K-SMART Kingston Light Rail [Tram] System Framework Proposal:

Performance Specification

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1. Executive Summary

Objective

The Performance Specification is intended to provide sufficient information for the Borough and its Consultants to agree whether a Light Rail/Tram System is technically & financially feasible, to be included in the long term transport strategy of the Borough. This will require the following:

- an initial assessment of the likely demand that a Light Rail System could attract;
- an outline engineering feasibility, route survey and capital cost estimate;
- an assessment of contribution toward regeneration and planning objectives, with reference to (inter alia) the London Plan, the RBK UDP and London Development Agency priorities;
- an assessment of the economic and financial case for construction and operation of a Light Rail System;
- an initial assessment of environmental impacts; an initial assessment of highway traffic impacts once operational

Approach to an Integrated Transport System

A summary of the core objectives:

- ❑ Integrated long-term transport strategy, with more direct links & better interchange options.
- ❑ Improved safety and security on public transport
- ❑ Reduction crowding, congestion and the frequency of gridlock on the main ingress & egress road arteries in Kingston.
- ❑ Reduction in traffic pollution
- ❑ Reduction in the dependence on the car for work, social & shopping trips.
- ❑ Promotion of sustainable development – K+20
- ❑ Encouragement Economic Growth & employment opportunities.
- ❑ Promotion of equality and inclusion

The Performance Specification requires the design of the Light Rail System to encompass:

- the 21st Century concept of Integrated, Sustainable public transport.
- the incorporation of `heavy rail' corridors, into a Light Rapid Transit Scheme.
- The critical issue of how an Integrated Public Transport system delivers a Modal shift in travelling patterns, reducing the dependency on the private motor car.
- Junction priority
- Road width restriction
- Street running

LRT/Tram Option

Known factors which influence people's perception and therefore their propensity to use a mode of travel, rate tram 50% higher than a bus way and almost double that of a typical bus system; therefore the advantages of the tram must be fully exploited.

The question whether, bus derived technology is able to offer the same overall standards of service that is possible with tram and the technical sustainability of buses as well as their ability to really make a difference to passengers' modal choice must be examined.

Decision makers in the field of real estate have a tendency to perceive the tram network and stations as significantly more desirable than bus services and bus stops when a commercial development is planned.
The reasons usually given for this are, better understand ability of tram routes and services, more pleasant environment around stations and far more service reliability. Studies show that a rail to rail or bus to rail transfer is significantly less onerous than a bus to bus transfer.
However, bus as an integrated part of a transit network contributes far more significantly than when operating as a solo service. In comparison, extra road building and maintenance expenditure in a bus only town could be 1.67 greater than a town with a tram system. Furthermore, each tram passenger can be credited with an improved energy efficient journey to the time of 41%. Former motorists being attracted to an integrated public transport system could reduce the overall energy demand by 22% per capita compared with a bus only town. More importantly a bus only system is often perceived as a lower level of public commitment and certainly does not guarantee the level of pursuance needed to

justify acceptance of reliability by regular commuters. Indeed, bus operators themselves, changing travel patterns on a regular basis with adjustments to new passenger demands followed by modifications to suit operational convenience, often cause a feeling of insecurity to passengers.

A tram service on the other hand can have a major effect on land use development and its performance alone can cause passenger volumes to increase, reducing the need to use the car and helping to reduce sprawl. Although the ridership of bus services can decline as against a population and economic activity growth, the research has shown that with a mixed tram and bus transport system patronage increases. Furthermore, a bus only town will have a far greater time length per capita, but much lower transit service. Although a very large expansion of the bus system may attain large percentage increase in its use, this increase is not considered sustainable over a long period unless a mixed system of bus and tram is used.

In terms of traffic management and environmental improvements, it is recognised that when a portion of tram route is built on a street by resuming traffic lanes, it adds to, not subtracts from the passenger carrying capacity of the corridor. This installation can have a traffic calming effect within the corridor. Furthermore, a tram service tends to control traffic whereas a bus service is controlled by traffic. If introduced with a positive urban design approach a tram system can be accompanied with an active greening of the town. For the town centres, the system will integrate harmoniously with intense human activity. Low noise and zero local emission electric traction enhances the environment in a way not possible with an internal combustion engine bus, regardless of the fuel type. There is a fear that the public response to be somewhat muted to a bus only system and it will not capture the public imagination in the same way as a tram. A decision based on the availability of funds rather than providing an effective transit solution is not considered as a good basis for committing public funds. It is also accepted that due to changing circumstances, a downgraded transit scheme should at regular intervals be put back on the “table” to ensure that an inferior scheme is not provided by default. Although lower costs schemes may be more expedient, the financial savings derived from substituting a lower cost scheme will, in today’s financial climate pale into insignificance when traffic congestion may force a more robust solution.

Finally, light rapid transit is not seen as a stand-alone universal solution but rather one element of an integrated long-term strategy. A new system would require extensive revision to existing bus services so that these complement rather than compete with provision on the core alignment. Bus services in corridors deemed unsuitable for rapid transit would still require bus priority measures. The transport hierarchy would have to be applied boldly when determining how to make the most efficient use of road space. A decision to opt for light rapid transit would inevitably mean that less road space would be available for other traffic, including local deliveries and private cars. Traffic management and parking policy would need to establish a traffic hierarchy – ensuring that vital local deliveries can be made efficiently on the revised road network. Economic measures that could include congestion charging, workplace parking levies and public transport fare subsidies might all have a role.

2. Introduction

Background

Kingston upon Thames is considered to be a medium sized town centre supported by buses and radial railway systems. For its economic vitality and future sustainability, the tram is considered to be the principal method of travel and a key element in the Royal Borough's transport strategy. This is further emphasised by the fact that the motoring community will respond to an appeal for modal changes if a quality alternative transport mode is provided first.
Forecasting how many people will use a new public transport system and the revenue that they will pay in fares is a central part of economic, social and financial case for investment, however, this is a highly technical process in which it is increasingly difficult to apply some common sense and sanity checks. Professionally accepted ridership forecasting processes typically do not take the attraction of rail into account.
The different impacts that new public transport can have on the trips that people make range from taking the same trip by a new mode to making trips that were not made before.

Strategic Context

There are a number of physical constraints which impact on the cost or the practicality of new infrastructure in and beyond the Borough. These include the River Thames, the Hogsmill River, the A3 and the rail network which radiates from Raynes Park station into four lines which pass through or terminate in the Borough. The Royal Park in Richmond is also a constraint on options for a Kingston/Richmond link. Due to the radial nature of heavy rail lines the road system provides for most of the local transport needs, whether by public or private transport, and use of the road is dominated by the car.
The Royal Borough of Kingston upon Thames, in co-operation with Transport for London, wishes to examine the feasibility of a light rapid transit system centred on Kingston Town. The system would have two principal functions. The first would be providing capacity for the radial journeys needed to access Kingston town centre, which is by far the largest trip attractor in the Borough, and already subject to excess demand by private vehicles. The second would be improving orbital links by public transport across south and west London through the Borough, linking Kingston town centre with the Five District Centers:

Kingston, Surbiton, New/Old Malden, Tolworth, Chessington World of Adventures plus a Link to Sutton, to join the proposed Croydon Tramlink Extension

3. Concept/Requirements

Segregated Street Running

For a tram system to be rapid and operationally feasible it must be a segregated double tracked system.
In order to deliver "rapid transit", trams (and to a greater or lesser extent) alternative modes of rapid transit, must be enabled to operate efficiently in a situation where passengers can achieve ease of access and be able to achieve an average speed at least equivalent to that of the private car - rather than that of the stage service bus. This implies a need to achieve effective segregation, in some form, from other road traffic.
In a suburban situation that is commonly achieved through full segregation on dedicated right-of-way adjacent to the highway and traffic signal priority at each highway junction. The presumption of use of abandoned or under-used heavy rail corridors as convenient rapid transit conduits has been proved (e.g. Midland Metro) to dissuade rather than attract patronage as a result of inadequate direct passenger access to their desired destinations.

For a tram system to be operationally feasible it should be double tracked, and segregated wherever possible. The ideal carriageway width for a double tracked segregated tramway is 15.7 metres. This standard allows a minimum provision of a 3 metre segregated transit lane, two 3.65 metre wide running lanes for other vehicles and a 1.2 metre wide cycle lane (adjacent to the tram lane). At pinch points it may be possible to reduce the above criteria such that running lanes for general traffic need only be 3.0 metres wide and the cycle lanes are deleted. This would give a minimum requirement for a double tracked segregated tramway of 12 metres.

Junction Priority

In an urban situation, segregation is commonly achieved through the use of dedicated highway lanes, either exclusively for the tram, or in particularly congested situations exclusively for public transport. The latter is less desirable as blocking of the tram by slow-moving or loading buses. Dedicated traffic signal priority is essential, to the inevitable detriment of other road users. Access for servicing properties, parking and loading in these situations have to be specifically catered for clear of the tramway and often tortuous routes have to be established to enable that. The mixing of trams with urban traffic as a fudged solution to difficult traffic management issues has been proved (e.g. Sheffield Supertram) to result in specific delays to the tram at key traffic junctions, and a reduction in average tram speed to a point where "rapid" transit becomes a misnomer.

K+20 & the UDP

Kingston has long been recognised as a successful town centre and holds Metropolitan centre status in the draft London Plan. It continues to attract public and private investment but scope for development is linked to actual and perceived traffic conditions in the town centre. One of the major issues for the Council for the next 20 years is therefore transport. The UDP draft policies emphasise sustainable travel and state that the Council will seek to improve accessibility to, and within, the town centre by giving greater emphasis to the needs of public transport users, pedestrians, cyclists and people with disabilities. A public inquiry on the Unitary Development Plan starts on 11 March 2003. In addition a long-term plan for Kingston town centre is being drawn up under the heading of K+20 and this will provide much of the strategic input into Kingston's local development document (LDD) which will succeed the UDP process.

General Requirements

The Project shall comply with the detailed requirements of the Performance Specification. It shall also comply with and satisfy the requirements set out below:

(a) the Light Rail System shall be constructed and operated so that it is safe, reliable, efficient and environmentally friendly and accessible to all irrespective of mobility impairments, as far as is reasonably practicable;
(b) the scheme shall take account of the need to react safely and quickly to emergencies in all aspects of its design and construction of the Light Rail System;
(c) the operation of the Light Rail System shall be of a high standard of presentation and public image. The Light Rail System shall be operated efficiently with minimum disturbance to the public and minimum delay to passengers;
(d) the Light Rail System shall be designed, constructed, installed, commissioned, operated and maintained so as to satisfy all appropriate standards and codes as is consistent with Good Industry Practice.
(e) the Light Rail System shall comply with all relevant Laws and regulations in place.

The Light Rail System will operate as an integral part of the public transport network in Greater London. The scheme shall be subject to a statutory duty to co-ordinate with public transport services and their operations which includes the Light Rail System. There is a requirement to co-operate with Transport for London in this respect and shall comply with Transport for London's reasonable requirements in relation to ensuring co-ordination of public transport services in those areas affected by the Light Rail System.

