLE and street lighting should be considered.

Supply will be taken from the sub-stations in underground ducts to the OLE system when it will be fed through the poles via isolators at 750v dc to the feed cable. Return currents via the wheels and track is then fed back via a collection mat to the sub-station. All equipment is insulated and earthed to prevent touch potential building up. A stray current mat may be required below the rails for monitoring or capturing stray currents, these are located below the running rails.

All parallel feeder cables and control cables will route through underground ducts parallel to the running lines. The ducts will have draw pits at regular intervals.

*Poles*

Consideration will be given to the use of lighting column reflecting the local environment to support OLE. It should be noted that the form and appearance of the combined lighting and OLE pole should cater for the additional loading applied by the OLE. Where dedicated OLE poles are used then the OLE pole should be of the same design as the adapted lighting column. These issues will be reflected in the design manual for the streetscape, as with the requirement for centre supports for the OLE, which may necessitate separate lighting columns depending on the road layout.

*Building fixings*

Wherever possible the overhead line will be registered from building pull off fixings to minimise the visual impact on the cityscape. In residential and areas in the city centre where building fixings are not feasible or desirable combined OLE and lighting poles are the preferred solution.

### 6.3.3 Depot

The proposed depot site is at Leith. The location and layout is described on drawing 203011/EDIN/0556.

The facilities which would be required to service a fleet size of 14 LRVs are likely to include the following:

- Maintenance shed (90m × 30m single storey portal frame building c/w overhead travelling crane);
- Integral floor access pits & inspection platforms;

- Integral control & communication centre;
- Wheel lathe;
- Automated vehicle washing facility;
- Other associated M & E equipment (including substation);
- Stabling trackwork & inspection platforms (for 14no. LRVs, preferably more for expansion);
- Materials storage & laydown area (vehicle delivery & removal needs careful consideration); and
- Road access & parking.

## 6.4 Construction

The construction of Line 1 is programmed to commence in mid 2006 with an estimated construction period (excluding Optimism Bias) of 36 months.

One of the early activities required for construction is the diversion of Public Utilities from beneath the tramline. This has, historically been undertaken, either as an advanced works contract or as part of the main works contract. Generally the inclusion of this phase within the main contract provides a reduction in programme due to the ability to coordinate efficiently within the main contract. However, the disadvantages of this approach may impact, particularly on the main contract in the form of increased programme risk and further consideration should be given to the implementation of "long lead" or high risk Utility diversions (pertaining, in particular to key "golden assets") as part of an advanced works contract. The 36-month construction period is based upon the utilities diversions being undertaken entirely as part of the main contract.

The construction of Line 1 will potentially impact upon the environment and steps are required to mitigate the impact of works.

A number of possible works sites have been identified and will be included in the Draft Bill application for powers to temporarily use the site for construction purposes. These sites are addressed within the Environmental section.

Bearing the above in mind, the general sequence of track construction following diversion of the services within each area will be as follows:

1. Site clearance.
2. Demolition if required.
3. Removal of hard landscaping, etc if required.
4. General excavation.
5. Installation of drainage, ducts and stray current protection beneath track formation.
6. Lay granular capping material if required.
7. Lay sub base/blinding.
8. Fix reinforcement.

9. Lay first stage concrete.
10. Install rails and complete stray current protection.
11. Complete drainage/ducting above first stage concrete.
12. Lay second stage concrete around rails.
13. Construct Stops where required.
14. Install main cabling.
15. Complete highway/accommodation works and final surfacing where possible.
16. Install OLE supports.
17. Complete final surfacing.
18. Install OLE wiring and complete cabling.
19. Energise and commission.

Further details of construction aspects are contained in Appendix C11.

## 6.5 Capital Cost

### 6.5.1 Construction

Capital cost estimates for Line 1 have been compiled from criteria generated by the project team appointed to undertake the Technical, Operational and Environmental Commission and, in particular, the following documentation:

- Route Corridor Plans prepared by Mott MacDonald with supplementary annotations by Babtie and Gillespies;
- Utilities Diversionary Works estimates sourced by Babtie;
- Townscape design/treatment category schedules prepared by Gillespies; and
- Structures Reports and Proposal Sketches prepared by Mott MacDonald.

The costings are presented in Table 6.3, set at a base point of Quarter2 2003. Costs have been derived from a comprehensive database compiled from analyses of costs for the infrastructure works of completed and proposed LRT schemes throughout the UK, currently advised prices from vehicle manufacturers and preliminary diversionary works estimates obtained from utilities companies. The resulting estimates take account of the prevailing factors influencing this particular scheme including location, relative complexity, environment and anticipated programme. Optimism Bias, at a rate of 31%, is also included. This rate has been generated through applying the guidance notes on Optimism Bias.

**Table 6.3 Interim Capital Cost Estimate Summary**

| Element | Sub-Element | Estimated Costs (£) | Element Cost (£) |
|---|---|---|---|
| Civils | Clearance | 1,705,000 | |
| | Bulk Earthworks | 2,525,000 | |
| | Structures | 4,415,000 | |
| | AHW/Acc.Works | 20,690,000 | |
| | Prelims (Prop.) | 5,870,000 | |
| | Design (Prop.) | 2,113,000 | 37,318,000 |
| Electrical | Power Supply | 7,592,000 | |
| | OLE | 6,523,000 | |
| | Sigs & Comms | 10,628,000 | |
| | Prelims (Prop.) | 4,950,000 | |
| | Design (Prop.) | 1,782,000 | 31,475,000 |
| Stops | Platforms & Equip. | 6,203,000 | |
| | Prelims (Prop.) | 1,240,000 | |
| | Design (Prop.) | 446,000 | 7,889,000 |
| Depot | OM&C Facility | 10,255,000 | |
| | Prelims (Prop.) | 2,055,000 | |
| | Design (Prop.) | 740,000 | 13,050,000 |
| Track | Trackwork, formation, drainage, ducting | 33,220,000 | |
| | Prelims (Prop.) | 6,645,000 | |
| | Design (Prop.) | 2,393,000 | 42,258,000 |
| Land Purchases | Land/Property acquisition & compensations | 23,330,000 | 23,330,000 |
| Other: | | | |
| Utilities Diversions | Diversionary Works | 30,000,000 | |
| | Design & Co-ordination | 1,800,000 | 31,800,000 |
| Vehicles | Purchase (14 no units) | 21,700,000 | 21,700,000 |
| Project Costs | Promoters & consultants, Pre-Ops, insurances | 10,500,000 | 10,500,000 |
| **Sub-total** | | | **219,320,000** |
| Optimism Bias | 31% | 67,989,000 | 67,989,000 |
| **Total** | | | **287,309,000** |

All estimated costs exclude VAT and relate to gross capital expenditure prior to commencement of operation of the system with no offset allowances in respect of revenue, contributions or concession values.

The coverage of the capital cost estimates for the various elements of the scheme can be briefly summarised as follows:

- ***Clearance*** – Removal of all obstructions, above natural ground level, necessary for construction of the permanent works excluding demolition of existing buildings and structures;
- ***Bulk Earthworks*** – Major reprofiling works, essentially through the former Haymarket to Granton railway corridor, including allowance for disposal of contaminated material;

- ***Structures*** – Construction of new and modifications to existing structures including associated earthworks and temporary works;
- ***Associated Highway and Accommodation Works*** – All modifications to the existing highways, drainage and streetscape, adjacent to the swept path including urban traffic control soft landscaping and any accommodation works required to 3rd party properties necessary as a result of the introduction of the tram infrastructure;
- ***Power Supply*** – Construction of buildings and installation of plant and equipment for substations; incoming 11kv supply; power distribution cabling; traction SCADA system; stray current control; electro-magnetic immunisation;
- ***OLE*** – Installation of support poles, building mountings, catenary wires and contact wires;
- ***Signalling and Communications*** – Installation of tram signals, automatic vehicle detection and recognition system and all communications, monitoring and security systems;
- ***Stops*** – Construction of platforms and access ramps; installation of platform furniture and equipment; platform surface water drainage; LV power supplies; ticket vending machines;
- ***Trackwork*** – Laying of encapsulated rails on reinforced concrete trackslab, sub-bases and capping layers; installation of points sets at turnouts and crossovers; nominal excavation to formation and disposal; track drainage; bonding of mash reinforcement as stray current mat; trackside ducting; layover facility; swept path infill finishes and delineator kerbs;
- ***Depot*** – Construction of a self-contained, fully equipped facility for the tram system operation and control together with full maintenance and stabling capability for Line 1;
- ***Contractor's Preliminaries*** – All obligations contributing to the construction contractor's on-costs and comprising: site accommodation and establishment; supervision and general contract management staff; traffic management and safety measures; temporary works; insurances; other incidental items not included in elemental costings;
- ***Design and Co-ordination*** – Contractor's design costs for the system infrastructure works; co-ordination of utilities diversionary works and 3rd party accommodation works; liaison with 3rd parties and local authorities;
- ***Land & Property*** – Acquisition costs for all land and property required to accommodate the proposed route alignment together with associated compensation costs;
- ***Utilities Diversions*** – Diversions and/or protection of utilities companies' apparatus necessary to avoid any disruption to the tram services by future repair and maintenance works;
- ***Vehicles*** – Procurement of a fleet of 14 nr nominal 40m, bi-directional, low floor trams with on-board passenger information system, CCTV and driver communication facility; and
- ***Project Costs*** – Project implementation comprising: promoter's internal costs and external advisors' fees; pre-operational costs incurred during the commissioning phase; promoter controlled insurances.

### 6.5.2 Life Cycle

Life-cycle costings have been estimated essentially from the capital cost data. The estimated costs relate to replacements and renewals necessary over a 30-year operational period and exclude running costs and routine maintenance costs. The areas covered are:

- Track and highway;
- Stops;
- Power supply;
- Signals and telecommunications;
- Passenger communications;
- Ticketing;
- Vehicles;
- Depot; and
- Other buildings.

The total cost for these is estimated at £44,624,636.

## 6.6 Operations

This section covers the operational aspects of the system as they affect the feasibility and appraisal of the scheme. The issues covered here are:

- Run times;
- Operating patterns;
- Service planning; and
- Operating and maintenance costs.

A more detailed discussion (including further aspects such as: provision of turnback facilities, revenue system, depot) appears in Appendix C.

### 6.6.1 Run Times

The single overarching objective from the operational viewpoint is to minimise journey times, so as to maximise the attractiveness of the service and minimise operating costs and rolling stock resources. This requires attention to:

- Vehicle performance;
- Maximum running speed between stops;
- Stop dwell times; and
- Traffic signal delays.

Vehicle performance is not generally a major issue as the limiting factor on acceleration and braking is normally passenger comfort. Running speed between stops is important but provided the tram can operate free of obstruction by other traffic, the actual speed limit is not critical when there are frequent stops. In general tram speeds are governed by the speed limit on the adjacent highway, although a higher limit may be possible where the route is fully segregated. The key is to achieve free flow wherever possible so that the running speed is the maximum safe speed for any particular type of environment.

The system requirements for an effective scheme can therefore be defined as follows:

- Segregation from traffic wherever possible – and certainly wherever congestion is likely;
- Maximum priority at junctions;
- Efficient boarding and alighting arrangements (for all people including those with mobility impairments); and
- A high standard horizontal alignment to minimise local speed restrictions and lateral acceleration – hence short radius curves should be used sparingly.

To these can be added further elements required to maximise the attractiveness of the system to passengers, including:

- High quality vehicles and traction control systems to minimise jerk rates;
- Frequent and regular 'turn up and go' service at all times; and
- Good quality pedestrian access to stops.

Estimates of run times for Line 1 have been prepared using the Steer Davies Gleave run time model, which is described in Appendix C. This calculates times from the following key inputs:

- Vehicle performance – acceleration and deceleration rates;
- Link characteristics – distances, curvature, maximum speed; and
- Delay characteristics – stop dwell times, junction delays.

The model forecasts a total time of **40.5 minutes** around the loop, excluding any layover time allowance, equivalent to an average journey speed of 23.3 km/h. The times between individual stops are also shown in Appendix C.

### 6.6.2 Operating Patterns

The configuration of Line 1 as a continuous loop poses special issues for service planning and operations because there are no 'natural' termini. Determining the service pattern is therefore more complex than with a simple end-to-end route. The appraisal has been based on continuous loop running in both directions with a layover at a single 'terminus' en route. Under this option there would be self-contained clockwise and anticlockwise services, and each tram would pause for a short time at the layover point before continuing in the same direction. It has been assumed that the full service frequency is provided throughout the loop, i.e. there are no short workings.

Some layover time is normally provided in any tram or other public transport service to allow for drivers changing ends (if reversing), resetting of controls and destination displays, entering trip data, recovery from minor delays etc. For a loop service with a journey time of around 40 minutes, a layover of 4-5 minutes per circuit is an appropriate assumption. This figure is similar to those found on other LRT systems with a mixture of segregated and on-street operation. In practice the total cycle time (the sum of the loop run time and the layover) must be a multiple of the headway. The layover time is therefore also influenced by the actual values of the run time and headway, and is therefore generally adjusted to 'take up the slack' when planning the timetable. This may limit flexibility, especially at times when wider headways are being operated.

Facilities for turning back trams at intermediate points are also required, to provide for scheduled short workings, to allow services to be maintained over part of the route during disruption affecting a local area (planned or otherwise) and to allow a failed vehicle to be returned to the depot by the shortest practical route. Typically, these facilities will consist of a simple (normally trailing[16]) crossover, operated from the control centre, which is sufficient for occasional use during disruption.

### 6.6.3 Service Planning

The maximum passenger flows from the preliminary demand forecasts have been summarised in Table 6.4, which sets out the maximum hourly flows on the western and eastern sectors (sides) of the loop for the Feasibility Study Route (Option 1).

Table 6.4 also shows line capacity figures, based on a service of 8 trams per hour (i.e. a headway of 7½ minutes). The design of the vehicle has not been finalised at this stage but is likely to be about 32-40m in length[17], with a vehicle capacity of about 80 passengers seated and up to 230 passengers in total (based on standing at 4 per m$^2$) [18]. These passenger capacities would give a line capacity of 1,840 total places per hour (pph) in each direction, of which 640 would be seated places.

**Table 6.4 Passenger Flows - Maximum by Sector**

| Forecast Year | Time Period | Western Sector (City Centre to Lower Granton Road via Crewe Toll) — All figures passengers per hour | | Eastern Sector (City Centre to Lower Granton Road via Leith Walk) | |
|---|---|---|---|---|---|
| | | Clockwise | Anticlockwise | Clockwise | Anticlockwise |
| 2011 | AM Peak | 844 | 1,408 | 911 | 481 |
| | Interpeak | 367 | 488 | 497 | 295 |
| | PM Peak | 1,252 | 745 | 952 | 639 |
| 2026 | AM Peak | 1,125 | **2,416** | 1,623 | 756 |
| | Interpeak | 505 | **662** | 584 | 350 |
| | PM Peak | 1,636 | 1,102 | **1,973** | 872 |
| Line capacity (total) | | 1,840 each direction (at 4 standing passengers per m$^2$) | | | |
| Line capacity (seated) | | 640 each direction | | | |

In peak periods, figures shown in **bold** are in excess of <u>total</u> capacity (at 4 standing per m$^2$)
In the interpeak period, figures shown in **bold** are in excess of <u>seated</u> capacity

These figures show that in the **peak** hours, the flows in the year 2011 on both the eastern and western sides of the loop are well within the total capacity of 1,840 pph. In 2026, however, flows exceed this capacity in two cases. First, on the eastern sector the evening peak clockwise flow of 1,973 pph

[16] A trailing crossover is one arranged so that vehicles have to reverse to cross to the other track – i.e. in normal operation they pass through the turnouts in the trailing direction.
[17] Preliminary track layout design has, however, made allowances for vehicles up to 40m in length.
[18] See section 6.3.

exceeds capacity by about 7%. This would mean that the standing density would be slightly more than 4 per $m^2$, but by only a small amount. Secondly, the morning peak flow on the western sector, at 2,416 pph, would be in excess of the 1,840 figure by more than 30% and would be equivalent to a standing density approaching 6 per $m^2$. This would be undesirable on the grounds of both passenger comfort and stop dwell times and would therefore require mitigation. Ideally, the service would be increased to about 10 trams per hour, which would bring the standing density back close to 4 per square metre. This could be accomplished by 'fine-tuning' the timetable to provide a higher frequency over the affected section only, thus minimising the additional resources, though sufficient capacity to meet the clockwise demand on the eastern sector would need to be maintained. It is possible that this could be achieved without any additional vehicles in the fleet, by a mixture of short workings and a slight reduction in the service in the clockwise direction.

In the **interpeak,** flows are within the seated capacity of a service of 8 trams per hour, with one minor exception. Thus, a seat would be available to any passengers who wanted one, bearing in mind that a proportion of passengers choose to stand even when seats are available. Whilst it would be operationally possible to reduce the service level in the inter-peak and thus increase load factors, this would result in some passengers being required to stand. Furthermore, sensitivity tests show that this would not reduce operating costs by a significant amount compared with the proposed flat frequency profile across the day. The 'flat' profile would be consistent with existing UK systems, which in most cases operate at the same frequency all day (the main exception being Manchester which operates at a slightly higher frequency in the AM peak only).

Outside the main weekday time periods (peak and inter-peak), lower frequencies will be required to meet the expected lower levels of demand. As an initial assumption for service planning and appraisal purposes, the profile shown in Table 6.5 is proposed. To a large extent these frequencies will be flexible in response to actual demand during different time periods, so that (for example) on Fridays and Saturdays the evening service could be increased in frequency and last trams scheduled later. Although there would be some effect on the maintenance regime, the net effect on the appraisal case of variations in service level and demand/revenue at off-peak times would be marginal.

**Table 6.5 Service Operating Periods and Frequency Profile**

| Day | Period | From | To | Frequency (trams per hour) |
|---|---|---|---|---|
| Monday-Friday | early morning | 05:00 | - 07:00 | 4 |
| | AM peak | 07:00 | - 09:30 | 8 |
| | Inter-peak | 09:30 | - 16:30 | 8 |
| | PM peak | 16:30 | - 19:00 | 8 |
| | evening | 19:00 | - 24:00 | 4 |
| Saturday | early | 05:00 | - 09:00 | 4 |
| | shopping hours | 09:00 | - 18:00 | 8 |
| | evening | 18:00 | - 24:00 | 4 |
| Sunday | early | 08:00 | - 10:00 | 4 |
| | daytime | 10:00 | - 18:00 | 4 |
| | evening | 18:00 | - 24:00 | 4 |

### 6.6.4 Operating and Maintenance Costs

*Staffing*

It is assumed that the system is operated by a company set up for the purpose; in practice the actual form will depend on the structure of the successful concession company or consortium. For the purposes of estimating operating costs it has been assumed to be a stand-alone company structure containing all functions in-house, although out-sourcing of some activities is very likely.

The staffing structure of an operating company can be divided into:

- Management staff performing central functions such as financial control, accounts, personnel, marketing, etc.;
- Operations staff, consisting of drivers, conductors, controllers, supervisors, revenue system and control staff and instructors; and
- Maintenance staff, covering vehicles, track, Overhead Line Equipment (OLE), stops, ticketing and other equipment, signalling and communications.

Staff numbers in some cases (notably drivers and conductors) can be estimated directly from operational statistics; in other cases they can be estimated from track mileage, fleet size etc. Some central management and support staff numbers can only be defined directly by comparison with experience elsewhere.

It is estimated that a total of 184 staff will be required to operate Line 1 as a free-standing operation, made up as follows:

- Management, finance and administration staff: 14
- Operations staff: 121, including:
  - *40 drivers*
  - *40 conductors*
- Maintenance staff: 49
- Total: 184

*Operating cost model*

Operating and maintenance costs have been estimated using the Light Rapid Transit Operating Cost Model developed by Steer Davies Gleave, which builds up the total annual cost of operating the system from a number of variables or characteristics. These can be separated into a number of main categories:

- System characteristics – operating days per annum, hours of operation, etc.;
- Route characteristics – route lengths, journey time, peak and off-peak frequencies, number of stops, etc.;
- Vehicle characteristics – method of propulsion, weight;
- The management/staffing structure of an operating company (as set out above); and
- Shift lengths, holiday entitlements, expected sick days, number of staff required on duty etc. to determine the number of operational staff required.

Also in the model are a series of cost rates and assumptions relating these system descriptors to annual costs, including:

- Salary levels by grade;
- Energy costs per vehicle kilometre and centrally;
- Vehicle maintenance costs fixed and per vehicle kilometre;
- Fixed equipment maintenance costs per route/track kilometre;
- Revenue collection costs;
- Insurance;
- Overheads; and
- Policing.

