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 in-filled 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 will need to be replaced by semi-mature specimen trees of a minimum 30cm girth aligned to suit the revised design, which itself will 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 Vehicle Technology

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.

6.2.1 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.

6.2.2 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.

6.2.3 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.

6.2.4 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 STAG2 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 ($4/m^2$) normal load	100 – 230
Passenger capacity ($6/m^2$) 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)	$1.00m/s^2 - 1.30m/s^2$
Maximum service braking rate	$1.10m/s^2 - 1.30m/s^2$
Minimum emergency braking rate	$3.0m/s^2$
Operational acceleration and braking rate	$0.9m/s^2$ (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 "lawned" 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. To ensure that the design quality is commensurate with a City of Edinburgh's standing, a Design Manual has been developed. The Design Manual addresses, amongst other things, the Principles of Design for Surfacing and states:

> *"The tramway surfacing will be influenced by its environment/context. The final palette of materials selected must be capable of satisfying equally aesthetic and technical requirements. As part of the Partnership Working Framework, where agreement has been reached with CEC [City of Edinburgh Council], certain areas of streetscape may be subject to additional funding initiatives to enhance the environment.*
>
> *Where appropriate, preference will be given to natural materials, especially in historic areas.*
>
> *The extent of the area to be resurfaced will be influenced by technical conditions of each location and the prerequisite to provide a seamless fit with the surrounding streetscape*

context. The overarching objective is to ensure that all the available space is used positively to improve and extend the public realm."

The extent of surfacing works following this approach has been costed based on the following reinstatement criteria:

- 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

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 will 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 cyclists 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 will 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. 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 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

25%, 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	25%	54,830,000	54,830,000
Total			**274,150,000**

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 re-profiling 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.

The capital costs of the system will be met from a number of sources, including grant-funding from the Public Transport Fund and private sector financial contributions, since the scheme is beneficial to the operation of a number of businesses, developers and enterprises. Revenue will cover operating costs.

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 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.

It should be noted that these figures are average hourly flows, and do not take account of a 'peak within the peak'. Short term loadings, in terms of their equivalent hourly flows, could therefore be expected to be rather higher than indicated, and it is therefore desirable to allow some 'headroom' between hourly flow and capacity.

[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.

Table 6.4 Passenger Flows - Maximum by Sector

Forecast Year	Time Period	Western Sector (City Centre to Lower Granton Road via Crewe Toll)		Eastern Sector (City Centre to Lower Granton Road via Leith Walk)	
		Clockwise (pass/h)	Anticlockwise (pass/h)	Clockwise (pass/h)	Anticlockwise (pass/h)
2011	AM Peak	844	1,414	912	483
	Interpeak	368	498	498	294
	PM Peak	1,247	750	954	641
2026	AM Peak	1,126	**2,422**	1,620	755
	Interpeak	505	**673**	585	349
	PM Peak	**1,989**	1,106	1,653	872
Line capacity (total)		1,840 each direction (at 4 standing passengers per m^2)			
Line capacity (seated)		640 each direction			

Notes: For the peak periods, the figures shown in **bold** are in excess of total capacity (at 4 standing per m^2)
In the interpeak period, the figure shown in **bold** is the only one in excess of seated 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 1,989 pph exceeds capacity by about 8%. This would mean that the standing density would be more than 4 per m^2, but by only a small amount. The demand forecasts indicate flows exceeding capacity over the section from the City Centre as far as Craigleith, but beyond Haymarket the excess would be only 2-3%, which not significant.

Secondly, the morning peak anticlockwise flow on the western sector, at 2,422 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. Higher standing densities are 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 such fine-tuning 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. However, the forecast year 2026 is a considerable way into the future and it is possible that other general changes will have take place by then, such as the acquisition of additional trams. The excess of demand over capacity in 2026 on one section of route is not, therefore, considered to be a significant issue at this stage.

With the exception of the section discussed above, flows are below capacity by a sufficient margin to allow for some short term peaking of demand within the peak hour without breaching the standard of 4 passengers per square metre.

In the **interpeak,** flows are within the seated capacity provided by a service of 8 trams per hour, with one minor exception. This is the flow of 673 on the western sector, anticlockwise, in 2026. However, even here the excess is only about 5% and is maintained for only a short distance.

Thus, in the interpeak a seat would be available to any passenger who wanted one, bearing in mind that a proportion of passengers typically 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 is consistent with existing UK systems, which in most cases operate at the same frequency all day. (The main exceptions are Nottingham, which runs at 8 tph in the inter-peak and 10 tph in the peaks, and Manchester, which operates at an enhanced frequency in the AM peak only).

Outside the main weekday time periods (peak and interpeak), 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. Operator profits are specifically excluded, on the basis that for most UK tram schemes, where a PFI style procurement is typically employed, the revenue risk is taken by the concessionaire and hence the level of profit is given by the difference between revenues and operating costs.

Operating cost estimates

Table 6.6 shows a summary of the operating cost estimate together with some operating statistics output from the model: the overall net operating cost estimate is £5.82m per annum.

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**		

DPOF Operating cost estimate

An operating cost estimate for Line 1 has been independently developed by the operator appointed under the DPOF agreement (see section 8.2.7). This estimate, of **£6.287m per annum**, includes operator profit in the total cost estimate, whilst the estimate presented above is net and excludes profit.

Given the commercial sensitivity of the profit level sought by the operator, it is not possible to explicitly state what the operator profit margin would be. However, assuming a reasonable mark up on the estimate, the operator estimate is broadly consistent with the STAG estimate above.

At the current time, the envisaged procurement route for Line 1 is for **tie** and its partners to assume the revenue risk, with the operation of the system being undertaken by a private operator and a fee paid to them by **tie**. On this basis, the operating cost derived by the operator is employed within this STAG appraisal.

6.7 Bus Network

6.7.1 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; and
- 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 are 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 therefore sets out a set of potential bus network changes, focusing on 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 development of these changes takes cognisance of the relative economic and financial impact on the case for Line 1. The best economic case (Cost to Government) will be produced where the bus services are left unchanged; however, this will produce the weakest financial case for both Line 1 and bus. In essence, Line 1 would add significant public transport supply (albeit with some increase in public transport demand due to transfer from car) diluting the available revenue to the various public transport operators. Removal of bus services will improve the financial case for both bus and Line 1, since the reduction in bus operating costs would compensate for the reduction in bus revenue and the demand and revenue for Line 1 would increase as bus passengers seek alternative routes. However, the removal of bus routes will impact on those passengers remaining on the bus network, reducing the economic benefit of Line 1.

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 Line 1 is introduced. However, it is necessary to take a 'snapshot' view of the network in order to provide the basis for assessment.

The final configuration of an integrated bus/tram public service will be developed by the City Council and **tie** as part of the DPOF process with the appointed tram operator and existing bus operators at an early stage of the project. It is recognised that this is an area of project risk and how this is being managed is set out in Chapter 8.

6.7.2 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. 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.

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): 1: Clermiston-City Centre-Easter Road-Ocean Terminal 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	
C	Inverleith Road	27	10	
D	Orbital via Granton and Leith	32/ 32A	20	
D	Orbital via Crewe Rd	38	20	

6.7.3 Potential Bus Changes

The potential changes to the bus network, set out in Table 6.8, 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
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**

Corridor		Existing		Proposed		Change		% change
		bph	pph	bph	pph	bph	pph	bph & pph
A	Leith Walk	49	3,430	27	1,890	-22	-1,540	-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	1,610	16	1,120	-7	-490	-30%
C	Inverleith Road	20	1,400	17	1,190	-3	-210	-15%
D	Orbital	6	420	6	420	0	0	0%
Total		**111**	**7,770**	**80**	**5,600**	**-31**	**-2,170**	**-28%**

The notional reduction in capacity of around 2,200 places per hour will be broadly offset by the capacity supplied by tram Line 1. At 8 trams per hour, this will be approximately 2,000 passengers per hour per direction on each side of the loop (4,000 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 1,540 places per hour is offset by 2,000 per hour by tram.

6.7.4 Resource implications

An estimate of the savings that 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 represents an annual saving of around £2.2 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.

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

6.7.5 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 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).

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 should be driven by a limited number of key objectives within the STAG process. On this basis, we elected to undertake a restricted 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 will be carried forward as an integral part of a full loop, potentially resulting in a single Preferred Route.

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. It is important to 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 will be likely to increase the cost of George Street compared to Princes Street. The run times are slower on George Street, but this option is expected to 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.

The appraisal of environmental impacts indicates that there are likely to be adverse impacts from both options but that those of the George Street option will be greater. The George Street option is expected to lead to greater noise impacts, as a result of the quieter evening and night-time environment compared to Princes Street. Both options will have large adverse effects on visual amenity and the city centre townscape but the impact is considered to be greater on George Street. The enclosed layout, designed vistas and high architectural quality of George Street, combined with the human scale of the buildings, means that the tram is likely to more dominant than in Princes Street. Charlotte Square, with its intact architecture and generally smaller scale, is particularly sensitive. Although the adverse impact on the townscape will still be large, Princes Street is judged to be less sensitive because of its more variable architectural quality and because it is already a major public transport corridor; the tram will only re-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 tend to 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 is likely to 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. As stated previously, 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, which will further increase the cost of the Telford Road option. The tram run times are slower on Telford Road, with an impact on highway operations, compared to the former railway solum which is completely segregated.

Environmentally, the Telford Road option would produce 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 maximises 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 allows better transport integration. Accessibility to the Western General Hospital is maximised by the Telford Road option; the former railway solum option gives 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: Restricted STAG2 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* *PV Costs*	£m £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 • To reduce pollution • To reduce congestion • 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 have an 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;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: Restricted STAG2 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* *PV Costs*	£m £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 • To reduce pollution • To reduce congestion • 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. Large 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. 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 10.5m p.a. (assuming railway corridor alignment at the Telford Rd 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: Restricted STAG2 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* *PV Costs*	£m £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 • To reduce pollution • To reduce congestion • 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 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	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	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	direct access. On-street alignment reduces highway capacity, with negative impact on non-user 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: Restricted STAG2 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* *PV Costs*	 £m £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 • To reduce pollution • To reduce congestion • 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 providing 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 will 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 Central Case Definition

This section provides a summary of the transport impacts from the implementation of the Central Case (Line 1 option), which has been modelled with basis on the following assumptions:

- Line 1 with 8tph and a run time of 40.5 minutes (with a 4.5 minute layover assumed at Lower Granton Road, giving 45 minutes in total);
- 23 stops, corresponding to those presented at public consultation, but with two stops on Princes Street (see section 7.2.2 below);
- Fares parity with buses;
- Bus network changes as set out in Section 6.7; and
- Unchanged bus speeds between the Reference Case and Line 1 (see Section 6.7.5).

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.

Earlier designs 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 micro-simulation model (VISSIM) to ensure that the tram and bus run times are not penalised. As part of the revised configuration the two stops on Princes Street were rationalised into one more centrally located stop revising the total number of stops to 22. 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 tram appraisal had begun and therefore was not specified within the original scope of the work specified for this stage. Its impact on the current design of appropriate integrated layouts is under high-level review. No detailed consideration of CETM is taken into account within the current reports.

7.2.3 Transport Impacts

This section sets out the demand for Line 1 and the associated impacts on other public transport demand and on the highway network. The information presented here is based on the outputs from a comprehensive computer based transport modelling process; 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.