Quality Assurance

The Design shall be developed, implemented and monitored as an effective quality management system which shall ensure that the requirements of this Performance Specification are satisfied. The Client shall retain the right to call upon an independent Health & Safety auditor to monitor adherence to this. The quality system shall:

(a) ensure that quality requirements are determined and satisfied for all processes throughout the Construction Phase and Operation and Maintenance Phase for the Light Rail System.
(b) provide for early and prompt detection of actual or potential deficiencies, trends or conditions which shall result in unsatisfactory quality, and for timely and corrective actions.
(c) Include the establishment and implementation of procedures which clearly identify organizational structure, roles, responsibilities and processes to ensure the satisfactory integration and interfacing of all elements comprising the Light Rail System.
(d) Include a Quality Plan which is in accordance with the Quality System Model for Quality Assurance and Design Development ISO 9001/9002.

Design Criteria

The Light Rail System shall be designed so that once built and commissioned, it satisfies all of the construction, operation and maintenance Performance requirements and shall also comply with the following principles:

(a) to ensure that unless otherwise required by relevant standards, the design of the Light Rail System accommodates the reasonably predictable extremes of the local climatic conditions.
(b) the design and construction of the Light Rail System shall ensure that the appearance of both equipment and infrastructure is attractive and reduces visual intrusiveness. The Light rail System shall be landscaped in order to maintain the character of the areas through which it passes and to mitigate any adverse visual impact.
(c) the vehicles operated on the Light Rail System are to be designed to a high aesthetic standard in terms of passenger comfort and ride quality as specified in Section 13. The vehicles shall be safe, reliable, attractive, energy efficient and environmentally friendly. The vehicles shall be procured from the range manufactured by a recognized manufacturer of electric Light Rail vehicles; the short listed models should be proven in operational use, on other Light Rail System, in the UK and Europe.
(d) the Light Rail System is to be designed, constructed and operated as an integral system to provide the level of safety and reliability required by this Performance Specification.

(e) the Light Rail System shall be capable, without the need to make changes to the fixed infrastructure, including the Permanent Way, the power supply and signaling system, of providing for a 33% increase in passenger carrying capacity above that initially required by section 13 section 14 of this Performance specification. The increase in passenger carrying capacity shall be calculated by applying 33% to the product of :

I. the passenger carrying capacity [at 4pax/m2] of the largest type of Tram initially introduced to operate on the Light Rail System.
II. the number of scheduled departures on the full system in both directions during the busiest hour in the week. This increase in passenger carrying capacity may be achieved either by operating more services and/or by employing longer trams.

The Light Rail System shall be designed, built and maintained, including the renewal of subsystems and components as necessary, to a standard that will ensure that it will be capable of continued operation for a period of at least forty years without the need for a *Significant Change* more frequently than once every five years.

The Light Rail System shall be designed, with the minimum design lives specified below, for the following component parts assuming operation at the enhanced levels noted in the table below:

Element	**Design Life (in years)**
New Structure	120
Track Bed	50
New Track	15
Switches and Crossings	10
Overhead Line Equipment	25
Power Distribution Cables & Equipment	30
Tram Vehicles	20
Tram Stops & Furniture	10
Depot	50

4. The Routes

The Five District Centres Option:

Kingston, Surbiton, New/Old Malden, Tolworth, Chessington World of Adventures

Kingston Town centre:

The roads in Kingston town centre are relatively narrow, with large numbers of pedestrians and cyclists. Many premises do not have off-street loading bays. There are two bus stations: at Fairfield (for routes from the east) and Cromwell Road (for routes from the south and west). The services to the north (65 and 371) terminate in Brook Street and High Street respectively. Most bus services, at least when leaving the town centre, use stops located in Eden Street.

A one-way system around the town centre for tram-based transit vehicles has been considered as follows. Unless permitted to use the section of Clarence Street outside the Bentall Centre and Marks & Spencer, the main pedestrianised shopping street, trams would have to use Wood Street past the railway station as the northern portion of the circuit. This means that the circuit would have to be traversed in an anti-clockwise direction.

South from a stop outside Bentall's in Wood Street, there would appear to be two options for the western portion of the circuit:

Thames Street – Market Place; or Union Street

Option 1 would turn right into Clarence Street, and then left into Thames Street. The latter turn is very sharp and trams may have to encroach on the path of northbound traffic from Bishops Hall. Trams would then travel through the western side of Market Place (which would require relocation of some stalls) before turning left into Eden Street. Again this left turn is very sharp and traffic signals may be required.

Option 2 would continue south in Wood Street past the side of the churchyard before deflecting left to join Union Street. At its northern end Union Street is very narrow, but it would appear to be feasible to permit use by trams.

The southern and eastern portions of the circuit would follow the existing contra-flow bus route along Eden Street and Clarence Street. A tram stop would be provided in Eden Street immediately south of Clarence Street.

In light of the difficulties in the vicinity of the Market Place, it is not considered practical to provide a one-way system around the town centre. It is suggested that a two-way route between London Road and Penrhyn Road should be provided as follows.

Fairfield North, westbound and the old London Road eastbound

Eden Street or a parallel route through the proposed development

Brook Street and Wheatfield Way

A tram / bus interchange should be provided in the vicinity of Eden Street.

Surbiton Town centre:

The route through Surbiton town centre extends from the Claremont Road junction with the Waitrose car park (at the southern end of The Crescent), via Victoria Road to Brighton Road

Claremont Road, to the north of Victoria Road, has a carriageway up to 10 m wide. There are bus stops on each side and four parking meter bays on the western side of the road. The total road width, between shop fronts, is about 19 m. Consequently, it would be possible to widen the carriageway to 12 m. However, the footways would be a little more than 3 m, which is narrow for a town centre. In addition, servicing to the shops and offices would be difficult.

Claremont Road joins Victoria Road at a roundabout, which also links St Mark's Hill and St James' Road. The entrance to the railway station is also from the roundabout (with the exit located in Victoria Road 30 m to the west). St. Mark's Hill forms the main road linking the town centre and Ewell Road to the east, and is used by buses. St James' Road provides access to a residential area, with some commercial premises, and a car park in St Philip's Road (to the rear of the Somerfield store).

To provide priority to transit vehicles, this junction should be converted to signal control, with a hurry call facility. This would be facilitated if St James' Road were to be made one-way north-westwards (away from the junction).

Victoria Road, which forms the main shopping street in Surbiton, has a carriageway that narrows to 7.5 m in places. Parking and loading bays are provided, to the east of St Mary's Road on the southern side, and to the west on the northern side. Access to the Sainsbury car park is located to the south of Victoria Road opposite St Andrew's Road.

The total road width is insufficient to permit the carriageway to be widened. Consequently transit vehicles would suffer the delays frequently experienced in a shopping street. To reduce delays to the rapid transit vehicles, other traffic flows should be minimised. This could be achieved by making Victoria Road a one-way street with a contra-flow lane for transit vehicles.

Victoria Road joins Brighton Road at an uncontrolled crossroads, with Brighton Road forming the main road. Victoria Road flares on the approach to the junction, to provide two narrow lanes. Brighton Road has a carriageway only about 10 m wide. This is insufficient to provide a dedicated right turn lane into Victoria Road, and queues form on the northern approach to the junction.

Brighton Road cannot be widened, as it passes under the main railway line only 50 m south of the junction. Traffic signals, with a hurry call facility, should be provided at the junction. To reduce congestion at this junction, it would be necessary to restrict the right turn from Brighton Road into Victoria Road to transit vehicles, buses and cyclists only.

This could be achieved by making Victoria Road one-way westbound. Other vehicles wishing to access the town centre from Brighton Road (including shoppers wishing to use the Sainsbury car park) would have to do so via Maple

Road (at the traffic signals) and St Andrew's Road. This would be facilitated if St Andrew's Road were made one-way southbound.

The provision of priority to rapid transit vehicles along the route through Surbiton town centre presents a significant challenge. The roads are narrow, and cannot be widened, except in Claremont Road.

Consequently, trams would not be able to use Victoria Road unless all loading and parking were to be banned and be rigorously enforced during the tram operating hours. This is unlikely to be acceptable. If a tram-based transit system were to be provided to Tolworth, it would have to use St Mark's Hill and Ewell Road. Trams would be unable to turn directly between Claremont Road and St Mark's Hill, and it would be necessary for trams to pull into a stop in the station car park and then proceed (in the opposite direction) to continue the route.

Kingston to New Malden:

As it leaves central Kingston, London Road has a minimum carriageway width of about 10.5 m, with a westbound bus lane between just west of Cambridge Road and about 40 m west of the westbound stop-line at Queen Elizabeth Road. Eastbound buses stop in a lay-by immediately east of Queen Elizabeth Road, and the road flares on the approach to the junction with Cambridge Road.

The eastbound approach to the signal-controlled London Road / Cambridge Road junction has two ahead lanes and a right turn lane.

The route would turn into Cambridge Road, which between London Road and Hawks Road has a carriageway about 13.5 m wide. There would appear to be little opportunity for any widening. A westbound bus lane extends for about 80 m, from about 50 m west of Hawks Road to within about 100 m of London Road. The bus lane could not be extended closer to London Road (without causing a significant increased congestion) as the right turn queue often extends to the bus lane. If the bus lane were to be extended nearer the stop line, the queue of other traffic would lengthen, possibly to beyond the start of the bus lane, delaying buses from reaching the bus lane. An eastbound bus lane extends for about 80 m, from opposite Church Road (60 m from London Road) to 70 m from the stop-line at Hawks Road signal controlled junction. Again, the bus lane could not be extended closer to Hawks Road as the queue in the offside right turn lane often extends to the bus lane.

The Cambridge Road / Hawks Road / Chatham Road junction is controlled by traffic signals. A hurry call facility could be provided. The two-lane westbound Cambridge Road approach is divided into a left and an ahead lane. This is enforced at the signals by a short ahead only bus lane after the left turn slip road into Hawks Road.

Cambridge Road to the east of Hawks Road has a 9 m wide carriageway. This could be widened on the northern side in front of the flats in Ayliffe Close to provide a 12 m wide carriageway, but this would require the construction of a retaining wall.

Cambridge Road passes through a shopping parade west of Hampden Road. The width between shop-fronts is almost 18 m, and the carriageway could be widened to 12 m, with 3 m wide footways on each side.
To the east of Hampden Road as far as California Road, Cambridge Road continues with an approximately 10.5 m wide carriageway, which comprises a westbound bus lane (that operates Monday to Friday, 7 – 10 am) a lane for other traffic in each direction and an eastbound advisory cycle lane. Over much of its length, the footways are wide. With some limited land acquisition (to the east of King Henry's Road to provide an additional 1 m width) the carriageway could be widened to 12 m with 2 m wide footways on each side.
To the east of California Road as far as the railway bridge, Kingston Road also has an approximately 10.5 m wide carriageway, but it comprises a single lane and cycle lane in each direction. The footways / forecourts to the shops are wide and the carriageway could be widened to 12 m.
To the east of the railway bridge until the immediate approach to the Fountain Roundabout in New Malden, the carriageway narrows to under 9 m, although it still comprises a single lane and cycle lane in each direction. Except at the railway bridge itself, the carriageway could be widened to 12 m with 2 m wide footways on each side provided that an approximately 1 m strip is acquired from adjoining premises.
To provide priority for transit vehicles, the Fountain Roundabout should be converted to traffic signal control, with a hurry call facility. This would require the relocation of the fountain, which is at present located in the centre of the island.
A double track tram-based rapid transit system could be introduced, although there would be a pinch point in London Road and in Cambridge Road between London Road and Hawks Road, where trams could not be segregated from other traffic. However, between Hawks Road and the Fountain Roundabout at New Malden, an approximately 1 m wide strip of land would have to be acquired. The waiting and loading bans would have to be rigorously enforced, especially during peak periods.