The model reflects the relationships between the assumptions and input variables and resulting cost estimates in different ways. Some, particularly operations costs, vary directly with the size of the system (defined by service pattern, route length, number of stops, etc.), whereas others, such as certain management and administration costs, will be fixed within a range of alternatives under consideration. Other costs, such as maintenance costs, are semi-variable, where costs include a fixed element and increase with system size but less than proportionally. Overheads are added as a proportion of total costs. Insurance and policing are based on experience elsewhere on a route-km basis.

*Operating cost estimates*

Table 6.6 shows a summary of the operating cost estimates input to the appraisal together with some operating statistics output from the model.

**Table 6.6 Operating Cost Estimates and Statistics**

| Component | Sub-component | Operating Costs (£m pa) |
|---|---|---|
| **Staff** | | **3.96** |
| *of which* | *Drivers* | *0.81* |
| | *Conductors* | *0.63* |
| | *Other operations staff* | *0.97* |
| | *Management and administration staff* | *0.48* |
| | *Maintenance and engineering staff* | *1.07* |
| **Power** | | **0.28** |
| **Maintenance materials** | | **0.66** |
| **Insurance** | | **0.27** |
| **Policing** | | **0.20** |
| **Overheads** | | **0.27** |
| **Rates** | | **0.19** |
| **Total Operating Cost** | | **5.82** |
| **Operating statistics:** | | |
| **Annual vehicle kilometres (million)** | | **1.30** |
| **Operating cost per vehicle km** | | **£4.47** |
| **Annual vehicle hours** | | **61,100** |
| **Operating cost per vehicle hour** | | **£95** |

## 6.7 Technical Feasibility and Risks

The proposed alignment and options are feasible, based upon a number of key assumptions (and consequent risks, associated with these assumptions):

- The design is based upon vehicle parameters, described above (Section 6.2). No new or innovative, untried technology is proposed, but new traction technologies will be reassessed prior to implementation, as described in Section 6.2, above;
- The run times can be maintained – this depends on achieving adequate tram priority. Agreement with CEC has been reached, on junction and traffic management designs which demonstrate that the required level of tram priority can be achieved through practical and feasible alignment and junction design. Ultimately the design as implemented may vary, in detail by implementation stage, but has been established, in principle;
- Acceptability of urban design issues – this is being addressed through the development of a detailed design manual for agreement with CEC Planning, prior to implementation of the scheme;
- Integration with bus – the design provides opportunity for bus integration and mitigates potential adverse impacts on bus. A degree of modal transfer is assumed to be

achieved. The risk of competition and predatory bus pricing is significant and has proved to be problematic on other schemes. Mitigation is proposed through ongoing liaison with bus services and detailed design development aimed at bus integration and may also be achieved through contractual or procurement methods.

## 6.8 Bus Network

### 6.8.1 General

As part of the definition and appraisal of Line 1, it is necessary to consider the effect on bus provision in the corridors served by the tram and, to a lesser extent, in parallel corridors. The reasons for this are that:

- frequencies on the bus network are virtually certain to change in response to the introduction of trams, if for no other reason than abstraction of passengers;
- some reorganisation of routes is also likely to match bus service provision to new patterns of demand;
- a reduction of bus services, even though it cannot be guaranteed in a deregulated environment, has significant benefits in terms of the environment and the operation of congested corridors.

**tie** and the City council is undertaking an exercise to involve an operator at an early stage with a Development, Partnering Operating Franchise (DPOF). A key element of which will be the establishment of an integrated bus service.

This section sets out a set of potential bus network changes amounting to a partial restructuring of routes currently serving demand between the City Centre and the Leith, Newhaven, Granton and Crewe Toll areas to set a notional Central Case.

The work underlying this was carried out before a series of route and timetable changes was announced by Lothian Buses, to take place on 20 July 2003. However, the effects of these changes have been factored into the results and there are no significant changes to the conclusions.

It is recognised that bus networks change constantly, and that the route structure in north Edinburgh will have altered, perhaps significantly, by the time the tram line is introduced. However, it is necessary to take a 'snapshot' view of the network in order to provide the basis for assessment.

### 6.8.2 Existing Services

Bus services have been grouped into six 'corridors' for the purposes of analysis:

A: Leith Walk

AB: Easter Road (coded because it is parallel to A)

AC: other routes linking the City Centre and Leith

B: Crewe Road

C: Inverleith Road

D: Orbital routes

Table 6.7 shows the existing services in these corridors (from 20 July 2003). All quoted frequencies are for Monday to Saturday daytime.

**Table 6.7 Bus Services in Line 1 Corridor**

| Corridor | | Route | Headway (minutes) | Change on 20 July 2003 (if significant effect on corridors) |
|---|---|---|---|---|
| A | Leith Walk | 7 | 10 | |
| A | Leith Walk | 10 | 10 | |
| A | Leith Walk | 11 | 10 | |
| A | Leith Walk | 12 | 10 | |
| A | Leith Walk | 14 | 15 | |
| A | Leith Walk | 16 | 10 | Daytime service increased from every 15 to every 10 minutes |
| A | Leith Walk | 22 | 10 | |
| A | Leith Walk | 25 | 10 | |
| A | Leith Walk | 49 | 20 | |
| AB | Easter Road | 1 | 15 | Split into 2 routes (both every 15 minutes):<br>1: Clermiston-City Centre-Easter Road-Ocean Terminal<br>21: Gyle-Clermiston-Crewe Toll-Duke Street (effectively an orbital) |
| AB | Easter Road | 35 | 20 | |
| AC | parallel to Leith Walk (via Lochend) | 34 | 15 | Daytime service increased from every 20 to every 15 minutes |
| AC | parallel to Leith Walk (via Broughton Road) | 36 | 30 | |
| B | Crewe Road | 19 | 15 | |
| B | Crewe Road | 42 | 20 | Replaced previous service 28 at same frequency |
| B | Crewe Road | 29 | 10 | |
| B | Crewe Road | 37/37A | 10 | |
| B | Crewe Road | First 129 | 15 | |
| C | Inverleith Road | 8 | 15 | |
| C | Inverleith Road | 17 | 15 | |
| C | Inverleith Road | 23 | 10 | |

| Corridor | | Route | Headway (minutes) | Change on 20 July 2003 (if significant effect on corridors) |
|---|---|---|---|---|
| C | Inverleith Road | 27 | 10 | |
| D | Orbital via Granton and Leith | 32/32A | 20 | |
| D | Orbital via Crewe Road | 38 | 20 | |

Not all services run the full length of the corridor (for example route 11 only traverses about half of Leith Walk before turning along Pilrig Street). However, the routes shown above have been selected on the basis that they serve at least some demands that would be served by Tram Line 1. Other routes, which cross the corridor or travel along them for only short distances, have been omitted.

### 6.8.3 Potential changes

The potential changes to the bus network have been developed on the basis that:

- A notional reduction in frequency is justified where the tram is in direct competition with bus services; the closer the tram is to the bus corridor, the larger the reduction, since more existing bus demand will be attracted to the tram.
- This applies between major centres even where buses and trams follow different routes, for example between the City Centre and Granton,

  BUT
- Frequency reductions should be avoided as far as possible for routes where there is no tram alternative;

  AND
- Existing linkages provided by buses should be preserved as far as possible if the tram does not provide an alternative.

Table 6.8 shows the changes proposed for the purposes of the Central Case.

**Table 6.8 Bus Service Changes in Line 1 Corridor**

| Corridor | | Route | Proposed change |
|---|---|---|---|
| A | Leith Walk | 7 | Divert via Commercial Street and Henderson Street to replace 22 |
| A | Leith Walk | 10 | Withdraw between Newhaven and city centre |
| A | Leith Walk | 14 | Divert via Easter Road and Royal Mile to replace 35 |
| A | Leith Walk | 16 | Withdraw between Silverknowes and city centre |

| Corridor | | Rout e | Proposed change |
|---|---|---|---|
| A | Leith Walk | 22 | Withdraw between Ocean Terminal and city centre |
| AB | Easter Road | 35 | Withdraw between Ocean Terminal and city centre |
| B | Crewe Road | 19 | Withdraw between Granton and city centre |
| B | Crewe Road | 42 | Withdraw between Silverknowes and city centre |
| B | Crewe Road | 29 | Divert half of service as 29A via Telford Road and Groathill Road North to replace 42 at same frequency |
| C | Inverleith Road | 8 | Divert to Caroline Park (extended 17 provides new service to Muirhouse) |
| C | Inverleith Road | 17 | Extend from Granton to Silverknowes to replace 16 on this section |
| C | Inverleith Road | 27 | Extend some journeys to serve Silverknowes Prom loop to replace 42; reduce to 3 bph between Silverknowes and city centre (extended 17 provides service to Muirhouse and Silverknowes) |
| D | Orbital via Crewe Road | 38 | Divert to Granton to replace part of 19 (particularly the link between Granton and Western General Hospital) |

The aggregate impact on the corridors of these changes is Table 6.9. This shows the change in buses per hour (bph) per direction and places per hour (pph) per direction, assuming 70 places per bus.

### Table 6.9 Bus Supply Changes

| | | Existing | | Proposed | | Change | | % change |
|---|---|---|---|---|---|---|---|---|
| Corridor | | bph | pph | bph | pph | bph | pph | bph & pph |
| A | Leith Walk | 49 | 3430 | 27 | 1890 | -22 | -1540 | -45% |
| AB | Easter Road | 7 | 490 | 8 | 560 | +1 | +70 | +14% |
| AC | parallel to Leith Walk | 6 | 420 | 6 | 420 | 0 | 0 | 0% |
| B | Crewe Road | 23 | 1610 | 16 | 1120 | -7 | -490 | -30% |
| C | Inverleith Road | 20 | 1400 | 17 | 1190 | -3 | -210 | -15% |
| D | Orbital | 6 | 420 | 6 | 420 | 0 | 0 | 0% |
| **Total** | | **111** | **7770** | **80** | **5600** | **-31** | **-2170** | **-28%** |

The notional reduction in capacity of around 2200 places per hour will be broadly offset by the capacity supplied by tram Line 1. At 8 trams per hour, this will be approximately 2000 passengers per hour per direction on each side of the loop (4000 per hour in total between the City Centre and Granton/Leith). On Leith Walk, the proportional reduction is greater because the tram exactly parallels the bus, but even here the reduction of 1540 places per hour is offset by 2000 per hour by tram.

### 6.8.4 Resource Implications

An estimate of the savings which would accrue from these service changes has been produced by identifying the number of vehicle hours and vehicle kilometres represented by the changes to each route, and aggregating the results for all routes over a full year, making allowance for lower levels of service during early mornings, evenings and Sundays.

The results suggest a saving of about 1.37 million vehicle kilometres and 89,000 vehicle hours per year. At a cost of £25 per hour, this would represent an annual saving of around £2.1 million.

The net change in vehicle requirement would be 15 vehicles in service, representing a reduction in the required Lothian Buses fleet of about 18 vehicles. In proportion to the total normal bus fleet of around 550 vehicles[19], this is a very small reduction of about 3%.

It would be possible to re-deploy the displaced vehicles on other services, either by increasing frequencies or introducing new routes. Unless directly related to the tram scheme, this would be a matter for the bus operator. Some additional revenue could be generated as a result, but the net effect cannot be estimated. It is more likely that such new services could be unprofitable and therefore require revenue support (otherwise they would already be provided commercially).

Re-deploying the displaced vehicles on feeder services to the tram would be another possibility, but it is difficult to identify where there would be a market for such services in connection with Line 1, given the loop configuration, the lack of catchment areas to the north and the relatively short distances from the City Centre. Again it is likely that such services would require revenue support. Subjectively, Lines 2 and 3 would probably offer better opportunities for bus feeders in view of their more radial nature and more extensive hinterland.

As outlined in section 6.8.3 the final configuration of an integrated bus/tram public service will be developed by the City Council and **tie** as part of the involvement of a tram operator and bus operator at an early stage of the project.

### 6.8.5 Bus speeds

The demand modelling process used in the development of Line 1 utilises an interface between the highway model and public transport model, which transfers highway speeds to the latter to derive bus speeds. Allowance is made for the slower running speeds of buses compared to general traffic and for the existence of bus lanes.

During the development of Line 1, this process led to modelled delays to the bus network arising from highway network changes to accommodate Line 1. In practice it was felt that these delays were excessive and that such delays would be mitigated during the detailed design process and/or explicit bus priority measures implemented. On this basis, it was decided to assume that bus speeds across the network remained unchanged between the Reference Case and Line 1 scenario (although bus speeds were modelled changing between the forecast years of 2011 and 2026).

[19] An approximate figure, excluding coaches and open top buses.

This modelling assumption may underestimate the impact of Line 1 on bus operations, thus overestimating the benefits of Line 1. However, this assumption also removes the benefits of improved bus operations arising from a less congested highway network following car transfer to Line 1. On balance, it is felt that the impact is broadly neutral.

# 7 STAG2 Appraisal

## 7.1 Option Sifting

Before undertaking a comprehensive STAG2 appraisal of the options for Line 1, it was evident that the decision between the remaining route alignment options would be driven by a limited number of key objectives within the STAG process. On this basis, we elected to undertake a high level STAG2 appraisal, focusing on these key objectives, to ascertain whether there was a clear preference at each option location. Should this prove to be the case, the best performing option would be carried forward as an integral part of a full loop, potentially resulting in a single Preferred Route should both optional sections be resolved in this process.

On this basis, this section sets out the appraisal of the route options, namely:

- George Street / Princes Street; and
- Telford Road / former railway solum.

The appraisals only cover the route sections where the options exist, not the loop in its entirety.

### 7.1.1 George Street / Princes Street

Detailed scheme development and analysis of the two options has been undertaken and this is set out in an option study report (Mott MacDonald et al, 2003). Tables 7.1 and 7.2 set out the resultant ASTs for the George Street and Princes Street options respectively. Note that the ASTs have not been fully completed; rather they have been used to demonstrate the key drivers and impacts to inform the choice between the two options.

Considering the technical aspects of the scheme, both options have comparable capital costs, with George Street some £0.8m more expensive. However, this excludes the cost of PU diversions and this would likely increase the cost of George Street compared to Princes Street. The run times are slower on George Street, but this option would have less impact on highway operations.

At consultation, the public expressed a clear preference for Princes Street, with its balance of providing accessibility whilst minimising the visual impact, noting the environmental and heritage impact of the George Street option.

Environmentally, the George Street option has much more severe impacts. Noise and vibration impacts are greater, but the key impact is on visual amenity, cultural heritage and landscape. The enclosed form, the designed vistas and the high architectural quality of George Street, combined with the human scale of the buildings, means that the impact of the tram would be significant and much more dominant than in Princes Street. Charlotte Square, with its intact architecture and generally smaller scale, is even more sensitive. Conversely, Princes Street, because of its variable architectural quality, is less sensitive than George Street. Also, Princes Street has the advantage in townscape terms, that it is already a major public transport corridor; the tram would enforce this aspect of its character.

The impacts on safety and economy are judged to be comparable, with no clear advantage to either option. The softer effects on patronage, such as system visibility, use of a natural transport corridor, safety and security and tourism would favour Princes Street.

The Princes Street option has advantages to transport integration, since this road is the principal bus route through the City Centre. On a similar basis, the Princes Street route would provide better accessibility benefits; it is the main retail area with surveyed pedestrian flows three times that of George Street and enjoys a strong relationship with both the Old and New towns.

Given the merits of the respective options set out above, Princes Street is the preferred option and this option has been carried forward for inclusion in the appraisal of the full loop.

### 7.1.2 Telford Road / Former Railway Solum

Detailed scheme development and analysis of the two options has been undertaken and this is set out in an option study report (Mott MacDonald et al, 2003). Tables 7.3 and 7.4 set out the resultant ASTs for the Telford Road and former railway solum options respectively. Note that the ASTs have not been fully completed; rather they have been used to demonstrate the key drivers and impacts to inform the choice between the two options.

Considering the technical aspects of the scheme, the Telford Road option is materially more costly than the railway solum, the respective costs being £15.4m and £6.4m. However, this excludes the cost of PU diversions and this would likely further increase the cost of the Telford Road option. The tram run times are slower on Telford Road and would impact on highway operations, compared to the former railway solum which is completely segregated.

Environmentally, the Telford Road option would give rise to greater noise and vibration and air quality impacts, whilst the former railway solum option would lead to some re-balancing of biodiversity. Safety and security impacts are marginal and comparable in both cases. The economy impacts favour the former railway solum, which would maximise through patronage due to the superior run times, with no highway impacts. Integration benefits are marginally in favour to the Telford Road option, since this would allow better transport integration. Accessibility to the Western General Hospital would be maximised by the Telford Road option; the former railway solum option would give rise to an additional 300m walk access (4-5 minute walk time).

Given the merits of the respective options set out above, the former railway solum is the preferred option and this option has been carried forward for inclusion in the appraisal of the full loop.

### 7.1.3 Preferred Route

On the basis of the option sifting set out above, a single Preferred route alignment has now been identified and this is the subject of detailed appraisal set out below.

### Table 7.1 George Street: STAG2 Appraisal Summary Table

| | | | |
|---|---|---|---|
| **Proposal Details** | | | |
| *Name and address of authority promoting the proposal* | | | |
| *Proposal name* | | *Name of planner* | |
| *Proposal description* | | *Capital Costs/Grant*<br>*Revenue Support*<br>*PV Costs* | <br>£m<br>£m/year |
| *Funding sought from* | N/A | *Amount of application* | N/A |
| **Proposal Background** | | | |
| *Geographic context* | | | |
| *Social context* | | | |
| *Economic context* | | | |
| **Planning Objectives** | | | |
| *Planning objectives* | *Performance against planning objectives* | | |
| • To improve accessibility<br>• To reduce pollution<br>• To reduce congestion<br>• To make the transport system safer and more secure | | | |
| *Rationale for selection of proposal* | | | |
| **Implementability Appraisal** | | | |
| *Technical* | George Street has a high level of PU apparatus, resulting in high cost and extended construction period. | | |
| *Operational* | Run time of 420 seconds between the Picardy Place and Shandwick Place stops. Some road closures throughout year will necessitate alternative operational plan. | | |
| *Financial* | Estimated capital cost overall of £16.1m, excluding PUs | | |
| *Public* | Public consultation highlighted concerns about the environmental and heritage impact of running on George Street and Charlotte Square. | | |
| **Environment** | | | |
| **Mitigation options included (costs and benefits)** | | | |
| **Sub-objective** | **Qualitative information** | **Quantitative information** | **Significance of impact** |
| Noise and vibration | Tram will not adversely impact upon already high daytime ambient noise level. However, during evening and night (post 7:00pm) operating periods, tram will become dominant noise source. Tight radii at either end of George Street will likely lead to some wheel squeal. | | Moderate adverse |
| Air quality — overall | | | |
| Air quality $CO_2$ — global | | | |
| $PM_{10}$ – local | | | |
| $NO_2$ – local | | | |
| Water quality, drainage and flood defence | No significant impacts | | |
| Geology | No significant impacts | | |

| | | | |
|---|---|---|---|
| Biodiversity | No significant impacts | | |
| Visual amenity | Large impact due to scale of vehicle related impact. OLE wires and poles would impact on primary view along street. | | Large adverse |
| Landscape / Townscape | OLE very detrimental. George Street is the prime street in the urban design hierarchy of the New Town and thus the most sensitive. | World Heritage Site and Conservation Area | Large adverse |
| Agriculture and soils | No significant impacts | | |
| Cultural heritage | Connection to building facades possible, but listed building consents may not be forthcoming. Strong objection from Historic Scotland to route through Charlotte Square. | | |
| **Safety** | | | |
| **Sub-objective** | **Item** | **Qualitative information statement** | **Quantitative information** |
| Accidents | Change in annual personal injury accidents | Reduced pedestrian conflict due to change to pelican from zebra crossings at three junctions. | |
| | Change in balance of severity | | |
| | Total discounted savings | | |
| Security | | Security improvements to those transferring from bus. Low pedestrian activity outside business hours potentially increases risk. | Small positive |
| **Economy** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| User Benefits | Travel Time | Long run time reduces benefits to through trips. Good penetration of commercial and business centre of Edinburgh. Poor integration with bus network reduces potential benefits. | Early testing indicated annual patronage of 10.32m p.a. (assuming railway corridor alignment at the Telford Road option) |
| | User Charges | | |
| | Vehicle Operating Costs | | |
| | Quality / Reliability Benefits | | |
| Private Sector Operator Impacts | Investment Costs | | |
| | Operating & Maintenance Costs | | |
| | Revenues | | |
| | Grant/Subsidy payments | | |
| Economic activity and location impacts | Local Economic Impacts | | |
| | National Economic Impacts | | |
| | Distributional Impacts | | |
| **Integration** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| Transport interchanges | Services & ticketing | Poor integration with bus network. | |
| | Infrastructure & information | | |
| Land-use transport integration | Transport assessment | No significant impacts | |

| | | | |
|---|---|---|---|
| Policy integration | Fit with key policies | No significant impacts | |
| **Accessibility & Social Inclusion** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| Community accessibility | Public transport network coverage | | |
| | Access to other local services | | |
| Comparative accessibility | Distribution / Spatial impacts by social group | | |
| | Distribution / Spatial impacts by area | | |
| **Cost to Public Sector** | | | |
| **Item** | **Qualitative information** | | **Quantitative information** |
| Public Sector Investment Costs | | | |
| Public Sector Operating & Maintenance Costs | | | |
| Grant/Subsidy Payments | | | |
| Revenues | | | |
| Taxation Impacts | | | |
| **Monetised Summary** | | | |
| Present Value of Transport Benefits | | | |
| Present Value of Cost to Government | | | |
| Net Present Value | | | |
| Benefit-Cost to Government Ratio | | | |