Demand forecasts for Line 1 were previously undertaken at OBC (see Section 4.2.1); the forecasts presented here are based on the latest modelling analysis using a more comprehensive and robust modelling tool. It is considered that use of the current modelling tool would broadly replicate the results presented in the OBC in relative terms, but with lower demand levels across the options. In that context, the conclusions of the OBC remain robust.

The impact on overall travel demand[20] 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, but significant nevertheless.

Table 7.5 Hourly Travel Demand (Person Trips) by Public and Private Transport

		2011			2026		
		AM	IP	PM	AM	IP	PM
Reference Case	Public transport	45,595	27,484	42,030	48,555	28,501	46,174
	Private car/LGV	172,293	130,079	201,140	218,546	160,317	252,245
Line 1	Public transport	46,980	28,442	43,406	52,484	30,769	49,007
	Private car/LGV	171,696	130,060	200,723	216,472	160,430	250,329
Differences	Public transport	1,385	958	1,376	3,929	2,268	2,833
	Private car/LGV	-598	-19	-417	-2,074	113	-1,916

Table 7.6 presents the Line 1 aggregate demand by modelled period (morning peak, inter-peak and afternoon peak) and year (2011 and 2026). Broadly, the demand is comparable by direction, with the clockwise direction being materially higher in the PM peak. Annual demand is forecast at some

[20] Throughout the modelled area of Edinburgh and its environs.

9.44m in 2011[21], growing strongly to reach 13.69m by 2026. This growth is largely as a result of increasing traffic congestion making the tram increasingly attractive. The estimated revenue is £6.59m and £9.62m, respectively, giving average fare yields of around 70pence/trip. This is in line with expectations, given the current fare scales, ticket mix and ticket fraud assumptions.

Table 7.6 Hourly Line 1 Demand

	2011			2026		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**
Clockwise	2,010	1,208	2,131	3,175	1,485	3,376
Anti-clockwise	2,040	1,063	1,727	3,231	1,349	2,395
Total	4,050	2,271	3,858	6,406	2,834	5,771
Annual demand		9.44m			13.69m	
Annual revenue (£m, 2003 prices)		£6.59m			£9.62m	

A significant proportion of this demand is trips new to public transport; this is illustrated in Table 7.7. These new public transport trips include trips transferring from car and generated trips (trips that were not made at all previously or additional trips arising from increases in trip frequency). In 2011, some 16%-20% of Line 1 demand will be new public transport passengers; this will increase up to 28% in 2026. These estimates compare well with observed data from existing light rail systems, which typically have around 20% of demand being former car users.

Table 7.7 Hourly Line 1 Demand from New PT Trips

	2011			2026		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**
Central Case Demand	4,050	2,271	3,858	6,406	2,834	5,771
of which new PT demand	794	364	708	1,793	659	1,178
% of Central Case	20	16	18	28	23	20

The impact on public transport demand is significant, as demonstrated in Table 7.8, in terms of the number of boardings by mode, presented by modelled hour (morning peak, inter-peak and afternoon peak) and year. The impact in 2011 reduces bus demand by some 2,400 boardings in the peaks and around 1,200 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.

[21] This compares to some 20m previously estimated in the Waterford Transit Modelling Report (2001) for the tram option – see Table 4.1. Demand for the guided bus option has not been estimated at this study stage, but would be expected to reduce proportionately from the original 9.3m.

Table 7.8 Hourly PT Boardings by Mode

Test	Mode	2011			2026		
		AM	IP	PM	AM	IP	PM
Reference Case	Bus	41,400	26,290	40,255	41,910	27,085	41,932
	Rail	10,878	3,851	8,905	16,545	5,128	14,403
	Line 1	0	0	0	0	0	0
	Total	52,278	30,140	49,160	58,455	32,213	56,335
	(Demand	*45,595*	*27,484*	*42,030*	*48,555*	*28,501*	*46,174)*
Line 1	Bus	38,996	25,080	37,887	39,942	26,766	38,783
	Rail	10,952	3,852	8,952	17,416	5,234	15,034
	Line 1	4,050	2,271	3,858	6,406	2,834	5,771
	Total	53,998	31,203	50,697	63,764	34,834	59,588
	(Demand	*46,980*	*28,442*	*43,406*	*52,484*	*30,769*	*49,007)*
Changes	Bus	-2,404	-1,210	-2,368	-1,968	-1,039	-3,149
	Rail	74	1	47	871	106	631
	Line 1	4,050	2,271	3,858	6,406	2,834	5,771
	Total	1,720	1,062	1,537	5,309	1,901	3,253
	(Demand	*1,385*	*958*	*1,376*	*3,929*	*2,268*	*2,833)*

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 Inter-peak 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