Kingston to Tolworth, Chessington and Park & Ride

1. The proposed Light Rail System would cross the A3 on a new Tram bridge:
2. The proposed dual-alignment would run South West from Tolworth, along the South-side of the A3 to Hook.
3. The Light Rail system, would turn South to run down the A243; Hook Road (Elm Road to Bridge Road) and Leatherhead Road (Bridge Road, Harrow Close, Garrison Road) to the proposed Chessington World of Adventures Park & Ride

At Tolworth a bridge would carry a two-track tram line across the A3 roundabout and down a gentle ramp into Tolworth Broadway. If there were room a wider bridge could also accommodate a cycle and pedestrian path and perhaps a bus-only lane for use by bus services to and from Epsom and Ewell. Tolworth

Broadway, Ewell Road and St Mark's Hill converted to carry one segregated tram line and one line of road traffic in each direction where width allows, with loss of road traffic lane where it does not. Tram route would then pass Surbiton Station with a stop, then go up Claremont Road, Maple Road, Surbiton Road and Penrhyn Road to enter the town centre by a route which would depend on the planning and redevelopment of the south-east sector of the town centre. All these roads would also be converted to carry one segregated tram line and one line of road traffic in each direction where width allows (or can be obtained without demolition of buildings), with loss of road traffic lane where it does not.

Link to Sutton –proposed Croydon Tramlink Extension:

A long term aspiration, to provide an SE orbital link between Kingston, Sutton and Croydon, would be realised by extending the Light Rail System to Sutton and thereby linking up to the proposed Sutton extension of Croydon Tramlink.

The Corridor Option:

Kingston – Surbiton – Tolworth – Chessington - Chessington World of Adventure

Kingston to Surbiton:

Leaving Kingston town centre via Wheatfield Way, there is a short southbound bus bypass lane at the College Roundabout. Immediately south of the roundabout, to the signal-controlled junction with The Bittoms (outside Kingston College and the Crown Court), Penrhyn Road is about 15 m wide with two lanes in each direction giving priority to Trams. To reduce traffic flows, and hence congestion, it is suggested that Penrhyn Road, between the College Roundabout and The Bittoms, be restricted to Trams, buses and cyclists only: Grove Crescent would have to be closed at its junction with Penrhyn Road. Other vehicles wishing to travel between the town centre and Surbiton Road would do so via High Street and Portsmouth Road.

To the south of The Bittoms (outside County Hall and Kingston University), the carriageway narrows to approximately 10.5 m. There is a northbound bus lane (operational Monday to Sunday, 7 am to 7 pm) from about 60 m south of Woodbines Avenue and the bus bay outside the Crown Court. There would appear to be an opportunity to widen the carriageway to 12 m, by removing the landscaped areas in front of County Hall and Kingston University and part of the car parking area at the university.

To the south of the bus lane, Penrhyn Road narrows further (to about 8 m at its junction with Surbiton Road) with a single lane in each direction. Parking is permitted on the eastern side of the road. It would be possible to widen the carriageway, on the western side, to 9 m. However, this would require the parking bays to be removed.

The route continues southwards through the shopping parade at Surbiton Road. The carriageway (excluding the parking bay on the eastern side) is about 10 m wide. The distance between the shop-fronts is about 18 m, and with 3 m footways, it would be possible to widen the carriageway to 12 m.

The route follows the present bus route, which turns into Surbiton Crescent at a priority junction. Surbiton Crescent is a largely residential street with the Surbiton High School on its eastern side.

The alternative route continues via Surbiton Road and Maple Road.

The carriageway of Surbiton Road, between Surbiton Crescent and the signal-controlled junction with Maple Road (at the Assembly Rooms) is about 10 m wide. The carriageway flares to two lanes in each direction, at the signal-controlled junction; Surbiton Crescent and Maple Road, a hurry call facility should be provided and it may be desirable to restrict egress from the road to buses. All other vehicles would have to turn right into Uxbridge Road (which is already a one-way street) towards Portsmouth Road.

The route south of Maple Road, for tram- based systems would be via Claremont Road. This predominantly residential road is about 9 m wide. A double track tram-based rapid transit system could be introduced.

Surbiton to Tolworth

Two routes exist for the route between Surbiton and Tolworth Broadway:

via Upper Brighton Road, Kingsdowne Road, Ewell Road; or

via St Marks Hill and Ewell Road.

Route via Upper Brighton Road and Kingsdowne Road

As described above, this route is suitable only for a bus-based system. To the south of Surbiton town centre, Upper Brighton Road has a carriageway that is about 7.5 m wide. There would appear to be little opportunity for widening. Consequently, buses would be unable to avoid delays that occur.

The five-arm mini-roundabout at the junction of Upper Brighton Road with Kingsdowne Road and Langley Avenue is congested at peak periods. To provide priority to buses, the junction should be converted to signal control. It would be necessary to reduce conflicts at the junction, which could be achieved by closing Langley Road and making Langley Avenue one-way south-westwards (away from the roundabout) as far as its junction with Corkran Road.

Kingsdowne Road is a wider single carriageway road with a carriageway width of up to 9.5 m. There would appear to be little opportunity for widening. 120 m from the roundabout with Upper Brighton Road a signal-controlled pedestrian crossing controls the westbound flow, towards the roundabout, providing gaps in the circulating traffic that permits northbound traffic (including buses from Hook) on Upper Brighton Road to enter the roundabout. Kingsdowne Road joins Ewell Road at a signal-controlled junction, where a hurry call facility should be provided.

Due to the restricted width of Upper Brighton Road (between Victoria Road and Kingsdowne Road), it would not be possible to provide priority for buses. However, a bus lane could be provided in Kingsdowne Road on its approach to Upper Brighton Road.

To the east of Surbiton town centre, St Mark's Hill has a carriageway about 9 m wide with a service road located outside the shops on the southern side. The width remains broadly the same to its junction with Ewell Road. There would appear to be little opportunity to widen the carriageway by more than about 1 m by narrowing the footways to 2 m.

St Mark's Hill joins Ewell Road at a signal-controlled junction that, it is understood, is to be improved. The design of the junction is constrained by the bridge that carries Ewell Road over the railway 50 m south of the junction, where the carriageway is currently about 7.5 m wide. A hurry call facility should be provided to give priority to transit vehicles.

South of the railway bridge, Ewell Road widens, to about 10.5 m, as it passes through the Oakhill Conservation Area. This width is maintained through the shopping parade to the zebra crossing south of Langley Road. The road then widens further, with a carriageway width of about 12 m on the approach to the traffic signal-controlled junction with Kingsdowne Road.

Route through Tolworth:

Ewell Road south of Kingsdowne Road has a wide single carriageway (approx. 12.5 m wide) leading to the dual 7.5 m carriageways, through the Broadway shopping centre in Tolworth. Priority vehicle lanes could be provided, but this would require the removal of a significant amount of on-street parking throughout the shopping centre. At the junction with the A3 Kingston Bypass, it is proposed to provide a twin-track tram route through the roundabout, crossing the A3 (which is in an underpass) on a new bridge. To the south of the A3, the A240 Kingston Road is a dual carriageway road, with two lanes southbound and three lanes northbound.

Hook to Chessington World of Adventures

The A3 Hook Interchange comprises a grade-separated roundabout with the A3 in an underpass. The roundabout is relatively compact, and there would appear to be little opportunity to construct a busway through the centre on a new bridge.

Hook Road to the south of the A3, as far as the roundabout at Bridge Road, has dual two-lane carriageways about 7.5 m wide, which narrow at the pedestrian crossings (where the central reserve is widened). However, on the northbound approach to the Hook Interchange, the northbound carriageway is marked with three narrow lanes, one for each movement at the junction. There would appear to be little opportunity to widen the carriageways, or for a northbound bus lane.

The Hook Road / Elm Road / Clayton Road junction is controlled by traffic signals, where a hurry call facility should be provided.

Leatherhead Road to the south of the Hook Road / Bridge Road roundabout is a single two-lane road. Consequently, southbound traffic from Hook Road has to merge from two lanes into one. The resulting queue often blocks back through the roundabout, obstructing traffic wishing to enter from Bridge Road, and extending into Hook Road.

Leatherhead Road, between Bridge Road and Harrow Close has a carriageway about 9 m wide. Further south, to the junction with Garrison Lane, the carriageway narrows to about 7.5 m. The Leatherhead Road / Garrison Lane priority junction should be converted to signal control with a hurry call facility. Between Garrison Lane and Chalky Lane, Leatherhead Road has a carriageway width of 7 m, widening to 9 m to provide right turn lanes at the accesses (to the Barwell Trading Estate and the Chessington World of Adventures). There would appear to be little opportunity to widen the road to provide a bus lane, as the right turn lanes must be maintained.

Kingston – New Malden – Old Malden – Worcester Park – Cheam – Sutton

Kingston to Sutton:

The proposed route is considered in three sections:

1. Kingston to New Malden, via London Road, Cambridge Road and Kingston Road as described in section 2.2);
2. New Malden to Worcester Park, via Malden Road;
3. Worcester Park to Sutton.

Between the Fountain Roundabout, to the south of New Malden town centre, and the A3 Kingston Bypass, Malden Road has a carriageway about 7.5 m wide. This could be widened to 9 m if the verge and trees on the eastern side were removed. The carriageway could be widened to 12 m with 2 m wide footways on each side if an approximately 1 m wide strip is acquired from adjoining premises. The design is to provide a double track tram route through the roundabout, crossing the A3 (which is in an underpass) on a new bridge.

To the south of the A3, Malden Road has a carriageway about 9 m wide, with a single highway and cycle lane in each direction.

The Malden Road / South Lane junction is signal controlled, with a single lane on each approach. A hurry call facility should be provided and the junction widened, using the wide verge on the eastern side, to provide two lanes on each approach to Malden Road. The carriageway would narrow to the current 9 m to pass under the railway bridge.

To the south of the railway bridge, the Malden Road / Church Road junction should be converted to signal control with a hurry call facility. Malden Road continues through the shopping parade at Old Malden with a carriageway about 9 m wide, with a single lane and cycle lane in each direction. There is a wide footway / forecourt in front of the shops, and the carriageway could be widened to 12 m.

Between Fullbrooks Avenue and The Manor Drive, Malden Road continues with a 9 m carriageway, with a single highway and cycle lane in each direction. At the traffic signal controlled junction at Station Approach, outside Worcester Park station, Malden Road has two lanes on each approach. A hurry call facility should

be provided. Central Road, as it passes under the railway bridge, has dual 6 m carriageways.
A double track tram-based rapid transit system could be introduced, although through the railway bridge to the north of Old Malden, shuttle working on a single track would be required.