**Table 7.2 Princes Street: STAG2 Appraisal Summary Table**

| | | | |
|---|---|---|---|
| **Proposal Details** | | | |
| *Name and address of authority promoting the proposal* | | | |
| *Proposal name* | | *Name of planner* | |
| *Proposal description* | | *Capital Costs/Grant*<br>*Revenue Support*<br>*PV Costs* | £m<br>£m/year |
| *Funding sought from* | N/A | *Amount of application* | N/A |
| **Proposal Background** | | | |
| *Geographic context* | | | |
| *Social context* | | | |
| *Economic context* | | | |
| **Planning Objectives** | | | |
| *Planning objectives* | *Performance against planning objectives* | | |
| • To improve accessibility<br>• To reduce pollution<br>• To reduce congestion<br>• To make the transport system safer and more secure | | | |
| *Rationale for selection of proposal* | | | |

| Implementability Appraisal | |
|---|---|
| *Technical* | A moderate level of PU apparatus necessitating diversions will incur capital cost and associated construction disruption. |
| *Operational* | Run time of 364 seconds between the Picardy Place and Shandwick Place stops. Significant number of road closures throughout year will necessitate alternative operational plan. |
| *Financial* | Estimated capital cost overall of £15.3m, excluding PUs. |
| *Public* | Princes Street was supported by 66% of public consultation respondents. These highlighted that Princes Street offered the best balance between accessibility for the public, visual impact and commercial gain for city centre businesses and tourist attractions. |

| **Environment** | | | |
|---|---|---|---|
| **Mitigation options included (costs and benefits)** | | | |
| **Sub-objective** | **Qualitative information** | **Quantitative information** | **Significance of impact** |
| Noise and vibration | Tram will not adversely impact upon already high daytime ambient noise level. However, during late evening and night (post 11:00pm) operating periods, tram will become dominant noise source. | | Small adverse |
| Air quality — overall | | | |
| Air quality $CO_2$ — global | | | |
| $PM_{10}$ – local | | | |
| $NO_2$ – local | | | |
| Water quality, drainage and flood defence | No significant impacts | | |
| Geology | No significant impacts | | |
| Biodiversity | No significant impacts | | |
| Visual amenity | Impacts on views to Castle across OLE and down street along OLE | | Large adverse |
| Landscape / Townscape | OLE detrimental (but on balance less so than in George Street) | World Heritage Site and Conservation Area | Large adverse |
| Agriculture and soils | No significant impacts | | |
| Cultural heritage | | | |

| **Safety** | | | |
|---|---|---|---|
| **Sub-objective** | **Item** | **Qualitative information statement** | **Quantitative information** |
| Accidents | Change in annual personal injury accidents | Improvement in pedestrian safety arising from installation of pedestrian crossings and fixed track route for tram. | |
| | Change in balance of severity | | |
| | Total discounted savings | | |
| Security | | Security improvements to those transferring from bus. High pedestrian volumes promotes safer environment. | Small positive |

**Economy**

| Sub-objective | Item | Qualitative information | Quantitative information |
|---|---|---|---|
| User Benefits | Travel Time | Good penetration of commercial and business centre of Edinburgh. Good interchange with bus network and softer factors (tourism, safety and security) maximise patronage benefits. | Early testing indicated annual patronage of 10.51m p.a. (assuming railway corridor alignment at the Telford Road option) |
| | User Charges | | |
| | Vehicle Operating Costs | | |
| | Quality / Reliability Benefits | | |
| Private Sector Operator Impacts | Investment Costs | | |
| | Operating & Maintenance Costs | | |
| | Revenues | | |
| | Grant/Subsidy payments | | |
| Economic activity and location impacts | Local Economic Impacts | | |
| | National Economic Impacts | | |
| | Distributional Impacts | | |

**Integration**

| Sub-objective | Item | Qualitative information | Quantitative information |
|---|---|---|---|
| Transport interchanges | Services & ticketing | Good integration with bus network. | |
| | Infrastructure & information | | |
| Land-use transport integration | Transport assessment | No significant impacts | |
| Policy integration | Fit with key policies | Provision of Line 1 consistent with historic and existing polices for transport and land use planning | |

**Accessibility & Social Inclusion**

| Sub-objective | Item | Qualitative information | Quantitative information |
|---|---|---|---|
| Community accessibility | Public transport network coverage | | |
| | Access to other local services | | |
| Comparative accessibility | Distribution / Spatial impacts by social group | | |
| | Distribution / Spatial impacts by area | | |

**Cost to Public Sector**

| Item | Qualitative information | Quantitative information |
|---|---|---|
| Public Sector Investment Costs | | |
| Public Sector Operating & Maintenance Costs | | |
| Grant/Subsidy Payments | | |
| Revenues | | |
| Taxation Impacts | | |

| Monetised Summary | |
|---|---|
| Present Value of Transport Benefits | |
| Present Value of Cost to Government | |
| Net Present Value | |
| Benefit-Cost to Government Ratio | |

### Table 7.3 Telford Road: Preliminary Appraisal Summary Table

| **Proposal Details** | | | |
|---|---|---|---|
| *Name and address of authority promoting the proposal* | | | |
| *Proposal name* | | *Name of planner* | |
| *Proposal description* | | *Capital Costs/Grant*<br>*Revenue Support*<br>*PV Costs* | <br>£m<br>£m/year |
| *Funding sought from* | | *Amount of application* | N/A |

| **Proposal Background** | |
|---|---|
| *Geographic context* | |
| *Social context* | |
| *Economic context* | |

| **Planning Objectives** | |
|---|---|
| *Planning objectives* | *Performance against planning objectives* |
| • To improve accessibility<br>• To reduce pollution<br>• To reduce congestion<br>• To make the transport system safer and more secure | |
| *Rationale for selection of proposal* | |

| **Implementability Appraisal** | |
|---|---|
| *Technical* | Route length 2.54km, 47% segregated (Craigleith to Caroline Park). Landtake required, notably at northern end to access Western Approach Road. Significant traffic interface issues, requiring new and revised signalisation and loss of parking. Significant earthworks and PU diversions required |
| *Operational* | Run time 5.9mins (Craigleith to Caroline Park), excluding junction delays. |
| *Financial* | Capital cost £15.4m |
| *Public* | Public consultation responses showed Telford Road as the favoured route. However, some of the weighting is the result of a number of petitions and actions by cycle groups. Concern about safety and/or loss of cycleway along former railway solum. |

| **Environment** | | | |
|---|---|---|---|
| **Mitigation options included (costs and benefits)** | | | |
| **Sub-objective** | **Qualitative information** | **Quantitative information** | **Significance of impact** |
| Noise and vibration | Tram will not adversely impact upon already high daytime ambient noise level. However, during evening and night (post 7:00pm) operating periods, tram will become dominant noise source. Tight radii at access onto Telford Road will likely lead to some wheel squeal. | | Small adverse |

| | | | |
|---|---|---|---|
| Air quality — overall | Traffic impacts arising from street running may adversely affect air quality. | | Small adverse |
| Air quality $CO_2$ — global | | | |
| $PM_{10}$ – local | | | |
| $NO_2$ – local | | | |
| Water quality, drainage and flood defence | No significant impacts | | Neutral |
| Geology | Contaminated ground likely to be present at Fire Training Ground and disused petrol station on alignment. These would require remedial work before construction. | | Small positive |
| Biodiversity | No significant impacts | | Neutral |
| Visual amenity | Some visual impacts to properties on Telford Road and Groathill Avenue. | | Moderate adverse |
| Landscape / Townscape | Potential impacts on Telford Road and Groathill Avenue. | | Moderate adverse |
| Agriculture and soils | No significant impacts | | Neutral |
| Cultural heritage | No significant impacts | | Neutral |
| **Safety** | | | |
| **Sub-objective** | **Item** | **Qualitative information statement** | **Quantitative information** |
| Accidents | Change in annual personal injury accidents | On-street mixed running may marginally increase risk of highway related accidents. | |
| | Change in balance of severity | | |
| | Total discounted savings | | |
| Security | | Security improvements to those transferring from bus. On-street stop location provides visibility and presence of tram stop, with positive impact on personal security and incidence of crime. | |
| **Economy** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| User Benefits | Travel Time | Extended run times reduces level of through patronage. Local patronage maximised through visible presence and direct access. On-street alignment reduces highway capacity, with negative impact on non-user benefits. | Early testing indicated annual patronage of 10.32m p.a. (assuming Princes Street option in the City Centre) |
| | User Charges | | |
| | Vehicle Operating Costs | | |
| | Quality / Reliability Benefits | | |
| Private Sector Operator Impacts | Investment Costs | | |
| | Operating & Maintenance Costs | | |
| | Revenues | | |
| | Grant/Subsidy payments | | |

| | | | |
|---|---|---|---|
| Economic activity and location impacts | Local Economic Impacts | No significant impacts | |
| | National Economic Impacts | | |
| | Distributional Impacts | | |
| **Integration** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| Transport interchanges | Services & ticketing | Good integration with bus network. | |
| | Infrastructure & information | | |
| Land-use transport integration | Transport assessment | | |
| Policy integration | Fit with key policies | | |
| **Accessibility & Social Inclusion** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| Community accessibility | Public transport network coverage | Provides good access to the Drylaw and Craigleith areas of north west Edinburgh. | |
| | Access to other local services | Provides good access (50m from stop) to the Western General Hospital (rear entrance). | |
| Comparative accessibility | Distribution / Spatial impacts by social group | | |
| | Distribution / Spatial impacts by area | | |

| | | |
|---|---|---|
| **Cost to Public Sector** | | |
| **Item** | **Qualitative information** | **Quantitative information** |
| Public Sector Investment Costs | | |
| Public Sector Operating & Maintenance Costs | | |
| Grant/Subsidy Payments | | |
| Revenues | | |
| Taxation Impacts | | |
| **Monetised Summary** | | |
| Present Value of Transport Benefits | | |
| Present Value of Cost to Government | | |
| Net Present Value | | |
| Benefit-Cost to Government Ratio | | |

**Table 7.4 Former Railway Solum: Preliminary Appraisal Summary Table**

| | | | |
|---|---|---|---|
| **Proposal Details** | | | |
| *Name and address of authority promoting the proposal* | | | |
| *Proposal name* | | *Name of planner* | |
| *Proposal description* | | *Capital Costs/Grant Revenue Support* | £m |

| | | | |
|---|---|---|---|
| | | *PV Costs* | £m/year |
| *Funding sought from* | | *Amount of application* | N/A |
| **Proposal Background** | | | |
| *Geographic context* | | | |
| *Social context* | | | |
| *Economic context* | | | |
| **Planning Objectives** | | | |
| *Planning objectives* | *Performance against planning objectives* | | |
| • To improve accessibility<br>• To reduce pollution<br>• To reduce congestion<br>• To make the transport system safer and more secure | | | |
| *Rationale for selection of proposal* | | | |
| **Implementability Appraisal** | | | |
| *Technical* | Route length 2.40km, 100% segregated (Craigleith to Ferry Road stop). Negligible PU apparatus. | | |
| *Operational* | Run time 4.9mins (Craigleith to Caroline Park), with no traffic interfaces. | | |
| *Financial* | Capital cost £6.4m | | |
| *Public* | The public consultation showed strong support for the railway corridor as a means of segregating trams from traffic and lessening congestion in the Telford Road area. | | |
| **Environment** | | | |
| **Mitigation options included (costs and benefits)** | | | |
| **Sub-objective** | **Qualitative information** | **Quantitative information** | **Significance of impact** |
| Noise and vibration | Potential noise impacts from tram operations to properties adjacent to alignment, where present ambient noise levels are low. Noise impacts may be significant at night. A wide corridor of land is available between Telford Road and Ferry Road and it may be possible to incorporate noise barriers or similar measures into any peripheral corridor landscaping/planting which would provide some noise mitigation for adjacent residential properties | | Moderate adverse |
| Air quality — overall | No significant impacts | | Neutral |
| Air quality $CO_2$ — global | | | |
| $PM_{10}$ – local | | | |
| $NO_2$ – local | | | |
| Water quality, drainage and flood defence | No significant impacts | | Neutral |
| Geology | No significant impacts | | Neutral |
| Biodiversity | Loss of small areas of habitat (designated Urban Wildlife Site). Badgers are known to reside on the railway corridor and therefore mitigation measures may be required. | | Small adverse |
| Visual amenity | Some visual impact on rear of Groathill Road properties | | Small adverse |
| Landscape / Townscape | Significant vegetation clearance required | | large adverse |

| | | | |
|---|---|---|---|
| Agriculture and soils | No significant impacts | | Neutral |
| Cultural heritage | No significant impacts | | Neutral |
| **Safety** | | | |
| **Sub-objective** | **Item** | **Qualitative information statement** | **Quantitative information** |
| Accidents | Change in annual personal injury accidents | No impact on highway accident levels. | |
| | Change in balance of severity | | |
| | Total discounted savings | | |
| Security | | Security improvements to those transferring from bus. | Small positive |
| **Economy** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| User Benefits | Travel Time | Able to maintain high running speeds, maximising level of through patronage. Segregated alignment has no direct impact on highway network operation. | Early testing indicated annual patronage of 10.51m p.a. (assuming Princes Street option in the City Centre) |
| | User Charges | | |
| | Vehicle Operating Costs | | |
| | Quality / Reliability Benefits | | |
| Private Sector Operator Impacts | Investment Costs | | |
| | Operating & Maintenance Costs | | |
| | Revenues | | |
| | Grant/Subsidy payments | | |
| Economic activity and location impacts | Local Economic Impacts | No significant impacts | |
| | National Economic Impacts | | |
| | Distributional Impacts | | |
| **Integration** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| Transport interchanges | Services & ticketing | Effective signage and marketing should ensure good integration with bus network from the Groathill Road North stop. | |
| | Infrastructure & information | | |
| Land-use transport integration | Transport assessment | | |
| Policy integration | Fit with key policies | | |
| **Accessibility & Social Inclusion** | | | |
| **Sub-objective** | **Item** | **Qualitative information** | **Quantitative information** |
| Community accessibility | Public transport network coverage | Provides good access to the Drylaw and Craigleith areas of north west Edinburgh. | |
| | Access to other local services | Provides reasonable access (350m from stop) to the Western General Hospital (rear entrance). | |
| Comparative accessibility | Distribution / Spatial impacts by social group | | |
| | Distribution / Spatial impacts by area | | |
| **Cost to Public Sector** | | | |
| **Item** | **Qualitative information** | | **Quantitative information** |

| | | |
|---|---|---|
| Public Sector Investment Costs | | |
| Public Sector Operating & Maintenance Costs | | |
| Grant/Subsidy Payments | | |
| Revenues | | |
| Taxation Impacts | | |
| **Monetised Summary** | | |
| Present Value of Transport Benefits | | |
| Present Value of Cost to Government | | |
| Net Present Value | | |
| Benefit-Cost to Government Ratio | | |

## 7.2 Line 1

### 7.2.1 Definition of Central Case

Demand forecasts and other outputs from the transport model are used in calculating the economic benefits from the options (e.g. travel time savings), as well as some environmental (e.g. highway pollutant emissions) and safety impacts (e.g. number of accidents). Appendix A details the transport model used. This section provides a summary of the transport impacts from the implementation of the Central Case Line 1 scheme.

The Central Case scheme has been modelled as follows:

- Line 1 with 8tph and a run time of 40.5 minutes (with a 4.5 minute layover assumed at Ocean Terminal, giving 45 minutes in total);
- 22 stops, corresponding to those presented at public consultation;
- Fares parity with buses;
- Bus network assumptions as set out in Section 6.8;
- Unchanged bus speeds between the Reference Case and Line 1 (see section 6.8.5)

Sensitivities around this Central Case have been carried out and are presented in section 8.6.

### 7.2.2 Princes Street

Full consultation has been undertaken during the development of the scheme to ensure all relevant parties and stakeholders views and principles have been taken into account during the design of the scheme. Within the timescale of this STAG appraisal process there have been several material revisions to the scheme design along Princes Street.

The current design, which is reflected in the qualitative appraisal throughout this STAG2, assumes the removal of westbound traffic on Princes Street and a central public transport lane provided in both directions, with tram and bus sharing this lane. A second discontinuous lane is provided in both directions to accommodate bus stopping and limited amounts of bus running. At key points, where the second lane is discontinued, widened pavements are provided to provide tram stops, reduced length pedestrian crossings and improved pedestrian circulation space.

The previous design retained the westbound traffic, with segregated tram running on central lanes and a bus lane in each direction, making five lanes in total. The roadway width was greater than that currently occupied and resulted in the loss of a narrow strip of Princes Street Gardens to accommodate it. Whilst robust from a transport viewpoint, the townscape impact and the wider aspirations for Princes Street precluded this option. Due to the long lead times and complexity of the transport modelling, the assessment and quantitative analysis of the route (noise and air quality, transport economic efficiency and accessibility) is based on the earlier five lane solution. The local transport effects along Princes Street have been subsequently reviewed on the basis of the revised configuration using a detailed micr-osimulation model (VISSIM) to ensure that the tram and bus run times are not penalised. From this work it can be concluded that the net impact of the design changes on the operational performance of the scheme will be negligible.

CETM was approved after the current work stream began and therefore was not specified within the original scope of the work specified for this stage. Its impact on the current STAG evaluation and the design of appropriate integrated layouts will be undertaken in detail in early 2004. No detailed consideration of CETM is undertaken into account within the current reports.

### 7.2.3 Transport Impacts

The impact on overall travel demand is presented in Table 7.5. The increase in public transport trips is significant, reaching nearly 4,000 in the 2026 AM Peak hour; the reduction in car travel is less marked.

**Table 7.5 Travel Demand**

| | | 2011 | | | 2026 | | |
|---|---|---|---|---|---|---|---|
| | | AM | IP | PM | AM | IP | PM |
| Reference Case | PT Passengers | 45,595 | 27,484 | 42,030 | 48,555 | 28,501 | 46,174 |
| | Cars/LGVs | 131,613 | 91,138 | 147,502 | 166,945 | 112,324 | 184,979 |
| Line 1 | PT Passengers | 46,980 | 28,442 | 43,406 | 52,484 | 30,769 | 49,007 |
| | Cars/LGVs | 131,156 | 91,125 | 147,197 | 165,361 | 112,404 | 183,575 |
| Differences | PT Passengers | 1,385 | 958 | 1,376 | 3,929 | 2,268 | 2,833 |
| | Cars/LGVs | -457 | -13 | -305 | -1,584 | 80 | -1,404 |

Table 7.6 presents the Line 1 aggregate demand by modelled hour and year and annually. Broadly, the demand is comparable by direction, with the clockwise direction being materially higher in the PM Peak. Annual demand, some 8.55m in 2011, grows strongly to reach 11.79m by 2026, largely as a result of increasing traffic congestion making the tram more attractive. Respective revenue is £6.6m and £9.6m, giving average fare yields of around 72p/trip. This is in line with expectations, given the current fare scales, ticket mix and ticket fraud assumptions.

**Table 7.6 Line 1 Demand**

| | 2011 | | | 2026 | | |
|---|---|---|---|---|---|---|
| | AM | IP | PM | AM | IP | PM |
| Clockwise | 2,009 | 1,207 | 2,127 | 3,176 | 1,484 | 3,372 |
| Anti-clockwise | 2,035 | 1,053 | 1,722 | 3,226 | 1,338 | 2,390 |
| Total | 4,044 | 2,259 | 3,849 | 6,402 | 2,822 | 5,762 |
| Annual demand | | 9.41m | | | 12.97m | |
| Annual revenue | | £6.57m | | | £9.57m | |

(£m, 2003 prices)

Of the demand, a significant proportion is new trips or transfer from car; this is illustrated in Table 7.7, which sets out the percentage of trips new to public transport. The nature of the model employed does not enable the level of transfer from car to be established explicitly, since it models trip frequency, distribution and time of day choice as well as mode choice.