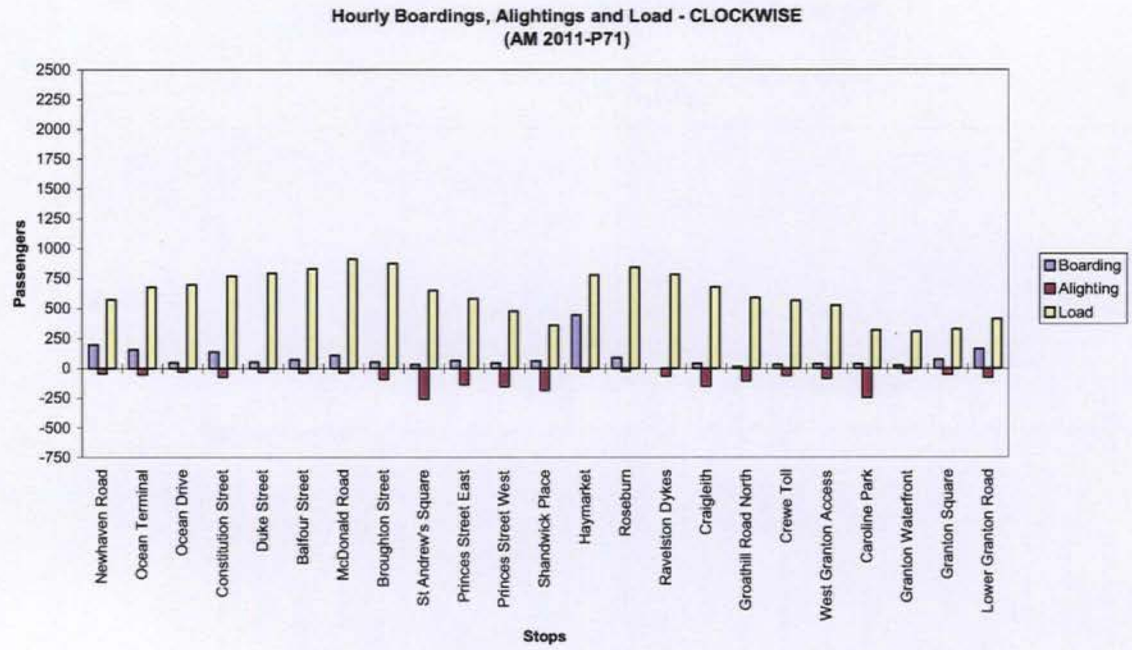


Figure 7.2 2011 AM Anti Clockwise Flows

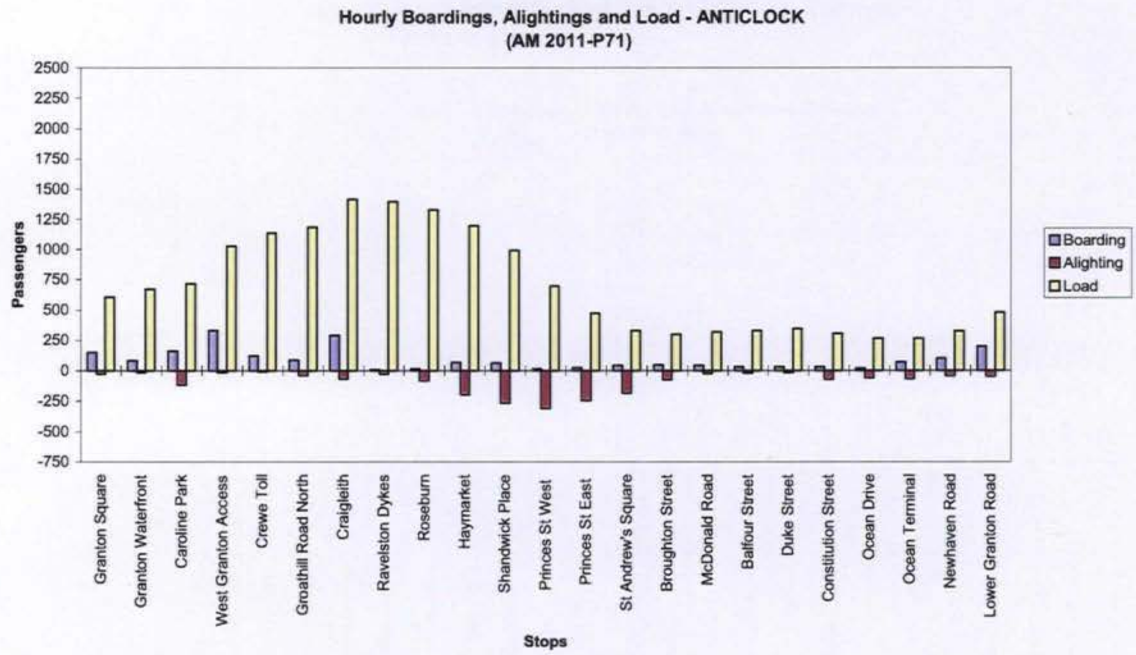


Figure 7.3 2011 IP Clockwise Flows

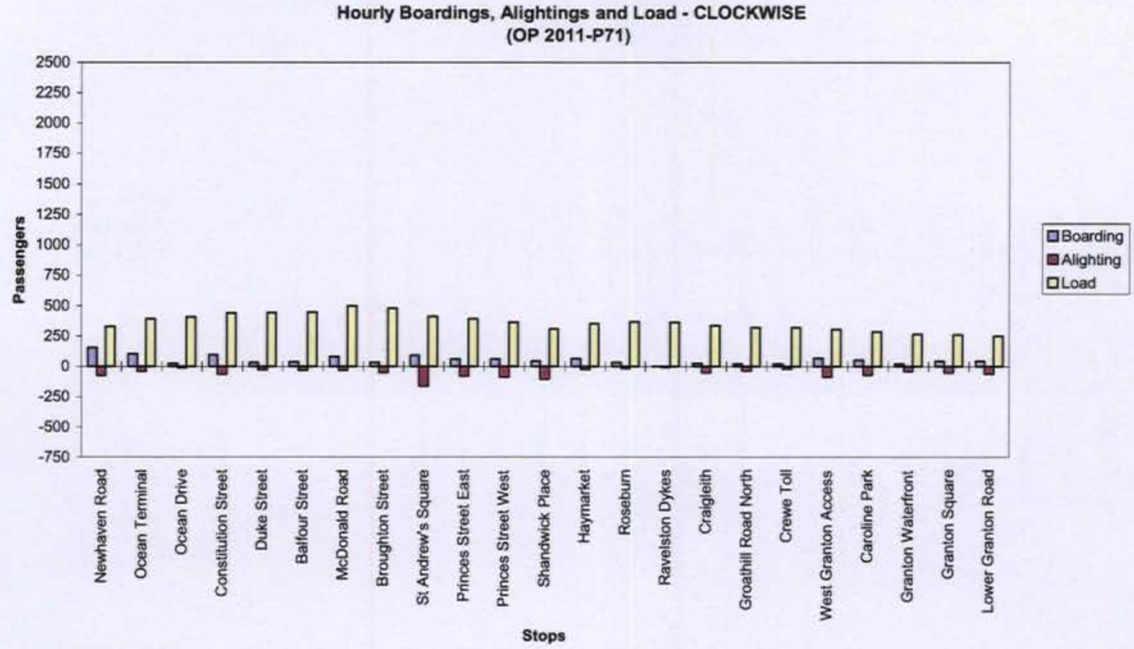


Figure 7.4 2011 IP Anti Clockwise Flows

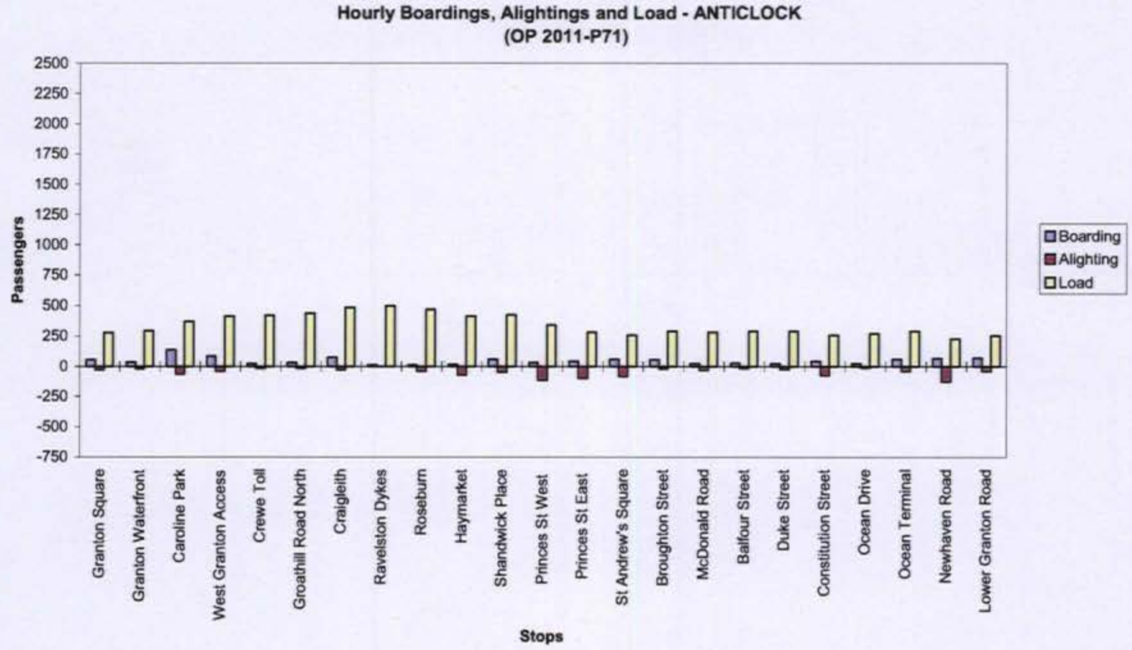


Figure 7.5 2011 PM Clockwise Flows

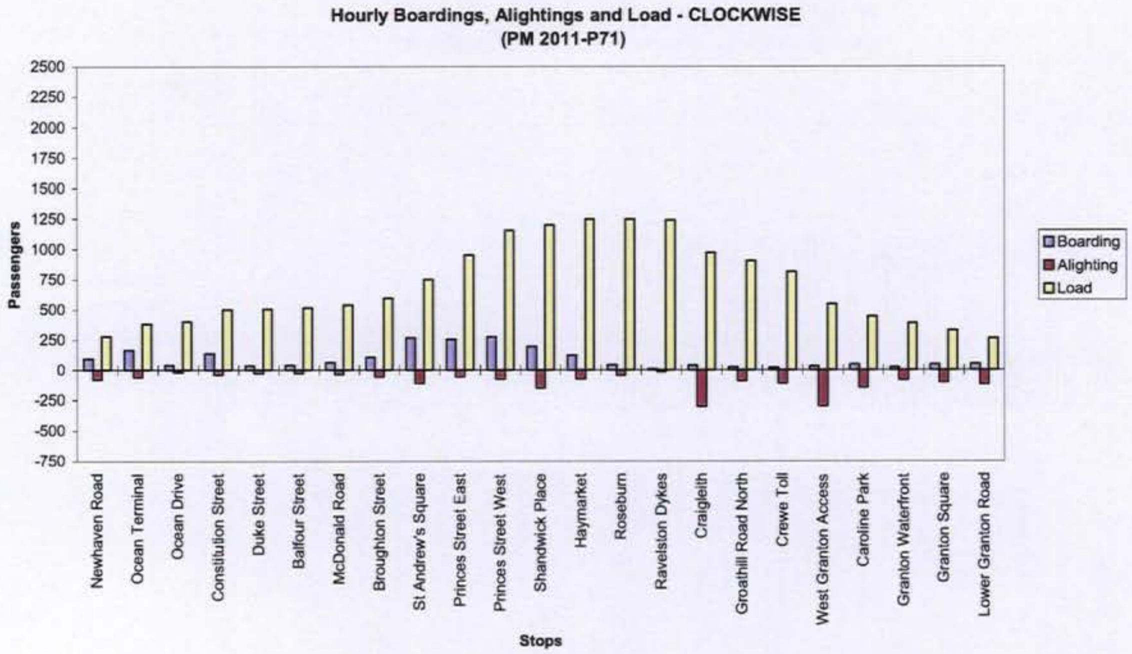


Figure 7.6 2011 PM Anti Clockwise Flows

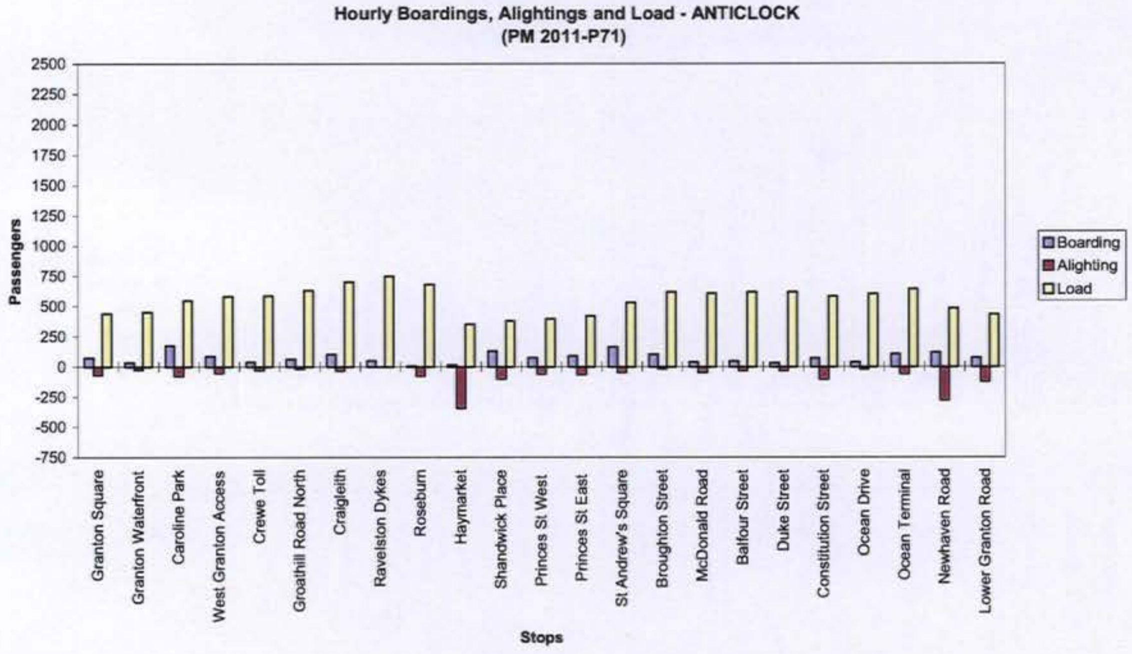


Figure 7.7 2026 AM Clockwise Flows

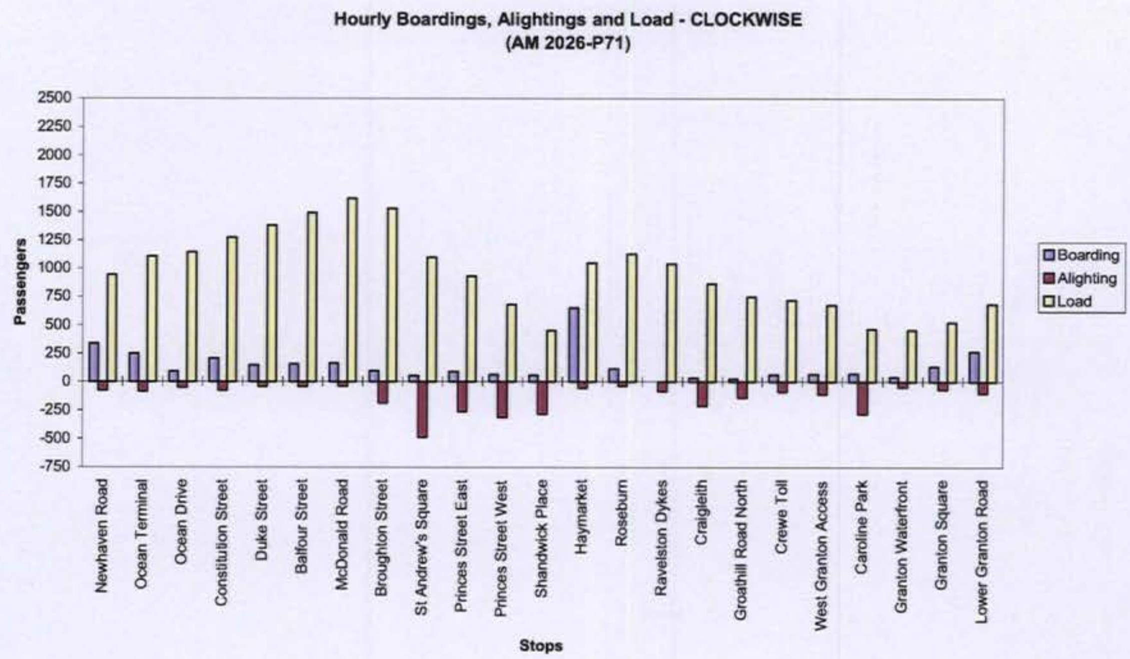


Figure 7.8 2026 AM Anti Clockwise Flows

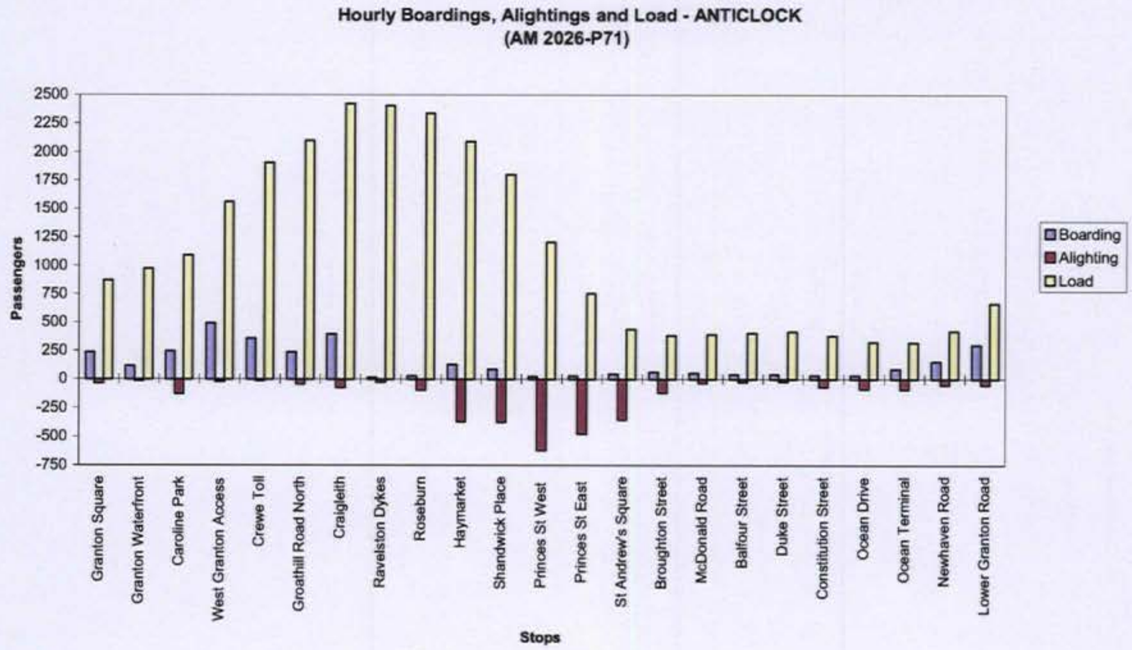


Figure 7.9 2026 IP Clockwise Flows

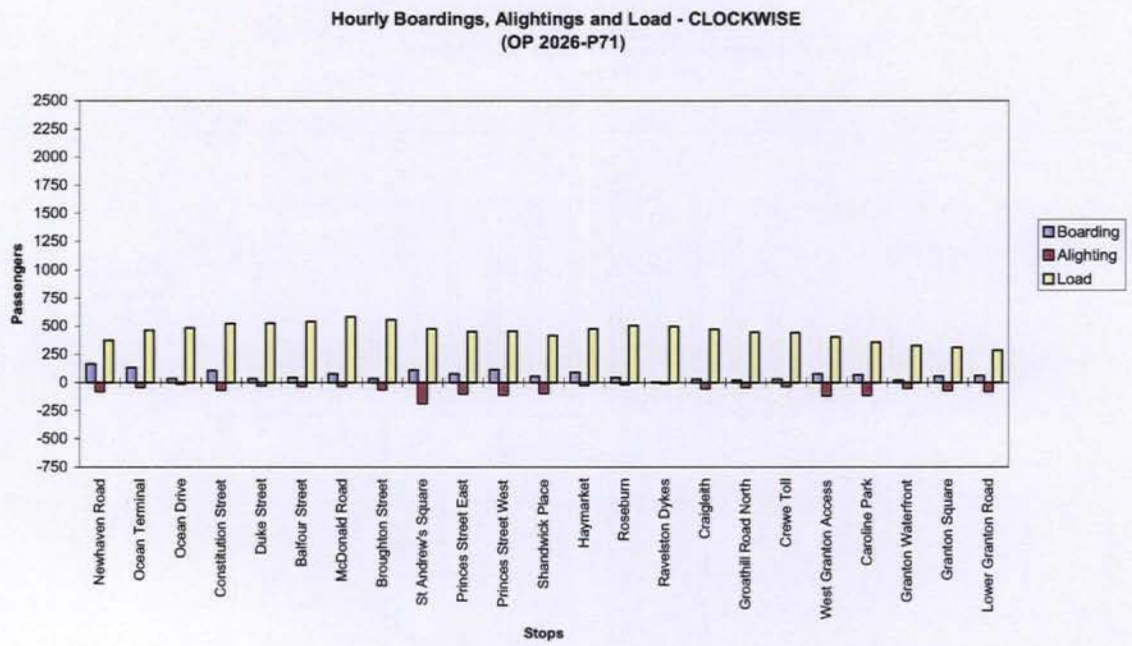


Figure 7.10 2026 IP Anti Clockwise Flows

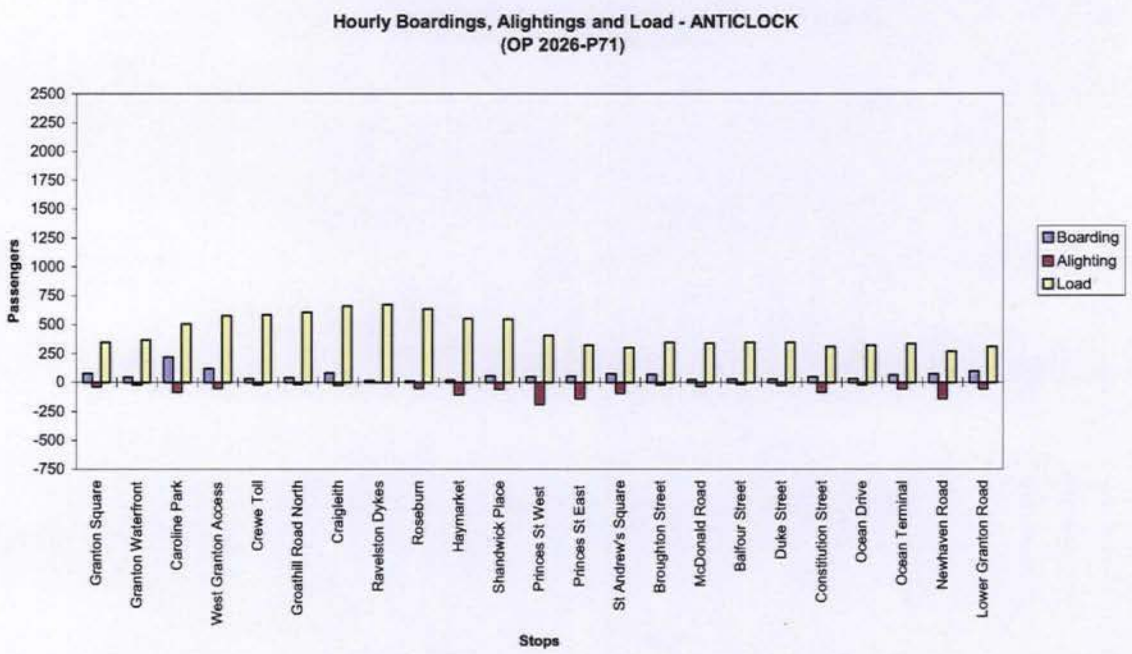


Figure 7.11 2026 PM Clockwise Flows

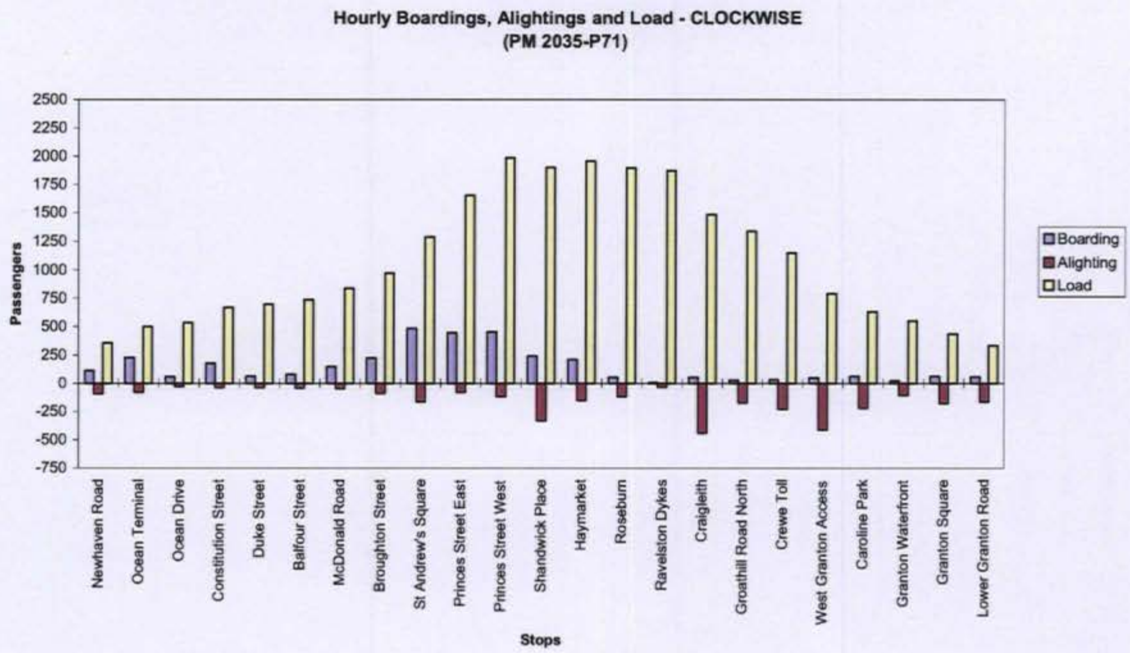
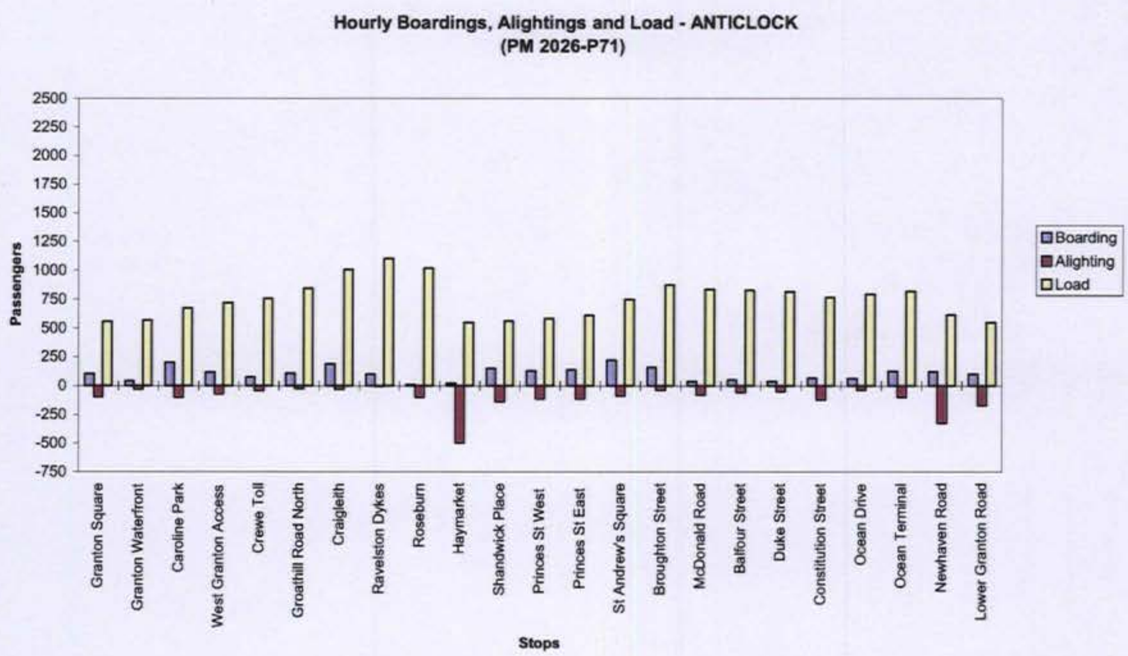


Figure 7.12 2026 PM Anti Clockwise Flows



7.3 Assessment Against the Planning Objectives

A key principle of STAG is that a scheme is assessed against both the planning objectives established by the planning authority and the Government's five overarching objectives. Performance against planning objectives is fundamental in a Part 1 appraisal, which seeks to define the choice and rational of preferred option(s) which best meets the planning objectives. The Part 2 appraisal is essentially a more detailed exploration and appraisal against both sets of objectives, providing an updated assessment of the scheme against the planning objectives and considering in detail appraisal against the five Government objectives. This section therefore reviews the appraisal of Line 1 against the planning objectives (see Section 2.3); the Government's five objectives are considered in detail in the remainder of this chapter.