The route would leave Worcester Park via Green Lane. The Central Road / Green Lane junction should be converted to signal control with a hurry call facility.
The route would follow the line of the Green Lane between the primary school and the riding school. The transit vehicle route would then turn along the footpath to the west of the riding school, before turning across the southern part of the riding school to join Amenity Way. Amenity Way, which is part of Merton Council's waste transfer station, has a carriageway about 7 m wide.

Transit vehicles would turn in to Garth Road at a junction that should be converted to traffic signal control, with a hurry call facility.
Garth Road, which is a traffic-calmed road through a largely residential area, has a carriageway about 7.5 m wide.
The Garth Road / A24 London Road junction would be converted to traffic signal control, with a hurry call facility. This junction would be extended to accommodate a new link for transit vehicles located between Elstead Court and the stream to the north of the houses in Hamilton Avenue.

The new link route would follow the footpath adjacent to the stream before turning to join the alignment of the disused road north of Minden Road (in the Kimpton industrial area). The route would continue across open land to join the road serving the Sutton Council's household waste site. The junction with Oldfields Road should be converted to signal control with a hurry call facility.
The route between Oldfields Road and Sutton town centre should follow the existing bus route along Collingwood Road.

Reuse or sharing of Heavy Rail Corridor – Tolworth to Chessington South

RBK would need to convince the SRA to permit complete take over of the Chessington rail line from its junction with the line to Epsom. A section of the track north east of Tolworth would become available to be converted into a rather linear tram depot/stabling area. The remaining section to the junction with the line to Epsom could be converted to a cycle and pedestrian path and/or released for development. Malden Manor station would be closed. Around 700 users would have to travel to Worcester Park in order to travel to London.

The section from Tolworth to Chessington South would be used exclusively for trams and enhanced by an extension in the south to a new CWOA station opposite the main northern entrance, preferably with a pedestrian bridge used to cross the A243. All users of rail services from Chessington North and South and

Tolworth to Waterloo, or other stations north of Tolworth, would have to take a tram to Surbiton and change there for a London service. This affects around 2,500 people a day though for a proportion of them their net journey time and opportunities could actually improve as a result of more frequent trams from their origin and use of fast train services from Surbiton.

5. The Fixed Track Infrastructure

Design Criteria

Clearance

The design of the Light Rail System shall ensure that the track spacing and clearances between Dynamic Kinematics' Envelopes (DKE's) of Trams on adjacent tracks and to fixed objects is in accordance with the requirements of HMRI.
The design shall ensure that horizontal clearances between kerb lines of roads & System structures shall not be less than those set out in the relevant D f T technical memoranda and the D f T publication "Roads and Traffic in Urban Areas" and shall meet the requirement of HMRI.

The Clearance Envelope (CE) is defined as the space occupied by the Vehicle Dynamic Envelope (VDE) plus the effects of Other Wayside Factors (OWF) including construction, fabrication, and maintenance tolerances for certain track and facilities plus Running Clearances (RC).
Simplistically this relationship can be expressed as follows:

$$CE = VDE + OWF + RC$$

Generally speaking, the clearance envelope represents the space in or into which, other than the light rail vehicle, no physical part of the system may be placed or constructed or may protrude.
The clearance envelope is normally referenced from, or represented by its relationship to, the theoretical centreline of track at Top of Rail (TOR).

a) Vehicle Dynamic Envelope

In addition to the LRV static dimensions, the vehicle dynamic envelope (VDE) includes all possible vehicle movements from vehicle tolerances and from certain closely-related rail/track tolerances. More specifically, the VDE is based upon the following assumptions:

1. Static geometry of the vehicle
2. Roll angle of ± 4°
3. Suspension lateral travel (per side)
4. Wheel gauge construction tolerance (per side)
5. Lateral wheel wear (per side)
6. Radial wheel wear
7. Rail gauge construction tolerance (per side)
8. Lateral rail wear (per side)
9. Wheel-to-rail sideplay (per side)

b) Other Wayside Factors

The clearance envelope (CE) can be determined by adding other wayside factors

(OWF) for certain construction and maintenance tolerances; plus running clearance to the vehicle dynamic envelope. Other Wayside Factors is the sum of certain construction tolerances (CT) plus certain maintenance tolerances (MT) plus a corded wall construction factor (CW) to account for the effects of certain wall construction, all where applicable.

$$OWF = CT + MT + CW$$

The following defines the Other Wayside Factors and are applicable to and included in the horizontal component of the CE:
CT = Construction tolerances (allowable deviation from design position)
Track = 12mm in open, paved, and direct fixation
Plus: poles or signals equipment = 25mm, or walls = 25mm,
or MT = Maintenance tolerances (allowable deviation from as constructed condition)
Track = 25mm in open track (each track), or = 12mm paved and Direct Fixation track.
CW = Additional width for chorded construction of walls, catenary poles, signal poles, other obstructions to be constructed outside of curves.

c) Running Clearances
In addition to the vehicle dynamic envelope and the other wayside factors, the clearance envelope includes an allowance for running clearances (RC). Running clearances can be considered as the RTD clearance contingency after the inclusion of all factors purporting to define the vehicle, the vehicle tolerances, the construction tolerances, and the maintenance tolerances.

Running clearances are specific to the ROW conditions encountered and shall include one of the following in any direction:

1. 25mm for traction power poles, conduit, signals, signs, and other non-structural members,
2. 50mm for walkway edge, or
3. 75mm for pantograph electrical clearance, or
4. 150mm for structural members, or
5. 12mm for adjacent LRV.

Swept paths

To travel along the alignment without colliding with any fixed obstacles, the Light Rail Vehicle (LRV), Tram; needs a space defined by the Swept Path. This is the dimension, to be taken into account for the design study. All the fixed obstacles (equipment or infrastructure of the Light Rail System) also other adjacent obstacles and structures; will be located or removed from out side of this path. The Kinematics' Envelope or gauge, plus a value of clearance from obstacles establish the Swept Path.
[Refer to section 13 – Rolling Stock]

In pedestrian areas, the Swept Path of the Tram shall be clearly delineated. The types of markings shall meet with the approval of the Royal Borough of Kingston, the Highways Authority and other statutory bodies; so as to make pedestrians, including the visually handicapped aware of potential danger.

Environmental Impact

The Light Rail Scheme shall be designed and built in a manner which minimises its impact on the built and natural environment and which protects, as far as is feasible, the existing flora & fauna. The Light rail Scheme shall be designed to minimise energy consumption and ecological damage and in particular, complies with BS5837 in relation to trees.

Reinstate and landscape the area affected by the Project Works following construction of the Permanent Way in accordance with the Royal Borough of Kingston's landscaping policy & requirements.

Incorporate the mitigation measures, identified in an Environmental Audit and additional studies required therein to access further likely impacts of the Light Rail Scheme. Relevant mitigation measures shall be incorporated into the detailed design and construction works.

Prior to commencing the relevant design process, complete the Environmental Audit and produce an Environmental Action Plan to ensure that all the identified mitigation measures and additional surveys are incorporated into the detailed design and the programming of the works.

The Light Rail Scheme shall be designed and constructed, with sympathetic consideration for the environment, through which it passes.
The new development must be sympathetic to the special character of the conservation areas in Kingston upon Thames, particularly in terms of its scale, visual intrusion, materials, landscape and impact upon local heritage.

Operational Noise & Vibration Requirements

The Light Rail System shall be designed & constructed, with all reasonably practicable steps to reduce the operating noise of the system.

All new structures having regard to operational noise and visual intrusion shall be designed in accordance with the criteria's as specified in section 4.
All structures shall be designed and constructed to mitigate operational noise and vibration propagation where appropriate and as far as is practicable by the use of current best practise:

I. Design the Light Rail System such that at Existing Noise Sensitive Resources, upon commencement of operations or within three months after the Actual Opening date.

a. for areas with Existing Noise levels les than or equal to 59dB(A), the Light Rail System noise shall not exceed 59dB(A)
b. for areas with Existing Noise levels greater than 59dB(A), the increase in noise due to operations shall not be greater than 3dB(A)

II. All noise levels refer to 24 hour L☚✆☙⑧🗋 at 1 meter from the relevant building façade.
III. Comply with the requirements for airborne noise from the Depot, which shall be demonstrated by the use of predicted noise levels and the measurement of existing noise levels at affected premises. The promoters shall take all reasonably practicable steps to reduce at source, by appropriate design or by management of activities within the depot, noise emanating from the depot.
IV. The Light Rail System shall be designed and constructed so as to achieve levels of noise inside adjacent dwellings, caused by vibration transmitted through the ground due to the passage of a Tram, which do not exceed a maximum sound level of 40dB(A) when measured using a sound level meter conforming to BS 5969 type 1`S' response.
V. The Tramway shall be designed and constructed so as to achieve levels of vibration not exceeding the following Vibration Dose Values as specified in British Standard BS 6472: 1992 in the foundation of any adjacent dwelling:-
    a. daytime (06:00 to 22:00) VDV Limit; 0.3m/s🗍🗐🖷▭
    b. night time (22:00 to 06:00) VDV Limit; 0.1m/s1.75

Construction and Track Slab

General Requirements

The new trackbed is to be designed and constructed, so as to provide the required structural support for the track, without the need for excessive or frequent maintenance and repair.

The trackbed shall include all associated equipment including, where necessary, but without limitation to, drainage ducts, ducts for power supply, signalling and telecommunications cables, traction cables and stray current apparatus. The location of the necessary associated equipment shall be clearly indicated on the approved trackform drawings.

Trackform

There are two principal trackforms within the Light Rail System:-

I. new track on private right of way.
II. on-street track

The design of the Light Rail System trackform shall ensure that the trackwork in the carriageway or pedestrian areas is flush with the road or pavement surface, so that the rails are embedded. Adjacent road surfacing shall be laid with the track upper flange or rail head, with a tolerance which meets the approval of both HMRI and the Highways Authority and maintained within that tolerance.

The design shall incorporate all measures necessary to provide adequate drainage of the trackwork, and shall cater for surface water arising from outside the paved track area. The design shall ensure that track drainage is not impeded by detritus in the street, particularly from Tram sanding equipment.

Grassed track may be used in; new track on private right of way sections, subject to approval under Sections 3.5 and 3, 7 of this performance specification. In grassed-tracked areas the design shall incorporate appropriate provision for maintenance.

The use of the LR55, twin prefabricated foundation troughs system, for laying the track of the Light rail System may be of consideration, so long as its specification shows a saving in programme and budget over conventional forms of track laying.

Drainage

The design of the Light Rail System shall provide for drainage where necessary to protect the formation of the system.
The Design shall include for appropriate measure to allow for long term changes which can reasonably be expected in ground water pressures.

I. groundwater levels in deep and shallow aquifers
II. the effects of the changes in the water table in the London basin.

The drainage shall be designed and constructed to current standards and Good Industry Practise. The drainage of all new bridge structures shall be positive and, unless otherwise required by the Royal Borough of Kingston or the relevant local authority, all surface water shall be piped to the local storm water sewer system by a defined drainage path. Particular attention shall be paid to ensuring that surface water drainage systems in the vicinity of the traction sub-stations are routed to avoid any risk of flooding of electrical equipment areas.

The drainage design is to be approved by the relevant Water Utility, Environment Agency and the Highway Authority. The design shall ensure that any new flows into existing drains and the method of connection are authorised by the Royal Borough of Kingston or the relevant local authority.