**Table 7.7 Line 1 Demand from New PT Trips**

| | 2011 | | | 2026 | | |
|---|---|---|---|---|---|---|
| | AM | IP | PM | AM | IP | PM |
| Central Case Demand | 4,044 | 2,258 | 3,849 | 6,402 | 2,822 | 5,762 |
| of which new PT demand | 794 | 362 | 707 | 1,794 | 659 | 1,179 |
| % of Central Case | 20 | 16 | 18 | 28 | 23 | 20 |

The impact on bus demand is significant, as demonstrated in Table 7.8. The impact in 2011 reduces bus demand by some 2,400 in the peaks and around 1,000 in the inter-peak. By 2026, the impact is less marked, due to the growth in the overall public transport market due to Line 1. This point is also reflected in the analysis of new PT demand presented in Table 7.7

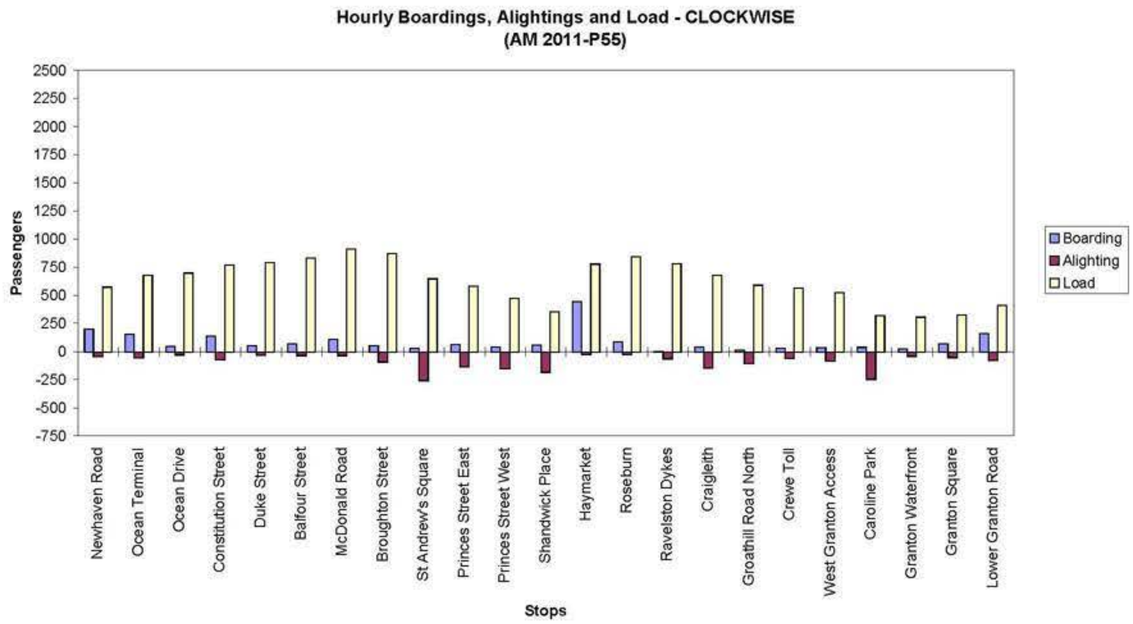
**Table 7.8 Bus Demand**

| | 2011 | | | 2026 | | |
|---|---|---|---|---|---|---|
| **Scenario** | **AM** | **IP** | **PM** | **AM** | **IP** | **PM** |
| Reference Case | 41,400 | 26,290 | 40,255 | 41,910 | 27,084 | 41,932 |
| Line 1 | 39,054 | 25,326 | 37,899 | 40,030 | 27,014 | 38,689 |
| Difference | -2,346 | -964 | -2,356 | -1,880 | -70 | -3,243 |
| % | -5.6 | -3.7 | -5.9 | -4.5 | -0.3 | -7.7 |

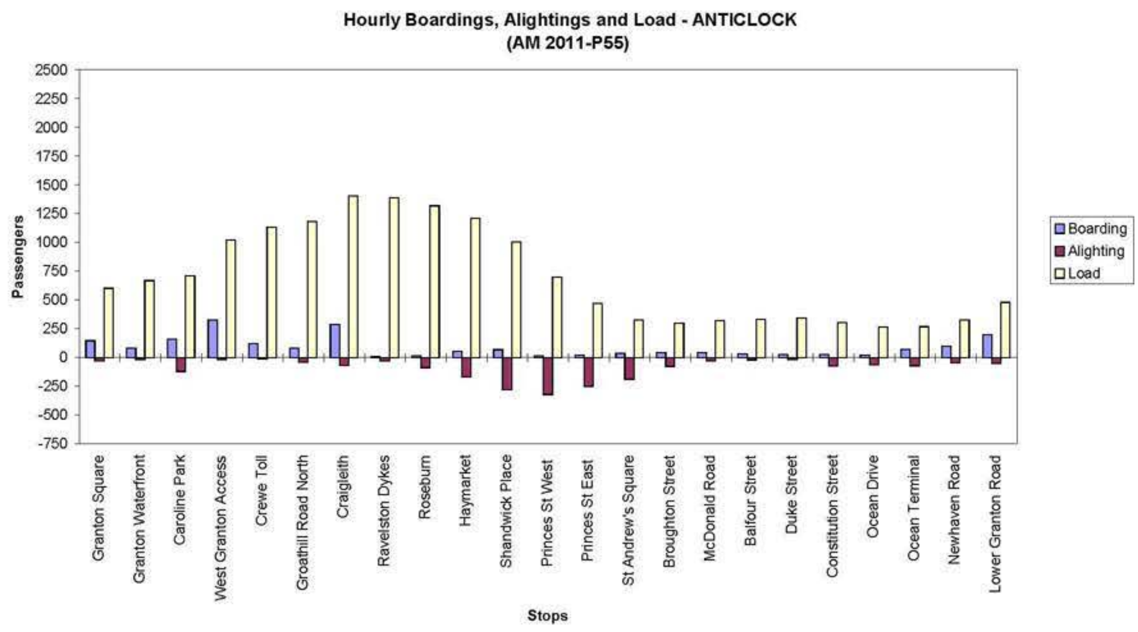
Line 1 demand profiles are presented in the following figures by year (2011 and 2026), period (AM Peak Hour, IP Hour and PM Peak Hour) and by direction (clockwise and anti-clockwise). Key points to note are:

- Although each direction has comparable boarding volumes overall, the trip patterns do lead to differing levels and locations of peak flow;
- The Leith Walk corridor has lower volumes of demand than the Roseburn corridor, due to the high level of bus competition on the former;
- Key trip generators are the section between Haymarket and St. Andrews Square and Granton. Leith and Leith Docks are lower, again reflecting the level of bus competition from this market; and
- The Interpeak demand is low and even along the route, compared to the Peaks, where the AM Peak anti-clockwise direction and PM Peak clockwise direction have significant peak flows.