7.3.1 Support the Local Economy by Improving Accessibility

Improve access to public transport network

Much of the alignment of Line 1 is along existing public transport (bus) routes and whilst the Central case assumes some withdrawal or restructuring of the bus network along the Line 1 route, buses will continue to run in parallel to Line 1 for much of its length. This will create a number of opportunities for public transport travel (and interchanges) in Edinburgh. In addition, the alignment along the Roseburn corridor will open up new opportunities for public transport access, notably in terms of journeys to Haymarket and the West End.

Improve access to employment opportunities

Line 1 will not only improve access to existing employment, it will also provide an opportunity to access new development sites planned for North Edinburgh (see Section 3.4). The wider consideration of public transport network coverage and associated accessibility is considered in section 7.8.1. It is demonstrated that Line 1 considerably improves access for a set of key employment destinations (although a few areas outside the Line 1 corridor experience slightly reduced accessibility due to changes to the bus network).

7.3.2 Promote Sustainability and Reduce Environmental Damage

Increase proportion of journeys made by public transport, cycling and walking

The modelling work for Line 1 has forecast increases in public transport demand, with reductions in demand by private car (walking and cycling trips are not modelled). This is shown in Table 7.9, with the associated share by public transport. For all modelled periods and years, the share by public transport increases, by around 0.5% points in 2011 and around 1.0% points in 2026. Note that these data relates to the whole modelled area of Edinburgh and its environs and that at a local level in the vicinity of Line 1 the change in share by public transport is greater.

This is illustrated in Table 7.11, which sets out the % point change in the share by public transport by sector for the 2011 AM peak hour. This shows material increases in the public transport share for trips from Granton, Leith Docks and the Railway Corridor, with large increases for particular sector to sector movements where Line 1 would improve the level of service offered by public transport considerably. These include Leith Docks to the City Centre (11.1%) and Haymarket (15.8%), Granton to the City Centre (9.3%) and Haymarket (14.4%) and the railway corridor to Leith Docks (15.3%).

Table 7.9 Share of Travel Demand (Person Trips) by Public Transport

		2011			2026		
		AM	IP	PM	AM	IP	PM
Reference Case	Public transport	45,595	27,484	42,030	48,555	28,501	46,174
	Private car/LGV	172,293	130,079	201,140	218,546	160,317	252,245
	PT share	20.9%	17.4%	17.3%	18.2%	15.1%	15.5%
Line 1	Public transport	46,980	28,442	43,406	52,484	30,769	49,007
	Private car/LGV	171,696	130,060	200,723	216,472	160,430	250,329
	PT share	21.5%	17.9%	17.8%	19.5%	16.1%	16.4%
Change in public transport share		0.6%	0.5%	0.5%	1.3%	1.0%	0.9%

Table 7.10 Share of Travel Demand (Person Trips) by Public Transport

No.	Area	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1	City Centre	0.5%	0.0%	-0.2%	2.3%	-0.6%	0.8%	0.2%	0.4%	0.1%	-0.3%	0.0%	0.0%	0.1%	0.1%
2	Haymarket	1.5%	2.5%	0.2%	1.6%	0.2%	1.7%	0.3%	0.4%	0.2%	0.0%	0.0%	0.0%	0.2%	0.6%
3	Leith	0.1%	1.1%	-2.3%	4.2%	0.6%	2.4%	3.0%	-1.7%	-0.2%	-0.2%	-0.5%	0.0%	-0.8%	0.0%
4	Granton	9.3%	14.4%	7.5%	8.0%	3.7%	2.2%	2.8%	3.0%	2.6%	1.0%	0.6%	0.1%	3.5%	5.3%
5	North LRT	-2.0%	5.4%	4.8%	4.0%	5.1%	2.4%	3.4%	-0.4%	1.2%	2.1%	-0.1%	0.8%	1.7%	1.1%
6	Leith Docks	11.1%	15.8%	8.9%	2.6%	6.4%	1.8%	8.9%	4.9%	3.1%	6.4%	-0.1%	0.8%	20.5%	7.8%
7	Railway Corridor	4.9%	6.3%	5.1%	2.7%	4.5%	15.3%	4.1%	2.5%	2.1%	2.3%	0.1%	0.2%	5.2%	4.0%
8	South Edinburgh	0.6%	-0.1%	0.0%	1.1%	-0.5%	1.9%	-0.1%	0.2%	1.0%	0.2%	-0.3%	-0.1%	0.1%	0.4%
9	East Edinburgh	1.3%	1.9%	0.8%	0.5%	0.3%	1.7%	1.1%	1.2%	-0.2%	0.9%	0.0%	-0.1%	0.1%	0.8%
10	West Edinburgh	2.0%	1.7%	0.9%	3.9%	2.5%	2.1%	1.8%	0.7%	0.7%	0.1%	0.1%	0.0%	0.4%	1.1%
11	Fife & North	-0.1%	-0.3%	0.1%	1.2%	0.8%	0.8%	1.1%	-0.4%	-0.3%	-0.3%	0.0%	0.0%	0.0%	0.0%
12	West Scotland	0.0%	-0.6%	0.0%	2.8%	-0.1%	2.3%	0.0%	-0.4%	-0.5%	-0.6%	0.0%	0.0%	0.0%	-0.1%
13	South & East	0.1%	1.0%	0.9%	1.8%	1.3%	5.8%	1.1%	0.3%	0.0%	-0.1%	0.0%	0.0%	-0.7%	0.2%
Total		1.0%	1.5%	1.2%	2.8%	1.7%	2.8%	1.4%	0.4%	0.3%	0.1%	0.0%	0.0%	0.0%	0.6%

Reduce local and global emissions

A detailed analysis has been undertaken to determine the impact of Line 1 on local and global air quality (see section 7.4.2). This analysis demonstrates that the tram has a moderate positive impact on air quality in 2011, and a minor positive impact in 2026, with an Air Quality Index[22] of –88,100 and –37,800 for NO_2, respectively.

At a global level, the impact of Line 1 is neutral in 2011, with CO_2 emissions resulting from tram operation being offset by decreases in CO_2 emissions across the highway network. However, by 2026, the reduction in traffic arising from Line 1 is sufficient to lead to a small reduction in CO2 emissions.

7.3.3 Reduce Traffic Congestion

Reduce number of trips by car

The modelling analysis undertaken has forecast that Line 1 will remove significant levels of car demand from the highway network; this is detailed in Table 7.11. In 2011, the levels are moderate in the peak hours, increasing substantially by 2026, which reflects the severe levels of congestion forecast by that time. The impact of highway demand in the off peak period is slight.

[22] The 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.

Table 7.11 Travel Demand (Car/LGV vehicle trips) by Private Transport

	2011			2026		
	AM	IP	PM	AM	IP	PM
Reference Case	119,648	82,853	134,093	151,768	102,113	168,163
Line 1	119,233	82,841	133,815	150,328	102,185	166,886
Differences	-415	-12	-278	-1,440	72	-1,277

Reduce traffic volume on key routes

The predicted changes in traffic flows as a result of the introduction of Line 1 are shown in Table 7.12[23]. Significant reductions in traffic flow (>100 veh/h) are forecast on Chester Street, Dalry Road (AM and off peak), Haymarket Terrace, Inverleith Row (AM peak and off peak), London Road, MacDonald Road (AM and off peak) and Market Street (PM peak). Conversely, flow increases are forecast on Dalry Road (PM peak), Ferry Road (AM peak), Morrison Street (AM peak and off peak), Palmerston Place, Queen Street (off peak and PM peak), Queensferry Road (off peak), Queensferry Street and The Mound (AM peak). As would be expected in a congested urban centre the patterns differ throughout the day. Generally, the impacts in the off peak periods are less significant than those predicted during the peak hours. The re-assignment impacts from the tram have also been modelled for the future year 2026 and the patterns are found to be very similar to those reported above, albeit with the absolute levels of traffic flow being higher under each case.

Table 7.12 Changes in Traffic Flows (2011)

	Reference Case			Line 1			Absolute Change		
	AM	OP	PM	AM	OP	PM	AM	OP	PM
Abbeyhill	710	843	1050	704	854	993	-6	11	-57
Calton Road	557	132	582	577	126	516	20	-6	-66
Chester Street	1045	838	838	996	776	726	-49	-62	-112
Commercial Street	1108	1070	1325	1063	1047	1325	-45	-23	0
Constitution St (North of junction with Salamander St)	1187	728	1104	1175	724	1093	-12	-4	-11
Constitution St (South of junction with Salamander St)	674	535	855	744	510	922	70	-25	67
Crewe Road (N)	739	853	1035	675	847	1012	-64	-6	-23
Crewe Road (S)	969	436	806	929	443	794	-40	7	-12
Dalry Road	1323	746	1468	1217	606	1656	-106	-140	188
Easter Road	514	454	493	421	486	581	-93	32	88
Ferry Road	1395	1277	1283	1513	1282	1288	118	5	5
George Street	1153	993	1222	1190	1088	1284	37	95	62
Granton Road	1511	536	1405	1504	527	1406	-7	-9	1
Haymarket Terrace	1518	1075	1314	1227	721	970	-291	-354	-344
Inverleith Row	1988	1089	2117	1869	1008	2139	-119	-81	22
Leith Walk (Cental/North)	1247	957	1280	1201	895	1199	-46	-62	-81
London Road	1283	889	1442	1101	682	1345	-182	-207	-97
MacDonald Road	683	316	786	370	342	683	-313	26	-103
Market Street	547	103	594	576	100	478	29	-3	-116
Morrison Street	1371	1295	1833	1978	1439	1908	607	144	75
Palmerston Place	543	347	704	900	550	1099	357	203	395

[23] It should be noted that these predictions do not take into account the effects of the Council's proposed Central Edinburgh Traffic Management (CETM) scheme, since these proposals were not committed at the time of the traffic modelling undertaken for Line One.

	Reference Case			Line 1			Absolute Change		
	AM	OP	PM	AM	OP	PM	AM	OP	PM
Pilrig Street	509	335	832	511	369	855	2	34	23
Queen Street	2355	2329	2302	2382	2447	2407	27	118	105
Queensferry Road	1808	1486	1788	1852	1646	1860	44	160	72
Queensferry Street	1470	1159	1478	1601	1402	1606	131	243	128
Salamander Street	1666	1545	1622	1587	1526	1595	-79	-19	-27
Starbank Road	1672	1390	1589	1585	1365	1560	-87	-25	-29
Telford Road	1847	1161	1234	1832	1156	1287	-15	-5	53
The Mound	1395	1277	1283	1513	1282	1288	118	5	5
West Granton Road	2139	1160	2053	2085	1116	2038	-54	-44	-15

Note: AM = morning peak hour traffic flow, OP = inter peak hourly traffic flow, PM = evening peak hour traffic flow. The Reference Case is the situation without the tram operating.