Utility Diversions

The design of the Light Rail System should ensure that the clearance of Statutory Undertakers' Apparatus from the Tramway corridor is taken into consideration. Any future concession to design, build, commission and operate a Light Rail System will detail the Concessionaires responsibilities for the Utility Diversions.

The Concessionaire is required to move, or undertake protective works, in relation to the Identified and the Unidentified Utilities so as to accommodate the construction and/or operation of the Light Rail System.

The Concessionaire will be deemed to have satisfied its obligations under this paragraph 5.2.3 in relation to moving Statutory Undertakers' Apparatus if the relevant Undertakers Apparatus are moved from a predetermined alignment for certain sections of the Light Rail System; over a width of Dynamic Kinematics' Envelope (DKE's) for the vehicle plus 500mm either side, prior to providing the Concessionaire with access to those sections of the Route.
The relevant sections are:

(a) the street running sections.
(b) the off-street, segregated running sections.
(c) the corridors shared with heavy rail lines.

The Concessionaire shall form a working party with the Royal Borough of Kingston, the affected Statutory Undertakers, the Highways Authority and HMRI to agree the most appropriate solutions for the Tramway alignment and the for the support of the OHLE within the street running sections and Network Rail for the shared corridors.

<u>Bridgeworks, subways and structures</u>

Bridges and subways shall be designed in accordance with the requirements of BS 5400 as implemented by the appropriate DfT documents.
Bridges over railway tracks shall comply with DfT Requirements as published and the Railways and Other Transport Systems [Approval of Works, Plant and Equipment] Regulations 1994.

Condition Surveys and Structural assessments of existing structures shall be undertaken by specialists in this field and reasonably recommended mitigation measure incorporated.
Where land under an existing structure is laid open to road traffic as a result of the Works and has headroom of less than 5.7m, the structure shall meet the requirements of BD 37/38 for vehicle collision loads on the structure. Parapets liable to accidental vehicular loading shall be designed in accordance with the requirements of D f T standard BD 52/93 for a P6 type parapet, but with a minimum height of 1850mm.

The railway Live load for structures carrying Trams shall be appropriate to the model of Tram selected, but shall not be less than 0.5 RL in accordance with Clause 8 of BS 5400 Part 2.
The Design for the Light Rail System, shall take into consideration, any modifications to existing structure necessary to accommodate the system.
Bridges & viaducts carrying the Light Rail System tracks or new structures passing over System tracks or Network Rail lines shall allow sufficient clearance

between the structures and the track to meet current Network Rail Group Standards and HMRI requirements for safe access along the tracks for the System and Network Rail personnel and for emergency evacuation.

The alignment of the Light Rail System tracks shall allow sufficient clearance between the System tracks and the Network Rail lines to meet current Network Rail Group Standards and HMRI requirements for safe access along the tracks for the System and Network Rail personnel and for emergency evacuation.

Bridges & viaducts carrying the Light Rail System tracks or new highway structures passing over System tracks or highways shall allow sufficient clearance between the structures and the track to meet current Highway Authority Standards and HMRI requirements for safe access along the tracks for the System and emergency services personnel and for emergency evacuation.

All structures shall be provided with a continuous walkway for emergency evacuation and access purposes.

Highway construction and reinstatement

All Highway construction and reinstatement shall be carried out, in accordance with:

1. The Specification for Highway Works, published by HMSO
2. as volume 1 of Manual of Contract Documents for Highways Works
3. The Design Manual for Roads and Bridges

The foundations of the track and carriageway shall be capable of accommodating the surface finishes required by the relevant Highway Authority.
Pavements for all vehicular paved areas shall be designed for the residual levels of traffic loading as determined by the Traffic Models.

Road Junction Realignment

Safety of road users is the overriding priority when designing road junctions.
Turning movement for relevant vehicles should be validated and as far as is reasonably practicable kerb lines shall be designed to ensure that vehicles do not enter the swept path of the tram.
Junctions shall be designed to ensure that Trams can proceed with the minimum of delays at signals.
The Tramway alignment shall be designed to maximise sight lines to signals and to ensure that trams are kept clear of and not delayed by queuing traffic, particularly that making right turns.
Layouts and signal phasing should be designed to maximise the number of \`with tram' movements possible.
The design of major and minor road junctions should, as far as is reasonably practicable, be constrained by existing highway boundaries.

The layout of junctions, must give due regard to the needs and requirements of cyclists and pedestrians.
Junction layouts should also pay due regard to the highway constraints within the immediate area (Tram and bus stops, bus priority, loading and access, highway boundaries and minor junctions.

Pedestrian strategy, footways and crossings

Particular care must be paid to the arrangements for access to stops and for crossing the tramway, especially close to motorised switches, to ensure that risks are reduced to 'as low as reasonably practicable' levels.

Where possible footway widths are to be maintained as existing.

A minimum general footway width of 2.0m is assumed. Where footway widths are less than the existing provision, suitable survey and analysis will be required, in conjunction with liaison with the appropriate authorities, to determine the acceptability of the proposals. This will also need to be assessed at pinch points where footway widths below 2m are under consideration.
The pedestrian crossing points of, track on off-street sections shall be designed:-

1) Surfaces at crossing points are to be level with the top of the running rails and surfaced in non-slip materials.
2) Crossings should be as near as possible at right angles to the Tram way
3) Crossings and approach ramps to them shall be accessible to those with disabilities, including users of wheelchairs.
4) The design of the crossing points shall, wherever practicable ensure that users are turned through ninety degrees before entering the crossing.
5) Controlled pedestrian crossing locations should be dictated by the development of Tram stop locations and signalised junctions.

Cycle strategy and cycle paths

Existing cycle lanes must be retained as far as is reasonably practicable as part of the design of the new highway/tramway layout.
Particular attention must be paid top the provision for cyclists and for managing the interface between cyclists and pedestrians at Tram stops.

1) Surfaces at crossing points are to be level with the top of the running rails and surfaced in non-slip materials.
2) Crossings should be as near as possible at right angles to the Tram way

Landscaping

The overall visual intrusion of the Light Rail System shall be minimised, using appropriate landscaping, incorporated in the design of the Tram Stops; power supply system and major structures. Visual assessments of the structural designs shall be undertaken by a specialist in this field.

Park & Ride (Chessington World of Adventure)

Park and Ride can help reduce congestion and pollution in busy urban areas, especially when combined with a Light Rail Transit system or bus priority measures on routes to the centre and parking controls.

6. Trackwork

General Requirements

The track alignment, geometry and track laying tolerances of the Light Rail System, shall be designed in accordance with Railway Group Standards Code and Railway safety principles and guidance (RSPG) Part 2 Section G Guidance on tramways, or other appropriate British or equivalent EU standards, except where modified by this Performance Specification or HMRI requirements

Alignment and geometry

Track Alignment Design Criteria Schedule:

The Design shall comply with the following parameters:

1	**Maximum design speed**	
	-on segregated track, away from the highway	80km/h
	- on segregated track in the carriageway [dependent on the general highway speed limit in force]	50km/h or 65 km/h
	- on non-segregated track in the carriageway [dependent on the general highway speed limit in force]	50km/h (where the highway speed is 30 mph) or 65km/h (where the highway speed is 40 mph)
	- on non-segregated track in pedestrian dominated areas	30km/h
2	Track gauge	1435mm
3	Maximum Tram width	2.65 m
4	Maximum Tram length	40 m
5	Maximum gradient	9%
6	Maximum radius horizontal curve	20m

7. Horizontal transition curves shall take the clothoid form and shall be applied where practicable to all circular curves.
8. The minimum length of straight between untransitioned circular curves shall be 10m except in switches and crossings.
9. The trackwork vertical alignment shall be designed so far as reasonably practicable, so as not to impose any constraint upon the speed of the Trams additional to that imposed by the horizontal alignment. Where reasonably avoidable, vertical curves of less than 500m, shall not be coincident with horizontal curves of less than 50m radius. Vertical curves should generally not be coincident with horizontal transition curves.

Switches, crossings and turnouts

Assurance of adequate and appropriate clearance for the passage of light rail vehicles throughout the mainline trackage, switches and special trackwork, Tram stops, Depots and operations facilities is one of the most fundamental concerns inherent in the design process and must be rigorously monitored during the construction phase. Design criteria for clearances are complex and are based on numerous assumptions and interfaces.
The design shall provide for; turn-outs, crossings, points, switches, interlacing and interruptions to the continuity of the rail head with **flange running** sections which minimize joint noise.
The Design shall minimize flange squeal through junctions. Points shall be provided with two moveable blades so mounted to allow the use of magnetic track brakes and their safe passage through the point work. All points shall be freely trailable.
The moving parts of turn-outs shall not be located on pedestrian crossings or in areas of heavy crossing and turning movements by road vehicles.
The location of turn-outs should be positioned to minimize operational noise and vibration and visual intrusion caused by associated OHLE.
All turn-outs, switches and points shall be powered by suitable electrically powered point motors and shall be integrated with the signaling system.
All turn-outs, switches and points shall be fitted with electrically powered point heaters, capable of providing protection down to -12deg C.
Expansion switches shall be provided at the junction of any continuous welded rail and jointed track. Switches and crossings shall be designed so that they are capable of through stressing as required.

Rail and rail fixings

The Design shall ensure that each trackform maxims the use of rails and fixings of industry-proven standard track components readily available in the EU.
The rails and track components shall comply with the relevant British or equivalent EU standards. The different trackforms shall, where reasonably practicable, utilise the same components for track fixing.
The head profile of new track shall be selected to take account of wear life, compatibility with the proposed wheel profile and to minimise noise & vibration.
The profile presented to the wheel tread and flange shall be compatible for off-street and on-street track. The width of the groove in on-street track shall be within the limits approved by both the HMRI and the Highway Authority.
Rails shall be capable of bearing an axle load of 12 tons, under normal operating conditions without plastic deformation.
Rails to be installed in curves of radius less than 125m shall be pre-curved.
Where it is impractical to design curves, to suit the available alignment space, with radius greater than 50m, proprietary mechanical flange greasers shall be installed in order to minimize flange squeal.

Check rails are to be installed in conjunction with rigid crossings to guide vehicle wheels, also as guard rails on the inside of small radius curves, in order to relieve the outside rail and minimize wear and flange squeal.

Heavy Rail Route Infrastructure; Tolworth to Chessington South

Attractions of shared track Corridor:

1. Reduced cost (both in infrastructure and in operation)
2. Less disruption from construction
3. Faster journey times on longer routes
4. Making better use of existing railways
5. The creation of high quality public transport links between cities, over existing railways, which leave the line each end to penetrate city centres
6. Providing much-improved services with less subsidy or none at all
7. The opportunity to create “seamless” transport systems and travel experiences

The issues involved:

1. Compatibility of the safety systems
2. Power supply of the track in relation to the power used by the vehicles (voltage, and third rail vs. overhead wires)
3. Width of the vehicles in relation to the position of the platforms
4. Height of the platforms

7. OHLE

General Requirements

In designing the OHLE, the following design criteria shall be adopted:
the use of unobtrusive OHLE including; support masts, contact wires, span wires, insulation systems, junctions, tensioners & section insulators.