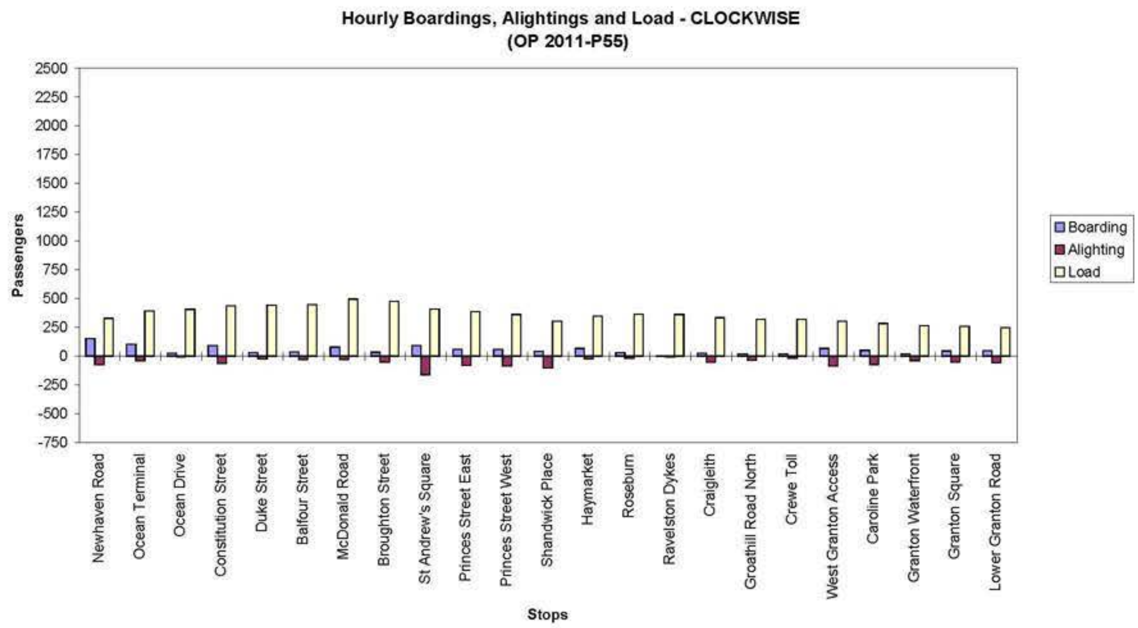
## Figure 7.1: 2011 AM Clockwise Flows



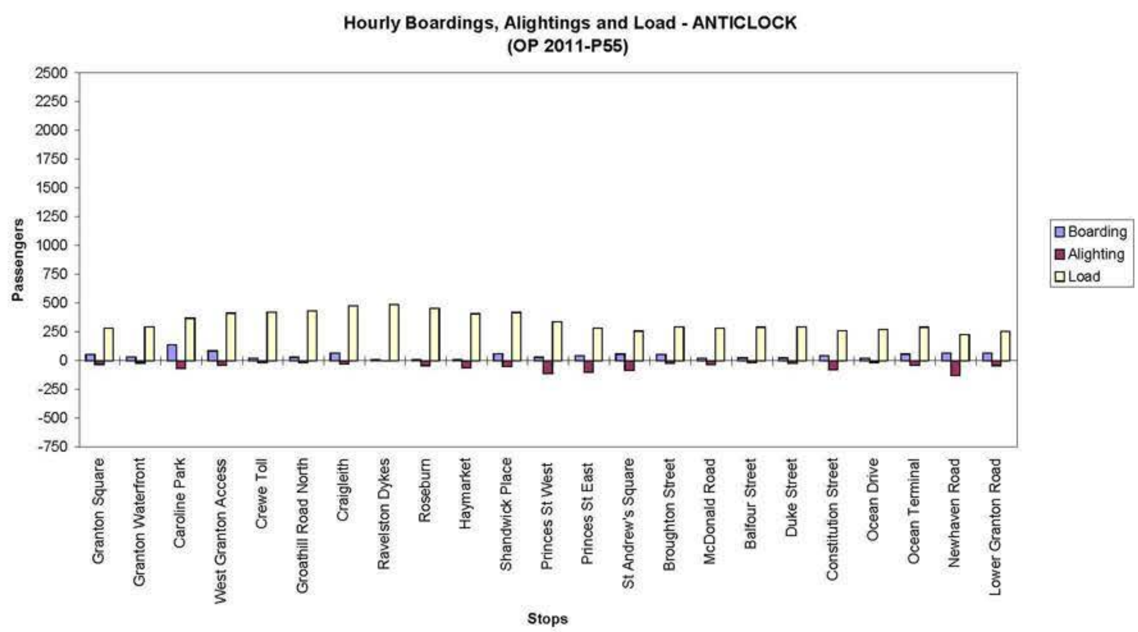

## Figure 7.2: 2011 AM Anti Clockwise Flows



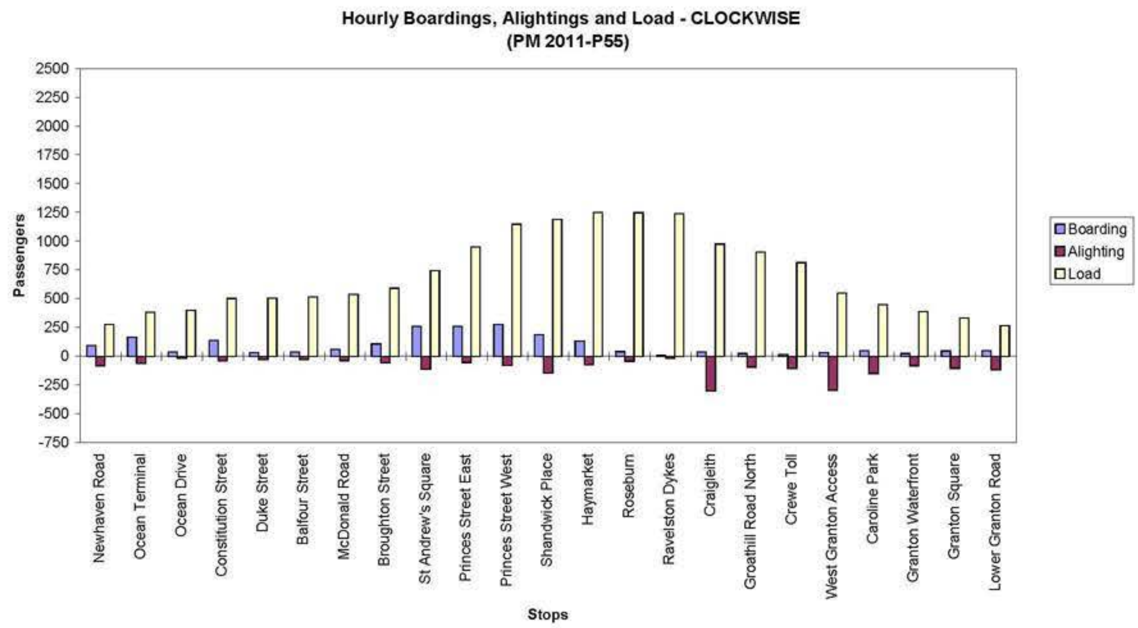
# Figure 7.3: 2011 IP Clockwise Flows



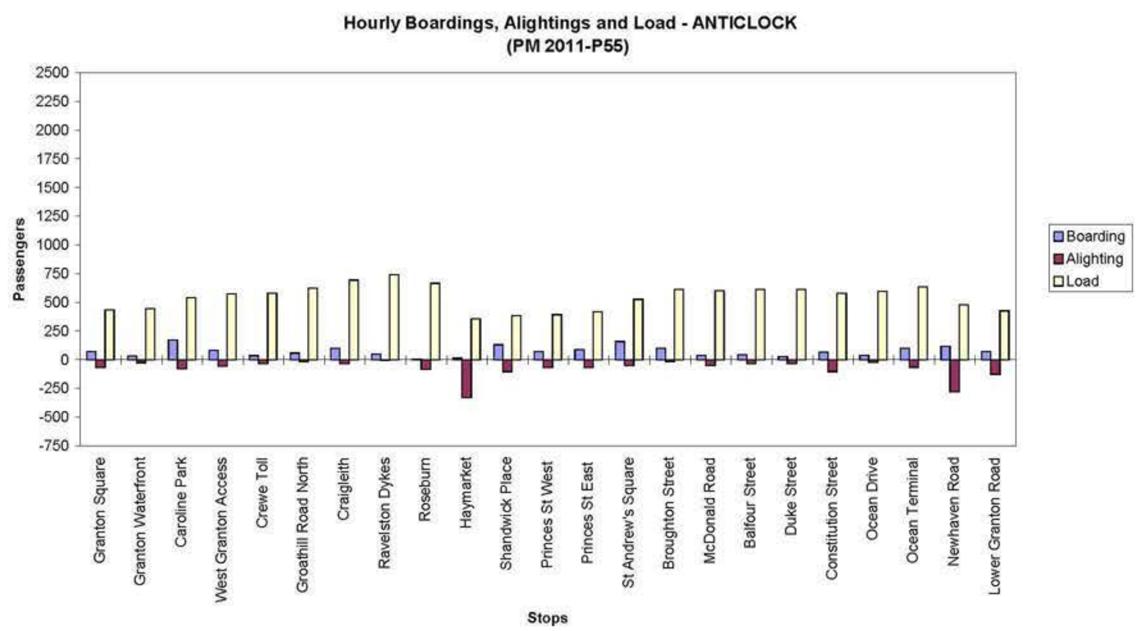

# Figure 7.4: 2011 IP Anti Clockwise Flows



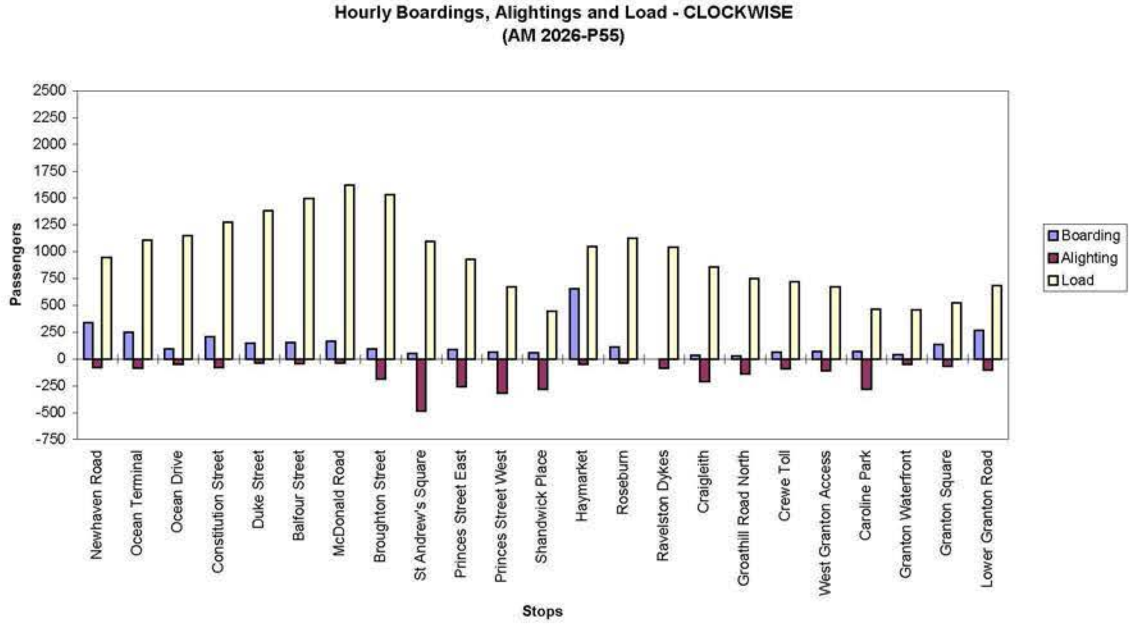
## Figure 7.5: 2011 PM Clockwise Flows



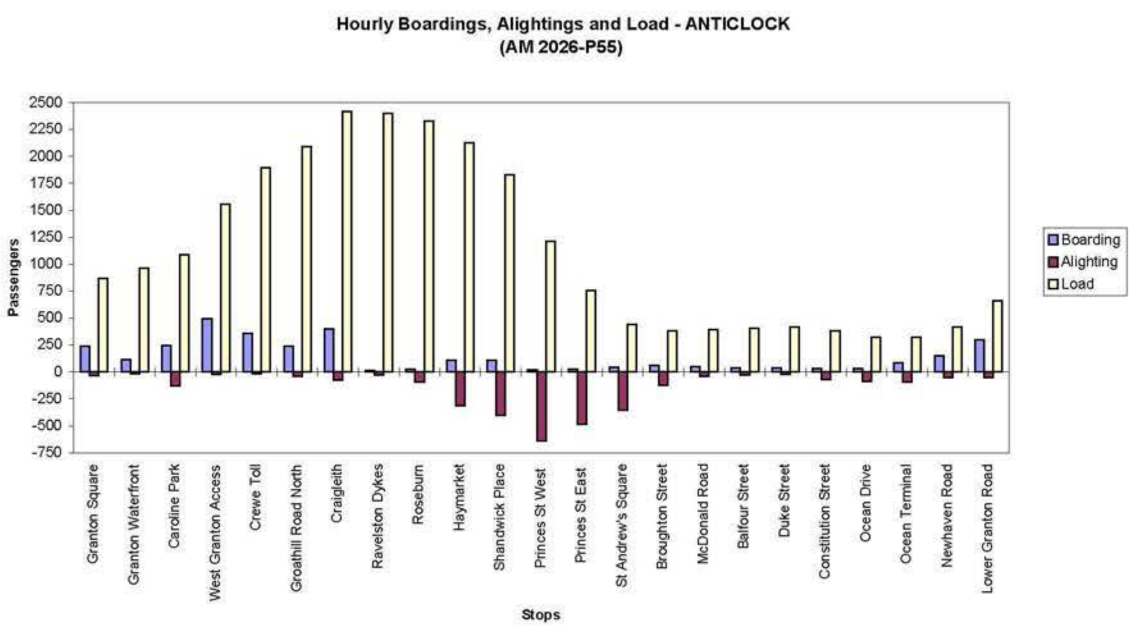

## Figure 7.6: 2011 PM Anti Clockwise Flows



## Figure 7.7: 2026 AM Clockwise Flows




## Figure 7.8: 2026 AM Anti Clockwise Flows



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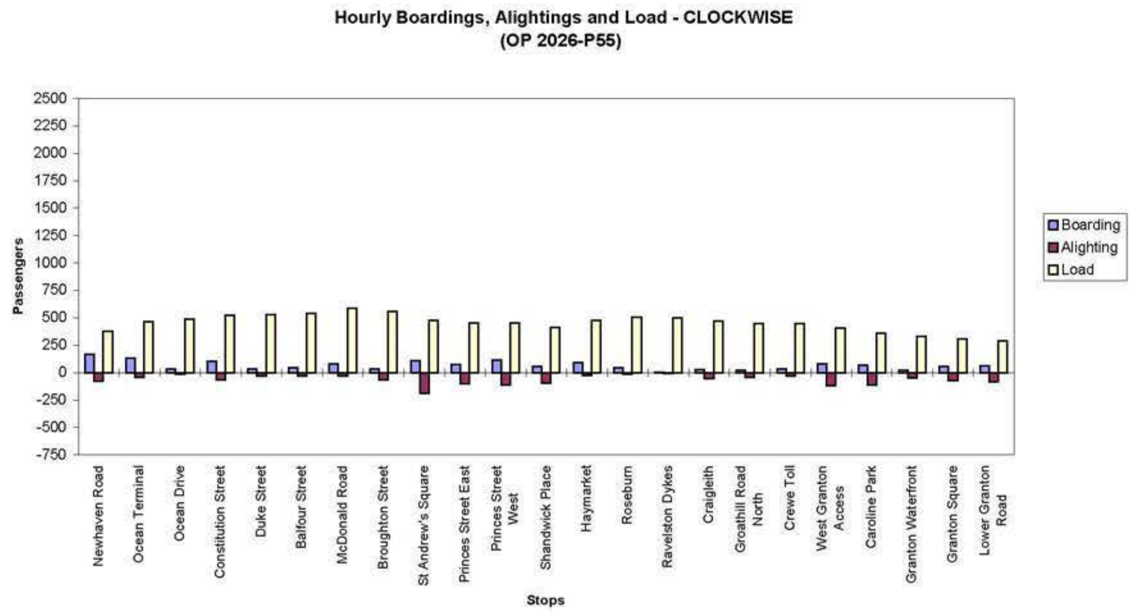
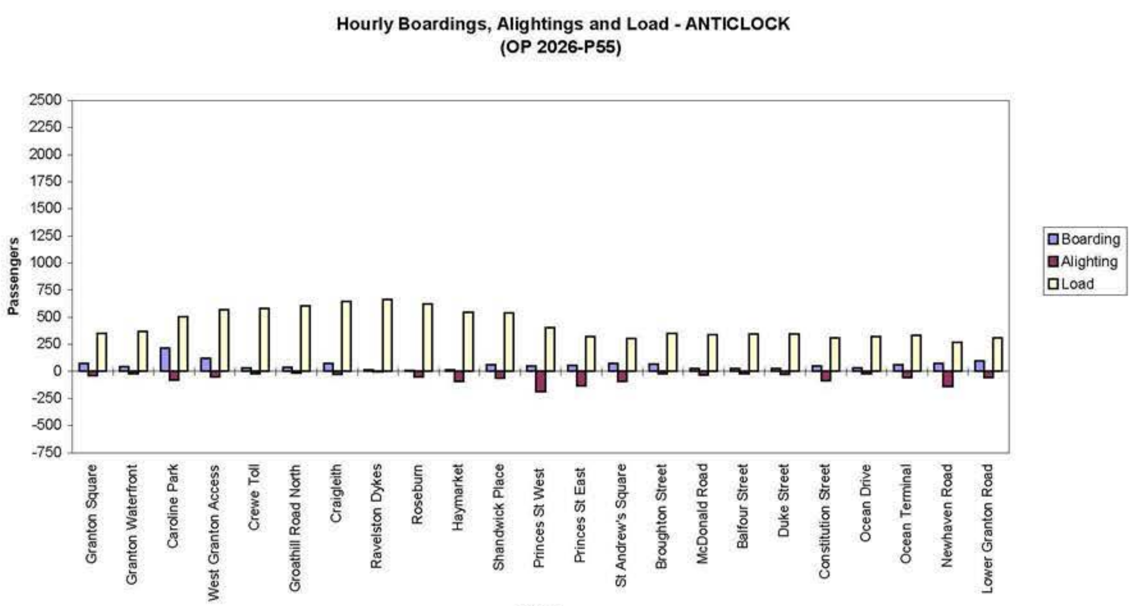
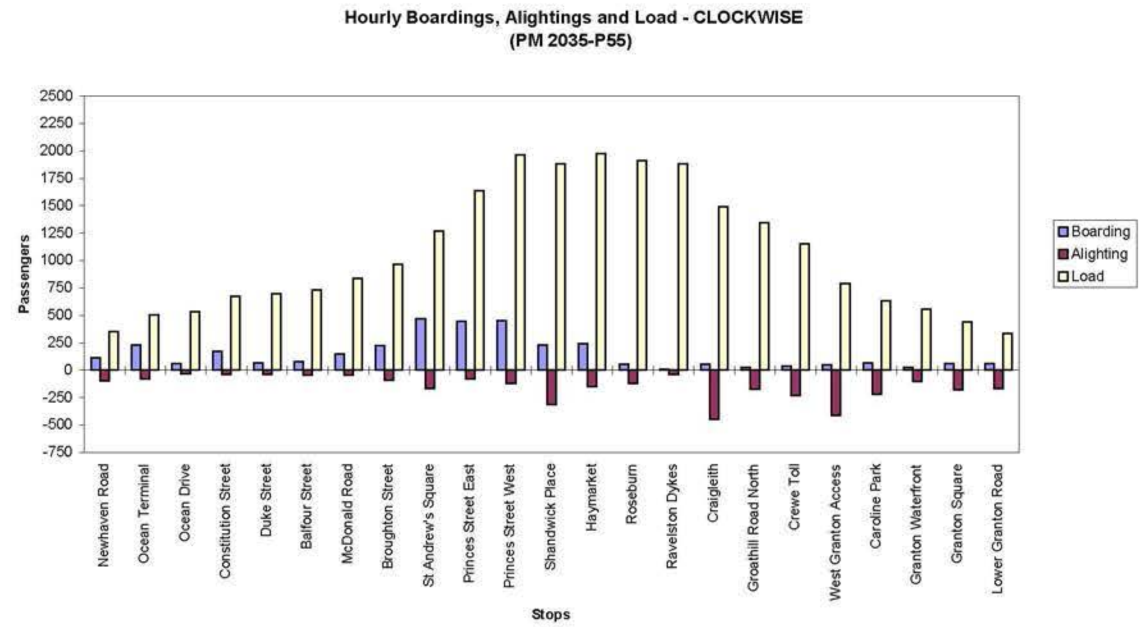
## Figure 7.9: 2026 IP Clockwise Flows



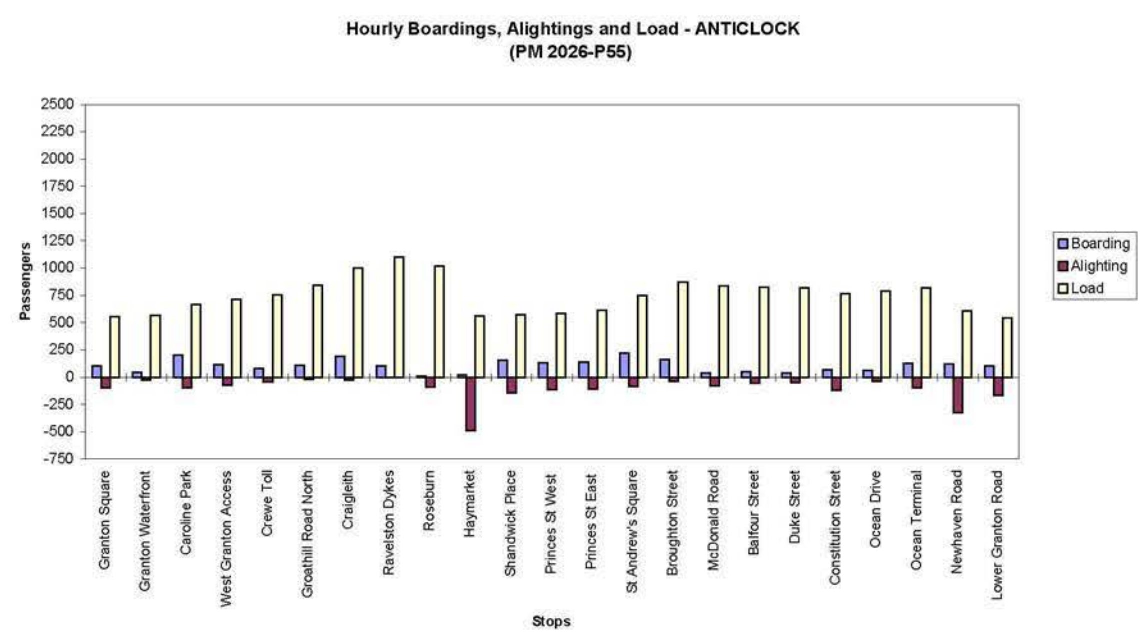

## Figure 7.10: 2026 IP Anti Clockwise Flows



## Figure 7.11: 2026 PM Clockwise Flows




## Figure 7.12: 2026 PM Anti Clockwise Flows



## 7.3 Environment

The environment objective involves protecting the built and natural environments, by minimising (or where possible avoiding) the temporary and permanent impacts of transport infrastructure and operation. Figure 7.13 illustrates the local environmental and planning designations, while Figure 7.14 shows a plot of the local road network.

This section reports the findings of the STAG Part 2 appraisal of environmental impacts of the proposed Edinburgh Tram Line 1 project. Further explanation of the methodologies, criteria and impact assessments for each environmental sub-objective is provided in Appendix B to this STAG report. Appendix B is divided according to each environmental sub-objective and incorporates additional information on each sub-objective, including worksheets.

A summary of the appraisal findings is presented in the Appraisal Summary Tables (Part 2), in Section 7.9 of this report.

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## Figure 7.13: Environmental and Planning Designations

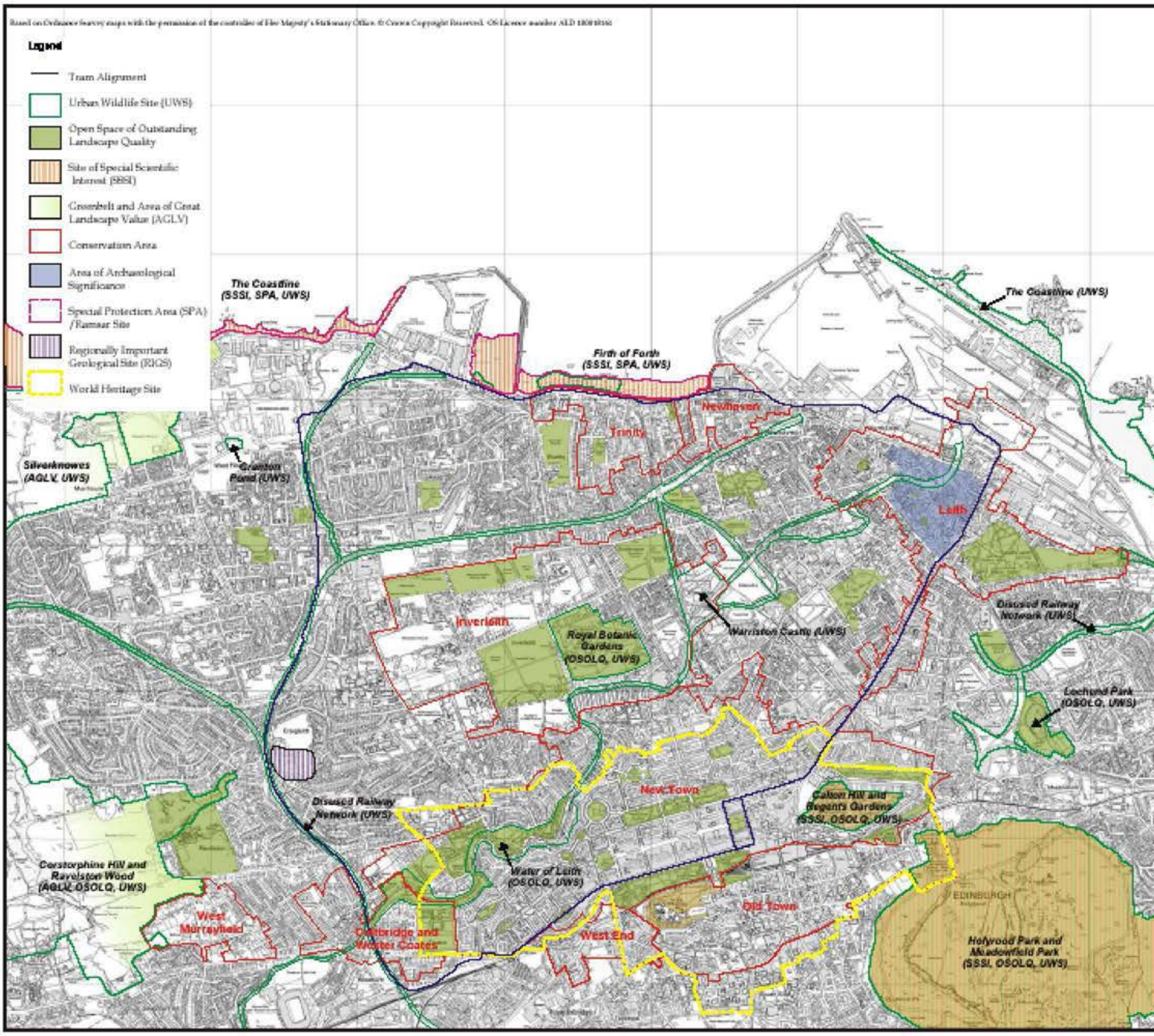
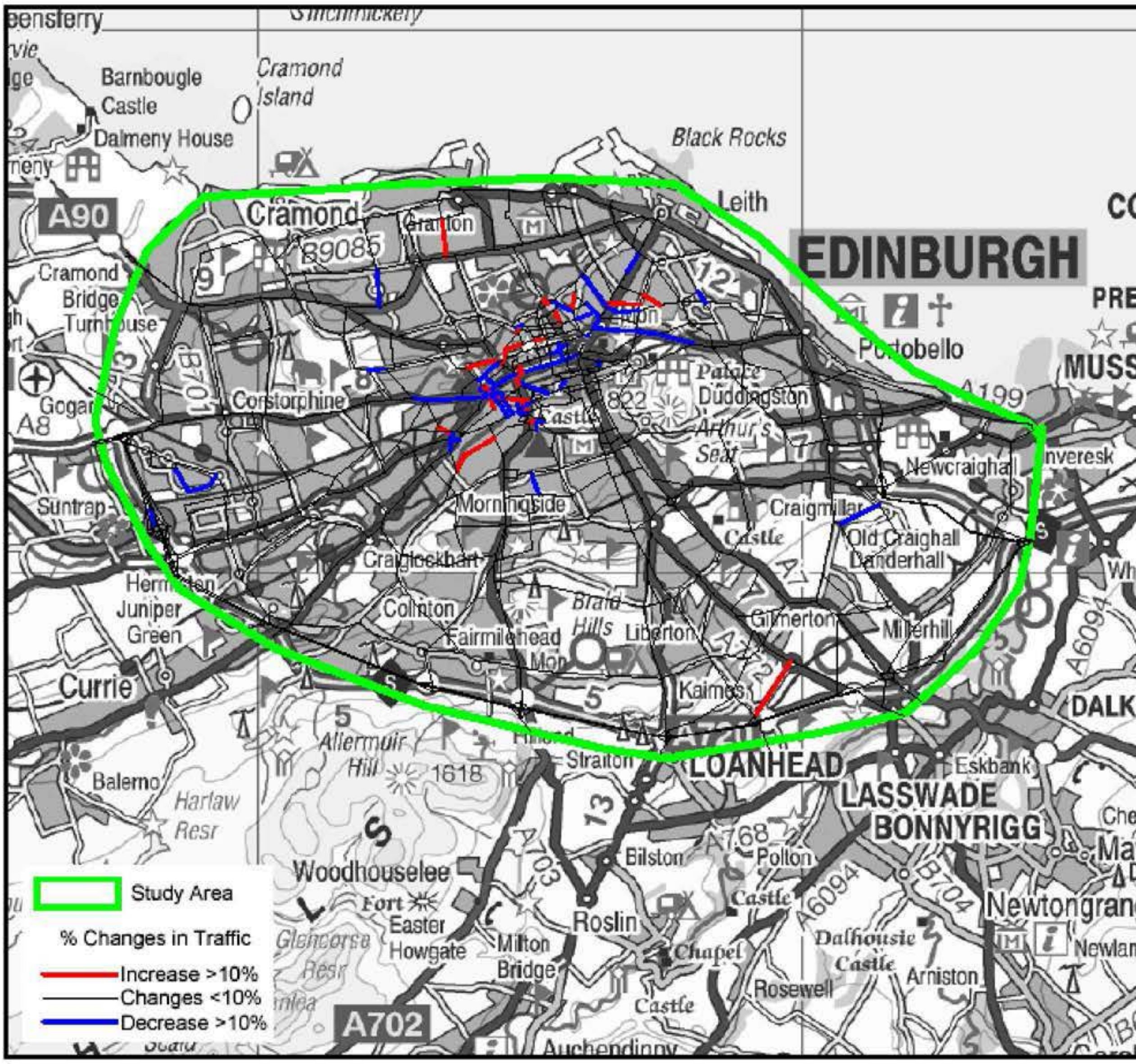


**Figure 7.14: Plot of Road Network**

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### 7.3.1 Noise and Vibration

This section of the report appraises the potential noise and vibration impacts arising from the construction and operation of the scheme as a whole.

There are two main potential impacts that can arise from construction and from operation of light rail schemes such as this. These are:

- Airborne noise – noise which propagates through the air to the receptor; and
- Ground vibration – vibration which propagates via the ground into a receptor building.

Details of the positive and negative effects of noise at specific locations in the vicinity of the proposed tram route will be provided in the Environmental Statement (ES).

The methods and criteria used to predict and evaluate noise and vibration impacts have been derived from relevant recognised national and international guidance. They are described in Appendix B1.

*Construction noise and vibration*

For the purpose of this appraisal, the following phases of construction have been assumed:

- Enabling works;
- Track laying; and
- Construction of tram stops.

Further consideration will be given to the potential construction phase noise impacts when the details of the construction methodology are developed.

Noise levels associated with enabling works and track laying will be most typical of those to be produced on a day-to-day basis during the construction phase. Enabling works and track laying will affect receptors along the length of the proposed alignment whilst stop construction will only affect those located in the immediate vicinity. Similarly, atypical works such as demolition or night-time working will only affect those receptors located in the vicinity of the specific work and will not be common to the whole scheme.

Based on typical plant items and using the methods recommended in BS5228, typical noise levels from the various works have been estimated. In the absence of mitigation, significant impacts are expected at receptors within approximately 40m of enabling works and approximately 15m of track laying and stop construction.

Best practicable means including the use of quiet plant and mobile noise barriers/enclosures will be adopted during construction to ensure noise impacts are kept to a minimum. However, some residual noise impacts are expected, albeit over limited durations.

Ground vibration may be perceptible at receptors within close proximity to the alignment construction works but is not expected to exceed the daytime assessment criterion. Hence, whilst vibration may be perceptible in some areas, due to its temporary nature, short duration and low levels, it should not give rise to adverse comment and impacts are not expected to occur.

The levels of vibration expected from construction works are considered unlikely to cause cosmetic or structural damage at any properties along the route.

*Tram operating noise and vibration*

The degree of noise impact caused by tram operation will depend on the baseline noise level without the tram, the additional contribution to this caused by the tram, and the resulting overall noise level compared to threshold levels for significant impacts. Separate consideration must be given to day and night time impacts.

Because of low baseline noise levels and the proximity of the tram to houses, significant noise impacts are predicted to occur at receptors along the disused rail corridor/cycle path from Roseburn to Crewe Toll. Houses closest to the tracks and not screened by the railway cutting will be most affected. Other receptors along the route are not predicted to experience significant noise impacts because of the high baseline noise levels from road traffic along the remaining sections.