The changes in traffic flow are largely due to the displacement of traffic by the tram, for example due to reduced road capacity in the streets on which the tram will operate and an element of re-routing of traffic in areas where particular traffic movements would be altered to accommodate the tram. (Perhaps the most significant example of the latter is Haymarket, where the preferred layout as it stands would result in Morrison Street becoming two-way, with a westbound contra flow bus lane incorporated within West Maitland Street. Similarly, the preferred layout for the junction of Lothain Road and Princes Street would require the banning of right turn movements from Shandwick Place to Lothian Road. This would result in a re-routing of traffic in this area of the city). It will therefore be necessary, as the scheme develops, to ensure that appropriate mitigation measures are introduced to ensure that the transport network works efficiently in these areas. Particular measures that could be introduced will vary according to the location and the range of amenities in the immediate vicinity. Examples of these measures will include:

- Appropriate signing to encourage traffic to use appropriate routes;
- Incorporation of traffic calming measures to discourage traffic from using residential streets (e.g. the streets to the east and west of Leith Walk);
- Review of parking and servicing provision on the adjacent local road network; and
- Provision of adequate parking for affected residents (e.g. at Granton Road).

In summary, whilst Line 1 removes significant levels of car demand from the highway network, at an individual street level it has only a slight beneficial impact on reducing traffic volumes on key routes, with flow decreases being largely offset by flow increases at a network level.

7.3.4 Make the Transport System Safer and More Secure

Reduce traffic accidents

The impact of Line 1 on the number of road traffic accidents has been estimated using model data on traffic flows by road type and the application of accident rates; the number of accidents savings by severity forecast is set out in Table 7.13 (see section 7.5.1 for full details). Overall, Line 1 is forecast to give rise to 7.6 accidents per annum in 2011, but fall thereafter, leading to a reduction of 51.0 accidents in 2026. (This change reflects the mix of flow by road type; by 2026, traffic will be dispersing onto road types with higher accident rates, on which flow reductions gives rise to a proportionally greater reduction in accident levels.) The majority of accidents are accounted for in terms of damage only accidents.

Table 7.13 Number of Accidents per Severity Level

	Annual Changes	
Severity	**2011**	**2026**
Damage	-6.8	45.5
Slight	-0.7	4.8
Serious	-0.1	0.6
Fatal	0.0	0.1
Total	**-7.6**	**51.0**

7.3.5 Promote Social Benefits

Improve liveability of streets

This objective covers a whole gamut of interlinked issues, including accessibility, safety, environment and economy. In essence, it is about enhancing streets as 'civic spaces', where priority is given to people rather than cars. The current design for Line 1 is focused on delivering a transport scheme, which where possible looks to deliver benefits to the wider urban realm. Line 1 will provide an opportunity to implement wider enhancements to the urban realm, either explicitly planned and implemented in conjunction with Line 1, or through the longer term effects of a planned framework for redevelopment and regeneration.

The regeneration effects of light rail typically take several years to become apparent and, to date, quantitative information about systems' impacts rarely has been collected. While it is difficult to demonstrate that tram schemes will themselves spark regeneration, they play a critical role in supporting it and shaping it in spatial terms. There is clear evidence of specific development projects led by light rail, such as in London Docklands, Salford Quays in Manchester and elsewhere. It is also clear that introducing light rail helps boost property values, both commercial and residential. Commercial values can experience uplifts of 100% or more, and effects on residential values can be discerned up to 1 km, or up to 20 minutes walk, from tram stops.

It is widely accepted that trams are more attractive than buses in urban areas, improving townscape features and liveability on the streets. This is valued by the wider public and not only by the users of the system.

Reduce social exclusion

Line 1 will provide a significant improvement in terms of the ability of the elderly and mobility impaired to use public transport. It will provide level boarding at stops, with the tram vehicle interior giving greater space and dedicated facilities for wheelchairs and/or prams, etc. The smooth ride and high level of comfort will make the tram system an attractive choice in comparison to other public transport modes. Such attributes will also be valued by other public transport users, albeit to a lesser degree.

The wider accessibility impacts are considered in section 7.8.2, which explicitly sets out the impact of Line 1 on accessibility for those households without a car. This demonstrates that for a set of key employment destinations, there is a significant net improvement in access afforded by Line 1. Whilst some of those households benefit marginally (under 5 minutes reduction in travel time), there are substantial beneficiaries of 10 minutes or more.

7.3.6 Summary

Table 7.14 provides a summary of the appraisal of the scheme against the planning objectives and problems in North Edinburgh (set out in Chapters 2 and 3, respectively). The significance of the impact of Line 1 is shown, with '+' representing a positive impact and '-' a negative impact. Across all the objectives, Line 1 is considered to have a positive impact, notably on the level of public transport and car demand and the associated mode share and the consequent impacts on the environment. Notwithstanding some adverse impacts arising from the bus network changes (which further detailed consideration as part of developing an integrated PT network should ameliorate to some degree), Line 1 has a positive impact on accessibility which will support the local economy and reduce social exclusion.

Table 7.14 Appraisal of Line 1 against Planning Objectives and Problems

Objective	Sub-Objective	Problems Socio-economic	Environment	Transport
Improve accessibility	Improve access to public transport.	+		+
	Improve access to employment.	++		+
Promote sustainability and reduce environmental damage	Increase journeys by public transport, cycling and walking.		+++	+++
	Reduce local and global emissions.		++	
Reduce traffic congestion	Reduce trips by car.		+	+++
	Reduce traffic on key routes.		+	+
Promote safety and security	Reduce traffic accidents.			+
Promote social benefits	Improve liveability of streets.	+	+	
	Reduce social exclusion.	++		

As can be seen, Line 1 has considerable potential to:

- Contribute to improve the local economy (greater potential for regeneration);
- Facilitate access to employment opportunities (more attractive, integrated, comfortable, efficient and reliable public transport alternative);
- Reduce the adverse impacts of transport on the environment (zero exhaust emissions produced by the trams in urban areas, reduced noise levels, townscape benefits);
- Reduce traffic and congestion (greatest potential as an alternative to the private car, with decongestion benefits); and
- Reduce social exclusion (providing widely accessible, particularly to the new areas of employment and social deprivation in north and west areas of Edinburgh, and affordable transport connections for all).

7.4 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 7.10 of this report.

7.4.1 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.

Figure 7.13 Environmental and Planning Designations

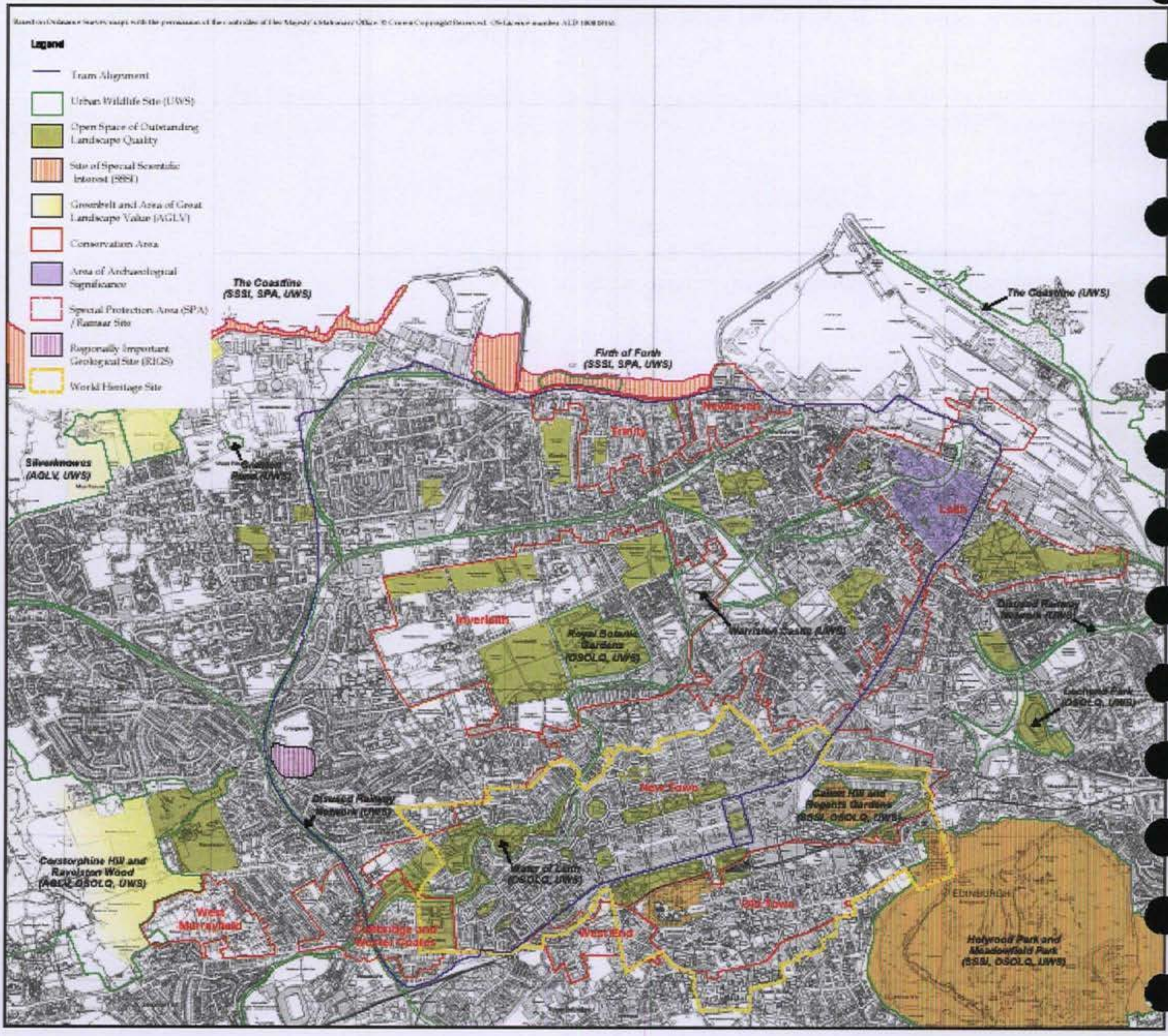
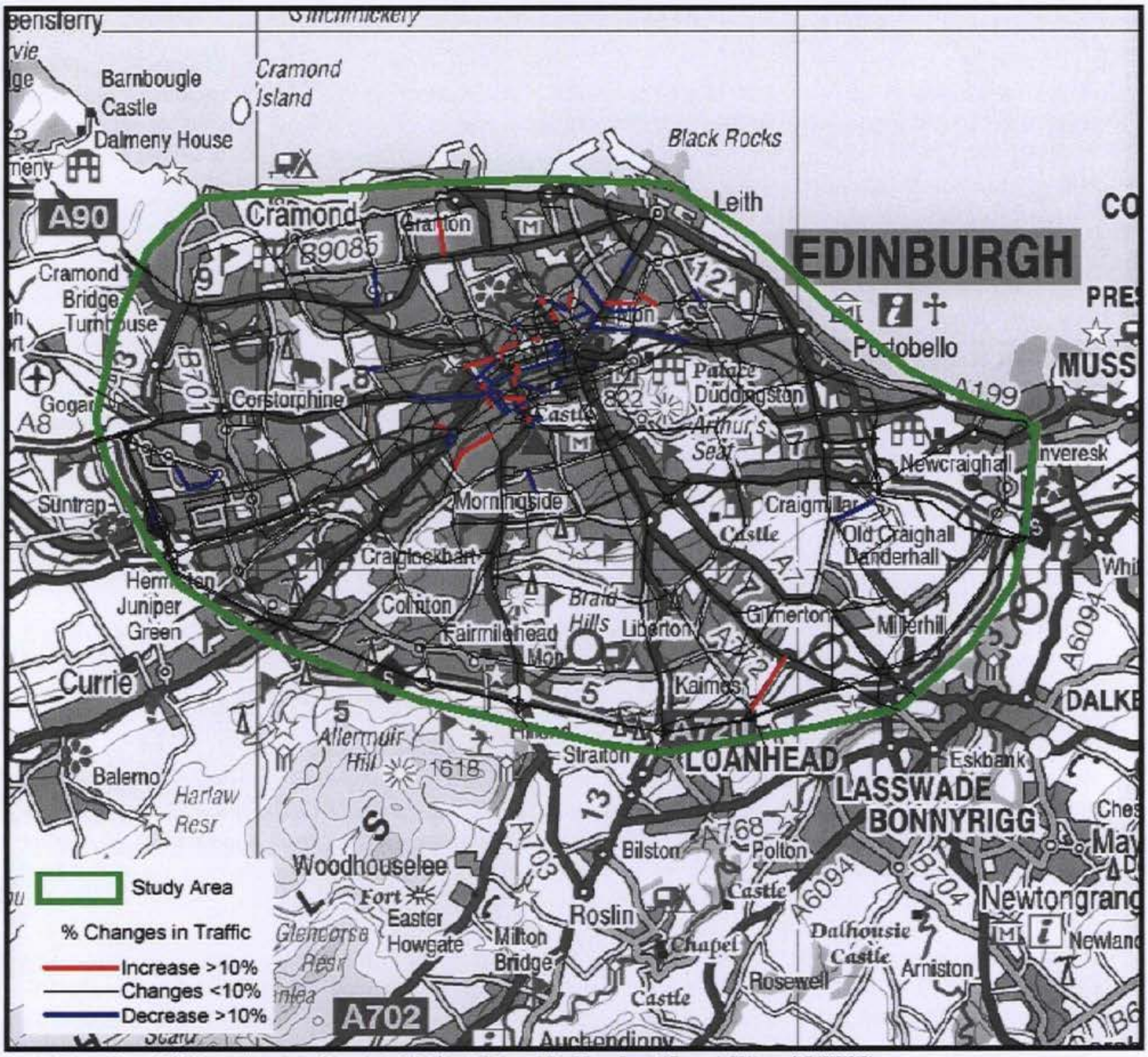