Support Masts

Masts must be reduced to an absolute minimum, choosing wall fixings or direct structure fixings instead wherever possible, especially in Conservation Areas. Spacing should be as great as is practicable ensuring a minimum of wire sag; the UK practice is to design so that even if one mast is knocked down in a road accident, the wire will remain above a height of 5,2m for road user's safety

The most effective reduction is to place masts as centre bracket arms, located in the 'six foot' between lines. The result is usually a well-balanced system putting all overhead equipment in the track area and away from pavements and third-party ground. Because masts are evenly loaded, they may be of modest size.
The second approach is to utilise double-track bracket arms, where one mast supports both lines from one side; the mast must be of larger diameter as it is loaded unevenly, but the overall effect remains acceptable. If masts must be placed on both sides of the track there are advantages in combining the function with street lighting, or station canopy supports, and reducing the total of upright supports visible.
In addition to minimizing the number of masts, the detailed design should consider two approaches - to emphasise or camouflage. One option is to adopt the Victorian approach and embellishment the poles in scrollwork and spandrels, to emphasise their presence.
The modern approach is to camouflage, merging the masts into the background. Shape and colour are the key features. Taper masts may be made of concrete but the material is only really at home in an environment of all-concrete buildings where the colour and texture matches the surroundings. A steel mast with taper will need to be of thin section and large diameter for strength. The traditional waisted mast is formed by joining two or three progressively smaller sections together.
When a mast is viewed from ground level, the upper two thirds appear against the sky as background. To hide the mast, it should he painted pale blue or grey. The lower one-third appears against the scenery, and there is more freedom to integrate it with the background. In rural areas this lower part can be green; in urban areas painted to match other street furniture.

Contact Wiring

For a 750V system running up to 80km/hr with suitable pantographs, one contact wire only is required. Twin contact wires not only stand out against the sky, but they do not wear evenly with the premature replacement of both likely.
Wherever possible, wires should be supported from span wires fixed directly to a convenient wall or facade of a nearby building. To obtain permission from the building owner will involve a complex legal process to obtain the wayleave, and the process can take two years to agree for a building fixing. If wall fixings are to be used they must be agreed in principle by the Promoter or Concessionaire, in the very early stages of the project. The alternative is extra masts which obstruct pavements, look unsightly, and are more expensive.

Insulation systems

Contact wires must be separated electrically from the supports, and include double or triple insulation. Where the wires are supported by span wires, there are two possibilities for this. The span may be formed in a single insulated polymeric rope, or it may be formed in steel wire using separate discrete insulators. The former gives a smooth appearance to the eye, but is black and of larger diameter than the steel, which is lighter in colour but requires separate insulators.

Section switches

The overhead system must be separated along its length by section insulators and isolator switches for maintenance and emergencies. Switches may be mounted at the mast top, with linkage down to a handle at shoulder level, but the resulting assembly is ugly and handles are a collision danger. It is preferable to mount switches in a line side cubicle with cables running in ducts to the masts, and up inside the masts to the contact wire.
Section insulators are the most visual of all overhead components, and create more maintenance effort and wear and tear than any other component. There are great practical advantages to reducing mass and size, including visual benefits.

Tensioning and junctions

The contact wire must be tensioned to limit the sag. For street-running applications, this is done by using a fixed-termination system, so that the wire is tensioned when installed and the value of tension, and sag, vary with the temperature. This is acceptable for speeds up to 50km/hr, but above this figure the wire must be tensioned automatically which implies breaking it into sections individually tensioned and overlapped with the adjacent lengths. It is here that there are major visual disturbances to cope with.
To apply the tension, either stacks of weights may be used with a pulley mechanism, or a gas tensioner. The former visually intrusive, involves regular

maintenance, and leaves the system open to vandalism. The latter has the disadvantage of higher initial cost. At overlaps, there are two sets of contact wires and this inevitably creates a visual disturbance, especially at the point of passing current over the gap between wires a flexible loop is required which takes up space and may be awkward to camouflage. The best philosophy is to locate overlaps where the local geography hides them from general view.
At complex junction layouts, the overhead design should consider wall fixings and span wires to support the complex wire arrangement. Modern road junctions have the advantage of many traffic islands which give extra possible locations for masts; the neatness of junction layouts is the key task for the overhead design.

8.Tramstops

General Requirements

The Light Rail System shall be designed and constructed, to be RVA & DDA compliant for passengers boarding the trams; with the front face of each platform at a constant height of 350mm above top of the rail. During the design stage and the construction phase, Transport for London shall be consulted on all aspects of access and mobility.

Tramstops shall be constructed at between 0.5 and 0.75 km intervals.
The Feasibility Study proposes, a total of 26 No Tramstops:
11 No on the Kingston-Surbiton-Tolworth-Chessington route
15 No on the Kingston-New Malden-Worcester Park-Sutton route

Platforms

Each platform shall be of sufficient area to accommodate the projected passenger flow for each location and shall have no less than 2m clear circulation width. Platforms shall be 2m longer than the external maximum length, between extreme passenger door openings of the proposed maximum Tram length.
The platform shall be level with the Light Rail Vehicle floor and at a constant height above rail level. All crossfalls shall be away from the platform edge.
Platforms may form part of the footway, providing that adequate circulation space for boarding and lighting passengers is allowed.
Safety ramps shall be provided at each end of all platforms and shall conform to the HSE and D f T’s Requirements (produced by HMRI) and the Railways and Other Transport Systems [Approval of Works, Plant and Equipment] Regulations 1994.
Tactile paving shall be provided to meet DDA and RVA standards.
A designated pedestrian crossing points at each end of the platforms. The track crossing shall be in general compliance with the Context Study Drawings.
Each Stop shall be connected to the public highway by at least one footpath, which shall be in accordance with DDA & RVA.

The Design and layout of platforms and Stop equipment shall meet the requirements of HMRI.
The Design of the Stops should ensure that Stops are adequately marked and signposted and are consistent with the Light Rail Systems corporate image.

Furniture

The following is to be provided on both platforms at each Tramstop:

1. A minimum of one shelter, with seating and space for a wheel chair.
2. Cycle racks.
3. A minimum of two litter bins.
4. A notice board, adequate for the display of timetables and system information.
5. Dependant on the type of ticketing system that will be proposed for the Light Rail System; a passenger operated machine (POM) or TVM, will be installed on each platform.
6. Adequate standards of lighting which comply with BS 5489, will be provided for Tramstop platforms, footpaths between each stop and public highways and pedestrian crossings at stops.

CCTV

Each Tramstop shall have CCTV surveillance, capable of viewing the entire platform area.
Surveillance will be carried out from the System Control Centre. Recording CCTV equipment shall be provided.

Passenger Information Display (PIDS)

At each Stop, on both platforms a Passenger Assistance and Communication point (PAC), together with a digital display Passenger Information Display (PIDS), connected to the System Control Centre will be provided.

9. Depot

General Requirement

The depot should be designed to maintain in the region of 30 trams, with a stabling capacity of 25 trams. The stabling area is to be easily extendable by adding new tracks, to reach a stabling capacity of 35 trams for instance.

Maintenance Organisation

a) Preventative Maintenance

In the course of scheduled interventions, the components that make up the rolling stock are subject to checks and repairs, even before fouling, age, fatigue and wear have affected operation, or have reduced their performance in the service for which they were designed.

Two types of operation are usually carried out:

- Systematic preventive maintenance consists in carrying out a servicing routine, following a pre-established schedule, such as:

  . cleaning of on-board equipment
  . check and evaluation
  . inspection of correct operation to reveal hidden faults
  . adjustments enabling optimum operations
  . safety checks and practical application of instructions imposed by the law and bye-laws linked to safety.

- Conditional preventive maintenance consists in carrying out operations that are subject to pre-determined events, on equipment having measurable parameters that vary slowly:

  . a wear threshold (diameter of tyres, minimum height of pantograph contact , and others)
  . temperature threshold (check on motor operating temperature, cooling circuits, and others)
  . vibration levels.

b) Corrective Maintenance

This consists of repairing or changing faulty equipment. These repairs and changes only become necessary through observed failures:

- during rolling stock service,
- in the course of preventative maintenance inspections.

Corrective maintenance involves two kinds of intervention:

Breakdown in Service:

This will require a specific intervention, to be carried out mainly by the operator within the limits of both rolling stock and operating rules.

Immediate repairs are carried out rapidly with the view to clearing the line as quickly as possible. It concerns equipment that does not affect safety, and is limited to re-establishing sound operating conditions.

Repairs:

This is an intervention of lasting character, carried out by maintenance staff. This covers interventions carried out following incidents that occur in operation, the accidental repairs which generally involve a longer stoppage of equipment as well as important overhauls of an entire tram.

After repair, the rolling stock must conform to its original specifications.

c) Further Maintenance Operations

Preventive maintenance and corrective maintenance must be completed by:

- Operations that contribute to the good image of public transport (appearance and comfort) such as washing of vehicle exteriors, cleaning of passenger compartments, checks on wheel rotation and freshening up paintwork.

- Various necessary operations such as filling up the sand boxes or windscreen wiper liquids.

CHOICE OF A SITE FOR THE DEPOT

a) Necessary Surface Area

The necessary tenement for setting up a depot as proposed is estimated at around 50,000m², but it depends mainly on the following criteria:

- Geometric shape of the site under study
- Relative positions of rolling stock and on-site road vehicle access
- Urban Planning constraints, main utilities
- Minimum curve radius for rolling stock in the depot (25m).

b) Location Criteria for the Depot

The choice of an optimum location for the depot depends mainly on operating criteria such as:

- Proximity of depot to the line under operation
- Facility of connection to main tracks
- More or less similar journey times to supply the various termini
- Proximity of the busiest section allowing easy addition or withdrawal of trams.

c) The Site Proposed

It is proposed to locate the depot, south of the A3 between Tolworth & Chessington, on the old MoD site.

Facilities

STORAGE OF ROLLING STOCK

Storage is designed for 35 trams. The trams are parked within the depot boundaries on sidings designed to receive a maximum of 3 vehicles, so as to limit problems of morning exits in the event of a breakdown of the leading vehicle.
For reasons of economy, trams are stored in the open, but nevertheless protection in the form of roofing can be provided.
Surface area of garaging is flat, and is equipped with electric junction boxes as well as water points placed to enable the cleaning of tram interiors after the evening shift.

WORKS EQUIPMENT GARAGING

Works equipment is intended for maintenance operations of fixed installations such as tracks, overhead lines, and others.
Depending on the type of work required and the access available to the line for maintenance personnel, works equipment can be rail, road or mixed equipment.
This equipment will be stored in the fixed installation workshop.

SERVICE STATION

The service station is used mainly for vehicles at the end of the evening shift. It will be located before the tracks diverge to the storage sidings.
It allows reception of trams in single units mainly to carry out the following operations:

- sand box filling: this is done periodically using the sand transfer installation by low-speed fluidisation, without moving the vehicle.

- exterior washing: this is done by a three-brush mobile gantry installed at the service station exit.
- interior cleaning: this is done by the cleaning personnel that could be seconded by an automatic vacuum cleaner.

Further operations can be carried out in the service station, such as filling of windscreen washing tanks or various inspections.

WORKSHOP

Dimensions of the workshop and the number of workstations for rolling stock in the maintenance workshop are calculated mainly on the following assumptions:

Number of positions for scheduled inspections	=3.0
Number of breakdowns per day	= 9.6
Average repair time	3 hours
Number of workshop opening hours	12 hours
Number of positions for corrective maintenance	12.8 x 3/12 = 2.4
Total number of positions	5.5

It is proposed to fit out 5 positions on pits and 3 positions on slab track, allowing to carry out the following main functions:

a) Intervention on Track on Pits

Track on pits are designed to facilitate access, replacement and handling of all equipment anywhere on trams for period inspection. They also allow access for repairing damage.
The greatest use of inspection pits will be during start-up of the network and burn-in of rolling stock, during the manufacturer's after-sales servicing.
After this initial phase, the use of track pits tends to diminish over a period of time, but this decrease is generally compensated by network developments with the purchase of further equipment as well as the necessity for new service operations as the rolling stock gets older.

b) Intervention on Slab Tracks

– scheduled maintenance:

Slab tracks are mainly provided, during scheduled interventions, for maintenance of doors, inter-circulation modules, and for repairs and maintenance on bodywork.

– corrective maintenance:

Corrective maintenance on slab tracks concerns the repair of damages due to traffic accidents or to vandalism.

As this type of damage is very much dependent on the urban area and on the behaviour of passengers, it is difficult to determine workstation needs accurately.

Equipment

One of the slab track position will be equipped with an elevating platform device allowing lifting of tram bodies mainly to carry out the following interventions:

- changing bogies,
- work on suspension systems and brakes,
- interventions prior to plating and paint works,
- major inspection maintenance.

One of the other slab tracks in the workshop could also be equipped with a mobile jack.

a) **Sheet Plating, Paintwork, Polyester**

This function will be examined depending on the materials used and technology chosen for the design of rolling stock.

Initially, as a basic solution the following is required:

- A specialized slab track equipped with a chassis straightening bench for interventions of sheet plating and bodywork, as well as touching up paintwork directly on vehicles.

- A sheet plating workshop for all works on dismantled parts of bodywork, tramway sheet plating and sections.

- A workshop for polyester, equipped with a small open dry filtration paint booth.

b) Wheel Re-shaping

Vehicle wheel re-shaping is carried out on a specialized track, equipped with an in-pit tyre lathe without dismantling. It allows simultaneous repair of 2 wheels.

c) **Upkeep of Dismantled Equipment**

Maintenance on dismantled equipment is carried out in the following specialized workshops:

- bogie workshop,
- mechanical workshop,
- electromechanical workshop,
- electronics workshop,
- battery workshop,
- Upholstery workshop, etc.

10. Control Centre

General Requirement

The Central Control Room allows direct observation of tram movement at the entry of the depot and on the storage. The Central Control Room is located in the building where the drivers arrive for their shift in order to facilitate direct communication between staff.

The operation premises, a part of which can be on the upper floors, mainly comprise:

- The Centralised Control Room (CCR)
- Driver clocking-in premises, comprising operations office, staff room, and letterboxes, etc.
- Workshop management offices
- Document filing room
- Conference, meeting and training room(s)
- Cloakrooms and toilets
- First-aid premises
- Site entry checkpoint.

Duty premises including mainly:

- Storage and warehouse premises,
- Oil depot,
- Technical premises such as compressor and boiler-room, if any,
- Power supply premises,
- Substation serving depot and line,
- Transmission room,
- Premises for central technical management of the depot.

11. TRACTION POWER SUPPLY

System description

The traction voltage shall be 750Vdc, derived from local REC 11/6.6kVac networks via SCADA-controlled 12-pulse solid state transformer-rectifiers located in 13 traction substations at approximately 2.5 km spacing along the 20km route. The positive pole of the supply will feed the overhead line equipment (OLE) via feeder circuit breakers in the substations and off-load isolators housed with OLE earthing switches in trackside cubicles.

Most sections of OLE will normally be double-end fed from the substations at each end, and all will be protected by switchgear with direct acting overcurrent, relay over-current earth fault, and intertripping schemes. As a general rule, the ‘up’ and ‘down’ OLE will be permanently interconnected as a single circuit within a section. The power system is designed to be receptive to regeneration, whereby regenerated energy from braking trams is re-distributed for use by accelerating trams; there is no facility for regenerating into the REC system. The tolerance of traction voltage is therefore quite large, but will be within the IEC 850 limits of +20% -30% of nominal.

The traction power system will normally operate with all substations contributing. However, in the event of a single substation outage, the remaining substations will be able to support the full service during the outage period, whilst maintaining voltage within the above limits. The Depot stabling area and roads will be separately fed from a dedicated rectifier supply with the depot rails isolated from the main line as a stray current prevention measure. The workshop will have a small dedicated rectifier supply due to the need to safety earth the negative pole. The OLE will be divided into electrical sections running from substation to substation feeder points. At these locations the OLE will be fed via manually operated ‘off-load’ feeder isolators; these are to be provided with earth positions and locking, for use with the Permit-to-Work system.
The OLE sections will be further divided strategically into sub-sections, where demanded by operational reliability considerations. The sectioning points will be bridged by manually-operated or motorised ‘off-load’ section isolators; these are to be provided with earth positions and locking, for use with the Permit-to-Work

system. Section isolators provided on the OLE for the Depot Workshop Roads will additionally be equipped with interlock keys, removable only in the earth position, for use in connection with the Energisation Warning and Depot Permit schemes.

The OLE itself will comprise a mixture of designs to suit different types of location and service speeds. Street-running OLE will consist of simple twin 107sq mm contact wires suspended from cross-spans, with an accent on the use of building fixings wherever practicable. On segregated sections, some catenary-suspended equipment may be used, again with a copper cross-section equivalent to two 107sq mm wires. Fixed and auto-tensioned OLE will be applied as appropriate to the location, and the wire height above track will be within the range 3.8 to 6.1m. OLE supports will not in general be bonded to the track, but will be double-insulated (or continuously-insulated) from the conductors.

Electrical Operation

The traction power system will be continuously monitored from the Control Room over the SCADA system. All substations and OLE sections will normally be energised, unless required to be made safe for work on or near the equipment. An estimated 12 No Substations will be required for the proposed Light Rail system at 2km intervals:
2 No in central Kingston
1 No at the Depot
4 No on the Kingston-Surbiton-Tolworth route
5 No on the Kingston- New Malden-Worcester Park-Sutton route.

Traction substations shall be sited at locations subject to approval by TfL and the appropriate local authorities.
The design of the Traction Substations shall minimise the overall size of the substation in order to make the building as unobtrusive as possible. Substation buildings will be designed to be in keeping with the environmental character in their vicinity.

Earthing and Bonding

The earthing and bonding for the Light rail system shall comply with Regulations and Standards applicable to the various types of equipment and voltage levels in use. At the time of writing, the principles of earthing and bonding are embodied in Codes of Practice and Technical Specifications for the various E&M Work Packages which form part of the construction project works. As these sub-Contracts are let, and knowledge is gained of the detail of the equipment to be supplied and installed, an Earthing and Bonding Policy document will be developed, for use by all the sub-Contractors.
The earthing and bonding of Traction Substation equipment and Electrical Distribution equipment will follow standard REC Supply Industry standards,

Electricity at Work Regulations and IEE Regulations. At each Traction Substation, all equipment enclosure metalwork will be earthed to a substation earth bar which will be connected to a dedicated 'Kingston Tram' earth rod system. Although this will be capable of operating independently from the REC HV earthing system, the two systems will normally be connected together.

The traction return utilises the running rails, which will therefore be connected to the substation negative busbars. There therefore arises the usual conflict found on dc running-rail return traction systems, owing to the dual function of the track in acting as both a return conductor and a protective 'earth': for the former function an insulated track is preferable in order to prevent stray current flow in the earth, while for the latter function an earthed track is preferable in order to limit touch and step voltages

<u>Stray Current/Electomagnetic compatibility</u>

Wherever possible, both rails are to be used for return purposes, in order to limit track voltage rises and hence to control stray earth return currents. For the same reasons, along-track bonding will be designed, installed and maintained to a high standard. Rail-to-rail cross-bonding will be installed at 200m intervals, with additional track-to-track cross-bonding at 400m intervals. The traction return system will be electrically sectioned, nominally at 1200m intervals, by means of insulated rail joints normally bridged by bonding cables. The purpose of this is to provide a means of locating track-earth faults. A similar facility will be provided at phased construction boundaries.
The traction return system will not be deliberately earthed at any point, again as part of the stray current mitigation principle. The only exception to this is the Depot Workshop tracks, which will be earthed to the building services earth, isolated from the main line negative return, and fed from a separate dedicated rectifier.

Compliance; (Task; Designer / Supplier / Contractor / Installer)

- EEC Directive (89/336/EEC) – 03/04/89
- EEC Directive (92/31/EEC) – 28/04/92
- EEC Directive (9/5/EEC) – 08/04/00
- UK Statute (92/2372) – 28/10/92. Fully Compliant by – 01/01/96
- LV Directive (73/23/EEC)
- Machinery Directive (98/37/EEC)
- Radio and Telecommunications Terminal Equipment (99/5/EEC)
- DTI Guidelines on Directives and UK Regulations
- Network Rail (Railtrack) Code of Practice GM/RC/1500
- LUL Standard 2-01018-001-A1 PSC M1-00721 (E1027-A3)
- LUL Manual of Good Practice M1027-A2
- EN 50121-1: 2000 Railway Applications – EMC
    - Part 1: General

- Part 2: Emissions of the whole railway systems to the outside world.
- Part 3: Rolling Stock
- Part 4: Emissions and immunity of the Signalling and Telecommunications apparatus.
- Part 5: Emissions and immunity of fixed power supply installations and apparatus.

Compliance Management (Task; Designer / Competent body)

- Competent body shall produce an EMC Management Control Plan
- Competent body shall produce a Qualitative EMC Project Wide Risk Assessment and Threat Matrix.
- Competent body shall produce a Quantitative EMC Risk Assessment with Mitigation Measures for each perceived threat.
- Competent body / Designer shall implement an EMC Review Change Control process.
- Competent body / Designer shall produce an “EMC Evidence of Compliance” File / Document to demonstrate the “Design” is compliant and compatible.

In order to mitigate the potential effects of Stray Earth current leakage, a Code of Practice will be drawn up by the Promoters of the scheme, and, after a series of meetings, the Statutory Undertakers will enter legal agreements with the Promoters on the adoption of the Code.

The Code shall not be limited to the following:

1. Use of 20mV potential swing as an indicator of plant at risk
2. Use of insulated rail joints for track insulation testing in sections
3. Inclusion of double-insulated OLE and unbonded poles, with testing
4. Special provisions for OLE poles with street lighting
5. Principle of floating negative returns, replacing diode earthing
6. Use of self-restoring spark gaps
7. Agreement on practical level of track insulation
8. Use of electrically-separate earthed workshop tracks
9. Revised form of concrete track slab and stray current collection, including:
10. principle of 100m slab sections with end connections to stray current collector cable
11. Electrical test methods for track and slab stray current collection system

12. Signalling & Communication Systems

Assumptions

Trams will operate entirely on line of sight principles.

The use of beacon based tram detection and bus priority signalling for trams will be acceptable to HMRI.