In those locations along the former railway corridor where significant impacts could occur noise barriers can be provided to mitigate the impact and these will be considered in further detail in the ES. The design of the tram will include acoustic design and damping of wheels to reduce wheel squeal on tight bends. The detailed design of the track on such bends will also include measures to minimise wheel squeal and, if necessary, once the scheme is operating, consideration will be given to other techniques to reduce wheel squeal on tight bends.

Ground vibration will potentially be perceptible at receptors within approximately 20m of the alignment. It is not possible to confirm at this stage whether vibration will be perceptible at any properties, but if it is, the estimated levels are not expected to exceed the daytime assessment criterion beyond approximately 4m from the tracks. Whilst vibration may be perceptible in these areas, it will be transient and low level, and is not expected to give rise to adverse comment. Impacts are therefore not predicted to occur.

The expected levels of ground vibration are well below the criteria relating to the structural integrity of buildings. Consequently, no impacts on buildings located adjacent to the scheme are predicted.

*Strategic assessment of road traffic noise impacts*

The outputs from a transport model have been used to estimate the effect of the tram on road traffic noise, comparing the existing situation and the Do-Minimum in 2011 and 2026 with the with scheme situation in those years using STAG appraisal methodologies. The appraisal method uses the Calculation of Road Traffic Noise to predict changes in traffic noise on each road link based on changes in traffic flows, speed and composition obtained from the traffic model. Changes in the number of households where residents are likely to be annoyed by noise on each road link have been estimated using GIS analysis of 2001 census data to identify the numbers of properties bordering each road link. The total numbers experiencing an increase, decrease or no change in noise levels have been estimated by the summing of the household estimates for all links in the traffic model. The study area includes the A720 and all road links within it. Appendix B1 gives further details of the appraisal method.

The results are summarised in Table 7.9. It must be appreciated that the approach provides only a broad brush picture of the area-wide impacts of the scheme. Household numbers are only approximate and should be treated as indicative of the broad scale of potential comparative benefits and disbenefits between options. Nonetheless, the appraisal method is considered to be reliable in assessing the nature of the strategic traffic noise impact, in particular whether it is expected to be positive, negative or broadly neutral.

**Table 7.9 Estimated Numbers of Households Potentially Annoyed by Noise**

| Scenario/Scenarios Compared | Estimated Properties experiencing noise levels expected to cause annoyance |
|---|---|
| Base Case (2001) [20] | 14,300 |
| 2011 Do Minimum | 15,200 |
| 2011 With Scheme | 15,200 |
| 2026 Do Minimum | 15,800 |
| 2026 With Scheme | 15,800 |
| 2011 Do Minimum × Base Case (2001) | 900 |
| 2011 With Scheme × Do Minimum | 0 |
| 2026 Do Minimum × Base Case (2001) | 1,500 |
| 2026 With Scheme × Do Minimum | 0 |

[20] The traffic data for the Base 2001 scenario was incomplete when used in this assessment due to recoding some road links from the Base to future scenarios. This incompatibility of link coding has skewed the results for the roads that have been recoded.

The results indicate that the scheme will have no effect on population annoyance due to noise in Edinburgh.

Estimated numbers of properties affected by perceptible changes in noise levels (i.e. increases or decreases of more than 3dB)) are given in Table 7.10 below.

**Table 7.10 Number of Households Experiencing Perceptible Noise Changes**

| Scenarios Compared | Estimated Number of Properties Experiencing Changes | |
|---|---|---|
| | Perceptible increase in noise levels (> plus 3dB) | Perceptible decrease in noise levels (>minus 3dB) |
| 2011 With Scheme × Do Minimum | 0 | 50 |
| 2026 With Scheme × Do Minimum | 0 | 50 |

The methods used to estimate properties experiencing perceptible changes in road traffic noise and levels sufficient to cause annoyance are again approximate. Hence, whilst the scheme appears to deliver a slight positive impact in both 2011 and 2026, with an estimated 50 properties experiencing a perceptible decrease in traffic noise, the changes are in practice insignificant given the accuracy of the appraisal method and the underlying variability of the baseline noise environment.

*Summary*

The majority of the tram route follows existing roads and the additional noise generated by tram movements is not expected to give rise to significant noise impacts in these areas. Where the tram alignment runs along the disused Roseburn to Crewe Toll rail corridor noise barriers will be required and, provided an appropriate design can be developed, for most locations they will mitigate significant impacts that would otherwise occur. Acoustic damping will be incorporated in the tram design to mitigate the potential for wheel/rail noise. Some slight residual impacts may be unavoidable.

On the road network traffic changes resulting from the tram's operation will give rise to minor noise decreases in some areas, but the overall effect of the scheme on noise from the road network is predicted to be neutral.

### 7.3.2 Air Quality – Overall

Several air pollutants can significantly affect local air quality if they occur at sufficiently high concentrations. The key pollutants to be considered in this STAG appraisal, in respect of local air quality, are Nitrogen Dioxide ($NO_2$) and Particulate Matter ($PM_{10}$) emitted from road traffic. Tram operation will have negligible impact on air quality along its route. An important pollutant at the global level is Carbon Dioxide ($CO_2$) emitted from road traffic and by generation of electricity to power the tram.

*Criteria*

Air quality standards for $NO_2$ and $PM_{10}$ at the local level are presented in Table 7.11.

**Table 7.11 Air Quality Criteria**

| Pollutant | | Objective | Date for Compliance |
|---|---|---|---|
| Nitrogen Dioxide ($NO_2$) | Annual Mean | 40μg $m^{-3}$ | 31st December 2005 |
| | 99.8th %ile of Hourly Means | 200μg $m^{-3}$ | 31st December 2005 |
| Particulate Matter ($PM_{10}$) | Annual Mean | 40μg $m^{-3}$ | 31st December 2004 |

| Pollutant | | Objective | Date for Compliance |
|---|---|---|---|
| | 90.4th %ile of Daily Means | 50µg $m^{-3}$ | 31st December 2004 |
| | Annual Mean | 18µg $m^{-3}$ | 31st December 2010 |
| | 98.1%ile of Daily Means | 50µg $m^{-3}$ | 31st December 2010 |

Appendix B2 provides information on background air quality in the City of Edinburgh. An Air Quality Management Area (AQMA) has been declared in the city centre as a result of the predicted exceedance of the short term and long term $NO_2$ objectives. Traffic is a major source of pollution in the city centre and measures planned by the Council focus on controlling emissions from this source.

*Methodology*

A spreadsheet model has been used to assess the impact of changes in road traffic from the introduction of the tram. The method is based on STAG and uses the DMRB graphical screening method to estimate changes in roadside concentrations of $NO_2$ and $PM_{10}$ from changes in road traffic due to the operation of the tram. Data on traffic flow, composition and speed are obtained from the traffic model. The assessment covers all road links within and including the A720.

The risk of exposure of the population to changes in pollutant concentrations is assessed based on the number of households within 200m of road links experiencing increases, no change or decreases in concentrations of $NO_2$ and $PM_{10}$. Data on household numbers are derived from GIS analysis of the 2001 postcode census data. Using this method, properties can be counted more than once if they are located within 200 metres of more than one link. This is corrected for the analysis. Households are then weighted according to their distance from the roadside using standard factors from DMRB, to account for decay in pollutant concentrations from the roadside. The following scenarios are assessed:

- Base Year 2000;
- Do Minimum 2011 (without the tram);
- Do Something 2011 (with the tram);
- Do Minimum 2026 (without the tram); and
- Do Something 2026 (with the tram).

The traffic data for the Base 2001 scenario were incomplete when used in this assessment due to recoding some road links from the Base to future scenarios. This incompatibility of link coding may have skewed the results for the roads that have been recoded but this is not thought to affect the overall assessment from Base 2001 to Do Minimum 2011.

Further details of the air quality assessment method are provided in Appendix B2.

*Air quality results*

An estimate of the weighted number of properties located within 200 metres of roads experiencing an improvement or degradation in air quality is presented below in Table 7.12. The estimated number of households near roads predicted to experience no change in air quality is also presented.

**Table 7.12 Number of Households with Changes in Air Quality**

| Scenarios Compared | Number of Households with | | | | | |
|---|---|---|---|---|---|---|
| | Improvement in Air Quality | | No change in Air Quality | | Worsening in Air Quality | |
| | $NO_2$ | $PM_{10}$ | $NO_2$ | $PM_{10}$ | $NO_2$ | $PM_{10}$ |
| Base 2001 × Do Minimum 2011 | 268,450 | 238,300 | 1,250 | 200 | 11,700 | 9,100 |

| Scenarios Compared | Number of Households with | | | | | |
|---|---|---|---|---|---|---|
| | Improvement in Air Quality | | No change in Air Quality | | Worsening in Air Quality | |
| | $NO_2$ | $PM_{10}$ | $NO_2$ | $PM_{10}$ | $NO_2$ | $PM_{10}$ |
| Do Min 2011 × Do Som 2011 | 177,250 | 174,000 | 26,200 | 3,400 | 77,950 | 70,200 |
| Do Min 2026 × Do Som 2026 | 119,100 | 112,050 | 22,750 | 1,000 | 139,550 | 134,500 |

Note: totals for $NO_2$ and $PM_{10}$ differ because of the application of different weighting factors.

During the ten year period from the Base 2001 to Do Minimum 2011 air quality is predicted to improve in most areas in the absence of the tram as a result of improvements in vehicle and fuel technology. The tram, will lead to a further increase in the number of households near roads predicted to experience lower $NO_2$ and $PM_{10}$ concentrations in 2011. More properties will be near roads with improved or unchanged air quality than are near roads with worse air quality.

By 2026 a few more households will be near roads with better or unchanged $NO_2$ concentrations than are near roads with worse, but more households near roads with worse $PM_{10}$ concentrations then better. This is thought to be due to added congestion in 2026.

An indication of the relative magnitude of the exposure to pollutant emissions can be gained from the air quality index which is a product of the weighted number of households and the change in roadside air quality for each road link aggregated over the whole study area. A negative value implies an improvement in air quality and a positive value represents a deterioration. The larger the value, the more significant the impact. The air quality indices for the proposed scheme are shown in Table 7.13.

**Table 7.13 Air Quality Indices**

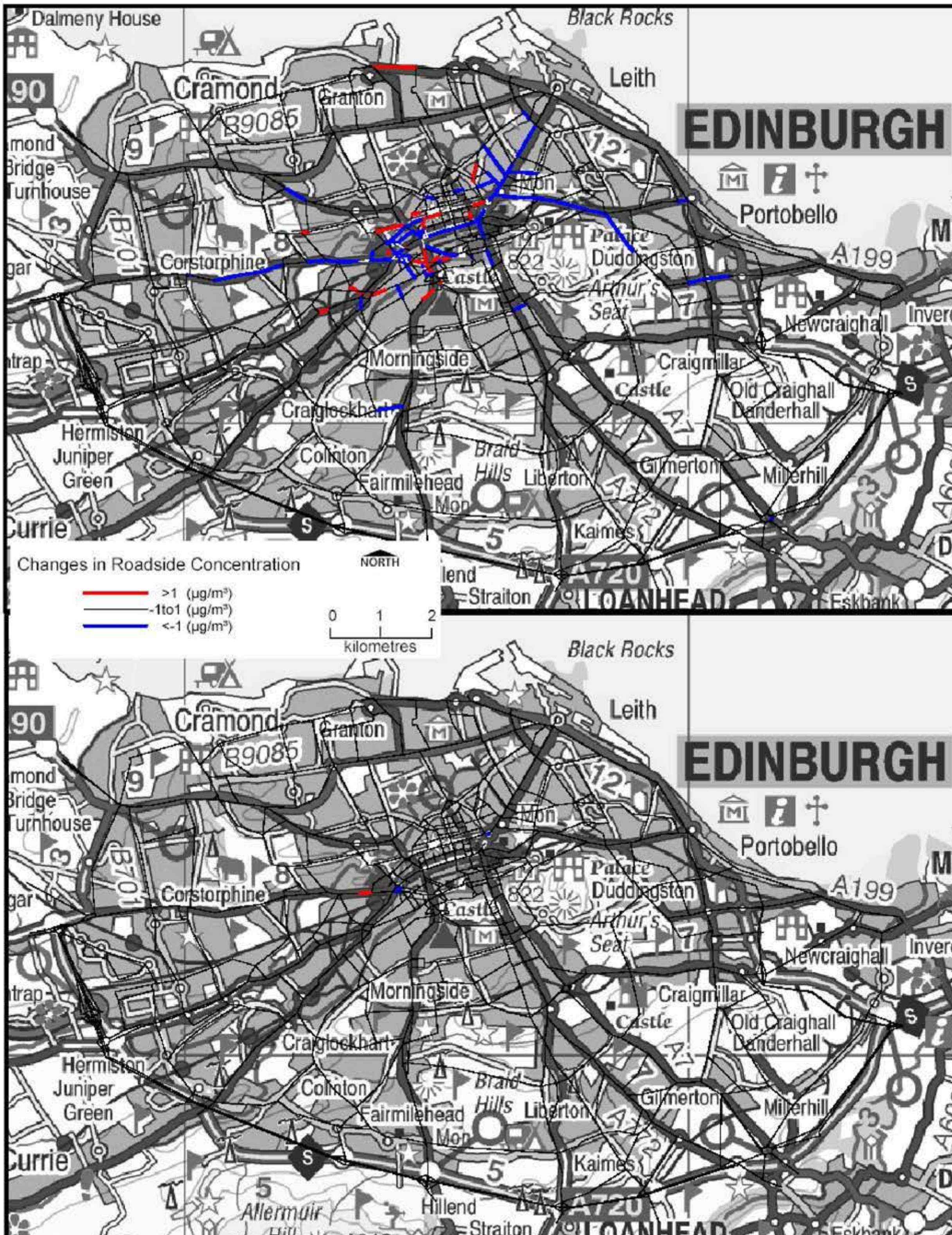
| Scenarios Compared | $NO_2$ Index | $PM_{10}$ Index |
|---|---|---|
| Base × Do Minimum 2011 | -2,949,400 | -354,300 |
| Do Minimum 2011 × Do Something 2011 | -88,100 | -6,000 |
| Do Minimum 2026 × Do Something 2026 | -37,800 | -17,300 |

The indices indicate that the tram has a moderate positive impact on air quality in 2011, in particular for $NO_2$, and a minor positive impact in 2026.

Further analysis has been carried out to assist in the interpretation of these results. The results are presented in Appendix B2. These show that the majority of roads in the study area (approximately 90 % in 2011; approximately 75% in 2026) are predicted to experience negligible changes in pollutant concentrations (changes smaller than 1 $\mu g\ m^{-3}$) as a result of the introduction of the tram. These changes in pollutant concentrations are plotted on a road by road basis Figure 7.15 ($NO_2$ in the upper map and $PM_{10}$ in the lower map).

STAG also requires a qualitative comment on the performance of a scheme in terms of the UK Air Quality Strategy. The assessment indicates that without the tram there will be an improvement in compliance with air quality objectives between 2001 and 2011. The introduction of the tram is predicted to increase compliance further in 2011. By 2026 the tram there should be a slight drop in the non-compliance with $NO_2$ objectives compared to Do Minimum and no change in non-compliance with $PM_{10}$ objectives.

**Figure 7.15: Changes in Roadside $NO_2$ and $PM_{10}$ Concentrations**



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CEC00632759_0145

*Greenhouse gas assessment*

Edinburgh tram Line One has the potential to impact on carbon dioxide emissions by affecting traffic on the road network and by requiring generation of electricity to power the tram.

The effect of the tram on road traffic emissions of $CO_2$ is calculated using data from the traffic model as input to a standard DMRB spreadsheet. This takes account of the impact of changing vehicle and fuel technology on emissions per vehicle kilometre. Emissions from tram operation are calculated from estimates of power consumption for the tram and standard factors for $CO_2$ emissions from UK electricity generation.

Table 7.14 below presents the overall emissions of $CO_2$ in each of the scenarios assessed.

**Table 7.14 Summary of Net Carbon Dioxide Emissions**

| Scenario | Carbon Dioxide Emissions (kilo-tonnes/annum) |
|---|---|
| Base | 1,219 |
| Do Minimum 2011 | 1,252 |
| Do Something 2011 | 1,252 |
| Do Minimum 2026 | 1,451 |
| Do Something 2026 | 1,441 |

The $CO_2$ emissions resulting from power consumption by the tram (626 tonnes) offset the decrease in transport $CO_2$ emissions across the study area road network as a result of its operation in 2011 (see Appendix B2). The result is that there is no overall change in $CO_2$ emissions as a result of the introduction of the tram in 2011. By 2026 the reduction in traffic is sufficient to lead to a small net reduction in $CO_2$ emissions of 10,000 tonnes.

*Conclusions*

A major positive impact on air quality is predicted to occur independently of the tram between 2001 and 2011. Edinburgh Tram Line 1 will lead to a further moderate positive improvement in air quality in the city in 2011. More households are predicted to experience an improvement in air quality than a worsening as a result of the tram, although in most areas the change in air quality will be very small. In 2026 the impact on air quality is predicted to be minor positive.

There will be a moderate negative impact on $CO_2$ emissions between now and 2011 due to traffic growth without the tram, followed by a further moderate negative impact from 2011 to 2026. The effect of the tram on this will be neutral in 2011 and a minor positive impact in 2026.

### 7.3.3 Water Quality, Drainage and Flood Defence

The assessment has considered the effects on water quality of construction, permanent development and operation of the scheme. Water resource issues assessed include surface water features along the route, the quality and sensitivity of these features, hydrogeology and groundwater resources, and drainage and flooding.

The impacts of construction activities and run-off from the scheme on water quality have been assessed, and mitigation proposed to minimise predicted impacts.

Further information on assessment methodology is provided in Appendix B3.

*Surface water*

The primary watercourses in the corridor of the tram route are the Water of Leith and the Firth of Forth. The scheme crosses the Water of Leith at two locations, at Coltbridge Viaduct and on Ocean Drive. The scheme runs on-street on Starbank Road near the foreshore of the Firth of Forth.

Recent water quality assessments undertaken by the Scottish Environment Protection Agency (SEPA) indicate that near Coltbridge Viaduct, the Water of Leith is of poor quality and near Ocean Drive it is of good quality. Overall, the Water of Leith is classified as a salmonid water of high amenity. As the scheme will utilise existing bridges to cross the Water of Leith, construction of the tram is unlikely to significantly impact water quality. SEPA Guidelines and Best Construction Practices will be adopted and mitigation measures implemented during construction to keep the risk of surface water impacts, particularly sediment-laden runoff, to the minimum necessary for the scheme.

Construction along Starbank Road has the potential to impact on surface water resources within the Firth of Forth due to construction plant and activities located within the tidal area. During construction the contractor will adopt SEPA requirements and guidelines, as outlined in Appendix B3, to minimise potential impacts upon surface water resources. Mitigation measures will include a coffer dam during construction along Starbank Road to ensure no polluting materials enter the Firth of Forth. A construction method statement will be submitted to the relevant statutory authorities for approval prior to commencement of construction.

During operation the scheme will use existing drainage and sustainable urban drainage measures (see below) where appropriate, to reduce impacts from any increase in sediment runoff. As a result it is unlikely to cause any significant impacts upon surface water.

*Hydrogeology and groundwater*

The scheme is located within the area of a minor aquifer, which contains fractured or potentially fractured rocks. These do not have a high primary permeability or other features of varying permeability. Short sections of the scheme within the city centre are within areas with formations of rock with negligible permeability, generally regarded as containing insignificant quantities of groundwater.

SEPA has confirmed that there are no designated source protection zones along the tram alignment. As no sensitive groundwater resources have been identified along the alignment for the tram and because of the nature of construction and operation activities of the tram, the scheme is not expected to create any significant impacts upon hydrogeology or groundwater resources.

*Drainage*

The majority of the route runs along existing roads and surface run-off will be drained via existing underground sewers and storm drains. Within the Roseburn Railway Corridor the gradient of surrounding land varies, with the tram running on embankment and in cutting within different sections of the corridor. The existing drainage regime of the corridor consists of stormwater drains installed for the former railway and these will be utilised for the operation of the tram.

Minor drainage improvements will be implemented in specific locations where required. In locations where new drainage is required, the principles of Sustainable Urban Drainage Systems (SUDS) will be applied. SUDS measures include detention basins or wetland areas to remove pollutants in the run-off from hard surfaces prior to their discharge to adjacent watercourses.

Implementation of mitigation and preventative measures, as outlined in Appendix B3, will ensure that development of the scheme will not result in any significant impacts on existing drainage systems or patterns.

*Flooding*

In 2001, the City of Edinburgh Council (CEC) commissioned a Flood Assessment Report, which identified flood alleviation and prevention works to be constructed along the Water of Leith. The majority of identified flood prevention construction locations are unaffected by the scheme, as it is not located within any identified high-risk flood areas in the vicinity of the Water of Leith. There will be no increase in flood risk along the alignment since no flood risk areas or flood plains are affected by new development. The contractor will be required to consult with CEC and SEPA to ensure that CEC flood prevention and alleviation measures are taken into account during detailed design of the scheme.

*Summary*

Overall the scheme is expected to have a minor negative impact on surface water quality and drainage in the short term during construction. Best construction practices will be adopted to minimise any sediment laden or contaminated runoff during construction. Utilisation of existing drainage and installation of sustainable drainage measures where appropriate will ensure that the operation of the scheme will not result in adverse impacts to water quality.

Construction and operation of the scheme will not increase flood risks along the alignment. The contractor will consult with SEPA and CEC during detailed design to ensure adherence to all requirements and guidelines.

There are limited existing groundwater resources along the route and the construction and operation of the scheme is not predicted to impact on these.

### 7.3.4 Geology

This section considers the impacts of the development on geology and soils and effects resulting from the presence of potentially contaminated land. It briefly outlines the baseline geological resource and existing features of note, and discusses potential impacts and mitigation measures to reduce negative impacts.

*Geology*

Glacial or raised marine deposits with areas of made ground underlie the route. The underlying bedrock comprises sedimentary rocks consisting of mudstone, siltstone, sandstone and occasional thin limestones and coal seams, all of Carboniferous age. Superficial geological deposits of the area, as described by BGS, indicate that the route is principally underlain by Glacial Till (Boulder Clay).

The proposed route runs in proximity to the designated sites, two Geological Sites of Special Scientific Interest (SSSI) in the Firth of Forth and at Calton Hill and one Regionally Important Geological Site (RIGS) at Craigleith.

The Firth of Forth is designated as a Geological Site of Special Scientific Interest given its contribution to understanding of the Lower Carboniferous (Dinantian) geology of the Forth area, and the worldwide significance of the sedimentary rock sequence for fossil remains. In particular, Wardie Shore is of international importance, having yielded at least eighteen species of fish fossil remains, including sharks. Consultation with Scottish Natural Heritage (SNH) has indicated that the proposed option for development along the shore of the Firth of Forth SSSI will not result in any adverse impact to the geological interest of the area, provided that construction access to the foreshore adjacent to Starbank Road for works to the seawall avoids the area of geological importance.

Calton Hill SSSI extends to approximately 13ha, and is designated for its geological interest as part of Arthur's Seat Volcano SSSI complex. The site is approximately 100m from the route at the top of Leith Walk. It will not be affected by the route.

The former quarry at Craigleith was designated a RIGS in 1999 by the Edinburgh Geological Society. Craigleith Quarry was operational for over 300 years, providing much of the sandstone used in the construction of Edinburgh's New Town in the 18th and 19th Centuries. The site is now a retail park, although the RIGS designation has renewed interest in the scientific and educational value of the rock outcrops. The proposed route passes approximately 30 metres west of the rock outcrops and is separated from the RIGS site by South Groathill Avenue. The proposed tram route will consequently have no impact on the Craigleith RIGS.

The proposals will not impact on the future workings of any mineral reserves.

*Soils*

Impacts to soils along the route are likely to be generic to construction activity including erosion, disaggregation, compaction and pollution. Soil erosion as a result of development is most likely to occur in the form of water erosion where the mean annual rainfall, storm intensity and frequency are comparatively high. The removal of vegetation, for example along the Roseburn Railway Corridor, will contribute to erosion. Where erosion by water occurs, chemical transfer to surrounding watercourses may be an impact. Disaggregation is effectively the mixing up of soils when disturbed, both physically and chemically, and can result in problems for the re-establishment of vegetation where the chemical composition is altered. Compaction can hamper the infiltration of water resulting in increased runoff and erosion. Soil compaction can also result in difficulties for the reestablishment of vegetation in terms of root penetration and waterlogging. Pollution of soils can occur from a number of sources, in particular vehicle oils, construction materials and lead from exhausts.

Throughout the development, good practice will be adopted in order to prevent the occurrence of these potential impacts, particularly in sections of the route that are off-street. The prevention of soil erosion will involve minimising the removal of vegetation during development, and revegetation of bare areas as soon as possible. Suitable drainage systems will be put in place in order to prevent surface water build up. Some degree of disaggregation is likely to occur regardless of the mitigation measures implemented, although removal and storage of soil horizons separately can help to reduce this significantly. Using vehicles with wide tyres to spread vehicle weight, minimising the width of tracks for vehicular access, and tilling of the area will all assist in reducing compaction. Assuming that good practice measures are adopted during construction of the tram, no significant impacts on soil resources are predicted.

Land take associated with the development of Edinburgh Tram Line 1 will not involve loss of any agricultural land.

*Contaminated land*

If contaminant materials are encountered during construction this can present a risk of pollution of subsurface soil and to the health and safety of construction workers and neighbours.

There are no Contaminated Land Register entries or notices in the route corridor, although analysis of historical data suggests that former land uses in some areas may have lead to land contamination. A City of Edinburgh Council report by Environmental and Consumer Services dated 12th September 2003, compiled for ERM, summarises its findings as follows:

> *'A large proportion of the proposed tramline [Line 1] overlays disused railway and tramline routes, which were present from approximately the 1800s until the 1960s. In addition to*

*this…potentially contaminative land-uses were identified along the proposed route, and within the immediate vicinity of the proposed route.'*

Any contaminated material encountered during construction will be dealt with in compliance with best practice, current legislation and statutory guidance, and no significant impacts resulting from the presence of contaminated material are predicted. The presence of contaminated land along the corridor is not expected to present any over-riding obstacle to development of the route. For areas where site investigation reveals the presence of contaminated land, a management plan will be prepared in order to comply with all relevant legislation. The plan will set out measures to avoid the remobilisation of contaminants via surface waters, groundwater and in the ambient air. Where potentially contaminated material is excavated, it will be investigated to determine the concentrations of any contaminants and to establish whether the material can be placed elsewhere on the site, and whether it should be classified as an environmental hazard by SEPA, or as special waste.

### 7.3.5 Biodiversity

*Sources of information*

The following sources of information have been used for the assessment:

- Consultation with statutory and non-statutory bodies;
- A Phase I Habitat Survey[21] undertaken by Edinburgh City Council in 2001[22];
- Site visits;
- A bat survey undertaken by Nocturne Environmental Surveyors in September 2003[23];
- Relevant national and local planning policies; and
- Other relevant published information.

*Prediction and evaluation of impacts*

An outline of the development proposals has been compared with the findings of the baseline survey to predict the direct impacts that may result from the scheme. In addition, likely effects on known habitats of nature conservation value in proximity to the scheme have been considered.

The ecological evaluation criteria used in the assessment are set out in Appendix B5.

*Ecological baseline conditions*

<u>General Ecological Context</u>

The proposed route for Line One runs mainly along existing roads. These are of limited nature conservation interest, with habitats restricted to street trees and amenity grassland strips. Other habitats in the surrounding area include those associated with parkland, gardens and abandoned land. The main fresh watercourse in the area is the Water of Leith. The proposals follow the Forth Estuary for part of the route between Granton and Leith.

The stretch of the route that supports the most significant terrestrial vegetation is the Roseburn Railway Corridor. This includes woodland and grassland habitats.

[21] A standardised system developed by the former Nature Conservancy Council to allow identification of areas of habitat of nature conservation interest relatively rapidly over a wide area.

[22] Phase 1 Habitat maps and Target Notes from this survey were provided by the Lothian Wildlife Information Centre.

[23] Nocturne Environmental Surveyors (September 2003) *Edinburgh Tram Line 1 Roseburn Corridor Bat Survey*.

Designated Sites

There is one site designated as of national importance for nature conservation interest within 200m of the route:

- *Firth of Forth Site of Special Scientific Interest (SSSI)*[24], *Special Protection Area (SPA)*[25]*/Ramsar Site*[26]. It extends to approximately 6,314 ha, and is designated primarily for regularly supporting wintering waterfowl, wildfowl and wader populations of European importance. The tram route is aligned within a few metres of the SPA along Lower Granton Road and Trinity Road and will encroach approximately 3m into the SPA along some 250m of Starbank Road at Wardie Bay.

There are also several sites of local nature conservation interest in proximity to the tram route, three of which are located at least in part within the boundary of the scheme. The route is aligned along the Roseburn Railway Corridor, an Urban Wildlife Site (UWS)[27], for approximately 3km and will encroach into the 'Coastline' UWS along approximately 250m at Wardie Shore. The Water of Leith UWS is crossed twice by the route, once via Coltbridge Viaduct in the Wester Coates area and once via Ocean Drive in Leith.

Protected Species

There are extensive signs of breeding and foraging badger[28] along the Roseburn Railway Corridor[29] and pipistrelle bats[30] (55kHz)[31] were recorded foraging along the corridor during a September survey. No roosts were identified.

There are several Local Biodiversity Action Plan (LBAP) habitats and species within the route corridor.

*Impact assessment*

The impacts of the mitigated scheme to biodiversity are reported in Appendix B5 and summarised below.

Designated Sites

Construction of the proposed walkway along Starbank Road will have significant direct and indirect impacts on the bird species of interest using this area, during construction. Mitigation measures will be implemented to reduce these impacts to the minimum necessary for the safe completion of the works. For the longer term opportunities will be sought in the design of the new structures to provide

[24] A site identified by Scottish Natural Heritage (SNH) as requiring special protection because of its flora, fauna, geological or physiographical features under the *Wildlife and Countryside Act, 1981 and amendments.*

[25] Special Protection Area (SPA) - a site designated under the European Directive on Conservation of Wild Birds (79/709/EEC) (known as the Birds Directive) to protect birds that are considered rare or vulnerable within the European Community and all regularly occurring migratory birds. Enacted in the UK through the Wildlife and Countryside Act, 1981 and subsequent amendments and the Conservation (Natural Habitats &c) Regulations, 1994.

[26] Ramsar Site - a site that has been designated under the *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (known as the Ramsar Convention) to protect internationally important wetlands.

[27] Sites within the local plan area which have been identified by CEC as being of known conservation interest in the local context in terms of their flora, fauna and geological features.

[28] Protected under the *Protection of Badgers Act, 1992.*

[29] Details of the status of badger along the route are contained in a separate and confidential report which is available to **tie**, CEC, SNH and CANHU.

[30] Protected under the *Wildlife and Countryside Act 1981 and amendments* and the *Conservation (Natural Habitats, & c) Regulations 1994.*

[31] Two species of pipistrelle are identified using a bat detector which picks up the frequency of the bat's call. One species emits a call at 45kHz, the other at 55kHz.

additional roosting opportunities for the species using the area and to mimic the existing habitat along the sea wall. SNH has advised that the proposals will require an Appropriate Assessment[32]. Ongoing bird monitoring will be undertaken in agreement with SNH to inform the assessment and guide the development of detailed mitigation for the habitats and species affected.

Construction of the tracks and walkway/cycleway will result in a significant impact to the Roseburn Railway Corridor UWS. The majority of vegetation will be removed along the embankments, affecting its function as a wildlife corridor. The impacts on this corridor will be limited to the minimum necessary through the implementation of mitigation measures, including the adoption of best practice measures during construction. As much vegetation will be retained as possible, consistent with safe completion of the works. No particular plant species of interest are known from the route. The Water of Leith will not be directly affected by the scheme.

Species of Note

Construction of the tram will result in significant temporary and permanent impacts to badger. Mitigation measures will be implemented to ensure that works undertaken in close proximity to badger setts and foraging habitat comply with the requirements of relevant legislation, in consultation with Scottish Natural Heritage (SNH) and the Scottish Executive Countryside and Natural Heritage Unit (CANHU). Appropriate mitigation measures will be implemented, in agreement with CANHU and SNH, to minimise habitat loss and disturbance to badger.

Bats are known to forage along the Roseburn corridor and the loss of a significant amount of vegetation will reduce their foraging habitat. The bat survey did not record any bat roost sites along the route. Prior to construction, all bridges and other built structures and mature and dead trees to be affected will be checked again for roosting bats and if bats are found, appropriate mitigation measures will be agreed with SNH and implemented. If bats are likely to be disturbed, a licence will be sought from CANHU and must be obtained before work can proceed.

There is a possibility of wildlife casualties once the scheme is operational. Mitigation measures such as badger tunnels and fencing will be implemented to accommodate badger movements and reduce the likelihood of casualties occurring. It is likely that wildlife will become habituated to the regular noise from the running of the tram vehicles.

### 7.3.6 Landscape

Landscape impacts are physical changes caused by a development which affect the character of the landscape and how it is experienced. They can consist of direct impacts on specific landscape features and elements or more subtle effects upon the overall pattern of elements, which together make up the local character. Where the area being discussed is predominantly built-up, it is described as 'townscape' rather than landscape.

This section:

- Describes the existing townscape of the area affected by Tram Line 1, dividing it into 'character zones' to aid description and analysis;
- Considers the sensitivity of the various character zones affected;
- Defines the potential townscape impacts; and

[32] An Appropriate Assessment is required to determine the impacts of the proposal upon Natura site interests and specifically to provide the information necessary to ascertain whether it will adversely affect the site's integrity.

- Sets out the measures proposed for mitigation.

The methodology is based on the 'Guidelines for Landscape and Visual Assessment' (LI and IEMA, 2nd Edition, 2002) and the STAG guidelines. Details are given in Appendix B6.

Edinburgh is long established as one of UK's national cultural assets and is the most highly valued of Scottish townscapes. It contains one of the largest areas of Georgian architecture in Europe and almost the entire city centre is inscribed on the UNESCO register of World Heritage Sites due to its unique architectural heritage and distinctive townscape. Conservation areas cover about one third of the city and there is general agreement that its special urban qualities have to be safeguarded and protected.

The route has been divided into a series of character zones (as illustrated by Figure 7.16) and the major impacts of Line 1 on townscape and mitigation measures proposed by **tie** are described below, zone by zone. Baseline descriptions and full details of impacts are given in Appendix B6.

*Consultations*

Consultations regarding the townscape impacts of Tram Line 1 have been undertaken with the City of Edinburgh Council City Development (Planning), Historic Scotland and Edinburgh World Heritage Trust.

*Scheme design and mitigation*

The indicative design developed by the Line 1 team has been used as a basis for these assessments. The proposals include the following elements relevant to the assessment of landscape impacts:

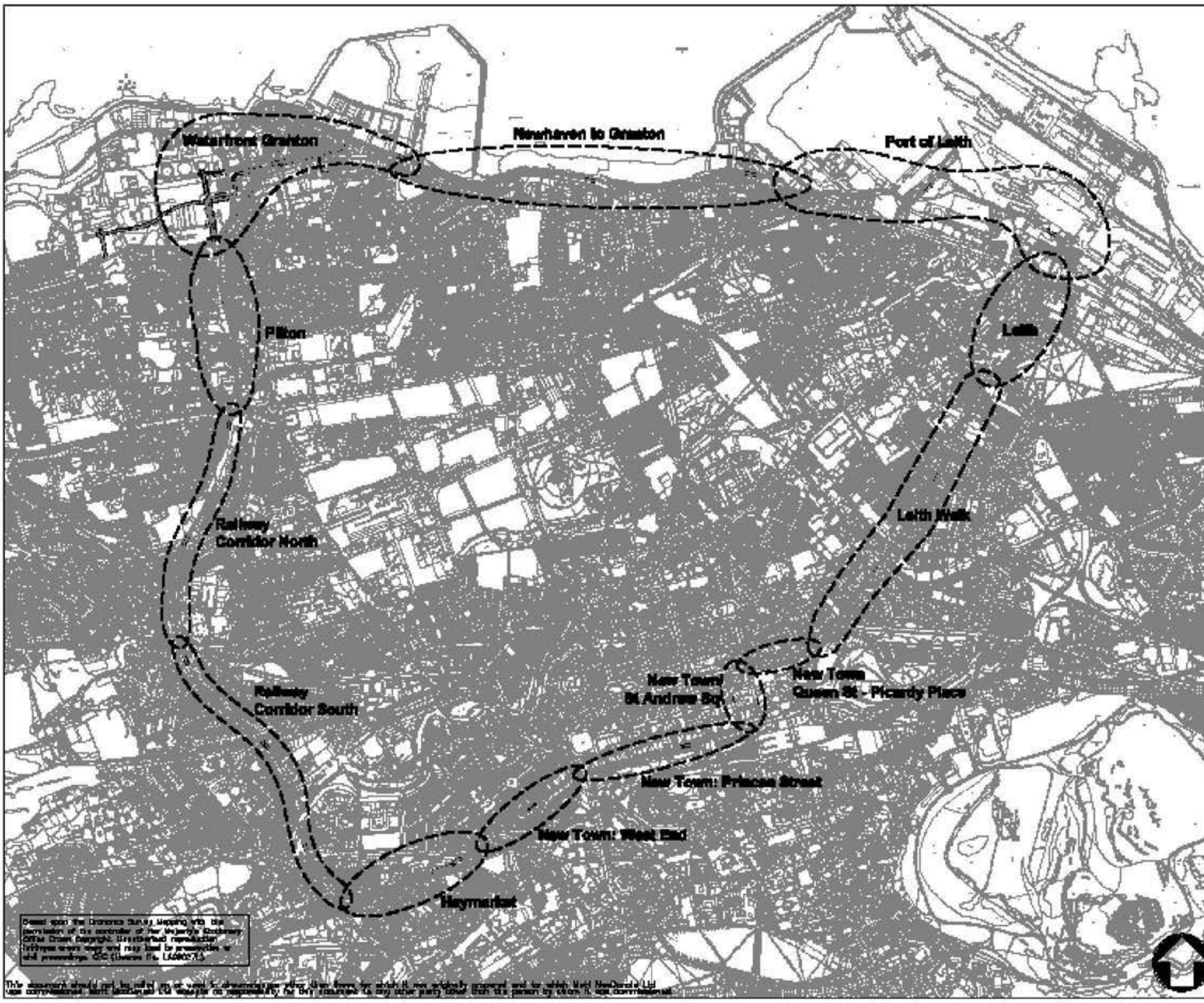
- A twin-track light rapid transit track-bed, generally at existing grade, paved in a variety of materials according to the situation;
- Stops with shelters, lighting, seating, ticketing and information;
- Tram vehicles;
- Overhead line equipment – conductor wires, supported on a combination of cables or poles;
- Substations;
- Signalling equipment and signs;
- The tram depot; and
- Alterations to various existing bridge and retaining wall structures.

Specific items, such as re-grading of parts of the railway embankment at Roseburn and alterations to structures, are highlighted below.

A number of major road junctions will be comprehensively redesigned and existing traffic will be diverted from the tram route in a number of places. There will be some townscape impacts off-site due to changes in traffic flows but these are not expected to be sufficient to cause significant impacts on the townscape.

The main sources of townscape impact will be the overhead infrastructure (wires and supports referred to as overhead line equipment (OLE)) new and altered structures such as bridges, new buildings, the tram depot and substations, and the tram stops with their associated shelters, seating, etc.

**Figure 7.16: Townscape Zones**




The tram signalling equipment and additional traffic signalling and signage will generally have small effects but they will add clutter to the streetscape and may in sensitive locations raise the overall townscape impact above a threshold for significant impacts.

The tram vehicles themselves will also have an impact in areas not currently trafficked, such as the railway corridor.

Construction activities for the tram will appear as an ordinary construction site of the sort common in urban areas, except that the sites will generally be long and linear, and will partially fill what are normally spaces within the fabric of the city. Many activities, such as the erection of the OLE supports and the equipping of the line will be of such short duration that their effect on the townscape is negligible. The location and disposition of the major construction compounds is unknown at the time of writing and cannot therefore be specifically assessed.

The tram will be a new element in the city, clearly visible to all and its impact will be dependent on the design of the system. There is substantial potential for mitigation through ensuring that the various new and altered elements are appropriately designed and integrated into the fabric of the city.

A Design Manual is being progressed which sets out the principles of urban design and detailing to be followed in the final design. This will provide specimen designs for key areas, including the whole of the World Heritage Site. Contract requirements will ensure that the final design complies with the Design Manual.

General mitigation commitments arising from the Design Manual include:

- Improvements to the pedestrian realm affected by the tram, including comprehensive wall to wall repaving of key areas;
- Careful design of the OLE to simplify the layout, balancing conductor wire and support cable sizes against support spacing so as to minimise the size of the wiring;
- Detailing and design of wire supports and their arrangement to suit the form of the street, particularly at junctions;
- Use of visually appropriate methods of OLE support, including designing a simple and elegant support column, attractive in its own right;
- Integrating the OLE supports with other vertical elements in the street (lighting and signing poles) as far as possible, and coordinating the spacing of new and existing poles, replacing existing lighting columns where appropriate;
- Simple alignment of the tram track to avoid as far as reasonably possible the need for complex OLE support structures or wiring, including straight alignments along the principal city centre streets to respect the formality of urban design of the New Town;
- Use of surfacing and kerb materials appropriate to the location, in accordance with CEC public realm guidelines;
- Coordinated and visually integrated design of tram stops, creating high quality pedestrian spaces, with the shelters, seating, signage and other equipment designed as an integrated whole, visually light and transparent.

*Impacts and mitigation commitments*

Haymarket

West of Haymarket Terrace, the introduction of the tram will have minor townscape impact. East of Haymarket Terrace, the tram will have a major adverse townscape impact on the edge of the New Town and the World Heritage Site.

The demolition of the Caledonian Ale House will have the effect of weakening the already poor enclosure to Haymarket Junction. However, the tram route and stop will visually widen the road at Haymarket Terrace so that Rosebery House appears to be the natural building line where at present it appears incongruously set-back. The widening and flaring out of Morrison Street will set back the future building line in a manner that will weaken the enclosure of Haymarket.

The tram stop itself will constitute a small area of major beneficial impact. The degree to which this offsets some of the major adverse impact above will depend on the quality of design of the area between the station and the stop.

New Town: West End

The West End, from Haymarket to Princes Street, is an architecturally coherent extension of the New Town, and part of the World Heritage site. The tram will run on road with a stop envisaged between Coates and Atholl Crescents. Overall the tram will have a major adverse townscape impact.

Mitigation commitments include use of a straight alignment along West Maitland Street and Shandwick Place to respect the formality of urban design of the New Town and development of a visually integrated design for the tram stop, creating a high quality pedestrian space. To accommodate the stop the edges of the gardens will be reconstructed and made good on a new line set back by up to 2 metres. The redesign and reconstruction of the affected parts of the garden spaces will be to a design and standard acceptable to Historic Scotland and CEC Planning Department.

There is the potential for further mitigation outwith the remit of Line 1 by taking the opportunity to comprehensively upgrade the whole of the garden spaces at Coates and Atholl Crescents.

New Town: Princes Street

The tram will run in a straight line along the centre of Princes Street, on an alignment designed to respect the formality of the street, and allow for the simplest, and thus least intrusive overhead wiring design. Where possible, it will also be designed to allow footway widening.

The works to the road will have a positive effect on the townscape, reducing the carriageway widths and simplifying kerb alignments. The OLE will have a negative effect, particularly in terms of the designed vistas and the iconic tourist views such as the Castle and Old Town skyline. The use of support columns in Princes Street is particularly sensitive because there are no existing permanent vertical elements in the street. For this reason a bespoke support column will be designed which will be attractive in its own right.

A stop is envisaged just east of Castle Street, positioned so that it does not affect the vista of the Castle from Castle Street. It will take the form of extended build-outs of the pavement across the near-side lane. The shelters and other equipment will be designed as an integrated whole, visually light and transparent to reduce their intrusion into views along Princes Street.

Overall the introduction of the tram to Princes Street, despite the committed mitigation, will have a major adverse townscape impact, primarily arising from the OLE.

There is the potential for further mitigation outwith the remit of Line 1 by taking the opportunity to comprehensively redesign and upgrade Princes Street as a whole.

New Town: St Andrew Square

St Andrew Square marks the end point of George Street and is a key element in the formal layout of the New Town. Between Princes Street and Queen Street the tram will run single-track, northbound up South St David Street and down North St David Street and southbound along the equivalent route on North and South St Andrew Streets. Stops are envisaged between St Andrew Square and Meuse Lane, so that they do not impact on the square itself or the vista down George Street, and so they are as close as practical to Waverley Station.

The OLE and the stops will have a major adverse townscape impact through this section, particularly on the designed vista from South St David Street to the Scott Monument.

There is the potential for further mitigation outwith the remit of Line 1 by integrating the design of the tram fully into the planned townscape improvements to St Andrew Square.

New Town: Queen Street to Picardy Place

Similar to the West End, although broader and more austere, this is also part of the World Heritage site and highly sensitive. The northbound tram will run on-street single-track on Queen Street and both north and southbound trams will run twin-track in a straight alignment along the centre of York Place.

In order to accommodate road traffic, two vehicle lanes will be maintained in each direction. This requires the widening of York Place by approximately 3m and replacement of the kerb on the south side between North St Andrew Street and Elder Street East by a low retaining wall. The OLE will have a negative effect particularly in terms of the introduction of support poles into the streetscape of York Place, which currently has no vertical elements apart from the buildings.

Overall the introduction of the tram to Queen Street and York Place, despite the committed mitigation, will have a major adverse townscape impact, primarily arising from the OLE and the level changes.

Leith Walk

The junctions at the top of Leith Walk will be entirely reorganised, with the roundabouts at Picardy Place and London Road both replaced by T-junctions. The introduction of segregated running tram lines will entail the widening of Leith Walk between these junctions, with consequent loss of pavement space at Antigua Street and at Greenside Place in front of the Playhouse and the Omni Centre. The trees at Picardy Place and in front of St Mary's Cathedral will be lost, opening up the space and losing the sense of enclosure to the cathedral. The new large traffic island in front of Picardy Place provides the opportunity to partially fill the void in the townscape created by this junction.

At Elm Row, the south end of the decorative railings, hedge and line of trees will be truncated but these will be reinstated to match the existing on a new line to suit the revised road layout.

Down Leith Walk the tracks will generally follow the alignment of the street, along the centre of the road, but weaving slightly at a number of places to allow for right turn lanes. The OLE will consist of conductor wires supported from span wires between kerb mounted poles. This will have a negative effect on the townscape, particularly in the long views down Leith Walk. To mitigate this, **tie** have committed to the integration of the layout and design of span wire supports and design and positions of street lighting columns to give an ordered layout of a family of columns, including the replacement of the existing street lighting.

At the north end of Leith Walk, some minor road widening and realignment of parking and loading bays will be required which is likely to lead to the loss of a proportion of the existing street trees.

Stops are envisaged at Picardy Place, MacDonald Road, Balfour Street and the foot of Leith Walk, all currently as island stops designed to appear as well-detailed slightly raised areas of pavement, with Picardy Place linked to the large pedestrian traffic island.

Overall the introduction of the tram to Picardy Place and Leith Walk, despite the committed mitigation, will have a negative townscape effect of high magnitude, primarily arising from the OLE, the removal of the maturing trees and the prominent location of the Picardy Place tram stop.

Leith

The tram route will run on-street, sharing road space with all other traffic through Leith from the foot of Leith Walk along Constitution Street to the dock gates at Constitution Place, with a stop at the old town centre between Queen Charlotte and Bernard Streets.

Apart from the area of the stop and minor junction alterations at Bernard Street, the alterations to the streetscape will be minimal. The main mitigation of potential impacts will be to support the OLE from span wires fixed to buildings where practical, to minimise the requirement for kerb mounted poles, and to carry through a coordinated and visually integrated design for the tram stop, creating a high quality pedestrian space and including improvement to the pedestrian realm in the vicinity.

The old town centre of Leith has a distinctive small-scale local character that is highly sensitive to change. The introduction of the tram, despite the committed mitigation, will have a major adverse townscape impact on this Conservation Area, primarily arising from the OLE and from the tram stop partially filling what is presently a void in the townscape.

There is the potential for further mitigation of the impact of the tram in Leith, outwith the remit of **tie**, by extending the streetscape improvements associated with the stop to encompass the whole of the old Leith town centre.

Port of Leith

The tram route will run partly on-road and partly on new roadside segregated alignments as part of redevelopments, from Constitution Street along the line of Ocean Drive to Ocean Terminal, and along the dock road past the entrance to Chancelot Mill. A ramp will be constructed to link from the dock road up to join Lindsay Road at Anchorfield. There will be two stops, at Ocean Terminal and on Ocean Drive between Constitution Street and Tower Place.

The tram depot will be located just inside the port area, on the east side of the route, immediately north of the dock gates on Constitution Street. The depot building will, by its very nature, take the form of a large industrial shed, albeit well designed and detailed. The size and position of the depot is such that it removes the potential for making the dock area more 'permeable' - new routes into future dock development areas will not be possible. Careful consideration will therefore be given to the quality of pedestrian routes provided around the edge of the site, as well as to the frontage treatments.

In the industrial parts of the port, the tram will be an additional element with a minor impact on the townscape. In the areas currently being redeveloped it will form part of a much wider townscape change: the introduction of overhead cabling and the Ocean Terminal tram stop will have a moderate townscape impact but they will be minor elements compared with the much larger scale changes caused by the redevelopment.

The main mitigation commitment in the port area is the coordination of the design for the tram and for the new developments to ensure, as far as possible, the proper integration of the tram with the new townscape.

Newhaven to Granton

The tram will run from Newhaven to Granton along the waterfront, a quiet, primarily residential, seafront with open views to the Forth. Detailed alterations to the road alignment will be required along much of the length and stops are envisaged at Newhaven, adjacent to Great Michael Square, and at the east end of Lower Granton Road.

Starbank Road is particularly narrow with restricted pavement widths and in a 'Do Nothing' scenario restrictions will have to be imposed on frontage access and informal parking. Abuse of this will impact a tram timetabling. Mitigation is proposed in the form of a new 3 metre wide footway and cycle path provided on the seaward side of the existing sea wall. As this is progressed, the environmental effects on the bird life will have to be further investigated, and liaison on the form undertaken with the City planners.

The route between Trinity Crescent towards Granton Square will be segregated, on street. The arrangement will be one of segregated running to the north of a revised alignment for Lower Granton Road. The revised arrangement offers better provision for parking by residents and improvement in noise and vibration levels caused by traffic, which currently runs close to residential properties. This alignment also addresses the issues associated with right turns and the aspects of loading points for buses. The tram road alignment to the north also provides the opportunity to use grass track and therefore improve the aspects of urban space being provided.

The introduction of the tram to this area, despite the committed mitigation, will have a major adverse townscape impact in the Newhaven Conservation Area and a moderate adverse townscape impact elsewhere, primarily arising from the partial enclosure that the OLE will give to the open sea-front sections of the line. A well designed stop at Newhaven could have a moderate beneficial impact by providing a focus and visual and functional link between the old village and the new harbour-side developments.

Waterfront Granton

The tram route runs through the Granton Waterfront development area from Granton Square to West Granton Access at the northern edge of Pilton. As the area is currently undergoing comprehensive redevelopment, the tram alignment has been determined primarily through the development master-planning process. Through much of the area, the tram will form part of a transport boulevard, with short sections of roadside segregated track. A stop is envisaged at Granton Square and two at key locations within the new development.

The scale of redevelopment of the Granton Waterfront area is so extensive that its character is primarily one of change, and it will be only slightly sensitive to further change. The townscape impact of the tram will therefore be minor and neutral.

The stop envisaged at Granton Square has a potential positive effect on the townscape by reinforcing what is currently a rather neglected nodal point in the urban fabric.

As in the Port of Leith, the main mitigation commitment is the coordination of the design for the tram and for the new developments to ensure, as far as this is possible, the proper integration of the tram with the new townscape.

Pilton

The tram route runs along a reserved corridor on the west verge of the recently constructed West Granton Access, which cuts a broad and still fairly raw swathe through this area of social housing. A stop is envisaged approximately mid-way and access to the east may be provided by demolishing a property on Crewe Road West to allow a footpath link.

The road corridor is separated from the neighbouring estates by substantial timber noise barrier fences and hedges and grass verges with a little planting. The construction of the tram will involve the loss of the verge and some planting, and the opening up of the temporary infill under part of the span of the bridge carrying West Pilton Place across the road. To mitigate this, it is envisaged that the track-bed will be infilled with grass and that boundary hedges will be planted where the space permits. The creation of the transport corridor has already had a significant major adverse townscape; the addition of the tram will have minor impact.

Railway Corridor

The tram will follow the former railway solum, now a linear open space and well used cycle and pedestrian path, from Ferry Road to the point where it meets the existing heavy rail just west of Haymarket. Stops are envisaged at Ferry Road, Telford Road, Craigleith and Ravelston Dykes.

The northern end of this corridor is a broad strip of neglected open ground, overgrown grass and shrubs bounded by low-rise housing and in part opening out onto a lightly used playing field. The southern half is mainly a lush woodland valley below surrounding residential areas but occasionally surfaces to level and in parts runs on embankment. A continuous overgrown hedge lines the path on either side and defines the boundary of the corridor. Stone bridges, extensive stone retaining walls and old platforms act as reminders of the former railway. Parts of the route can feel somewhat insecure and remote, particularly at night, because little of it is overlooked.

Alterations will be required to all the smaller bridges that the tram runs over, as well as the bridge over the A8 at Roseburn. Works will also be required to the Coltbridge viaduct, but the finishes will be reinstated such that there is no significant change to the appearance of the structure. At both ends of the corridor, the existing railway corridor is on embankment and substantial re-grading will be required to ramp the line down to existing grade.

The safety clearances required for the OLE, together with the combined width of the tram tracks and the cycle/foot path, mean that extensive tree clearance will be required, opening up the current enclosed nature of the railway corridor. In places, small retaining structures will be required to allow for the widening.

Significant major adverse landscape impact will be caused by the vegetation clearance although this opening up and the increased activity may make the railway corridor feel safer to cyclist and pedestrian users. Townscape impacts may be caused by work to the bridge at Roseburn. Committed mitigation includes replacement planting, sympathetic boundary treatments at pinch points, and appropriate and sympathetic design of the alterations to the structures.

*Summary*

Although the scheme provides opportunities for enhancing the local landscape in certain areas, adverse impacts would occur at varying degrees in different locations along the route. Table 7.15 summarises the landscape impacts for each area affected by the scheme.

**Table 7.15 Summary of Landscape Impacts**

| Location | Description | Importance | Impact |
|---|---|---|---|
| Haymarket | Potentially complex OLE support. Road alterations and demolitions weaken enclosure of junction area. Tram stop should improve Haymarket Terrace. | World Heritage Site<br>New Town Conservation Area (CA) | West of Haymarket Terrace: minor adverse to minor beneficial.<br>East of Haymarket Terrace: major adverse.<br>The tram stop: small area major beneficial. |
| West End | OLE in designed vista. Road widened into gardens. | World Heritage Site<br>New Town CA<br>West End CA | Major adverse. |
| Princes Street | OLE in designed vista and iconic tourist views. Footway widening. | World Heritage Site<br>New Town CA | Overall major adverse, primarily arising from the OLE. Footway widening beneficial |
| St Andrew Sq | OLE in designed vista and iconic tourist views. | World Heritage Site<br>New Town CA | Major adverse impact. |
| Queen St to Picardy Pl | OLE in designed vista. Road widened and awkward level changes. | World Heritage Site<br>New Town CA | Major adverse impact. Particular impact on National Portrait Gallery. |
| Leith Walk | Road widening and loss of enclosure, but also improvement opportunity at top of Walk. OLE particularly visible in long views. Loss of street trees at north end. | World Heritage Site (part)<br>New Town CA (part)<br>Leith CA (part) | Overall major adverse impact. |
| Leith | Distinctive small-scale local character, highly sensitive to | Leith CA | Major adverse impact |

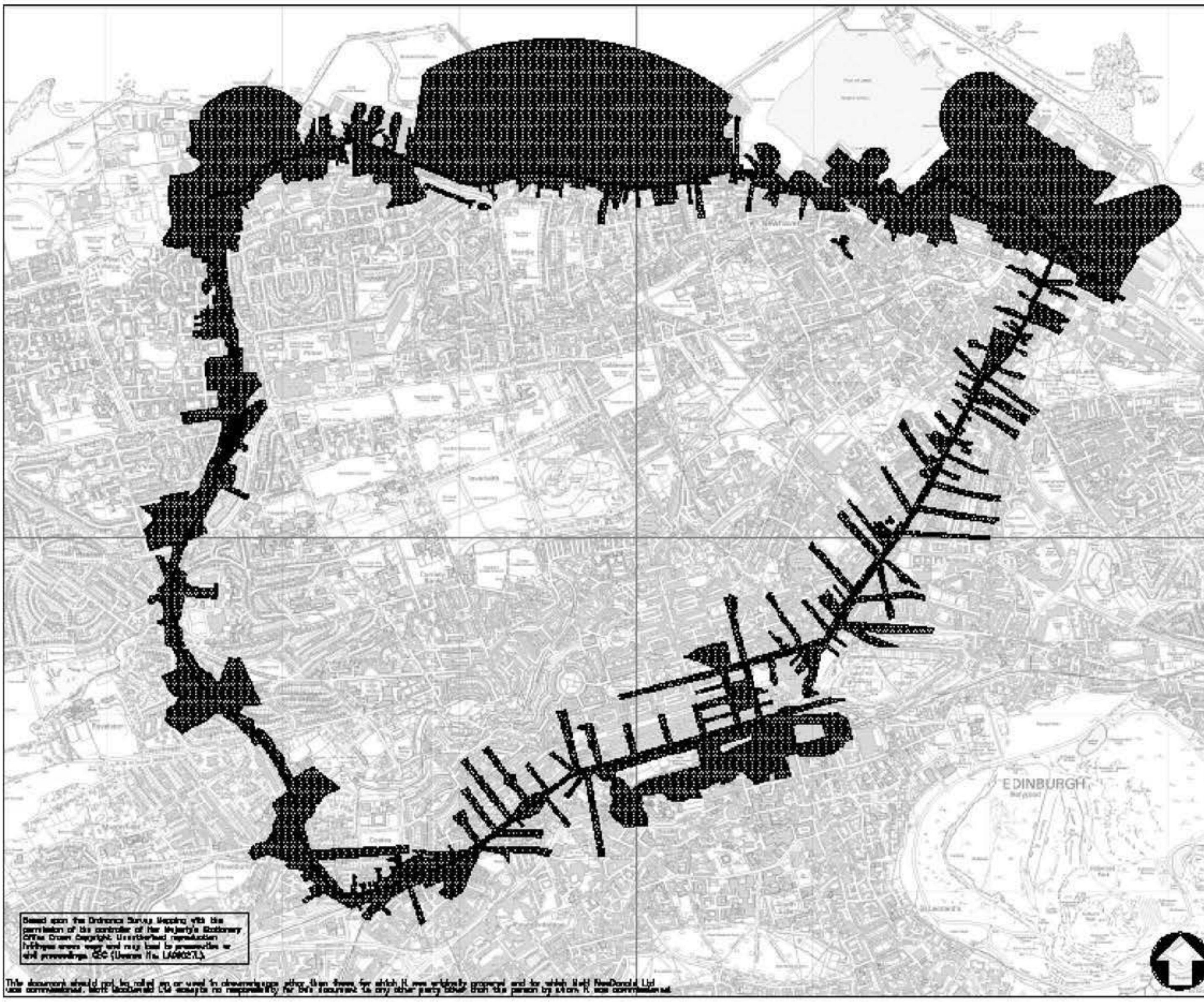
| | | | |
|---|---|---|---|
| | change. | | |
| Port of Leith | Tram a minor additional element in industrial parts, part of a much wider change elsewhere. | Leith CA (part) | Generally, minor impact, moderate in limited areas. |
| Newhaven to Granton | OLE will partially enclose open sea-front sections. New footpath at Starbank beneficial. | Newhaven CA (part) Trinity CA (part) | Stop at Newhaven moderate beneficial impact if well integrated. Moderate adverse impact elsewhere. |
| Waterfront Granton | Part of a much wider change. | - | Minor to neutral impact. |
| Pilton | Tram will be a minor addition. | - | Minor adverse impact. |
| Railway Corridor | Significant vegetation removal required. | Coltbridge and Wester Coates CA (part) | Major adverse landscape impact |

### 7.3.7 Visual Amenity

Visual impacts are changes in the composition and character of views available to people living, working and recreating in the area affected by the proposed development, changes in the visual amenity enjoyed by those who benefit from those views, and people's responses to these changes.

By definition, visual effects can only occur where the tram system is visible. Along much of the route, the tram and its infrastructure will be seen from a comparatively restricted area: from buildings facing directly onto the tram line and from streets that cross the line. The buildings that form the streets generally block views from further afield. The exceptions to this are where the tram runs through or alongside open space – most importantly along Princes Street, but also through parts of the Port of Leith, along the waterfront from Newhaven to Granton, and through parts of the Granton Waterfront development area. Figure 7.17 shows the area from which it is anticipated that the tram will be visible: the 'visual envelope'.

**Figure 7.17: Visual Envelope**




This section:

- Describes the extent of the area affected by Tram Line 1;
- Considers the sensitivity of the various receptors of visual impact;
- Defines the extent of visibility of the proposals and the potential visual impacts; and
- Sets out the measures proposed for the mitigation of these impacts.

*Approach*

Consultations regarding the visual impacts of Tram Line 1 have been undertaken with the City of Edinburgh Council City Development (Planning), Historic Scotland and Edinburgh World Heritage Trust.