Figure 7.14 Plot of Road Network



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 is not expected to 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 7.15 Estimated Numbers of Households Potentially Annoyed by Noise

Scenario/Scenarios Compared	Estimated Properties experiencing noise levels expected to cause annoyance
Base Case (2001) [24]	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

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 7.16 below.

Table 7.16 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

[24] 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.

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.

7.4.2 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 7.17.

Table 7.17 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
	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 7.18. The estimated number of households near roads predicted to experience no change in air quality is also presented.

Table 7.18 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
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 7.19.

Table 7.19 **Air Quality Indices**

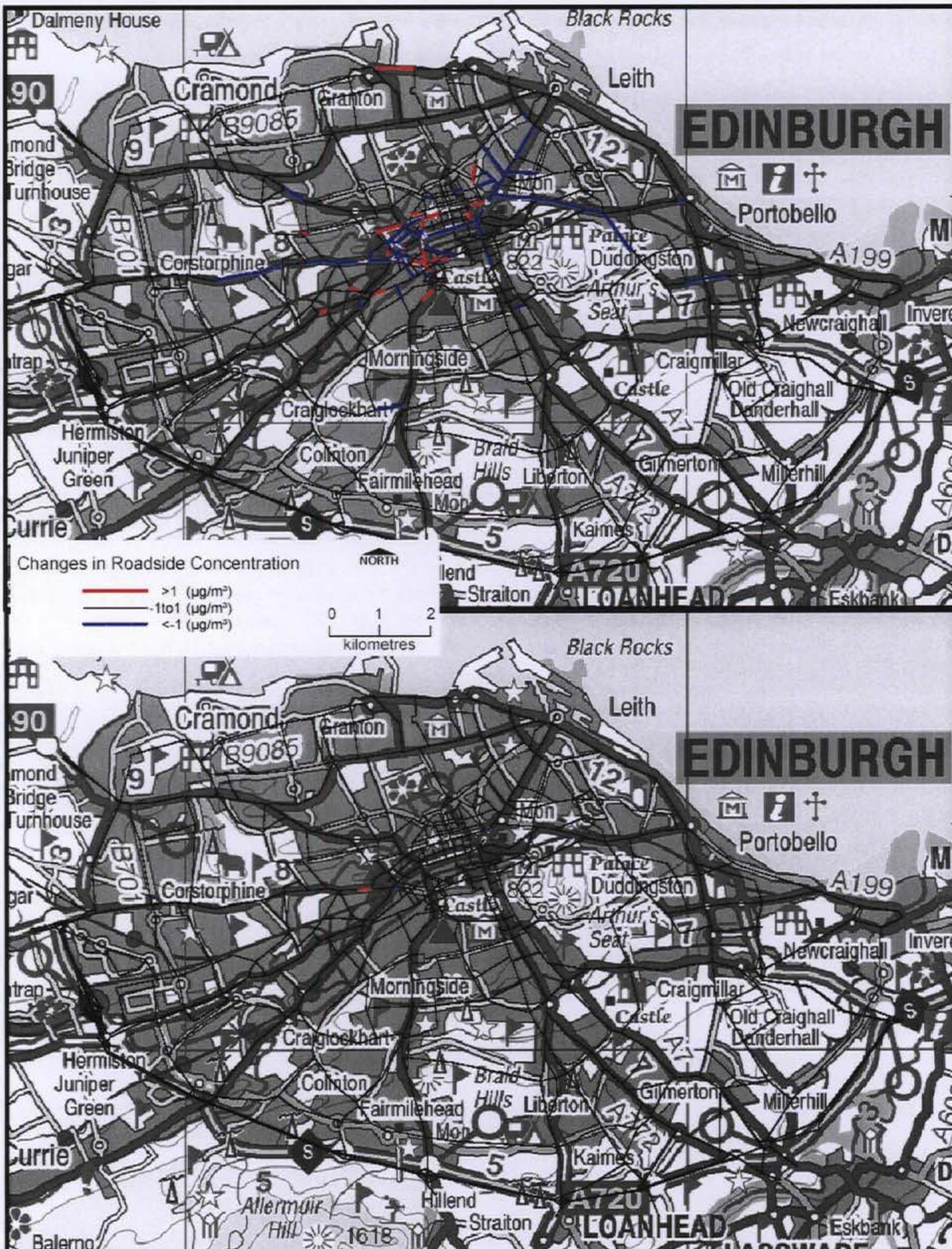
Scenarios Compared	NO_2 Index	PM_{10} Index
Base × Do Minimum 2011	-2,949,400	-354,300
Do Minimum 2011 × Do Something 2011	-88,100	-6,000
Do Minimum 2026 × Do Something 2026	-37,800	-17,300

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, 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



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 7.20 below presents the overall emissions of CO_2 in each of the scenarios assessed.

Table 7.20 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.

7.4.3 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.

7.4.4 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.

7.4.5 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[25] undertaken by Edinburgh City Council in 2001[26];
- Site visits;
- A bat survey undertaken by Nocturne Environmental Surveyors in September 2003[27];
- 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

General Ecological Context

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.

[25] 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.

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

[27] 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)*[28], *Special Protection Area (SPA)*[29]*/Ramsar Site*[30]. 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)[31], 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[32] along the Roseburn Railway Corridor[33] and pipistrelle bats[34] (55kHz)[35] 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

[28] 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.*

[29] 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.

[30] 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.

[31] 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.

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

[33] 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.

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

[35] 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[36]. 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.

7.4.6 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

[36] 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:

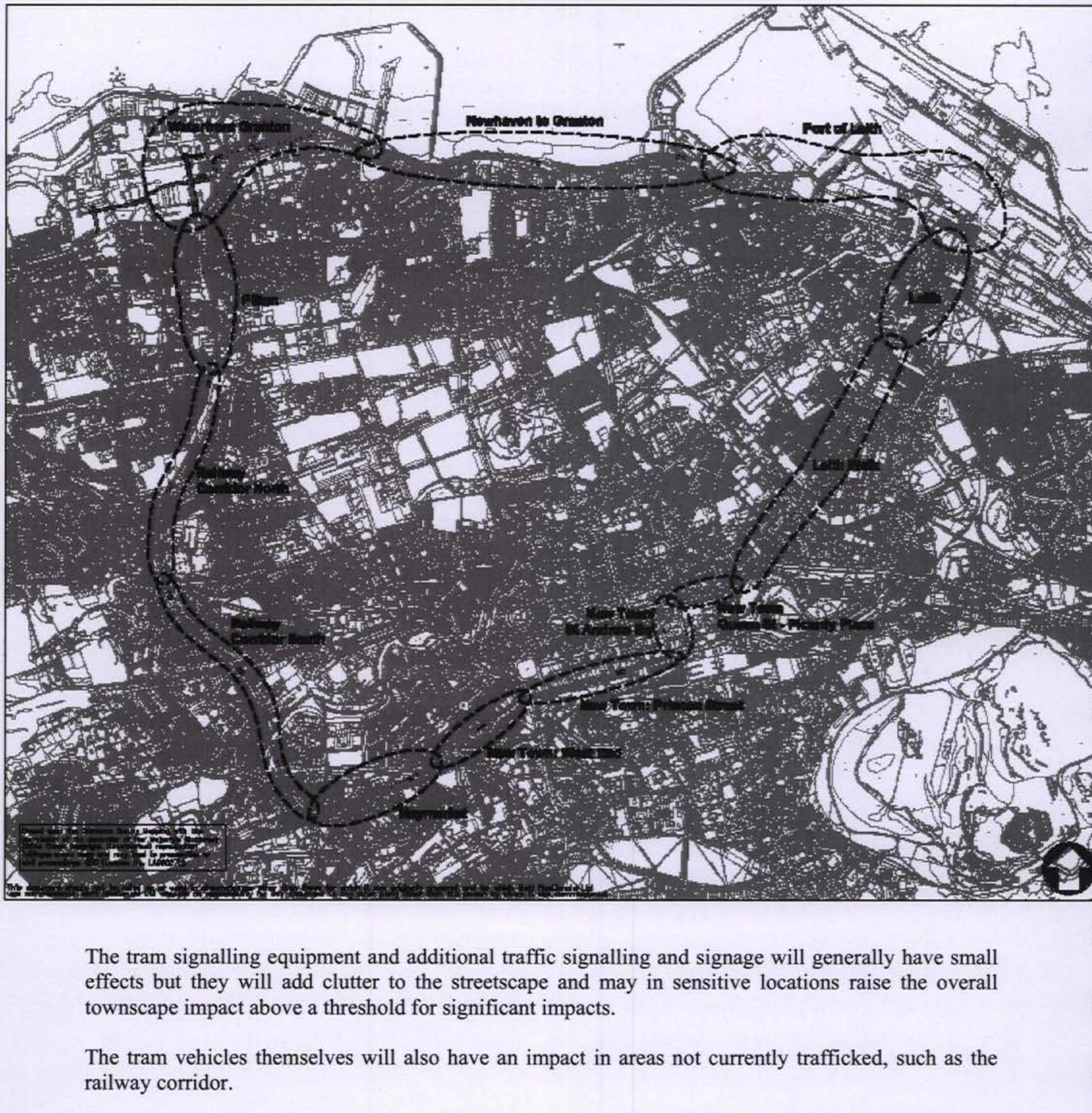
- A twin-track light rapid transit track-bed, generally at existing grade, paved in a variety of materials according to the situation;
- Stops with shelters, lighting, seating, ticketing and information;
- Tram vehicles;
- Overhead line equipment – conductor wires, supported on a combination of cables 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.