Trams will have maximum priority at junctions.

Trams will not be required to slow down at signals unless necessitated by line of sight limitations.

Signals will be designed to change to 'proceed' within sight of the tram driver and before the tram reaches the braking point.

Approval will be obtained from HMRI to allow more than 1 tram to pass a signal on a single proceed.

Tram controllers will be able to monitor TfL signals and input tram demands remotely in the event of a detection failure.

The design shall be undertaken in consultation with TfL Traffic Technology Services.

Design Principles

Tramway signals.

There will be no general requirement to signal tram movements other than at highway junctions or at points where tram movements may conflict.

Any tramway only signalling will be locally controlled and capable of operation independently of the central control and communication system.

Trams will operate on the line of sight principle. Speeds on the tram-way will be limited to ensure that trams can stop before reaching any obstruction on the line. There will be no block signalling or continuous detection of trams.

Tram signals will be independent of points. There will generally be no interlocking of points and signals.

All tram signals will be of the standard cluster and bar type. Illuminated point position indicators will be provided at all facing points.

Highway Signalling

On highway, tramway signals will form part of the highway signalling system.

The layout of junctions must take account of the need to site tramway signals in the highway and should maximise sightlines to tram signals.

The highway signalling system will, unless otherwise agreed with London Trams, be designed to give the maximum practicable priority to trams.

The highway layout must be designed to maximise the potential of the signalling system to offer levels of priority to buses parallel to and crossing the tramway.

Wherever reasonably practicable, advanced start facilities for cycles should be provided at signalled junctions.

Unless otherwise agreed with Surface Transport, 'All Red' pedestrian phases should be provided at signalled junctions subject to an assessment of pedestrian demand and pedestrian safety requirements.

Risk assessments will be required to demonstrate the safety of beacon based selective vehicle detection and differential priority signalling for trams.

Off highway tram signalling must be subjected to design risk assessment appropriate to the level of design development (indicative layout and functional performance specification at pre concessionaire tender stage).

Highway signalling proposals must be developed to a degree sufficient for use on TRANSYT and VISSIM modelling development and for the purposes of stage 1 and 2 Road Safety Audits.

Tram stages will be capable of extension to permit trams to pass at junctions within the same stage.

TRAMWAY SIGNALLING AND ROAD JUNCTIONS

Tramway Signalling Principles

The AVLS will automatically detect the position of the trams at all terminals depot exits and at key locations along the route. This will be done by means of detection loops in the four foot linked to lineside controllers. At terminals and junctions route selection will be performed by the driver or by the AVLS, and the signalling system will inform drivers of the route authorised.
The functions of the signalling & AVLS system will provide route setting, advance detection at road junctions with traffic signals, remote monitoring of routes, indication of routes and authorisation of movements by route signalling.
Safety sequences will be controlled by line safety equipment using tram presence detection from the AVLS, monitoring and control of switches, monitoring and control of lights and route release. All this information will be centralised in the Control Room for route supervision.
The route selection will be made either by the tram drivers from their control desk or by the on-board AVLS computer (i.e. signals from the tram are picked up by detection loops in the track).

Traffic Light Principles

The junctions will comply with the design principles of TfL/TTS. Where necessary, the junctions will be linked to the UTC system.
At cross-road intersections, trams will conform to normal road traffic regulations. Trams will be considered as road vehicles, and their movements will be managed by the local junction controller together with the general traffic flows and pedestrian movements. The tram driver will have a separate signal head using a matrix of white lights to avoid any confusion between trams and general traffic. With the use of advanced detection and communications through the UTC, the junction controller will have advanced warning of approaching trams, and can interrupt the cycle to ensure that the tram finds a compatible phase on arrival at a junction. As soon as the tram has cleared the junction the controller receives this information and reverts to dealing with the normal pattern of movement.

13. Rolling Stock

VEHICLE DESIGN Objectives and Principles

General & System Requirements

The objective of K-SMART is to provide the capacity to meet projected demand for public transport on the corridor. In doing so the tramway must provide a service frequency and journey time at both peak and off peak times to attract rider-ship without excessive operating cost.
The system should enhance the transport provision on the corridor, through the provision of a faster, more reliable and robust service, and integration with other forms of public transport along the route.
The definition of the vehicle at this stage is required to underpin the Level 3 design process. Selection of the actual vehicle to be used is a later part of the competitive procurement process for implementation. Given that this is some time in the future, the range of available vehicles is likely to have developed from what is running at present and on which the design assumptions will be based. In any case, we believe it is wise to not design the fundamentals of the infrastructure for any one specific design of tram, since this could present longer-term disadvantages. Equally, no parameters should be adopted that would preclude the use of specific current designs, unless unavoidable .It is a fundamental requirement that the vehicle design is compliant with HMRI requirements, as set out in the RSPG Part 2, Section G Guidance on Tramways, and with the DDA, specifically in relation to the RVAR.

Fixed Requirements

Track gauge is to be nominally 1435mm. The trams are to be bi-directional with doors on both sides and cabs at both ends. This is because trams will not be

turned at the end or intermediate termini and there are both side platforms and island platforms along the route.
Multiple unit operation is not envisaged. Shrouded mechanical couplings and sufficient control and communications functionality by through wiring are to be provided for one tram to assist another in a recovery situation.
Traction power supply is to be 750V dc by OLE.
The initial assumption is that a tram with 100% low floor, nominally in the range 300-350mm, and level platform entry at all doors is to be provided. Further comment on this issue is made in the configuration section; where further clarification on level entry, low floors and low gangways is also made.
It is assumed, that the tram selected will be a manufacturer's standard type, for economic reasons, and that any requirements that would preclude the use of current standard designs must be avoided. A standard design will be cheaper in first cost, and likely to be more reliable and easier to maintain due to the incorporation of operational experience through longer production runs.
It is assumed that the trams will not have to operate in either direction on a gradient in excess of 6.5%, the maximum natural gradient on the route being 4.8%. In the event of any infrastructure element (e.g. flyover or underpass) requiring a steeper gradient, the configuration and performance characteristics would have to be re-examined.
It is expected that the trams should be able to operate at a maximum OLE height of around 7.0m to allow for High Load routes. This may not be the case at present and is to be confirmed. The adoption of such a high height in principle only requires confirmation that a pantograph with the required reach is available and can be fitted to the standard tram design.

Parameters

In the succeeding sections of this specification, the individual parameters set out in summary here are reviewed and our recommendations set out.
The dimensional parameters required at this stage include the length and width, the minimum OLE contact wire height at which operation can be permitted, and the vehicle weight.
Alignment parameters include curvature and the Developed Kinematic Envelope (DKE).
.
An important assumption in relation to the vehicle DKE, is that the vehicles will have CCTV for the driver rear view, rather than external mirrors. CCTV for this application is now becoming increasingly common, being used in Nottingham, for instance, as well as on the Montpellier Citadis car used as a basis for the DKE in the above report. Adoption of CCTV rear viewing will prevent a risk of the DKE having to be increased in width due to the mirror design. Specification of CCTV cameras may impact on other aspects of the tramway design – e.g. street and stop lighting levels.
Air conditioning is to be provided in the driving cabs to provide an acceptable working environment for the drivers, given the large areas of glass around a

small area. Air conditioning of the passenger compartment is also to be provided. Minimum provision of internal and external destination indicators is to some extent defined by the RVAR.

Design Brief

This document sets out a number of requirements.

Maximum tram width of 2.65m is agreed.
Maximum length of trams in public service of 35m
Minimum horizontal curve radius of 25m is agreed.

Standardisation

There has been a recent trend to longer single cars such as are proposed in principle for the West London Tram project. However the choice of length may be limited to a set of standard configurations if a fully standard vehicle is to be obtained from a manufacturer. This is unlikely to allow a free choice of length, and different manufacturers' offers for the same requirement may therefore have different lengths, within a few metres.

The standard configurations available may limit the options for the number of powered bogies installed in the vehicle.
The internal layout of some standard designs allow greater flexibility in seating layout and the least flexible require most seats to be placed on podia meaning a step up into the seat, even if the gangway itself is level throughout. It may be considered that these are less low floor cars than low gangway cars. Some designs offer a wider free space through the articulations than others,

i.e. layouts for Citadis, Combino, the most relevant Flexity from Bombardier; also Nottingham Incentro, Croydon CR4000, South Yorkshire Duewag car and Midland Metro Ansaldo car for comparison.

Any standard design should be able to accommodate the RVAR requirements, although compromises on the layout in areas of flat floor may result.
All 100% low floor cars are based on the use of multiple modules, each of which is quite short and joined by an articulation assembly. Typically, "bogies" are located centrally to some of the modules, although they do not rotate relative to the body in the traditional way, having only very limited allowable rotation through the secondary suspension. This generic configuration has the advantage of minimising the DKE for a given width of vehicle, but there is evidence that very careful attention to track and pointwork geometry and quality is required to obtain

reasonable lateral ride characteristics, and avoid unnecessarily slow running at junctions etc.
Although 100% low floor cars, are assumed at this stage, consideration needs to be given to the acceptability of car designs with around 70% low floor and single steps to higher areas over motor bogies. Capital costs are likely to be lower, maintenance issues better understood, ride quality improved and the use of conventional bogies with axles may provide better tractive performance. These cars generally have some longer body sections, and fewer articulations, although one downside of this type of configuration is a larger DKE.
One design concept that has the effect of lowering the cost of 100% low floor cars has been to minimise the numbers of bogies for a given length. This has the effect of raising axle loads. Long-term effects on wear and noise are not clear as yet.
Another initial cost saving on most standard cars is not to fit air secondary suspension, which results in greater variation between floor height and platforms in day to day operation and, usually, some difficulty in achieving the relative height tolerance requirements of the RVAR under all conditions.

14. Operations

Tramway Operation

The trams are to be operated on line of sight with driver only operation. The tram driver will work to the line speed limits and judge a safe speed and distance between the tram and other road users and trams taking note of railhead conditions and other vehicle movements. The operation of the trams will at all times comply with the safety and operating procedures for the system.
The tram will be automatically routed according to the service pattern that it is running.

The tram will dwell at each stop and release and close the opened doors.
The operation of the tramway is to be based on a tram designed with all the doors accessible from a 40-metre platform. Passenger operation will be by the use of a single tram with no coupled tram passenger service operation. The systems will operate for approximately 20 hours per weekday being integrated with the first and last connecting services where practical. This will allow an infrastructure maintenance window of 4 hours.

The tramway will be operated with a timetabled early morning and late evening service, while the service when cars are being brought into and or removed from service.
Through the majority of the day the service should be run on primarily a headway basis using the facility provided by the AVLS system to instruct the driver of the

headway to the preceding vehicle. With the provision of passenger countdown indicators at each stop it is proposed to operate:
Peak – 5 to 8 minutes [including Saturday & Sunday]
Off-peak 8 to 12 minutes

The AVLS System will also transmit all the tram position data to the control room to allow the control room staff to regulate the service provided.

The use of video surveillance at stops should also be extended to the road junctions on the route to enable the control room to monitor the service and react to any problems at these locations. The stops should also be fitted with customer service help points.
The ticketing will be based on-stop with TVM's using cash and Oyster smart cards.

David Cockle
Leewood Projects Limited
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