<u>New Town: Princes Street</u>

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.

<u>New Town: St Andrew Square</u>

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.

<u>New Town: Queen Street to Picardy Place</u>

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, other adverse impacts can be expected at varying degrees in different locations along the route. Table 7.21 summarises the landscape impacts for each area affected by the scheme.

Table 7.21 Summary of Landscape Impacts

Location	Description	Importance	Impact
Haymarket	Potentially complex OLE support. Road alterations and demolitions weaken enclosure of junction area. Tram stop will improve Haymarket Terrace.	World Heritage Site New Town Conservation Area (CA)	West of Haymarket Terrace: minor adverse to minor beneficial. East of Haymarket Terrace: major adverse. The tram stop: small area major beneficial.
West End	OLE in designed vista. Road widened into gardens.	World Heritage Site New Town CA West End CA	Major adverse.
Princes Street	OLE in designed vista and iconic tourist views. Footway widening.	World Heritage Site 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 New Town CA	Major adverse impact.
Queen St to Picardy Pl	OLE in designed vista. Road widened and awkward level changes.	World Heritage Site 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) New Town CA (part) Leith CA (part)	Overall major adverse impact.
Leith	Distinctive small-scale local character, highly sensitive to	Leith CA	Major adverse impact

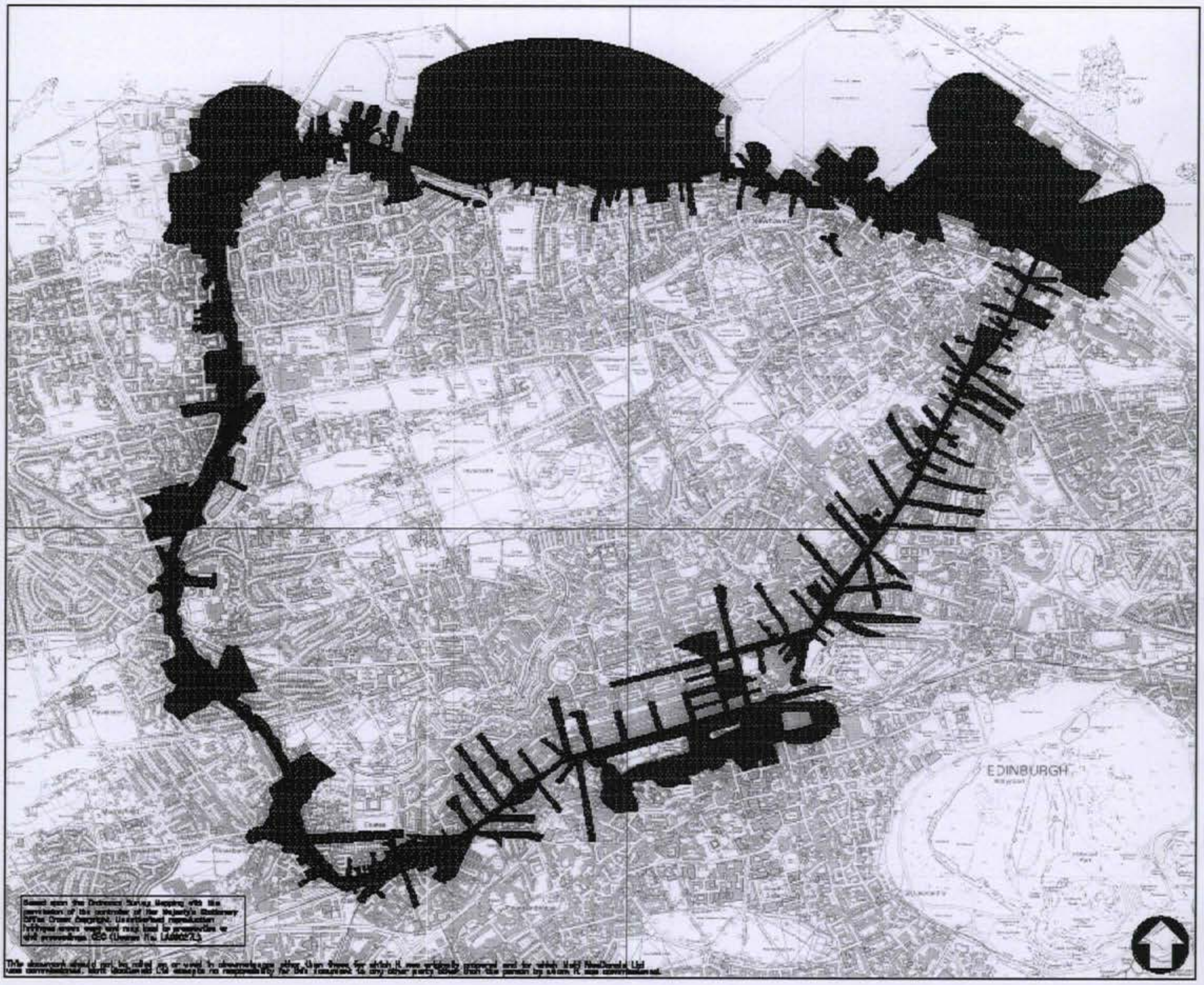
	change.		
Port of Leith	Tram a minor additional element in industrial parts, part of a much wider change elsewhere.	Leith CA (part)	Generally, minor impact, moderate in limited areas.
Newhaven to Granton	OLE will partially enclose open sea-front sections. New footpath at Starbank beneficial.	Newhaven 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

7.4.7 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.

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.

Visual impacts

Visual impacts will be created by:

- The tram infrastructure – overhead line equipment, signals, stops and shelters;
- The tram vehicles themselves;
- The buildings associated with the tram, such as the depot and the substations; and
- Alterations to structures such as the embankments on the railway corridor.

The sensitivity of the receptors of visual impact varies according to their activity and expectations. Those for whom the view is important or where changes will be particularly noticed, such as people enjoying tourist locations or outdoor recreation activities, iconic views of the city, designed vistas in the New Town and the main outlook from residential properties are highly sensitive. People travelling through or past (on roads and railways), shoppers and people enjoying indoor recreation activities are less sensitive and those whose attention can reasonably be expected to be focussed on their work or activity, i.e. offices and other workplaces, are least sensitive.

There will be visual impacts on virtually all the properties and roads along the tram route, on public open spaces and recreational sites such as Princes Street Gardens, St Andrew Square and the Roseburn cycle route, and from important tourist viewpoints such as Princes Street and Edinburgh Castle.

Major visual impacts are caused where proposed development is clearly noticeable and affects the character or quality of view for sensitive receptors. For this reason there will be major visual impacts along much of the route because of the unavoidable visibility of much of the tram infrastructure, particularly the overhead line equipment, from houses and flats along the route and from many of the main city centre tourist locations.

A summary of the visual amenity impacts is presented in Table 7.22.

Table 7.22 Visual Amenity Impacts

Location and Impact	Importance	Significance of Impact
Haymarket OLE generally seen against backdrop of buildings in short views across Haymarket Terrace and junction, longer views across station car park and railway. Tops of columns seen against sky in some places.	World Heritage Site New Town Conservation Area See Cultural Heritage for listed buildings	Major to minor adverse
New Town: West End OLE generally seen against backdrop of buildings in short views across the road, longer glimpses from side streets.	World Heritage Site New Town Conservation Area West End Conservation Area See Cultural Heritage for listed buildings	Major to minor adverse
New Town: Princes Street OLE generally seen against backdrop of Castle and the Old Town in open views across gardens. Backdrop of sky from parts of north side footway. Stops interrupt views locally.	World Heritage Site New Town Conservation Area See Cultural Heritage for listed buildings	Major to minor adverse
First New Town - designed vistas from cross streets and George Street. OLE will be just discernible against a backdrop of trees.	World Heritage Site New Town Conservation Area	Neutral (to be confirmed)

Edinburgh Castle Tram discernible but not significant in panoramic views from Castle	World Heritage Site Old Town Conservation Area Listed building	Neutral
New Town: St Andrew Square OLE generally seen against backdrop of buildings and trees in short views across the road, longer glimpses from side streets.	World Heritage Site New Town Conservation Area See Cultural Heritage for listed buildings	Major to minor adverse
New Town: Queen St to Picardy Place: OLE generally seen against backdrop of buildings and trees in short views across the road, longer glimpses from side streets.	World Heritage Site New Town Conservation Area See Cultural Heritage for listed buildings	Major to minor adverse
Leith Walk OLE generally seen against backdrop of buildings and trees in short views across the road, longer glimpses from side streets.	World Heritage Site (part) New Town Conservation Area (part) Leith Conservation Area (part) See Cultural Heritage for listed buildings	Major to minor adverse
Leith OLE generally seen against backdrop of buildings and trees in short views across the road, longer glimpses from side streets.	Leith Conservation Area See Cultural Heritage for listed buildings	Major to minor adverse
Port of Leith OLE generally seen against sky backdrop in open views across dock areas, against backdrop of buildings in some areas.	Leith Conservation Area (part) See Cultural Heritage for listed buildings	Major to minor adverse
Newhaven to Granton OLE generally seen against sky backdrop in open views across Firth of Forth, against backdrop of buildings in limited areas.	Newhaven Conservation Area (part) Trinity Conservation Area (part) See Cultural Heritage for listed buildings	Major to minor adverse
Waterfront Granton OLE generally seen against backdrop of buildings and trees in short to medium views across the new transport boulevard, longer glimpses from side streets.		Moderate to minor adverse (compared to new development without tram)
Pilton OLE generally seen against backdrop of buildings in short views across the road, longer glimpses from side streets		Moderate to minor adverse
Railway Corridor Views into railway corridor from surrounding houses substantially opened up. OLE and passing trams become visible, generally against backdrop of buildings and trees in short to medium views. Views substantially opened up at S end where embankment re-graded.	Coltbridge and Wester Coates Conservation Area (part)	Major to minor adverse

Mitigation

The mitigation for the visual impacts is generally to design the tram system well, so that it fits comfortably into the scene as far as possible. Elements such as the stops and road alterations which can be designed as positive features will be treated as such, so that whilst they are visible they do not detrimentally affect the quality of the view. Elements that will by their very nature be seen as detrimental, specifically the OLE, will be designed to be as visually light as possible, cleanly and simply detailed.

A Design Manual is being progressed which sets out the principles of design and detailing and in the construction contract will ensure that the final design complies with the Design Manual. Points in the Manual that are specifically intended to reduce the visual impact of the tram include: